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Emerging Challenges in Weed Management

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Extended Summary

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Extended Summary

Editors

Dr. Sushilkumar
Dr. R.P. Dubey
Dr. ParthaPratim Choudhury
Dr. MeenalRathore
Dr. C. Sarathambal

Organizers
Indian Society of Weed Science &
Directorate of Weed Science Research, Jabalpur

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Content

Lead presentations

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Conservation agriculture and weed management in South Asia -perspective and development

R.K. Malik*, Virender Kumar, Ashok Yadav and Anderew Mcdonald
International Maize and Wheat Improvement Center (CIMMYT), NASC Complex, DPS Marg, Pusa, New Delhi 110 012
**Email: rk.malik@cgiar.org*

Farmers in India adopt conservation tillage (CA) because, in the short-term, the technology can reduce operating costs, increase profitability and make better use of resources especially labor, water, and land. In the long run, farmers adopt these technologies because of benefits associated with sustainable intensification of cropping systems. In the present era, the climate change and sustainability of cropping systems have emerged as an area of importance. These are sound reasons for introduction of CA in South Asia. It was 20 years ago which marked the beginning CA with introduction of zero-tillage (ZT) in wheat to (1) reduce cultivation cost so that farmers can afford to purchase new but expensive alternate herbicides for the control of herbicide-resistant population of *Phalaris minor*, the most troublesome weed of wheat and (2) reduce land preparation period for timely wheat planting (Malik *et al.* 2002).

Weed problems in RWCS

High input based crop culture in the Northwest IGP has enabled weeds such as *P. minor* in wheat and *Echinochloa crus-galli* (L.) Beauv. in rice to dominate the weed flora. In the Eastern IGP, where input use is less and productivity levels are low, weed flora is dominated by both annual grasses and broadleaved weeds and some perennial grasses and sedges. However, the increasing use of more inputs has meant a shift in flora in favor of *P. minor* and *E. crus-galli* in the eastern IGP also. The high input based crop management is mainly responsible for fostering the dominance of a simplified weed flora. Simple weed flora leads to the adoption of herbicides. After long periods of continuous use of a single herbicide, *isoproturon,* accompanied by poor spray techniques resulted in evolution of resistance in *P. minor* against isoproturon in 1990s. Resistance was so severe that it led to large reductions in wheat productivity in NW-IGP in 1993-94.

Cropping system optimization

In the present study (3 years for rice and 4 years for wheat), on-farm participatory research in Bihar and Eastern UP has identified several critical entry points for improving cereal systems productivity. Major gains in the cropping system productivity are possible with DSR, MTNPR and early wheat sowing under ZT. The study area included five districts of Eastern UP and 4 districts of Bihar. For example, in 2012 the average paddy yields of 202 DSR, 95 MTNPR and 14 PTR trials in Eastern UP was 5.6, 6.0 and 5.3 t/ha, respectively for DSR, MTNPR and PTR with attendant gains in net returns and timeliness of harvest for both DSR and MTNPR. During the last 4 years, grain yield of wheat declined by approximately 50% with delays in wheat sowing from November to December due to the influence of terminal heat stress. Sowing in the first 20 days of November resulted in grain yield of wheat in the range of 5.4-5-6 t/ha under zero tillage (ZT) compared to a range of 4.2 -4.7 /ha under conventional tillage (CT).

Herbicide use

Based on on-farm and on-station trials, bispyribac-sodium 25 g/ha sprayed at 15-25 days after sowing (DAS; 2-4 leaf stage) was extremely effective against *Echnochloa* species and some broadleaf weed (BLW) and sedges in DSR and transplanted rice. Tank-mix of azimsulfuron 20 g/ha or pyrazosulfuron 25 g/ha with bispyribac 25 g/ha has also provided excellent control of complex weed flora including BLW and sedges including purple nutsedge. Azimsulfuron alone also provided effective control of most BLW and sedges. Halosulfuron alone at 60 g/ha was found excellent on sedges including *C. rotundus*. Many researchers have reported that pendimethalin (pre-emergence) followed by post-emergence application of bispyribac or azimsulfuron or bispyribac + azimsulfuron 15-20 DAS yielded similar to weed-free conditions In the EIGP, most herbicides available in the market are used in transplanted rice. This has put DSR farmers under pressure to use alternate methods like hand weeding which is becoming costly and scarce. Bispyribac + pyrazosulfuron or halosulfuron or azimsulfuron ares potential mixture which can control complex weed flora dominated by sedges including C. rotundus in these ecologies.

Herbicide resistance management

The problem of resistance was so serious that farmers in Haryana started sowing sunflower to exhaust the seed bank of *P. minor*. Crop rotation was possible only in small area and farmers needed a viable technology for herbicide resistance management. Zero-tillage made it possible to achieve three major objectives leading to create competition in favour of crop. These are optimum plant population, seeding at a time which is not conducive to *P. minor* emergence and accurate fertilizer placement. Zero-tillage in wheat reduces the emergence rate of *P. minor* compared to CT (Franke *et al.* 2007). In a study conducted by Franke *et al.* (2007) at farmer's field in Haryana, correlating the number of germinable *P. minor* seeds in soil with the number of *P. minor* seedling emerged; it was found that ZT reduced the emergence rate of first flush of *P. minor* by 50%. Rate of emergence of second and third flush was also lower in ZT plots compared to CT plots. The first flush of *P. minor* is more damaging to the crops compared to later flushes and ZT is found relatively more effective in reducing first flush than other flushes.

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Living with weeds -a new paradigm?

Nimal Chandrasena*
Principal Ecologist, GHD Water Science Group, GHD Pty Ltd. Level 6, 20, Smith Street, Parramatta, NSW 2150, Australia
**Email: nimal.chandrasena@ghd.com*

Some people, particularly in developed countries, have strong negative attitudes towards weeds, and a tendency to label potentially useful plant resources as invasive 'aliens', which are to be controlled at any cost. This undesirable attitude ignores the considerable evidence of the use of weed species by many societies, over a long period of human history. The recent application of 'species-focused' weed risk assessments have contributed to the maligning of many plant taxa as 'invaders' in the public's mind,undermining their worth as biological resources. Some of the methods used in the blitz against weeds, including the excessive use of herbicides, have resulted in undesirable consequences, such as herbicide resistance and negative impacts on biodiversity in farming landscapes. Weed Scientistsmay know that *weeds are only plants with colonising abilities*, whichhave the capacity to rapidly occupy naturally disturbed; or human-modified environments. However, the lay public does not understand this. When closely examined, the evidence is clear: *not all weedy taxa are bad all the time, just because they may interfere, under certain circumstances, with human interests*!

Many colonising taxa are worthy resources in diverse areas of human interest, and this includes aesthetic pleasure, as they are part of 'wild nature'. Some weeds provide culinary delightsfor humans, and are important as food sources for both vertebrate and invertebrate animals. Global research on pharmacological values of weedy taxa is quite intense. Recent times have seen an impressive growth in the list of weeds with medicinal values, used either as traditional 'herbal' remedies, or extracted for secondary metabolites. As many of our primary crops have 'weedy-relatives', the genes present in weeds appear crucial for future evolution of crops, particularly for characteristics, which may confer [1]'hardiness' (ability to tolerate variable environmental conditions). There is increasing recognition of the positive roles weeds play in maintaining the biological diversity of farming landscapes, providing food and shelter for a variety of animals. As fast-growing, colonizers,weed cover prevents bare soil from erosion by wind and water, and also assist by conserving water and nutrients, improving soils of poor quality. Insects, which pollinate crops, extensively use weeds as a source of nectar when crops are not in flower. In Europe, there is increasing recognition of the benefits of agro-ecological approaches to farming, including crop rotations, and balancing biodiversity and crop production. Farmers are encouraged to limit weed management measures to allow populations of beneficial organisms, such as natural predators of aphids (i.e. ground beetles, spiders) to develop, thereby reducing the reliance on aphicides. Weeds also attract crop pests; and there is evidence that pest populations in some crops are much lower in 'weedy fields' than in 'weed-free' crops. The core issue for sustainable agriculture is the balance between adequate weed control, including the prevention of weed-seed build up, and to 'live with some weeds' to support biodiversity and other known benefits.

The colonising strengths of several species are being used in the remediation of water and terrestrial environments that have been damaged by human activities. Globally, there is considerable interest in using the large biomass produced by these species as raw materials for countlesshouse-hold products, including bricks, paper and furniture; and as future bio-fuels. In addition, there are many opportunities for using colonising plants in phytoremediation, to scavenge soil pollutants, or in creating more sustainable farming systems. There are also significant prospects to further exploit chemical warfare between plants (allelopathy) to search for new bioactive chemicals, and for the use of allelopathic plant residues within low input agricultural systems. Exploiting various uses of weeds as bio-resources meets many of the criteria of the current 'Green Movement', in terms of being environmentally friendly materials, which can be utilized for human welfare, as opposed to being discarded as useless.

Therefore, within the field of Weed Science, a fresh look at weeds is essential. Perhaps a new and bold paradigm should be 'co-existing' or 'living with weeds',recognising their intrinsic worth as part of biodiversity, and the many possibleuses as bio-resources. Studies must re-focus on improved understanding of weeds,not just for the sake of controlling them, but for their ecological role, as well as social and economic benefits. The next generation of Weed Scientists must improve on our understanding of environmental, ecological or social factors that create unwarranted disturbances, in which colonising species dominate our landscapes.This would lead to more effective weed management through mitigation of such factors. It would also reduce the current confusion and negative attitudes towards weeds.

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Research needs for improving weed management in rice

B.S. Chauhan[1], Vivek Kumar[2], and G. Mahajan[2]
[1]*International Rice Research Institute, Los Baños, Philippines*
[2]*Punjab Agricultural University, Ludhiana, Punjab, India*

Weeds are the most important biological constraints to increasing rice productivity in Asia. They are managed by using herbicides; however, reliance on herbicides alone is not sustainable in the long run. There is thus a need to develop sustainable weed management strategies in different rice-based cropping systems. The development and adoption of improved weed management strategies must form an integral part of sustainable rice production. Improved weed management techniques in rice should focus on shifting the crop-weed balance in favour of rice by integrating possible cultural, physical, and biological weed management tools with judicious use of herbicides. Together, these approaches may be used as components of an integrated package in the future to slow down the evolution of new weed problems in rice production. The improved weed management approaches should aim to reduce the weed seed bank before crop sowing and reduce weed emergence and weed growth in rice. Rice (*Oryza sativa* L.), the staple food of more than 60% population of the world, plays a crucial role in the economic and social stability of the world. The resources for rice production land, water, nutrients, and labour% are becoming scarce. Therefore, meeting the rice demand of the burgeoning population is a great challenge in the future. In rice production, weeds are one of the major yield-limiting biological constraints worldwide. The dimension of the problem can be ascertained with the following examples. In India, about 33% of rice yield losses are caused by weeds (Mukherjee 2004), while in Sri Lanka, weeds accounted for 30-40% of yield losses (Abeysekera 2001). In world rice production, about 10% of the total yield is reduced by weeds. Globally, pests have a potential to reduce rice yield by 40%, of which weeds account for 32%. Annually, 10 million tonnes of rice produce are lost in China due to weed competition. This quantity of rice is sufficient to feed at least 56 million people for a year. Weeds are the universal pests in rice, causing losses that exceed tolerable levels in all seasons. Therefore, it is imperative that investment in weed management practices be made to reduce yield losses caused by weed competition. Total loss caused by weeds are tied up with cultural practices pertaining to weed control, land preparation, weed control expenses, and reduction in yield quantity and quality. Rice is cultivated in various ecosystems from irrigated to shallow lowland, mid-deep lands, deep water to uplands. In most of the Asian countries, including India, rice is cultivated mainly by manual transplanting of seedlings in puddled conditions. Weed control in puddled transplanted rice is done by a combination of pre-emergence herbicides, hand weeding, and water management.

The increase in production cost, shortage of labour, increased wages, and decreased water availability resulted in a shift from transplanting to direct seeding in many Asian countries. In India, dry-seeded rice is extensively practiced in the northwest Indo-Gangetic Plains because dry-seeded rice in this region provides the highest opportunity to attain optimal plant density and high water and labour productivity. However, weeds are a serious problem in dry-seeded rice because dry tillage practices and aerobic soil conditions are favourable for germination and growth of weeds, which can cause grain yield losses from 50 to 90% (Chauhan and Johnson 2011). With the adoption and development of dry-seeded rice, good crop growth can be obtained, but the lack of sustained flooding can cause great losses from weeds. Since weeds are a major constraint to dry-seeded rice cultivation, the success of dry-seeded rice warrants the intensive use of herbicides. Herbicides have been proven effective in many cases, but intensive herbicide use can cause environmental contamination and induce herbicide resistance in weeds.

Rice and rice weeds have similar requirements for growth and development. They compete for limited resources such as nutrient, moisture, light, space, etc. Most of the weeds, being C_4 plants, have higher adaptability and faster growth than rice, a C_3 crop. Weeds dominate the crop habitat and rice yield potential is reduced. Proper weed control in rice, especially dry-seeded rice, is achieved by using both pre- and post-emergence herbicides. But the use of herbicides brings about environmental problems because farmers lack knowledge about the proper use of herbicides. Currently, herbicides with ALS inhibitors are used in dry-seeded rice, which have high selection pressure and may exacerbate the problem of herbicide-resistant species. This problem can be solved only by implementing integrated weed management (IWM) in rice, which can go a long way to sustain rice production.

CONCLUSION

Therefore, it is imperative that investment in weed management practices be made to reduce yield losses caused by weed competition. Total loss caused by weeds are tied up with cultural practices pertaining to weed control, land preparation, weed control expenses, and reduction in yield quantity and quality. Rice is cultivated in various ecosystems from irrigated to shallow lowland, mid-deep lands, deep water to uplands. In most of the Asian countries, including India, rice is cultivated mainly by manual transplanting of seedlings in puddled conditions. Weed control in puddled transplanted rice is done by a combination of pre-emergence herbicides, hand weeding, and water management.

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Integrated weed management in conservation agriculture systems

A.R. Sharma* and V.P. Singh
Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004
**Email: sharma.ar@rediffmail.com*

Key words: Conservation agriculture, Crop residues, No-till farming, Non-selective herbicides, Rice-wheat system, Weed management

Transformation of 'traditional animal-based subsistence farming' to 'intensive chemical and tractor - based conventional agriculture' has led to multiplicity of issues associated with sustainability of these production practices. Conventional crop production technologies have inculcated: (i) intensive tillage to prepare fine seed- and root-bed for sowing to ensure proper germination and initial vigour, improve moisture conservation, control weeds and other pests, mixing of fertilizers and organic manures, (ii) monocropping systems, (iii) clean cultivation involving removal or burning of all residues after harvesting leading to continuous mining of nutrient and moisture from the soil profile; and bare soil with no cover, (iv) indiscriminate use of pesticides, and excessive and imbalanced use of chemical fertilizers leading declining input-use efficiency, factor productivity and environmental, ground water, streams, rivers and oceans pollution, and (v) energy intensive farming systems.

Conservation agriculture - a new paradigm

Conservation agriculture practices are designed to achieve agricultural sustainability by implementation of sustainable management practices that minimize environmental degradation and conserve resources while maintaining high-yielding profitable systems, and also improve the biological functions of the agro-ecosystem with limited mechanical practices and judicious use of external inputs. It is characterized by three linked principles, *viz.* (i) continuous minimum mechanical soil disturbance, (ii) permanent organic soil cover, and (iii) diversification of crop species grown in sequences and/or associations. A host of benefits can be achieved through employing components of conservation agriculture or conservation tillage, including reduced soil erosion and water runoff, increased productivity through improved soil quality, increased water availability, increased biotic diversity, and reduced labour demands. Conservation agriculture systems require a total paradigm shift from conventional agriculture with regard to management of crops, soil, water, nutrients, weeds, and farm machinery (Table 1).

Weed problems in CA

Weeds are the major constraints in CA-based systems. Shifts in weed populations from annuals to perennials have been observed in CA systems. Perennial weeds are known to thrive in reduced or no-tillage systems. Most perennial weeds have the ability to reproduce from several structural organs other than seeds. For example, Bermuda grass (*Cynodon dactylon*), nutsedge (*Cyperus rotundus*) and Johnson grass (*Sorghum halepense*) generally reproduce from underground plant storage structures: stolons, tubers or nuts and rhizomes, respectively. Conservation tillage may encourage these perennial reproductive structures by not burying them to depths that are unfavorable to emergence or by failing to uproot and kill them. Weed species shifts and losses in crop yield as a result of increased weed density have been cited as major hurdles to the widespread adoption of CA. Crop yield losses in CA due to weeds may vary depending on weed dynamics and weed intensity. However, the recent development of post-emergence broad-spectrum herbicides provides an opportunity to control weeds in CA.

Integrated weed management

Considering the diversity of weed problems, no single method of weed control, *viz.* cultural, mechanical or chemical, could provide the desired level of weed control efficiency under CA. Therefore, a combination of different weed management strategies should be evaluated for widening the weed control spectrum and efûcacy for sustainable crop production. Integrated weed management system is basi-

Table 1. Some distinguishing features of conventional and conservation agriculture systems

Conventional agriculture	Conservation agriculture
• Cultivating land, using science and technology to dominate nature	• Least interference with natural processes
• Excessive mechanical tillage and soil erosion	• No-till or drastically reduced tillage (biological tillage)
• High wind and soil erosion	• Low wind and soil erosion
• Residue burning or removal (bare soil surface)	• Surface retention of residues (permanently covered soil surface)
• Water infiltration is low	• Infiltration rate of water is high
• Use of *ex-situ* FYM/composts	• Use of *in-situ* organics/composts
• Green manuring (incorporated)	• Brown manuring/cover crops (surface retention)
• Kills established weeds but also stimulates more weed seeds to germinate	• Weeds are a problem in the early stages of adoption but decrease with time
• Free-wheeling of farm machinery, increased soil compaction	• Controlled traffic, compaction in tramline, no compaction in cropped area
• Mono-cropping/culture, less efficient rotations	• Diversified and more efficient rotations
• Heavy reliance on manual labour, uncertainty of operations	• Mechanized operations, ensure timeliness of operations
• Poor adaptation to stresses, yield losses more under stress conditions	• More resilience to stresses, yield losses are less under stress conditions
• Productivity gains in long-run are in declining order	• Productivity gains in long-run are in incremental order

cally an integration of effective, dependable and workable weed management practices that can be used economically by the producers as a part of sound farm management system. This approach takes into account the need to increase agricultural production, reduce economic losses, risk to human health and potential damage to flora and fauna, besides improving the safety and quality of the environment. Integrated weed management system is not meant for replacing selective, safe and efficient herbicides but is a sound strategy to encourage judicious use of herbicides along with other safe, effective, economical and eco-friendly control measures. The use of clean crop seeds and seeders and ûeld sanitation (weed-free irrigation canals and bunds) should be integrated for effective weed management. Approaches such as stale seedbed practice, uniform and dense crop establishment, use of cover crops and crop residues as mulch, crop rotations, and practices tor enhanced crop competitiveness with a combination of pre-and post-emergence herbicides could be integrated to develop sustainable and effective weed management strategies under CA systems.

CONCLUSIONS

It is possible to achieve the same or even higher yield with CA as with conventional tillage. Retention of crop residues on soil surface is essential for success of CA in the long-run. Zero-tillage along with residue has beneficial effects on soil moisture, temperature moderation and weed control. However, continued adoption of such systems cause shift in weed flora, and may result in emergence of perennial weeds like *Cyperus rotundus, Cynodon dactylon and Sorgum halepense* in most crops; and others like *Malava parviflora* and *Rumex dentatus* in wheat. Restricting tillage also reduces weed control options and increases reliance on herbicides. Altering tillage practices change weed seed depth in the soil, which play a role in weed species shifts and affect the efficacy of control practices. The CA is a machine-, herbicide– and management-driven agriculture for its successful adoption. Integrated weed management involving chemical and non-chemical methods (residue, cover crops, varieties etc.) is essential for success of CA systems in the long-run.

Herbicide Tolerant GM crops in India-Challenges and Strategies

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C. Chinnusamy, C. Nithya[1] and D. Ravishankar[1]
Dean, Agricultural College and Research Institute, Madurai, Tamil Nadu 625 104,
[1]Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641 003
**E-mail: chinnusamyc@gmail.com*

Crops made resistant to herbicides by biotechnology are being widely adopted in various parts of the world. From the genesis of commercialization in 1996 to 2011, herbicide tolerance has consistently been the dominant trait. Those containing transgenes that impart resistance to post-emergence, non-selective herbicides such as glyphosate and glufosinate will have the major impact. These products allow the farmer to more effectively use reduced or no-tillage cultural practices, eliminate use of some of the more environmentally suspect herbicides and use fewer herbicides to manage nearly the entire spectrum of weed species. In some cases, non-selective herbicides used with herbicide resistant crops reduce plant pathogen problems because of the chemicals' toxicity to certain microbes (Duke 1999).

Biotech crops reached 160 million hectares, up 12 million hectares on 8% growth, from 2010 and 94 fold increase in hectarage from 1.7 million hectares in 1996 to 160 million hectares in 2011, makes biotech crops the fastest adopted crop technology in the history of modern agriculture. The inclusion of several transgenes in a single hybrid or variety commonly referred as stacked genes or stacked traits. For example, some corn and cotton hybrids have been genetically engineered to contain two transgenes, one for insect tolerance and another for herbicide tolerance (e.g., Bt/glyphosate, or Bt/glufosinate). Furthermore, some corn hybrids have three traits, two for herbicide tolerance and one for insect tolerance (e.g., Liberty, Clearfield, and Bt). Stacked traits occupied ~25% of the global 160 million hectares.

From the genesis of commercialization in 1996 to 2011, herbicide tolerance has consistently been the dominant trait. In 2011, herbicide tolerance deployed in soybean, maize, canola, cotton, sugar beet and alfalfa, occupied 59% or 93.9 million hectares of the global biotech area of 160 million hectares. In 2011, the stacked double and triple traits occupied a larger area (42.2 million hectares, or 26% of global biotech crop area) than insect resistant varieties (23.9 million hectares) at 15%. The stacked genes were the fastest growing trait group between 2010 and 2011 at 31% growth, compared with 5% for herbicide tolerance and 10% for insect resistance. Over the past few years, several herbicide resistant crops (HRCs), both transgenic and non-transgenic, have become available in many countries for commercial cultivation. But in India, the technology of herbicide tolerant crops is in initial stage of field evaluation. Efforts have been made to evaluate and consolidate the agronomic management and advantages of herbicide tolerant transgenic crops.

Herbicide tolerant crops are strongly impacting weed management choices. In many crops their use will decrease the cost of effective weed management in the short to medium term. However, they offer the farmer a powerful new tool that, if used wisely, can be incorporated into an integrated pest management strategy that can be used for many years to more economically and effectively manage weeds. In maize and cotton transgenic crops, post emergence weed management with glyphosate proved to be the better management option for the control of weeds.

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Potentials of direct seeded rice with efficient weed management to improve and sustain productivity and profitability of rice-wheat cropping system in India

Ashok Yadav[1]*, Dharam Bir[2], Gurjeet Gill[3], R.K. Malik[4], Virender Kumar[4], Sudhanshu Singh[4], R.K. Jat[5], Pardeep Kumar[2], B.R. Kamboj[2] and Bhagirath Singh Chauhan[6]

[1]International Rice Research Institute, Patna/Delhi, India, [2]CCS Haryana Agricultural University, Hisar, India, [3]University of Adelaide, Waite Campus, Australia, [4]CSISA-CIMMYT, Patna Hub, India, [5]BISA, Pusa, Samastipur, Bihar, [6]International Rice Research Institute, Los Banos, Philippines

**Email: aky444@gmail.com*

Traditional manual transplanted rice in puddled soils, the most common and prominent planting system in irrigated situations of India is now very frequently been debated and questioned due to increased use of ground water leading to consistently decline in water table (0.1 to 1.0 m/yr) further resulting into water scarcity, increased energy use and pumping cost, labour availability and high cost, breakdown of soil aggregates/macrospores with seriously deteriorated soil health, decline in the yield of succeeding crop mainly due to soil compaction, and greenhouse gas(GHG) emission. Therefore, research and extension efforts along with farmers' interest particularly in NW India are now switching in favour of accelerated adoption of direct seeded rice (DSR) for benefits associated with it through reduced labour costs as well as savings in water and energy use besides assuming considerable decease in GHG emission and global warming potential. DSR is also being experimented under other rainfed lowland and upland ecologies in other southern and NE parts of country with considerable and promising signs of its high potentials. Research experiences further indicate that productivity and profitability of rice-wheat cropping system as a whole can be further improved and sustained by including the most important components of conservation agriculture (CA) including no-till not only for wheat but for both rice as well as wheat or fitting other suitable crops preferably legumes in rotationbesides retaining residues on soil surface. It will help improve soil health, reduce weed pressure and conserve moisture. Multi-locational experimental results and farmers' feedback across various regions and ecologies have invariably indicated great potentials of DSR provided improved agronomic and other management practices relevant to that environment are followed scientifically in a step-wise manner most importantly ensuring enough moisture through irrigation or rain water at critical stages of crop growth (active tillering, panicle initiation and grain filling) once crop attains uniform stand.Yield potentials and grain quality of DSR have already been realized comparable to puddled transplanted rice (PTR) along with associated benefits (20-30 % water saving, ₹ 5,000/ha saving in labour cost, ₹ 2,500-3,000 saving in other variable cost, reduced drudgery, energy, fuel, repair and maintenance, and improved system productivity through equal or more rice yields in scented/hybrid rice and 0.2-0.5 t/ha more wheat yields) indicating that puddling is not an essential bet for getting higher yield.

Among different yield improving strategies, weed management is still stands at the topwhich tends to be more challenging in DSR due to well-known reasons discussed earlier.Weed flora changes very rapidly just after the adoption of DSR. More diversified and intensive weed flora is the main hurdle which frequently forces farmers and researchers many a times to go on backfoot. Integrated weed management strategies including every possible means (competitive varieties, line sowing, cover crops, residue mulching, proper water management etc.)mainly based on herbicides and some hand-rouging are essential for achieving high yields in DSR. Stale seedbed technique not only proved effective in reducing weed density in DSR, it also controlled volunteer rice plants, and could be further helpful in the most crucial and likely events of weedy rice appearance in future. Based on trials on research farms and farmer fields, bispyribac-sodium 25 g/ha sprayed at 15-25 days after sowing (DAS; 2-4 leaf stage) was extremely effective against barnyard grass and some broadleaf weed species in DSR and transplanted rice. Recommendation of bispyribac-sodium for use in DSR in 2009 has played an important and most critical role in the adoption of DSR by local farmers in NW India, and now the recommendation is being followed in NE India also. Pre-emergence application of pendimethalin 1000 g/ha, or pretilachlor + safener 500 g/ha or oxadiargyl 100 g/ha can be used to effectively control aerobic grass weeds such as Chinese sprangletop, lovegrass, crowfootgrass, paragrass, goosegrass, blue panic grass and crabgrass. Post-emergence application of metsulfuron + chlorimuron 4 g/ha, ethoxysulfuron 18.75 g/ha, 2,4-D Ester or Amine 500 g/ha in combination with bispyribac 25 g/ha provide effective control of broadleaf weeds (BLW) and sedges. Tank-mix of azimsulfuron 20 g/ha or pyrazosulfuron 25 g/ha with bispyribac 25 g/ha has also provided excellent control of BLW and sedges including purple nutsedge. Azimsulfuron alone also provided effective control of sedges. Farmers in north-western India have now widely adopted the use of pendimethalin 1000 g/ha or oxadiargyl 100 g/ha at 0-3 DAS followed bybispyribac 25 g/ha at 15-25 DAS for broad-spectrum weed control in DSR. If needed, one hand-weeding can be given to prevent seed production by weeds that escape herbicide treatments.

Predicting invasive plants using weed risk assessment

Mool Chand Singh* and Madhu B. Priyadarshi[1]
Division of Plant Quarantine, National Bureau of Plant Genetic Resources, New Delhi-110 012
[1]ARIS Cell, National Bureau of Plant Genetic Resources, New Delhi-110 012
**Email: mchsingh@gmail.com*

Seeds and planting materials of different plant species are being imported into India. Many of these plants have the potential to become agricultural or environmental weeds and this risk needs to be assessed before allowing their entry. Weed risk assessment is a question based scoring system, containing 49 questions about the species. The questions include details of the plant's climatic preferences, biological attributes, reproduction and dispersal methods. A minimum number of questions must be answered before an assessment is made. The weed risk assessment uses responses to the questions to generate a numerical score that is positively correlated with weediness. The assessment method was tested against 170 plants representing both weeds and useful plants from agriculture and environment. The method was judged on its ability to correctly reject weeds and accept non weeds. A total of 40% plants were classified as serious weeds, 30% as common weeds and remaining 30% were non weeds. The system is designed to be operated by plant quarantine officers. The weed risk assessment system with explicit scoring of biological, ecological and geographical attributes is a useful tool for detecting potentially invasive weeds in other areas of the world.

The implementation of New Policy on Seed Development by the Government of India has provided stimulus for the import of seeds of various crops from all over the world. This has increased the risk for the introduction of exotic weeds into India. Weeds have major impacts on economies and natural environments worldwide including India. Many of these weeds have been purposely introduced as new crops or as ornamentals. To counter the threat to agriculture or the environment from new plants, regulatory authorities have a statutory responsibility to ensure that all plants proposed to be imported, which are not already established, be evaluated for their potential to damage the productive capacity or environment of the country. Quarantine in India officially came into operation with the passing of the Destructive Insects & Pests Act (DIP Act) in 1914. Plant Quarantine (Regulation of Import into India) Order 2003, of the Destructive Insects and Pests Act (1914) provides a legislative framework for the application of measures to prevent the introduction or spread of insect-pests and diseases affecting plants. Effective plant quarantine is important for the protection of the biodiversity of the natural environment and agricultural productivity. Infestation of agricultural system has the potential not only to incur costs in controlling pests & losses in production, but also to restrict access to export markets, if the pest has the potential to contaminate the marketable product. There are many approaches to predicting weed potential (Mack 1996), but there is an urgent need of an objective, credible and publicly acceptable risk assessment system to predict the weediness of the new plant introductions.

An acceptable weed risk assessment system should satisfy a number of requirements. It should be calibrated and validated against a large number of plants already present in the recipient country and representing the full spectrum of plants likely to be encountered as imports into that country. It must discriminate between weeds and non-weeds, such that the majority of weeds are not accepted, non-weeds are not rejected, and the proportion of plants requiring further evaluation is kept to a minimum. As international trade agreements require that prohibited plant should fit in the definition of a quarantine pest before they can be excluded by quarantine regulations the system must be passed on explicit assumption and scientific principles so that country cannot be accused of applying unjustified non-tariff trade barriers. Ideally the system should be capable of identifying which land use system the plant is likely to invade, to assist in an economic evaluation of its potential impacts. Finally, the system must be cost effective. This Weed Risk Assessment (WRA) system for India is designed in consultation with the weed scientists of Australia during the first author's advanced training at the University of Queensland, Brisbane, Australia.

The Weed Risk Assessment System with explicit scoring of biological, ecological and geographical attributes is a useful tool for detecting potentially invasive weeds in other parts of the world and should be used in Indian Plant Quarantine to assess the plants before issue of the Import Permit.

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Orobanche: weed biology and control measures

S.S. Punia and Parvender Sheoran[1]
Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana 125 004
[1]Principal Scientists (Agronomy), CSSRI, Karnal, Haryana
**Email: puniasatbir@gmail.com*

Orobanche or Broomrape (*Orobanche spp.*) locally known as Margoja, Rukhri, Khumbhi or Gulli is an achlorophyllous, phanerogamic, obligate, troublesome root parasite that completely depends on the host plant to complete its life cycle (Punia *et al.* 2012). Globally, root parasitism of *Orobanche* to numerous important broadleaf crops including common vetch (*Vicia sativa* L.), crucifers such as oilseed rape (*Brassica* spp. L.), broad bean (*Vicia faba* L.) and other crops belonging to Apiaceae, Asteraceae, and Solanaceae families have been reported (Sauerborn 1991), especially in Mediterranean region Southern, Northern and Eastern Europe, Africa, New Zealand, Australia, North, Central and South America. In India, *Orobanche* has emerged as a major threat to rapeseed-mustard production. Some of the farmers even abandoned the cultivation of mustard under the threat of this parasitic weed. This weed infestation is mostly confined to major mustard growing states of northern Rajasthan, Haryana, Punjab, Western UP, and north-east Madhya Pradesh. In Andhra Pardesh, 50% area under tabacco(40,000 ha) is infested with broomrapes and causing 50% crop losses. In Karnataka state, 90% area under bidi tobacco is infested with this weed with 50-60% yield losses in some areas. Yield losses due to Orobanche spp. tobacco growing areas in Tamil Nadu, Gujarat and Maharastra is also reported to be very high. Tomato crop is also infested with Orobanche spp. in Mewat and Bhiwani districts of state.

The attached parasite functions as a strong metabolic sink, often named "super- sink", strongly competing with the host plant for water, mineral nutrition and assimilate absorption and translocation. The diversion of these substances to the parasitic weed causes moisture and assimilates starvation, host plant stress and growth inhibition leading to extensive reduction in crop yield and distressed crop quality in infested fields. Depending upon the extent of infestation, environmental factors, soil fertility, and the crops' response damage from *Orobanche* can range from zero to complete crop failure (Dhanapal *et al*. 1996). Researchers have even tried to evaluate and predict significant correlations justifying crop damage based on *Orobanche* seed counts in soil samples.

The *Orobanche* genus includes six species that are of agricultural importance and cause devastating yield and quality losses to many agricultural crops around the globe. *Orobanche aegyptiaca* is the most dominating one in India; however, localized infestation of two other species namely *O. cernua* and *O. ramosa* has also been observed to some extent. Root parasitism of *Orobanche* to different crops including oilseed rape (*Brassica napus* L.), tomato (*Lycopersicon esculentum* Mill.) and tobacco (*Nicotiana tabacum* L.) is being reported in India and abroad. This parasitic weed has the tendency to proliferate well in coarse textured soils with high pH, low in nitrogen status having poor water holding capacity where the crop cultivation is either rainfed or dependent on sprinkler systems for irrigation.

In spite of continuous and extensive research by the plant breeders, weed scientists and plant protectionists, most parasitic weeds are still causing serious problems in large number of crops worldwide and are aggravating in many areas. No single effective, economical and practical remedial measures for parasite are available. Integration of cultural, preventive and chemical methods is required even though it is very costly.

Several methods for managing broomrapes include hand weeding, deep ploughing, crop rotation, alteration in seeding windows and fertilizer N scheduling, the application of organic manures and biofertilizers, chemical seed treatment, and kerosene/soybean oil droplets spray; however, they are inconsistent and have limited effectiveness. Secondly, feasibility and possible existence of these management practices under present scenario further limits and raises a question mark. Each of these methods has its merits and provides its own or in combination with others a solution to certain situations, but the general problem remains somewhat unresolved. For the effective management of *Orobanche*, the following practices could be adopted in an integrated manner to have better respite against the parasitic weed and sustaining the mustard productivity.

* Crop rotation of with non-host crops like wheat, barley and chickpea depending on the irrigation facilities and host crop
* Delayed sowing (25th October-10th November) of mustard supplemented with higher seed rate.
* Use of organic manures in combination with increased fertilizer N dose for enhancing crop vigour.
* Two sprays of glyphosate at25 g/ha at 30 DAS and 50 g/ha at 55 days after sowing provided the crop does not experience any moisture stress at the time of spray.
* Hand removal/pulling of left-over emerging shoots before flowering to reduce weed seed bank in the soil.

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Dry-seeded rice in north-west India: rationale and approaches

G. Mahajan and B.S. Chauhan[1]

[1]*Punjab Agricultural University, Ludhiana, Punjab*

[1]*Crop and Environmental Sciences Division, International Rice Research Institute, Los Baños, Philippines*

**Email: mahajangulshan@rediffmail.com*

Rice (*Oryza sativa*) production in north-west India plays a major role in providing food security and livelihoods of India. In north-west India, rice is primarily grown by transplanting seedlings in puddled fields. This production system is labour- and energy-intensive requiring a large amount of water (150 cm), out of which 20–25 cm is used for puddling only. Water and labour, however, are becoming increasingly scarce in the region raising the questions of environmental sustainability and sustainability of rice production systems (Chauhan *et al.* 2012). In the north-west Indo Gangetic Plains, overexploitation of groundwater for rice cultivation has led to declined in water table by 0.1 to 1.0 m/yr, leading to water scarcity and increased pumping water costs. A major challenge, therefore, is to develop production systems that allow rice yield to be increased in the face of declining water and labour availability due to increased competition with urban areas.

Rice cultivation in the puddled fields of north-west India deteriorates the physical properties of soil, adversely affects yield of the subsequent wheat crop, and contributes to methane emissions. To address the issues of rising water and labour scarcity, emission of green house gases and to enhance the sustainability of rice-wheat cropping system, cultivation of dry-seeded rice in north-west India is gaining the momentum. The development of short duration, weed-competitive and early-maturing cultivars and balanced and efficient nutrient management techniques along with increased availability of integrated weed management tools have encouraged many farmers to switch from transplanted to this production system.

There are many potential benefits of dry-seeded rice not only for improving labour and water productivity with many off-farm benefits, but also to enhance food security for millions of people in India due to increased rice productivity. However, weeds and nutrient management, including tolerance to new biotic and abiotic stresses, need to be overcome on priority. The shift in weed flora, reduced sink size, appearance of volunteer rice seedlings, poor crop emergence, particularly when the field is not levelled, and occurrence of rain immediately after sowing are the main obstacles to the promotion of DSR. There is an urgent need to develop criteria for identifying traits that are likely to be most helpful for weed management in direct seeding include seed germination in anaerobic conditions and tolerance of early submergence for uniform crop establishment, high and early seedling vigour with rapid leaf area development during the early vegetative stage for weed suppression, cultivars having an allelopathic effect, and herbicide-resistant rice cultivars. Research efforts are needed to fill the physiological gaps for improved nutrient uptake under moisture stress so that sink size in DSR could be increased.

The major concern of low to moderate nutrient-use efficiency in rice that ranged between 25-40% for nitrogen (N) and phosphorus (P) needs to be addressed. Water mining or maximization of water uptake from deeper layers of the soils is one of the most important mechanisms in DSR. The roots play a pivotal role in water and nutrient uptake, and act as sensors of water and nutrient status of the soil. During the interval between two rainfall events and irrigation, efficiency with which plant extracts soil moisture from deep layers is critical for maintenance of water and nutrient requirements of crops. Agronomic efforts are needed to improve yield stability under theses stresses in DSR. Sufficient root length and surface area in deep soil layer is currently the most accepted target trait for improving water-use efficiency in DSR. There is need to focus on root zone investigation to find agronomic cues to promote root zone development and resistance to lodging under low moisture. Sincere efforts are needed to reduce the evapo-transpiration losses with the help of soil amendments for high water-use efficiency.

There is a need to understand the photosynthetic characteristics of rice genotypes adapted to DSR with different N use efficiency (NUE) and explain the difference of N absorption and utilization between N-efficient and N-inefficient rice cultivars. Some recent studies suggested that, at high N levels, some rice cultivars could absorb more NO_2 than NH_4^+. This is important in dry- direct seeded rice because rice roots can aerate rhizosphere by releasing oxygen (O_2), and this activity promotes the process of nitrification, that is, the conversion of ammonium to nitrate. So there is a need to evaluate the difference in NUE among different rice cultivars, by determining nitrate uptake efficiency and the activities of key enzymes supporting the N-assimilation pattern. There is a need to determine the physiological basis of variability in N-efficient and N-inefficient cultivars. Compared to other graminaceous plants, rice secretes a very low amount of deoxy-mugineic acids as a phytosiderophore even under Fe deficiency, which is the main cause for the high sensitivity of rice to Fe deficiency. Sometimes severe chlorosis in rice due to Fe-deficiency has led to complete failure of the rice crop. This problem is aggravated in DSR, because Fe from the soil is not available in reduced form. So, strong agronomic and breeding efforts are needed to overcome this issue.

There is a need for research at both strategic and applied levels involving a holistic approach to arrest these issues. This will provide sound scientific basis to conduct research for developing effective and sustainable agronomic practices for DSR in north-west India, and establish appropriate information systems to support better decision making.

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Weedy rice and possible management approaches for its control in India

Bhagirath Singh Chauhan*[1] and Gulshan Mahajan[2]

[1]**International Rice Research Institute, Los Baños, Philippines*

[2]*Punjab Agricultural University, Ludhiana, Punjab, India*

Weedy rice is becoming a major threat to the production of direct-seeded rice systems in India. It reduces growers' income through yield reduction and lowering rice value. There is a poor understanding of its ecology and biology in different rice production systems in India. Because of similar physiological and morphological traits of weedy rice with cultivated rice, selective herbicides cannot be used to manage weedy rice in conventional rice cultivars. Therefore, there is a need to integrate different preventive, cultural, and chemical approaches to achieve effective and sustainable control of weedy rice. Some of these approaches are the use of weedy rice-free rice seeds for planting, use of stale seedbed practice, rotation of different rice establishment methods, line sowing of rice, use of cultivars with coloured leaves and stems, and cultivars able to emerge under anaerobic conditions, and adoption of crop rotation. The most important is to increase awareness about weedy rice among growers.

Rice (*Oryza sativa* L.) is the most important staple food in India, where it is grown on approximately 45 million ha with a production of 104 million tons. Rice is traditionally grown in India and most of the other Asian countries by manual transplanting of seedlings into puddled soil.

Weedy rice is unwanted plants of *Oryza sativa* that compete with rice and other crops. The evolution may be through natural hybridization, through de-domestication of cultivated rice to weedy rice, and / or through adaptation of wild rice. In India, weedy rice is prevalent in Uttar Pradesh, Bihar, Odisha, and West Bengal. The major traits of weedy rice are early shattering of the grain and variable seed dormancy (Azmi and Karim 2008). Because weedy rice and cultivated rice have similar physiological and morphological traits, selective herbicides are not available to control weedy rice in conventional rice cultivars. This presents a challenge for growers to manage weedy rice in India. Therefore, there is a need to integrate different preventive, cultural, mechanical, and chemical approaches to manage weedy rice. Recent reviews compiled detailed information on different weed management strategies to manage weedy rice in Asia and in particular, India. This article aims to provide brief information on possible management approaches to manage weedy rice in India.

CONCLUSION

Weedy rice is likely to become a major problem in direct-seeded rice systems because of simultaneous emergence of weedy rice with cultivated rice, absence of standing water at the time of crop and weedy rice emergence, and absence of selective herbicides to control weedy rice in conventional rice cultivars. However, integration of different preventive, cultural, and chemical approaches may provide effective control of weedy rice.

Future research issues

In our view, there are several research issues, which need to be addressed on weedy rice in India.

- Ø The most important need is to survey the extent of weedy rice infestation in different regions. There is also not clear understanding of identifying weedy rice.
- Ø There is a need to characterize morphological and physiological traits of weedy rice occurring in different parts of India. Better understanding of biology and ecology of weedy rice biotypes may help to identify weak points in its life cycle.
- Ø There is a need to increase awareness about weedy rice and evaluate the extent of contamination of weedy rice in rice seeds on growers' fields.
- Ø There is need to understand the mechanisms responsible for the genesis of weedy rice, and its possible transfer to other economically important crops and weeds.
- Ø Climate change is the reality in India and the problem of weedy rice infestation is expected to increase with the changing climate in the near future. Clear understanding is needed why gene flows form weedy plants to domesticated rice increases with higher levels of carbon dioxide.
- Ø There is a need to develop and evaluate guidelines for the risk management of herbicide-resistant rice.
- Ø The most important strategy to manage weedy rice is the integration of different management strategies. However, such information is not available in Indian conditions.

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Weedy rice: problems and its management

Sanjoy Saha, B.C. Patra, Sushmita Munda and T. Mohapatra
Central Rice Research Institute, Cuttack, Odisha 753 006
**Email: ssahacrri@gmail.com*

Weedy rice belongs to the same genus and species as cultivated rice but with different forma. It appears as hybrid swarms due to introgression of genes between wild and cultivated species in nature. In Asian rice, it is known as *Oryza sativa* var. *spontanea* whereas in African context it is said as *O. sativa* var. *stapfii*. It grows faster; produces more tillers, panicles and biomass; makes better use of available N; shatters earlier; has better resistance to adverse conditions; and possesses longer dormancy in soil. Because of its high competitive ability, it becomes a serious threat to rice growers worldwide. Great morphological variability, similar growth behavior and high biological affinity with cultivated varieties make its control difficult. No single management technique can effectively control weedy rice. An appropriate combination of preventive, cultural, mechanical and chemical control measures is essential.

Weedy rice, an introgressed form of wild and of cultivated rice (*Oryza sativa* L.), is native of Asia (Londo *et al.* 2006) but was first documented in North Carolina, USA in 1846 (Smith, 1981). A century after, it was considered a noxious weed in Arkansas, USA. Weedy rice infests rice fields in most of the rice growing areas in the tropics, and is particularly a problem in the direct-seeded rice systems of the Americas, the Caribbean and South and Southeast Asia (Mortimer *et al.* 2000).

The spread of weedy rice became significant over the last 30 years due to large scale cultivation of semi-dwarf indica-type rice varieties. The spread has further aggravated due to use of commercial seeds that contain seeds of the weedy rice and through the machines used in rice cultivation specially the tillage implements and mechanical harvesters. The increase in weedy rice infestation in South east Asia is closely associated with the increase in area under direct seeded rice (Delouche *et al.* 2007) and is a growing problem as this establishment method spreads in entire tropical Asia. Infestation of weedy rice is also reported to be higher in the no-till fields compared to the cultivated fields. The physical and physiological similarities of weedy rice to cultivated rice, adoption of direct seeded rice systems and the absence of standing water at the time of crop emergence in direct-sown rice fields, makes weedy rice infestation one of the most serious problems that farmers encounter during recent times. Due to that reason, in some countries where direct seeding is already a common practice, farmers are reverting to mechanized transplanting to manage weedy rice. Selective herbicides to control weedy rice in conventional rice cultivation are not available and therefore, managing weedy rice is a challenging problem for farmers in Asia For farmers, it becomes a difficult-to-control, aggressive weed that increases the costs of production, reduces yield, lowers the market value of their crop and, where not controlled properly, can render the infested land unfit for rice production. Due to difficulties in controlling, it has been posing cancerous threat to the rice farmers of many South-east Asian countries**.**

Further research is, therefore, urgently needed to determine the impact of different tillage systems, appropriate time and duration of flooding, the use of rice cultivars capable of emerging in anaerobic conditions, and herbicide practices on weedy rice growth and control. Integrated crop management practices with varietal aspects, such as crop plant density (seeding rate), narrow row spacing, weed competitive cultivars with good initial vigour and purple base rice varieties for easy identification of weedy rice in crop fields need to be evaluated for effective weedy rice management (Chauhan and Johnson 2010).

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Weed management beyond herbicide: role of ecological weed management

R.P. Singh and Ramesh K. Singh*
Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh
**Email: rks1660bhu@ gmail.com*

Weeds are endemic in both cropped and non-cropped area and causes considerable yield losses in crops, reduces land and water uses, aesthetic value, affect biodiversity and poses serious health problems in animal and human. . Importance of weeds is reflected in amount of manual laboure, tillage and herbicides used for their management. The introduction of synthetic selective herbicide 2,4-D during 1940's in agriculture was welcomed and widely accepted by farmers to control weeds in developed countries and developing countries as well. The ever increasing problem of herbicide- resistant weeds, herbicide persistence in soil and injury to succeeding crops and concern about herbicides effect on environment and human health care issues are driving farmers to reduce herbicide use and adopt strategies that are more robust and provide long-term management of weeds. Ecological weed management systems focuses on altering ecological niches in favour of crops by integrating agronomic factors such as competitive crop cultivars, crop rotation and sequences, seeding date, seed rate, row spacing and fertilizer management and also allelopathy where ever possible. Research and extension strategies that demonstrate both agronomic and economic merits of integrating cultural, mechanical and chemical control of weeds are required to encourage acceptance and adoption by farmers.

To meet the food and nutritional security of the ever-increasing population of the world, especially in countries like India, has become a challenge to policy makers and researchers; as a result producing more yield from decreasing cultivable lands is becoming the only approach in post green revolution era. This system is mostly based on the use of high rates of chemical fertilizers to meet nutritional requirements of crop and pesticides those control insect pest, diseases and weeds. Plant breeding for disease, and to some extent insects (GMC,s), resistant crops cultivars in combination with integrated pest management strategies have led to considerable reduction in the use of fungicides and insecticides worldwide. Conversably, the herbicide use is still increasing in both developed and developing countries. During 2012, India registered an impressive growth of 35% in herbicide use. Increased cost of manual weeding and lack of alternate non-chemical strategies led to heavy reliance on herbicides as a cheaper alternative to manual weeding.

Resistance to specific synthetic herbicides is increasing dramatically leading to lowering the land values resulting farmers to run out of weed-controlling herbicides.. There are currently 418 unique cases (species x sites of action) of herbicide resistant weeds globally with 224 species (129 dicot and 95 monocots). Weeds have evolved resistance to 21 of 25 known herbicide site of action and to 150different herbicides. Herbicide resistant weeds have been reported in 73 crops in 61 countries. The most recent cases are *Kochia scoparia*, *Lolium multiforum*, and *Poa anua* reported during 2013 from United State. In India, fortunately, only one confirms herbicide resistant weed biotype, *viz. Phalaris minor* in wheat has been reported (Malik and Singh 1995). In this context, the challenge is to develop integrated weed management (IWM) systems which reduces herbicide use and maintain sustainable crop production without compromising farmer's income and health of natural resources.

The basic principles in Ecological Weed Management are enhancement in crop competitiveness to minimize competitive pressure of weeds on the crop. It emphasizes on integration of agronomic, genetic, mechanical, biological and chemical means of weed management that promote crop growth and development with less weed interference in a environmentally safe agro-ecosystem.Increasing concerns over herbicide resistance, environmental and health hazards of herbicides and declining profitability due to emerging organic-markets have led to reorienting weed science research and education. The IWM involves intentional use of multiple tactics to suppress weeds and reduce cop damage to economically acceptable level. Emphasis should be placed on modifying habitat characteristics to reduce weed densities and promote crop growth. Multi-tactic, ecologically based weed management strategies are desirable to improve effect of individual tactics, to minimize risk of crop loss due to failure and to decrease the rate at which weeds adopt or evolve resistance against herbicides**.** The research approach to develop an IWM system must consider all aspects of cropping systems. Each cultural practice influences competitive ability of both the crop and the weed community. A sustainable IWM system must have ability to enhance crop competiveness in a complex interaction.

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Spread, impact and management of *Parthenium*

Sushilkumar*
Directorate of Weed Science Research, Adhartal, Jabalpur, Madhya Pradesh 4820 004
**Email: sknrcws@gmail.com*

Parthenium hysterophorus L., commonly called as rag-weed in English, is popularly known as carrot weed, congress grass, bittergrass or 'gajarghas in India. Earlier it was known to be a weed of fallow and wastelands only but now it has became a menace in almost all types of crops and forests land. Its colonization and dominance in natural habitat and crop lands has resulted in disastrous effects on bio-diversity in general and crop productivity in particular. The success of its dominance over other vegetation is due to its immense capacity of reproduction and survival in all seasons under a wide range of climatic conditions. To reduce the infestation and spread of this weed, management strategies have become prime concern not only in India but in many other countries. Immense seed production capacity, ability to germinate in varied climate, non-occurrence of seed dormancy, very tiny and light weight of seeds besides absence of natural enemies are the factors responsible for its dominance over other vegetation.

Spread of *Parthenium*: It has been reported from all states of India (Yaduraju et al. 2005). In context to density and infestation level, *Parthenium* spread and infestation was reported highest in Andhra Pradesh, Bihar, Chhatisgarh, Haryana, Karnataka, Maharastra, Madhya Pradesh, Punjab, Tamil Nadu and Uttar Pradesh. It was reported medium in infestation in Assam, Gujrat, Himachal Pradesh, Jharkahand, Jammu & Kahsmir, Uttarkhand, Orissa, West, Bangal and Rajasthan, The spread is in low intensity in Andman & Nicobar, Arunachal Pradesh, Goa, Kerela, Manipur, Mizoram, Mehgalaya, Nagaland, Pondicherry and Sikkim. Since its noticeable occurrence in 1955 at Pune (Maharashtra), it has spread in about 35 million hectares of land (Sushilkumar and Varsheny 2010) representing almost all the states and all type of terrestrial situation. Its spread in islands like Port Blair in Andaman &Nicobar and Minicoy in Lakshadweep is a recent invasion. Earlier, *Parthenium* spread was mostly restricted in fallow and wasteland but now it has also spread its tentacles in agricultural, horticulture and forestry land. It has widely spread in many national parks and forest nurseries in India. Parthenium has also spread from India to neighboring countries like Pakistan, Sri Lanka, Bangladesh and Nepal. It is believed that *P. hysterophorus* infestation is increasing rapidly in India and may be more widespread than shown here.

Impact of Parthenium: In India, the weed is well documented as one of the greatest source of dermatitis, asthma, nasal-dermal and naso-bronchial types of diseases. It has been estimated that 4 per cent population is directly sensitive to Parthenium. A major population does not feel any sensitization when they come in contact with *Parthenium* first time or for some time but in due course they may be sensitive for this weed. *Parthenium* is not palatable to livestock but if hungry cattle feed it, they may suffer from the symptoms like salivation, onset of diarrhea, anorexia and dermatitis. Till 1990', its impact was not known on crops but now it has become a major cause for the loss of crop production in rainy season crops. Now, its impact is visible in various crops of *Rabi* season too. *Parthenium* has also become a major cause of biodiversity loss in many forests. Corbett national park has badly affected with this weed and it has become a threat for the survival of herbivores due to replacement of palatable grasses. For the management of *Parthenium*, two hand weeding or two chemical sprays are essentially required to get complete relief. It was estimated that[1] 182000 million will be required per year to mitigate the problem by manual labour.

Management of *Parthenium*: So far no single method has been proved satisfactory to suppress *Parthenium* menace because each method suffers from one or more demerits such as impracticability, high cost, environmental safety, temporary relief. Manual removal of *Parthenium* is done widely in India but it is not cost effective due to its continuous germination in the field. Many herbicides namely, 2,4-D, metsulphuron-methyl, glypgosate and metribuzin have been found effective against *Parthenium* and are being used in India and other countries. In India, biological control through insect bioagent *Z. bicolorata* (Coleoptera, Chrysomelidae) has been found most successful in waste land, community land, horticulture and forestry ecosystem. The efforts made by Directorate of Weed Science Research (DWSR) for its introductory releases through Krish Vigyan Kendra, Agricultural Universities and state agricultural departments has established this bioagent in many states of India. In a study, based on the herbicide cost which would have incurred in the area controlled by the bioagents, the net economic return by third year was calculated 135% per annum, which increased to 608, 2700, and 12150% per annum for single application of herbicides by 4, 5 and 6 years, respectively . The total benefits by the biological control in six years had been of ₹ 62.34 million; 15585% benefit over initial investment. Sushilkumar (2006). In waste land and on the road and railway track side, replacement of *Parthenium* by competitive plant *C. tora* and *C. sereicea* may be recommended. Chemical methods may be effective for quick relief. Utilization of *Parthenium* for compost making has been considered more practical approach. Stakeholder participation has been considered effective for effective management of *Parthenium*.

Conclusion: Keeping in view the high reproductive potential and survival ability of *Parthenium* in varied climate, biological based integrated management has been considered to be the only viable solution.

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Herbicide tolerant crops: need, benefits and tacts

Ramamohan G, Ashish Bhan*, P.J. Suresh
Monsanto India Ltd. 5th Floor Ahura Centre, 96, Mahakali Caves Road, Andheri (E) Mumbai, Maharashtra 400 093
**Email: ashish.bhan@monsanto.com*

With a rapidly growing global human population, the demand for food, feed, clothing, energy and shelter is expected to increase in future. Given the multitude of social and environmental challenges - food security, depleting fresh water resources, environmental degradation, climate change etc - improving global agricultural productivity and efficiency is critical. In addition to enhancing the crop productivity, adopting optimal crop production regimens to realize the potential yields of the crop by reducing the losses to crop yields is also a significant strategy. From this context weed management assumes great importance. Weeds affect crop growth and yield more than any other pest. Weeds directly compete with crops for space, nutrients and water from the soil, thus considerably reducing input efficiency and negatively impacting the yield, if not removed in time. Weed management is needed and is a top priority during the initial stages of crop growth. As majority of the crops are dependent on rains for initiating the seed sowing process, farmers get busy and accord highest priority to cover as much as ground possible in limited time (with sowing operations) to make use of the available soil moisture. The labor cost is highest among all the costs for agricultural production (on an average 52% of total cost). With diversification of agriculture and urbanization labor force for agriculture will further shrink, which is a good sign to improve India's current poor record of Human Development Index. It is projected that by 2030, 40% of the population would be living in urban areas, which was only 30% in 2008, creating unprecedented shortage of labor force for use in rural agriculture. For weed management it is also timely availability of labor is very crucial. In addition, female labors are generally involved in manual operations like transplanting, harvesting and intercultural operations. Among them, women consider weeding as the second most drudgery prone activity due to prolonged postural stress

In the crop protection system, effective and timely weed management has assumed most important consideration for maximizing the yield. This can be substantiated by the fact that in the global crop protection market, herbicide use in the largest segment constituting more than 50% of the industry. Globally farmers have graduated from manual weed control to pre-emergence herbicides and then to post-emergence herbicides. Although the Indian Crop Protection market has been traditionally dominated by insecticides with over 70 % share, herbicides are a segment growing rapidly. In India too, use of post- emergence herbicides is growing in the crops where herbicide consumption is high e.g. wheat, rice, soybean, plantations and even vegetables. Alternate new technologies using latest biotech approaches like herbicides tolerant crops with broad spectrum non-selective non-residual herbicides are expected to provide better and more cost effective solutions. Herbicide tolerant crops will also allow India to leapfrog into a more advanced state without too much requirement at grower level. Post-emergence herbicides allow farmers flexibility of use based on the weed pressure in the field.

As illustrated earlier multiple reports including views of Ministry of Agriculture suggest that labour availability for agriculture operations has become a major issue in addition to the high labour cost. This big gap between demand and supply of Agricultural labor has also impacted the crucial aspects of weed management. In reality, timely availability of labor and physical conditions of the field like excess rains during monsoon months makes it very difficult for the labor to enter the field for hand weeding operations. Under such conditions use of an effective post-emergence herbicide is a good option for the farmer to control the weeds during the critical stages of the crop. Hence, science based solutions are needed to tackle this problem. In this regard, HT crops may offer simplified and efficient control of weeds particularly in wheat, rice and other crops like Oilseeds, Cotton, Maize and pulses *etc.*

HT crops are designed to provide superior weed control with minimum labor and chemicals, relative to labor intensive mechanical or chemical or manual weed control options. Overall, HT technology reduces the cost of production through lower expenditures for herbicides, labor, machinery, and fuel. It is also a proven fact that in order to promote sustainable agriculture concept, conservation tillage practices like reduced or zero tillage need to be given lot of emphasis for their obvious benefits to environment and soil health. HT crops have proved to be an effective enabler in adoption of resource conservation practices like conservation tillage. Use of the technology like herbicide tolerant crops can help in-house labor, if available, to divert to more productive and remunerative farm enterprises such as sericulture, mushroom cultivation, poultry, bee keeping, livestock rearing or pursuing other vocational interests therefore improving their overall social profile. This is apart from reducing drudgery on women and children who are primarily engaged in such operations, where available.

Some of the specific benefits from herbicide tolerant crops are:

* Offer greater economic and effective season long weed control choice adding to the existing options of manual weed control and selective pre & post emergence herbicides.
* Offers flexibility to farmers for over the top application (wider application window) and better weed control with outstanding crop safety
* Herbicides recommended and used for the herbicide tolerant crops are more environmental friendly as they are non-residual in nature.
* Herbicide tolerant crops help adoption of conservation tillage which helps in preventing soil erosion and reduces turnaround time between harvests to planting of next crop.

Herbicides residues: monitoring in soil, water, plants and non targeted organisms and human health implications: an Indian perspective

Shobha Sondhia

Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004

Email: shobhasondia@yahoo.com

Herbicides use is increasing throughout the globe due to increasing labour cost, choice of application of herbicides, quick weed control in crop and non-crop areas. In India, herbicide use has increased to 30% during the last 10 years in managing weeds in the country. Currently 50 herbicides are registered for use in various crops, out of this, one belongs to extremely hazardous in India, 4 belongs to highly hazardous, 22 belongs to moderately hazardous and 23 belongs to fourth category that is unlikely to cause any harmful effects. According to World health organization (WHO)"Any substance or mixture of substances in food for man or animals resulting from the use of a pesticide and includes any specified derivatives, such as degradation and conversion products, metabolites, reaction products, and impurities that are considered to be of toxicological significance" are defined as residues.

Herbicide persistence, degradation and residues in the soil

Herbicides persistence in the soil is expressed as half life which largely depends on the soil properties, concentration and nature of chemical and climatic conditions (Sondhia 2009). In Indian tropical conditions, the half-life of imadazoline, phynylureas, sulfonylureas, triazines, chloroacetinalides, dinitroanilines, diethyl ethers, thiocarbamates, and fop group of herbicides in soil are found to varied 57-71, 13-60, 13-147, 12-58, 5-60, 12-77, 19-29, 19-24, and 8-24 days (Sondhia and Varsheny 2010). Application of atrazine at recommended dose left no residue whereas application at double the recommended dose recorded 0.056 µg/g of residue in the soil. Fentazamide residues were 0.03 to 0.04 mg/kg in soil of rice field. Fluazifop-p residues in soil of soybean field were found 0.051 to 0.079 ìg/g. Pendimethalin persisted up to 200 days in soil of wheat field and at higher dose caused phytotoxicity to the succeeding sorghum crop. Imazethapyr persisted up to 210-240 days in soil of soybeans at 50 to 200 g/ha applications rates. Whereas imazosulfuron, oxyfluorfen and isoproturon degraded to non-detectable level within 60-120 days (Sondhia and Varsheny 2010).

Herbicide residues in cereal crops

Herbicides such as butachlor, fentazamide pretilachlor, oxyfluorfen, 2-4D, ethoxysulfuron, imazosulfuron, pyrazosulfuron-ethyl, pinoxsulam and metsulfuron-methyl residues in rice crop and metsulfuron-methyl, pyrazosulfuron-ethyl, triasulfuron, isoproturon, clodinafop-propargyl, fenoxaprop -p-ethyl, tralkoxydim, pinoxaden, carfentrazone-ethyl and sulfosulfuron in wheat were found either below maximum residue limit or below detectable limits (Sondhia and Varsheny 2010).

Herbicide residues in pulses and oilseed crops

Low pendimethalin residues were found in mature chickpea and pea grain and straw. At harvest, residues of quizalofop ethyl on black gram seed, and foliage were found below 0.01 mg/kg. No residues of trifluralin in black gram and diclosulam in soybean plant were detected. At harvest 0.012 and 0.036 µg/g fluazifop-p-butyl residues were found in the soil of soybean crop with 0.250 - 0.500 kg/ha application rates.

Herbicide residues in other crops

In made tea 0.14–0.20 µg/g and 0.35–0.44 µg/g napropamide was found in X and 2X doses. At Anand, pendimethalin applied at 0.60-0.25 % resulted in 0.376 to 0.079 µg/g residues in tobacco leaves. Alachlor residues were found at trace level in cotton plant, cotton lint and oil at 2.5-5.0 kg/ha application rates. Pendimethalin residues at 0.5 kg/ha application rate were not detected in the soil of lucerne crop. 2,4-D suspected leaf malformation was found in affected leaves with residues of 0.06 µg/g. Anilophos and fluchloralin were detected ND–0.042 mg/kg and 0.012–0.06 mg/kg in cucumber and onion, respectively.

Herbicide residues in vegetables

At harvest, 0.008, 0.001, and 0.014 ìg/g residues of pendimethalin were found in tomato, cauliflower, and radishes, respectively. At harvest, pendimethalin, fluchloralin, and oxadiazon residues were found below the MRL in onion bulbs. Similarly, at harvest, 0.009 and 0.006 µg/g terminal residues of fluchloralin applied at 0.75 -1.50 kg/ha rates were found in stover and grains. Oxyfluorfen residues in cabbages, radish and pendimethalin residues in edible parts of radish were found below MRL values. In chickpea and mustard, low levels of fluchloralin residues were detected in soil at 150 days.

Herbicide residues in water system and fishes

A 0.015 - 0.002 mg/kg of pyrazosulfuron ethyl residues day were detected between 21 to 35 days in the underground water. Residues of atrazine (NO-1.056 µg/L) were detected in the water of Singoor and Osmansagar reservoir, Hyderabad. Residues of atrazine ranged from 0.0007 -0.0173 mg/L where as 0.9 to 45 µg/L of simazine were detected in the groundwater of Delhi. Dissipation of sulfosulfuron in natural water and soil showed the DT_{50} and DT_{90} values 67-147 and 222-488 days. Butachlor interferes with cellular activities in fishes even at low dose level (1.0 µg/g) at genetic level inducing chromosomal aberrations and posing a serious concern towards the potential danger of butachlor for aquatic organisms.

CONCLUSION

It can be concluded that in India herbicide contamination of soil, plants and natural waters occurs infrequently and at low levels. With few exceptions aquatic herbicides do not accumulate and persist in fish. Though some reports of herbicide poisoning are reported though data on the occurrence of herbicide-related illnesses among defined populations in human, the domain of herbicide illustrates a certain ambiguity in situations in which people are undergoing life-long exposure.

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Crop-weed interactions under climate change

V.S.G.R. Naidu and T.G.K. Murthy
Krishi Vigyan Kendra, Central Tobacco Research Institute, Rajahmundry 533 105
**Email: naidudwsr@gmail.com*

Climate change projections suggest 2.4–6.4°C increase of global average temperature by the end of 21st century. Studies indicate that significant warming is inevitable regardless of future emission reductions. If these forecasts are realized, crops and cropping systems are likely to experience significant changes and it is so for the associated weeds too. Weeds are major threat to Agriculture and biodiversity as they out-compete crops and native species and contribute to land degradation. Climate change poses several challenges for managing weeds. Globally, there is a growing list of recent changes in species' distributions, abundances and lifecycles that are highly likely to be due to climate change (Fuhrer 2003).

Climate change means more extreme weather events, greater stress on native species, climate driven activities such as introduction of new species / crops. The increased extremes expected with the climate change, such as long drought periods and occasional very wet years, may worsen weed invasion because established vegetation (both native and crop) will be vulnerable, leaving areas for invasion. Weeds with high reproduction and efficient seed dispersal mechanisms may be better able to take advantage of the expected calamities like cyclones and floods. The characteristic of weeds to be able to respond rapidly to disturbances such as climate change, may give them a competitive advantage over less aggressive species. Agricultural adaptations to climate change, including new products and shifts into new areas, will also create more opportunities for weeds.

Extreme events create conditions congenial for weeds to extend their range and invade new areas or out-compete native species in their existing range. Warmer temperatures will force some species to relocate, adapt or perish. Species that are active in summer will develop faster. Warmer climate restrict temperature sensitive species to high altitudes. In plains areas, this effect on distribution range is magnified because species without the ability to move to higher elevations must relocate further in the same altitude. Weeds with efficient dispersal mechanisms are better equipped to shift their range, while species with short life cycles are better equipped to evolve, and increase their tolerance of warmer temperatures. Weeds respond to climate change by, Changes in geographic distribution, Changes in the timing / duration of life cycles, Changes in the population dynamics, Shift in natural habitats, Changes in the ecosystem structure and composition (decline or extinction of some species and invasion by other species)

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Management of perennial weeds under non cropland hill ecosystems

L-17

N.N. Angiras*
Former Professor and Head Agronomy, CSKHPKV, Palampur, Himachal Pradesh 176 062
**Email: angirasn@yahoo.co.in*

Lantana camara L.var. aculeata, Parthenium hysterophorus (L.), Chromolaena adenophorum Spreng.,Imperata cylindrica (L.) Beauv, Urtica dioca (L.) and *Ageratum* houstonianum (Mill.) are the major obnoxious perennial weeds of non cropland hill ecosystems. Because of the available favourable agro climatic conditions, their ability to propagate by seed, stem and roots, faster dissemination by wind, water, birds, animals and machinery and ability to adapt adverse conditions, these weeds are difficult to control and have spread like a wild fire in almost all the states . But because of availability of more uncultivated land in hills, these weeds have become more problematic in hilly regions of the country. Suppression of useful vegetation in pasture and grasslands, orchards, forests, tea gardens, field bunds and other cropped and non-cropped lands by their competitive and allelopathic effects is causing threat to plant biodiversity, shrinkage of grazing land,economic losses to the forest wealth, reduction in productivity of grasslands up to 90 per cent, monkey menace, stray cattle menace thereby compelling the farmers to stop cultivation of crops. Preventive, mechanical, chemical, biological, utilization and integrated methods to manage these obnoxious perennial weeds have been discussed in this paper. These weeds should be cut at frequent intervals before flowering to exhaust food reserves in their vegetative propagules, check production of seeds and their dissemination. The cut biomass should be utilized to prepare compost, as mulch, biogas production, making furniture, as fuel wood and other industrial uses as per the weed species. A three phased integrated technology to manage Lantana camara under different hill ecosystems has been developed and demonstrated in large areas.In waste lands and forestland ecosystems biological agents like *Zygograma bicolorata*, *Cassia tora* or *Cassia sericea* should be introduced to check population of *Parthenium hysterophorus* and *Ageratum houstonianum*. In pasture and grasslands, herbicides should only be used in integration with plantation of fast growing forage species, recommended fertilizer use, and harvesting or grazing schedules. These integrated technologies to manage *Parthenium*, *Lantana* and *Ageratum* have been demonstrated on large scale in different ecosystems. However, for effective results, these technologies need to be adopted on campaign basis with the active participation of public, development departments of the Government, Scientists and policy makers. To tackle this serious problem at national level, it is imperative for the central Govt. to create a national body to manage these obnoxious weeds with a priority to manage them in the hills else they will continue to act as source of seed for the plains.

Herbicide resistance: magnitude, mechanisms and management

S.K. Guru and V.P. Singh
G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand
**Email: skguru123@yahoo.com*

Herbicide resistance of weeds is a worldwide problem. It is defined as the inherited ability of a weed or crop biotype to survive and reproduce following treatment with a dose of herbicide to which the original population was susceptible. Repeated and intensive use of herbicides with similar mechanisms of action in crops/cropping systems over a period of time leads to development of resistant biotypes within the community due to selection pressure. Development of multiple resistances poses a greater threat to the production systems. There are 421 herbicide resistant weeds at present reported from 63 countries having resistance to 152 different herbicides with 22 sites of action. Prominent among these are *Lolium rigidium, Avena fatua, Amaranthus retroflexus, Chenopodium album, Elusine indica, Echinocloa cruss-galli*, *Digitaria sangunalis* and *P. minor* (Heap 2014).

Widespread cases of resistances have been reported for different action groups such as inhibitors of photosystems, acetolactate synthase, acetyl-CoA carboxylase, protoporphyrinogen oxidase and more recently, in the EPSP synthase inhibitor, glyphosate. Use of herbicides with a single site of action, their multiple applications during a growing season or herbicides that have long soil residual activity influence resistance development. Frequent use of a herbicide creates the selection pressure that favours the spread of resistant biotypes. Consequently, the resistant biotypes may develop cross and multiple resistance (Bachie and Tardiff 2012). Weed characteristics such as high seed production potential with effective seed dispersal mechanisms and seed longevity in soil seed bank favour resistance.

Mechanisms of target site resistance includes altered herbicide binding site due to amino acid substitutions and over-production of the target site whereas non-target site resistance includes reduced uptake and enhanced metabolism of the herbicides as well as their sequestration. Herbicide degradation by cytochrome P450 enzymes reduces delivery of herbicide molecules to the target site. For many herbicide mechanisms of action, there are multiple mechanisms of resistance possible. Resistance to photosystem inhibitors result from mutations of the D1 protein. Enhanced metabolism either by glutathione-s-transferase or cytochrome P450 has also been proposed. The mechanism for paraquat resistance has been ascribed to decreased herbicide translocation. Resistance to ACCase inhibitors has become widespread particularly in *Lolium rigidium, L multiflorum, A fatua* , *Setaria viridis*, *Echinochloa crusgali* and *E. Colona.* Recent reports of *P. minor* resistance to this group have been ascribed to mutations in one or more gene encoding the ACCase enzyme. Resistance to ALS inhibitors are due to many resistance mutations in the ALS enzyme. In polyploid species of *Echinocloa crussgalli,* nucleotide substitution of a G with a T confers resistance to this group. Resistance to glyphosate have been reported in 16 weed species in 14 different countries and is becoming a significant problem worldwide. Both, target site EPSPS gene mutation/amplification and non-target site resistance mechanisms, have been proposed. Physiological mechanisms include dissimilar mobility of the herbicide in the whole plant resistance to tubulin assembly-inhibiting herbicides have been reported in only 10 weed species. In India, isoproturon resistant *Phalaris minor* biotypes have developed multiple resistances to ALS inhibitors, ACCase inhibitors, and premix of herbicides. Both target site and enhanced metabolism are reported from Haryana. This poses a major threat to wheat growers in India and a major challenge to the researchers. Molecular modelling studies have revealed that resistance is due to alterations in secondary structure near the binding site. Isoproturon derivatives have been proposed to regain sensitivity in the resistant biotypes.

Management of Herbicide resistance

Changes in crop production strategies combined with a changing climate necessitates reorientation of weed management practices towards an integrated approach involving judicious combinations of cultural, mechanical and biological methods to minimize the dependence on herbicides. Management practices including tillage, stale seed bed, planting time and method of herbicide application are some of the short duration resistance management strategies. Allelopathic crop cultivars will be helpful to further reduce the herbicide load. Monitoring of herbicide resistances should continue in areas with higher levels of herbicide consumptions. Using physiological, biochemical and molecular tools to elucidate herbicide induced epigenetic gene expression will unfold yet unexplained mechanisms of resistance (Yaduraju 2012).

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L-19

Biology and management of *Ambrosia psilostachya* and *Ambrosia artemisiifolia* invasive alien weeds in Karnataka

T.V. Ramachandra Prasad*[1], M.T. Sanjay[2], R. Devendra[2], R.R. Rao[3], N. Satyanarayana[2] and N. Kulkarni[1]
[1]National Institute of Plant Health Management, Hyderabad and [2]University of Agricultural Sciences, Bengaluru; [3]INSA Visiting Scientist, Bangalore
**Email: tvramachandraprasad@gmail.com*

Out of 50 species of *Ambrosia* recorded in the world, 21 species alone are distributed in North America. In Greek, genus *Ambrosia* means the "food of gods". Only two species namely common ragweed (*Ambrosia artemisiifolia* L.) and great ragweed (*A. trifida* L.) cause most allergy problems in human beings, as they produce about a billion pollen grains that cause more hay fever than any other plants put together. In India, two species recorded are perennial ragweed, *Ambrosia psilostachya* DC, in Turuvekre taluk in Tumkur District in January 2012 and common ragweed, *A. artemisiifolia* L. in Krishnarajapuram railway station yard, Bangalore in May 2013 in southern Karnataka.

Ambrosia psilostachya -. is recorded in ten villages namely Muniyur, M. Bevinahally, Gottikere, Srirampura, Pura, Madihally, Madihally Palya, Aralikere, Arisinadahally, Dwaranahally, common lands, social forestry area, invading nearly 400 acres in Turuvekere taluk, Tumkur district, causing altering biodiversity, eliminating grasses, increasing cost of cultivation, lowering the growth and yields of field crops, horticultural crops and plantation crops. This weed has been declared as domestic quarantine weed by the National Institute of Plant Health Management, Ministry of Agriculture, Hyderabad. Transportation of soil, coconut and Arecanut seedlings from infested fields has aided in spreading the plant to other areas in Turuvekre Taluk.

As both the species of ragweeds are noticed in limited area, all kind of efforts can be made to contain the weed immediately and eliminated totally in a period of 4 to 5 years. In this direction, the University of Agricultural Sciences, Bangalore, Directorate of Weed Science Research, Jabalpur, National Institute of Plant Health Management, Hyderabad and Directorate of Plant Protection, Quarantine & Storage, Ministry of Agriculture, Karnataka State Department of Agriculture are working jointly in creating awareness, educating farmers about control measures and ill effects, pursuing villagers to adopt measures to totally eradicate the weed from their fields as well as on public lands in case of *A. psilostachya*. Restriction on the transportation of infested soil, plant materials, implements or other items from the Ambrosia infested area to other adjoining non-infested areas, to prevent the spread of the weed is being attempted. As a first step, about 100 acres of farmers' lands have been treated with glyphosate 41 SL at 10 ml / liter of water or 71 SG at 7.5 g / liter of water and 2,4-D sodium salt at 2.0 g / liter of water to obtain 100% top kill of perennial ragweed. The University of Agricultural Sciences, Bangalore and Directorate of Weed Science Research, Jabalpur is taking appropriate measures to contain *A. artemisiifolia* in K.R. Puram railway yard and to prevent further spread. The farmers of the affected villages have formed "*Ambrosia* Eradication and Welfare Association" and are distributing herbicides to the farmers to take active role in eradication of the weed. The expenses in this regard is met by NIPHM, Hyderabad and herbicides are provided by UAS, Bangalore through the famers' association.

In the history of weed science in India, elimination of ragweeds – *A. psilostachya* and *A. artemisiifolia* will be the first attempt in India and particularly in southern Karnataka, with firm determination through coordinated efforts of all the concerned organizations.

Microbial weed control : opportunities and challenges

L-20

Akhilesh Kumar Pandey
M.P. Private Universities Regulatory Commission, Gyan Vatika, WALMI Road, Bhopal, Madhya Prdesh 462 016
**Email: akpmycol@yahoo.in*

Microbial weed control represents an ecofriendly means to manage obnoxious weed through the naturally occurring microorganisms and their by-products. They either kill or hinder the growth of weeds so that beneficial plant species can gain a competitive advantage. India is a mega diversity country characterised by a variety of microbes supported by extraordinary environmental conditions. Several microbes and their by-products have been evaluated for their potential in weed management under three major strategies like classical, bio herbicidal and integrated approach. A vast diversity of microorganism inhabiting in nature is largely untapped and the potential discovery and characterization of these microbial wealth represents an opportunity to complement chemical herbicides, or reduce the potential for erosion or soil degradation due to tillage for weed control. Discovery of biological controls for invasive plants represents an alternative way to slow the spread of these weeds using natural enemies. The development of biocontrol agents would lessen the need for chemical herbicides and provide greater options for weed management. Microbes have a place in integrated, ecologically based weed management and their potential is only just being realized.

The concept of utilizing microbial herbicides has been explored for more than a quarter century, but there remain many challenges, *viz.* efficacy of the microbial activity, survival of micro organisms, persistence of the suppressive compound, delivery systems, determining host range, and avoiding injury to non-target organisms to overcome before they can be widely used in agricultural, range and forest lands, or waterways. Compatibility with chemical herbicides, regulations, commercialization, mass production and economic feasibility are the other challenges for microbial applications. Various aspects of utilization of microbial wealth in weed management and discussed in this article.

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O-1

Effect of conservation agriculture based systems and weed management practices on weeds and yield of rice

V. Pratap Singh*, V.C. Dhyani, S.P. Singh and Tej Pratap

College of Agriculture, GBPUA&T, Pantnagar, U.S. Nagar, Uttarakhand 263 145

**Email: vpratapsingh@rediffmail.com*

Due to growing resource degradation problems worldwide, conservation agriculture (CA) has emerged as an alternative strategy to sustain agricultural production. The practice of zero tillage and residue retention have emerged as the two cardinal principles of CA. Rice wheat rotation is one of the most important cropping systems of the world. The productivity of the system is decreasing due to pathogens, multi nutrient deficiencies and weed flora besides increasing soil health problems (Singh *et al.* 2012). Rice is normally taken as transplanted and wheat after conventional tillage in rice wheat system. The principles of CA in rice wheat system may include reduced or no tillage, residue recycling, and green manuring. The use of green manure crops having bioherbicidalcharacteristics or weedsmothering capability would have the additional benefit of adding biomass to soil. Sesbania, which is known to fix a large amount of atmospheric nitrogen, has been tried as a pre-rice legume as a source of N (Ladha *et al.* 2000). Sesbania, being an aquatic plant, can also be grown together with rice to suppress weeds. The present investigation was underway to see the effect of conservation agriculture based cropping systems on rice weeds and yield.

METHODOLOGY

A field experiment was conducted since *Kharif* 2012-13 at N.E. Borlaug Crop Research Center of GBPUAT, Pantnagar to develop an appropriate establishment method in rice-wheat cropping system along with weed management practices under irrigated ecosystem. Total eight treatments consisting of five establishment methods in main plot, and three weed control methods in sub plot were laid out in strip plot design with three replications (Table 1). During *Kharif* 2013, rice variety "Pand Dhan 12" was sown on July 01, 2013 in DSR and ZTR plots, wherever, transplanting was carried on July 15, 2013. Bispyribac-Na was sprayed on July 23, 2013 as early post emergence in direct seeded rice (DSR) and zero tillage rice(ZTR) and on August 3 in transplanted rice(TPR) by using 500 litre of water per ha with knap sac sprayer fitted with flat fan nozzle, hand weeding was done on Aug 5, 2013.

RESULTS

After one crop cycle (rice and wheat), IWM practices had its impact on weeds and grain yield of rice. Significantly less weed dry weight and maximum grain yield of rice was obtained in this treatment. Grain yield was at par in herbicidal control and IWM though. On the other hand TPR (CT)-wheat (ZT)-sesbania (ZT) practice resulted in maximum grain yield owing to least weed dry weight in this treatment (Table 1). Conservation agriculture practices had their impact on weed dry weight and grain yield of rice. Under unweeded control, direct seeded rice performed well when residues were retained in both rice and wheat crop together with sesbania green manuring following wheat. The yield was even higher than the transplanted rice based cropping systems when weeds were controlled effectively. TPR (CT)-Wheat (ZT)-Sesbania (ZT) controlled weeds completely under IWM, however maximum yield was obtained with DSR(ZT)+R-Wheat (ZT)+R–Sesbania. Both the treatment remained statistically at par under IWM. (ZT).

Table 1. Interaction effect of establishment methods and weed management on grain yield of rice in rice wheat system during 2013-14.

Treatment Weed Management practices	Cropping systems TPR(CT)-Wheat (CT)	TPR(CT)-Wheat (ZT)-Sesbania(ZT)	DSR(CT)-Wheat (CT)- Sesbania (ZT)	DSR(ZT)-Wheat (ZT)- Sesbania ZT)	DSR(ZT)+R-Wheat (ZT)+R -Sesbania (ZT)	Mean
Recommended .herbicide	4800 (23.0)	5466 (13.5)	5533 (54.5)	5133 (79.4)	5600 (50.1)	5306 (50.1)
IWM (Recommended herbicide+ 1 hand weeding)	5466 (1.6)	5866 (0.0)	5866 (10.0)	5466 (9.7)	6200 (20.4)	5773 (8.3)
Unweeded	3566 (74.2)	4466 (40.4)	650.0 (145.5)	600.0 (239.3)	3033 (194.8)	2463 (138.8)
Mean	4611 (32.9)	5266 (17.9)	4016 (70.0)	3733 (109.5)	4944 (98.5)	
LSD(P=0.05) for grain yield	For Cropping system: 453, For weed management practices: 187, Interaction a)between two establishment methods at the same level of weed management practices: 664, b) between two weed management practices at the same level of establishment methods: 562					
LSD(P=0.05) for Weed Dry weight	For Cropping system: 16.0, For weed management practices: 7.0, Interaction a)between two establishment methods at the same level of weed management practices: 24.0, b) between two weed management practices at the same level of establishment methods: 21.0					

Note: Values in parenthesis are total weed dry weight (g/m^2) values in respective treatments

CONCLUSION

It can thus be concluded that under conservation agriculture system direct seeded rice crop can perform better in terms of grain yield provided weeds are controlled effectively. Zero tillage system worked better than the conventional tillage only when residues were retained.

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Comparative efficacy of new herbicides for weed control in dry seeded rice

C.T. Abraham*, T. Girija, K.M. Durga Devi, K.U. Jithin and Deepa Chandran
AICRP on Weed Control, Kerala Agricultural University, Thrissur, Kerala 680 656
**Email: ctabraham@yahoo.com*

Rice is a crop where weeds are a problem. Dry seeded rice has the most severe weed competition, compared to wet seeded or transplanted rice. Grasses, sedges and broad-leaved weeds usually infest rice. However, grass weeds are more difficult to manage as they are similar to rice in many ways. Spraying cyhalofop-butyl to control grass weeds, *fb* 2,4-D or Almix to control broad-leaved weeds and sedges during 2-3 week stage of rice is a common recommendation for weed control in rice. Recently new herbicides like penoxsulam, azimsulfuron, bispyribac-sodium, fenoxaprop and metamifop etc. are available as alternatives to these herbicides (Abraham *et al.* 2012 and 2013). As the efficacy of these herbicides are likely to differ against different weeds, it is essential to evaluate these herbicides in a field with complex weed flora.

METHODOLOGY

A field trial was conducted in Kerala Agricultural University, Thrissur during *Kharif* 2013. The trial consisted of five new herbicides (penoxsulam 25 g/ha, fenoxaprop-ethyl 60.38 g/ha, metamifop 125 g/ha, azimsulfuron 35 g/ha and bispyribac-sodium 25 g/ha compared with the present recommendation of Cyhalofop-butyl 100g/ha *fb* chlorimuron-ethyl + metasulfuron-methyl (Almix) 8 g/ha. Hand weeded and unweeded control was also included for comparison. The trial was laid out in RBD with three replications. The herbicides were applied at 15-18 days after sowing. Observations on species wise count and dry matter production of weeds as well as growth and yield of rice were taken. The crop was sown on 27-05-2013 and harvested on 20-09-2013.

RESULTS

Major weeds in the field were: *Echinochloa colona, Sacciolepis interrupta* and *Leptochloa chinensis* among grass weeds, *Cynotis axillaris* and *Ludwigia parviflora* among broad leaf weeds and *Cyperus iria* among the sedges. Results of the study showed that all the herbicide treatments brought down the weed population significantly compared to unweeded control. The herbicides differed in their effect on different weeds. Fenoxaprop, Metamifop and Cyhalofop were very effective against *Echinochloa colona, Sacciolepis interrupta* and *Leptochloa chinensis*. However, these herbicides were not effective against broad leaved weeds and sedges. Bispyribac-sodium was effective against all weeds except *Leptochloa chinensis.* Penoxsulam and azimsulfuron were effective against broad leaf weeds and sedges and gave reasonable control of grass weeds. All herbicides resulted in significant reduction in the count and dry matter production of weeds, but not a complete control (Fig. 1). Hand weeding recorded the highest grain yield of 3.25 t/ha. Among the herbicides, cyhalofop-butyl *fb* Almix gave the highest yield of 2.82 t/ha. Other herbicide treatments also resulted in higher grain yield (2.49 to 2.56 t/ha) compared to the poor yield of 925 kg/ha in unweeded control (Fig. 2).

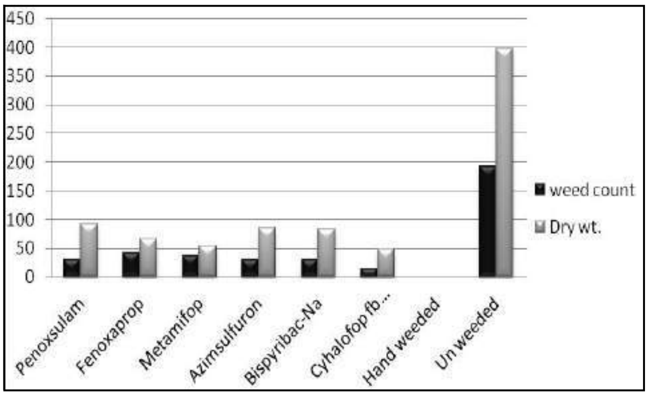

Fig. 1. Effect of treatments on weed count (no./m^2) and dry weight (g/m^2)

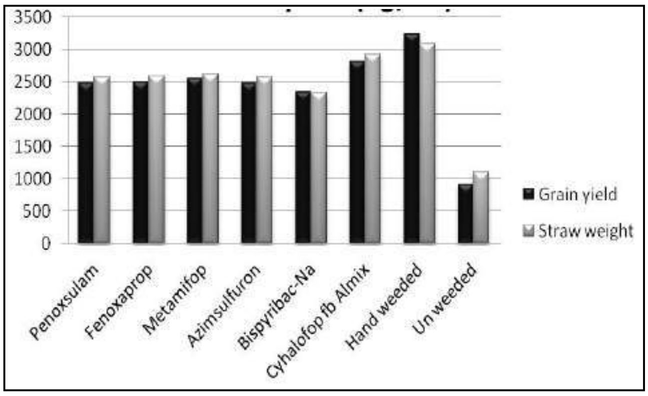

Fig. 2. Effect of treatments on grain and straw yield (kg/ha)

CONCLUSION

The study revealed that the herbicides cyhalofop, metamafop and fenoxaprop-p-ethyl were very effective against grass weeds, but not against sedges and broad-leaved weeds. The herbicides bispyribac-sodium was effective against all weeds except *Leptochloa chinensis*. Azimsulfuron and penoxsulam gave reasonable control of all types of weeds. None of the herbicides resulted in a complete control of the weeds.

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Response of sunflower to pre- and post-emergence herbicides and its residual effect on succeeding greengram

D. Subramanyam* V. Sumathi and K. Siva sankar
Department of Agronomy, S.V. Agricultural College, Tirupati, Andhra Pradesh 517 502
**Email: subbuagro@yahoo.com*

Sunflower (*Helianthus annuus* L) is an important oilseed crop in India. Due to its slow initial growth, sowing in wider spacing coupled with high dose of fertilizer application and irrigation encourages the heavy weed infestation lead to reduced yield. Pre-emergence application of herbicides such as pendimethalin, alachlor and metolachlor are not effective in controlling all the categories of weeds during critical period of crop weed competition. Post-emergence application of quizalofop 75 g/ha proved to be safe to sunflower crop (Hang Chen *et al*. 2000), in contrary, quizalofop 60 g/ha applied at three leaf stage recorded phytotoxicity rating of 0.7 in 0-10 scale. The present investigation was undertaken to know the response of sunflower to pre-and post-emergence herbicides and its residual effects on succeeding greengram.

METHODOLOGY

An experiment was conducted during *Rabi*, 2010-11 at S.V. Agricultural College, Tirupati campus of ANGRA University in a randomized block design with ten treatments and three replications. The test variety of sunflower"*NDSH-1*" was sown on December 12, 2010 with a spacing of 45 cm × 20 cm. Herbicide phytotoxicity on crop at 10 days after herbicide application (DAHA) on sunflower was estimated with phytotoxicity scale of 0= no injury to crop and 100 = complete damage of crop. To know the residual effect of herbicides applied in sunflower on succeeding green gram, a test variety LGG-460 was sown on April 7, 2011 after light ploughing without disturbing the original layout. Recommended management practices were adopted for both the crops as per the package of practices of University.

RESULTS

The predominant weed flora observed in the experiments field were *cyperus rotundus* (40%), *Trichodesma indicum* (27%), *Euphorbia thymifolia* (15%), *Celosia argentea* (6%) *Digitaria bicornis* (4%), *Bracharia reptans* (4%) and other weeds (4%). The crop phytotoxicity rating of 15 was observed with pre-emergence application of oxadiargyl 250 g/ha on sunflower at 10 DAHA and it causes yellowing followed by bleaching of leaves due to inhibition of protox enzyme. Post-emergence application of herbicides did not show remarkable phytotoxicity symptoms on sunflower. The growth parameters, viz., plant height, dry matter production and seed yield of sunflower were the highest with pre-emergence application of pendimethalin *fb* propaquizafop (Table 1). The lowest seedling vigour index was calculated with pre-emergence application of oxadiargyl 250 g/ha than pendimethalin treated plots due to initial phytotoxicity on sunflower. Among the pre-and post-emergence herbicides applied to sunflower, all the herbicides did not show any residual effect on greengram in terms of growth parameters like seedling vigour, plant height and dry matter production including seed yield significantly, but the highest values of the above parameters were recorded in greengram with pre-emergence application of pendimethalin *fb* propaquizafop applied to sunflower due to effective control of weeds in preceding crop of sunflower.

CONCLUSION

It can be concluded that pre-emergence application of pendimethalin 1000 g/ha *fb* propaquizafop/quizalofop 60 g/ha applied at 20 DAS is effective is suppressing the weed growth in sunflower without showing any crop phytoloxicity to sunflower or succeeding greengram in sandy loam soils and pre-emergence application of oxadiargyl 250 g/ha showed phytotoxicity rating of 15 on sunflower with yellowing and bleaching of young leaves.

Table 1. Weed dry weight, phytotoxicity and growth parameters of sunflower at 40 DAS as influenced by different pre-and post-emergence herbicides and its residual effect on succeeding greengram at 20 DAS.

Treatment	Dose (g/ha)	Time of application (DAS)	Weed dry weight (g/m^2)	Sunflower				Greengram			
				Seedling vigour index	Plant height (cm)	Dry matter production (t/ha)	Seed yield (t/ha)	Seeding vigour index	Plant height (cm)	Dry matter production (kg/ha)	Seed yield (t/ha)
Pendimethalin	1000	2	6.98 (48.3)	6.27	57	0.302	1.54	21.5	10.2	99	0.78
Oxadiargyl	250	2	7.15 (50.6)	5.68	54	0.249	1.29	19.6	9.3	98	0.78
Pendimethalin *fb* fenoxaprop	1000& 60	2&20	6.15 (37.4)	6.38	63	0.312	1.66	19.8	9.7	94	0.79
Oxadiargyl *fb* fenoxaprop	250 & 60	2&20	6.56 (42.5)	5.94	55	0.278	1.37	19.2	9.1	101	0.79
Pendimethalin *fb* propaquizalofop	1000&60	2&20	6.19 (37.8)	6.69	71	0.391	2.10	20.3	9.8	104	0.82
Oxadiargyl *fb* propaquizalofop	250 & 50	2&20	6.46 (41.2)	5.98	57	0.296	1.45	22.0	11.0	91	0.79
Pendimethalin *fb* quizalofop	1000 & 50	2&20	6.19 (37.9)	6.36	65	0.332	1.80	20.1	10.0	98	0.80
Oxadiargyl *fb* quizalofop	250 & 50	2&20	6.46 (41.1)	5.85	56	0.292	1.37	22.6	11.5	97	0.78
HW twice	-	2&20	2.62 (6.3)	6.65	69	0.348	1.81	19.6	10.2	99	0.81
Unweeded check	-	20&40	8.75 (76.0)	6.57	53	0.220	1.05	20.2	10.6	90	0.77
LSD (P=0.05)		-	0.23	NS	6	0.403	0.16	NS	NS	NS	NS

DAS: Days after sowing, DAHA: Days after herbicide application, PEH: Pre-emergence herbicides, POH: Post-emergence herbicides

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Alternative strategies for sustainable management of weeds

Ramanathan Kathiresan
Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamil Nadu 608 002
Email: rm.kathiresan@sify.com

The options for integration in a weed management programme are wide, as several elements such as pattern of cropping, land management practices, agricultural inputs and component enterprises offer ancillary benefits of managing weeds and these could well be integrated with the weed control options such as mechanical, biological and chemical measures. Sustainability in managing weeds under varied farming conditions such as wetland rice farming and rainfed or irrigated upland farming with these integrations are discussed in this paper.

METHODOLOGY

Farming elements offering weed solutions

i) Fish culture and poultry rearing in rice

Annamalai University has evolved an innovative integrated rice farming system to manage weeds. The best suited component elements fish culture and poultry rearing were selected from among rabbit, duck, fish and poultry birds for integration. The optimum mode of integration was also determined, including stocking density of fish fingerlings and poultry birds, size of fish trenches, size of poultry cages and nature and quantity of agro inputs. The herbivorous feeding habits of fish fingerlings contributes to weed suppression while the acidic pH and allelomediatry principles of poultry waste interferes with weed seed germination. These positive contributions from these two component farming elements are responsible for the suppression of both the invasive alien species in the rice ecosystems in three districts shown in Table 1.

i) Goats in upland crops

This technology involves rearing goats and using them for manuring as well as plant protection in crops that are grown during the succeeding cropping season. Under existing goat rearing modes, farmers rear goats, exclusively on herbs and vegetation available on social and ranching sites. In this intervention, farmers are trained to rear the goats, allowing them to graze on the weed vegetation (mostly perennial grasses like *Cynodon dactylon* (L.) and sedges like *Cyperus rotundus*) that predominate the cropped lands during the off-season. The reduction in weed biomass in the farmers' fields because of grazing by goats in the off-season was higher in Cuddalore and Nagapattinam districts compared to Villupuram. This is attributed to closer grazing of goats for want of excessive or adequate flushes of weed vegetation in the off-season in these two districts compared to Villupuram.

ii) Use of pigs for weed control in rice

Experiments during consecutive rice seasons at Annamalai University revealed that the use of pigs for burrowing the puddle fields before transplanting of rice compared better to other off-season land management techniques, viz., summer ploughing and glyphosate spray 1.0 kg/ha 45 days before transplanting, in reducing nut sedge population. This treatment in combination with incorporation of tamarind husk 10 t/ha and hand weeding recorded the highest weed control indices.

iii) Integrated control of invasive Eichhornia crassipes

Managing the aquatic weed water hyacinth through the integration of the insect bio-control agent *N. eichhorniae / bruchii* with the use of dried plant material of the medicinal herb *Coleus amboinicus* was shown to be effective through participatory research. This herb is allelopathic on water hyacinth through the mechanism of membrane disruption and electrolyte leakage and the dried plant powder easily gets absorbed into the weed through the leaf scrapings made by the insects (Kathiresan 2000). The insects are released in 24 watersheds spread throughout the district 1000 per water shed at the first instance in October 2009. The aqueous extract of dry leaf powder of *C. amboinicus* was sprayed in January 2010. Among various modes tried for using this weed in order to affix the tag of utility for speeding up public participation in controlling this weed, extraction of nanofibers using three methods; chemical (alkali and peroxide) and mechanical treatments (TEMPO mediated oxidation treatment) were successful. The obtained nanofibers from the weeds using the above three treatments was estimated to be about 5 - 100 nm in diameter of the fibers and lengths in several micron meters. From the nanofibers, the transparent thin film, transparent sheet, paper and then the transparent biodegradable nano composites were prepared (patent no. 1877/Del/2010).

Table 1. Weed suppression due to fish and poultry components in rice

Location	Weed count/m^2				Weed biomass g/m^2			
	L. chinensis		*M. quadrifolia*		*L. chinensis*		*M. quadrifolia*	
Districts	Rice alone	R+F+P	Rice alone	R+F+P	Rice alone	R+F+P	Rice alone	R+F+P
Cuddalore	16	11	38	22	56	38	42	26
Villupuram	9	7	26	19	42	31	46	32
Nagapattinam	21	13	42	27	62	34	32	21

CONCLUSION

The role of changing climate in triggering the invasive behaviour of certain weed species resulting in a shift in the floristic composition of weeds is becoming obvious. Such a scenario warrants the need for multiple options to address a particular weed problem rather than relying upon unified approach. Accordingly, exploring the feasibility of engaging a systems approach of integrated farming, indigenous knowledge base and weed utility offers good weed solutions that reinforces sustainability.

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Topramezone (33.6% SC) + atrazine (50% WP) tank mix efficacy on maize

M. Madhavi*, T. Ramprakash, A. Srinivas and M. Yakadri
Weed Science Research Centre, ANGRAU, Hyderabad, Andhra Pradesh
**Email: molluru_m@yahoo.com*

Maize is an important rainy season crop in Andhra Pradesh. Maize being a widely spaced crop gets infested with a variety of weeds and subjected to heavy weed infestation, which often inflicts huge losses ranging from 28-100%. For effective control of composite weed flora use of broad spectrum post emergence herbicides is the best choice. Topramezone is a HPPD inhibiting herbicide registered for post-emergence weed control in maize. Topramezone provided excellent control of broad leaved weeds and annual grasses evaluated when tank mixed with atrazine (Bollman *et al.* 2008).Since information on broad spectrum post-emergence herbicide and its tank mix usage with atrazine for weed management in maize is meagre, the present investigation was undertaken with the objective to evaluate the bioefficacy of post-emergence herbicide topramezone with and without adjuvant for weed management in maize and to compare the efficacy of tank mix of topramezone and atrazine on maize.

METHODOLOGY

Field experiments were conducted at Acharya N.G.Ranga Agricultural University during kharif and rabi seasons of 2011- 2012in randomized block design with three replications with plot area of 20 m^2. Target crop was maize with hybrid DHM- 117 and maize production systems followed local common farming practice. Topramezone 33.6% SC 16.8, 21.0 and 25.2 g/ha was tank mixed with atrazine 50%WP 250 g/ha and tested with and without MSO adjuvant. Topramezone alone 25.2 g/ha and atrazine 1000 g/ha, hand weeding and unweeded control were also used for comparison. Tank mix topramezone + atrazine were applied as post-emergence herbicide at 20 DAS of maize using spray solution at 500 l/ha with knapsack sprayer fitted with fan nozzle. Weed control (visual assessment of weed count and weed biomass reduction) was determined at 20 and 40 days after herbicide application. Maize crop injury was recorded at 1, 3, 5, 7, 14 and 28 DAA by visual assessment based on 0-10 injury scale where '0' was no injury and '10' was complete crop death. Maize grain was harvested in each plot, weighed and grain yield was expressed on per hectare basis.

RESULTS

Weed flora observed in the experimental field comprised of *Cyperus rotundus* among sedges, *Digitaria* sp, *Dactyloctenium aegyptium, Dinebra arabica, Cynodon dactylon* and *Eleusine indica* among grasses, *Parthenium hysterophorus, Melilotus alba, Trianthema portulacastrum, Euphorbia geniculata, Commelina* spp, *Tridax procubens* and *Amaranthus viridis* among broad leaved weeds. Topramezone 21.0 and 25.2 g/ha tank mixed with atrazine 250 g/ha and MSO adjuvant effectively controlled almost all annual grassy weeds except *Cynodon dactylon* which was bleached but recovered after some time. *Cyperus rotundus* was also not affected where as it resulted in excellent control of broad leaved weeds which were otherwise difficult to be controlled. Tank mix of topramezone + atrazine with MSO adjuvant resulted in higher weed control efficiency, lower weed dry matter comparable to that of hand weeding. Higher maize grain yield was recorded with hand weeding (5.88 t/ha) *fb* topramezone at 21.0 or 25.2 g/ha tank mixed with atrazine 500 g/ha (5.71 t/ha and 5.58 t/ha) and all are on par with each other. Tank mix application of topramezone + atrazine with MSO adjuvant at doses tested did not injure maize at 1-28 days after application.

Table 1. Bio-efficacy of tank mix of topramezone(36.6%SC) + atrazine (50%WP) on maize

Treatment	Dosage g/ha	Weed control efficiency (%)			Weed dry matter (g/m^2)	Grain yield (t/ha)	Phytotoxicity
		Grasses	Sedges	BLWs			
Topramezone 336 g/L SC + atrazine 50% WP	16.8 + 250	43.3	16.7	53.0	26.2	4.82	0
Topramezone 336 g/L SC + atrazine 50% WP	21 +250	63.3	25,0	74.2	21.7	5.38	0
Topramezone 336 g/L SC + atrazine 50% WP	25.2 + 250	63.3	41.7	81.8	19.3	5.56	0
Topramezone 336 g/L SC + atrazine 50% WP + MSO adjuvant 2 ml/lt	16.8 + 250	60.0	16.7	62.1	22.6	5.11	0
Topramezone 336 g/L SC + atrazine 50% WP + MSO Adjuvant 2 ml/lt	21 + 250	73.3	25,0	92.4	13.3	5.58	0
Topramezone 336 g/L SC + atrazine 50% WP + MSO adjuvant 2 ml/lt	25.2 + 250	80.0	41.7	92.4	12.3	5.71	0
Topramezone 336 g/L SC	25.2	50.0	25.0	66.7	40.2	5.42	0
Atrazine 50% WP	1000	3.3	16.7	68.2	45.7	4.65	0
Hand weeding		6.6	75.0	95.4	17.3	5.88	0
Untreated Control		-	-	-	111	2.32	0
LSD (P=0.05)					3.69	0.32	

CONCLUSIONS

Topramezone 33.6% SC 21.0 g/ha tank mixed with atrazine 250 g/ha with MSO adjuvant can be recommended for post emergence application for broad spectrum weed control in maize without any crop injury.

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Utilization of weed species for crop improvement under the regime of climate change

Bhumesh Kumar, Meenal Rathore, Partha. P. Choudhury, R. Singh, N. Tripathi and K. Meena

Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 480 004

**Email: kumarbhumesh@yahoo.com*

World population is growing at an alarming pace with more than 90% of them in developing countries. To feed the growing population, an increase in food production at the similar pace also will be needed. In recent past, despite of continuous efforts of crop breeders, stagnancy has been seen in crop production resulting in ever-widening gap in demand and supply of food items threatening food and nutritional security. Together, food and nutritional security requires three main points to be taken care of - first, a contingent plan for farming in case of adverse climatic conditions leading to failure of main crops; second, utilization of farming land which are poor in resources i.e. water scarcity; and third, growing of the wild / weedy species with possible bio-fortification of micronutrients which will help in providing better nutritional quality at reasonable price to the poor people. To achieve such goal, there is an urgent need to see the variation within known domestication traits in species which are suitable for harsh climate, locally adapted and nutritionally acceptable among consumers. Weeds like *Echinochloa crussgali* and *Physalis* fulfill the above criteria and can go a long way hence chosen for the study. Apart from these, many weed species are identified which can be utilized as source of genetic material for crop improvement especially under the regime of climate change.

METHODOLOGY

Nursery of about 110 accessions of *Echinochloa crusgalli* collected from different locations was prepared in Petri plates having vermiculite medium. After 8 DAS, seedlings were transplanted in field having proper moisture in 6 meter rows. After transplanting, irrigation was applied immediately. Optimum cultural practices were adopted and observations were recorded at suitable growth stages. Variations in morphology, phenotypes, phenology, domestication traits and yield attributes are being observed. In addition, phylogenetic relationship among accessions of the genus *Echinochloa* is also being studied. Preliminary experiments also initiated to study the available variation in different domestication traits for *Physalis* species. Weed species have been tested for abiotic stress tolerance for the purpose.

RESULTS

Vast variations are available among different accessions of *Echinochloa* in terms of height, number of tillers / plant, leaf area / plant, root length, number of panicle / plant and length of panicles. Detailed studies on physiological parameters, yield, and yield attributes, shattering behaviour, dormancy, molecular diversity analysis were conducted.

Different accessions of *Physalis* species were collected. Initial studies showed huge variation in fruit shape, colour, size and fruiting habit. These are further analyzed for their nutritional values. Experiment was conducted to see the water tolerance for *Physalis* spp. Results suggested that *Physalis minima* can tolerate a very high degree of water deficit can survive almost from desiccation. Several weed species are identified which can be used as a genetic material for crop improvement to ensure food and nutritional security under futuristic climate change scenario.

Table 1. Variations in different characteristics among different accessions of *Echinochloa* species.

	38 DAS				52 DAS	
	Plant height (cm)	No. of tillers / plant	Leaf area (cm^2) / plant	Root length (cm)	No. of panicles / plant	Length of panicle (cm)
Minimum	54.6	2.20	57.69	9.60	2.60	11.96
Maximum	125.0	22.73	1735.74	34.33	25.80	22.44
Mean	99.6	5.58	430.02	20.53	3.77	15.19
SEm ±	2.2	0.61	26.78	1.33	0.45	0.70
SEd ±	3.2	0.86	37.87	1.89	0.64	0.99
LSD (P=0.05)	4.4	1.2	53.02	2.64	0.89	1.38

CONCLUSION

Keeping in view the nutritional status and ability to survive in harsh climate, weeds like *Echinochloa crusgalli* and *Physalis* species (two common weed species in India) are potential species which may prove a boon in achieving food security with dietary diversity and alleviating problem of malnutrition. Weeds are reservoir of naturally available gene pool (however, unexplored) and can be used as a source of genetic material for traits like competitiveness, stress tolerance and bio-fortification for crop plants.

Allelopathic effect of *Parthenium* on maize

Y. Nganthoi Devi[1], B.K. Dutta[1], Romesh Sagolshemcha[2] and N. Irabanta Singh*[2]
[1]*Ecology and Environmental Science, Assam University, Silchar 788 011*
[2]*Centre of Advanced Study in Life Sciences, Manipur University, Canchipur 795 003*
**Email: irabanta.singh@gmail.com*

Parthenium hysterophorus L. has achieved the status of the countries "worst weed" owing to its allelopathic effects on agricultural crop production and harmful effects on people and animals (Sushilkumar 2012). It was observed that plants exhibit allelopathy by releasing water soluble phytoxins from leaves, stem, fruits and seeds and such metabolites play an inhibitory role in delay or complete inhibition of seed germination, stunted growth and injury to root systems of plants (Rice 1984). The objectives of this investigation were to determine the effect of *Parthenium* on growth and productivity of *Zea mays.*

METHODOLOGY

Influence of *Parthenium* residue on growth of maize

Twenty healthy seeds of *Zea mays* were sown in each plastic bag containing dried *Parthenium* biomass at the concentration of 50, 100, 150, 200 and 300 g / 10 kg of soil at 0.5 cm below the soil surface. Plastic bag without any *Parthenium* biomass was taken as control. Each treatment was replicated three times and kept in randomized complete design. Percentage of germination and germination index "S" were calculated. The seedling length of *Zea mays* were calculated on 15 and 30 DAS.

Influence of *Parthenium* on productivity of maize

Seed of *Parthenium* and *Zea mays* were sown in 1x2 m^2 plots in randomized complete block design. After one month of sowing, population of *Zea mays* and *Parthenium* was maintained in different ratios of 1:5, 1:10, 1:15 and 1:20, respectively. Plot of *Zea mays* alone was maintained as control. Plant height, plant weight and productivity on corn were observed after 4 months of sowing in treated and control plots.

RESULTS

The dried biomass of *P. hysterophorus* in soil markedly reduced the germination percentage of Z*ea mays* with increase of amount as compared to control. This showed that weed biomass in the soil contains some inhibiting chemicals resulting in the reduced germination of maize. In 300 g / 10 kg soil both fresh and dry weights of maize were significantly decreased compared to control after 15 and 30 DAS. The population of *Parthenium* also affects the productivity of corn length and weight with increase in population. In 20:1 ratio plots the plant height and weight of corn of *Zea mays* was reduced to 12.7% and 47.2%, respectively. Corn productivity of maize also reduced greatly (44.7%) as compared to control in previously infested region with *Parthenium*. This may presumably be due to the release of inhibitory compounds that remain active and stable for considerable duration in soil which causes marked reduction or stop growth of plant (Shaukat and Siddiqui 2001). The present trial also showed the same effect. There was a detectable impact on the growth of *Zea mays* by *Parthenium*.

Table 1. Effect of *Parthenium* on the growth and productivity of *Zea mays* L. (values are mean of all replicates)

Influence of *Parthenium* growth				Influence of *Parthenium* residue					
Treatment P:Z	Plant height (cm)	Whole plant weight (g)	Weight of corn (g)	Treatment	Germination (%)	Shoot length (cm)		Dry weight (g)	
						15 days	30 days	15 days	30 days
Control	279	537.2	146.4	Control	98	7.3	18.9	2.56	5.31
5:1	267	495	132.7	50 g / 10kg soil	80	5.9	17.3	2.23	4.92
10:1	265.2	480	105	100g / 10kg soil	68.3	4.9	16.2	1.97	4.31
15:1	250	465.3	92	150g / 10kg soil	55.3	4.3	14.5	1.82	3.54
20:1	243.6	410.6	77.3	200g / 10kg soil	50	3.4	11	1.70	3.43
PI*	246.5	417.1	81	300g / 10kg soil	46.7	2.6	8.9	1.62	3.10

CONCLUSION

It may be concluded that *Parthenium* as an extract, dry biomass or weed considerably depressed growth and productivity of maize.

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Residues of metsulfuron-methyl and chlorimuron-ethyl in laterite soil under wet sown rice

K.M. Durga Devi* and C.T. Abraham
Kerala Agricultural University, Thrissur, Kerala 680 656
**Email: durgadevikm@rediffmail.com*

Metsulfuron-methyl and chlorimuron-ethyl are selective herbicides coming under sulfonyl urea group and their mixture formulation Almix 20 WP (metsulfuron-methyl 10% + chlorimuron-ethyl 10%) is recommended 4 g / ha along with 0.2% surfactant, in wet sown and transplanted rice at 15-20 days after sowing or transplanting for controlling sedges and broad leaved weeds (KAU 2011). The breakdown of these herbicides in soil is largely dependent on soil conditions such as temperature, moisture, organic matter and pH. In order to see the persistence of these two chemicals in the laterite soil under wet sown paddy, experiments were carried out during the first crop of 2008, 2009 and 2010 at Agricultural Research Station, Mannuthy, Kerala Agricultural University.

METHODOLOGY

The present paper is a part of the Net work trials on "Studies on herbicide residues in food chain, soil and ground water" conducted under All India Coordinated Research Programme on Weed Control. There were six treatments, *viz.* two levels of Almix(R), *viz.* 4 and 8 g / ha, two levels of cyhalofop-butyl (Clincher(R)) 100 and 200 g / ha and the two levels of combination of these two herbicides, with three replications. The herbicide formulations, Clincher(R) and Almix(R) were applied at 18 and 21 days, respectively after sowing rice var. Onam in plots of size 5 x 4 m. The soil had a mean pH of 5.0, organic carbon content 0.79%, available P 48.8 kg / ha and available K 413.0 kg / ha. The soil belonged to Ultisol order with sandy loam texture. Persistence of metsulfuron-methyl and chlorimuron-ethyl in the soil was estimated at 0 and 15 days after spraying and at the time of harvest by taking soil samples from the plots at 0-15 cm depth. For the estimation of metsulfuron methyl and chlorimuron methyl residues from soil, soil samples (25 g) were extracted with 50 ml acetone. Column clean-up was done with 3 g florisil and 5 g anhydrous sodium sulfate, eluted with acetone (100 ml) and directly injected into gas chromatograph Shimadzu GC 2010. Conditions for gas chromatography were : Detector : ECD, Column : BPX 5, Temperature : Column : 210^{0}C ; Injector :230^{0}C : Detector : 250^{0}C .

RESULTS

The results (Fig. 1) showed that the persistence of metsulfuron-methyl was higher than that of chlorimuron-ethyl at both the doses. At recommended levels, 36.45% of the initial residues of metsulfuron-methyl had dissipated from the soil by 15 days after spraying. In the case of chlorimuron-ethyl, the corresponding value was 52.7%. At double the recommended dose, metsulfuron-methyl and chlorimuron-ethyl dissipated to 45.1% and 51.1% of their initial residues. At the time of harvest, residues of both the herbicides were below the detectable level of 0.01 microgram per gram of soil.

CONCLUSION

Metsulfuron-methyl and chlorimuron-ethyl are persisted in laterite soil for more than 15 days after spraying. However, their residues are dissipated to below detectable level by the time of harvest, indicating that they are safe for application in wet sown rice.

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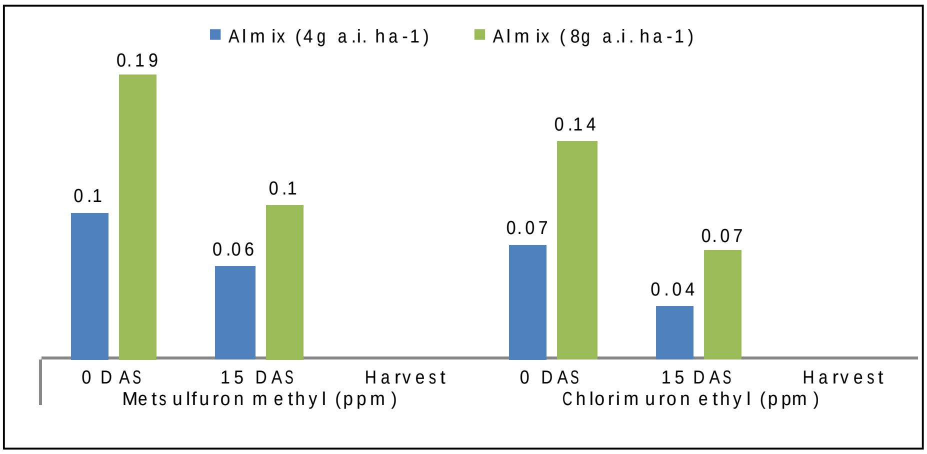

Fig. 1. Persistence of metsulfuron methyl and chlorimuron ethyl in soil at the recommended and double the recommended rates of application

Contribution of brown manuring to weed suppression and nitrogen nutrition of wet seeded rice under varying nitrogen fertilization

B. Gangaiah*, M.B.B. Prasad babu, P.C. Latha, T. Vidhan Singh, P. Raghuveer rao, B. Sreedevi and R.M. Kumar
Directorate of Rice Research, Rajendra Nagar, Hyderabad, Andhra Pradesh 500 030
**Email: bandla_gan@hotmail.com*

Rice (*Oryza sativa* L.), major food crop of India is predominantly grown by transplanting nursery raised seedlings in puddled soils in *Kharif* season with high and stable productivity. However, the ever escalating labour costs for nursery rising and transplanting has paved way for wet seeding of rice (WSR). Simultaneous germination of crop and weeds in WSR leads to intense and prolonged crop-weed competition. Through use of herbicides (pyrazosulfuron-ethyl (pre-emergence) + bispyribac-sodium (post-emergence) weed management is done effectively in WSR. Brown manuring (BM) of *Sesbania aculeata* (Wills.) has been explored as a tool for weed management and nitrogen (N) economy (Gopal *et al.* 2010) in WSR. However, meagre information is available on weed management potential of BM in WSR in relation to N nutrition, hence; the present field investigation was made.

METHODOLOGY

A field experiment was carried out during *Kharif* 2012 at Directorate of Rice Research, Rajendra Nagar, Hyderabad, Andhra Pradesh in clay loam soil with 7.8 pH that was medium in available N, P and K. Treatments formed by combination of two BM (with and without *Sesbania* BM) in main plot and four nitrogen (N) levels (0, 60, 90 and 120 kg/ha) in sub-plot (20 m^2) were tested in four times replicated split plot design. Rice *'BPT5204'* seeds soaked in water for a day and incubated for germination for a day were broadcast in a well prepared puddle soil 40 g/sub-plot. In BM plots, *Sesbania* seeds soaked in water for day were broadcast following rice seeding 18 g/sub-plot. On 10th day, plants were thinned/readjusted to attain a plant density of 80 (rice) and 30 (*Sesbaina*). BM crop was knocked down on 30th day after seeding (DAS) through 2, 4-D spray 0.60 kg/ha. Weed count {grasses, sedges and broadleaved weeds (BLW)} was recorded on 1 m^2 quadrate prior to herbicide spray, all the weeds were uprooted, washed in water, oven dried and total dry weight was recorded. Phosphorus and potassium fertilizers 60 kg P_2O_5 and 50 kg K_2O/ha were applied through single super phosphate and muriate of potash uniformly. Nitrogen as per treatment was broadcast applied on 5, 35 and 55 DAS. Two manual weeding was done (34 and 54 DAS) and data on crop growth, yield was recorded.

RESULTS

The data (Table 1) revealed significant impacts of *Sesbania* BM on sedge and BLW count (thus total weed count) and total weed biomass. Though the total weed count reduction due to BM was small (15.7%), the reductions in weed biomass (46%) was substantial. Additional BM plants (30/m^2) in rice crop by way of competing for physical space has reduced weed count and by strongly competing for resources has drastically reduced the weed biomass. The WSR crop under BM has recorded 0.16 t/ha higher grain yield than no BM plot and this increase was estimated to be equivalent to 7.4 kg N fertilization. Reduced weed biomass and enhanced yield of WSR due to BM in the current study are supported. The data also revealed that though N fertilization failed to alter weed count, the weed biomass was significantly lower in unfertilized WSR crop. Intense competition among rice crop and weed plants for N (limiting resource of the current study) has resulted in significantly less weed biomass production in unfertilized control as compared to that of N fertilized plots. The N fertilized plots have statistically similar weed biomass production. WSR crop grain yield increased significantly with each successive increase of N dose up to 120 kg/ha. Nitrogen response of WSR was found quadratic in nature ($y = -0.2425 x^2 + 1.8355x + 1.8525$; $R^2 = 0.9725$). Interaction effect of N and BM reveal that the contributions of Sesbania BM (from leaf fall and decomposing stems and roots & root nodules) to the yield of rice crop were seen at low N dose only (up to 60 kg/ha). Estimation of BM contributions to N nutrition of WSR from interpolated yield data of rice reveal that the BM contribution was highest (19 kg) in no N applied plot and decreased thereafter as the N dose increased to the lowest of 2.5 kg at 90 kg N dose.

CONCLUSION

Table 1. Effect of brown manuring and nitrogen fertilization on weeds, grain yield and N economy of WSR.

Treatment	Weed count (/m^2)				WB	GY	NE
	Grasses	Sedges	BLW	Total			
Brown manure (BM)							
BM	35.7	5.30	2.00	43.0	13.5	4.70	7.4
No BM	38.2	9.20	3.60	51.0	25.0	4.54	-
LSD (P=0.05)	NS	1.80	1.07	6.5	3.0	0.07	
Nitrogen dose (kg/ha)							
0	36.8	7.90	2.80	47.5	16.4	3.39	19.0
60	36.7	7.90	2.90	47.5	19.1	4.72	8.0
90	36.0	7.40	2.70	46.0	20.4	5.01	2.6
120	36.3	7.80	2.90	47.0	21.1	5.37	-
LSD (P=0.05)	NS	NS	NS	NS	2.73	0.07	

WB - Weed biomass (g/m^2), GY - Grain yield (t/ha) NE - N economy (kg/ha)*, * N economy was worked out by interpolation of rice yield data

It is evident from the study that *Sesbania* brown manuring in wet seeded rice in puddle soil was promising not only from its contribution to N nutrition (when no N or 60 kg N/ha) but also for its weed growth suppression.

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Weed management strategies through post-emergence herbicides in pulses

Narendra Kumar*, K.K. Hazra and N. Nadarajan

Indian Institute of Pulses Research, Kanpur, Uttar Pradesh 208 024

**Email: nkumar.icar@gmail.com*

The effective weed control in pulses is essential to maximize seed yield and quality and to reduce weed competition in following crops. It is estimated that weed causes about 20-40% yield loss in pulses. Adequate weed control can be difficult to achieve because pulses have a relatively low growth habit and open canopy early in the growing season. Additionally, few herbicides are registered for the use in pulses and that too for pre-emergence or pre-plant application. Therefore, most of the recommendations in pulses are combination of pre-emergence herbicide and manual weeding. The earlier research programme on weed management in pulses was focused primarily on pre-emergence (PE) herbicides. The use of post-emergence (POE) herbicides may be one of the tools to mitigate the effect of weeds to a great extent (Kumar 2010 and Kumar and Hazra 2012). The use of post-emergence herbicides as the sole form of weed management has increased dramatically over the past decade as an integrated management of weeds in many field crops. Currently, there is very little information available on post-emergence herbicides application in pulses. Therefore, the present investigation was carried out.

METHODOLOGY

A field experiment was conducted during 2008 to 2012 at Indian Institute of Pulses Research, Kanpur, India (26^{o} $27^{/}$ N, 80^{o} $14^{/}$ E and 152.4 m above MSL) to identify the post-emergence herbicides in pulses for effective weed control. The climate this region is tropical sub-humid, receives annual rainfall of 722 mm and mean annual maximum and minimum temperature is 33.0 and 20.0^{o}C, respectively. Initially for 2008 to 2010, screening trials were conducted to identify post-emergence herbicides available in market. For this purpose, post-emergence herbicides recommended under different crops were used to screen in both rainy as well as winter season pulses. After identification of herbicides, trials were conducted during different seasons of 2010-13 to identify the optimum dose and time of application of these POE herbicides alone or in combination with Pendimethalin (PE).

RESULTS

The major weeds present in pulses during different seasons are presented in table 1. Out of the different post-emergence herbicides used under evaluation trials chlorimuron, metribuzin, metsulfuron-methyl and metsulfuron-methyl + chlorimuron have shown toxicity to almost all pulses grown during rainy as well as in winter season. The phytotoxicity of pendimethalin 1.25 kg/ha applied as pre-emergence was observed in mustard under chickpea + mustard intercropping system. Imazethapyr toxicity was observed in winter season pulses like chickpea, lentil and fieldpea. Imazethapyr even at lower dose of 15 g/ha had shown phytotoxicity in chickpea in which chickpea plants became stunted and bushy and leaves were small and narrow. In case of winter pulses, significantly highest chickpea grain yield was recorded in pendimethalin 1.25 kg/ha (PE) + quizalofop-ethyl 125 g/ha (POE) (1360 kg/ha) which was at par with pendimethalin 1.25 kg/ha (PE) + manual weeding (1.33 t/ha) and pendimethalin 1.25 kg/ha (PE) + quizalofop-ethyl 150 g/ha (1.29 t/ha). Among herbicides combinations, highest weed control efficiency (52.9%), gross return (40,800/ha), net return (14,890/ha) and B: C ratio (1.57) was recorded in pendimethalin 1.25 kg/ha (PE) + quizalofop-ethyl 125 g/ha (POE). The results of 2 years study suggest that Pendimethalin 1.25 kg/ha (PE) + quizalofop-ethyl 100-125 g/ha (POE) may be recommended for effective control of weeds in chickpea. The same treatment was also found effective in lentil and field pea. Quizalofop-ethyl 100 g/ha was also found effective to contain rice ratoons growth which is a major problem in rice fallow-pulses. Similarly in case of rainy season pulses, highest yield of mungbean (0.92 t/ha) was recorded in pre-emergence application of pendimethalin 1.25 kg/ha + manual weeding which was closely followed by pendimethalin 1.25 kg/ha (PE) + imazethapyr 100 and 80 g/ha (POE). However, lowest yield of mungbean was recorded in pendimethalin 1.25 kg/ha (0.35 t/ha). The highest weed control efficiency (74.2%), gross income (‘ 34,468/ha), net return (‘ 18,618/ha) and B: C ratio (1.89) was recorded in pendimethalin 1.25 kg/ha (PE) + imazethapyr 100 g/ha (POE). Pendimethalin 1.25 kg/ha (PE) + imazethapyr 100 g/ha (POE) was found effective in other rainy season pulses like pigeonpea and urdbean. However in summer mungbean, maximum yield was recorded in post-emergence application of imazethapyr 80 g/ha (1.02 t/ha).

CONCLUSION

From above study it can be inferred that pendimethalin 1.25 kg/ha (PE) + quizalofop-ethyl 100 g/ha (POE) may be recommended for effective weed control in winter pulses (chickpea, lentil and field pea) and Pendimethalin 1.25 kg/ha (PE) + imazethapyr 100 g/ha (POE) in rainy season pulses (pigeonpea, mungbean and urdbean). Whereas in summer mungbean, imazethapyr 80 g/ha (POE) and quizalofop-ethyl 100 g/ha (POE) in rice fallow-pulses may be recommended.

Table 1. Major weed flora recorded during different seasons in pulse crops.

Season	Type of weeds	Name of weeds
Kharif	Non- grassy	Digera arvensis, Commelina benghalensis, Celosia argentea, Trianthema monogyna, Euphorbia hirta
	Grassy	Digitaria sanguinalis, Cynodon dactylon, Panicum sp., Echinochloa colonum, Setaria glauca
	Sedges	Cyperus rotundus
Rabi	Non- grassy	Chenopodium album, Anagallis arvensis, Vicia sativa, Fumaria parviflora, Asphodelus tenuifolius, Convolvulus arvensis, Melilotus indica, Medicago denticulate
	Grassy	Phalaris minor, Avena ludoviciana
	Sedges	Cyperus rotundus

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Impact of long term use of manure and fertilizers on weed infestation in jute in Indo-Gangetic plain

Mukesh Kumar*, D.K. Kundu, A.K. Ghorai, Sonali P. Mazumdar and Amar Preet Singh
Central Research Institute for Jute and Allied Fibre, Barrackpore, Kolkata, West Bengal 700 120
**Email: mukesh.agro@gmail.com*

Weeds are important components of agricultural ecosystems. Weed communities and their diversity play a significant role in determination of the nature of weed management strategies to be adopted. Weed diversity and its growth behaviour and composition often changes due to change in selection pressures imposed by different agronomic practices. Fertilizer application is one of the most widespread agronomic practices that are used to improve soil fertility and enhance crop productivity. It significantly affects weed growth and community composition directly through affecting the soil nutrient availability and indirectly through intensifying resource competition between crops and weeds (Wan *et al.* 2012). The objective of the present study was to examine the long term effect of manure and fertilizer application on composition and diversity of weeds in jute under jute-rice-wheat sequences.

METHODOLOGY

This study was conducted as a part of the in long-term fertilizer experiment which was established at the Central Research Institute for Jute and Allied Fibres, Barrackpore (22°452 N, 88°262 E, 9.0 m msl) in 1971 with jute-rice-wheat cropping sequences in the new alluvial soil in the hot humid subtropic of eastern India. The experiment was laid out in RBD,involving of 10 fertilizer/manure treatments, *viz.* 50% NPK, 100% NPK, 150% NPK, 100% NPK+ hand weeding (for all three crops), 100 % NPK+ Zn 10kg/ha in wheat, 100% NP, 100% N, 100% NPK + FYM (10 t/ha), 100% NPK-S (no Sulphur) and control (no fertilizers was applied) with 4 replication. The recommended (100%) dose of fertilizers in jute was 80 kg N, 16 kg P and 33 kg K/ha. The sources of N, P and K in all the treatments were urea, SSP and MOP, respectively, except in 100% NPK-S treatment,where source of P was DAP. The weed survey was conducted on 1 May 2012 and 28 April 2013 in jute at 25 DAS crop growth stages.The sampling of weeds was done by using four randomly selected 50 cm × 50 cm quadrats in each plot of size 20×10 cm.The species wise weeds number in the quadrats was recorded.Biodiversity of the weeds was measured, includingthe species richness *R* (i.e. the amount of speciesincluded in a quadrat); the species diversity, which was measured by the Shannon-Wiener index (*i.e.* $H' = -\sum Pi * \ln Pi$) in which *Pi* is the proportion of individual numbers of the species to the total individual number of each species in the quadrat. It was calculated from the formula as $Pi = Ni/N$, of which *N* is the total individual number of each weed species and *Ni* is the individual number of the species; the degree of community dominance, as measured by the Simpson index, $D = \sum Pi^2$; the community evenness, as measured by the evenness index, $E' = H'/\ln S$. As there was no significant difference in two years data hence, all the calculations were done using mean data of two years.

RESULTS

Application of different doses of fertilizers affected the weed community and composition in jute. A total of 12 weed species was observed in the experimental plots were *Cyperus rotundas, Brachiaria ramose*, *Digitaria sanguinalis*, *Echinochloa colona, Eleusine indica*, *Amaranthus viridis, Physalis minima Cleome viscosa*, *Digera arvenses*, *Phyllanthus niruri, Portulaca oleracea* and *Trianthema portulacastrum.* The density and dominance of these weed species varied with different doses of fertilizers. Dominance of *Cyperus rotundus* was observed in lower doses of fertilizers application and having Importance Value Index (IVI) of 157,144 and 118 in control, 50% NPK and 100% NPK + hand weeding, respectively. In contrast, dominance of *Echinocloa colonum* was recorded in 100% NPK+ Zn (IVI=109) and150% NPK (IVI=82) *i.e.* in balanced and higher fertilizer doses. *Physalis minima* was dominant in 100% N (IVI=81), 100% NPK (IVI=96) and 100% NPK + FYM (IVI=71) compared to other weed species.The higher weed species richness (R=12) and Shannon-Wiener index *i.e.* weed diversity were recorded in 100% NPK + FYM (1 t/ha) treatment (Fig. 1). While, the lowest weed species richness and diversity was recorded in control plot. Weed species evenness was the highest in higher doses of fertilizers (150% NPK) and the lowest was in 100% NPK +hand weeding. In hand weeded plot the highest dominance (IVI=144) of *Cyperus rotundus* was recorded among the 10 weed species, resulted in the lowest weed species evenness. Simpson index was the highest in the 100% NPK and the lowest in 100% NPK + hand weeding and control plot.

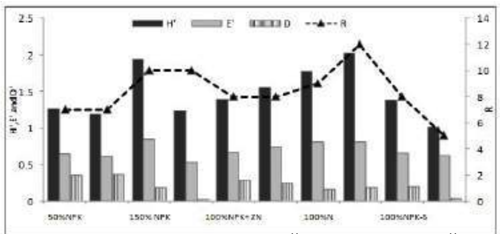

Fig. 1. Shannon-Wiener index (H*), Evenness (E*), Simpson index (D) and species richness (R) of weeds under different fertilizers/manure treatments.

CONCLUSION

Thus it may be concluded that higher infestation of *Cyperus rotundus* was recorded under lower doses of fertilizer while, higher infestation of *Echnichloa colonum* under higher doses of fertilizers. The highest weed species richness and diversity was observed under 100% NPK + FYM (10 t/ha) treatment. Hence, weed management practices in FYM applied field should be given the highest priority.

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Purple nutsedge interference, economic threshold and management in soybean

T.K. Das* and N.T. Yaduraju
Division of Agronomy, Indian Agricultural Research Institute, New Delhi 110 012
**Email: tkdas64@gmail.com*

Soybean [*Glycine max* (L.) Merrill] is commonly infested with weeds, including *Cyperus rotundus* L. (purple nutsedge; family *Cyperaceae*). It is a perennial invasive weed with colonization habit (Rogers *et al.* 2008) and multiplies rapidly through extensive network of under-ground tubers, showing apical dominance. It is highly persistent, grows consistently up to the maturity of soybean and is hardly controlled by the usual selective herbicides. The use of pre- and post-emergence herbicides for almost 10-15 years has led to preponderance of *C. rotundus* in soybean (Kumar *et al.* 2012), causing considerable yield losses. Under global climate change, *C. rotundus* is likely to pose more interference on soybean or other crops due to its higher water-use efficiency, greater leaf area, root length and dry weight, and greater numbers of tubers in response to elevated CO_2 level (Rogers *et al.* 2008). The interference effect of *C. rotundus* across the densities on soybean and its economic threshold (ET), causing economic losses have hardly been investigated in India and elsewhere, but would be useful for its management. Therefore, these experiments were undertaken to evaluate the degree of interference of *C. rotundus* across densities in soybean; to determine its economic threshold; and to find out a suitable management practice with dormancy breakers and tank-mix herbicides.

METHODOLOGY

The experiments were undertaken at the Indian Agricultural Research Institute, New Delhi during 2006-2009 in soybean, 'Pusa 20.' Soil was alluvium (Typic Ustochrepts; Order Inceptisol) in origin and sandy-loam with 0.54% organic C and pH 7.7. The available P (17.5 kg P/ha) and K (180.1 kg K/ha) were medium, but available N (260.5 kg N/ha) was low in soil. In the first experiment, eight infestation levels of *C. rotundus*/weeds, which included six pure stand densities of *C. rotundus* (Cyp 0, 25, 50, 100, 150, 200 plants/m^2), and two natural weed infestations including *C. rotundus* (UWC) and excluding *C. rotundus* (UWC-Cyp) were adopted. A common application of pendimethalin 0.75 kg/ha at 2 DAS was made to all *C. rotundus* densities plots to eliminate other weed species and to achieve uniform pure stands of *C. rotundus*. The required densities of *C. rotundus* were maintained from 20 DAS by periodical counting, and hand pulling of its excess population, and of other weeds, escaping pendimethalin treatment. A non-linear regression model (Cousens 1985) was fitted to calculate the ET of *C. rotundus* in soybean. The second experiment was undertaken during 2008 and 2009 to evaluate the efficacy of dormancy breakers supplemented with herbicide tank-mixes *versus* sequential applications for weed management in soybean. Both the experiments were laid out in a randomized block design with three replications. Data on *C. rotundus* and weed dry eight, soybean growth and yield parameters and yield were recorded every year.

RESULTS

All natural weeds in UWC treatment and *C. rotundus* plants at Cyp 200 accumulated dry weights similar between them in all four years, but significantly higher than those in all other *C. rotundus* densities, except the Cyp 150 in 2007, and 'natural weeds excluding *C. rotundus*' (UWC-Cyp) in 2007 and 2009. The 'natural weed infestation including (UWC) and excluding *C. rotundus* (UWC-Cyp)' and the treatment of 200 *Cyperus rotundus* plants/m^2 caused greater reductions in soybean yields and were the most competitive. The ET of *C. rotundus* in soybean was 19-22 plants/m^2. The yield losses caused by the ET ranged between 9.1 and 11.5%, which are an economic loss under this situation. All herbicide treatments irrespective of tank-mixes and sequential applications were comparable with weed-free check and resulted in significantly higher soybean seed yield than that in unweeded control. All tank-mixes and sequential applications of pendimethalin and imazethapyr resulted in a complete control of all broad-leaved weeds in both the years. The control of *C. rotundus* was more in the tank-mixes of pendimethalin (0.75 kg/ha) and imazethapyr (0.1 kg/ha) PE with GA_3 (400 ppm), and KNO_3 (6%) compared to their respective sequential applications. These two tank-mixes in terms of total weed control or weed control efficiency were superior to others.

CONCLUSION

All natural weeds infestation including *C. rotundus*, and the pure stand density of *C. rotundus* 200 plants/m^2 were equally competitive against soybean. The ET determined in this study using several production factors is more precise and reliable than the ET determined with only yield losses. A tank-mix application of pendimethalin (0.75 kg/ha) and imazethapyr (0.1 kg/ha) as PE with GA_3 (400 ppm), and KNO_3 (6%) may be recommended for effective control of weeds including *C. rotundus* in soybean.

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Integrated weed management in transplanted rice under rain fed conditions of Eastern Himalayan Region

L.K. Baishya*, M.A. Ansari and N. Prakash

ICAR Research Complex for NEH Region, Nagaland Centre, Medziphema, Nagaland 797 106

**Email: lkbaishya@rediffmail.com*

Weed infestation is one of the major constrains for low yield of rice in the Eastern Himalayan Region. The weed flora consists of grasses, sedges and broad leaf weeds causing yield reduction of rice crop up the 5-100% (Singh *et al.* 2002). Farmers mostly follow manual weeding which is costly, time consuming and also limited by availability of labour and weather condition during the critical period. So, the present study was undertaken to develop a productive, profitable and effective weed control practice for transplanted rice.

METHODOLOGY

The experiment was conducted at Research Farm of ICAR RC for NEH Region, Nagaland Centre, Medziphema during *Kharif* season of 2010 and 2011. The experimental soil was sandy loam texture, acidic in reaction pH 5.4, high in organic carbon 0.80%, low in nitrogen 188 kg/ha, moderate in phosphorous 20 kg/ha and low in potassium 48 kg/ha. The experiment was conducted in randomized block design with seven treatment, each replicated thrice (Table 1). The paddy variety, Ranjit was grown with all agronomic package and practices and harvested at maturity.

RESULTS

Weed indices: The major weed flora observed in the experimental field consisted of grasses –*Axonopuscompresus, Cynodon dactylon, Elusine indica;* broad leaves weed – *Alternanthera philaxeroides*, *Commenlina diffusa* and sedges- *Cyperus iria* and *C. rotandus.* Weed control treatments significantly reduced the dry matter accumulation of weeds over the control. The lowest dry matter accumulation was recorded in the weed management practices, application of *butachlor*1.2 /ha at 4th DAT and 2,4-D 1.5 /ha at 7th DAT followed by mechanical weeding at 45 DAT and hand weeding at 60 DATover control and other weed management practices. The highest WCI (0.77), WEI (8.05) and WMI (113.74) were recorded by the same weed management practices. This might be due to higher efficacy of herbicide as well as manual/hand weeding in controlling the broad spectrum weeds in paddy.

Grain and Straw yield: The weed management practices, application of butachlor 1.2 /ha at 4th DATand 2,4-D 1.5 /ha at 7th DAT followed by mechanical weeding at 45 DAT and hand weeding at 60 DATrecorded the highest grain (5.3 t/ha), straw (7.01 t/ha) and harvest index (44.03) over control and other treatments under study. The same treatment recorded 87.28% increased in paddy yield over control and other weed management practices. This might be due to favorable condition for efficient utilization of available growth resources in these treatments under the study as reported by Subramanyam (2007).

Economics: The highest net return was recorded in the weed management practices, application of butachlor 1.2/ ha at 4th DAT and 2,4-D 1.5 /ha at 7th DAT followed by mechanical weeding at 45 DAT and hand weeding at 60 DAT Rs. 46.1 x 10^3 at the cost of cultivation Rs. 19.5 x 10^3. This same treatment gave highest B: C ratio 3.37, crop profitability Rs 341.83 ha/day, economic production efficiency 39.26 kg/ha/ day and biological production efficiency 91.19 kg/ha/day.

Table 1. Effect of weed management practices on Economics, B: C ratio and crop profitability of transplanted rice mean data of two years).

Treatment	Net return (x10^3 `/MJ)	B: C ratio (`)	Crop profitability (`/ha/day)	Economic production efficiency (kg/ha/day)	Biological Production efficiency (kg/ha/day)
Control	14.93	1.85	110.56	20.96	54.52
MW (30 DAT) + HW (45 DAT)	23.91	2.22	177.14	25.19	67.19
Butachlor 1.2 kg/ha at 4th DAT	28.86	2.58	203.19	27.63	69.33
Butachlor 1.2 kg/ha at 4th DAT + MW (45 DAT)	35.59	2.88	263.67	32.07	79.70
Butachlor 1.2 kg/ha at 4th DAT + MW (45 DAT) +HW (60 DAT)	38.64	3.01	286.24	34.30	82.59
Butachlor 1.2 kg/ha at 4th DAT+ 2,4-D 1.5 kg/ha at 7th DAT + MW (45 DAT)	41.75	3.13	309.24	36.52	86.44
Butachlor 1.2/ha at 4th DAT + 2,4-D 1.5 /ha at 7th DAT + MW (45 DAT)+ HW(60 DAT)	46.15	3.37	341.83	39.26	91.19

CONCLUSION

Thus results of the present investigation clearly demonstrate that weed management practices application of *butachlor*1.2 /ha at 4th DAT and 2,4-D 1.5 /ha at 7th DAT followed by mechanical weeding at 45 DAT and hand weeding at 60 DAT can be practiced to achieve better land utilization, high yield as well as profitability and than their weed management practices under rain fed sandy loam soils.

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Efficacy of herbicide mixtures in rainy-season grain sorghum

J.S. Mishra*[1], R. Kalpana[2], V.S. Kubsad[3], Pushpendra Singh[4], N.S. Thakur[5], Z.N. Patel[6], U.N. Alse[7], S.S. Rao[8] and J.V. Patil[9]

[1,8,9]Directorate of Sorghum Research, Hyderabad 500 030, [2]AICSIP, TNAU, Coimbatore; [3]AICSIP,UAS, Dharwad; [4]AICSIP,MPUAT, Udaipur; [5]AICSIP RVSKVV,CA, Indore; [6]AICSIP, NAU, Surat; [7]AICSIP, VNMKV, Parbhani

**Email: mishra@sorghum.res.in*

Yield loss in grain sorghum due to weeds ranges from 15 to 97% depending on crop cultivars, the nature and intensity of weeds, spacing, duration of weed infestation and environmental conditions (Tamado *et al*. 2002). Atrazine, the most commonly used pre-emergence herbicide to control weeds in grain sorghumhas a low effectiveness on grassy weeds. The present study was undertaken to evaluate the efficacy of herbicide mixtures / sequential application of herbicides for broad-spectrum weed control in rainy-season grain sorghum.

METHODOLOGY

Field experiments were conducted under All India Coordinated Sorghum Improvement Project (AICSIP) at six locations (Coimbatore, Udaipur, Dharwad, Parbhani, Indore and Surat) during rainy-seasons of 2011 and 2012. Treatments (Table 1) were replicated thrice in a randomized block design. Herbicides, as per the treatments were applied in 500 l / ha spray volume with knapsack sprayer fitted with flat-fan nozzle. Pre-emergence herbicides were applied next day after sowing and post-emergence herbicides at 25 days after sowing (DAS). Weed density and total weed dry matter were recorded at harvest from 1 m^2 area by placing a 50-by 50-cm quadrate randomly at four places in each plot.

RESULTS

Weed flora varied with the locations but some of the weeds like *Cynodon dactylon, Cyperus rotundus,Commelina benghalensis,* and *Parthenium hysterophorus* were observed at most of the locations. Unchecked weeds caused 48-51% reduction in grain yield of sorghum. Pendimethalin mostly controlled grassy weeds and atrazine, the broad-leaved weeds. Application of atrazine 0.25 kg / ha as pre-emergence +2 hand weeding at 30 and 45 DASsignificantly reduced theweed pressure and increased the grain yield of sorghumas compared to weedy check. Among the herbicide mixtures, tank-mixed application of atrazine 0.25 kg + pendimethalin 0.50kg / ha as pre-emergence followed by post-emergence application of 2,4-D 0.50 kg / ha at 25 DAS, atrazine 0.25 kg / ha as pre-emergence *fb* 2,4-D 0.50 kg / ha as post-emergenceand atrazine 0.25 kg / ha pre-emergence *fb* pendimethalin 0.50 kg / ha at 30 DAS (after first hand weeding as pre-emergence between rows- *Layby* application) were equally effective, but more economical than the atrazine + 2 HW (Table 1).

CONCLUSION

In view of labour scarcity for manual weeding and high labour costs, tank mixed pre-emergence application of Atrazine + pendimethalin (0.25+0.50 kg / ha) followed by post-emergence application 2,4-D at 0.50 kg / ha at 25 DAS or pre-emergence application of atrazine at 0.25 kg / ha *fb* pendimethalin 0.50 kg / ha at 30 DAS (after first hand weeding as pre-emergence between rows- *Layby* application) provided broad-spectrum weed control, higher grain yields and net profits.

Table 1. Effect of weed control methods on weeds, growth, yield and economics in sorghum (mean of 6 locations)

Treatment	Weed population at harvest (no./m^2)		Weed dry weight (g/m^2)		Grain yield (t/ha)		Net returns (x10^3` /ha)		B:C ratio	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
Atrazine 0.50 kg/ha as PE *fb* 1 HW at 30 DAS	42	44	79	77	3.49	3.80	29.06	44.17	2.55	2.74
Atrazine 0.25 kg/ha PE *fb* 2 HW at 30 and 45 DAS	21	20	24	29	3.65	4.29	30.75	49.91	2.54	2.86
Pendimethalin 0.50 kg/ha PE *fb* 1 HW/interculture at 30 DAS	37	38	69	68	3.39	3.84	29.36	44.20	2.52	2.75
Atrazine 0.25 + pendimethalin 0.25 kg/ha as PE (Tank mixed)	43	47	79	82	2.92	3.27	25.95	37.01	2.49	2.58
Atrazine 0.25 + pendimethalin 0.50 kg/ha as PE (Tank mixed)	40	44	71	75	3.15	3.21	27.62	36.66	2.59	2.57
Atrazine 0.25 + pendimethalin 0.50 kg/ha as PE (Tank mixed) *fb* 2,4-D 0.50 kg/ha as POE	34	34	65	64	3.52	3.63	31.60	43.97	2.83	2.86
Atrazine 0.25 kg/ha PE *fb* 2,4-D 0.50 kg/ha as POE	42	43	67	71	3.35	3.52	30.31	42.71	2.86	2.84
Atrazine 0.25 kg/ha PE *fb* pendimethalin 0.50 kg/ha at 30 DAS (after first hand weeding as PE between rows- *Layby* application)	36	27	58	42	3.25	3.64	29.74	45.69	2.67	2.89
Weedy check	96	108	312	231	1.90	2.11	14.81	19.03	1.81	1.64
LSD (P=0.05)	21	34	97	73	0.39	0.53	6.25	15.62	0.48	0.63

PE - Pre-emergece, POE - Post-emergence, *fb* - followed by, HW - Hand weeding, DAS - days after sowing

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Productivity of sunflower- maize sequence as influence by long term tillage and weed management practices

M.T. Sanjay* T.V. Ramachandraprasad, R. Devendra, R.C. Gowda and G.R. Hareesh

AICRP on Weed Control, MRS, University of Agricultural Sciences, Hebbal, Bangalore, Karnataka 560 065

**Email: mt.sanjay@gmail.com*

Weed management is an important aspect in crop production. Tillage practices have been a major weed control techniques for several decades. Tillage helps in weed management by uprooting, burying them deep, by changing the soil environment and inhibiting the weeds germination and establishment by burying the weed seeds both vertically and horizontally (Dorado 1999). A change from conventional tillage to a conservation tillage system can lead to shift in weed species composition. Weed shifts can also occur both within a population of a certain species (e.g., surviving mutants), or within a plant community (e.g., certain species). So a field investigation was undertaken during 2005 - 2013 to know the influence of long term tillage and weed management practices on the productivity of sunflower – maize crop sequence.

METHODOLOGY

The field experiment was conducted during summer and *Kharif* 2005-2012 with eight sunflower (summer) and maize (*Kharif*) crop sequence at the Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore. The soil type was sandy clay silt loam with pH of 6.1, OC of 0.45%, available P_2O_5 of 71 kg / ha and K_2O of 174 kg / ha**.** This trial was laid out in a split plot design with three replications. In sunflower crop two tillage systems (M_1 / M_3 – zero tillage and M_2 / M_2 – conventional tillage repeated twice) and three weed management practices (W_1 - butachlor 50 EC 1.0 kg / ha, W_2 – hand weeding at 20 and 40 DAS, W_3 – unweeded control) and in maize crop two tillage systems (M_1 / M_2 – zero tillage and M_3 / M_4 – conventional tillage repeated twice) and three weed management practices (W_1- atrazine 50 WP 1.0 kg / ha, W_2 – hand weeding at 20 and 40 DAS, W_3 – unweeded control) were tried with a total treatment combination of twelve. Zero tillage refers to glyphosate 41 % SL herbicide application followed by removal of weeds by scrapping the top portion of the weeds and conventional tillage refers to once disking + twice cultivation.

RESULTS

Major weed flora observed in the experimental plots was *Cyperus rotundus* (sedge), *Cynodon dactylon, Digitaria marginata, Chloris barbata, Echinochloa colona* (grasses), *Commelina benghalensis, Euphorbia geniculata, Spilanthus acmella (*broad-leaved weeds) in sunflower and *Cyperus rotundus* (sedge), *Cynodon dactylon, Digitaria marginata, Chloris barbata, Echinochloa colona, Eleusine indica* (grasses), *Borreria articularis, Euphorbia geniculata, Euphorbia hirta, Ageratum conyzoides*(broad-leaved weeds) Averaged over 2005 to 2012, seed yield of sunflower in plots receiving zero tillage continuously (1.15 t / ha) and conventional tillage in the previous crop *fb* zero tillage for current sunflower (1.25 t / ha) gave slightly lower seed yield than the plots receiving zero tillage in previous crop fb conventional tillage in the current sunflower (1.33 t / ha) and continuous conventional tillage (1.38 t / ha) (Table 1).

Table 1. Effect of tillage and weed management practices on the seed yield of sunflower (SF) – maize in the sunflower – maize system during 2005 to 2012 at Hebbal, UAS, Bangalore

Year S05-K05- to - S12-K12	Sunflower seed yield (t / ha)				Maize kernel yield (t / ha)				Cost of tillage / WMP, ` / ha		Saving in weeding cost / tillage x10^3 ` / ha#	
Tillage practices	2005S	2009S	2012 S	Mean	2005K	2009K	2012 K	Mean	Maize	SF	Maize	SF
ZT – ZT – ZT – ZT	2.05	0.89	1.08	1.15	4.82	4.18	1.99	3.78	2.55	2.22	0.70	0.85
ZT – CT- ZT- CT	2.21	1.07	1.43	1.33	5.28	4.26	2.33	4.06	2.55	3.07	0.70	--
CT – ZT- CT- ZT	1.89	0.89	1.29	1.25	5.43	4.29	2.78	4.34	3.25	2.22	--	0.85
CT – CT- CT- CT	2.07	1.02	1.74	1.38	5.49	5.36	2.96	4.58	3.25	3.07	--	--
LSD (P=0.05)	NS	NS	NS	NA	NS	NS	0.65	NA	NA	NA	NA	0.85
W_1 – Herbicide	2.23	1.13	1.41	1.37	5.36	4.60	3.33	4.61	2.89	3.45	3.31	4.05
W_2 – HW (20&40 DAS)	2.55	1.29	1.89	1.61	5.78	5.83	3.00	5.16	6.20	7.50	-	-
W_3 – Unweeded control	1.38	0.48	0.85	0.84	4.62	3.15	1.18	2.79	-	-	-	-
LSD (P=0.05)	0.45	0.47	0.27	NA	0.78	0.90	0.53	NA	NA	NA	NA	NA

Over 2005 to 2012 (eight years mean data), plot given with zero tillage continuously resulted in lower maize kernel yield (3.78 t / ha) perhaps due to poor growth of maize. Plots grown under zero tillage in previous season and conventional tillage in the current season (4.34 t / ha) gave slightly lower yield than continuous conventional tillage, averaged over eight years (4.58 t / ha). Among weed control treatments, plots treated with atrazine (4.61 t / ha) and two hand weeding (5.16 t / ha) gave higher yields than unweeded control (2.79 t / ha). In sunflower cropping system alone, conventional tillage system resulted in additional cost of ‘ 850 / ha in sunflower as compared to zero tillage system (‘ 2,225 / ha), averaged over eight cropping systems during 2005-12 (Table 1). While, the use of butachlor saved ‘ 4050 / ha in sunflower over hand weeding, which was expensive, were obtained in zero tillage - butachlor combination in the sunflower cropping system. However, the seed yields obtained in these treatments were also slightly lower particularly in zero and conventional tillage fb zero tillage for the current season (Table 1). In maize adoption of conventional tillage system caused an additional cost of ₹ 700/ha as compared to zero tillage system (₹ 2,550/ha), whereas the use of atrazine treatment resulted in saving of ' 3310/ha over hand weeding (₹ 6,200/ha). Both the tillage systems in combination with atrazine resulted in savings of ₹ 3,310/ha, as against requirement of ₹ 6,200/ha for hand weeding alone. This was further proved by comparable yields of atrazine with hand weeding (Table 1).

CONCLUSION

Under sandy loam soils, use of conventional tillage perhaps favoured the initial good establishment, good growth of sunflower and maize crops resulting in higher yield and economics compared to zero tillage system. With respect to weed management, use of pre-emergence herbicide in both the systems gave similar yield as that of hand weeding but significantly superior over unweeded control.

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Effect of tillage and weed management options on productivity, energy-use efficiency and economics of soybean

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U.K. Behera*, Monsefi Ali and A.R. Sharma
Division of Agronomy, Indian Agricultural Research Institute, New Delhi 110 012
**Email: u.k. ukbehera2008@yahoo.com*

In North-Western India, fatigue in yield level of different crops, shrinking of farm returns due to rise in input costs, decline in factor productivity, low energy use efficiency and environmental degration are the challenges for improving crop and farm productivity. Under these situations resource conserving technologies involving zero tillage, conservation tillage, bed planting and integrated weed management etc. are recognized as potential tool to restore the degraded ecologies and entrance farm productivity.The studies were conducted during 2008-09 on productivity, energy relations and economic in soybean involving different tillage and crop establishment practices and weed management options. The grain yield of soybean was significantly influenced due to tillage and crop establishment practices. The maximum grain yield of 2.32 t/ha was recorded in conventional tillage raised-bed treatment, which remained similar with conventional tillage flatbed system and zero tillage permanent bed system. However, all these treatments gave significantly higher grain yield than zero tillage flat system. Among weed management options, the maximum grain yield of 2.18 t/ha was recorded with treatment constituting of pendimethalin + 1 HW. This treatment performed similarly with application of only pendimethalin but was significantly superior to control, chlorimuron-ethyl alone as post-emergence application and pendimethalin as PE and chlorimuron-ethyl as POE. The energy relations, *viz.* input energy, output energy, net energy and energy use efficiency were statistically similar in most of the cases except energy-use efficiency for soybean due to different conservation tillage and crop establishment techniques. Weed management treatments significantly influenced the energy relations in soybean crop. The highest energy output (99,188 MJ/ha) was recorded in convention tillage (CT) - raised bed, which was closely followed by CT flat-bed (97,567 MJ/ha). The highest output of 105,470 MJ/ha was obtained in weed free treatment, while the lowest output was obtained in control (83,565 MJ/ha). There was 26.2% additional energy output due to control of weeds. The cost of cultivation varied for different tillage and crop establishment practices from Rs 16,674 in zero tillage to Rs 18,374 in conventional tillage raised-bed. Similarly the cost of production for different weed management options varied Rs 15,977 for control to Rs 19,977 in weed free treatments. The cost of production was 12% higher in pendimethalin + 1 HW treatment comparison to only application of pendimethalin.

Herbicide residues and their microbial remediation in soil

Shashi Bala Singh*[1], Lata[2] and Divya Sharma[2]

[1]*Division of Agricultural Chemicals,* [2]*Division of Microbiology, IARI, New Delhi 110 012*

**Email: sbs_agch@yahoo.com*

Due to shift of rural population to the urban areas, use of herbicides has become a widespread practice, in order to combat the weed situations. Despite their usefulness in the increment of food production, their extensive use has led to the presence of residues in food and environmental contamination. The World Health Organization (WHO) data show that only 2-3% of applied chemical pesticides are effectively used for preventing, controlling and killing pests, while the rest remains in the soil (EPA 2005). The ultimate "sink" of the pesticides applied in agriculture care is soil. Therefore, the surface soil containing residual pesticides causes toxicity in the surrounding environment. Real and perceived concerns about pesticide toxicity have promoted their strict regulation in order to protect consumers, environment and also the users of pesticides. Thus, reliable and accurate analytical methods are essential to protect human health and to support the compliance and enforcement of laws and regulations pertaining to food safety. At present, the pesticide waste is being treated by physico-chemical methods which are not efficient and effective. Among biological approaches, the use of microbes / consortia with degradative ability is considered the most efficient and cost-effective option to clean herbicide-contaminated sites.

Soil being the storehouse of multitudes of microbes, in quantity and quality, receives the chemicals in various forms and acts as a scavenger of harmful substances. The efficiency and the competence to handle the chemicals vary with the soil and its physical, chemical and biological characteristics. Microorganisms play an essential role in the bioconversion and total breakdown of pesticides in the environment. Bioremediation is the breakdown (biodegradation) of contaminating compounds using microorganisms. These microbes often use contaminants as a food source, thereby completely eliminating toxic compounds by changing them into basic elements such as carbon dioxide and water, a process known as mineralization. Incomplete degradation may also occur, or the partial breakdown of the original contaminant to a less complex form. Another result may be the transformation of a compound to a different chemical structure that may affect the toxicity and mobility of the original agent. Sometimes immobilization of a compound occurs where the agent is overcome by the microbe but not eliminated or altered, which is often a potential benefit but rarely a final solution.

Microbial degradation of persistent herbicides like pendimethalin , atrazine (Singh *et al.* 2007), fluchloralin (Singh and Kulshrestha 1995), metolachlor and alachlor (Maisnam *et al.* 2009) was studied and potential microbes isolated for their rapid degradation. Similar studies are carried out with a persistent insecticide bifenthrin (Sharma *et al.* 2012) and five different PAHs (Choudhary *et al.* 2011). In one of the recent studies a bio-surfactant producing bacteria was used as an additional amendment which itself was a slow degrader but helped in solublizing the low water soluble pesticide and made it available for degradation. This study is with a persistent insecticide but the procedures can be extended for bioremediation of problematic herbicides from soil.

METHODOLOGY

Persistence study of bifenthrin was conducted in soil. A bacterial strain *Serratia marcescens,* L-11 which was found to be biosurfactant producing and PAH degrader in earlier studies was procured from Division of Microbiology. A consortium of this strain was prepared along three fungal strains *Aspergillus niger, Aspergillus flavus* and *Achaetomium strumarium* which were isolated from bifenthrin contaminated soil. Degradation / persistence studies of bifenthrin were conducted with this consortium in broth and soil and residues analyzed using GC analysis. Carbon and nitrogen requirements were also assessed. Degradation products were also indentified by comparison with prepared authentic samples using HPLC.

RESULTS

Bifenthrin pesticide is strongly adsorbed on soil and therefore less bioavailability in solution for microbial degradation (Half-life in soil=147 days). Results indicated that using consortium the degradation half life of bifenthrin in soil could be reduced to 27.4 days. Such microbes can be utilized for the remediation of low water soluble persistent compound especially at industry effluent sites. The major advantage of bioremediation is that it is a natural process and can be used at a much lower cost than many other treatment technologies. Additional carbon source could enhance the degradation.

CONCLUSION

Although the conducted studied used a pesticide for termite control but similar bio-surfactant producing microbe mediated studies can be useful for residue management of persistent herbicides. Specially for those herbicides which are strongly adsorbed on soil and have very less solubility in water rendering unavailable for biodegradation by microbes. However, it is essential that such microorganisms are thoroughly evaluated for safety before release into environment.

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Weeds and weed management of rice in Karnataka state – a review

Adusumilli Narayana Rao[1]*; S.P. Wani[2], M. Ramesha[3] and J.K. Ladha[3]

[1]Visiting Scientist, Resilient Dryland Systems and International Rice Research Institute (IRRI): International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru- 502 324; Hyderabad, India;[2] Director, Resilient Dryland Systems, ICRISAT:[3] IRRI/India Office, 1st Floor, CG Block, NASC Complex, DPS Marg, New Delhi 110 012, India

**Email: anrojaya1@gmail.com*

Rice is one of the staple food crops of India and Karnataka state is one of the major rice producing states in India (Rao 2010). The rice productivity in the state is around 2.4 t/ha. Due to advantage direct-seeded rice, the farmers in Karnataka are opting to shift to direct-seeding of rice. Weed management is critical for realizing optimal yields of direct-seeded rice in particular and rice in general (Rao *et al*. 2007). An attempt is made to review the research work carried out on weeds and weeds and management of rice in Karnataka state of India during the past 30 years.

METHODOLOGY

The objective of the study was to review the published literature on weeds and weed management in rice in Karnataka, identify improved weed management technologies for passing on to farmers and suggest research needs based on farmers requirements. For this purpose, literature survey was made and the publications,of past thirty years, on the selected subject were collected. The publications were studied, analyzed and thesummary is presented in this review.

RESULTS

Of 96 weed species reported to be associated with rice in Karnataka, the dominant weeds varied with method of rice establishment (Table 1).The research carried out so far in the state is herbicide based. The herbicides that were found to be effective in rice seedling nurseries include: cyhalofop-p-butyl, bispyribac sodium, bensulfuron methyl + pretilachlor, butachlor, pretilachlor + safener, anilophos and fluchloralin. Even though hand weeding was found to be effective in all methods of rice establishment, it is time consuming, tedious and costly as labor is becoming scarce, unavailable in time and costly. The herbicides that were found effective include: a) oxyfluorfen + pretilachlor, pyrazosulfuron in aerobic rice; b) pendimethalin, thiobencarb, molinate + propanil, molinate, bispyribac sodium, cyhalofop-butyl at + chlorimuron + metsulfuron , fenoxaprop + chlorimuron + metsulfuron and fenoxaprop + ethoxysulfuron in dry-seeded rice; anilofos + 2,4-D, thiobencarb, anilofos, pendimethalin, pretilachlor, acetachlor, azimsulfuron + metsulfuronm-ethyl, bispyribac-sodium, butachlor, cinosulfuron, oxadiazon, quinclorac, in transplanted rice; and c) anilofos, butachlor + halosulfuron-methyl, butachlor + safener, oxyfluorfen, pretilachlor + safener , butachlor in wet-seeded rice.

Table 1. Most commonly reported weeds species in rice established by varying methods.

Most reported weed species	Rice (all establishment methods)	Transplanted rice	Dry-seeded and aerobic rice	Wet-seeded rice
1	*Echinochloa colona*	Cyperus iria	Ageratum conyzoides	Eclipta prostrata
2	Cyperus difformis and Cyperus iria.	*Echinochloa colona*	Commelina benghalensis	Alternanthera sessalis
3	Eclipta prostrata	Eclipta prostrata	*Echinochloa colona*	Cyanotis axillaris
4	Ludwizia parviflora	Ludwizia parviflora	Cynodon dactylon	Digitaria ciliaris
5	Rotala verticiclaris	Rotala verticiclaris	Cyperus procerus	Echinochloa crus-galli

CONCLUSION

Integration of herbicides with hand weeding or inter cultivation was found to be effective in rice established by different methods. Options that were found economical in managing weeds varied across the different rice establishment methods Need for development of location specific sustainable integrated weed management strategies (Rao *et al.* 2007, Rao 2010, Rao and Nagamani 2010) and extension of available technologies to the farming community in Karnataka is emphasized.

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Broad spectrum weed management in chickpea for NEPZ

Devendra Singh*, I.B. Pandey, Subodh Kumar, R.S. Singh and V. Bharti

Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar 843121

**Email: devendrasingaicrpweed@yahoo.com*

Heavy infestation of weeds is one of the major constraints for successful cultivation of chickpea.Potential yield loss in chickpea due to weeds infestation ranges between 22–100% (Saxena and Yadav 1976). Very little work has been reported on weed management in chickpea. Keeping this in view the present investigation was carried out for broad spectrum weed management in chickpea.

METHODOLOGY

A field experiment was conducted during the *Rabi* season of2012-13 at research farm of Tirhut College of Agriculture Dholi, Muzaffarpur. Eleven treatment combinations were evaluated in randomized block design with three replications (Table 1).Chickpea variety 'BG 256' was sown in row 30cm apart. Recommended dose of fertilizer (20:40:20 kg N:P:S) was applied as basal,uniform cultural practices and plant protection measures were adopted. Data on weed density m^{-2} were recorded randomlyby using 0.25 m^2quadrate from each plot.

RESULTS

Phyto-toxic effect on chickpea plant was observed with application of fenoxaprop-ethyl, oxyflurofen and pendimethalin + imazethpyr combination in early stages up to 16 to 21 days after herbicide application.

Equally higher grain and straw yields 2.35 and 1.95 t/ha, 2.46 and 2.33 t/ha, 2.49 and 2.17 t/ha, 2.29 and 2.22 t/ha and 2.26 and 2.10 t/ha were recorded under treatments Weed free, pendimethalin CS + one hoeing, One hoeing with wheel hoe + line weeding, pendimethalin EC + One hoeing, pendimethalin CS formulation respectively. All above treatment were found at par among themselves except the application of pendimethalin CS + one hoeing and alone pendimethalin CS formulation in respect of weed management.

Lower weed dry weight (1.72g/m^2, 1.81g/m^2, 2.11 g/m^2, 1.94 g/m^2 and 2.66 g/m^2) and higher weed killing efficiency (92.8%, 91.9%, 90.5%, 91.26% and 88.1%) were also observed in treatments Weed free plot, one hoeing with wheel hoe + line weeding, pendimethalin EC + one hoeing, pendimethalin CS + one hoeing and pendimethalin CS formulation respectively. The above result clearly indicate that the reductionin weed dry weight resulted more weed killing efficiency and higher grain and straw yields of chickpea in Combined application of pendimethalin both formulation(EC and CS) with one harrowing or harrowing alone in combination with line weeding. All had similar effect to weed free plot.

Table 1. Grain yield, straw yield, weed dry weight and weed killing efficiency as affected by weed control treatments

Treatment	Grain yield (t/ha)	Straw yield (t/ha)	Weed dry matter g/m^2 at 60 DAS	Weed killing efficiency
Pendimethalin EC 1 kg/ha, PE + one hoeing 30 DAS	2.29	2.22	2.11	90.58
Pendimethalin CS formulation (1 kg/ha), PE	2.26	2.10	2.66	88.12
Pendimethalin CS formulation (1kg/ha), PE + one hoeing at 30 DAS	2.49	2.17	1.94	91.26
Oxyflurofen 0.25 kg/ha PE + one hoeing at 30 DAS.	2.09	2.05	1.81	91.93
Fenoxaprop-ethyl 60g/ha POE at 25-30 DAS.	1.60	1.46	10.54	52.72
Pendimethalin 30 EC formulation + imazethpyr 2% (ready mix combination) 1kg/ha PE.	1.80	1.73	11.45	48.71
Pendimethalin 30 EC formulation + imazethpyr 2% (ready mix combination) 1kg/ha PE + One hoeing at 30 DAS.	1.91	2.03	10.15	54.65
One hoeing at 30-35 DAS by wheel hoe.	2.46	2.43	4.69	78.97
Weedy check	1.74	1.46	8.44	62.37
Weed free	2.349	1.95	1.72	92.37
Mulching with rice straw (6 cm) 30 DAS)	1.266	1.05	22.51	00.00
LSD (P=0.05)	0.235	2.01	1.28	5.45

CONCLUSION

Pre-emergence application of pendimethalin either CS formulation or EC formulation along with one harrowing by wheel hoe or one harrowing by wheel hoe at 30 DAS followed by line weeding is very effective to control weed in chickpea field for North Eastern Plain Zone.

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Assessment of compatibility of herbicides with insecticides

A.S. Rao*

ANGRAU, Integrated Weed Management, Regional Agricultural Research Station, Guntur, Andhra Pradesh 522 034
**Email: atlurisrao@gmail.com*

In general, post emergence application of herbicides may coincide with insecticides application also. Presently, farmers are applying post emergence herbicides and insecticides separately as there is no recommendation/information regarding their tank mixing. Some of the farmers are tank mixing herbicides with insecticides which sometimes cause injury/not working because of lack of compatibility. Little information is available on compatibility of herbicides with insecticides (Finlayson *et al.* 1975). Severe crop injury may result from tank mixing herbicides with organophosphorous insecticides (Kreuz and Raymonde 1992). Therefore, tank mixing of herbicides with insecticides is of paramount practical importance to farmers in view of the labour scarcity and increased cost of labour wages. Keeping this in view, the present experiment is proposed to test the compatibility of herbicides with insecticides, in order to save time and cost of spraying.

METHODOLOGY

A lab and field study was conducted during *Rabi* 2011-12, at Regional Agricultural Research Station, Lam, Guntur to study the compatibility of some important post emergence herbicides (fenoxaprop-ethyl, quizalofop-ethyl, propaquizafop, cyhalofop-butyl, pyrithiobac, bispyribac, imazethapyr) with commonly used insecticides like monocrotophos, chlorpyriphos, acephate, acetamipride, imidachloprid and fipronil). Before field testing, all the above herbicides were directly mixed with the above insecticides under lab conditions by mixing equal quantities of both the herbicides and insecticides and various characters like heat generation, colour, precipitation, phase separation if any, agglomerations, scum formation, crystal formation, chemical reaction if any, physical compatibility etc. were observed.Then the recommended dose of herbicides and insecticides were tank mixed before spraying on the recommended crop and all the above observations were also observed before spraying on the recommended crop. The recommended post emergence herbicides like cyhalofop-butyl, propaquizafop, quizalofop-ethyl, fenoxaprop-ethyl and imazethapyr were tank mixed with all the above insecticides and sprayed on blackgram*'PU-31'* at 23 DAS. Similarly, the rice post emergence herbicide bipyribac-sodium was tank mixed with all the above insecticides and sprayed on direct seeded rice (variety BPT 52044 DAS. The post emergence cotton herbicide pyrithiobac was tank mixed with all the above insecticides and sprayed on cotton (variety Mallika) 62 DAS. The crop injury, if any, was observed daily upto 14 days after spraying.

RESULTS

Results of the trial indicated (Table 1) that post emergence herbicides like fenoxaprop-ethyl, quizalofop-ethyl, propaquizafop, cyhalofop-butyl, and imazethpyr were found to be compatible with insecticides like monocrotophos, chloropyriphos, acephate, acetamipride, imidachloprid, fipronil in blackgram without any crop injury. Further, the herbicides bispyribac-sodium in rice and pyrithiobac in cotton were also compatible with above insecticides without any crop injury.

Table 1. Compatibility chart of herbicides with insecticides

Herbicides \ Insecticides	Monocrotophos	Chlorophytiphos	Acephate	Acetamipride	Imidachloprid	Fipronil
Fenoxaprop-ethyl	C	C	C	C	C	C
Quizalofop-ethyl	C	C	C	C	C	C
Pyrithiobac	C	C	C	C	C	C
Propaquizafop	C	C	C	C	C	C
Bispyribac	C	C	C	C	C	C
Cyhalofop-butyl	C	C	C	C	C	C
Imazethapyr	C	C	C	C	C	C

Note: C = Compatible as tank mixtures

CONCLUSION

It was concluded that all these herbicides are compatible with the insecticides mentioned above as no adverse effects occur as result of mixing them together directly as well as tank mixing. However, these results need further confirmation.

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Effect of integrated weed management in spring harvested sugarcane ratoon

R.K. Singh*, M.K. Singh and K. Singh

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005

**Email: rksingh_agro@rediffmail.com*

Sugarcane (*Saccharum officinarum* L.) is an important commercial cash crop. In India more than 50 to 55% of sugarcane acreage is occupied by rations. Sugarcane ratoons are highly exhaustive having higher demand for nutrients because of shallow root system, decaying of old roots, sprouting of stubble buds, immobilization of nitrogen and sever weed infestation (Lal and Singh 2008). Manual weeding is one of the most effective weed control measures but timely availability of agricultural labourer is of remote possibility, manual hoeing / weeding are costly and labour intensive and timely quality availability of chemicals combine with low purchasing power of the individual farmers thus, there is need to identify effective integrated weed management options. The works on integrated weed control in sugarcane ratoon crop is very meager in Varanasi region of Eastern Uttar Pradesh. Considering the above facts this experiment was conducted during 2009-10 with integrated approach to control weeds in spring planted sugarcane.

METHODOLOGY

A field experiment was conducted during spring ratoon seasons of 2009-2010 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. The experimental soil was sandy clay loam with pH 7.85, organic carbon 0.32%, low available N (184.62 kg / ha), low available P (24.55 kg / ha) and medium available K (234.37 kg / ha). Ten treatments were randomly assigned in simple randomized block design with three replications (Table 1). The cane plantation was already installed with a row spacing of 75 cm in the experimental field. The crop was harvested and the plantation was irrigated with flooding system of irrigation. Fertilizers were applied as per recommended dose of the area. The crop was uniformly fertilized with 120 kg N, 60 kg P_2O_5 and 60 kg K_2O per hectare giving half of the nitrogen and full dose of phosphorus and potassium as basal in furrows. Remaining nitrogen was top dressed in two equal splits at 60 and 90 DAP. Sugarcane ratoon crops were raised with recommended practices.

RESULTS

Weed flora of the experimental plots as observed during the critical period of crop-weed completion were broad leaf weeds such as *Chenopodium album, Asphodelus tenuifolius, Trianthema partulacastrum and chorchorus* spp., sedges- *Cyperus rotundus* and grasses, *viz. Cynodon dactylon, Sorghum halepense, Panicum maximum, Dactyloctenium aegyptium* and *Setaria glauca*. The effect of treatments in reduction of weed density and weed dry matter were obtained due to various treatments compared with weedy check. In the plot where weed free conditions were maintained the cane yield obtained was 70.1 tonnes / ha. Effect of treatments on number of millable canes and cane length was significant and the highest cane yield (68.1 t / ha) was obtained under the treatments involving three hoeing (15, 45 and 75 DAR) followed by trash mulching which were at par with all other treatments except weedy check, one hoeing and one hoeing followed by trash mulching. The maximum weed infestation was recorded in weedy check plot with lowest cane yield *i.e.* 49.9 t / ha.

Table 1. Effect of integrated weed management in spring harvested sugarcane ratoon

Treatment	Weed density (no. / m^2)		Weed dry weight (g / m^2)		Millable canes (x10$^{3`}$ / ha)	Cane yield (t / ha)
	15 DAR	45 DAR	15 DAR	45 DAR		
One hoeing at 15 DAR	1.00	10.23	7.90	9.96	65.1	58.3
One hoeing at 15 DAR+ trash mulching	1.00	9.11	6.10	8.75	78.9	64.1
Two hoeing first at 15 DAR and second at 45 DAR	1.00	6.71	4.15	6.66	86.3	60.7
Two hoeing first at 15 DAR and second at 45 DAR + trash mulching	1.00	6.82	4.45	6.70	88.5	66.4
Three hoeing first at 15 DAR, second at 45 DAR and third at 75 DAR	1.00	6.59	4.13	6.35	101.1	67.7
Three hoeing first at 15 DAR, second at 45 DAR and third at 75 DAR+ trash mulching	1.00	6.18	4.11	4.13	109.3	68.1
Atrazine 2.0 kg / ha (PE) followed by 2,4-D 1.0 kg / ha (PE) at 60 DAR	9.66	5.11	3.98	3.98	108.5	67.9
Thick trash mulching in furrow	6.37	6.42	4.98	6.45	101.1	66.8
Weed free	0.00	0.00	0.00	0.00	115.3	70.1
Weedy check	14.33	19.21	13.9	16.5	48.9	49.9
LSD (P=0.05)	6.19	9.31	4.35	4.45	9.1	9.9

CONCLUSION

The integrated weed management practice; three hoeing first at 15 days after rationing (DAR), second at 45 DAR and third at 75 DAR followed by trash mulching is the most effective weed management practice for controlling weeds in spring harvested sugarcane ratoon closely followed in order by atrazine 2.0 kg / ha (PE) followed by 2,4-D 1.0 kg / ha (PE) at 60 DAR, three hoeing first at 15 DAR, second at 45 DAR and third at 75 DAR, thick trash mulching in furrow, two hoeing first at 15 DAR and second at 45 DAR followed by trash mulching and two hoeing first at 15 DAR and second at 45 DAR.

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Conservation agriculture - potential way for weed management

U.P. Singh*, J. Padmavathi, H.S. Ravi Kumar, Himanshu Singh and Lakhapati Singh
Department of Agronomy, Institute of Agricultural sciences, BHU, Varanasi, Uttar Pradesh
**Email: udaipratap.singh1@gmail.com*

Conservation Agriculture (CA) is a system designed to achieve agricultural sustainability by improving the biological functions of the agroecosystem with limited mechanical practices and judicious use of chemical inputs (FAO, 2010). CA is focused on three principles; i) less disturbance of soil by minimum tillage or zero-tillage and use of herbicides for suppression of weeds, ii) retention of sufficient residues on the soil surface, and iii) cover crops and crop rotations to control the weeds, pests and diseases, and protect the soil from erosions (Mader and Berner 2012). CA with the application of permanent ground cover and diversified crop rotations, together with minimum soil disturbance after a transition period of about 2-4 years, results in significant reduction of weed pressure with the subsequent reduction in herbicide use (Friedrich 2005).

Weed management through conservation agriculture:

Zero/minimum tillage: Reduced or zero-tillage tillage decreases the weed population through creating unsuitable conditions for weed seed germination (Benech-Arnold *et al*. 2000).CA based crop management practices, *viz.* permanent no-till residue managed beds and double no-till (zero till direct seeded rice- zero till wheat) reduced weed infestation in rice-based cropping systems of eastern Uttar Pradesh due to less weed seed bank disturbance in soil and proper cover of soil by the residue (ISWS News Letter 2013). The field managed under minimum tillage or zero-tillage holds the weed seeds on the soil surface that increases the predation possibility of weed seed. Zero-till DSR with anchored residue was found to be most effective in minimizing weed density, dry weight and nutrient depletion by weeds (Singh 2012).

Residues Retention: Retention of residues suppresses the weeds by modifying the microclimatic condition of soil (Robinson,1998). Presence of crop residues on the soil surface reduces the possibility of weed seed contact with the soil, thus hinders the weed seeds germination rate.The residues on soil surface accelerate the microbial decay of weed seeds through protecting them from excessive cold and hot temperature (Crist and Friese 1993). Residue retention with *Trichoderma* application and residue retention alone was found more effective over the residue removal in minimizing the weed density and total dry weight in zero-till wheat (Kumar 2009). Hence, residues retention on the surface could be a good weed management option.

Cover crops, crop rotations and weed control: Appropriate crop rotations and growing of cover crops during fallow period helps to suppress the weed population by smothering and allelopathic effect (Peigné *et al*. 2007). Perennial grasses (*Imperatacylindrica, Cynodon dactylon*) and other problem weeds (e.g. *Striga* spp. or *Chromolaena odorata*) can be suppressed by one or two seasons of cover crops.According to Teasdale *et al*. (2004), growing of wheat, maize and soybeans in rotation tends to decrease the weed seed bank and abundance of the broadleaf weed. A permanent residue cover reduces the sunlight exposure of weed seeds and compete with the weeds for space and nutrient. Sesbania as a cover crop significantly reduced sedges and broadleaved weeds in ZT direct seeded rice (Ghosh 2010). Hobbs (2007) argues that CA reduces the problem of weeds by 50-60 % by inhibiting weed germination through mulch or cover crops. Cover crops may affect weed community dynamics through alteration of nutrient cycling processes, particularly N cycling (Ngouajio M and McGiffen ME Jr 2002).

CONCLUSION

Adopting CA practices while integrating minimal soil disturbance, need based residue retention and sensible crop diversification can be a potential option for sustainable weed management.

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Integrated weed management for higher green forage yield and quality in oat

P.S. Bodake*, C.M. Bisiwasi, S. H. Pathan, P.M. Choudhari
Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra 413 722
**Email:pramegash@gmail.com*

In India, oat (*Avena sativa* L.) is the major cereal forage crop for *Rabi* season which is quick growing, palatable and nutritious for the livestock. Compared to other cereal straws which have similar chemical compositions, oat straw has more digestible organic matter. Being a winter, irrigated and long durational crop, the oat is heavily infested with various species of annual and perennial weeds. This infestation results in decline in fodder productivity. In the changing climate situation weeds have a greater genetic diversity than crops. Consequently, if a resource (light, water, nutrients or carbon dioxide) changes within the environment, it is more likely that weeds will show a greater growth and reproductive response. Changes in temperature, wind speed, soil moisture and atmospheric humidity can influence the effectiveness of herbicide applications. However, on the other side due to scarcity of labourers, it becomes very difficult to manage the weeds in time under irrigated condition resulting in to more crop weed competition for nutrient, light, moisture and space thus, causing substantial reduction in green forage yield and quality of oat (Anonymous 2010). Hence the present investigation was carried out to find the effective integrated weed management method in oat crop.

METHODOLOGY

A field experiment was conducted at the farm of Forage Crops Research Project, M.P.K.V, Rahuri during *Rabi* 2011-12 to study the effect of integrated weed management on growth, yield and quality of oat. The soil was loam and low in available nitrogen, available phosphorus and very high in potassium with pH 8.4. The trial of nine treatments was laid out in randomized block design (RBD) with three replications. Oat variety '*RO-19*' (*Phule harita*) with spacing of 30 cm in rows and fertilizer dose of 100:50:40 ($N:P_2O_5:K_2O$) kg/ha part.

RESULTS

The major weed species observed included dicot weeds such as *Chernopodium album* and *Parthenium hysterophorus*; and monocot weeds such as *Cyperus rotundus* and *Cynodon dactylon*. The lowest population (plants/m^2) and dry weight of weeds were recorded in weed free check and was at par with post emergence metsulfuron methyl at 0.004 kg /ha at 3 WAS+1 HW at 5 WAS, pre-emergence pendimethalin at 0.75 kg/ha+1 HW at 5 WAS and post emergence 2,4-D at 0.75 kg/ha at 3 WAS+1 HW at 5 WAS resulting into higher WCE than other treatments. These results are corroborated with the results of Kumar *et al*. (2001). Weed free check recorded significantly higher growth and yield attributes compared to other weed control treatments. Amongst integrated weed management treatment highest green forage (43.30 t/ha) and dry matter (9.26 t/ha) yield of post emergence metsulfuron methyl at 0.004 kg/ha at 3 WAS + 1 HW at 5 WAS and pre-emergence pendimethalin at 0.75 kg /ha + 1 HW at 5 WAS, giving the lowest WI. Similar trend was observed in Crude protein and crude fibre yield and proved to be the most remunerative weed control treatment, recording the highest net monetary returns (₹ 17,331/ha) and benefit: cost ratio (2.00).

Table 1. Weed dynamics, forage yield, quality and economics as affected by different integrated weed management treatments in oat

Treatment	GFY (t/ha)	DMY (t/ha)	Dry wt. of weeds (kg/ha)	WCE (%)	WI (%)	Crude protein content (%)	Crude protein yield (t/ha)	Net returns ($x10^3$₹/ha)	B:C ratio
Weedy check (Control)	24.51	4.53	543	0.00	45.45	7.1	0.32	7.31	1.59
Weed free check	44.93	9.72	000	100.0	0.00	7.2	0.70	10.70	1.42
HW at 3 WAS	37.17	7.37	057	89.32	17.24	7.1	0.52	13.12	1.79
HH at 3 WAS	32.27	6.12	236	56.20	28.18	7.0	0.42	10.58	1.70
Pendimethalin 0.75 kg/ha + 1 HW at 5 WAS	41.66	8.70	025	95.44	7.26	7.2	0.63	14.97	1.82
2,4-D at 0.75 kg/ha 3 WAS + 1 HW at 5 WAS	34.72	6.67	028	94.76	22.67	7.1	0.47	10.08	1.57
Metsulfuron-methyl 0.004 kg/ha at 3 WAS + 1 HW at 5 WAS	43.30	9.22	013	97.60	3.60	7.2	0.66	17.33	2.00
2,4-D at 0.75 kg/ha at 3 WAS + 1 HH at 5 WAS	33.49	6.38	046	91.53	25.45	7.1	0.45	9.79	1.58
Metsulfuron-methyl at 0.004 kg/ha at 3 WAS + 1 HH at 5 WAS	39.21	8.14	043	92.16	12.7	7.2	0.59	14.58	1.87
LSD (P=0.05)	2.75	0.80	029	4.50	6.00	NS	0.06	2.16	0.13

CONCLUSION

It can be concluded that post emergence metsulfuron-methyl at 0.004 kg/ha at 3 WAS+1 HW at 5 WAS, can be a better option for weed control in oat alongside pre-emergence pendimethalin at 0.75 kg/ha+1 HW at 5 WAS as it ensures higher green forage and dry matter yield which is even at par with weed free check; and it provides higher net returns and B:C ratio.

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Effect of pre-emergence herbicides on weed flora and yield of sesame

Raghwendra Singh* and Dibakar Ghosh

Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004

**Email: singhraghu75@gmail.com*

Sesame (*Sesamum indicum* L.) is one of the oldest crops known to humans. There are archeological remnants of sesame dating to 5500 BC in the Harappa Valley in the Indian subcontinent. India ranks first in area and second in sesame production bycontributing 23.2% and 18.5% of the world area and production respectively. In India, it is cultivated in an area of about 1.80 million hectares with a production of 0.64 m t. The presence of weeds can negatively influence sesame yield. Upadhyay (1985) reported weed-induced reductions of sesame yield up to 135% and a need for a critical weed-free period up to 50 days after planting. The initial growth of sesame is slow; therefore, the suppression of weed growthat early period of crop growth is critical. Hence, this study was designed to evaluate the effectiveness of different pre-emergence herbicides (alone and in combination) on weed flora of summer sesame.

METHODOLOGY

A field experiment was conducted at experimental farm (23°132 N, 79°582 E, and 390 m above mean sea level) with plot size of 12 m^2 of Directorate of Weed Science Research (ICAR), Jabalpur (M.P.) India. Wheat during summer season of 2013. The soil of experimental field was clay loam in texture, neutral(7.2) in reaction, medium in organic carbon (0.79%), available nitrogen (312 kg N/ha) and phosphorus (18 kg P_2O_5/ha) but high in available potassium (291 kg K_2O/ha). The experiment was laid out in randomized block design, replicated thrice, comprises 8 treatments *viz*. Pendimethalin 750 g/ha, oxyfluorfen 150 g/ha, imazethapyr 60 g/ha, metribuzin 200 g/ha, pendimethalin 750 + imazethapyr 50 g/ha,imazethapyr 35 g/ha + imazamox 35 g/ha, two handweeding (2 HW) and weedy check. Sesame variety 'TKG-22' was sown with recommended package of practices. Fertilizers were applied through urea, di-ammonium phosphate and muriate of potash @ 60 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha.

RESULTS

The pre-emergence herbicides have varied response over broad and narrow leave weeds. Pendimethalin750 + imazethapyr 50 g/ha showed better control over *Alternanthra philoxeroides* and was at par with other herbicides tried, except imazethapyr 35 g/ha + imazemox 35 g/ha,which shows that lower dose of imazethapyr have lesser impact on *Alternanthra philoxeroides*. Metribuzin controlled *Cichorium intybus* effectively and was statistically similar to oxyfluorfen 150 g/ha, imazethapyr have very less effect on this weed. Emergence of *Euphorbia geniculata*was checked by almost all the herbicides. Minimum dry weight of broad leave weeds was recorded with combination ofpendimethalin750 + imazethapyr 50 g/ha. The population of *Digitaria sanguinalis*was significantly reduced with the application of imazethapyr 60 g/ha and oxyfluorfen 150 g/ha. Though the herbicides reduced the population of *Dinebrretroflexa* but the difference was not upto the level of significance. *Echinocloa colona* the major narrow weed was effectively controlled by pendimethalin 750 + imazethapyr 50 g/ha, metribuzin 200 g/ha, and pendimethalin 750 g/ha. The minimum dry weight of narrow leaf weed was recorded with the application of pendimethalin 750 + Imazethapyr 50 g/ha (Table 1). The effective control of weeds in sesame was also reported by Grichar and Dotray (2007) with the use of pendimethalin at 750 g/ha. The maximum yield was harvested with two handweeding and it was significantly superior over all other treatments. Though all the preemergence herbicides suppressed the weeds significantly over weedy check but they also have negative effect on sesame seed germination. Among the herbicides the best yield was recorded with the treatment pendimethalin 750g/ha.

Table 1. Effect of pre-emergence herbicides on density and dry matter of broad and narrow leaf weeds and yield of summer sesame

Treatment	Broad-leave weeds: Density(no./m^2)			Broad-leave weeds	Narrow-leaved weeds: Density(no./m^2)			Narrow-leaved weeds	Yield t/ha
	Alternanthra philoxeroides	*Cichorium_ intybus*	*Euphorbia geniculata*	Dry weight (g/m^2)	*Digitaria sanguinalis*	*Dinebra retroflexa*	*Echinocloa colona*	Dry weight (g/m^2)	
Pendimethalin 750 g/ha	2.0^{C}	13.1^{B}	4.6^{AB}	10.7^{BC}	1.8^{ABC}	1.3^{A}	5.1^{CD}	6.3^{BC}	0.55^{B}
Oxyfluorfen 150 g/ha	3.4^{C}	5.8^{C}	1.7^{AB}	11.4^{BC}	0.2^{D}	4.3^{A}	11.4^{AB}	8.6^{B}	0.37^{CDE}
Imazethapyr 60 g/ha	3.7^{BC}	15.7^{B}	3.4^{AB}	14.0^{BC}	0.7^{D}	1.6^{A}	7.0^{BC}	6.1^{BC}	0.41^{CD}
Metribuzin 200 g/ha	5.3^{ABC}	3.6^{C}	6.6^{AB}	18.2^{B}	1.9^{AB}	4.0^{A}	4.5^{CD}	6.1^{BC}	0.45^{BC}
Pendimethalin750 + imazethapyr 50 g/ha	1.7^{C}	16.2^{B}	9.0^{A}	8.9^{BC}	1.2^{BCD}	1.3^{A}	4.1^{CD}	4.8^{CD}	0.53^{B}
Imazethapyr 35 g/ha + imazamox 35 g/ha	9.3^{A}	20.4^{AB}	1.2^{B}	9.2^{BC}	0.8^{CD}	1.3^{A}	7.1^{BC}	6.3^{BC}	0.34^{DE}
2 Hand weeding	3.6^{BC}	4.6^{C}	1.3^{B}	7.4^{C}	0.6^{D}	1.0^{A}	1.7^{D}	2.3^{D}	0.68^{A}
Weedy check	8.6^{AB}	25.7^{A}	6.47^{AB}	31.8^{A}	2.84^{A}	4.3^{A}	12.4^{A}	13.1^{A}	0.27^{E}
LSD (P=0.0)	3.1	4.5	4.5	5.8	0.6	NS	3.0	2.11	0.06

CONCLUSION

It may be concluded that pendimethalin750 controlled the broad leave as well as narrow leave weeds and recorded better yield among pre-emergence herbicides in summer sesame.

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Effect of pre-emergence botanical and chemical herbicides on weed management in paddy and their effects on soil microflora

R.K. Ghosh*, P. Adhikary, R. Poddar, R. Das, S. Sentharagai and D. Shamurailatpam

Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, West Bengal 741 252

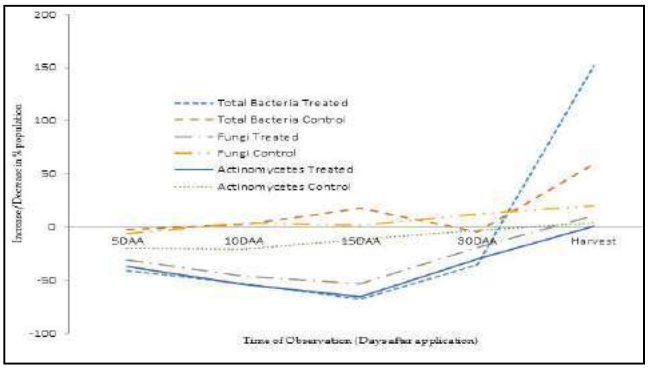
**Email: rkgbckv@rediffmail.com*

Agriculture, which is sustainable since its' inception through 'Jhum cultivation', is the backbone of a nation as well as for the world food security. Global population is gradually increasing, in 1930 it was only 2 billion and now 7.3 billion, in 2045 it is estimated 9.0 billion. The world having only 51.0 billion ha land therefore, only 170 square meter / person will be available. There is a minor potentiality of increasing food production by increasing the arable land thus the major way for increasing the food production lies on increasing the productivity / unit area by using the available resources with best management practices overcoming the problems of current climate change and farmers' traditional habitat. Weed, the major pest, causes 11.5% world and 12.5% national food production and in paddy which is the major crop in West Bengal, it causes around one forth losses in production. Though hand weeding is the traditional weed management but because of more labour wages and problems of labour availability in critical crop weed competition stages the farmers are seeking for alternate management. Chemicals may be botanicals or synthetics are the best alternative (Jana *et al.* 2011, Ghosh *et al.* 2012).

Field experiments were conducted at this Viswavidyalaya during 2007-12 to study the effect of pre-emergence aqueous extracts of botanicals and chemical herbicides on weed control efficiency, yield advantage and impact on soil microflora in paddy cv. IET 4786. All 23 experiments were conducted following the system intensification with best management of available resources. Keeping plot size minimum 4 x 5 m and having varied treatment numbers (7- 12) the randomized block design were followed with three replications in all experiments. On transplanted summer paddy ten botanicals in three different experiments [aqueous leaf extracts (ALE) of *Parthenium hysterophorus, Tectona grandis, Calotropis procera, Bambusa vulgaris, Echinochloa colona, Blumea lacera, Hibiscus sabdariffa, Ageratum conyzoides, Cyperus difformis* and *Cucumis sativus* were applied within one day after preparation 10% (100 ml / l of water) at 1 DAT]. In kharif transplanted paddy ten PE chemical herbicides (bispyribac-sodium 10 SC, pyrazosulfuron-ethyl 10 WP, butachlor 50 EC, triasulfuron 20 WG, pretilachlor 50 EC, pretilachlor 30.7 EC, oxadiargyl 80 WG, pyrazosulfuron-ethyl 0.75% + pretilachlor 30% WG, pendimethalin 38.7% CS and oxyfluorfen 23.5 % EC) were tested with varied doses in ten different experiments. On direct seeded *Kharif* paddy six PE chemical herbicides (cyhalofop-butyl 10 EC, carfentrazone 40 DF, bispyribac-sodium 10 SC, butachlor 50 EC, pretilachlor 30.7 EC and oxyfluorfen 23.5% EC) were tested with varied doses in six different experiments while on nursery paddy four chemical herbicides (cyhalofop butyl 10 EC, butachlor 50 EC, bispyribac sodium 10 SC and pretilachlor 30.7 EC) were tested in four different experiments with varied doses of herbicides. In all experiments along with weedy check and twice hand weeding at 20 and 40 DAT / DAS a common mechanical weeding was applied at 30 DAS / DAT. The soil was sandy loam, neutral pH and the recommended fertilizer dose of neem cake 2 t / ha, N:P:K 60:30:30 in *Kharif* and 100:50:50 kg / ha in summer paddy were applied.

The results showed that in transplanted *Kharif* paddy the weed control efficiency (WCE) at 25 DAA was varied from 64.46 - 89.31% and maximum average yield (from ten different experiments) was obtained from hand weeding twice (3.99 t / ha) *fb* pyrazosulfuron-ethyl 0.75% + pretilachlor 30% WG (3.90 t / ha). In direct seeded *Kharif* paddy (six different experiments) the corresponding figures were WCE 53.00 - 83.57% and 2.87 t / ha (hand weeding twice) followed by bispyribac-sodium 10 SC (2.79 t / ha) while in nursery *Kharif* paddy the WCE 65.30- 87.57 %. The aqueous leaf extracts of botanicals in transplanted summer paddy could manage only the grassy weeds. The WCE ranged 40.30 (*Cyperus difformis* ALE) - 81.95% (hand weeding) and the yield paddy ranged from 3. 18 (weedy check) to 6.21 t / ha (hand weeding). The microflora population in both bio and chemical treatments initially showed decrease upto 21 DAA and thereafter a gradual increase in all experiments.

In conclusion the herbicides of both bio and chemicals may able to substitute the traditional hand weeding with minor affecting the population of soil microflora while recording more biological yield.



Effect of pre-emergence (PE) herbicide on percentage Total Bacteria,Fungi and Actinomycetes population (mean of twenty experiments)

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Weed management in organic agriculture systems

R.P. Dubey
Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004
**Email: dubeyrp@gmail.com*

Organic agriculture has gained momentum during the last two decades owing to the concerns expressed on the safety of environment, soil, water and food chain. During 2011, 162 countries in the world were practicing certified organic agriculture in an area of 37.2 m ha *i.e.,* 0.86% of the total agricultural land (FAO 2013). It is estimated that only about 0.3% of the total cultivated area in India is under organic farming, mostly in the states like Madhya Pradesh, Odisha, Maharashtra, Jammu & Kashmir, Rajasthan, Karnataka, West Bengal, Gujarat, Uttarakhand and north-eastern hill states. Weed management in organic agriculture is the one of the biggest challenge for obtaining optimum crop production levels. Hence, it is desirable to develop and evaluate organic weed management methods in major cropping systems.

METHODOLOGY

Several field experiments were conducted to compare the organic weed management practices against the inorganic and integrated methods during 2010-2012 at DWSR, Jabalpur. The major cropping systems studied were rice-wheat, soybean-wheat and okra-tomato. The treatments included weed management practices like stale seed bed, mulching with straw and black polythene, intercropping, and manual weeding, while herbicides alone comprised the inorganic, and herbicide + hand weeding as integrated method of weed management. The experiments were conducted in fixed plots.

RESULTS

Rice-wheat cropping system

Application of FYM 10 t/ha with 2 HW was most effective in controlling the weeds in DSR however, FYM 10 t/ha + Sesbania incorporation 30 DAS produced the highest rice grain yield of 5.26 t/ha followed by recommended NPK (5127 kg/ha) as compared to control (2.55 t/ha).

Application of 50% FYM + 50% NPK along with herbicide (clodinafop 60 g/ha) *fb* 1 HW was most effective in reducing the weed infestation. However, the wheat grain yield was highest in NPK (4896 kg/ha) followed by FYM 10 t/ha + berseem intercropping (4.68 t/ha).

Soybean – wheat cropping system

The lowest weed density and dry biomass at 60 DAS in soybean was recorded under the treatment 50% NPK+50% FYM and herbicide+ 1 HW.The soybean yield was at par among the treatments *i.e.,* FYM 10 t/ha + 2 hand weeding 25 and 45 DAS (2.55 t/ha), FYM 10 t/ha + Sesbania incorporation 30 DAS (2.52 kg/ha), 50% FYM + 50% NPK+ herbicide fb 1 hand weeding 25 DAS (2.48 kg/ha) and NPK (2.44 t/ha).

Application of 50% FYM + 50% NPK along with herbicide (clodinafop 60 g/ha) fb 1 HW was most effective in reducing the weed infestation in wheat. However, the wheat grain yield was highest in NPK (5.79 kg/ha) followed by FYM 10 t/ha + berseem intercropping (5.19 kg/ha).

Okra- tomato cropping system

Application of FYM + black polythene mulch was the most effective in reducing the weed infestation and production of highest yield of okra (19.46 t/ha) followed by FYM 10 t/ha + 2 hand weeding 25 and 45 DAS (15.57 t/ha)and straw mulch (14.57 t/ha).Application of FYM + black polythene mulch was the most effective in reducing the weed infestation and production of highest yield of tomato (32.48 t/ha) followed by FYM 10 t/ha + 2 hand weeding 25 and 45 DAS (29.02 t/ha).

CONCLUSION

It was concluded that FYM 10 t/ha + sesbania incorporation at 30 DAS in rice and soybean, and FYM 10 t/ha + berseem intercropping in wheat could be a viable option for organic weed management in rice-wheat and soybean-wheat systems.Similarly,in okra-tomato system FYM 10 t/ha + straw mulching and 2 hand weedings were the best organic weed management practices while however, black polythene mulch was the most effective in controlling weeds and obtaining higher yields.

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Innovations in phytochemicals for weed management

D.K. Pandey*

Directorate of Weed Science Research, Maharajpur, Jabalpur, Madhya Pradesh 482 004

**Email: dayapandey@hotmail.com*

Innovations in phytochemicals for weed management continue to be priority area for environmental and toxicological costs of synthetic herbicides, rising instances of development of herbicide resistance in weeds, high costs and long time (about 13 years) required to bring out a new molecule to the market, and present crisis in the industry due to not forthcoming any new major molecule over the past two decades in spite of premier institutions and herbicide industries worldwide. Innovations in phytochemicals were initiated at the Directorate of Weed Science Research, Jabalpur way back in 1991. This involved initially selection of plant species for investigation. Prominent and noxious weeds, pesticidal and medicinal plants, and some species not belonging to either of the categories, were selected for the investigations. These included ragweed *Parthenium* (*Parthenium hysterophorus*), lantana (*Lantana camara*), neem (*Azadirachta indica*), tropical soda apple (*Solanum viarum*), ban tulsi (*Croton bonplandianum*), mugwort (*Artemisia vulgaris*), East Indian valerian (*Valeriana wollichii*), *Strobilanthus atropurpureus*, *Artemisia vestita*, sesame (*Sesamum indicum*), *Spinasia oleracea*, etc. plant parts and their allelochemicals.

Initially, the plant parts (including leaf, stem, petiole, wood, root, inflorescence, flower, fruit pulp and peel, and seed, as applicable and relevant, were powdered and evaluated for their herbicidal activity on major crop wheat and rice and their major weeds *P. minor* and *Echinochloa crusgalli* seed germination and early seedling growth in the dark, and on floating (*E.crassipes*, *Salvinia molesta*, *Pistia stratiotes*, *Spirodella polyrrhiza*, *Azolla pinnata* and *Lemna pausicostata*) and submerged (*Hydrilla verticillata*, *Ceratophyllum demersum*, *Najas graminea*, *Potamogeton crispus* and *Chara zeylanica*) aquatic weeds outdoors. The plant parts showing potential herbicidal activity were taken up for further studies. Allelochemical crudes were prepared from the plant parts showing appreciable activity and the preparations were evaluated for the herbicidal activity.

The investigations resulted in isolation of some of the potential herbicidal molecules. The molecules were purified using chromatographic techniques and characterized by using physico-chemical characteristics involving spectral details. Attempts were also made to elucidate their mechanism of action and analyzed implications of presence of the molecules in the species on chemical ecology including allelochemical interactions.

Some of the interesting findings and deductions emanating from the investigations include information generated on herbicidal activities of the plants, plant parts, allelochemical crudes, major constituents from some of the important weeds and plants and their allelochemicals, and implications on allelochemical interactions and herbicidal potential of the isolated molecules. *Parthenium* plant parts residues and allelochemical crudes had potential inhibitory activity on crop and weed seed germination and potential herbicidal activity on floating and submerged aquatic weeds. Parthenin, a sesquiterpene lactone showed herbicidal activity on all floating and submerged aquatic weeds at 25-100 ppm.

Twenty seven allelochemicals were evaluated for their herbicidal activity on prominent floating and submerged aquatic weeds. Investigations established selective herbicidal activity of allelochemicals in some instances e.g., hydroquinone killed green musk chara (*Chara zeylanica*) at a concentration which was not toxic to rice, supporting occurrence of selectivity in allelochemicals, and prompting intensification of studies to find such secondary metabolites for the development of natural herbicides or for deriving lead for the development of environment friendly herbicides. Studies also showed that hydroquinone was herbicidal to submerged aquatic weed *Ceratophyllum demersum* at as low as 1 ppm (0.01 mM) and lethal at 8-11 ppm (0.075-0.10 mM). The toxicity symptoms on the weed were dull green appearance followed by loss of biomass, and bleaching and fragmentation of the plant resulting in death in 3-12 days. Relatively higher toxicity of hydroquinone, a phytotoxin, to *Ceratophylum demersum* than to rice appeared to be due to capability of the latter to withstand excessive accumulation of the hydroquinone in the roots and inability of the chemical to reach the shoots. The phytotoxin appeared to have killed the aquatic weed by causing massive damage to cellular membrane integrity, loss of metabolic activities and macromolecules, accompanied by associated starvation and accumulation of oxidative stress. Such a differential toxicity of a phytotoxin, which is short lived in the environment, to a crop and associated weed may have potential of weed management under certain circumstances. *Lantana* plant parts and their allelochemical crude herbicidal property appeared to be mostly due to phenolics as the pentacyclic triterpenoids (lantadenes) isolated from the plant parts were insoluble in water and hence it was difficult to assign them role in chemical ecology and allelochemical interactions in natue. Neem plant parts and their allelochemical crude showed varying degrees of herbicidal activity on aquatic weeds. The seed residue had relatively higher bioherbicidal activity. One of the isolated fractions soluble in ethyl acetate had potential herbicidal activity on aquatic weeds at 25-100 ppm, attempts are underway to characterize the molecule. Plant parts residues, their allelochemical crude and terpenoid and alkaloid fractions from *Solanum viarum* seeds were potential herbicidal for some of the aquatic weeds. *Croton bonplandianum* plant parts residues were herbicidal to aquatic weeds and phenolics appeared to be responsible for the bioactivity. *Artemisia* plant parts and methanol soluble constituents were herbicidal to *Ceratophylum demersum* at 100 ppm. One of the fractions was lethal to *Phalaris minor* at a concentration (e.g., 100 ppm) non-toxic to wheat, rice and *Echinochloa crusgalli* seed germination. The *Valeriana wollichii*, *Artimisia vulgaris* var. *nilagirica*, *Strobilanthus atropurpureus* and *Artemisia vestita* were also herbicidal to aquatic weeds. Investigations are underway on characterization and mechanism of action of isolated molecules of potential herbicidal activity.The innovations in phytochemicals for weed management need intensification for harnessing advantages out of natural treasure of molecules of plant secondary metabolites. The natural treasure mostly remains yet not fully explored for the development of newer herbicides and / or newer site of action and / or providing lead for the newer herbicides to overcome, at least in part, the current problems of the industry.

Weed as organic inputs, as medicine and as food

A.S. Rajput*, V.Y. Deoghare, Priyanka Pradhan P. Ravindranath

Regional Centre of Organic Farming ,Ministry of Agriculture Govt. of India Nagpur Maharashtra 440 001

**Email: asrajput67@gmail.com*

"*Amontrum aksharam nasti, Nasti Mulam vanaostham, Ayogya Pursas nasti, Yoja Tatha Tatra durlabha.*" Means there is no letter in the world which do not farm any mantra, no plant, in the world which do not be used as medicine, similarly no men in the world who do not contain few good things, only there is a need of good management. There are several weeds processing special nutritional and healing powers that could be utilized as very good source of organic inputs, medicinal plants and food (Table 1).

Weeds can be composted along with other organic inputs and cow- dung and good quality N, P and K, can be prepared. The efficiency of this compost N P K is better than chemical fertilizers (NPK). Today, some farmers have a renewed interest in organic methods of managing weeds since the widespread use of agro-chemicals has resulted in purported environ-mental and health problems. It has also been found that in some cases herbicide use can cause some weed species to dominate fields because the weeds develop resistance to herbicides. In addition, some herbicides are capable of destroying weeds that are harmless to crops, resulting in a potential decrease in biodiversity on farms. It is important to understand that under an organic sys-tem of weed control, weeds will never be eliminated but only managed.

Organic weed management is a holistic system involving an entirely different approach to managing a farming system. The organic farmer is not inter-ested in eliminating all weeds but wants to keep the weeds at a threshold that is both economical and manageable. A farmer who manages weeds organi-cally must be intimately familiar with the type of weeds and their growth habits to determine which control methods to employ. Under organic methods of weed management weeds are mostly high in minerals nutritional contents and other soil imbalance. Weeds like *Dandelions*, have roots that extent deep into the subsoil to bring up important trace mineral nutrients useful to higher plants (Duka and Atchley 1986). Similarly other weeds such as *Purslane* make soil condition by extending tendrils and filaments to provide shade, moisture and soil aeration and ultimately improvement of water holding capacity. The few weeds are consumed as food are known as *Amarnth, Purslane, dandelions* and nettles. Soil solarization ,mulch such as living mulch, organic mulch ,mechanical weed management and biological weed management are the best options for utilization of weeds as organic inputs, medicine and as food (Michael 1987, Melissa and Verlinden 2003).

Table 1. Comparative nutritional values of leafy vegetables and weeds

Nutrient	Lamb's quarter	Purslane (mg)	Average weed (mg)	Average leafy veg. (spinach, kale, lettuce, *etc.)* (mg)
(PER 100 G)				
Calcium	309 mg	103	186	106
Beta-carotene	7 mg	1.5	5.6	3.6
Fiber	2.1 g	3.5	2.7	2.4
Niacin	1.2 mg	0.5	0.9	0.45
Iron	1.2 mg	3.5	2.7	2.4
Phosphorus	72 mg	39	57	46
Potassium	-	-	382	445
Protein	4.2 g	1.7	2.8	2.7
Riboflavin	0.44	0.1	0.24	0.16
Thiamin	0.16	0.03	0.11	0.08
Vitamin C	80 mg	25	68	57

(Source: Duke JA and Atchley AA, CRC Handbook of Proximate Analysis Tables of Higher Plants, CRC Press, 1986)

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Effect of integrated weed management practices on lentil mustard intercropping system under rainfed condition in Terai region of eastern India

Ashim C. Sinha* and Biswapati Sinha

Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal 736 165

**E-mail: ashim_sinha50@rediffmail.com*

Pulses are the basic ingredient in the diets of a vast majority of Indian population as they provide a perfect mixture of high biological value when supplemented with cereals. The countries demand for edible oils is expected to rise more than double from the current level in the next 12 years, according to the projections made by the National Council of Applied Economic Research (NCAER). Weed management research in intercropping is still in its infancy, probably because no systematic and coordinated research to improve the efficiency and productivity of intercropping has been undertaken, hence the present investigation was undertaken.

METHODOLOGY

A field experiment was carried out during the *rabi seasons of* 2008-09 and 2009-10 at instructional farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal in sandy loam soil to study the effect of integrated weed management practices on lentil + mustard intercropping system under rainfed condition. The experiment comprised 10 treatments of 2 intercropping systems (sole lentil and lentil intercropped with mustard) in main plots and 5 weed control methods [glyphosate 2.5 l/ha as pre -plant application (PPA) one day before sowing (DBS) + post-emergence application (PEA) at 25 days after sowing (DAS), glyphosate 2.5 l/ha as PPA + hand weeding at 25 DAS, hoeing (twice) at 25 and 45 DAS, handing weeding (twice) at 25 and 45 DAS and unweeded control] in subplots with three replications in split-plot design. Lentil variety "*Asha (B-77)*" was sown in 30 cm apart with mustard variety "*Sharama (RW-85-59)*" in 3:2 row ratios. Fertilizers were applied uniformly through urea, single super phosphate and muriate of potash 20 kg N, 60 kg P_2O_5 and 40 kg K_2O respectively for Lentil and 60 kg N, 40 kg P_2O_5 and 40 kg K_2O respectively for mustard.

RESULTS

Broad-leaved weeds were predominant followed by sedges and grassy weeds. *Polygonium* sp. dominated over all other weeds throughout the cropping season and more than 65% of the total weed population at harvest. The next dominating weeds were *Chenopodium album* followed by *Vicia sativa, Cyperus rotundus* and *Cynodon dactylon*. Extensive canopy of intercrops precluded penetration of solar radiation up to the weeds and smothered them leading to lower weed dry weight. Results corroborate with the findings of Ram *et al*. (2003). All the weed control methods significantly reduced the total weed population and total dry weight of weeds over unweeded control. Hand weeding (twice) at 25 and 45 DAS recoded significantly lower weed population and dry weight of total weeds at harvest compared to rest of the weed control methods. (Table 1). All the weed control methods significantly increased the yield attributes viz. no. of pods /plant, no. of seeds/pod and test weight over unweeded control being maximum under hand weeding (twice) followed by glyphosate 2.5 lit/ha as PPA + hand weeding at 25 DAS, glyphosate 2.5 l/ha as PPA combined with post-emergence application (PEA) at 25 DAS and hoeing twice (Table 1). Results corroborate with the findings of Sinha and Dads (2005).

CONCLUSION

When lentil is intercropped with mustard in 3:2 row ratio with hand weeding (twice) at 25 and 45 DAS, it proved to be beneficial to achieve and sustain higher productivity . But when labour is limited, glyphosate 2.5 l/ha as PPA integrated with one hand weeding at 25 DAS may be used for effective control of weeds in Lentil + mustard intercropping system.

Table 1. Weed density, weed dry weight, Leaf area index, Dry matter accumulation, yield attributes, yield and economics of Lentil as influenced by cropping systems and methods of weed control

Treatment	Weed density (no./m²)	Weed dry weight (g/m²)	Leaf area index (LAI) at 75 DAS	Dry Matter accumulation (DMA) at harvest	No. of pods /plant	No. of seeds /pod	1000 seed wt.(g)	Sole crop lentil (q/ha)	Inter crop mustard (q/ha)	B:C ratio
Cropping System(C)										
Lentil (L)	51.5	29.3	2.41	283.1	24.2	3.6	18.3	9.67	-	2.33
Lentil + Mustard	47.9	25.8	2.11	275.5	17.9	2.7	16.2	5.26	4.34	2.32
LSD (P=0.05)	2.03	2.19	0.13	4.09	2.75	NS	1.89	2.31		
Weed control methods(M)										
Glyphosate 2.5l/ha as PPA(1DBS)+ PEA at 25 DAS	45.6	22.3	2.29	290.3	22.9	3.3	17.1	8.61	4.89	1.24
Glyphosate 2.5l/ha as PPA(1DBS)+ HW at 25 DAS	43.1	19.8	2.36	277.9	23.6	3.4	19.9	9.18	5.14	1.32
Hoeing (twice) at 25 and 45 DAS	55.4	32.7	2.21	268.4	21.7	3.1	15.8	6.52	3.31	1.17
Hand weeding (twice) at 25 and 45 DAS	40.3	16.5	2.49	321.7	26.3	3.8	21.6	10.7	5.87	1.40
Un weeded control	64.5	46.4	1.97	238.1	10.7	2.1	11.7	2.31	2.52	0.09
LSD (P=0.05)	1.71	1.92	0.11	3.78	1.67	0.33	1.15	1.17		

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Survey of *Kharif* weed flora in rice of eastern Vidarbha zone

V.M. Bhale*, JayshriKarmore, P.V. Shingrup and J.P. Deshmukh
Department of Agronomy, Dr. P.D.K.V, Akola, Maharashtra 444 104
**Email: vmb1957@yahoo.co.in*

Rice *(Oryza sativa* L.) is the most important staple food for more than half of the world's population. India has the largest area among rice growing countries and stands second in production (Walia *et al.* 2012). Globally, rice yield losses due to pest have been estimated at 40% of which weeds have the highest loss potential (32%) (Oerke and Dehne 2004). In eastern vidarbha region rice is the dominant crop which occupies 7.7 lakh ha area with production of 5.78 lakh tones with productivity of 0.77 t/ha.With current scenario of climate change and weed management approach, shift in weed flora is widely observed in all rice cultivating districts of eastern vidarbha. Therefore, weed survey on various species occurred in rice was carried out for five districts of eastern vidarbha region. The survey was implemented with following objectives to conduct effective survey and monitoring for the weeds in rice, to classify dominant weeds in rice of eastern vidarbha region and to develop district wise weed mapping.

METHODOLOGY

The Vidarbha region comprises three sub-divisions, *viz.* western Vidarbha central Vidarbha and Eastern Vidarbha. In Western Vidarbha soybean, cotton, sorghum, pigeonpea, gram and wheat are major grown crops. The central Vidarbha region comprises mainly soybean and cotton based cropping system. While the eastern Vidarbha is dominated with mainly rice based cropping system.

For the survey, four villages in each tahsil were selected to record weed flora from cropped areas. Weed count was recorded with the help of quadrate in 1/m^2. area. The data were collected and processed to derive the density, frequency, relative density, relative frequency and importance value index (IVI) were calculated.

RESULTS

The eastern vidarbha region having five districts which is dominant with crop rice. It is observed that weed species in rice field were different in these districts which varies from place to place. Nagpur district :In rice field *Cynodon dactylon* was dominating with higher values of density (5.75/ m^2), frequency (65%), relative density (27%), relative frequency (18.3%) and IVI (45.3). *Alternanthera sessilis* was found predominant with 21.18% relative density, 17% relative frequency and 37% IVI. In addition to these, other species, *viz. Cyperus rotundus, Mimosa pudica, Commelina ben-ghalensis, Digera arvensis, Celosia argentea, Saccharum spontaneum* were observed in rice. The occurrence of *Alternanthera sessilis* in rice field was a new introduction.

In Bhandara district, rice is only the predominant crop and weed observed are presented herewith. The maximum value of density and relative density was observed with *Ischaemum rugosum* followed by *Commelina diffusa, Echinochloa colona* and *Echinochloa crusgali.* The other species were *Ischaemum rugosum* and *Commelina diffusa* which has recorded maximum frequency, relative frequency and IVI values in rice crop. The species, *viz. Pasphalum distichum, Marsilea quadrifolia, Synedrella nodiflora, Ludwigia perennis* were also found prominent in rice crop.

In Gondia district *Oryza punctata* was found more frequently and recorded maximum relative density, relative frequency and IVI. In rice crop of Gondia district the *Brachiaria spp.* was also more dominating with 18% relative density, 20% relative frequency and 38.15 IVI. The other species observed were *Ludwigia perennis, Ischaemum rugosum, Cyperus rotundus* and *Marsilea quadrifolia.*

Chandrapur district *Gnaphalium polycaulon* has recorded 36.88% frequency followed by *Ludwigia perennis* and *Ammannia baccifera*. However *Cynodon dactylon* and *Cyperus rotundus* recorded 28% and 16% frequency. The relative density, relative frequency and IVI value were maximum with *Gnaphalium polycaulon* followed with *Ammannia baccifera* and *Ludwigia perennis*. The other species observed were *Ischaemum rugosum, Commelina benghalensis* and *Marsilea quadrifolia*.

It was observed from Table 5 that in Gadchiroli district *Oryza punctata* was most dominating weed, which has recorded 33% relative density, 28% relative frequency with 61.62 IVI. The *Ludwigia perennis* has recorded 46% frequency, 23.78% relative frequency and 44.04 IVI. In addition to these the other species observed were *Ammannia baccifera, Pasphalum distichum, Cynodon dactylon, Marsilea quadrifolia* and *Commelina diffusa.*

CONCLUSION

The survey of weeds were carried out in five districts indicated that weed species observed in different regions were specific. Though the crop was same but species of weeds were different. In Nagpur district *Alternanthera sessilis, Digeraarvensis were* the most dominating species observed. In Bhandara district *Ischaemum rugosum, Echinochloa colona, Marsilea quadrifolia* were the dominant species recorded. In Gondia district *Oryza punctata*, *Brachiaria* spp, were found dominant. In Chandrapur district *Gnaphalium polycaulon, Ammannia baccifera* observed most dominant while in Gadchiroli district*Oryza punctata, Ludwigia perennis* were found most dominant. This clearly indicate that crop-weed association is varies with location, soil type and other factors. This survey gives clear picture of how weed flora found dominant in respective district.

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Biology and eco-physiology of purple nut sedge

R. Devendra*, M.T. Sanjay, Manjunatha S.B and T.V. Ramachandra Prasad
AICRP on Weed Control, UAS, MRS, Hebbal, Bangalore, Karnataka 560 024
**Email: devenda.wc.uasb@gmail.com*

Population of purple nut sedge (*Cyperus rotundus* L.) increased significantly over initial in 1600 days under prevailing cropping systems owing to suppression of grassy and broadleaved weeds by crop husbandry. Dominance of apical bud over the lateral buds found in individual tuber and younger tuber dominate in a chain, thus nut sedge persists (Schonbeck 2012). With this background, an attempt was made to assess effect of different seasons on the number of types of tuber produced and biomass distribution in different plant parts. Effect of glyphosate spray and solarization with hot water irrigation on number of tubers produced were also assessed.

METHODOLOGY

Single tuber weighing (0.95±0.08 g) were sown in pots of size (30x10x10 cm^3) filled with sandy loam soil. NPK 60:30:15 (kg / ac) were applied during sowing with three replications. Periodic biomass of different types of tubers, shoot and tuber's connecting stolon, root and inflorescence were recorded and total biomass (g / plant) was computed. Different tubers were separated as small, medium and large tubers based on their weights: 0.1-0.25, 0.26-0.5 and 0.5 g respectively. Their numbers and weights were recorded using top loading balance (Sansui SSP- 0.2 g – 1 kg ± 0.1g) in grams. Plots of size 2 x 2 m^2 having uniform infestation of *Cyperus rotundus* were prepared. Varied concentration of glyphosate, *viz.* 1.5, 1.0, 0.75 and 0.5 kg / ha, with or without jaggery (2%), were sprayed twice at intervals of 48h during July / August (senescence induced for 48 h increased translocation) Biomass (g / plant) and number of different types of tubers per plant were observed 45 days after second spray. The plots were left fallow for the rest of the months of the year. For solarization, transparent plastic sheet of any thickness was covered over canopy of purple nut sedge and peripheral edge was tucked into the soil and made air tight during month of April. Hot water irrigation (40 l / m^2) was given once in five days in modified solarization technique. During night, coconut leaf frond was placed over plastic mulch to avoid dogs tearing the mulch.

RESULTS

Biomass increased against time and mean tuber biomass (of all growth stages and replications) was highest (44%) followed by shoot, root, stolons and least in inflorescence (28%, 22%, 5% and 2% respectively). Strong correlation between total biomass and number of tertiary tubers (r= 0.868) was noticed than primary and secondary tubers and r values were 0.807 and 0.518 respectively. Thus, tertiary tuber production was targeted and tertiary tuber was more than primary and secondary tubers numbers. Single tuber produced 67tubers / pot. Young tuber sprouts first and dominated (Schonbeck 2012) but in this study small tubers' shoot contributed least (20%) to the total shoot weight compared to primary (40%) and secondary (35%). Repeated glyphosate application to the fixed plots reduced all types of tuber numbers. Small tubers percent reduction increased by 40-85%, such a trend was not observed in medium and large tubers. Sprouting of primary and secondary tubers was not stable. Soil solarization significantly increased soil temperature from 38.9^{0}C to 52.9^{0}C and caused reduced number of tubers by 58, 55 and 100 % over control for small, medium and large tubers respectively (Table 1). Solarization affect was at par with glyphosate application.

Table 1. Effect of solarization with hot water (once in five days) and glyphosate (1.3 kg/ha) on different size tubers and total tuber numbers/0.25 m^2 of purple nut sedge

Treatment	Small/tertiary	Medium/secondary	Large/primary	Total
Glyphosate	6.5^b	1.0^b	0^b	6.5^b
Plastic Mulch (PM)	5.5^b	3.0^{ab}	0^b	8.5^b
PM + Hot water	$9.0^{b\ (58.1)}$	$2.0^{ab\ (55.0)}$	$0^{b\ (100)}$	$11^{b\ (66.1)}$
Control	21.5^a	4.5^a	6.5^a	32.5^a
LSD (P=0.05)	5.25	2.78	2.61	7.44

Values in parenthesis indicates percent reduction over control

CONCLUSION

Solarization led to a drastic reduction in tuber production which was at par with glyphosate (1.3 kg / ha) treatment. Thus, solarization followed by glyphosate application may drastically reduce tubers production in *Cyperus rotundus.*

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P-02

Spectral signatures of wheat, little seed canary grass and wild oat

***M.B.B. Prasad Babu, Vikas Jain[1] and Sushilkumar[2]**

Directorate of Rice Research, Rajendra Nagar, Hyderabad, Andhra Pradesh 500 030

[1]KVK, Damoh, Madhya Pradesh 470 661; [2]Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004

**Email: mbbprasadbabu@gmail.com*

Precision management of agricultural inputs such as herbicides for weed control is crucial to ensure profitable cultivation of crops and long-term sustainability of the land. Spectral approaches involving the use of plant reflectance spectra based on the light reflected from the plant surfaces offer great potential for weed detection and selective herbicide application in precision agriculture. Spectral signatures of crops and weeds (Felton *et al*. 2002) which can be used for differentiating weed patches either from a fallow background field or from a mixed stand of weeds and crops. In India, very little information is available on the spectral signatures of crops and weeds.

Littleseed canary grass (*Phalaris minor*) and wild oat are the two most troublesome winter season grassy weeds affecting yields of wheat crop, in the north-western states of the country. While littleseed canary grass is a major problem in rice-wheat system, wild oat (*A. ludoviciana*) is a very troublesome weed in non-paddy rotations in light to medium textured soils. The present study was made to establish the spectral signatures of wheat and two weeds, viz. littleseed canary grass, wild oat and their admixtures.

METHODOLOGY

Two field experiments were conducted in *Kharif* 2006 at Directorate of Weed Science Research, Jabalpur, Madhya Pradesh in sandy clay loam soil with a pH of 6.85 and EC of 0.372 dsm^{-1} which was low in available nitrogen, medium in phosphorus and high in potassium. In each experiment seven treatments consisting of crop alone, weed alone, and increasing densities of weed (50, 100, 200, 300 and 400 plants/m^2) were studied in RBD with three replications. Wheat was sown on 24th June, 2006 with a seed drill, with a row spacing of 22.5 cm, in both the crops. The required quantity of weed seed was evenly spread in the plots and mixed well with the soil to maintain the desired plant population. After germination the weeds were thinned to the desired density as per the treatment. Thinning of weeds was carried out up to a period of one month after sowing. Nitrogen, phosphorus and potassium fertilizers 120 kg N/ha, 60 kg P_2O_5 and 50 kg K_2O/ha were applied through urea, single super phosphate and muriate of potash uniformly. Observations on LAI, biomass, chlorophyll content, spectral reflectance and yield attributes were recorded. Spectral observations in four bands ranging from visible to near infrared region (*i.e.* from 400 nm to 900 nm) were recorded between 12 to 2 pm. with the help of ground truth radiometer of Optomech Make, Model: 041. The spectral indices, *viz*. radiance ratio (RR) and normalized difference vegetation index (NDVI) were calculated as follows:

NIR reflectance % (NIR) = (NIR radiance/radiance of the $BaSO_4$ plate) x 100 Red reflectance % (R) = (Red radiance/radiance of the $BaSO_4$ plate) X 100

Radiance Ratio (RR) = NIR / R

Normalized Difference Vegetation Index (NDVI) = (NIR-R) / (NIR + R)

RESULTS

The red reflectance (%) of wheat decreased as growth period progressed up to 90 DAS and thereafter increased in all the treatments while infrared reflectance (%) followed a reverse trend. The per cent red reflectance of P*halaris minor and Avena ludoviciana* increased with increasing density from 50 to 400 plants/m^2. The red reflectance of wheat crop was much lower than that of both weeds at all the growth stages. With increasing density of both the weeds, infrared reflectance decreased at all the growth stages. The infrared reflectance of wheat crop was much higher than that of P*halaris minor and Avena ludoviciana* at all the growth stages. The lower red reflectance of wheat in comparison to the two weeds under study can be attributed to the higher chlorophyll content. Radiance ratio and NDVI of all treatments was highest at 90 DAS and at this stage all treatments are distinguishable from each other. Radiance ratio and NDVI for pure wheat was higher than that of pure *Avena ludoviciana* and *Phalaris minor* at all growth stages.

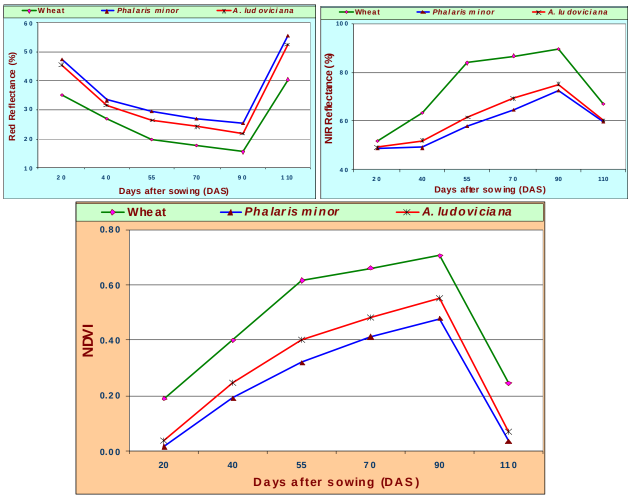

Fig. 1. Red reflectance and NIR reflectance (%) of pure wheat, *Phalaris minor* and *Avena ludoviciana*

CONCLUSION

The results show that based on spectral reflectance data wheat and weeds, *viz*. littleseed canary grass and wild oat can be identified. Weed free wheat crop can also be differentiated from weed infested crop at 90 DAS. Both RR and NDVI were found to be well correlated with the grain yield of wheat.

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Pignut - a weed of concern

R.R. Upasani and Sheela Barla and A.N. Puran

Department of Agronomy, Birsa Agricultural University, Ranchi, Jharkhand 834 006

**E-mail: upasani.ravikant@gmail.com*

Pignut (*Hyptis suaveolens* L.) is a very common plant found in India and some parts of Asia and Latin America. They bear purplish, small and pretty flowers. The leaves resemble Tulsi leaves but are much bigger and when crushed they give a distinct smell-hence the name. A drink is made from the soaked seeds of the plant. This plant has many medicinal properties. It is also an insecticidal plant; the dried and powdered plant is used to keep off some insects. It is also known to have some larvicidal properties which can reduce the population of the infamous mosquito *Aedes agypti* to a certain extent. The leaves decoction is used to wash the skin with boils and eczema. The crushed leaves are applied on the forehead to treat headaches. In the Traditional System of Medicine, the *Hyptis suaveolense* is used as a stimulant, carminative, for wounds, sudorific, galactogogue, catarrhal condition, infection of uterus, and parasitic skin diseases. Present paper deals with different morphological and reproductive characteristics of *Hyptis* which confer greater advantage to *Hyptis* in comparison to other species growing in its vicinity along with control methods prescribed to check its growth. *Hyptis suaveolens* is a weed of roadsides, crops and cultivation, pastures, rangelands, grasslands, open woodlands, riverbanks, floodplains, coastal environs, disturbed sites and waste areas. It is most common in wetter tropical regions, but sometimes also grows in sub-tropical and semiarid environments.

Morphological features

The leaf varies in size, ranging from 3 to 5 cm in length and 2 to 4 cm in breadth. The margin of leaf is serrated with a 3 cm long petiole. The plant starts flowering at the age of 2 to 3 months. It produces many blue flowers in small cymes along the branch that ends with reduced leaves. Sepals are fused together and hairy. Flowers are 0.5 cm long but fruits attain a size of 1 cm and become ribbed. Flowers are blue, 2 lipped, about 8 mm long, with a limb 5 mm in diameter. Androecium comprises of 4 stamens. Flowering starts from October to February. *Hyptis* fruits which are nutlets are about 1.2-1.5 mm long. The seeds are protected in spined hard hairs which help in its dispersal and are slightly notched at the end. Seed dimorphism in *Hyptis* is helpful in its germination across a range of temperature conferring year round seed germination. In addition to it, small seeds have greater surface to volume ratio showing greater germination rates than in the large seeds (Cideciyan *et al*. 1982).

Effects of Hyptis suaveolens

It is reported that *Hyptis suaveolens* may be used to replace *Parthenium* in nature as it has potential to inhibit seed germination and growth of target weed due to the presence of allochemicals. However he emphasized more detailed study is required to explore the bioherbicidal nature of the allelopathic compounds present in leaves of *Hyptis suaveolens*. Different growth parameters of Parthenium such as size and number of the leaves, height, branches, capitula and seeds/plant were inhibited by leaf residues of H. *suaveolens.*

CONCLUSION

Hyptis suaveolens has allelopathic effect on nearby plants as it does not allow other plants to grow. Fortunately this weed grows mainly in non cropped areas thus cultivated area are safe. However, the multiple benefits of *Hyptis suaveolens* cannot be ignored. Numerous studies have been conducted on different parts of *Hyptis suaveolens* but this plant has not yet developed as a drug by pharmaceutical industries. A detailed and systematic study is required for identification, cataloguing and documentation of plants, which may provide a meaningful way for the promotion of the traditional knowledge of the herbal medicinal plants.

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Weed infestation in maize through farm yard manure

Sagar Kafle, Pawan Kumar Sharma*[1] and Tarundeep Kaur
Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab 141004
[1]Department of Floriculture and Landscaping, Ludhiana, Punjab 141004
**Email: pksharmapau62@pau.edu.*

Maize is one of the most important cereal crops after wheat and rice in the world, and a principal staple food in many countries, particularly in the tropics and sub-tropics. The crop, being of an exhaustive nature, requires balanced supply of all plant nutrients. Conjoint application of inorganic fertilizer and organic manures to replenish the soil fertility is hence necessary. Integrated farming system comprising of livestock rearing vis-à-vis crop production, is mostly followed in Indian agriculture, and farm yard manure (FYM) is, therefore, a viable option among all organic sources. However, contamination of litter with weed seeds reduces quality of the manure. Information regarding weed infestation in Punjab conditions through farm yard manure is lacking, hence an investigation was carried out in this context.

METHODOLOGY

A field experiment was carried out at students research farm of the Department of Agronomy, Punjab Agricultural University Ludhiana during *Kharif* 2013 to investigate the effect of locally available farm yard manure and inorganic nitrogen levels on weed infestation. Three FYM levels (0, 15 and 20 t/ha) as main plot and five nitrogen levels (0, 93.75, 125, 156.25 and 187.5 kg N/ha) as sub plot treatments were arranged in split plot design having four replications. Maize variety '*PMH-1*' was sown by dibbling method maintaining spacing of 60 ×20cm in June 2013. Phosphorus in the form of single superphosphate and potassium as muriate of potash were applied as per the recommendations, while urea was used to fulfill the nitrogen requirement as per the treatments. Herbicide atrazine 2.0 kg/ha was applied as pre-emergence spray on the following day of sowing. Data on weed dry matter and species-wise population were recorded 30 days after sowing.

RESULTS

Results of the experiment showed that weed dry matter increased significantly with the application of FYM but the differences between two FYM levels (15 and 20 t/ha) were not statistically significant. FYM application 15 and 20 t/ha increased weed dry matter by 13.32% and 18.65% over control (No FYM) respectively. Nitrogen levels also caused significant variation in weed dry matter. The differences between two consecutive levels were not statistically significant. However, each nitrogen level was significantly different from the next lower level.

Table 1. Effect of farm yard manure and nitrogen levels on weed dry matter and weed count after 30 days of sowing

Treatment	Weed dry matter (g/m^2)	Weed population (no./m^2)		
		Digiteria sanguinalis	*Cyperus rotundus*	*Eleusine indica*
FYM levels (t/ha)				
Zero	68.30	31.04	63.60	46.80
15	77.40	45.76	81.20	58.00
20	81.04	48.20	85.40	62.40
LSD (p=0.05)	6.58	6.42	8.08	3.60
Nitrogen levels (kg/ha)				
Zero	66.83	41.32	72.67	51.70
93.75	71.33	40.84	76.33	47.00
125.0	76.33	41.80	76.70	57.34
156.25	80.34	41.64	77.32	60.32
187.5	83.06	42.64	80.67	62.18
LSD (P=0.05)	5.77	NS	NS	NS

Categorization of weed population into different species revealed that increase in population of only *Cyperus rotundus* L, *Digiteria sanguinalis* and *Eleusine indica* was observed with the application of farm yard manure. Increase in FYM level from 15 t/ha to 20 t/ha though increased the weed population, but increase was not significant except for *Eleusine* indica (L) Gaerth. The effect of nitrogen levels on weed population was not significant. Interaction between two factors was also not significant.

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Major weed species was found in finger millet

Srishti Pandey*, Pooja Mandal and H.L. Sonboir
Department of Agronomy, College of Agriculture, Raipur, Chhattisgarh 492 001
**Email: ag.srishtipandey@gmail.com*

Finger millet (*Eleusine coracana* L.) is an important small millet crop. It is used both as medicinal and traditional purposes. Weed competition result in drastic reduction in yield up to 20 to 50 per cent. The critical period of crop weed competition for the finger millet varies from 25-45 days after sowing (Lall and Yadav 1982). The work on the effect of post emergence herbicides in weed management of finger millet is very limited; therefore, keeping these points in view the present investigation was carried out.

METHODOLOGY

The present investigation entitled "Evaluation of post-emergence herbicides for weed management in direct sown Finger millet." was carried out at Instructional cum Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India, during the *Kharif* 2012. The experiment was laid out in randomized block design (RBD) with three replications and thirteen treatments of post-emergence herbicides. The finger millet cultivar "*GPU-28*" was sown and harvested on 1[th] July, 2012 and 20[th] November, 2012 respectively, using seed rate of 10 kg/ha at 25 cm distance. Weed counts (number/m^2) was recorded by putting a quadrate (0.25 m^2) at random spots in each plot and relative weed density (%) was calculated by using the formula

$$\text{Relative weed density (\%)} = \frac{D}{Td} \times 100$$

D = Weed density of weedy check plot of different weed species at different interval; and Td = total weed density of weedy check plot

RESULTS

Weeds

At 15 DAS, the percentage composition of *Echinochloa colona (28%)* was recorded highest. At 30 DAS the percentage composition of *Echinochloa colona* (29%) followed by *Phyllanthus urinaria* (17%) and 45 DAS the percentage composition of *Echinochloa colona* (25%) was recorded highest followed by *Eclipta alba* (18%) while, at 60 DAS, the composition of *Echinochloa colona* (20%) was recorded highest. At 75 and 90 DAS, the percentage composition of *Echinochloa colona* (22% and 25%, respectively) was recorded highest followed by *Eclipta alba* (21% and 19%, respectively). At harvest the percentage composition of *Alternanthera triandra* (39%) was recorded highest (Table 1).

The major weed flora of experimental field consisted of *Echinochloa colona*, *Phyllanthus urinaria, Eclipta alba, Alternanthera triandra and Cyperus iria*. Other weed species like *Commelina benghalensis, Cynodon dactylon, Cynotis axillari, Cyperus rotundus, Euphorbia hirta*, *Euphorbia geniculata, Fimbristylis miliacaea etc*. were also observed in the experiment field in negligible quantum. These results were in conformity with Pradhan *et al*. (2010) and Gowda *et al*. (2012).

CONCLUSION

Echinochloa colona among grasses, *Cyperus iria* among sedges and *Alternanthera triandra, Eclipta alba* and *Phyllanthus urinaria* among broad leaf weeds were dominant. Over all the most dominant species was *Echinochloa colona* which ranged between 24-46 per cent at all the growth stages.

Table 1. Weed density and relative weed density at different interval in weedy check in direct seeded finger millet

Major weed species	Weed density (m^2) DAS						Relative weed density % DAS					
	15	30	45	60	75	90	15	30	45	60	75	90
Echinochloa colona	30.0	85.0	100	72.0	64.0	52.7	40.4	45.8	36.3	24.3	29.2	35.5
Cyperus iria	2.3	18.0	35.0	67.0	20.3	8.3	3.1	9.7	12.6	22.6	9.3	5.6
Alternanthera triandra	9.0	9.3	25.0	26.7	20.0	18.3	12.1	5.0	9.0	9.0	9.1	12.4
Eclipta alba	3.3	18.3	51.3	59.7	57.3	28.7	4.5	9.9	18.5	20.1	26.2	19.3
Phyllanthus urinaria	13.7	30.3	35.3	38.3	30.7	26.3	18.4	16.3	12.7	12.9	14.0	17.7
Other weed species	16.0	24.7	30.3	32.7	26.7	15.3	21.5	13.3	10.9	11.0	12.2	10.3
Total weed species	74.4	185.6	277.6	296.3	219	149.6	100.0	100.0	100.0	100.0	100.0	100.0

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Weedy and nitrophilous diversity around sea buckthorn in Trans-Himalayan region

M.S. Raghuvanshi*, P.C. Moharana[1] and J.C. Tewari[1]
Regional Research Station, Central Arid Zone Research Institute (CAZRI), Leh, Ladakh, J&K 194 101
[1]Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan 342 003
**Email: omsai.msr@gmai.com*

Seabuckthorn (*Hippophae rhamnoides L.*) is a deciduous shrub, occurs sparsely and at low cover on a variety of vegetation types of less mobile sand dunes, on bare rocky mountain slopes and gravely plains. But the *Hippophae* scrub includes stands where this thorny, deciduous is becoming a consistent and more prominent feature of native Europe and Asia. It is a pioneer species and prefers to grow in low humid, alluvial gravel, wet landslips and riverside with brown rusty-scaly shoots. It is also a multipurpose fast growing species, serving as a measure of biodiversity conservation, soil conservation, medicines, food, wildlife habitat enhancement, farmstead protection, fodder and fuel wood. It has an extraordinary capacity to grow and survive under adverse conditions (-40 to 40º C) and has extensive subterranean rooting system with strong soil binding ability, useful for soil stabilization, river bank control and water retention. Ecologically, *Hippophae* is useful for conserving soil, especially on fragile slopes, due to its extensive roots which possess nodules that fix nitrogen and improve fertility. As a result of this, herbs under the seabuckthorn grow luxuriantly. A five-year plant has a taproot of 3 m and horizontal roots of 6 to 10 m. Similarly, a three-year old plant can produce 10 to 20 new generation plants by root turions. It begins to develop root shoots in third and fourth years. An 8 to 10-year old seabuckthorn forest can fix 180 kg of nitrogen/ha/year. It was recorded that the about 83 per cent of the root nodules are at the depth of 0-15 cm. While at 15-35 cm, the nodules decrease to 4-13 per cent. This may be due to presence of root nodules present in the biological layer of soils (0-15 cm) that supports more plant species.

METHODOLOGY

In order to understand characteristics of this useful plant in cold arid and high altitude habitat, a survey was carried out by Regional Research Station, CAZRI, Leh during 2013 encompassing six different land use patterns; sea buckthorn orchard (34°10'N 77°37'E), wet- /marshy land (34°05'N 77°36'E), cropped area periphery (34°05'N 77°36'E), barren land (33°58'N 77°41'E), hilly slope (34°05'N 77°36'E) and river banks (34°03'N 77°38'E). Mean annual precipitation is about 80-300 mm, which is very scanty and negligible in this region of cold desert. The extent and characteristics of the grassy and broad-leaved weeds and associated flora were observed depending on the degree of *Hippophae* dominance under different habitats.

Green belt under Seabuckthorn vegetation, feeding animals in cold arid region

RESULTS

During the survey in different habitats at Leh Valley, following observations on various weed species and related flora were noted associated with varied stages of *Hippophae*. Bushes were found more scattered and small and not yet densely suckering in the early stages of *Hippophae*. Species changed with the land use system and the advancement of *Hippophae* stages. Predominant species in wet-/ marshy land were *Triglochin maritima* (Juncaginaceae), *Glaux maritima* (Primulaceae), *Halerpestes sarmentosa* (Ranunculaceae), *Potentilla anserine*, *Circium arvense, Lentopodium nanum*, *Allium corolinum*, *Eurotia* spp. *Taraxacum officinale.* In barren land where *Hippophae* was noted, it supported Canada thistle (*Circium arvense*), *Setaria* spp., *Chenopodium album, Ambrosia artemisiifolia, Clematis sp. In sea buckthorn orchard, around fencing and at* river side belt*, Festuca, Phragmites, Agrotis humilis, Cirsium arvense* were found dominant. On hilly track, only few species like *Myricaria germanica and Phragmites* sp. were noted. In areas having no presence of *Hippophae, the top soils were* eroded and no vegetations were present.

CONCLUSION

Seabuckthorn is a unique and valuable deciduous *shrub* with an economic potential of 0.5-1.2 t/ha of berries under natural habitat. It is not only encouraging vegetation other than weedy but it is required to be prevented from invasive nature of weed species especially *Cirsium arvense,* which spreads quickly and forms mono-specific stands. Addition of 3% mass of thistle root and stem residues to the soil reduced and slowed down the growth of companion plant species, resulting in recued pasture along seabuckthorn.

Phyto-sociological association of weeds in rainfed *Kharif* crops of Purulia district, West Bengal

D.C. Mondal*, A. Hossain and B. Duary

Sriniketan Centre, Palli Siksha Bhavana, Visva-Bharati, Sriniketan, West Bengal 731 235
**Email: dcmondaldwsr@gmail.com*

Knowledge of weed flora, population and distribution is pre-requisite to formulate economic and effective weed management strategy. Information on the weed flora in *Kharif* crops of Purulia district is meager. Hence an effort has been made to identify the weeds in rainfed *Kharif* crops and to document their phyto-sociology.

METHODOLOGY

A detailed survey was conducted in Santuri and Raghunathpur block of Purulia district under red and lateritic region during *Kharif,* 2013. The area of survey laid between $23^0 29.228'$ to $23^0 35.074'$ N and $86^0 35.669'$ to $86^0 54.553'$ E, altitude 186-212 M above MSL, the climate subtropical, semi-arid with hot dry summer and short bracing winter, annual rainfall varied from 1200-1400 mm. Soil was red sandy to shallow moderately deep loam. Rice, maize, pigeon pea, cowpea, groundnut, greengram, sesbania and mixed crop maize + lady's finger were grown in *Kharif,* rice as main crop and potato, wheat, winter maize and vegetables in winter. Hand weeding twice in rice; hoeing and weeding in other crops are the major management practices. Data on weed infestation in rice, maize, pigeon pea, cowpea, maize+ lady's finger intercropping and sesbania were taken following list count method suggested by Misra (1968) and Raju (1997) using 50 × 50 cm quadrat. The data were computed for determining frequency %, density and their relative value for calculating importance value indices (IVI). The species with higher IVI were considered as dominant.

RESULTS

Altogether 41 weed species (9 grasses, 25 broadleaved, 7 sedges) belonging to 35 genera and 20 families were identified. The diversity of the species was found within *Poaceae* (9 species), *Cyperaceae* (7 species), *Asteraceae* and *Euphorbiaceae* (3 species in each), *Onagraceae, Rubiaceae* and *Scrophulariaceae* (2 species in each), rest of the families had one species in each. The largest genus was *Cyperus* (4 species), followed by *Fimbristylis, Lindernia* and *Phyllanthus* (2 species in each), rest genera had one species in each. Rice, maize, pigeon pea, cowpea, maize + lady's finger intercropping and sesbania were infested with 17, 16, 21, 19, 14, 14 weed species respectively.

Lindernia in rice, *Oxalis* in maize, maize-lady's finger intercropping and Sesbania; *Melochia* and *Mollugo* in pigeon pea; *Cyperus* in cowpea had 100% frequency. Thirteen species had 80% frequency; rest of the species had less than 40%frequency. There were 21 weed species that had less than 2 plants/m^2. This shows that higher density of only certain weeds (*Cynodon, Oxalis, Lindernia, Cyperus, Melochia, Mollugo*) were problematic to *Kharif* crops.

Lindernia, Fimbristylis, Ludwigia, *Marsilea* were recorded dominant in rice; *Oxalis, Cyperus, Cynodon* in maze; *Cynodon, Mollugo, Melochia* in pigeon pea; *Cyperus, Cynodon, Oxalis* in cowpea; *Oxalis, Cynodon, Melochia, Cyperus* in maize- lady's finger intercropping; *Cynodon, Oxalis, Paspalum* in sesbania. Top 10 weed species with higher IVI values in *kharif* crop comparised *Cynodon, Oxalis, Cyperus, Paspalum*, *Digitaria, Echinochloa, Cyperus, Melochia, Mollugo* and *Fimbristylis*. Among these major weeds, only 3 species were dicot species and rest species were monocot having shallow adventitious root systems competing for surface minerals, water and light.

CONCLUSION

The phyto-sociological study of the weeds of various crops in Purulia district as a whole should be carried out extensively to understand biological diversity, dominance, distribution pattern, agricultural importance economic uses so that the information could be utilized in weed management.

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Web-based tool for identification of weeds

Sandeep Dhagat*, V.S.G.R. Naidu and A.R. Sharma
Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004
**Email: dhagatsandeep@gmail.com*

Identification of weed species is essential for proper documentation and development of suitable management strategies. However, this requires expertise and experience to identify weed species, which is often not available at different institutions. In order to simplify the technique of weed identification and make the information to all stakeholders, this Directorate has developed different databases which help in weed identification through the characteristic morphological features of these species. In the Directorate's website (www.nrcws.org), in database hyperlink, three main databases are hyperlinked: weed seed identification, weed seedling identification and weed identification.

METHODOLOGY

With the help of IT tools, web-based and e-modules were prepared. To build web-based module, we have utilize the GUI window based applications, ASP.NET used as front-end and SQL used as back-end application. All images were store in database as binary form. Structure query language (SQL) is used for query purpose; this helps in generate the output results from the stored information from database. All the information of weeds were collected from the hand book on Weed Identification (Naidu 2012), and Weed Seed Atlas (Naidu and Varshney 2007). The main objective of these tools was to present an updated inventory of available 337 weed species. We included all relevant information that would help to identify weeds: shrubs, herbs and other species considered invasive, which are associated with agricultural lands, pasture lands, industrial and urban sites, roads and other places. These web-based tools / softwares allow the user to identify the weeds with help of selected morphological characteristics, and extract the closest matches from the database, rather than manually searching through thousands of entries.

RESULTS

In this method of identifying weeds, the users can search / browse weeds using a number of search techniques, such as searching by scientific name, common name and family name in alphabetical letter. The user can also identify the weeds by weed thumbnails (weeds pictures) and search by other weed characteristics (Table 1). In order to use these web-based softwares, one has to choose from the available databases which are most adapted to the picture identification. After following the "validate" link corresponding to the knowledge database chosen, the picture(s) of the species are selected and the identification process is launched. The user can select the requisite image or name of weed to retrieve the data of that species with all the desired identification characters.

Table 1. Search by other weed characteristics

Habit	Life cycle	Stem		Leaved			Flower		Seed	
		Type	Shape	Shape	Edge	Arrangement	Type	Colour	Shape	Surfac
Herb	Annual	Hairy	Glabrous	Opposite	Smooth	Cordate	Single	Black	Globular	Stellate
Shrub	Biennial	Velvety	Cylindrical	Alternate	Rounded	Deltoid	Spike	Brown	Heart	Shaped
Grass	Perennial	Angular	Ridged	Whorled	Lobed	Elliptic	Raceme	White	Flat	Finely
		Glabrous	Grooved	Rosette	Pointed	Falcate	Panicle	Green	Thick	Shiny
		Cylindrical	Square		Featherel	Hastate	Uneble	Orange	Triangular	Smooth
		Fistular	Triangular			Lanceolate	Compound	Purple	Kidney	Roughly
						Linear	Composite	Gray	Disc	Sparsely
						Lyrate		Yellow	Granular	Glandular
						Obcordate		Red	Pyramid	Reticulate
						Oblanceolate		Pink	Globose	Longitudin
						Oblong		Tan	Oval	Pitted
						Obovate		Blue	Rhomboidal	Rough
						Orbicular		Creamy	Angular	Granular
						Oval		Violet	Pyramidal	Verrucose
						Ovate			Ellipsoid	Apiculate
						Reniform			Oblong	Glossy
						Runcinate			Elliptic	Punctate
						Sagittate			Ovate	Papillose
						Spatulate			Conical	Rugose

CONCLUSION

The web-based tools help the researchers to identify unknown weeds easily and comprehensively with minimum input. These interactive softwares would be highly useful to students, researchers, quarantine officers and scientists, and also serve the purpose for ready reference for identifying the weed species.

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Effect of day time application of post emergence herbicides on weeds, and yield of transplanted rice

Monika Soni* and K.K. Jain

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur,Madhya Pradesh 482 004

**Email: monika.soni8@gmail.com*

Rice is one of the most important food grains crop for human consumption. It is the most commonly and widely grown in India including Madhya Pradesh during *Kharif* season. Madhya Pradesh contributes 3.45% in the production of India. The production of Madhya Pradesh is 1106 kg/ ha (Anonymous 2012). Mainly herbicides are being used for effective control of herbicides but the herbicides efficacy was affected by various factors, *viz.* rate, temperature, weed height, adjuvant, relative humidity, day time (morning afternoon and evening) and dew. Among these the day time also important for controlling the efficacy of herbicides because the day time also indirectly controlled the temperature in the atmosphere and soil. The herbicide molecule also affected by the day time application of herbicide. Herbicide and day time may interact with each other for controlling the weeds and increase the grain yield of rice. The information on this aspect is managed; therefore the present investigation was conducted.

METHODOLOGY

The present investigation was carried out at the Research Farm of Krishi Nagar, JNKV, Jabalpur during 2010 and 2011. The treatments were consisted with 6 weed control practices weedy check, bispyribac sodium, penoxsulam, pyrazosulfuron-ethyl, cyhalofop-butyl + almix and fenoxaprop-p-ethyl + almix as main plot treatment and three day time application (morning, afternoon and evening) as sub plot treatment were laidout in split plot design with three replications. The spraying of herbicides was done by mixing the required quantity of herbicide in measured quantity of water at the rate of 500 liters/ha using Kapsnake sprayer with flat fan nozzle. Various studies were carried out on weeds and crop.

RESULTS

The field showed the predominance of *Cyperus iria*, *Fimbristylis miliacea, Alternanthera philoxeroides, Echinochloa colona, Paspalum distichum* and *Eclipta alba*. The weed control practices marked identical influence on weed density, dry weight and finally weed control efficiency (Table 1). The grain and straw yield also showed that the weed control treatments caused significant variations. The post emergence application of pyrazosulfuron-ethyl proved significantly superior for higher yield (6.35 and 6.48 t/ha) over weedy check during both the years. The post emergence application of pyrazosulfuron-ethyl also recorded higher net monetary returns (₹ 59,700 and 61,459/ha).

CONCLUSION

It was concluded that the application of pyrazosulfuron-ethyl at 25ml /ha after 10 days as post emergence in transplanted rice showed higher efficacy for controlling the broad spectrum weeds, *viz.* grassy, broad leaf and sedges and resulted highest grain yield and economics among all the post emergence herbicides. Evening time application of different post emergence herbicides was found the suitable time of application for better activity in transplanted rice; however morning time application was also found similar.

Table 1. Effect of day time application different post emergence herbicides on weeds, crop yield and economics of rice

Treatment	Total weed density at 30 DAS (m^2)		Total weed density at 90 DAS (m^2)		Total weed density at harvest (m^2)		Total weed dry weight (kg/ha)		Weed control efficiency		Grain yield (t/ha)		Straw yield (t/ha)		Net monetary returns (x10³₹/ha)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Bispyribac- sodium	7.35 (53.7)	6.81 (46.1)	11.79 (138.7)	11.41 (129.8)	9.09 (82.3)	8.49 (71.7)	69.03 (536)	66.15 (494)	35.9	37.1	5.36	5.48	10.34	10.64	45.23	46.84
Penoxsulam	5.82 (33.6)	5.30 (28.0)	10.43 (108.4)	9.93 (98.5)	7.81 (60.7)	7.01 (49.2)	61.77 (431)	56.73 (372)	48.4	52.7	5.67	5.78	10.95	11.30	49.59	51.25
Pyrazosulfuron-ethyl	4.46 (19.7)	3.89 (15.0)	8.89 (78.7)	8.39 (70.3)	6.18 (37.9)	5.62 (31.6)	48.69 (285)	44.34 (246)	65.9	68.6	6.35	6.48	12.28	12.41	59.70	61.46
Cyhalofop-butyl + almix	6.75 (45.3)	6.07 (36.7)	11.12 (123.2)	10.63 (112.9)	8.49 (71.7)	7.73 (59.7)	64.92 (474)	60.30 (413)	43.2	47.4	5.38	5.73	10.40	11.03	44.50	49.29
Fenoxaprop-p-ethyl + almix	5.15 (26.4)	4.76 (22.3)	9.60 (92.1)	9.23 (85.1)	7.12 (50.5)	6.46 (41.6)	54.86 (345)	48.79 (287)	58.7	63.4	6.17	6.26	11.93	12.00	56.20	57.32
Control	8.79 (76.7)	8.78 (76.6)	13.55 (183.2)	12.84 (164.7)	11.21 (125.1)	10.36 (106.8)	86.71 (836)	84.05 (786)	0.0	0.0	4.26	4.63	6.48	7.10	30.31	35.33
LSD (P=0.05)	0.40	0.41	0.54	0.72	0.33	0.58	2.54	2.00	4.54	2.94	0.13	0.14	0.33	0.60	1.76	2.01

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Regeneration potential and carryover effect of glyphosate treated nutsedge

Navjyot Kaur*, M.S. Bhullar, Simerjit Kaur and Tarundeep Kaur
Punjab Agricultural University, Ludhiana, Punjab 141 004
**Email: navjyot_grewal@yahoo.com*

Cyperus rotundus, commonly known as purple nutsedge / dila / motha is a serious perennial *Kharif* weed infesting 52 crops in more than 90 countries (Bendixen and Nandihalli 1987). It is mainly propagated by tubers, which have several buds that can sprout repeatedly and hence make cultural or manual methods ineffective for its control. Glyphosate [N-(phosphonomethyl)glycine] belongs to the glyphosphate herbicide classification and its mechanism of action appears to be the inhibition of nucleic acid metabolism and protein synthesis, by way of aromatic amino acid synthesis inhibition. The present investigations were carried out to find out its effective herbicidal control with the post-emergence application of glyphosate and to monitor its carryover effect.

METHODOLOGY

A field having enough natural population of *C. rotundus* was prepared during second week of July, 2013 and *Cyperus* was allowed to emerge. The plot size of 2 m x 3 m was demarcated and replicated four times. Glyphosate was applied @ 0.5, 0.75, 1.0 and 1.5 kg / ha during first week of August and second split application was applied 4 days after first application. The population of *Cyperus* was recorded before spray and again 20 days after spray (DAS) for living shoots. The tuber population was taken by digging up to 30 cm depth using a quadrate of 30cm x 30cm at the same spot from where shoot population was taken at the end of season. For studying its carryover effect, ten tubers were digged out 30 DAS from 0-15 cm depth replication – wise from each treatment and were planted into pots to observe their propagation potential.

RESULTS

All glyphosate treatments significantly reduced *Cyperus* shoot populations due to shoot mortality. Glyphosate 1.5 kg / ha was most effective in controlling *C. rotundus* in terms of shoot mortality, tuber number and tuber weight. There was about 50 and 44% reduction in tuber number and tuber weight / m^2 up to 30 cm depth as compared to respective controls due to glyphosate 1.5 kg / ha treatment (Table 1). Studies conducted by Doll and Piedrahita (2006) indicated that glyphosate kills *C. rotundus* foliage and the tubers attached to treated plants and regrowth after glyphosate application under field conditions is due to dormant tubers which sprout after treatment. In present study, carryover effect was observed due to all glyphosate treatments as indicated by significant reduction in tuber sprouting (10 days after planting into pots). Number of shoots per pot were also significantly reduced due to all glyphosate treatments except 0.5 kg / ha (20 days after planting into pots). Moreover, there was significant decline in tuber number and tuber weight per pot (45 days after planting into pots) due to all glyphosate treatments. Minimum tuber number and tuber weight per pot was observed due to glyphosate 1.5 kg / ha and the response was at par with glyphosate 1.0 kg / ha (Table 1). Glyphosate 1.5 kg / ha caused 60 and 53% reduction in tuber number and tuber weight per pot, respectively, as compared to controls.

Table 1. Effect of glyphosate application on propagation potential of *Cyperus rotundus*

Treatment (Dose kg/ha)	Percent mortality	Tubers/m^2 up to 30 cm depth	No. of tubers sprouted (out of ten)	No. of shoots /pot	Tuber weight (g)/pot
Glyphosate 1.5	48.3 (56)	146.0	1.8	8.5	11.1
Glyphosate 1.0	41.4 (44)	191.3	3.3	9.3	12.9
Glyphosate 0.75	40.0 (42)	190.7	3.5	11.5	15.4
Glyphosate 0.5	32.2 (29)	224.7	3.3	16.3	16.2
Control	0 (0)	291.3	8.3	17.5	23.5
LSD (P=0.05)	14.2	34.6	3.3	6.9	6.4

Parentheses are original values. Data subjected to square root transformation

CONCLUSION

Glyphosate 1.5 kg / ha caused significant shoot mortality of purple nutsedge with a concomitant decline in tuber sprouting and tuber production making it a suitable candidate to manage *Cyperus rotundus*.

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Emergence pattern of selected annual weeds in coconut garden

T. Girija, C.Laly John and C. T. Abraham

College of Horticulture, Vellanikkara, Kerala Agricultural University. Theissur Kerala 680 656

**Email girijari@gmail.com*

Accumulation of weed seeds helps in the build up of a population in the soil seed bank. Germination of these seeds in portions over a number of years accounts for the persistence of annual weeds in the ecosystem. Weed seeds exhibit distinct seasonal variation in germination which is determined by both intrinsic factors like dormancy and extrinsic factors like moisture content of soil, temperature, light etc. Seeds buried in soil and exposed to natural temperature cycles exhibit seasonal variation in germination. To understand the seasonality of germination of weed seeds from the soil seed bank of a coconut plantation a long term trial was started in the coconut plantation at the College of Horticulture, Vellanikkara, Thrissur in 2008.

METHODOLOGY

The germinating weed seedlings were uprooted and counted species wise at 15days interval from 5 peg marked regions of 0.25 m^2 area in the field. The observations were taken for five years. To understand the influence of season on germination a time series analysis of the data was done with the monthly weed count taken for the period from July 2008 to June 2013. A multiplicative model was assumed for the time series as given by Lynwood *et al*. 1990.

$$Y = T \times S \times C \times I$$

Where, Y- weed count in a month, T- trend component, S- seasonal variation,

C- cyclic variation, I- irregular component.

Weed seed germination is influenced by seasons and the weather conditions. The method of moving averages was used to work out the seasonal indices. This involved eliminating the other components as given in the formula using SPSS 17 statistical package.

$$\text{Seasonal index} = \frac{\text{Original weed count}}{\text{Estimated trend Value (TCI)}} \times 100$$

Seasonal index is expressed as percent weed count.

RESULTS

The major weeds observed in the coconut garden were *Axonopus compressus, Borreria articularis, Biophytum sensitivum, Brachairia miliformis, Centrosema pubscens, Commelina benghalensis, Cyperus iria, Chromoleana odorata, Curculigo orchioides, Desmodium gangeticum, Elephantopus scaber, Euphorbia hirta, Hemidesmus indicus, Ischaemum indicum, Mimosa pudica, Mitracarpus villosus, Phyllanthus niruri, Pouzolzia zeylanica, Ruellia prostrata, Sida acuta, Sida cordata, Stachytarpheta indica, Synedrella nodiflora, Scoparia dulcis, Triumfetta indica.*

The weeds were found to occupy two different strata. The upper strata was occupied by the species such as, *Borreria articularis, Hemidesmus indicus*, *Sida* spp and *Synedrella nodiflora*. The seasonality of germination of these species revealed that they germinate with the receipt of summer showers in March - April and the reaches a peak by the advancement of the South West monsoon season which starts from May - June in the state, by August, the population declines and a second flush of the weed is seen in September - October with the arrival of the North East Monsoon in September - October. The germination of the weed continues till December after which there is a lull in its germination.

Hemidesmus indicus is a weed found to germinate through out the year. The weed predominates during summer season. The peak germination period of *Hemidesmus* is from November to March, since most of the other weed species do not germinate during this season it is a predominant weed in upland ecosystem during summer.

Both *Sida* spp and *Synedrella nodiflora* are weeds which start germination from April May with the receipt of summer showers in the state and continues upto November-December. However, the germination of *Sida* spp is higher during the period from June- July to September - October. The germination peak of *Synedrella nodiflora* is during August-September and goes upto November- December. It is one of the main weed species observed during the period from December to February in the state.

Table 1. Seasonal indices (%) of weeds of coconut garden

Month	*Hemidesmus indicus*	*Sida* spp	*Synedrella nodiflora*	*Borreria articularis*
January	112.27	15.14	0.00	2.62
February	170.34	0.00	0.00	0.00
March	169.68	0.00	0.00	0.00
April	125.12	23.98	0.00	36.62
May	38.17	24.89	186.91	197.93
June	32.38	98.28	122.77	138.88
July	99.45	304.18	250.86	394.24
August	74.11	250.20	276.11	75.36
September	40.33	135.64	172.43	87.24
October	53.10	258.46	123.85	95.61
November	136.91	71.84	67.08	162.43
December	148.16	17.39	0.00	9.08

CONCLUSION

To reduce the weed density in an existing ecosystem it is essential to know the time of germination of the weed species. Seasonality index helps to identify the peak period of incidence of the weed.

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Diazotrophic endophytes of nut grass and their colonization pattern

C. Sarathambal*[1] and K. Ilamurugu[2]
[1]*Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004*
[2]*Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641 003*
**Email: saratha6@gmail.com*

Most plants in their native environments depend on interactions with microorganisms for their existence. Endophytic bacteria ubiquitously inhabit most plant species and have been isolated from a variety of plants. Recently, it has been reported that endophytic bacteria may promote plant growth and suppress the plant diseases probably by means similar to plant growth-promoting rhizobacteria (PGPR). Therefore, a better understanding of endophytic bacteria may help to elucidate their functions and potential role more effectively in developing sustainable systems of crop production. The search for natural association and endophytic interaction of diazotrophs with grass species is considered very promising, especially in grasses that grow naturally with adverse environmental conditions. These plants are considered excellent hosts to identify superior endophytes that may potentially impact the crop growth (Bagwell *et al*. 2013). Hence, the present investigation is focused to identify and characterize the unexplored culturable endophytic diazotrophic bacterial diversity of nut grass.

METHODOLOGY

Nut grass (*Cyperus rotundus*) samples were collected from Chickarasinikere, Mandya, Karnataka (77° 3´ 35.9" E, 12° 17´ 34.78" N) and carefully removed from soil by repeated washing. Specimen of surface sterilized roots and leaves were macerated and 0.1 ml of serial dilutions in 4% (commercial) sugar solution up to 10^{-6} and there dilutions were inoculated into vials containing selective N-free semi solid media. After four to six days of incubation at 30°C, the population size was estimated by the MPN method and pellicle forming bacteria were subjected to further purification by streaking on N free agar plates. Diazotrophic endophytes identified by 16S rRNA gene sequencing. The identity of 16SrRNA sequence was estabilished by performing a similarity search against the GenBank database (http://www.ncbi.nih.gov/BLAST) and the multifaceted plant growth promoting traits evaluated for four isolates.

The elite isolate were screened and further analysed for their potential of endophytic colonization. Dehulled seeds of rice (*cultivar- ADT 43*) were surface sterilized and treated with the selected bacterial inoculant for 15 min. The roots and culms from 15 days old fresh rice seedlings were cut, fixed with 3% (v/v) glutaraldehyde, for 2 h at 4°C and washed with 0.1 M phosphate buffer (pH 7.2) at room temperature for 10 min. The samples again post fixed in 1% (w/v) osmium tetroxide in the same buffer for 2 h at 4°C. The fixed samples were dehydrated in a graded ethanol series for 5 minutes in each concentration. Then the samples were treated with CO_2 and mounted on an aluminum cylinder with silver paste, and finally covered with a steam of carbon and ionized gold. Localization and distribution of endophytic bacteria on roots and culms of rice seedlings were analyzed by scanning electron microscopy (SEM) (ICON, anaytical FEI Quanta 200, USA) operated at 15 kV at an 8-10 mm distance. Colonizing ability of the endophytic isolates in rice seedlings were documented as microphotographs.

RESULTS

In the present study, the 16S rRNA gene sequence homology of diazotrophs isolated from rhizosphere of selected grass species revealed the presence of diversity of g Proteobacteria and Firmicutes (Table 1). All the four strains exhibited multiple plant growth promoting activities and between the isolates, the PGPR activities varied quantitatively. On the basis of multiple plant growth promoting traits the elite isolate (*Serratia* sp. CRE2) were taken for endophytic colonization study.

The endophytic colonization in the rice seedlings (roots and culm) were examined by SEM analysis. The preferable sites of bacterial attachment and subsequent entry are the apical root zone with the thin-walled surface root layer such as the cell elongation and the root hair zone (zone of active penetration), and the basal root zone with small cracks caused by the emergence of lateral roots (zone of passive penetration). At these sites bacteria are often arranged in microcolonies comprising several hundreds of cells (Zacha *et al*. 2010). Results indicated that endophytic bacteria were preferentially colonized in the rhizoplane of rice roots. Diazotrophic cells were observed in the longitudinal and horizontal sectioned roots and culms.

Table 1. Molecular authentication of endophytic strains from nut grass species by 16S rRNA gene sequence homology

Isolate code	Closest relative in database	Gen bank accession no.	Per cent homology	Biochemical properties		
				Cellulase	Pectinase	Motility
CRE1	*Pantoea* sp.	KF906837	98	+	-	+
CRE2	*Serratia* sp.	KF906838	99	+	+	-
CRE3	*Bacillus* sp.	KF906840	99	+	-	-
CRE4	*Klebsiella pneumoniae*	KF906842	99	+	+	+

CONCLUSION

According to our results, endophytic bacteria seem to be uniformly distributed on the rhizoplane of the root and also we identified colonization at the intercellular junction. The present work suggest that exploring the elite diazotrophic strain having multiple plant growth promoting traits, as bioinoculants for nutrient management and for biotic and abiotic stress mitigation and sustainable crop production with fewer chemical inputs.

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Invasiveness of wild *Rosa* in Kaziranga National Park, Assam

I.C. Barua*, M. Devi, J. Deka, N.K. Vasu[1] and R. Sarmah[1]
Assam Agricultural University, Jorhat, Assam 785 013
[1]Directorate of Kaziranga National Park, Bokakhat, Assam 785 612
**Email: iswarbarua0101@ymail.com*

Thomas (2003) defined Range land as "natural grassland in which the climax vegetation or the potential plant community consists principally of native grasses, forbs (broadleaved herbs) and shrubs that are valuable as forage and are in sufficient quantity to justify its use for grazing". In the Kaziranga National Park of Assam nearly 3% of its total geographical area is the Rangeland, which plays an important role in maintaining the ecological balance. Shrinkage of this Rangeland, mainly due to increasing invasion by a thorny weed is becoming a serious problem since last few years.

METHODOLOGY

The Kaziranga National (KN) Park comprises nearly 430 sq. km. core area situating along the river Brahmaputra between latitudes 26°30' N and 26°45' N, and longitudes 93°08' E to 93°36' E. In this park intensive survey was conducted for last two decades in search of the diversity and extent of damage done by the invasive weeds like *Mimosa diplotricha* and other alien species. Incidentally, a wild species belong to *Rosa* L. has been recorded as one of the most dominant weeds in some specific situations within and around the Park. Plant specimens of this species have been critically examined and identified with the help of literature and consultation with Herbaria of international repute. Areas of infestation have been estimated through repeated ground survey.

RESULTS

Few invasive weeds are creating havoc in the Kaziranga National Park of Assam since last few decades. Next to *Mimosa diplotricha*, perhaps, a wild *Rosa* is one of the most trouble giving weeds – more particularly in the moist grazing lands. Large thickets of this thorny straggling shrub has made passing through impossible even for large animals like elephants, buffalos and rhinoceros. The effect of increasing population of this wild rose has basically damaged the Rangelands and neighbouring swamplands, reduced drastically the diversity of other plant species, destroyed habitats and grazing areas of animals and several birds. The highest density and maximum severity of the weed was recorded in Baguri Range, however, its spreading footsteps became distinctly visible to Burapahar Range towards west and Kohora Range towards east (Table 1).

This wild rose possessed red to green stems, leaves with 3 to 11 numbers of leaflets and usually 5-petaled white flowers with numerous yellow stamens. Straight and hardly curved thorns, solitary and large flowers (3-5 cm across) and some other morphological characters showed its resemblance with the coastal East Asiatic species *Rosa luciae* Fr. and Rochebr.; and its fimbriate stipules, tomentose younger parts, and few other characters showed affinity with *Rosa multiflora* Thunb. But, the presence of (i) large laciniate and pubescent bracts, (ii) paired prickles near the base of the petioles, (iii) 1.0 to 3.0 cm long and 0.7 to 1.5 cm wide leaflets in combination with the above mentioned characters confirmed its identity as "Macartney Rose" *Rosa bracteata* Wendl. var. *scabricaulis* Lindl. ex Koidz. *Rosa bracteata* is native to southern China, Taiwan and Japan and distributed as invasive weeds in many parts of Europe, USA, West Indies and Australia. In India, perhaps this is the first record of this species, that too as an invasive weed in K. N. Park. The dense thicket of *R. bracteata,* remained undamaged during Rangeland management operations including annual burning of grasslands, became a permanent shelter place for the Burmese python. As a whole it has increased ecological threats by reducing grazing areas and forage productivity, displacing indigenous plant species and extricating several wild animals, birds and other creatures. The soil with high moisture content round the year and with 5.5 to 6.0 pH was found to be ideal for *Rosa bracteata* in the K. N. Park. The size of the clumps varied from 2-5 m in diameter and 2-3 m in height. This weed propagated basically by means of seeds, while, the vegetative sprouting from the stem base are responsible for expansion of the size of the clumps.

Table 1. Estimated area under macartney rose infestation in the Kaziranga National Park

Intensity Grade	Infested area	Range	Approx. area
I	Kaoimari to Amkasani	Baguri	2.5 sq. km.
II	Murphuloni area	Baguri	2 sq. km.
III	First addition area	Burapahar	1 sq. km.
IV	Ajgar area	Kohora	3 sq. km.

CONCLUSION

"Macartney Rose", the wild weedy member of *Rosa* has been recorded in the Kaziranga National Park as one of the serious threats for the Rangelands. Nearly 8.5 km^2 areas of rangelands and neighbouring swamplands have already been infested by the thorny and perennial thickets of this weed. This weed has appeared as driver species responsible for alteration of ecosystem properties and removal of native species in the Park, removal of which is like to help in the restoration of the ecosystem.

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Polygonums as bio indicators of certain crop-ecosystems

Mitali Devi*, Bhaskar Sharma, Nilay Borah, I. C. Barua and J. Deka
Assam Agricultural University, Jorhat, Assam 785 013
**Email: mitalidevi0311@gmail.com*

Polygonums are highly populated herbaceous weeds in North-east India. Though there are about 300 species under the genus *Polygonum* L. (Polygonaceae), their distribution is restricted mostly in sub-tropical to temperate region, except a few tropical ones. Majority of the Polygonums are annual and propagate by means of seeds. Presences of large ochreate stipules, biconvex or trigonous achinal fruits (Nutlets) are characteristic features of *Polygonum*. Out of nearly 80 species of the genus occurring in India, 32 species are known to be occurring in Assam. Amongst these, some Polygonums possess affinity to specific habitats, in other ways they could be used as indicator species of the particular situations.

METHODOLOGY

The plant sample of *Polygonum* species were collected, critically studied and identified. Associated crops in their places of occurrence as well as the soil quality were also studied.

RESULTS

As many as 11 numbers of species belonging to the genus *Polygonum* have been identified as indicator of 10 different situations. Out of these, *P. hydropiper* has traditionally been used by the farming community of this region to identify the soil suitability for transplanted rice cultivation. *P. pleibium and P. viscosum* were the only obligate weeds to the winter season crops and rest were facultative weeds of different crops of Assam. The moist rice fallow fields during February to June became green in the entire Assam and West Bengal because of excessive growth of summer Polygonums like *P. glabrum, P. hyropiper* and *P. orientale.* With their high density, the *Polygonum* species characteristically monopolized the places of their occurrence during their peak growing period. The species identified as indicator of certain situations are as follows:

Name of species	Situations of occurrence	Indicator of soil /situation
P. lapathifolium	Riverbeds, Steam bank, in sand rich soil and peat soil; neutral to slightly alkaline (7-7.5 pH). New alluvium with great depth. Lighter texture with good drainage.	Soil rich in organic content, good for cultivation of winter vegetables
P. orientale	Typically loamy soil with high organic carbon (greater than 2%). Moderate moisture holding capacity keeps soil moist even in dry season.	Soil with heavy amount of organic matter and suitable for cultivation of upland crops
P. pleibium and *P. viscosum*	Acidic soils (4.5-5 pH) of old alluvial origin.	Cropland fertile soil, suitable for wheat, vegetables and upland rice
P. perfoliatum	Fertile upland soil, partially shaded. Clay-loam to loamy-clay soils with fairly good organic matter content so as to facilitate water retention and good drainage of excess water.	Fertile soil, suitable for wheat, vegetables and upland rice
P. hydropiper	Wet situation and edges of peat lands. Gleyed soils with massive structure with acidic pH, with high undecomposed matter content.	Suitable for typical transplanted rice growing.
P. glabrum	Moist rice fallow land. Alluvial soils with completely structure less A1 horizon, hence poor drainage.	Suitable for transplanted rice and jute cultivation.
P. chinense	Partially shaded damp soil. Organic matter rich, more or less neutral top soil supporting high microbial activity.	Soil suitable for summer vegetables
P. barbatum	Damp soil along the streams and peat lands and edges of transplanted rice land under least disturbed condition. High moisture holding gleyed soils having a reduced layer with high undecomposed organic matter content.	Suitable for transplanted rice cultivation.
P. pulchrum	Perennial less disturbed grass land and forest floor-soil. Deep well structured soils with near neutral acidity.	Soils are with fairly moderate organic matter content and suitable for cultivation of upland crops.
P. strigosum	Along the banks of water bodies and aquatic rice lands. Soils of silty texture with high CEC (Cation Exchange Capacity), hence fertile.	Soil suitable for cultivation of upland crops.

CONCLUSION

Some of the common *Polygonum* species can be used as indicator of certain land situations as they indicate fertility levels and potential nutrient deficiencies, water logging or compaction problems, pH levels and so on of soil situations.

Effect of herbicides on weed dynamics and yield of Indian mustard

R.S. Singh*, Anil Pandey, D.K. Dwivedi, I.B. Pandey and D. Singh
Department of Agronomy, Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar 843 121
*****Email: dr.ramashankarsingh@gmail.com*

Indian mustard (*Brassica juncea*) is one of the most important edible oilseed crops in India after groundnut but in Bihar, it occupies first position both in area and production. Weed infestation is the most serious constraint accounting for the major losses incurred to agricultural produce (Nambi *et al*. 2006). Hand weeding by hired laborers is generally done by the farmers but due to scarcity and availability of laborers during peak period, increasing labor wages, time consuming and cumbersome operation, it becomes imperative to go for chemical weed control due to its edge over manual weeding to overcome these problems. Weed flora which were found in the experimental field were *Cynodon dactylon, Polypogon monspeliensis, Avena fatua, Chenopodium album, Anagallis arvensis, Cannabis sativa, Convolvulus arvensis, Circium arvense, Physallis minima, Cyperus rotundus* etc. Keeping these facts in view, this experiment was undertaken.

METHODOLOGY

The experiment was conducted at Research Farm of Tirhut College of Agriculture, Rajendra Agricultural University, Pusa, Samastipur, Bihar in the year 2011-12 to 2012-13 during *Rabi* seasons. The soil of the experimental plot was sandy loam with pH value of 8.6. Initial soil analysis value of experimental field was: organic carbon (0.473%), available nitrogen (250.6 kg/ha), phosphorus (30.42 kg/ha), and potassium (157.3 kg/ha), sulphur (21.46 ppm) and boron (0.2 ppm). The experiment was laid out in randomized block design with eleven treatments each replicated thrice (Table 1). Variety taken of Indian mustard was '*Rajendra Sufalam*'. Recommended doses of fertilizers *i.e.,* 80:40:40:20 kg $N:P_2O_5:K_2O:S$ /ha were applied uniformly in all the treatments.

RESULTS

Herbicides applied had significant effect on weed count, weed dry biomass, weed control efficiency and yield of mustard. Lowest weed count, dry weight and maximum weed control efficiency were recorded under isoproturon 1.0 kg/ha (30 DAS) and isoproturon 0.75 kg/ha (30 DAS) which were found at par but post emergence application of isoproturon at lower rate *i.e.,* 0.75 kg/ha was found more effective because isoproturon at higher dose 1.0 kg/ha had suppressing effect on mustard crop. It was also found that irrigating the field immediately after application of higher dose of isoproturon had phyto-toxic effect on crops resulting in slower growth of crop as well as its chlorotic effect on leaves and due to these reasons plots treated with lower dose of isoproturon resulted in highest mustard yield (1.84 t/ha) similar to yield realized under weed free (1.94 t/ha) condition.

Table 1. Effect of herbicides on weed dynamics and yield of Indian mustard

Treatment	Weed count/m²	Dry wt. (g/m²)	WCE (%)	Mustard yield (t/ha)
Pendimethalin 1.0 kg/ha (P.E)	295	17.3	59	1.75
Oxadiargyl 0.09 kg/ha (PE)	364	24.8	41	1.41
Trifluralin 0.75 kg/ha (PPI)	382	23.9	43	1.47
Oxyfluorfen 0.15 kg/ha (P.E)	311	18.2	57	1.65
Quizalofop 0.06 kg/ha (20-25DAS)	228	19.8	53	1.60
Clodinafop 0.06 kg/ha (20-25 DAS)	274	17.4	59	1.56
Isoproturon 1.0 kg/ha (P.E)	226	16.3	61	1.65
Isoproturon 1.0 kg/ha (30 DAS)	117	12.7	70	1.63
Isoproturon 0.75 kg/ha (30 DAS)	186	14.5	69	1.84
Weedy free	06	0.2	100	1.94
Weedy check	497	42.1	-	0.99
LSD (P=0.05)	97	6		0.32

CONCLUSION

Isoproturon 0.75 kg/ha (30 DAS) was found most effective against broad leaved weeds for their control in mustard field.

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Weed flora of non cropped areas in Haryana

S.S. Punia*, Yash Pal Malik, Amarjeet, and Rajbir Shoeran

Department of Agronomy, CCS HAU Hisar, Haryana 125004

**Email: puniasatbir@gmail.com*

Weeds under non cropped areas are equally important as they are responsible for reduction of aesthetic values of landscapes, reduction of grazing area under pastures; impeding of flow of drains and canals. Keeping this in view, survey of non cropped area for wed flora was conducted in Haryana.

METHODOLOGY

Visual ranking of weed flora (1-V) based on severity of infestation was made along road sides and vacant lands. State was divided in to five zones based on rainfall and soil types: North-east humid zone: Rainfall is 900-1100 mm, soils are sandy loam - loam in texture in districts of Panchkula, Ambala and Yamuna Nagar, North eastern plain zone with loamy soils and rainfall of 600-800 mm-in districts of Kurukshetra, Karnal, Kaithal, Panipat and some parts of Sonepat (Sonepat and Ganour tehsil), South-western plain zone with sandy-sandy loam soils, under ground water is brackish in nature, rainfall is low (350- 550 mm) in districts of Jind, Kalayat and Rajound of Kaithal, Hisar, Rohtak, Fatehbad, Jhajjar, Rewari, Gohana tehsil of Sonepat, part of Bhiwani and Sirsa, Sand dunal areas with rainfall of 300-500 mm with sloppy lands, light in texture, poor water holding capacity in Loharu, Badhra, Tosham and Siwani areas of Bhiwani, Ellenabad and Nathusari Chopta of Sirsa, Bhattoo of Fatehbad, Balsamand and Saharawa areas of Hisar, Satnali in Mahender garh and South Haryana with sandy loam to loam soils, rainfall is around 450-600 mm in districts of Gurgaon, Faridabad, Mewat and parts of Mahendar Garh

RESULTS

Different weed flora were observed during the survey. The weed species found in the classified zones are given in table.

Weed spp.	Ranking	Severity of infestation
ZONE I		
Cannabis sativa	I	Very High
Cassia occidentalis	II	High
Parthenium hysterophorus	III	Moderate
Sida rohmbifolia	IV	Moderate
Cassia tora	V	Low
ZONE II		
Cassia occidentalis	I	High
Parthenium hysterophorus	II	Moderate
Sida rohmbifolia	III	Moderate
Chenopodium ambrosoides	IV	Low
Xanthium strumarium	V	very Low
ZONE III		
Chenopodium ambrosoides	I	Very High
Suaeda fruticosa	II	Very High
Parthenium hysterophorus	III	High
Abutilon theophrasti	IV	Low
Croton bonplandianum	V	Low
ZONE IV		
Helianthus annus	1	Very high
Aerva javanica	II	High
Calotropis procera	III	High
Suaeda fruticosa	IV	Moderate
Croton bonplandianum	V	Low
ZONE V		
Parthenium hysterophorus	I	High
Suaeda fruticosa	II	High
Chenopodium ambrosoides	III	Moderate
Saccharum spontaneum	IV	Moderate
Croton bonplandianum	V	Low

CONCLUSIONS

Cannabis sativa, Cassia occidentalis and *Parthenium hystreophorus* are the major weeds in all zones except in zone IV where soils are coarse, loam sand in texture predominated with *Helianthus annus* and *Aerva javanica. Cassia tora* is found to replace *Parthenium* only in high rainfall areas of zone I where in zone II and III, *Chenopodium ambrosoides* is replacing *Parthenium* along roadsides.

Germination of weedy rice under anaerobic conditions

Meenal Rathore*, Raghwendra Singh, Bhumesh Kumar and Dibakar Ghosh
Directorate of Weed Science Research, Maharajpur, Jabalpur, Madhya Pradesh 482 004
**Email: mnl.rthr@gmail.com*

Weedy rice is an emerging problem in Asia and is known to affect crop yield and produce quality. The menace has infested rice fields with a shift to direct seeding of rice. Standing water / flooding is known to suppress weedy rice emergence. Broadcasting of germinated seedlings in puddled soil having standing water is practiced in an effort to manage weedy rice. But still, weedy rice is known to occur. Being a natural hybrid of cultivated and wild rice the biosimilar weed has properties of both rice types and, as a result, varied properties. The origin of weedy rice varies across geographical regimes, and hence properties will also tend to vary. Seedling establishment, a parameter important for germination under flooded conditions, will also vary. In an effort to assess existing variability for germination under anaerobic conditions in weedy rice, a study was conducted at Directorate of Weed Science Research, Jabalpur.

METHODOLOGY

Fifty five accessions of weedy rice, collected across different states of India, were tested for germination along with ten varieties of cultivated rice during *Kharif* 2013. All the seeds of accessions showed good germination ranging in between 95-100%. Ten seeds were uniformly placed 1cm beneath the soil and covered with 6 cm. standing water. The experiment was conducted in a completely randomized design and with three replications. Observations were recorded for determining percentage seed germination, germination index, vigor index, dry matter production, root and shoot length 15 DAS. Tetrazolium test was also conducted to assess viability of seeds that had not germinated under anaerobic conditions.

RESULTS

Among the sixty five accessions studied, only twenty seven germinated. The 38 accessions that had not germinated included six cultivated rice, and responded positive to the tetrazolium test indicating that the seeds were viable but did not germinate under existing anaerobic conditions. The accessions that germinated included four rice cultivars and 23 weedy rice accessions. Variations were observed in cultivated ad weedy rice for the parameters studied. However, there was no significant variation amongst the cultivated rice. Amongst weedy rice accessions studied, highest germination was recorded in the sixth accession from MP(100%) and the third accession form Kerela (100%) (Table 1). This accession from MP also had the highest vigor index (2928) which was significantly superior over the others. On the other hand, few accessions revealed very poor germination (20%) and vigor indices. Immense variation was found amongst the weedy rice accessions studied for the parameters observed with significant differences in all, except root length.

Table 1. Effect of anaerobic seeding on seedlings of rice cultivars and weedy rice accessions

	Parameters studied					
	DMTF	Germination Index	Germination (%)	Root Length (cm)	Shoot Length (cm)	Vigour index
T1: UP	0.0171^{AB}	0.31^{ABC}	30^{ABC}	6.00^{A}	27.33^{AB}	1040^{ABC}
T2: UP	0.0086^{ABC}	0.07^{ABC}	20^{ABC}	3.50^{A}	16.10^{AB}	392^{ABC}
T3: UP	0.0116^{ABC}	0.17^{ABC}	40^{ABC}	4.53^{A}	19.96^{AB}	888^{ABC}
T4: UP	0.0089^{ABC}	0.21^{ABC}	20^{ABC}	4.00^{A}	26.70^{AB}	614^{ABC}
T5: UP	0.0118^{ABC}	0.57^{ABC}	53^{ABC}	3.72^{A}	18.86^{AB}	1263^{ABC}
T6: UP	0.0137^{ABC}	0.23^{ABC}	26^{BC}	5.40^{A}	22.93^{AB}	770^{BC}
T7: UP	0.0198^{AB}	0.21^{ABC}	20^{ABC}	9.00^{A}	23.00^{AB}	640^{ABC}
T8: UP	0.0117^{ABC}	0.46^{ABC}	66^{ABC}	4.85^{A}	20.91^{AB}	1686^{ABC}
T1: MP	0.0013^{BC}	0.07^{ABC}	20^{ABC}	0.50^{A}	1.50^{B}	40^{ABC}
T2: MP	0.0123^{ABC}	0.28^{ABC}	40^{ABC}	6.75^{A}	29.30^{AB}	1442^{ABC}
T3: MP	0.0123^{ABC}	0.34^{ABC}	60^{ABC}	5.90^{A}	17.27^{AB}	1390^{ABC}
T4: MP	0.0098^{ABC}	0.47^{ABC}	30^{ABC}	8.22^{A}	18.22^{AB}	883^{ABC}
T5: MP	0.0110^{ABC}	0.13^{ABC}	40^{ABC}	4.62^{A}	19.58^{AB}	968^{ABC}
T:6 MP	0.0134^{ABC}	0.67^{ABC}	100^{A}	4.98^{A}	24.30^{AB}	2928^{A}
T7: MP	0.0143^{AB}	0.21^{ABC}	20^{C}	6.37^{A}	29.77^{A}	722^{C}
T1: Kerela	0.0031^{C}	0.20^{ABC}	60^{ABC}	2.02^{A}	7.57^{B}	575^{C}
T2: Kerela	0.0101^{ABC}	0.83^{A}	93^{AB}	3.67^{A}	20.79^{AB}	2306^{ABC}
T3: Kerela	0.0125^{ABC}	0.81^{AB}	100^{A}	3.10^{A}	24.95^{AB}	2805^{AB}
T1:CGH	0.0057^{BC}	0.16^{C}	46^{ABC}	2.63^{A}	12.92^{AB}	775^{BC}
T1:JKD	0.0101^{BC}	0.69^{ABC}	93^{AB}	3.72^{A}	21.52^{AB}	2392^{ABC}
T1: WB	0.0016^{BC}	0.21^{ABC}	20^{ABC}	6.00^{A}	7.20^{AB}	198^{ABC}
T1:Bihar	0.0120^{ABC}	0.43^{ABC}	73^{ABC}	2.70^{A}	24.56^{AB}	2014^{ABC}
C:Jyothi	0.0065^{BC}	0.18^{BC}	40^{ABC}	2.52^{A}	15.93^{AB}	805^{BC}
C: Sahbhagi	0.0077^{BC}	0.39^{ABC}	73^{ABC}	4.29^{A}	19.14^{AB}	1718^{ABC}
C: Jaya	0.0255^{A}	0.07^{ABC}	20^{ABC}	3.61^{A}	28.50^{AB}	658^{ABC}
C: IR64	0.0018^{AC}	0.07^{ABC}	20^{ABC}	4.40^{A}	2.55^{B}	51^{ABC}
C: P.Basmati	0.0107^{ABC}	0.28^{ABC}	40^{ABC}	2.75^{A}	29.15^{AB}	1276^{ABC}
LSD at 1%	.0081	0.49	54.04	NS	13.81	1597

Accessions, T- weedy rice, C - cultivated rice

CONCLUSION

As hypothesized, variation in germination / seedling establishment is present among weedy rice accessions collected across a geographical region.

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Enhanced accumulation of cadmium in giant reed by chelating agent

P.J. Khankhane*, Aasfa Tabassum and Akhilesh Patel
Directorate of Weed Science Research Maharajpur, Jabalpur, Madhya Pradesh 482 004
**Email: pjkhankhane@yahoo.com.ph*

Soil contaminated by metal elements like cadmium which mainly originate from nonferrous mineral processing and smelting activities, has become one of the major environmental concerns and has profound effects on health of human beings. Numerous struggles have been done to invent processes for the restoration of effected soils. In recent times, phytoextraction of metal contaminants from disturbed soils has been fascinated due to its lesser cost of implementation than others and loads of environmental paybacks (Salt *et al*. 1998). There are certain factors that determine ability of a plant for phytoremediation e.g. plants ability to cultivate a large biomass with high contents of toxic metals in its shoots. In this context, effort were made to investigate ability of *Arundo donax* to absorb chelating agents such as EDTA.

METHODOLOGY

A pot experiment was carried out using *Arundo donax* L in net house facility during *Kharif* 2013 at Directorate of Weed Science Research, Jabalpur. *Arundo donax* was exposed to different concentrations of ethylene diamine tetra-acetic acid (EDTA) concentrations applied at 0, 3 and 6 ppm. The growth and chlorophyll reflectance of plants were taken during experimentation and cadmium accumulation in different parts was evaluated at harvesting stage of plant. After harvesting plant samples processed for metal analysis.

RESULTS

The cadmium accumulation in shoot increased with increase in cadmium concentration. The higher cadmium accumulation was observed in root than shoot part of *Arundo donax*. The addition of EDTA 3-6 mg/L further enhanced the cadmium accumulation in shoot (Fig. 1). However, the EDTA 6 mg/L enhanced 2- 3 times higher cadmium accumulation in root as compared to control. The order of cadmium accumulation was root > stem > leaf. No adverse effect of cadmium levels were observed on plant in terms of height and chlorophyll reflectance by leaves of *Arundo donax*. But, the root length and root biomass of plant was reduced when chelating agent was applied 6 mg/L. The order of cadmium accumulation was root > stem > leaf.

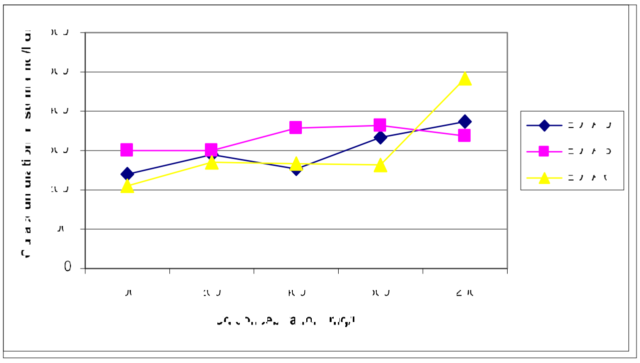

Fig. 1. Enhancement of cadmium accumulation by EDTA in shoot of *Arundo donax*.

CONCLUSION

The concentrations of Cadmium in giant reed shoots significantly increased when applying EDTA at lower levels. Combined use of EDTA along with high biomass producing *Arundo* has implication for phyto-extraction of cadmium contaminated sites.

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Fimbristylis diversity in rice ecosystems of Assam

Rupam Sarmah, I.C. Barua and B. Kumar[1]

Assam Agricultural University, Jorhat-785013, [1]Directorate of Weed Science Research Centre, Jabalpur, Madhya Pradesh
**Email: rupam1915@gmail.com*

Sedges are an integral part of the vegetation of rice ecosystems of entire Eastern and North-eastern India to China and South East Asia, amongst which the members of *Fimbristylis* Vahl (*Cyperaceae*) are of common occurrence in damp upland to medium low land situations. They have often been considered as driver species causing serious depletion of rice yield and quality. Chowdhury (2005) enumerated total 23 species in the state Assam and the report of Rao and Verma (1982) confirmed the presence of as many as 33 species in the entire North-East India. The miniature structure and vegetative mimicry made *Fimbristylis* a complex group from taxonomical point of view. Hence, in the present study the weedy *Fimbristylis* of rice lands were critically studied and their identification key has been prepared for easy recognition in the field.

METHODOLOGY

The plant sample of *Fimbristylis* species have been collected from different places of Assam, basically from the rice cultivated area. Collected plant samples are critically studied in the laboratory and identified with the help of literature and consultation of Herbaria of Botanical Survey of India.

RESULTS

As many as 9 numbers of species belonging to the genus *Fimbristylis* have been identified in different rice ecosystems in Assam. Amongst these, *Fimbristylis littoralis* and *F. miliacea* have been found with high density in terraced, autumn (both upland and medium low land) and winter rice crop ecosystems. Similarly, *Fimbristylis aestivalis* and *F. globulosa* have been found in upland autumn rice ecosystem, as well as along the bunds of transplanted rice fields. In shifting cultivation (*Jhum) Fimbristylis globulosa* occurred as a common weed, which badly affected the growth and development of rice plants. *Fimbristylis bisumbellata* and *F. dichotoma* have been found in summer rice, autumn rice (both upland and low land) and winter rice ecosystems; these were also of common occurrence along the bunds of transplanted rice as good contributor to the soil seed bank.For their easy recognition, the following "Key" for identification is developed.

1 a. Stem and leaves are extremely narrow and thread like, (plant height less than 12 cm.) ……… (2)

1 b. Stem and leaves are wider, never thread like, (plant height more than 12 cm.) ……………….. (3)

2 a. Anthela reduced to solitary or some time 1-3 spikelets; stem non-rhizomatous; bracts setaceous, 1-3, as long as or shorter than spikelet ………………………… ***F. ovata***

2 b. Anthela laxly compound or decompound, 5-8 rayed; stem shortly rhizomatous; bracts filiform, several, much longer than spikelet ……………………….. ***F. aestivalis***

3 a. Leaf represented by sheath only, lamina absent, spikelet obtuse; gynoecium glabrous ... ***F. globulosa***

3 b. Leaf with distinct sheath and lamina; spikelet acutish (obtuse in *F. littoralis*), gynoecium hairy or nearly so ……………………………………………………… (4)

4 a. Anthela often reduced to 1-2 spikelets, rarely more; bract setaceous, as long as or shorter than spikelet ………………………………………… ***F. tristachya***

4 b. Anthela with many spikelets; bract usually foliaceous …………………………………………………… (5)

5 a. Spikelet 2-5 mm long in supradecompound (less often decompound) anthela; stigma 3; nuts trigonal ………………………………………………… (6)

5 b. Spikelet longer than 6 mm in compound or decompound (less often supradecompound) anthela; stigma 2; nuts lenticular ……………………………………… (7)

6 a. Spikelet subglobose, obtuse; leaves equitant, laterally flattened ………………………… ***F. littoralis***

6 b. Spikelet ovoid-oblong, acutish; leaves not equitant, dorsoventrally flattened ……………… ***F. miliacea***

7 a. Stem and leaves pubescent to tomentose; nuts 1.0-1.5 mm long ……………………………… ***F. tomentosa***

7 b. Stem and leaves glabrous; nuts shorter than 1 mm long ……………………………………………… (8)

8 a. Glumes more than 2 mm long, 3 nerved; stems trigonous, 1.0-1.5 mm thick, some times with short and woody rhizomes; leaves one third to one half as long as the stem ……………………………… ***F. dichotoma***

8 b. Glumes 1.0-1.5 mm long, strongly keeled; stem compressed to trigonous, nearly 1mm thick, never rhizomatous; leaves shorter than to subequalling the stem ……………………………… ***F. bisumbellata***

CONCLUSION

Nine species of *Fimbristylis* had very frequent occurrence in rice ecosystems in Assam. The miniature structure and vegetative mimicry made *Fimbristylis* a complex group from taxonomical point of view. A taxonomic "Key" is developed, therefore, for easy recognition of the taxa to the species rank.

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Integrated weed management in carom seeds

N. Nalini*, A. Srinivas and T. Ram Prakash
Department of Agronomy, College of Agriculture, ANGRAU, Hyderabad, Andhra Pradesh 500 030
**Email: nalinithara@gmail.com*

Ajwain (*Trachyspermum ammi L.*) is belongs to the family Apiaceae. It is the one of the most important seed spice crop mainly grown in Rajasthan, Andhra Pradesh, Madhya Pradesh and Karnataka. The seeds of ajwain have essential oil content in the range of 2.4%. The fruits find its use as an antispasmodic, anti flatulent and diuretic anti microbial. Ajwain germination comes at 12-15 days after sowing, so initial slow growth of seed spices leads to severe weed crop competition and reduces growth as well as yield is as high as 91.4% (Mali and Suwalka 1987)

METHEDOLOGY

Afield experiment was carried out during *Rabi* season of 2012-13 at college farm, Rajendranagar, ANGRAU to evaluate their efficacy of pre emergence and post emergence herbicides and their combination on ajwain and also effectiveness of integrated weed management approaches involving the mechanical methods conjugation with pre emergence herbicide usage. The thirteen treatments were arranged in randomized block design with three replications. The ajwain local verity sowed in the experimental field with recommended practices. Fertilizers were applied uniformly through urea, single super phosphate and Murate of potash 40-20-20 ka/ha, respectively. Data on weed growth, yield performance and economics were recommended.

RESULT

Among the Pre emergence herbicide oxyfluorfen 0.12 kg/ha as pre *fb* hand weeding at 40 DAS and in post-emergence herbicides oxyfluorfen 0.12 kg/ha as pre *fb* quizalfop-p-ethyl 0.05 kg/ha as PoE at 20 DAS was observed lowest weed density and weed dry matter(Table 1).

Maximum weed index was recorded in weedy check treatment (64.33%).Among the integrated weed treatments oxyfluorfen 0.12 kg/ha as pre *fb* quizalfop-p-ethyl 0.05 kg/ha as PoE at 20 DAS (11.77%). This clearly indicated that weeds were controlled effectively under oxyfluorfen 0.12 kg/ha as pre *fb* quizalfop -p-ethyl 0.05 kg/ha as PoE at 20 DAS. The highest seed yield was obtained by hand weeding at 20, 40 and 60 DAS (1.15 t/ha) and lowest (0.41 t/ha) was recorded in weedy check treatment. The yield loss due to uncontrolled weed growth as compared to hand weeding.

Table 1. Effect of different integrated weed management practices on weed growth, yield and economics of ajwain.

Treatment	Weed density at 40 DAS	Weed dry matter (g/m) at 40 DAS	Weed control efficiency (%) at 40 DAS	weed index (%)	Seed yield (t/ha)	B:C ratio
Pendimethalin 1.0 kg/ha as PE *fb* hand weeding at 40 DAS	10.55 (110.5)	5.42 (28.4)	44.44	35.93	0.74	1.8
Oxyfluorfen 0.12 kg 0 kg/ha as PE *fb* hand weeding at 40 DAS	8.62 (73.4)	4.49 (19.2)	62.54	16.97	0.95	2.4
Pretilachlor 0.5 kg/ha PE *fb* hand weeding at 40 DAS	13.23 (174.1)	6.41 (40.1)	21.69	45.63	0.62	1.6
Quizalfop -p-ethyl 0.05 kg/ha as PoE at 20 DAS	12.14 (146.6)	5.67 (31.2)	37.16	54.98	0.52	1.4
Propaquizafop 0.05 kg/ha PoE at 20 DAS	13.56 (182.9)	6.91 (46.8)	8.54	57.14	0.49	1.4
Pendimethalin 1.0 kg/ha as PE *fb* quizalfop -p-ethyl 0.05 kg/ha as PoE at 20 DAS	8.97 (79.5)	4.86 (22.7)	55.66	33.16	0.77	2.0
Oxyfluorfen 0.12 kg/ha as PE *fb* quizalfop-p-ethyl 0.05 kg/ha as PoE at 20 DAS	6.25 (38.2)	4.04 (15.4)	70.01	11.77	1.01	2.7
Pretilachlor 0.5 kg/ha as PE *fb* quizalfop -p-ethyl 0.05 kg /ha as PoE at 20 DAS	12.00 (143.2)	5.93 (34.4)	33.06	48.23	0.59	1.6
Pendimethalin 1.0 kg/ha as PE *fb* propaquizafop 0.05 kg/ha as PoE at 20 DAS	9.97 (98.5)	5.23 (26.4)	48.48	42.94	0.65	1.8
Oxyfluorfen 0.12 kg/ha as PE *fb* propaquizafop 0.05 kg/ha as PoE at 20 DAS	8.23 (66.9)	4.70 (21.1)	58.71	36.28	0.73	1.9
Pretilachlor 0.5 kg/ha as PE *fb* propaquizafop 0.05 kg/ha as PoE at 20 DAS	12.55 (156.5)	6.10 (36.3)	29.19	53.59	0.53	1.4
Hand weeding at 20, 40 and 60 DAS	5.1 (25.1)	3.66 (12.4)	75.71	-	0.15	2.3
Weedy check	15.34 (234.6)	7.22 (51.2)	-	64.33	0.41	1.2
LSD (P=0.05)	1.43	0.66			0.08	2.4

Original values are given in parentheses, which were transformed to $\sqrt{x+1}$

CONCLUSIONS

It was concluded that integrated weed management practices that application of oxyfluorfen 0.12 kg/ha as pre *fb* quizalfop -p-ethyl 0.05 kg/ha as Poe at 20 DAS and oxyfluorfen 0.12 kg/ha as pre *fb* hand weeding at 40 DAS was most effective for controlling weeds, improving seed yield and profitability of ajwain.

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Weed spread risk potential of seeds of some of the important weeds

D.K. Pandey*

Weed Biology and Physiology Section, Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004

**Email: dayapandey@hotmail.com*

Anthropogenic and diverse climatic and agro-climatic conditions derived differences in distributions of problem weeds kept intact areas in different regions of the country from such invasions. However, natural and anthropogenic forces sustain risk of spread of the weeds, more so of invasive species, to yet un-infested areas. Many niches may be waiting to support newer weeds by being favourable climate and ecosystems. Thus, crop production and protection and protection of human and animal health, environment and natural biodiversity continuously sustain threat of weed attack, especially from the invasive species. Anthropogenic factors including transport of man and materials across areas may, among other factors, play a crucial role in deciding weed problem dynamics in an area. Awareness of risks of the sustained weed invasions among concerned clienteles, citizens and state agencies is essential for exercising measures to prevent or minimize weed spread to newer areas. This may involve identification of weed species with high risk potential of invading yet un-invaded areas and practical and effective measures to prevent or minimize entry of such weeds to the vulnerable areas. Spread of weeds through viable seeds is one of the primary mechanisms of infestations. Thus, it is necessary to know viability of seeds of the weeds at or near ambient environment to predict their weed spread risk potential when such seeds are contaminants or trapped in diverse niches like food grains and their raw products, crop seed lots and in transported and transportable packaging and packaged materials. At present, such valuable information on the extent of viability of weed seeds at or near ambient conditions is rare in the scientific literature. Hence, investigations were undertaken to find out longevity of weed seeds at ambient temperature with a view to assess weed spread risk potential of some of the important weeds.

METHODOLOGY

Seeds of weeds were collected from their stands since 1992. The seeds were allowed to dry at ambient conditions, moisture contents measured, and kept in glass containers at ambient temperature in the Physiology Laboratory of the Directorate of Weed Science Research, Jabalpur. Viability (germination) of the seeds was tested at yearly intervals. The tests were repeated at least thrice in each case and the data were done mean plus minus standard deviation.

RESULTS

Different weeds have species specific temperatures facilitating germination. Some of the seeds had hard seed coat requiring wearing out of the coat naturally or scarification for facilitating for germination testing in the laboratory. The weed seeds lost viability almost abruptly as is evident from years to 50% germination were close to the years to lose viability, except in *Phalaris minor* (Table 1). The weed seeds included in the study had viability extending from 6-13 years depending on the species.

CONCLUSION

Viability of weed seeds, referred to as weed spread risk potential, was 6-10 years in 13 species and 11-13 years in remaining 4 species. The seeds of these species trapped in diverse niches sustain risks of infestation for the seed viability durations. Weed seed contamination of these species need to be checked and contaminated seed be destroyed for preventing their infestation to newer areas and to check intensification of infestation to already infested areas.

Table 1. Viability of weed seeds at ambient condition

Weed species	Moisture contents (FW)	Germination testing temperature (ºC)	Initial germination	Years to 50% germination decline	Years to lose viability
Alternanthera sessilis	9.7	20	96±3	5	8
Asphodelus tenuifolius	9.7	25	56±2	4	6
Avena ludoviciana	9.8	20	95±2	5	6
Cassia sericea	9.8	30 (HSS)	95±4	8	10
Cassia tora	9.4	30 (HSS)	96±2	7	9
Caesulia axillaries	9.9	25	49±3	5	6
Chenopodium album	10.2	15/25	68±5	8	9
Cichorium intybus	10.6	25	92±2	6	9
Echinochloa glabrescens	9.4	30	95±3	9	11
Euphorbia geniculata	10.2	30 (HSS)	95±2	6	7
Ipomoea hederacea	11.4	25	94±2	11	13
Ischaemum rugosum	9.2	20	94±1	9	11
Medicago denticulata	10.5	25 (HSS)	94±3	10	13
Melilotus alba	9.8	15/25 (12 h cycle)	94±3	8	10
Parthenium hysterophorus	9.6	20	98±1	5	7
Phalaris minor	9.8	18	91±4	3	7
Rumex dentatus	9.3	15/25	93±3	7	10
Trifolium flagiferum	10.3	30	92±2	6	8

Values are means ± SD of three replications. FW, Fresh weight basis, and HSS, hard seeds scarified.

Viability regeneration potential of glyphosate-treated nut grass

R.R. Upasani*, Sheela Barla and and A.N. Puran

Department of Agronomy, Birsa Agricultural University, Ranchi, Jharkhand 834 006

**Email: upasani.ravikant@gmail.com*

Cyperus rotundus, also known as purple nutsedge , is a problematic weed in cultivated field as it competes for resources like nutrients, moisture and light faster than any other arable crop. It is a perennial plant that may reach a height of up to 140 cm. The names "nut grass" and "nut sedge" are derived from its tubers, that somewhat resemble nuts, although botanically they have nothing to do with nuts. Its growth habit and mode of propagation pose special problems for control. Although hand weeding and deep digging are generally adopted as control measures, sprouts reappear within 48 h of hand weeding and/or deep digging. The present study was undertaken to standardize the herbicidal treatments for effective control of this pernicious weed.

METHODOLOGY

A field experiment was conducted at Agronomical Research Farm of Birsa Agricultural University to find out the efficacy of glyphosate on viability and regeneration of *Cyperus rotundus*. The experiment was laid out in a randomized block design with three replications. The treatment comprised of three levels of glyphosate *i.e.*, 1.5, 1.0, 0.75 and 0.5 kg/ha with or without jaggery (2%).The experimental plot was pre infested with *Cyperus rotundus*. The population of *Cyperus rotundus* was counted prior to application of herbicide. The plot size was 3 x 1.5 m. The aqueous herbicidal solution of glyphosate herbicide alone as well as mixed with jaggery was sprayed at 15 days after germination (2 leaf stage) as per treatment twice at an interval of 48 hrs by using a sprayer with flood-jet nozzle. The densities of tubers were counted at 30 and 60 days after application of herbicides. To test the germination potential of tubers after spray, 10 tubers per treatment were collected randomly, at one month after spraying and were germinated in pots.

RESULTS

Glyphosate at 1.5 kg/ha was applied at 15 days after germination and was found to be most effective, followed by glyphosate at doses of 1.0 kg/ha, 0.75 kg/ha and 0.5 kg/ha respectively. Similarly, bulbs treated with 1.5 and 1.0 kg/ha glyphosate showed no tuber germinated, however tubers receiving lower levels of glyphosate as well as jaggery mixed glyphosate did not influence mortality of *Cyperus rotundus* tubers. Similar findings were also observed by Ameena *et al.* (2013).

Table 1. Effect of glyphosate on mortality of *Cyperus rotundu*

Treatment	Initial density of *C. rotundus* (no./m²)	Days after application of herbicide					
		15 days		30 days		60 days	
		Density (no./m²)	Mortality (%)	Density (no./m²)	Mortality (%)	Density (no./m²)	Mortality (%)
Glyphosate (1.5 kg/ha)	87	4	95	2	97.7	0	100
Glyphosate (1.0 kg/ha)	68	8	69	5	92.6	0	100
Glyphosate (0.75 kg/ha)	89	8	93	5	94.4	3	96.63
Glyphosate(0.5 kg/ha)	78	15	72	10	87.2	6	92.31
Treat-i + jaggery (2%)	85	54	36	25	70.6	20	76.47
Treat ii+ jaggery (2%)	102	65	43	45	55.9	35	65.69
Treat-iii + jaggery (2%)	85	78	8	55	35.3	50	41.18
Treat-iv + jaggery (2%)	98	85	15	78	20.4	69	29.59
Control (untreated)	102	98	4.6	86	15.7	95	6.86
LSD(P=0.05)		11.3	3.5	3.02	3.18	3.31	14.7

Table 2. Number of re - germinated tubers of *Cyperus rotundus*

Glyphosate	Regenerated shoots/m²
Glyphosate 1.5 kg/ha	0
Glyphosate 1.0 kg/ha	0
Glyphosate 0.5 kg/ha	1
Glyphosate 0.75 kg/ha	1
Treat-i + jaggery (2%)	3
Treat-ii+ jaggery (2%)	5
Treat-iii + jaggery (2%)	6
Treat-iv+ jaggery (2%)	8
Control (untreated)	8

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Studies on relative performance of diversified weed management practices in Bt cotton

A.S. Rao*

Acharya N.G. Ranga Agricultural University, Regional Agricultural Research Station, Guntur, Andhra Pradesh 522 034
**Email: atlurisrao@gmail.com*

Cotton is an important commercial crop grown in rainy season and weeds pose a serious problem in its cultivation because of its wider row spacing and initial slow growth. Though, information on use of pre and pest emergence herbicides, inter-cultivation, integrated weed management practices is available (Rao 2011) but information pertaining to their relative performance is scanty. Hence, the present investigation was conducted.

METHODOLOGY

A field experiment was conducted during *Kharif* 2011-12 at Regional Agricultural Research Station, Lam, and Guntur (A.P) to study the comparative performance of different weed management practices in *Bt.* cotton. The experiment consisting of seven treatments (Table 1), conducted in a randomized block design with three replications. The soil of the experimental plot was clay loam with a pH of 8.0, low in available nitrogen, phosphorus and high in available potassium. The cotton variety '*Mallika Bt'*. was sown in July, 2011 by adopting all the recommended package of practices except weed control. The data on weed density and dry weight per unit area were recorded at final pricking and transformed to $\sqrt{x+½}$ transformations to normalize their distribution. The prevailing input and output costs were taken into consideration for calculating the economics of different treatments.

RESULTS

No crop injury was observed with the herbicides/ implements used under the study. No.of bolls per plant and kapas (cotton) yield were significantly influenced by the treatments under study. Inter cultivation aand also with hand weeding recorded the highest kapas yield (2.32 t/ha) and high BCR (0.42). Season long weed competition in weedy check caused an yield reduction of 60% compared to hand weeding. All the treatments significantly reduced the weed density and dry weight over weedy check. Among the treatments, pre emergence application of pendimethalin 1.0 kg/ ha *fb* quizalofop ethyl 50 g/ha + pyrithiobac 63g/ha significantly reduced the weed growth and was at par with all other treatments except intercropping with green gram (in case of weed dry weight at final picking (Table 1).

CONCLUSION

It was concluded that sequential application of pendimethalin 750 g/ha as pre- *fb* post-emergence application of pyrithiobac 63 g/ha + quizalofop ethyl 50 g/ha applied at 20, 40, and 60 DAS was most effective in reducing weed growth and increasing kapas yield with profitability of Bt.cotton whenever hand weeding not possible.

Table 1. Effect of different treatments on weed growth, yield and yield components in cotton

Treatment	Dose (g/ha)	Time of application (DAS)	At final picking			No. of bolls /plant	Boll weight (g)	Kapas yield (t/ha)	Cost of treatment (x10³₹/ha)	BCR
			Weed density (no./m²)	Weed dry weight (g/m²)	Crop dry wt. (g/m²)					
Unweeded check	-	-	7.9 (61.7)	25.3 (640.0)	216	9.6	4.42	0.921	-	-0.28
Hand weeding		20, 40 & 60	4.8 (23.0)	15.9 (253.3)	465	36.9	5.26	2.320	9.00	0.42
Inter-cultivation	60	20, 40 & 60	5.9 (35.6)	19.9 (405.0)	394	15.2	4.80	1.493	3.00	0.09
Inter cropping with green gram*			6.2 (38.0)	21.9 (481.7)	357	10.6	4.91	1.206	2.00	0.03
Mechanical weeding with power weeder		20, 40 & 60	5.2 (26.6)	17.5 (310.0)	399	18.4	4.99	1.598	6,.64	0.08
Pendimethalin *fb* inter cultivation	1000	20, 40 & 60	5.1 (26.0)	20.6 (435.0)	412	24.3	4.88	1.984	4.30	0.41
Pendimethalin *fb* quizalofop-ethyl + pyrithiobac	1000+ 50+63	20, 40 & 60	5.1 (25.3)	16.1 (260.3)	430	25.1	5.15	2.210	9.73	0.41
LSD (P=0.05)			0.9	3.9	71	3.9	NS	0.260		

*Green gram yield 1.54 t/ha,

Note: DAS - Days after sowing, Data transformed to $\sqrt{x+0.5}$ transformation. Figures in parentheses are original value

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Evaluation of new pre-emergence herbicides for weed control in transplanted rice

A. Sundari*
Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu 608002
**Email: sundari1911@yahoo.co.in*

Rice is the world's most important food crop as it is the staple food of almost 3 billion people. Tamil Nadu alone contributes nearly 8% of the national rice production from an area of 2.2 million hectares, with a production of 8.55 million tonnes, (Anonymous 2011). Weeds are one of the best competitors in their early growth stages than at later stages, and hence the growth of crops is affected and yields reduced. (Jacob and Syriac 2005). Transplanted rice is infested with wide range of weed species, *viz.* grasses, sedges and broad leaved weeds. There is more attention towards the chemical weed control in transplanted rice. Several new herbicides are coming to market and they need to be tested for their efficacy to control the weeds in rice crops. An attempt has been made in the present study to evaluate the efficiency of new herbicides.

METHODOLOGY

Field investigations were carried out at Annamalai University Experimental Farm, Annamalai nagar to study the bioefficacy of new pre-emergence herbicides for weed control in transplanted rice during *Navarai* (January to April, 2011) and *Kuruvai* (June to September, 2011) in a randomized block design with eight treatments consisting of new herbicides along with conventional herbicides, *viz.* butachlor. Twice hand weeding and unweeded control were included for comparison and replicated thrice using the rice variety ADT 36. Recommended package of practices were followed.

Fertilizers were applied uniformly through urea, single super phosphate and muriate of potash at 120 kg N, 38 kg P_2O_5 and 38 kg K_2O/ ha, respectively. As per the treatment schedule pre emergence herbicides were sprayed with knapsack sprayer fitted with floodjet nozzle using 600 liters of water/ha at 3 DAT with adequate soil moisture. Data on weed growth, yield performance and economics were recorded.

RESULTS

Weeds like *E. colonum* (22.7%), *L. chinensis* (24.63%), *C. rotundus* (19.99%) and *M. quardrifoliata* (32.68%) were present in major proportions among the total weeds and these were significantly influenced by the weed control treatments. Regardless of season, all treatments significantly influenced weed biometrics, crop growth, yield components and yield of rice. Among the treatments, metsulfuron methyl + chlorimuron ethyl at 0.004 kg/ha on 3 DAT + one hand weeding at 30 DAT recorded the least weed counts, weed biomass and the highest weed control index favouring higher yield attributes and grain yield. This was at par with two hand weedings on 20 and 40 DAT. yield.

Table 1. Effect of weed control treatments on weed growth, yield and economics (mean of two seasons)

Treatment	Total weed count (no./m^2)	Weed biomass (kg/ha)	Weed control index (%)	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (x10^3` /ha)	Returns/ rupee invested (x10^3` /ha)
Unweeded control	(69.74)* 8.38	425	-	3.13	4.76	21.09	1.60
Twice Hand weeding (20 and 40 DAT)	(14.35) 3.85	142	66.58	4.95	6.71	24.32	2.24
Butachlor at1.5 kg/ha on 3 DAT + one hand weeding on 30 DAT	(50.24) 7.12	345	18.82	3.85	5.09	21.02	1.77
Oxadiargyl at 0.07 kg/ha on 3 DAT + one hand weeding on 30 DAT	(26.26) 5.17	227	46.58	4.27	6.02	23.21	2.03
Pyrazosulfuron-ethyl at 0.025 kg/ha on 3 DAT + one hand weeding on 30 DAT	(33.54) 5.83	265	37.64	3.98	5.69	22.25	1.98
Bensulfuron-methyl + pretilachlor at 0.06+0.6 kg/ha on 3 DAT + one hand weeding on 30 DAT	(19.77) 4.50	185	56.47	4.56	6.34	23.80	2.11
Metasulfuron-methyl + chlorimuron-ethyl at 0.004 kg/ha on 3 DAT + one hand weedingon 30 DAT	(11.01) 3.39	111	73.88	5.07	6.89	23.21	2.41
Anilophos 1.25 kg/ha on 3 DAT + one hand weeding on 30 DAT	(41.50) 6.48	302	28.94	3.69	5.40	22.21	1.84
LSD (P=0.05)	0.62	32.82	-	0.27	0.28	-	-

*Values in parantheses are original. Data transformed to square root transformation

CONCLUSION

From the study, it may be concluded that application of metsulfuron methyl + chlorimuronethyul at 0.004 kg/ha on 3 DAT + one hand weeding on 30 DAT is considered to be judicious recommendation to rice farmers in view of inadequate labour and higher weeding cost.

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Integrated weed management in hybrid maize

***A. Sundari**
Department of Agronomy, Annamalai University, Chidambaram, Tamil Nadu 608 002
**Email: sundari1911@yahoo.co.in*

Maize is one of the most important cereal crop in the world agricultural economy used both as food for human beings and feed for animals. It has very high yield potential per hectare than other crops so it is called "Queen of Cereals". The demand for maize in India is 11.7 million tonnes for the year 2015. Low maize production in India is attributed to several causes. Weed competition is a major constraint in maize cultivation resulting in reduction of yield to the extent of 33 to 72 %. Integrated weed management is gaining importance under the present trend of farming system. However, if the herbicides are applied with an advanced systems instead of conventional systems that gives control equivalent to conventional systems, despite the advantages of low volume spraying in terms of reduced labour requirement and more speedy application (thus freeing labour for other tasks) and technology as a tool for farm owners to increase productivity (Raston 1997). With this background, a field study is programmed to study the integrated effect of mechanical cum herbicidal combinations along with different herbicide application methods for effective weed management in maize.

METHODOLOGY

Two field experiments were conducted at Annamalai University Experimental Farm, Annamalainagar to evolve a suitable weed management programme for hybrid maize '*Cargill'* during summer (February–May) 2011 and *Kharif* (July –October) 2011. The experiments were laid out in Randomized block design replicated thrice with eight treatments.

Treatments consist of paraquat herbicide spraying with two types of nozzles along with fluchloralin. Twice hand weeding and unweeded control were included for comparison. Recommended package of practices were followed. Fertilizers were applied uniformly through urea, single super phosphate and muriate of potash at 135 kg N, 62.5 kg P_2O_5 and 50 kg K_2O/ha, respectively.

The pre-sowing herbicides, *viz*. fluchloralin was sprayed with 500 litres of water/ha through knapsack sprayer fitted with floodjet nozzle and incorporated in the plots before sowing and followed with light irrigation. The post emergence herbicide, *viz*. paraquat was sprayed on 15 DAS with 500 litres of water/ha through knapsack sprayer fitted with polijet nozzles and floodjet deflector nozzle separately in specified plots. Data on weed growth, yield performance and economics were recorded.

RESULTS

Three weed species namely *T. portulacastrum*, *C. rotundus* and *C. dactylon* occurred in major proportions and the influence of the treatments on these weed species were significant. Among the different weed control measures, fluchloralin 1.5 kg/ha + one hand weeding at 45 DAS excelled the other treatments by recording the highest growth and yield components and least weed population, total weed biomass and nutrient depletion by weeds with the highest weed control index of 87.46% favouring higher yield attributes and grain yield of 5.07 t/ha. Unweeded control recorded the highest weed counts and weed biomass resulting in very poor grain yield of 2.01 t/ha.

Table 1. Effect of weed control treatments on growth and yield of maize (mean of two seasons)

Treatment	Total weed count (no./m²)	Weed biomass (g/m²)	Weed control index (%)	No. of grains/ cob	Grain yield (t/ha)	Stover yield (t/ha)	Total cost of cultivation (x10³?/ha)	Return/ rupee invested
Unweeded control	(158.1) 12.60	118.5	-	268.2	2.01	3.17	11.73	1.07
Hand weeding twice at 25 and 45 DAS	(42.8) 6.58	21.20	82.10	400.8	4.73	8.03	13.33	2.25
Paraquat 0.5 kg/ ha as POE (15 DAS) with flood jet deflector nozzle	(115.6) 10.77	56.90	51.98	290.4	2.80	4.84	11.88	1.52
Paraquat 0.5 kg/ ha as POE (15 DAS) with poli jet nozzle	(112.2) 10.62	53.58	54.78	311.0	3.12	5.29	11.88	1.66
Paraquat 0.5 kg/ ha as POE (15 DAS) with flood jet deflector nozzle + one hand weeding at 45 DAS	(47.9) 6.96	26.88	77.73	357.2	4.10	6.98	12.68	2.06
Paraquat 0.5 kg/ ha as post emergence (15 DAS) with poli jet nozzle + one hand weeding at 45 DAS	(45.7) 6.79	23.56	80.11	379.5	4.40	7.38	12.68	2.21
Fluchloralin 1.5 kg/ ha as pre-sowing soil incorporation	(97.7) 9.92	49.77	58.00	334.5	3.51	6.07	12.64	1.94
Fluchloralin 1.5 kg/ ha as pre-sowing soil incorporation + one hand weeding at 45 DAS	(35.0) 5.95	14.85	87.46	422.0	5.07	8.62	13.26	2.43
LSD (p=0.05)	0.28	4.07	-	13.25	0.29	0.37	-	-

CONCLUSION

It is evident that pre-sowing soil incorporation of fluchloralin 1.5 kg/ha supplemented with one hand weeding at 45 DAS could be suggested as an efficient and economic weed control practice for irrigated maize. In case of labour scarcity, hand weeding could be replaced by post emergence paraquat spray 0.5 kg/ha on 15 DAS through polijet nozzle as the polijet nozzle imparts safety to the crop canopy with reduced phytotoxicity ratings.

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Effect of pre-plant and post-emergent herbicides on yield and economics of chilli + onion + cotton intercropping system

Rajesh S. Kalasare*, Ramesh Babu, B.N. Arvind Kumar, Shrikant K Phajage, P.K. Suryawanshi
Department of Agronomy, College of Agriculture, University of Agricultural Sciences, Dharwad, Karnataka 580 005
**Email: rskalasare@gmail.com*

Intercropping chilli + onion + cotton is well established and remunerative cropping system of transitional tract of Dharwad in Karnataka. It is necessary to control weeds at the early stages of crop growth to achieve the desired productivity. The cost involved in hand weeding and unavailability of labourers in time for manual weeding has necessitated the use of chemicals and improved tillage practices for weed control for evolving integrated weed management strategy for rainfed chilli + onion + cotton intercropping system.

METHODOLOGY

The field experiment was conducted at Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad during *Kharif* 2009. The soil of the experimental site was medium black with pH of 8.00. The experiment was comprised of 11 treatments with combination of different herbicides like Pendimethalin (PPA), oxyfluorfen (PPA), alachlor (PPA), pendimethalin CS (PPA) and fenoxyprop ethyl (POE), oxyfluorfen (POE), farmer's practice, weed free check and weedy check. The experiment was laid out in randomized block design (RBD) with three replications. The gross and net plot size was 9.0 x 6.0 m and 7.2 x 4.8 m, respectively. The chilli seedlings were transplanted with the spacing of 90 x 60 cm onion seeds were sown 15 x 15 cm and cotton 90 x 60 cm. All the Pre-plant application of herbicides was done on soil surface 5 days well in advance of chilli transplanting and the post-emergence application was sprayed on 45 DAT. The observations on weed dry weight, weed control efficiency was recorded at 30, 60, 90, 120 and at harvest. Number of fruits per plant and fruit weight in chilli and number of bolls (per plant) and mean boll weight (g) in cotton was recorded at different pickings of chilli and cotton, onion bulb weight (g/plant) was recorded at the time of harvesting. Chilli equivalent yield was obtained on the basis of green chilli fruit, onion bulb and seed cotton yield and the yield was expressed in terms of tonnes per hectare basis and net return was calculated ¹/ha. B:C ratio was calculated on the basis of cost of cultivation and net return.

RESULTS

The weed species found in experimental area included grassy weeds, broad-leaved weeds and aone sedge - *Cyperus rotundus*. All the herbicides significantly reduced weed biomass. Among the herbicides treatments, pre-plant application (PPA) of oxyfluorfen 0.15 kg/ha + post-emergent application (POE) of oxyfluorfen 0.15 kg/ha (POE) HW at 30 and 60 DAT recorded lower weed dry weight (11.87 g/m^2) and weed control efficiency (91.17%), higher number of green chilli fruits, onion bulb weight, number of bolls and mean boll weight in cotton. These treatments recorded significantly higher chilli equivalent yield (7.43 t/ha, 6.58 t/ha, respectively) and B:C ratio, net return was also higher in these herbicide treatments is due to their higher weed suppressing ability and higher weed control efficiency, which in turn resulted in higher chilli equivalent yield, net return and B:C ratio (Anonymous 2005).

CONCLUSION

It is concluded that pre-plant application oxyfluorfen 0.15 kg/ha + post-emergence application of oxyfluorfen 0.15 kg/ha is most effective for controlling weeds, improving chilli equivalent yield and profitablility of chilli + onion + cotton intercropping system.

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Effect of herbicides on weed control and yield of flue cured virginia tobacco

S. Kasturi Krishna*, S.V. Krishna Reddy and K. Nageswara Rao

Central Tobacco Research Institute Research station, Jeelugumilli , Andhra Pradesh 533 105

**Email: krishnakasturi@rediffmail.com*

Weeds in FCV (*Flue Cured Virginia*) tobacco are generally kept under control by summer cultivation, inter-cultural operations and one or two hand weedings given during the period of crop growth in tobacco. In the irrigated Alfisol conditions monocots are the dominant weeds and most of the weeds in the rows are controlled by intercultural operations. But the weeds around the plants with in the row after 45-50 days after planting are to be controlled by manual weeding only. Under todays conditions of labour scarcity, chemical method of control is the best option. Hence, this study was conducted to assess performance of herbicides in weed management in FCV tobacco under irrigated alfisols.

METHODOLOGY

A field experiment was conducted at the Central Tobacco Research Institute Research Station, Jeelugumilli with the variety '*Kanchan durin'* in *Rabi* seasons of 2010-11and 2011-12. The experimental soil was slightly acidic (pH 5.8) and with low soluble salts (0.20 dS/m), chlorides (25 ppm) and nitrogen (137 kg/ha), medium P (21 kg/ha) and low K (77 kg/ha) in surface layers. The experiment was conducted in RBD with 10 treatments (Table 1). All the treatments were integrated with four inter-cultural operations.

RESULTS

Grassy weeds and broad leaf weeds were predominant. Wherever herbicide application was done statistically lower weed dry matter production was recorded at 30, 60, 90 days and at harvest. Weed management practices involving Quizalofop-ethyl recorded cured leaf yields at par with that of weed free check. Post emergence spraying of quizalofop-ethyl at 15+75, days after planting effectively controlled the grassy weeds and also gave higher yields when compared to weed free check. Herbicides not only increased the yield but also increased the desirable chemical characteristics in tobacco (Yousafzai *et al*. 2006). Spraying of quizalofop-ethyl at 15, 60, 75 days after planting with intercultural operations gave yields on a par with that of weed free check.

Table 1. Tobacco yield and weed dry weight as influenced by weed control treatments in FCV tobacco

Treatment	Cured leaf yield (t/ha)	Weed dry weight (kg/ha)			
		30 DAP	60 DAP	90 DAP	At final harvest
PPI of pendimethalin + PE spray of quizalofop- ethyl 30 DAP	2.02	60.7	133	213	250
PPI of pendimethalin + PE spray of quizalofop- ethyl 75 DAP	1.98	54.3	103	150	198
PE spray of quizalofop-ethyl 15 DAP	2.19	49.3	150	395	430
PE spray of quizalofop-ethyl 60 DAP	2.19	150	125	169	232
PE spray of quizalofop-ethyl 75 DAP	2.19	122	263	60	139
PE spray of quizalofop-ethyl 15 + 75 DAP	2.30	47.0	197	71	180
PE spray of quizalofop-ethyl 60 + 90 DAP	2.22	146	235	128	104
PE spray of quizalofop-ethyl 75 +125 DAP	2.14	143	275	80	44
Weed free check (hand weeding)	2.23	113	65	77	63
Weedy check	1.65	175	1480	1583	1717
LSD(P=0.05)	9.90	17.06	56.49	42.09	60.59

CONCLUSION

Post emergence spray of Quizalofop-ethyl at 60 g/ha at any stage of crop growth can be used in integrated weed management along with intercultural operations to control monocot weeds which are dominant in the irrigated Alfisols.

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Assessment of premix formulation of low dose broad spectrum herbicide on the productivity of wheat

S.S. Kushwah*, R.S. Kushwah, S.K. Singh and V.B. Singh

RajmataVijayarajeScindiaKrishiVishwaVidyalaya, KrishiVigyanKendra, Gwalior, Madhya Pradesh 474 002

**Email: shailendrakushwah91@rediffmail.com*

Wheat is the important cereal crop among the food grains in Madhya Pradesh and Gwalior district as well. It is grown on 52.60 lakh ha in M.P. and 1.25 lakh ha in Gwalior district. Participatory Rural Appraisal (PRA) survey conducted in villages *Badkisarai*and *Banwar*in *Bhitarwar* block of the district indicated that most of the farmers used 2,4-D for weed control in wheat without assessing the presence of weed flora in their fields, which was not controlling grassy weeds. Weeds causes yield reduction to the tune of 15-50% or some times more depending upon weed density and type of weed flora (Jat *et al*. 2003). Farmers were not aware about the use of low dose broad spectrum herbicide formulations for control of both narrow and broad leaf weeds in their wheat crop. Hence to manage the complex weed florain wheat crop under on farm situationsthis experiment was conducted to evaluate a broad spectrum low dose herbicide for the effective weed control in wheat, through On Farm Testing carried out in the KVK adopted villages for the two consecutive years.

METHODOLOGY

Famers led field experiments were carried out in KVK adopted villages -*Badkisaraiand Banwar* in Bhitarwar block of the district during winter seasons of 2011-12 and 2012-13. The soils of the farmers fields were clay loam and sandy clay loam in texture in the villages Badkisarai and Banwan respectively with pH 7.9-8.2 and EC 0.32-0.46 dSm^{-1}.The available N, P_2O_5 and K_2O were 280-325,20-25 and 180-240 kg/ha respectively. Treatments comprised of Sulfosulfuron + Metsulfuron 30+2 g/ha, 2,4-D-500 g/ha (farmers practice) and Weedy check were evaluated in Randomized Block Design (RBD) on 5 famers fields taking each farmers field as separate replication. The seed was treated with fungicide carboxin 2g/kg seed. Wheat crop received one pre sowing, 03 and 05 post sowing irrigations in villages Badkisarai and Banwar respectively. Similarly farmers have used 125 and 100 kg/ha seed in these two villages respectively. Higher seed rate and reduced fertilizers were used in village Badkisarai as crop was sown late in December last week.

Herbicides were sprayed using a spray volume of 500 liters/ha with a knap sack sprayer fitted with flat fan nozzle. Data on weed count and weed dry weight from an area enclosed in aquadrate of 0.25 m2 at four place under different treatment plots were recorded at 60 DAS.Data on individual and total weed density were subjected to square root transformation (log x+1).

RESULTS

Among the applied herbicides, premix of sulfosulfuron + metsulfuron 30+2 g/ha significantly reduced both grassy and broad leaf weeds over 2,4-D 500g/ha and weedy check and also recorded significantly lower weed density and higher weed control efficiency (96.65 and 95. 54%) compared to weedy check and 2,4-D (farmers practice) .

Application of the premix (sulfosulfuron + metsulfuron 30+2 g/ha) significantly yielded higher number of spikes/ m^2,seed weight/spike and seed yield of wheat (Table 1) over weedy check and farmers practice. No phyto toxicity was noticed on wheat crop under premix formulation; however growth of crop was stagnated for 5-7 days after application. It was concluded that premix formulation of sulfosulfuron+metsulfuron 30+2 g/ha was proven most effective against complex weed flora in wheat.

Table 1. Effect of low dose broad spectrum herbicide on yield attributes and yield of wheat

Treatment	Spikes/m2		Seed weight /spike (g)		Yield (t/ha)	
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13
Sulfosulfuron + metsulfuron 30g+2g/ha.	285	273	1.50	1.80	4.42	4.13
2,4-D 500g/ha.	267	262	1.17	1.41	4.01	3.61
Weedy check	231	236	1.36	1.20	3.34	3.26
SE m±	4.2	7.08	0.02	0.08	0.09	0.08
LSD (P=0.05)	13.7	23.1	0.08	0.26	0.29	0.25

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Management of diverse spectrum of weeds in aerobic rice of Puducherry

P.Saravanane* and V.Chellamuthu

Department of Agronomy, Pandit Jawaharlal Nehru College of Agriculture & Research Institute, Karaikal, Puducherry 609 603

**Email: psaravanane@rediffmail.com*

Rice is the world's most important wetland crop. The looming global water crisis threatens the sustainability of irrigated rice, which is the biggest water user in Asia. Aerobic rice is the new concept of growing rice in non-puddled and non flooded aerobic soil. However, the important problem in aerobic rice is weeds. The weeds are reported to cause yield losses between 30 and 98% (Oerke and Dahane 2004). Considering the above facts, a field experiment was conducted to study the effect of pre emergence application of herbicides on diverse weed spectrum in aerobic rice in Puducherry, India.

METHODOLOGY

A field experiment was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry U.T during *Kharif* (June –September) 2011 on sandy clay loam soil. The soil had pH of 6.94, low in available nitrogen (119 kg/ha) and high in available phosphorus (24 kg/ha) and potassium (366 kg/ha).

The experiment was laid out in randomized block design with seven treatments (Table 1). The recommended fertilizer dose for rice is 100: 50: 50 kg NPK /ha during *Kharif* season.The rice cultivar '*PMK 3*' was sown on 3rd June, 2011 with the spacing of 20 cm x 10 cm. The data on weed density and dry weight was transformed using $\sqrt{x+0.5}$.

RESULTS

In general, grasses dominated the weed spectrum of aerobic rice. The weed density and dry weight was significantly influenced by weed control treatments (Table 1). Among the pre-emergence herbicides tried, application of pendimethalin 1.0 kg/ha, restricted the weed density and dry respectively Significantly higher weed density and dry weight was noticed under unweeded control.

Uncontrolled weeds cause poor crop growth and lowest yield with unweeded control (600 kg/ha) with a yield reduction of 80.7% due to severe weed competition. All the weed control treatments improved the number of productive tillers, grain filling percentage and yield of aerobic rice over weedy check. The effective control of weeds resulted in highest number of productive tillers (6.3) and filled grain percentage (75.2%), which had a positive impact on rice yield (30.96 t/ha). More B:C ratio was realized with pre-emergence application of pendimethalin and hand weeding twice compared to other treatments.

Table 1. Effect of weed management practices on weed density and dry weight

Treatment	Grass density (no./m²)	Broad leaved weed density (no./m²)	Sedges density (no./m²)	Total weed density (no./m²)	Total weed dry weight (g/m²)
TButachlor 1.25 kg/ha	14.9 (207)	2.6 (4.7)	1.4 (1.3)	15.1 (213)	14.9 (219)
Pendimethalin 1.0 kg/ha.	11.3 (125)	10.0 (90.0)	2.3 (3.7)	15.1 (219)	13.8 (180)
Pretilachlor with safener 0.45 kg/ha	13.7 (174)	8.3 (71.7)	0.5 (0.0)	15.9 (246)	16.7 (262)
Anilophos 0.4 kg/ha	12.9 (157)	9.2 (79.7)	1.7 (2.3)	15.7 (239)	16.5 (257)
Hand weeding twice	10.2 (93)	6.8 (55.0)	3.8 (11.0)	13.0 (159)	11.9 (135)
Weed free	2.8 (5.7)	2.6 (4.3)	0.5 (0.0)	3.6 (10)	0.8 (4.0)
Unweeded control	18.1 (320)	6.1 (43.3)	3.4 (8.3)	19.6 (372)	19.9 (381)
LSD (P=0.05)	3.44	NS	1.08	3.94	4.27

Figures in parentheses are original values. Transformation is $\sqrt{x+0.5}$

CONCLUSION

From the results, it can be concluded that pre- emergence application of pendimethalin 1.0 kg/ha super imposed with one hand weeding at 30 DAS was effective in reducing weed growth and increased grain of aerobic rice with better benefit- cost ratio.

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Weed density as influenced by castor crop and its leaf litter with castor genotypes, plant density and nitrogen management under rainfed

Adinath Paslawar*, P.G.Ingole, V. M. Bhale and A. P. Karunakar
Cotton Reseach Unit. Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104
**Email: adinathpaslawar@rediffmail.com*

Castor (*Ricinus communis* L.) is a high value industrial oilseed crop having high plasticity suiting to wide range of soil environments and capacity to adjust its growth according to moisture availability in soil. Globally, India occupies a premier position in the area, production and productivity. Crop rotation with tall and dense crop growth varieties, high density planting system may be helpful in reduction in weed population where mono-cropping is followed. Therefore, the study was undertaken to study the impact of nutrient management on crop productivity and weed density by castor genotypes under different plant geometry in two seasons.

METHODOLOGY

A field trial were conducted during *Kharif* 2008-09 and 2009-10 on a silty clay loam soil at the Agronomy Department Farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola The treatment consisted of two genotypes ('*AKC-1*' and '*GCH-4'*) and three plant spacing (90 x 45 cm, 120 x 45 cm and 90 x 90 cm) and four nitrogen management (125% N, 100% N, 75% N + 25% N (FYM) and 50% N + 25% N (FYM) + *Azospirillium*). The experiment was laid out in split plot design and replicated thrice. For control of weeds one weeding and two hoeing were undertaken. The mean weed population at first weeding of first season and during second season was counted per metre square. Similarly number of dropped leaves m^2 was recorded. The total leaf litter (kg / ha) was calculated. The crop was sown on 21st and 16th July in first and second season and rainfall amounted to 372 and 377 mm respectively.

RESULTS

Dominance of broad leaved weeds was observed in experimental field. The mean weed population at first weeding of first season crop was 56.1 m^2 and during second season it was 6.0 m^2. The reduction in weed population after one season of castor was (89.1%) due its canopy cover after 75 DAS and fallen leaves layer over soil surface up to harvest of crop suppressed the weed population.

There was no significant variation due to genotypes, indicating population of weeds at first weeding of first season crop was uniform and their reduction was numerically highest in *GCH 4.* Population of weeds at first weeding during 2008-09 was uniform and it was significantly influenced by different plant density during 2009-10. The highest reduction in number of weeds m^2 was under narrow spacing than wider spacing. This indicated that higher plant density with maximum canopy cover and leaf fall over soil surface suppressed weed population.

The mean seed yield was highest during second year (2.62 t / ha) than first year (1.93 t / ha) Seed yield was obtained significantly higher with *GCH-4* at 90 x 45 cm and seed yield was higher when 125% N (75 kg N / ha) was applied to castor. It was at par with 100% N (60 kg N / ha) The leaf fall was higher with GCH-4 with 90 x 45 cm as compared to 120 x 45 cm and similarly leaf fall was maximum, when N was applied with 125% N (75 kg N / ha).

Table 1. Weed population at first weeding of castor in 2008-09 and 2009-10 and seed yield of castor and leaf litter of castor as influenced by genotypes, spacing and N management.

Treatment			Weed population(m^2) at first weeding of season		Seed yield of castor (t/ha)		Leaf litter of castor crop (t/ha)	
			2008-09	2009-10	2008-09	2009-10	2008-09	2009-10
Main plot treatment								
A)	Genotypes							
	V1-	AKC-1	56.1	6.1	1.81	2.50	1.61	2.08
	V2-	GCH-4	56.0	5.9	2.05	2.71	1.66	2.12
		LSD (P=0.05)	NS	NS	0.04	0.05	-	
B)	Plant Spacing							
	S1-	90x45 cm	55.8	5.3	2.38	3.09	2.10	2.74
	S2-	120x45 cm	56.6	6.0	1.85	2.54	1.62	2.06
	S3-	90x90 cm	55.8	6.7	1.55	2.19	1.18	1.50
		LSD (P=0.05)	NS	0.6	0.05	0.06		
Sub plot	*Nitrogen Management*							
	N1-	125% N	55.0	6.1	2.09	2.82	1.71	2.25
	N2-	100% N	54.2	5.6	2.00	2.67	1.65	2.11
	N3-	75% N + 25% N (FYM)	57.5	6.2	1.88	2.56	1.63	2.06
	N4-	50% N + 25% N (FYM) + *Azospirillium*(ST)	57.3	6.1	1.73	2.37	1.57	2.01
		LSD (P=0.05)	NS	NS	0.11	0.43	-	-
		General Mean	56.1	6.0	1.93	2.61	1.63	2.10

CONCLUSION

It can be concluded that castor may be included in crop rotation as competitive crop under high density (24,891 plants / ha) to reduce the weed density under *rainfed.*

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Efficacy of post emergence weedicides on productivity of *Bt* cotton

D.V. Shelke*, A.N. Paslawar, J.P. Deshmukh, P.V. Shingrup and A.D. Deshmane
Department of Agronomy Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola,Maharashtra 444 104
**Email: dshelke88@gmail.com*

Cotton (*Gossypium hirsutum* L.), a very important commercial crop of India, sustains the cotton textile industry in the country. Losses caused by weeds in cotton ranges from 50 to 85 per cent depending upon the nature and intensity of weeds. The critical period of weed competition in cotton was found to be 15 to 60 days (Kakade 1996). To be successful, weed management systems require advance planting and timely execution. Hence, the study was carried out to find out suitable herbicides either alone or in sequence or in combination with cultural practices for proper and timely control of weeds.

METHODOLOGY

A field experiment was conducted during *Kharif*, 2011-12 under rainfed condition at Agronomy Farm of Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experimental plot containing medium black soil having 5.1 per cent organic carbon, 212 kg/ha available nitrogen, 15.5 kg/ha available phosphorous, 321 kg/ha available potassium and 7.82 pH. Eight treatments *i.e.* pendimethalin 1.25 kg /ha, PE + hoeing (T_1) , quizalofop-ethyl 0.050 kg/ha PoE + hoeing (T_2), fenoxyprop-ethyl 0.100 kg/ha, PoE + Hoeing (T_3), Pyrithiobac sodium 0.100 kg/ha PoE +hoeing (T_4), pyrithiobac sodium 0.050 kg/ha + quizalofop-ethyl 0.025 kg/ha + Hoeing (T_5), *In-situ* recycling of sunhemp at 30 DAS (T_6), farmers practice (2 H + 2 HW (T_7) and control (T_8) were laid out in a randomized block design with three replications. The cotton variety '*MRC - 7326'* was sown.

RESULTS

Plant height, No of boll per plant were significantly influenced by different weed-control treatments. The highest values were higher in farmers practice while minimum height and bolls per plant was recorded in control. The highest weed control efficiency (81.62%) and lowest weed index (4.41) in Bt cotton was observed in farmers practice and was at par with *In-situ* recycling of sunhemp at 30 DAS. The lowest weed control efficiency (66.94%) was recorded in pyrithiobac sodium at 0.100 kg/ha PoE + hoeing .

The highest gross returns (₹ 56,722/ha), net returns (₹ 39,022/ha) and B:C ratio (3.20) were obtained in farmers practice and was followed by *Insitu* recycling of sunhemp at 30 DAS in cotton , Quizalofop-ethyl 0.050 kg/ha PoE + hoeing Pendimethalin 1.25 kg /ha PE + hoeing.

Table 1. Plant height, number of bolls, seed cotton yield, WI and WCE (%) and their economics as influenced by weed management practices on

Treatment	Plant height (cm)	No. of Boll per plant	SCY (t/ha)	Weed Index	WCE (%)	Gross returns ($x10^3$₹/ha)	Net returns ($x10^3$₹/ha)	B: C
Pendimethalin 1.25 kg/ha PE + hoeing	107.7	25.38	1.18	9.25	71.14	51.59	34.65	3.05
Quizalofop-ethyl 0.050 kg/ha PoE + hoeing	108.9	26.55	1.21	7.19	76.03	52.76	36.06	3.16
Fenoxyprop-ethyl 0.100 kg/ha PoE + hoeing	102.9	21.79	1.00	22.94	68.82	44.25	27.62	2.66
Pyrithiobac sodium 0.100 kg/ha PoE + hoeing	102.0	20.78	0.96	26.53	66.94	42.23	25.40	2.51
Pyrithiobac sodium 0.050 kg/ha PoE + quizalofop-ethyl 0.025 kg/ha PoE + hoeing	105.3	22.76	1.05	19.51	70.31	46.04	28.99	2.70
Insitu recycling of sunhemp at 30 DAS in cotton	109.1	27.44	1.25	4.41	75.90	54.29	37.64	3.26
Farmers practice (2H+2HW)	116.1	28.62	1.30	-	81.62	56.72	39.02	3.20
Control	96.5	18.83	0.87	33.37	-	38.42	23.51	2.58
LSD (P-=0.05)	10.25	3.49	0.14	-	-	1.98	1.98	-

CONCLUSION

Bio-mulching sunhemp at 30 DAS found to be economical in Bt-cotton under rainfed condition and influenced seed yield.

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Efficacy of pre- and post-emergence herbicides against weed flora in soybean

J.P. Deshmukh*, P.V. Shingrup, K.J. Kubde, V.M. Bhale, and S.S. Thakare

Department of Agronomy, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola, MAharashtra 444 104

**Email: jpdagro@rediffmail.com*

Soybean (*Glycine max* L.) is a miracle "Golden bean" of 21st century mainly due to its high protein (40%) and oil (20%) content and is now making headway in Indian Agriculture. Weed competition is one of the most important causes of low yield in Vidharbaha region, which estimated to be of 31-84% (Kachroo *et al*. 2003). The traditional method of weed control is expensive, tedious and time consuming. Under such circumstances, use of effective herbicides gives better and timely weed control. Hence the present investigation was undertaken.

METHODOLOGY

A field investigation was carried out at the farm of Agronomy Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) during the *Kharif* season of 2012. The experiment was laid out in randomized block design with eight treatments replicated thrice. The experimental site was fairly uniform in topography with clayey in texture and slightly alkaline in reaction. Overall the rainfall and its distribution were satisfactory for crop. Sowing of soybean *JS-335* was done on 2nd July 2012. Herbicides doses were applied as per the treatments. Phytotoxicity symptoms due to herbicides on crop was recorded by using a visual score scale of 0-10.

RESULTS

All the herbicide treatments significantly minimized the weed number and weed dry matter when compared with unweeded control. None of the herbicides under study showed any phytotoxicity symptoms on crop. Among the various treatments lowest total weed count was observed under treatment Quizalofop-ethyl 0.075 kg/ha followed by Imazethapyr 0.100 kg/ha which was at par with treatment Odyssey 0.070/kg PoE 15 DAS. The highest grain yield (2.21 t/ha) and NMR (₹ 51175/ha) was noticed in same treatment but statistically found at par with other herbicide treatments. While highest B: C ratio was recorded in Odyssey 0.080 kg / PoE 15 DAS.

Table 1. Weed population/m^2, Weed dry matter g/m^2, Weed control efficiency (%), grain yield (t/ha), Net monetary returns (₹ /ha) and B:C ratio as influenced by weed control treatments in soybean

Treatment	Weed population /m^2 at harvest	Weed dry matter g/m^2 at harvest	Weed control efficiency (%)	Grain yield (t/ha)	NMR (x10^3`/ha)	B:C Ratio
T1:Weedy check	51.67	18.05	-	0.97	9.99	1.44
T2: 1 Hand weeding + 1 hoeing	38.67	13.52	25.09	2.18	47.00	2.81
T3: Pendimethalin at1.0 kg PE	37.67	11.08	38.61	2.27	51.88	3.16
T4: Quizalofop-ethyl at 0.075 kg PoE 15 DAS	36.33	9.91	45.09	2.00	43.12	2.82
T5: Imazethapyr at 0.100 kg PoE 15 DAS	36.00	8.74	51.57	2.17	48.53	3.01
T6 : T4+T5	29.33	8.32	53.90	2.44	56.26	3.23
T7: Odyssey at 0.070 kg PoE 15 DAS	31.67	10.70	40.72	2.12	48.30	3.13
T8: Odyssey at 0.080 kg PoE 15 DAS	34.00	11.62	35.62	2.21	51.17	3.25
LSD (P= 0.05)	4.63	3.02	-	0.30	10.10	-

CONCLUSION

The treatment Quizalofop ethyl 0.075 kg/PoE 15 DAS followed by Imazethapyr 0.100 kg/PoE 15 DAS found better in controlling weed, dry matter accumulation, weed control efficiency, grain yield and NMR of soybean.

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Integrated weed management in maize

J.P. Deshmukh*, P.V. Shingrup, M.S. Dandge, V.M. Bhale and A.N. Paslawar

Department of Agronomy, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104

**Email: jpdagro@rediffmail.com*

Maize is one of the most important cereal crops in many parts of the world as well as in India. Maize, being a rainy season and widely spaced crop, gets infested with variety of weeds. The loss of yield due to weeds in maize (*Zea mays* L.) varies from 28–93%, depending on the type of weed flora and the intensity and duration of crop-weed competition (Sharma and Thakur 1998). Manual weeding is difficult due to inadequate availability of labour and lack of workable field conditions at critical stages of crop-weed competition. In such a situation use of herbicides become essential. Hence, the present investigation was undertaken.

METHODOLOGY

Field experiment was carried out at Agronomy Department farm, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola (MS) during the *Kharif* season of 2011. The experiment was laid out in randomized block design with eight treatments replicated four times. Sowing of maize '*Maharaja'* was done on 6th July 2011. Herbicide treatments were applied as per the treatments. Phytotoxicity symptoms due to herbicides on crop was recorded by using a visual score scale of 0-10.

RESULTS

The major weed flora during *Kharif* season in maize both broad and narrow leaved weeds but dominance of broad leaved weeds were observed in entire field. All the weed control treatments significantly minimized the weed number and weed dry matter when compared with unweeded control. Oxyflurofen alone and in combination with cultural practices shows some phytotoxic effect on maize plant initially but it recovered in few days. Treatment T_7 (Hand weeding on 20 and 40 DAS) recorded significantly lowest weed count, weed dry weight and weed control efficiency followed by treatment T_5 (Atrazine 1.0 kg/ha PE on 3 DAS + MW at 30 DAS). These results are in agreement with the results reported by Malviya Alok and Bhagwan Singh (2007).

The highest grain yield (t/ha) was noticed in hand weeding twice on 20 and 40 DAS but statistically found at par with other herbicide treatments.

Table 1. Weed population/m², Weed dry matter/ gm², Weed control efficiency (%), grain yield (t/ ha), Net monetary returns (₹) and B:C ratio as influenced by weed control treatments in maize

Treatment	Weed population /m² at harvest	Weed dry matter g/m² at harvest	Weed control efficiency (%)	Grain yield (t/ha)	NMR (x10³₹/ha)	B:C Ratio
Oxyfluorfen 0.2 kg/ha PE	41.50	49.39	39.86	2.72	19.78	2.45
Atrazine 1.0 kg/ha PE	32.25	38.38	53.26	3.05	23.53	2.80
Pendimethalin 0.75 kg/ha PE DAS	37.25	44.33	46.01	2.85	20.87	2.52
Oxyfluorfen 0.2 kg/ha PE + MW at 30 DAS	37.50	44.63	45.65	3.11	22.14	2.46
Atrazine 1.0 kg/ha PE + MW at 30 DAS	26.75	31.83	61.23	3.34	25.04	2.70
Pendimethalin 0.75 kg/ha PE + MW at 30DAS	31.50	37.49	54.35	3.14	22.42	2.46
Hand Weeding Twice on 20 and 40 DAS	22.00	26.18	68.12	3.35	22.72	2.30
Weedy Check	69.00	82.11	-	1.76	10.88	1.87
LSD (P=0.05)	8.18	9.74	-	0.55	5.66	-

CONCLUSION

Among the herbicidal treatments, Atrazine 1.0 kg/ha PE followed by mechanical /hand weeding at 30 DAS proves better in controlling weed, dry matter accumulation, weed control efficiency, grain yield and NMR However, treatment T_7 hand weeding twice on 20 and 40 DAS proves superior over in all aspects except B:C ratio.

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Evaluation of different herbicides on weed flora and yield of *Bt* cotton

P.V. Shingrup*, J.P. Deshmukh, S.U. Kakade, V.M. Bhale, S.P. Patil and P.M. Pawar
Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104
**Email: pvshingrup@gmail.com*

Cotton (*Gossypium* spp. L.) is one of the important cash crops in India, which plays an important role in the nation economy. India ranks 1st in area and 2nd in production of the cotton. In Vidarbha, cotton is grown predominantly as a rainfed crop on about 15.60 lakh ha with production 35.50 lakh bales and 228.00 kg/ha productivity. Weed control under rainy period is biggest hurdle in crop production. The most acute weed competition is noticed from 15 to 55 days after emergence of crop (Sreenivas 2000). The traditional method of weed control is expensive, tedious and time consuming. Under such circumstances, use of effective herbicides gives better and timely weed control. Hence the present investigation was undertaken.

METHODOLOGY

A field investigation was carried out at the farm of Agronomy Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola during *Kharif,* 2012. The experiment was laid out in randomized block design with eight treatments replicated thrice. The experimental site was high in nitrogen, medium in phosphorous and fairly rich in potash and slightly alkaline in reaction. Sowing of rainfed *Bt* Cotton CV, *MRC-7326* was done at spacing of 90 x 60 cm on 2nd July, 2012 with RDF 60:30:30 NPK kg/ha. Herbicides were applied as per the treatments and phytotoxicity symptoms on crop was recorded by using a visual score scale of 0-10.

RESULTS

The major weed flora during *Kharif* season in cotton crop in the selected area composed of varied weed species of monocot and dicot, *viz. Commelina benghalensis, Cynodon dactylon, Cyperus rotundus, Euphorbia hirta, Tridex procumbense, Parthenium hysterophorus, Alternanathera triandra, Xanthium strumarium, Portulaca oleracae, Amaranthus viridis, Corchorus acutangulus*. None of the herbicide under study showed any phytotoxicity symptoms on crop. Lowest weed count was observed under treatment 2 hand weeding + 1 hoeing but was at par with treatment cotton + green gram (cover crop). This might be due to smothering effect of intercrop. Under herbicide treatments, pyrithiobac-Na 0.075 kg/ha PoE 20-40 DAS + hoeing at 40 DAS recorded lowest weed count but found at par with pendimethalin 1.25 kg/ha PE + hoeing at 30 DAS. This might be due to better control of weeds by post emergence herbicide. Similar trend was also observed in weed dry matter and weed control efficiency. These results are in agreement with the results reported by Thorat *et al.* (2007). The highest seed cotton yield (kg/ha), NMR (₹/ha) and B:C ratio were noticed in pyrithiobac-Na 0.062 kg/ha PoE 20-40 DAS + hoeing at 40 DAS.

Table 1. Weed population, Weed dry matter, Weed control efficiency, seed cotton yield, NMR and B:C ratio as influenced by different treatments

Treatment	Weed population at harvest (per m^2)	Weed dry matter at harvest (g/m^2)	Weed control efficiency (%)	Seed cotton yield (t/ha)	NMR (x10^3 `/ha)	B:C Ratio
Cotton + green gram (*cover crop*)	49.0	99.5	48.0	1.29	19.14	1.58
Pendimethalin 1.25 kg/ha PE + hoeing at 30 DAS	50.7	103.9	45.7	1.35	20.69	1.60
Quizalofop-ethyl 0.075 kg/ha PoE 20-40 DAS + hoeing at 40 DAS	59.7	122.3	36.1	1.34	21.06	1.63
Pyrithiobac-Na 0.062 kg/ha PoE 20-40 DAS + hoeing at 40 DAS	59.3	121.6	36.4	1.38	22.04	1.65
Pyrithiobac-Na 0.075 kg/ha PoE 20-40 DAS + hoeing at 40 DAS	52.0	106.6	44.3	1.38	21.59	1.63
Propaquizafop 0.075 kg/ha PoE 20-40 DAS + hoeing at 40 DAS	63.0	129.8	32.1	1.26	17.51	1.52
Weedy check	90.7	191.3	-	0.86	2.79	1.09
2 Hand weeding + 1 hoeing	41.7	84.56	55.8	1.36	15.69	1.40
LSD (P=0.05)	11.2	22.90	-	0.26	10.84	-

CONCLUSION

Among all treatments, pyrithiobac-sodium 0.062 kg/ha PoE 20-40 DAS + hoeing at 40 DAS proves best in controlling weed, dry matter accumulation, weed control efficiency, higher seed cotton yield, NMR and B:C ratio.

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Efficacy of pre emergence herbicides on maize-chickpea cropping sequence

P.V. Shingrup*, M.S. Dandge, A.N. Paslawar, V.M. Bhale and J.P. Deshmukh
Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104
**Email: pvshingrup@gmail.com*

Timely weed management practices play an important role in the successful cultivation of the crop. Yield loss occurs from 37% to complete crop failure due to weed competition in maize (Oerke and Dehne 2004). The conventional method of weed control by hoeing and hand weeding are very laborious, expensive and time consuming and needs to be often repeated at different intervals. As a result, the crop suffers from severe weed competition in its early growth period (Sharma 1981). Therefore, the present investigation was planned to find out the efficacy of pre emergence herbicide in comparable with conventional practices for weed management and yield performance of maize-chickpea cropping sequence.

METHODOLOGY

An investigation was carried out during 2011-12 at Agronomy Farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. The experiment was laid out in split plot design with three replications. Main plot treatment for maize crop comprises of five treatment combinations and subplot treatments for chickpea consists of four treatment combinations of weed control method (Table 1). Weed population, weed control efficiency and economics of the treatments were worked out. sowing of maize was done on 6th July, 2011 and chickpea on 15th November, 2011. Phytotoxicity symptoms due to herbicides on crop were recorded by using a visual score scale of 0-10.

RESULTS

The major weed flora during *Kharif* season in maize crop in the selected area composed of *Xanthium strumarium, Celosia argentea, Tridax procumbens, Portulaca oleracae, Euphorbia hirta, Parthenium hysterophorus, Digera arvensis, etc.* while during *Rabi* season in chickpea *Asphoedulus tenuifolius, Chenopodium album, Argemone mexicana, Melilotus alba, Portulaca oleracea, Euphorbia hirta, Parthenium hysterophorus, Digera arvensis, Physalis minima, Cyperus rotundus, Convolvulus arvensis, Amaranthus viridis* etc. were observed in entire field.

Results indicated that application of atrazine 0.75 kg/ha PE *fb* 2,4-D PoE significantly reduced weed population, weed dry matter accumulation, and highest weed control efficiency and resulted in maximum yield, whereas in chickpea, application of pendimethalin 0.75 kg/ha *fb* hand weeding significantly reduced weed population, weed dry matter accumulation and highest weed control efficiency and resulted in maximum yield. System productivity in terms of maize equivalent yield was maximum when atrazine 0.75 kg/ha PE *fb* 2,4-D PoE was applied to the maize crop. However, in chickpea, it was highest when application of pendimethalin 0.75 kg/ha *fb* hand weeding. Similarly, the NMR was higher with the aforementioned weed control practices in maize-chickpea system. However, interaction effect was found non significant.

Table 1. Weed population, dry matter of weed, weed control efficiency, maize equivalent yield and NMR as influenced by different treatments

Treatment	Weed population at harvest in maize (per m^2)	Dry matter of weed at harvest in maize (g/m^2)	Weed population at harvest in chickpea (per m^2)	Dry matter of weed at harvest in chickpea (g/m^2)	Weed control efficiency (%)	Maize equivalent yield (t/ha)	NMR (x10^3 ` /ha)
Main Plot (Maize)							
Mechanical weeding (2)	34.8	42.2	38.5	51.8	44.6	6.84	46.05
Atrazine 0.75 kg/ha PE	38.9	48.3	39.3	53.1	36.5	6.25	43.25
Atrazine 1.25 kg/ha PE	35.8	44.4	38.6	51.1	41.6	7.32	54.88
Atrazine 0.75 kg/ha PE *fb* 2,4-D 0.5 kg/ha PoE	22.9	28.4	39.3	47.1	62.6	7.35	55.64
Weedy check	62.8	76.0	35.3	48.4	--	5.88	39.30
LSD (P=0.05)	5.1	6.2	NS	NS	-	0.50	4.71
Sub Plot (Chickpea)							
Mechanical weeding (2)	38.9	47.7	30.3	39.7	43.0	7.26	52.32
Pendimethalin 1.25 kg/ha PE	38.7	47.5	43.4	57.3	17.8	6.69	47.92
Pendimethalin 0.75 kg/ha PE *fb* mechanical weeding	37.8	46.3	25.9	34.5	50.6	7.84	57.56
Weedy check	40.8	49.9	53.3	69.7	-	51.15	33.49
LSD (P=0.05)	NS	NS	4.4	5.7	-	0.40	4.14

CONCLUSION

Application of atrazine 0.75 kg/ha as PE *fb* 2,4-D as PoE (30 DAS) to maize and application of pendimethalin 0.75 kg/ha *fb* hand weeding (30 DAS) significantly reduced weed population and weed dry matter accumulation and increased weed control efficiency, maize equivalent yield, and NMR under maize-chickpea system.

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Weed density, weed dry weight and seed cotton yield of *Bt* cotton as influenced by irrigation methods and fertigation levels

S.U. Kakade*, V.M. Bhale, J.P. Deshmukh and P.V. Shingrup

Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104
**Email. snjykakade@gmail.com*

Among the different advantages of drip irrigation over furrow irrigation, reduced weed competition is remarkable one. Drip irrigation reduces weed infestation due to limited wetting of root zone only. Drip irrigation, an advanced method of precise application of water at right time at the active root zone of the crop, is one of the method by which 50 per cent of weed growth can be reduced as compared to furrow irrigation in cotton (Padmakumari and Sivanappan 1979). Fertigation, a modern approach of application of fertilizers through irrigation water, offers potential for more accurate and timely crop nutrition at root zone of the crop only, thereby reducing the nutrient losses, which also influences the weed menace. Therefore, an attempt has been made to study weed growth under drip irrigation and split application of N and K through fertigation in comparison with furrow band method of fertilizer application.

METHODOLOGY

The field experiment was conducted at Research Farm of Agronomy Department, *Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra* on *Bt* Cotton (MRC 7326) under fertigation during 2011-12 on clay loam soil. The experiment was laid out in randomized block design with six treatments and four replications for each treatment. The recommended dose of fertilizer used for cotton was 100:50:50 NPK kg/ha. The total rainfall received during the crop growth period was 471.2 mm in 35 rainy days. The experimental site was established with inline drip irrigation system (16 mm) with a lateral installed at 120 cm with 60 cm dripper spacing. The recommended dose of fertilizer was applied as per the treatments through fertigation tank of 90 lit capacities. P was applied as basal and N as urea and K as muriate of potash through irrigation water in five splits as per the treatments. In drip band and furrow band application method half of the N and full dose of P and K were applied as basal application at the time of sowing and remaining half dose of N was top-dressed at 30 days and at 60 days after sowing.

RESULTS

Drip band application and fertigation significantly reduced the weed density and dry weight as against furrow band application due to restricted area of wetting of soil surface under drip irrigation as compared to furrow irrigation. With regards to split application of N and K, drip band application resulted in significantly more weed density and weed dry weight (except at 40 DAS) as compared to other four drip fertigation levels. The three fertigation levels (75%,100% and 125% NK) were found at par with each other in respect of weed density at 20 DAS and higher level of drip fertigation (125% NK) had significantly more weeds compared to the lower level of drip fertigation of 50% NK. The same trend as weed density was observed in case of weed dry weight at 20 DAS and 40 DAS. The substantial reduction in weed infestation under drip fertigation as compared to furrow band application was also reported by Veeraputhiran and Kandasamy (2001).

Table 1. Weed density, weed dry weight, cost of weeding and seed cotton yield as influenced by furrow band application and drip fertigation methods in *Bt* cotton

Treatment	Weed density (no./m^2)		Weed dry weight (g/m^2)		Cost of weeding ($x10^3$ `/ha)	Seed cotton yield (t/ha)
	20 DAS	40 DAS	20 DAS	40 DAS		
100% RDF through furrow band application	197.3	165.7	82.7	69.7	7.68	2.35
100% RDF through drip band application	138.6	111.8	59.9	51.0	5.28	2.77
Fertigation with 50% RDNK	111.7	88.1	44.2	38.2	4.08	2.40
Fertigation with 75% RDNK	116.6	91.4	47.9	41.6	4.44	2.89
Fertigation with 100% RDNK	121.7	101.8	52.0	45.6	4.80	3.29
Fertigation with 125% RDNK	125.7	104.0	54.1	46.4	5.04	3.68
Mean						
Furrow band application	197.3	165.7	82.7	69.7	7.68	2.35
Drip band application	138.6	111.8	59.6	51.0	5.28	2.77
Drip fertigation	118.9	96.3	49.6	43.0	4.59	3.07
LSD (P=0.05)	10.9	6.7	4.7	5.3	-	0.38

The increases in seed cotton yield due to drip fertigation and drip band application were 23.41 % and 15.08%, respectively over furrow band application. This might be due to less competition of weeds with crop and better availability of nutrients to cotton crop in drip fertigation.The higher level of drip fertigation (125% NK) was significantly superior over all other fertigation levels and drip band and furrow band application in respect of seed cotton yield. The yield obtained with 50% NK/ha by fertigation was comparable with that of 100% fertilizer dose through furrow band indicating a saving of 50% fertilizers by fertigation. Veeraputhiran and Kandasamy (2001) reported the significant yield improvement and 60 kg N/ha saving by fertigation in cotton over furrow band method.

CONCLUSION

It is concluded from the study that of fertilizer application in drip band and split application of nutrients through drip fertigation minimise the weed density and weed dry matter at various growth stages, reducing the cost of weeding and increasing the seed cotton yield as compared to application of fertilizers in band through furrow irrigation.

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Efficacy of herbicides and cultural management on weed control in gram

P.O. Bhutada and V.M. Bhale
Department of agronomy, Dr. PDKV, Akola, Maharashtra *444 104*
**Email: vmb1957@yahoo.co.in*

Chickpea is an important crop of *Rabi* crop, which needs timely weed management practices play an important role in the successful cultivation of the crop. Chickpea suffers severely due to competition stress of weeds with yield reduction to the tune of 20 to 49.5% depending on nature and density of weeds (Yadav *et al.* 1983). The conventional method of weed control by hoeing and hand weeding are very laborious, expensive and time consuming and needs to be often repeated at different intervals, therefore, the present investigation was planned to find out efficacy of herbicides and cultural management practices on weed control in gram (*Cicer arietinum*).

METHODOLOGY

An investigation was carried out during 2010-11 at farm of Agronomy Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in randomized block design with 10 treatments and 3 replications for each treatment (Table 1). The Chickpea variety (*Jaki 9218*) sown at gross plot size 5 x 5.5 m and net plot size 4.2 x 4 m, on 4th November, 2010. Weed population, weed dry matter, weed control efficiency, grain yield of chickpea and economics of the treatments were worked out.

RESULTS

In chickpea, major weed flora were observed during *rabi* season was *Agemone mexicana, Melilotus alba, Portulaca oleraceae, Euphorbia hirita, Digera arvensis, Phasalis minima, Cyperus rotundus, Convolvus arvensis, Amaranthus viridis etc.* in field.

Lowest weed population and weed dry weight was found in pendimethalin 1 kg/ha with 1H at 40 DAS which was at par with cultural treatments 2H at 15 and 40 DAS with HW at 30 DAS. Weed control efficiency was highest in cultural treatements 2H at 15 and 40 DAS with HW at 30 DAS (85.09%) which was at par with treatements PE pendimethalin 1kg/ha with H at 40 DAS . Weed index was also minimum with treatements pendimethalin PE 1kg/ha with H at 40 DAS.

Plant height recorded highest with treatments pendimethalin 1 kg/ha with H at 40 DAS which was at par with treatements 2H at 15 and 40 DAS with HW at 30 DAS. Alone PE application of pendimethalin 1 kg/ha also recorded maximum plant height than rest of treatements. Similar result observed in count of branches per plant. Number of pods per plant, 100 seed wt and NMR were recorded maximum with treatments 2H at 15 and 40 DAS with HW at 30 DAS which were at par with treatments pendimethaline 1 kg/ha with H at 40 DAS. Among herbicidal treatment lone application of pendimethalin 1 kg/ha proves significantly superior over the rest of treatments. Similar results were observed with NMR and B:C ratio observed with treatments 2H at 15 and 40 DAS with HW at 30 DAS which was at par with the treatment pendimethalin 1 kg/ha with H at 40 DAS (Hosseini 1998).

Table 1. Weed dry weight, WCE, and weed index in chickpea as affected by different treatments

Treatment	WDW (g)	WCE (%)	WI (%)	Plant height (cm)	Branches (per plant)	Pods (per plant)	100 seed weight (g)	NMR (x10^3₹/ha)
Weedy check	17.3	0	61.6	41.2	20.7	36.5	20.8	14.41
Imazethapyr PE 75 g/ha	4.6	73.2	17.7	51.6	24.9	41.2	23.4	39.01
Imazethapyr POE 75 g/ha	4.5	73.8	22.9	56.5	25.1	41.2	23.1	35.67
Pendimathalin PE 1 kg/ha	4.0	76.9	6.1	62.4	28.5	46.7	25.6	47.19
Quizalofop POE 50 g/ha	4.4	74.5	12.5	57.3	25.4	45.0	24.3	42.93
Imazethapyr PE 75 g/ha + H at 30 DAS	4.2	75.7	16.4	57.7	26.0	42.2	23.1	40.83
Imazethapyr PE 75 g/ha + H at 40 DAS	4.4	74.8	18.9	58.8	26.6	44.0	23.5	38.05
Pendimathalin PE 1 kg/ha + H 40 DAS	3.1	82.1	2.3	70.3	29.9	52.6	25.6	50.67
Quizalofop POE 50 g/ha + H 40 DAS	4.1	76.1	12.4	63.3	27.3	49.9	24.4	43.67
2H at 15 and 40 DAS + HW at 30 DAS	2.6	85.1	0	67.1	28.8	54.4	26.2	53.22
CD	2.3			3.8	2.6	2.2	5.9	13.92
GM	5.3	69.2	61.6	59.0	26.1	45.4	23.9	40.57

CONCLUSION

The treatment consisting of pendimethalin 1 kg/ha + 1H at 40 DAS is an effective and profitable measure to control weeds in gram (*Cicer arietinum*).

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Efficiency indices of weed management in cotton

K. Nalini*, P. Murhukrishnan and C. Chinnusamy
Veterinary College and Research Institute, TANUVAS, Tirunelveli 600 051
**Email: naliniagr@gmail.com*

Cotton, the "*white gold* or the *king of fibres*" is one of the most important commercial crops in India. In India, cotton cultivation provides livelihood for over 4 million farming families. The weed species density and duration of the population determine the competitive damage of cotton. The more competitive species with the greatest density and longest duration will cause the most significant reduction in cotton production.

METHODOLOGY

Field trials were laid out in randomized block design with treatments replicated thrice. In the present study, various weed management practices, *viz*. pre-emergence pendimethalin 38.7% EC at 1.5, 2.0, 2.5 and 4.0 kg/ha + HW (T_1, T_2, T_3, T_4), pendimethalin 30% EC at 1.0 kg/ha + HW (T_5), EPOE trifloxysulfuron at 10 g/ha + HW(T_6), PE pendimethalin 30% EC at 1.0 kg/ha + PWW(T_7), pendimethalin 30% EC at 1.0 kg/ha + CRM + HW (T_8), PWW on 25 and 45 DAS (T_9), hand weeding twice (T_{10}), weed free (T_{11}) and unweeded checks (T_{12}) were included.

RESULTS

During winter 2008-09 season cotton crop, broad leaved weeds were dominant followed by grasses and sedges at early stages of crop growth, subsequently the grassy weeds dominated dominated the weed flora followed by broad leaved weeds and sedges. The relative density of grasses was lesser with pendimethalin (38.7%) at 2.0 kg/ha (T_2) whereas, the density of broad leaved weeds and sedges were lesser with trifloxysulfuron at 10 kg/ha (T_6) while, the grass weed density was more in this treatment at 25 DAS. During winter 2008-09, at 25 DAS the relative dry weight of grassy weeds was higher followed by broad leaved weeds in unweeded (T_{12}) control treatment. The relative dry weight of grassy weeds was lesser with pendimethalin (38.7%) at 2.0 kg/ha (T_2). During 2009-10 at 25 DAS, the relative dry weight of grassy weeds was higher followed by broad leaved weeds in unweeded (T_{12}) plot. The relative dry weight of grassy weeds was lesser with pendimethalin (38.7%) at 2.0 kg/ha (T_2). The summed dominance ratio (SDR) of weeds gives a clear picture of the dominance of the weed in the respective treatment and effectiveness of the weed control treatments. In the first crop, it was found that lesser values of SDR for grassy weeds were observed under pendimethalin (38.7%) at 2.0 kg/ha (T_2) and pendimethalin (38.7%) at 2.5 kg/ha at 25 DAS (T_3). Similar results was also obtained by Mian *et al.* (2007) who computed SDR found highest in grasses indicating principal dominancy as compared to other species. At 45 DAS lesser SDR values of broad leaved weeds and sedges were observed with trifloxysulfuron at 10 g/ha (T_6) and higher values of SDR for broad leaved weeds were observed with pendimethalin applied treatments.

Weed control efficiency (WCE) showed the maximum value under pre-emergence application of pendimethalin (38.7%) at 4.0 kg/ha (T_4) at 25 and 45 DAS. Pre-emergence application of pendimethalin registered higher WCE ranging between 93.45 and 65.8 per cent. The results of the present study indicated that application of pendimethalin (38.7%) at different doses followed by hand weeding produced higher WCE throughout the crop period which was comparable with the conventional weeding at 45 DAS. Hence, application of pendimethalin (38.7%) at 2.0 to 4.0 kg/ha followed by hand weeding is a quite suitable option to overcome the weed problem in cotton.

Pendimethalin (38.7%) at 2.0 kg/ha + hand weeding (T_2) recorded higher seed cotton yield of 58 and 32 per cent during winter 2008-09 and 2009-10 seasons, respectively over unweeded control. The next best treatment was the pendimethalin (38.7%) at 2.5 kg/ha + hand weeding (T_3). Application of pendimethalin at 1.0 kg/ha in combination with inter culturing plus hand weeding gave 199.4 per cent increase in seed cotton yield over untreated check was reported by Ali *et al*. (2005).

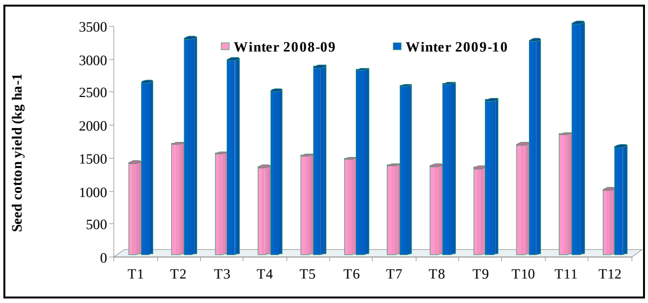

Fig. 1. Effect of weed management methods seed cotton yield in cotton

CONCLUSION

The success of the weed control operations is dependent on the time of weed seedling emergence, weed species and stage of crop growth. Timely applications of effective herbicide are able to reduce losses when there is an occurrence of targeted weeds, optimize herbicides efficacy against weeds and also minimize production cost or protect crops against injury.

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Pre and post emergence herbicide combinations for broad spectrum control of weeds in transplanted rice

N.K. Prabhakaran*, C. Nithya and M. Vijayakumar

Department of Agronomy, Directorate of Crop Management, TANU, Coimbatore, Tamil Nadu 641 003

**Email: nkpajay@gmail.com*

Weed competition is more severe in transplanted rice, and the yield losses caused by weeds in low land rice fields vary with time of weed infestation and planting method. Chemical weed control in transplanted rice has gained importance because of the intensity of weed problems, coupled with the lack of labour for weeding and high cost. The use of herbicides offers selective control of weeds right from beginning, giving the crop an advantage of good growth and competitive superiority over weeds (Saha 2005).Herbicide selectivity in transplanted rice can be improved by adjusting the time of application, reducing the dose of the herbicide. In this view, a field experiment was proposed to evaluate the efficiency of pre and post emergence herbicides/herbicide combinations for weed control and yield of transplanted rice.

METHODOLOGY

Field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore during *Rabi*, 2012-13 and the experiment was laid out in randomized block design with twelve treatments in fine clay loam soil and replicated thrice. The treatments comprised of early post emergence (EPOE) bispyribac sodium 25 g/ha, pre emergence (PE) pretilachlor 1000 g/ha, post emergence (POE) chlorimuron ethyl 10% + metsulfuron methyl 10% 4 g/ha, PE pyrazosulfuron-ethyl 20 g/ha, EPOE bispyribac Sodium + ethoxysulfuron 25 + 18.75 g/ha, EPOE bispyribac sodium + chlorimuron ethyl 10% + metsulfuron methyl 10% 20 + 4 g/ha (Tank mixture), PE pretilachlor 750 g/ha fb POE ethoxysulfuron 18.75 g/ha, PE Pretilachlor 750 g/ha fb POE chlorimuron ethyl 10% + metsulfuron methyl 10% 4 g/ha, PE pyrazosulfuron-ethyl 20 g/ha fb manual weeding on 25 days after transplanting (DAT), PE pretilachlor (6%) + bensulfuron methyl (0.6%) 6.6% GR 660 g/ha, hand weeding (HW) at 25 and 45 DAT and unweeded control. Medium duration rice variety CO (R) 50 was used in the field experiment.

RESULTS

In the experimental field, predominant grassy weeds observed were *Echinocloa colonum* and *Cyperus difformis* among sedges and broad leaved weed was *Ammania baccifera*. At 60 DAT, lower weed density and dry weight with higher weed control efficiency were recorded in HW at 25 and 45 DAT and it was on par with pre-emergence application of pretilachlor 750 g/ha *fb* POE chlorimuron + metsulfuron 4 g/ha (Table 1). Grain yield was conspicuously higher in HW at 25 and 45 DAT (6.05 t/ ha) and it was comparable with PE pretilachlor 750 g /ha + POE chlorimuron and metsulfuron 4 g/ha during *Rabi,* 2012-13. In economic point of view, PE pretilachlor 750 g/ha *fb* POE chlorimuron + metsulfuron at 4 g/ha resulted in higher net return (₹ 57,465/ha) and B:C ratio (3.35).

Table 1. Weed management treatments on total weed density, total weed dry weight, WCE at 60 DAT and grain yield in transplanted rice during *Rabi* 2012-13

Treatment	Weed density (no./m^2)	Weed dry weight (g/m^2)	WCE (%)	Grain yield (t/ha)	Net return (x10^3₹/ha)	B:C ratio
Bispyribac-Na EPOE 25 g/ha	6.4 (39.6)	5.0 (22.9)	67.8	4.60	37.53	2.48
Pretilachlor PE 1000 g/ha	6.4 (38.7)	5.3 (26.6)	62.6	4.46	37.87	2.55
Chlorimuron + metsulfuron (Almix) POE 4 g/ha	5.9 (33.4)	5.0 (23.4)	67.1	4.51	38.98	2.64
Pyrazosulfuron-ethyl PE 20 g/ha	7.75 (58.1)	6.3 (37.5)	57.1	4.81	42.85	2.77
Bispyribac-Na EPOE 25 g/ha + ethoxysulfuron 18.75 g/ha	6.2 (36.1)	5.0 (23.0)	67.6	4.97	41.83	2.55
Bispyribac-Na EPOE 20 g/ha + Almix 4 g/ha	5.93 (33.2)	4.9 (21.8)	69.3	4.62	38.37	2.52
Pretilachlor 750 g / ha *fb* ethoxysulfuron 18.75 g / ha (PE + POE)	3.3 (8.7)	2.6 (4.9)	93.1	5.19	46.17	2.79
Pretilachlor 750 g/ha *fb* almix 4 g/ha (PE + POE)	2.6 (4.9)	2.1 (2.5)	96.5	5.97	57.47	3.35
Pyrazosulfuron-ethyl PE at 20 g/ha *fb* hand weeding	5.6 (29.3)	4.4 (17.6)	75.3	4.60	36.08	2.31
Pretilachlor PE (6%) + bensulfuron (0.6%) 6.6% GR 660 g/ha	5.49 (28. 5)	4.7 (20.3)	71.4	4.64	38.61	2.53
Hand weeding at 25 and 45 DAT	2.2 (2,8)	1.8 (1.1)	98.5	6.05	50.82	2.57
Unweeded check	10.3 (104.8)	8.5 (71.8)	-	3.30	21.30	1.91
LSD (P=0.05)	0.5	0.44	-	0.37	-	-

Figures in parenthesis are means of original values. Data subjected to square root transformation

CONCLUSION

Hand weeding at 25 and 45 DAT and PE pretilachlor 750 g/ha *fb* POE chlorimuron-ethyl 10% + metsulfuron methyl 10 % 4 g/ha recorded higher and comparable yield. The economic return was higher in PE pretilachlor 750 g/ha *fb* POE chlorimuron-ethyl 10% + metsulfuron methyl 10% 4 g/ha under transplanted rice.

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Weed management in black gram under lateritic soil of West Bengal

A. Hossain*, B. Duary and D.C. Mondal
Directorate of Weed Science Research (AICRP-WC), Sriniketan Centre, PSB,Visva-Bharati, Sriniketan, West Bengal 731 236
**Email: ahossaindwsrc@yahoo.in*

Blackgram [*Vigna mungo* (L.) Hepper] is an important pulse crop in India. It is grown during summer as well as *kharif* season. Monsoon rains during kharif season results in lot of weed population and weed growth in this crop. Unchecked weeds have been reported to cause a 43.2 - 64.1% reduction in the grain yield of *Kharif* blackgram (Chand *et al*. 2004). Broad leaved weeds pose serious problem in blackgram cultivation. Post emergence application of imazethapyr at 50g/ha controlled mixed weed flora but resulted in slight injury to blackgram (Rao *et al*. 2010). Under this conditions, present investigation was carried out by using herbicides and herbicide mixtures to control mainly broad leaved weeds and mixed weed flora in broad leaved crop.

METHODOLOGY

The investigations were conducted in Agricultural Farm of the Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal during *Kharif* seasons of 2012 and 2013. The soil is sandy loam, slightly acidic in nature with medium nitrogen and phosphorus and low in potash. The experiment was laid out in Randomized Block Design with 10 treatments (Table 1) and 3 replications for each treatment. The crop variety of blackgram was kalindi.

RESULTS

The experimental field was infested with 14 weed species out of which 2 grasses and 12 broad leaved. The most pre-dominant weed species were *Melochia corchorifolia*, *Ludwigia parviflora*, *Murdania nudiflora* and *Lindernia ciliata* during both the years.Pre-emergence application of pendimethalin and post emergence application imazethapyr and pre-mix of imazethapyr + imazamox with its two different doses were found most effective in controlling grassy weeds. Pre-emergence application of imazethapyr + pendimethalin (pre-mix) with its three different doses was also found effective in reducing the number of broad leaved weeds.Pre-emergence application of imazethapyr + pendimethalin (pre-mix) at 900 g/ha recorded the highest number of pods/plant but this was statistically at par with imazethapyr + pendimethalin (pre-mix) at 800 and 1000 g/ha. Pre-emergence application of imazethapyr + pendimethalin (pre-mix) at 1000 g/ha recorded the highest yield, net return and wider B:C ratio. Due to phyto-toxicity effect of imazethapyr and imazethapyr + imazamox (pre-mix) the seed yield, net return and B:C ratio were very low.

Table 1. Effect of treatment on seed yield and economics in black gram (Pooled)

Treatment	Seed yield (t/ha) [pooled]	Gross return (x10^3₹/ha)	Net return (x10^3₹/ha)	B:C ratio
Pendimethalin 1000 g/ha as pre-emergence	0.84	37.93	20.63	1.19
Imazethapyr 50 g/ha at 20 DAS	0.59	26.37	9.02	0.52
Imazethapyr 70 g/ha at 20 DAS	0.61	27.22	9.53	0.54
Imazethapyr + pendimethalin (Pre-mix) 800 g/ha as pre-emergence	0.87	39.33	22.39	1.32
Imazethapyr + pendimethalin (Pre-mix) 900 g/ha as pre-emergence	0.88	39.60	22.63	1.33
Imazethapyr + pendimethalin (Pre-mix) 1000 g/ha as pre-emergence	0.90	40.32	23.32	1.37
Imazethapyr + Imazamox (Pre-mix) 40 g/ha at 20 DAS	0.68	30.51	13.78	0.82
Imazethapyr + Imazamox (Pre-mix) 50 g/ha at 20 DAS	0.69	31.09	14.31	0.85
Weed free (hand weeding at 20 and 40 DAS)	0.87	38.92	18.32	0.89
Weedy check	0.44	19.66	4.16	0.27

Price of black gram – Rs. 45/kg

CONCLUSION

Pre-emergence application of imazethapyr + pendimethalin at 800-1000 g/ha may be recommended to control mixed weed flora and to produce higher seed yield of blackgram.

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Standardization of seed rate and weed management in direct seeded rice

A.P. Singh*, R. Kumar, T. Chowdhury, N.Pandey, S.S.Kolhe, S.K. Dwivedi and G.K.Shrivastava

Department of Agronomy, Indira Gandhi krishi Vishwavidyalaya, Raipur, Chhattisgarh 492 012

**Email: apalsingh@yahoo.com*

In direct seeded rice, heavy seed rate is common practice. It gives two major disadvantages as consumption of large quantity of costliest input like seed and more problem of inter-plant competition. Another major constraint in direct seeded rice is weed, which, being a serious negative factor in crop production are responsible for reduction in yield of rice and weed management is considered as a positive factor in trapping the production potential. The extent of rice yield reduction due to weeds has been estimated from 15-95% (Gogoi *et al*. 1996). Keeping above facts in view, an experiment was conducted with the objectives to explore the possibilities to reduce the currently recommended seed rate in direct seeded rice and develop labour-less weed management technology.

METHODOLOGY

A field experiment was carried out at I.G.K.V, Raipur during rainy seasons of 2011 and 2012. The experimental soil was inceptisols low in organic carbon, low in available nitrogen, medium in phosphorus and high in potassium with neutral soil reaction. Four treatments comprised of fenoxaprop + ethoxysulfuron at 60 + 15 at 25 DAS, fenoxaprop + ethoxysulfuron *fb* bispyribac 60 + 15 *fb* 25 at 18 and 35, hand weeding twice at 20 and 35 DAS and one weedy check in main plot and four treatments in subplot comprised of three seed rates as 20, 30 and 40 kg/ha along with one recommended seed rate of 80 kg/ha. The experiment was laid out in split plot design replicated thrice. The gross plot size was 10 X 3 m. Medium duration rice cultivar *MTU 1010* was taken as test crop. The sowing of rice was done in the last week of June with the help of seed cum fertilizer drill with recommended dose of fertilizer, *i.e.* 100:50:30 kg/ha N: P: K respectively.

RESULTS

Floristic composition

Experimental field was dominated by broad-leaved weeds and sedges including *Alternanthera traiandra, Spilanthes acmella, Cynotis axillaris* and *Cyperus iria, Fimbrisyilis milliacea* whereas, *Echinochloa colona* was the dominating weed among grasses.

Weed population

Broad leaf weeds and sedges collectively dominated the weed flora by 67.78 % at 60 DAS, and similar trend continued till harvest. Among grasses, *Echinochloa colona* was the main menace. Weed population was slightly low under the treatment of fenoxaprop + ethoxysulfuron *fb* bispyribac at 60 + 15 and 25 g/ha and this was followed by hand weeding twice, at both stages. Among different seed rates, it was observed that weed population decreased gradually with the increase in seed rate at harvest.

Weed dry matter production

It is obvious from the data that among weed management practices, at harvest stage, significantly low weed dry matter was recorded under fenoxaprop + ethoxysulfuron *fb* bispyribac at 60 + 15 fb 25 g/ha as compared to weedy check, but it was at par with hand weeding twice. Among different seed rates, the weed dry matter was significantly low under 80 kg/ha as compared to 20 kg/ha seed rate, but, was at par with seed rates of 40 and 30 kg/ha, in order.

Yield attributes and seed yield

Seed yield varied significantly due to different weed management practices as well as seed rates. Among weed management practices, the significantly higher seed yield was recorded under hand weeding twice as compared to weedy check, but was at par with rest of the treatments. Yield attribute like effective tillers also followed the similar trend. The reduction in yield was maximum under weedy check. Among different seed rate treatments, significantly higher seed yield was recorded under 40 kg/ha as compared to 20 kg/ha, but, it was at par with 80 and 30 kg/ha seed rate. It is also noticeable the seed yield under 30 kg seed rate is also at par with current recommended seed rate of 80 kg/ha. Yield attribute like number of effective tillers/m^2 also followed the similar trend. The yield reduction was maximum under 20 kg followed by 30 and 80 kg/ha seed rate.

CONCLUSION

It was concluded that seed yield under fenoxaprop + ethoxysulfuron *fb* Bispyribac at 60 + 15 fb 25 g/ha and fenoxaprop + ethoxysulfuron at 60 + 15 g/ha was at par to hand weeding twice, in order. Also that seed yield under 40 kg seed rate/ha was significantly higher over 20 kg/ha but was at par to 30 and 80 kg seed rate/ha. It is also noticeable the seed yield under 30 kg seed rate is also at par with current recommended seed rate of 80 kg/ha.

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Pre- and post-emergence herbicides for integrated weed control in spring sunflower

Sukhpreet Singh* and SK. Dhillon
Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, Punjab 141 004
**Email: preetsukh44@pau.edu*

Sunflower (*Helianthusannus* L.) is an important oilseed crop cultivated for its premier oil and manifold uses of both industrial and pharmaceutical importance. Its wider adaptability, day neutral nature and responsiveness to better management practices have played a significant role in its cultivation across varied agro-climatic zones within a span of three decades of its introduction in the country. In Punjab, sunflower is grown in the spring season. Being a short duration crop, weed competition especially during early growth period is a serious constraint in sunflower production. Though pre-emergence application of pendimethalin is recommended in Punjab but information regarding efficacy of post-emergence herbicides is meagre. Hence present investigation for evaluation of post-emergence herbicides in combination with pre-emergence herbicides was undertaken.

METHODOLOGY

A field experiment was conducted during spring 2013 at Research Farm of Punjab Agricultural University, Ludhiana to evaluate the efficacy different pre- and post-emergence herbicides for integrated weed management in spring sunflower. The experiment was conducted on loamy sand soil with neutral pH, low in available N, high in available P and low in available K. Nine treatments comprising of different pre-and post-emergence herbicides at different doses in randomized block design were evaluated in 4 replications. Sunflower hybrid *PSH* 996 was raised with recommended package of practices. Fertilizers were applied uniformly in all the experimental plots through urea, single super phosphate and muriate of potash at 60, 30 and 30 kg/ha, respectively. The data on growth parameters, seed yield, weed growth and economics was recorded.

RESULTS

The composition of weeds indicated that broadleaf weeds (21/m^2) were found to be dominant followed by sedges (14/m^2) and grasses (6/m^2) in unweeded control at 30 DAS. Similar trend was observed at 60 DAS. *Oenothera laciniata* among the broadleaf and *Cyperus* spp. among the sedges were more dominant.

Different pre- and post emergence herbicides did not have any significant effect on most of the growth and yield parameters except in case of plant height, number of seeds per head and yield per plant. The seed yield of sunflower was maximum in weed free check (2.95 t/ha) *fb* pendimethalin at 0.75 kg/ha (38.7 CS) as Pre-emergence spray + one IC at 20 DAS followed by hand weeding at 40 DAS (2.89 t/ha). Both these treatments gave significantly better seed yield as compared to other treatments and were statistically at par with each other (Suresh and Venkatareddy 1994). There was no influence of any weed control treatment on oil content whereas oil yield followed the same trend as seed yield.

Economic analysis of the experiment revealed that weed free check gave maximum gross returns (₹ 1,09,382/ha) followed by pendimethalin at 0.75 kg/ha (38.7 CS) as pre-emergence spray + one IC at 20 DAS followed by hand weeding at 40 DAS (₹ 1,07,137/ha). However, net returns were maximum in case of treatment pendimethalin at 0.75 kg/ha (38.7 CS) as Pre-emergence spray + one IC at 20 DAS followed by hand weeding at 40 DAS (₹ 76,632/ha) because of increased labour costs in weed free check. The benefit cost ratio was also highest in this treatment (3.52) and minimum in case of control (2.65).

Table 1. Performance of Sunflower as influenced by different weed control treatments

Treatment	Weed count/ m^2	Weed dry matter (g/m^2)	Weed control efficiency (%)	Seed yield (t/ha)	Oil content (%)	Oil yield (t/ha)	Net returns (x10^3₹/ha)	B:C Ratio
Pendimethalin at 0.75 kg/ha (38.7 CS) as pre-emergence spray	20.1	13.4	70.5	2.42	36.2	0.87	63.94	3.47
Pendimethalin at 0.75 kg/ha (38.7 CS) as pre-emergence spray + one IC at 20 DAS followed by hand weeding at 40 DAS	15.8	10.4	77.1	2.89	36.3	1.05	76.63	3.52
Pendimethalin at 1.0 kg/ha pre-emergence spray + quizalofop-ethyl 10 EC at 37.5 g at 15-20 DAS as directed post-emergence spray	22.1	21.4	52.9	2.41	34.6	0.83	60.93	3.15
Pendimethalin at 1.0 kg/ha pre-emergence spray + propaquizofop at 62 g at 15-20 DAS as directed post-emergence spray	21.9	13.4	70.5	2.18	36.3	0.79	53.56	2.97
Pendimethalin at 1.0 kg /ha pre-emergence spray + fenoxoprop ethyl at 37.5 g at 15-20 DAS as directed post-emergence spray	22.7	23.0	49.3	2.48	36.4	0.90	65.15	3.43
quizalofop ethyl 10 EC at 37.5 g + chlorimuron-ethyl at 37.5 g /ha at 15-20 DAS	24.0	27.9	38.5	0.81	35.8	0.28	2.68	1.01
Farmers practice (Two IC at 20 and 40 DAS + one HW at 30 DAS	21.1	23.9	47.4	2.51	36.3	0.91	64.55	3.23
Weed Free (Three HW at 15, 30 and 45 DAS)	10.6	9.4	79.3	2.95	36.4	1.07	73.37	3.04
Unweeded control	40.2	45.4	-	1.67	34.8	0.58	38.70	2.65
LSD(P=0.05)	3.93	8.46	-	393	NS	146	-	-

CONCLUSION

From the results of the experiment it was concluded that pre-emergence spray of pendimethalin at 0.75 kg /ha (38.7 CS) *fb* one IC at 20 DAS *fb* one hand weeding at 40 DAS was most effective for controlling weeds and getting maximum seed yield and profitability from spring sunflower.

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Weed flora and yield of rice as influenced by integrated weed management under system of rice intensification (SRI)

Devendra Kumar Dewangan*, A.P. Singh, Anjum Ahmad and C.K. Chandrakar
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh 492 012
***Email:** devendewangan@gmail.com*

Chhattisgarh is known as rice bowl of central India. The area and productivity of rice in Chhattisgarh is 3.61 million ha and 1.5 t/ha (Anonymous 2009), which is quite low as compared to many states as well as country. Weeds are the major constraints in production of rice and cause yield reduction of 15-95 per cent (Gogoi *et al*. 1996). Weed problems are generally higher in SRI fields because absence of continuous submergence of water. Keeping these points in view, integrated approach of weed management was evaluated for more feasible and practicable control of mixed weed flora in SRI.

METHODOLOGY

The experiment was carried out at research cum-instructional-Farm, IGKV, Raipur (C.G.) during *Kharif* season (July to November) of 2009. The experiment was conducted in randomized block design (RBD) with three replications. Rice variety *"MTU-1010"* was grown as a test crop. Rice seedlings of 14 days old were transplanted with a spacing of 20 x 20cm. The crop was fertilized with 90, 60 and 40 kg N, P and K/ha applied through urea, single super phosphate and muriate of potash, respectively. Organic manures as green manuring crop was grown and incorporated in soil at flowering stage.

RESULTS

The dominant weed species were *Alternanthera triendra, Echinocloa colona, Fimbristylis miliacea and Cyperus iria* throughout the crop season. Other weeds were *Ischaemum rugosum, Boreria sirida, Commelina benghalensis, Cynotis axillaris, Aescheynomene indica etc*. Table 1 reveals that at harvest, the total and species wise dry matter accumulation by weed was lowest in treatment fenoxaprop-p-ethyl 60 g/ha+ ethoxysulfuron 15 g/ha followed by hand weeding twice and fenoxaprop-p-ethyl 60 g/ha+ ethoxysulfuron 15 g/ha + MW (two ways). Unweeded control yielded the highest dry matter accumulation. The highest grain yield and weed control efficiency was noted under fenoxaprop-p-ethyl 60 g/ha+ ethoxysulfuron 15 g/ha narrowly which was at par with hand weeding. This was owing to low crop-weed competition and longer weed free period which leads to high growth and yield of rice.

Table 1. Total and species wise weed dry matter accumulation, grain yield and WCE as influenced by weed management practices in SRI

Treatment	60 DAT					Total weed dry matter accumulation (m^2) at harvest	Grain yield (t/ha)	WCE
	Echinochloa colona	*Alternanthera triandra*	*Cyperus iria*	*Fimbristylis miliacea*	Other weeds			
Fenoxaprop-p-ethyl at 60 g/ha+CME+MSM at 4 g/ha at 20 DAT	4.30	4.45	3.45	2.45	3.61	132.85	4.11	52.05
Fenoxaprop-p-ethyl at 60 g/ha + Ethoxysulfuron at 15 g/ha at 20 DAT	3.32	3.82	2.35	2.11	3.08	116.0	4.33	58.11
Fenoxaprop-p-ethyl at 60 g/ha+ CME+MSM 4 g/ha at 20 DAT + MW (one way) at 35 DAT	3.30	3.76	2.20	1.98	2.76	113.3	4.53	59.09
Fenoxaprop-p-ethyl at 60 g/ha+ Ethoxysulfuron at 15 g/ha at 20 DAT + MW (one way) at 35 DAT	3.10	3.5	2.16	1.81	2.16	111.3	4.57	59.81
Fenoxaprop-p-ethyl 60 g/ha + Ethoxysulfuron 15 g/ha + MW (two way) at 20 and 35 DAT	2.20	2.05	1.29	1.20	1.40	80.07	4.83	70.93
Fenoxaprop-p-ethyl 60 g/ha+ CME+MSM 4 g/ha at 20 DAT + MW (two way) at 35 DAT	2.60	2.92	1.85	1.47	1.98	99.83	4.69	63.97
Mechanical weeding (one way) -12, 25, 35 DAT	4.45	5.66	3.58	2.53	3.85	148.6	4.09	46.37
Mechanical weeding (two way) -12, 25, 35 DAT	2.35	2.4	1.75	1.39	1.89	92.20	4.81	66.72
Fenoxaprop-p-ethyl + CME+MSM at 4 g/ha at 20 and 35 DAT	2.89	3.22	1.98	1.53	2.15	105.4	4.57	61.93
Fenoxaprop-p-ethyl + Ethoxysulfuron 15g/ha at 20 and 35 DAT	1.65	1.83	1.05	0.91	1.05	69.91	5.18	74.77
Hand weeding–20, 40 DAT	2.00	1.91	1.22	1.06	1.35	77.39	5.05	72.07
Unweeded control	11.8	10.63	8.25	6.39	9.72	277.0	2.11	-
LSD(P=0.05)	0.58	0.54	0.39	0.30	0.37	12.24	0.20	-

CONCLUSION

It was concluded that post-emergence combined application of fenoxaprop-p-ethyl 60 g/ha+ ethoxysulfuron 15 g/ha at 20 and 35 DAT and hand weeding (twice) were equally effective for controlling weeds and improving grain yield in system of rice intensification method of rice.

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Effect of imazethapyr against weeds in groundnut

S.L. Mundra* and P.L. Maliwal

Maharana Pratp university of Agriculture and Technology, Udaipur, Rajasthan 313 001

**Email: sampatmundra@yahoo.in*

Groundnut (*Arachis hypogea L.*) is an important oilseed crop of India grown throughout the year in one or other part of the country. Weeds besides competition for water, nutrients and light with the crop also hinder pegging, compete for underground space and make crop harvest cumbersome and ultimately cause loss in pod yield up to 100% depending on the weed density and duration of crop-weed competition. Majority of herbicides used in groundnut are commonly pre-emergence and have narrow spectrum of weed control while manual weeding is very expensive and sometimes damages the crop plants. This has necessitated the search of some post emergence herbicide for effective and economical control of weeds in groundnut. Keeping these facts in view, imazethapyr that provided a good control of weeds in groundnut (Singh 2009) was evaluated to work put efficacy of herbicide at different doses.

METHODOLOGY

A field experiment was conducted consecutively for two *Kharif* seasons of 2008 and 2009 at Instructional Farm of College of Technology and Engineering, Udaipur. The soil of experimental site was sandy clay loam. The experiment consisted of seven weed control treatments namely imazetapyr 0.5, 1.0 and 1.5 l/ha (through XL 10 IPR, the product of Excel Crop Care Limited, Mumbai); imazethapyr 1.0 and 1.5 l/ha (Lagaam product), hand weeding 20 days after sowing (only in 2009). The crop was raised applying recommended package of practices. Treatments were evaluated in randomized block design with four replications using variety *TG 37A* with the row spacing of 30 cm and plot size of 5 m x 4.2 m. Application of herbicide was made at 1-2 leaf stage of weeds using knapsack sprayer fitted with flat fan nozzle using 500 liters of water per hectare.

RESULTS

Data reveal that weed control efficiency 30 days after imposition of herbicide treatments evaluated on basis of weed dry matter fluctuated to a great extent under different weed control treatments. The mean weed control efficiency of monocot weeds ranged from 48.90 to 69.70% whereas for dicot weeds it varied between 60.19 to 79.60% under different treatments. Data clearly show that imazethapyr irrespective of its dose and product proved more pronounced in curbing the efficiency of dicot weeds than monocot weeds. Among various doses of herbicide, imazethapyr at 1.5 liter/ha through XL 10 IPR proved superior to other treatments in controlling monocots as well as dicot weeds as reflected by its highest weed control efficiency during both the years of experimentation with the mean value of 69.70 and 79.60%, respectively. This is because of the fact that this treatment effectively eliminated the weeds over rest of the treatments. Application of imazethapyr at the lowest dose of 0.5 liter/ha had the lowest weed control efficiency because of poor control of both the categories of weeds.

Compare to weedy check, all the weed control treatments significantly increased the pod yield during both the years of experimentation. The minimum pod yield was recorded under imazethapyr (XL 10 IPR) 0.5 l/ha whereas the maximum was recorded under imazethapyr (XL 10 IPR) 1.5 l/ha. However, the yield variation between 1.0 and 1.5 liter imazethapyr/ha was statistically at par. Variations in pod yield under different weed control treatments was found to be directly proportional to their respective weed control efficiencies which led to record better yield of this crop. Compared to weedy check the per cent mean increase in pod yield due to 1.0 and 1.5 liter imazethapyr (XL 10 IPR)/ha was 632.4 and 657.4, respectively. The result on pod yield was in close conformity with the findings of Sasikala *et al.* (2007).

Table 1. Effect of imazethapyr on weed control efficiency and pod yield of groundnut

Treatment	Weed control efficiency (%)						Pod yield (t/ha)		
	Monocot			Dicot					
	2008	2009	Mean	2008	2009	Mean	2008	2009	Mean
Imazethapyr 0.5 liter/ha (XL 10 IPR)	52.80	45.06	48.90	65.80	60.60	63.20	1.05	1.39	1.22
Imazethapyr 1.0 liter/ha (XL 10 IPR)	65.90	59.20	62.60	79.60	69.10	74.40	1.52	2.04	1.78
Imazethapyr 1.5 liter/ha (XL 10 IPR)	74.60	64.80	69.70	85.30	73.90	79.60	1.59	2.10	1.84
Imazethapyr 1.0 liter/ha (Lagaam)	67.30	55.80	61.60	79.80	67.60	73.70	1.52	1.89	1.71
Imazethapyr 1.5 liter/ha (Lagaam)	73.80	60.30	67.10	85.00	72.11	78.60	1.56	1.96	1.76
Hand weeding 20 DAS	-	50.00	50.00	-	60.19	60.19	-	1.90	1.90
Weedy check	-	-	-	-	-	-	0.25	0.23	0.24
LSD (P=0.05)	-	-	-	-	-	-	0.22	0.29	-

CONCLUSION

On the basis of two years research it can be concluded that application of imazethapyr XL 10 IPR at 1.0 liter/ha is quite effective in enhancing pod yield and reducing both monocot and dicot weeds in groundnut when applied at 1-2 leaf stage of weeds.

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Effect of drip irrigation, weed and integrated nutrient management on weed and yield parameters of potato

Chandresh Chandrakar, Anjum Ahmad*, Devendra Dewangan and A.P. Singh

Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh 492 012

**Email: anjumagro@gmail.com*

Potato (*Solanum tuberosum*) is the most important food and vegetable cum starch supplying crop of the world. There are several constraints in potato production, of which weeds often pose a serious problem. Hand weeding and hoeing are common practices followed in India. However, timely weed control may not be possible manually due to non-availability of labours and high rate of wages during peak period of farm operations. Hence, chemical weed control appears to hold a great promise in dealing with effective, timely and economic weed suppression. The overall strategy for increasing potato yields and sustaining them at a high level must include an integrated approach to the management of soil nutrients, along with other complementary measures.

METHODOLOGY

The field experiment was conducted at Indira Gandhi Krishi Vishwavidyalaya, Raipur during *Rabi* 2010-11 and 2011-12. The experiment was laid out in split–split plot design with three replications. The treatments consisted of three irrigation schedule, *i.e.* drip irrigation (125% of OPE), drip irrigation (100% of OPE) and control (furrow irrigation) as a main plot and four weed management, *i.e.* weedy check, hand weeding (at 25 and 45 DAP), metribuzin (500 g/ha PE) and chlorimuron + quizalofop (6 + 50 g/ha) at 20 DAP as sub plot and four integrated nutrient management, *i.e.* 100 % RDF, 100 % RDF + Micro nutrient (zinc sulphate 25 kg/ha), 75 % N inorganic fertilizer + 25% N poultry manure + PSB + *Azotobacter* and 50% N inorganic fertilizer + 50%N poultry manure + PSB + *Azotobacter* as sub sub plot. *Kufri Chipsona- 2* variety was used with spacing of 60 X 20cm.

RESULTS

Irrigation schedule positively influenced the yield attributes and yield. The number of stolons/plant, number of tubers /plant and tuber yield were significantly higher under drip irrigation (125% of open pan evaporation) than control (furrow irrigation) but was at par with drip irrigation (100% of open pan evaporation) during both the years and on mean basis. Among weed management practices, the number of stolons/plant, number of tubers /plant and tuber yield were significantly higher under metribuzin (500 g/ha PE) than weedy check and rest of the treatments. Significantly higher yield attributing characters *i.e.* number of stolons, tubers and tuber yield was found under treatment 75% N inorganic fertilizer + 25% N organic (poultry manure) + PSB + *Azotobacter* than other nutrient management practices during both the years and on mean basis. These findings are in agreement with those reported earlier by Arora *et al*. (2009).

Table 1. Effect of drip irrigation, weed management practices and integrated nutrient management on yield attributes of potato crop

Treatment	No. of stolons/plant			No. of tubers/plant			Tuber yield (t/ha)		
	2010-11	2011-12	Mean	2010-11	2011-12	Mean	2010-11	2011-12	Mean
Irrigation schedule									
I_1 – 100% OPE (Open Pan Evaporation)	26.47	29.38	27.91	12.43	15.63	14.03	30.16	31.24	30.59
I_2 – 125% OPE	26.98	29.72	28.35	13.00	16.13	14.57	31.02	32.01	31.49
I_3 – Control (Furrow irrigation)	24.37	26.39	25.37	9.15	11.56	10.35	20.74	21.68	21.21
LSD (P = 0.05)	0.53	1.41	0.66	0.90	0.72	0.78	0.91	0.93	0.92
Weed management									
W_0 – Weedy check	24.44	26.19	25.30	10.14	12.90	11.52	24.81	25.68	25.25
W_1 – Hand weeding at 25 and 45 DAP	26.35	28.88	27.59	12.30	15.04	13.67	28.57	29.48	28.96
W_2 – Metribuzin (500g/ha PE)	26.86	30.83	28.85	12.95	16.28	14.62	29.51	30.60	29.99
W_3 – Chlorimuron (CMS) + Quizalofop (6+50 g/ha) at 20 DAP	26.11	28.10	27.10	10.71	13.54	12.13	26.33	27.47	26.87
LSD (P = 0.05)	0.39	0.74	0.49	0.37	0.43	0.39	0.57	0.59	0.59
Integrated nutrient management									
F_1 – 100% RDF	24.82	27.17	25.97	10.50	13.49	12.00	24.85	25.82	25.30
F_2 - 100% RDF + Micro nutrient (zinc sulphate 25 kg/ha)	25.51	28.11	26.81	10.87	13.82	12.35	26.61	27.63	27.08
F_3 – 75% N Inorganic fertilizer + 25% N Poultry manure + PSB + *Azotobacter*	27.70	30.52	29.11	13.55	16.54	15.05	30.45	31.58	30.96
F_4 – 50% N Inorganic fertilizer + 50% N Poultry manure + PSB + *Azotobacter*	25.73	28.19	26.95	11.18	13.91	12.55	27.31	28.23	27.73
LSD (P=0.05)	0.45	0.69	0.49	0.52	0.49	0.48	0.77	0.75	0.73

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Effect of weed management on nutrient uptake by fenugreek and weeds

S.L. Mundra*, Narendra Singh, M.K. Kaushik and N.S. Solanki

Department of Agronomy, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan 313 001

**Email: sampatmundra@yahoo.in*

Fenugreek (*Trigonella foenum- graecum* L.) is an important legume condiment and seed spice crop grown in India is one of the major producer and exporter in the world. Weeds reduce grain yield of this crop to an extent of 86% (Tripathi and Singh 2008). Weeds are salient competitors of natural and men made resources which could have been otherwise useful for boosting up crop productivity (Singh and Sheoran 2008). Therefore, the crop should be free from weeds during its critical period of competition so as to check the yield losses and to increase the fertilizer use efficiency as well. The present investigation was therefore undertaken to study the extent of nutrient depletion by the crop as well as weeds under various weed management treatments and to minimize these losses by controlling weeds.

METHODOLOGY

A field experiment on weed management in fenugreek was conducted at Instructional Farm of Rajasthan College of Agriculture, Udaipur during *Rabi* 2011 with 12 treatment combinations namely pendimrthalin 1.0 kg/ha PE, pendimethalin 0.75 kg/ha PE without and with hand weeding 40 days after sowing (DAS), metribuzin 0.2 kg /ha PE, metribuzin 0.15 kg/ha PE without and with hand weeding 40 DAS, oxyfluorfen 0.15 kg/ha PE, oxyflourfen 0.1 kg/ha without and with hand weeding 40 DAS , one hand weeding 20 DAS, two hand weeding 20 and 40 DAS and weedy check. The soil of the experimental field was clay loam in texture. These treatments were replicated four times in RBD using variety *RMT-1* with the plot size of 5 x 3.6 m.

RESULTS

All the weed control treatments significantly enhanced the uptake of N and P by the crop compared to weedy check and the highest being recorded under pre-emergence pendimethalin 0.75 kg/ha + one hand weeding 40 DAS closely followed by two hand weeding 20 and 40 DAS which might be ascribed to higher weed control efficiency with these treatments (63.65 and 63.03%, respectively).

Higher weed control efficiency under these treatments resulted in more favourable environment for growth and development of Plants. Contrary, all the weed management treatments significantly reduced the uptake of N and P by the weeds compared to weedy check. The minimum removal of nitrogen (11.68 kg/ha) and phosphorus (1.66 kg/ha) by weeds were observed in pre-emergence pendimethalin 0.75 kg/ ha + One hand weeding 40 DAS closely followed by two hand weeding 20 and 40 DAS while, the maximum removal of nutrients by the weeds was observed under weedy check. The uptake of N and P by the weeds was estimated as 42.4 and 42.8%, respectively of the total removal (weed + crop) in weedy check and only 11.3 and 11.4% in pre-emergence pendimethalin 0.75 kg/ha + one hand weeding 40 DAS and 12.3% each of N and P under two hand weeding treatments, thus saving of 31.1% N and 31.4% P could be obtained by the adoption of pendimethalin 0.75 kg/ ha + one hand weeding 40 DAS while the respective saving of these nutrients under two hand weeding was 30.1 and 30.5%.

Table 1. Nutrient uptake studies in fenugreek under different weed management treatments

Treatment	Nitrogen uptake by crop (kg/ha)	Nitrogen uptake by weeds (kg/ha)	Phosphorus uptake by crop (kg/ha)	Phosphorus uptake by weeds (kg/ha)	Weed control efficiency at harvest (%)
Pendimethalin 1.0 kg/ha	74.71	14.42	10.37	2.08	54.74
Pendimethalin 0.75 kg/ha	67.57	15.55	9.42	2.35	52.78
Pendimethalin 0.75 kg/ha + HW 40 DAS	91.25	11.68	12.95	1.66	63.65
Metribuzin 0.2 kg/ha	68.55	15.20	9.66	2.17	52.70
Metribuzin 0.15kg/ ha	63.69	16.17	8.98	2.42	51.13
Metribuzin 0.15kg/ ha+ HW 40 DAS	79.89	12.36	11.53	1.77	61.71
Oxyfluorofen 0.15 kg/ha	63.88	15.86	8.91	2.35	51.68
Oxyfluorofen 0.15 kg/ha	60.87	16.77	8.44	2.49	49.38
Oxyfluorofen 0.1 kg/ha+ HW 40 DAS	76.05	12.76	10.69	1.87	60.57
One HW 20 DAS	64.78	15.45	9.03	2.17	52.92
Two HW 20 and 40 DAS	84.30	11.87	12.11	1.70	63.02
weedy check	47.98	35.33	6.69	5.0	-
LSD (P=0.05)	8.36	2.12	1.33	0.47	-

CONCLUSION

On medium fertility clay loam soil of Udaipur on the basis of one year data it is found that application of pre emergence pendimethalin 0.75 kg/ha along with one hand weeding 40 DAS found superior to other treatments except two hand weeding in saving of N and P through weeds to the tune of 31.1 and 31.4% respectively compared to weedy check and closely followed by two hand weeding 20 and 40 DAS.

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Effect of herbicides on nutrient uptake by weeds, crops and yield of *kharif* maize

R.K. Sonawane, M.S. Dandge, A.S. Kamble, P.V. Shingrup

Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104

Chemical weed control forms an integral part of modern agriculture. Effective weed control through herbicides curtails nutrient uptake by weeds and provide weed free environment to the crop. Present investigation was undertaken to find out the effect of herbicides on nutrient uptake by weeds as well as maize cultivated in *Kharif* season.

METHODOLOGY

The experiment was conducted during *Kharif* season 2010-2011 in Agronomy farm, Department of Agronomy, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The soil of the experimental field characterized as clayey in texture, slightly alkaline pH (7.87), moderate organic carbon status (0.39%), low available nitrogen (182.80 kg/ha), low available phosphorus content (19.90 kg /ha) and high potassium status (0.33 t/ha). The experiment was laid out in randomized block design replicated thrice. The treatments comprised of Weedy check (T_1), Hand weeding 20 and 40 DAS (T_2), Atrazine 0.75 kg/ha PE (T_3), Atrazine 1.25 kg/ha PE (T_4), Atrazine 0.75 kg / ha PE *fb* 2,4-D 0.5 kg/ha PoE (T_5), Oxydiargyl 0.09 kg/ha PE (T_6) and Oxydiargyl 0.09 kg / ha PE *fb* 2,4-D 0.5 kg / ha PoE (T_7). The maize cultivar used for experiment was Maharaja. Sowing was done by dibbling the seed in rows, marked at a spacing of 45 X 30 cm. The recommended dose of fertilizer, *i.e.* 120:60:60 kg/ha was applied through urea, single super phosphate and murate of potash. The operations were carried out as per the treatments. In treatment T_2, two hand weeding were given at 20 and 40 DAS. The quantity of herbicides required for the gross plot area was calculated as per treatments and sprayed with Knapsack sprayer coupled with flood jet nozzle. The pre-emergence spraying of herbicides atrazine and oxydiargyl was done on the next days after sowing of maize and post emergence herbicides, 2, 4-D was sprayed 40 days after sowing.

RESULTS

The predominant weed species observed were *Commelina benghalensis, Denebraarabica, Cynodon dactylon and Cyperus rotundus* among the monocotyledons and *Euphorbia geniculata, Euphorbia hirta, Physalis minima, Digeraarvensis, Lagascamollis, Acalyphaindica, Phyllanthus niruri and Parthenium hysterophorus* among the di-cotyledons.

The uptake of nitrogen by maize was significantly higher due to the treatment with atrazine 0.75 kg/haPE *fb* 2, 4-D 0.5 kg/ha PoE which was at par with hand weeding. This treatment (T_5) recorded significantly highest uptake of phosphorus and potassium too. Thus the uptake of N, P, K by maize was highest due to atrazine 0.75 kg/ha PE *fb* 2, 4-D 0.5 kg/ha PoE, followed by hand weeding. The crop-weed competition in the weedy check exerted an adverse effect on uptake of nutrients by maize. The increase in yield attributes and fodder yield was mainly due to effective weed control (Singh *et al.* 1998).

Table 1. Total weed population, nutrient uptake by weeds and maize crop, grain yield, fodder yield, Stover yield, Husk yield and grain stover ratio influenced by different treatments.

Treatment	Total weed population (m^2)			Nutrient uptake by weeds (kg/ha)			Nutrient uptake by Maize (kg/ha)			Grain yield (t/ha)	Fodder yield (t/ha)	Stover yield (t/ha)	Husk yield (t/ha)	Grain stover ratio
	15 DAS	60 DAS	At harvest	N	P	K	N	P	K					
T_1- Weedy check	49.33	125.6	75.00	45.52	6.22	29.49	45.11	9.01	35.39	1.91	3.28	1.00	0.19	1.89
T_2- Hand weeding (20, 40 DAS)	48.00	42.00	31.33	16.81	2.31	9.16	72.41	14.48	56.98	3.36	5.50	1.61	0.37	2.07
T_3- Atrazine 0.75 kg /ha PE	33.67	74.67	53.67	32.34	4.73	15.22	61.82	12.58	49.03	2.67	4.60	1.31	0.31	2.02
T_4- Atrazine 1.25 kg /ha PE	24.00	62.67	44.33	26.68	3.68	14.16	68.00	13.56	53.12	2.88	4.96	1.40	0.34	2.05
T_5- Atrazine 0.75 kg/haPE *fb* 2, 4-D 0.5 kg/ha PoE	34.33	46.33	40.33	21.26	2.82	10.14	84.12	16.67	65.06	3.57	6.15	1.69	0.45	2.10
T_6- Oxydiargyl 0.09 kg/ha PE	34.00	62.00	46.33	30.26	4.07	14.67	56.04	11.22	43.83	2.40	4.12	1.25	0.25	1.92
T_7- Oxydiargyl 0.09 kg/ha PE *fb* 2, 4-D 0.5 kg/ha PoE	34.67	53.33	43.33	22.46	3.14	12.88	59.08	11.77	46.21	2.51	4.32	1.30	0.27	1.93
LSD (P=0.05)	6.15	9.22	7.69	7.06	0.82	3.92	11.77	3.39	11.03	0.4	0.6	0.2	0.04	0.13

CONCLUSION

The nutrient uptake by weeds was observed highest in weedy check. Whereas, in maize total nutrient uptake was maximum with atrazine 0.75 kg/ha PE *fb* 2, 4-D 0.5 kg/ha PoE (T_5) and also provide extended weed control through the crop growth period in terms of improving yield contributing characters and consequently recording the highest grain yield/ha.

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Efficacy of cultural practices and herbicides on *Kharif* black gram

Kavita D. Rajput, A.S. Kamble* V.M. Bhale and R.K. Sonawane

Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104

**Email: ashitoshagronomist@gmail.com*

India is one of the known a premier pulse growing country than the other country. Pulses own a strategic position in intensive as well as subsistence agriculture. Black gram (*Phaseolus mungo* L.) is one of the important pulse crop grown in the rainfed farming system throughout India with a production of 13.26 lakh tonnes annually and average productivity of 418.4 kg/ha. Weeds compete with the crop plants more during *Kharif* season for water, plant nutrients, air, space and light and thus adversely affected production if they are not controlled at the time. In case where control of weeds is not possible through cultural and mechanical means, chemical control may be attempted and use of selective herbicides in legumes that can be effective and economical (Yadav *et al.* 1983).

METHODOLOGY

Experimental material consists of thirteen treatments different cultural and herbicidal combinations replicated thrice in. Black gram (var. *TAU*-1) was sown following randomized block design in three replications with 30X10cm spacing during *Kharif* 2010-11 at Agronomy Farm, Department of Agronomy, Dr. PDKV, Akola on clay loam soil. Fertilizer was applied at 20:40:00 NPK kg/ha through urea and diammonium phosphate. Data on weed growth and yield performance were recorded frequently.

RESULTS

Weedy check recorded significantly highest total weed population/m^2 and weed dry weight among all treatments and lowest with weed free treatment. Pre-emergence application of pendimethalin at 1500 g/ha and at 1000 g/ha recorded least total weed population over other treatments. Pre-emergence application of imazethapyr (T_5 and T_6) and pendimethalin (T_7 and T_8) proved significantly superior in minimizing the monocot, dicot and hence the total weeds count. Post-emergence application of quizalofop-p-ethyl at both concentrations fails to show significant effect. The lowest weed biomass (except weed free) was recorded in pre-emergence application of pendimethalin at 1500 g/ha PE and 1000 g/ha PE, followed by quizaiofop-p-ethyl at 75 g/ha PE, 2 hand weeding at 15 and 30 DAS, quizalofop-p-ethyl at 50 g/ha PE and fenoxyprop-p-ethyl at 125 g/ha PE which were at par with each other. These treatments recorded significantly low weed dry matter than post-emergence application of treatment T_{11} and T_{12} and T_4. Maximum weed control efficiency recorded with weed free followed by pendimethalin 1500 g/ha PE as pre-emergence application of pendimethalin at 1.5 kg/ha has higher weed control efficiency of black gram as compared to weedy check . The mild phyto-toxicity effect on plant stand was recorded with Imazethapyr application (T_5, T_6 and T_{13}) by stunting or slight discolouration at10 DAS. As reported by Mishra *et al.* (2004), who reported initial stunted growth and phyto-toxicity to black gram due to Imazethapyr, which recovered 15 days after application.

Table 1. Effect of different cultural practices and herbicides treatments black gram

Treatment	Total weed population (m^2)	Weed dry weight (g/m^2)	Weed control efficiency (%)	Crop photytoxicity score (10 DAA)
T_1 - Weed free	2.39	0.47	97.06	0
T_2 - Weedy check	65.44	15.98	-	-
T_3 - 2 Hand weeding (15 *fb* 30 DAS)	27.40	3.78	76.35	-
T_4 - 2 Hoeing (10 *fb* 20 DAS)	44.00	5.99	62.52	-
T_5 - Imazethapyr at 50 g /ha PE (At sowing)	38.62	5.00	68.71	1
T_6 - Imazethapyr at 75 g/ ha PE (At sowing)	33.10	3.95	75.28	2
T_7 - Pendimethalin at 1000 g /ha PE (At sowing)	19.25	3.05	80.91	0
T_8 - Pendimethalin at 1500 g/ ha PE (At sowing)	15.95	2.01	87.42	0
T_9 - Fenoxyprop-p-ethyl at 100 g /ha POE (15 DAS)	30.70	3.88	75.72	0
T_{10} - Fenoxyprop-p-ethyl at 125 g/ ha POE (15 DAS)	20.60	3.15	80.29	0
T_{11} - Quizalofop-p-ethyl at 50 g/ ha POE (15 DAS)	50.20	10.02	37.30	0
T_{12} - Quizalofop-p-ethyl at 75 g /ha POE (15 DAS)	35.55	4.95	69.02	0
T_{13} - Imazethapyr at 50 g /ha PE *fb* POE Quizalofop-p-ethyl at 50 g/ ha (At sowing *fb* 15 DAS)	47.00	8.80	44.93	1
LSD(P=0.05)	6.75	1.32	-	-

CONCLUSION

Pendimethalin, imazethapyr applied as a pre-emergence and fenoxyprop-p-ethyl applied as post-emergence recorded lower monocot, dicot weed and total weed count and total weed dry weight with maximum weed control efficiency. Application of imazethapyr at 75 g/ha and 50 g/ha as preemergence application caused phyto-toxicity but recovered in later stage of crop growth.

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Herbicidal weed control in green gram in Arid zone of Rajasthan

R.S.Yadav*, S.P.Singh, Vikas Sharma and R.C.Bairwa
AICRP- Weed Control Centre, Agricultural Research Station, SK RAU, Bikaner, Rajasthan 334 006
**Email: rsy.1961 @gmail.com*

Green gram (*Vigna radiata*) is a major pulse crop of arid and semi arid region of Rajasthan. It is a small stature crop and therefore, weeds successfully compete with the crop for moisture, nutrients, and space. Due to scarcity of labors and even high labor cost manual weeding is very difficult even in remote areas (Singh *et al*. 2003). Since herbicidal weed control particularly post - emergence application could be a solution to remove weeds in green gram. However, very little information is available for post- emergence herbicide application in green gram; hence the present investigation was under taken.

MATHODOLOGY

A field experiment was carried out during *Kharif* season of 2013 at SK Rajasthan Agricultural University Farm, Bikaner to test the efficacy of different post –emergence herbicides against weeds.There are ten treatments consisting of imezathapyr at 50 and 70 g/ha, imezathapyr + imazamox (pre –mix) at 60 and 70 g/ha at 20 DAS, imezathapyr + pendimathlin (pre-mix) at 800,900 and 1000 g/ha as pre emergence with pendimethalin at 1.0 kg/ha, weed free and weedy check. The treatments were arranged in randomized block design (RBD) with three replications. Green gram variety *SML 663* was sown with recommended package of practices. Fertilizers were applied uniformly through urea and DAP with 20 kg N and 40 kg P_2O_5/ha. Data on weed growth, yield performance and economics were recorded.

RESULTS

Broad-leaved weeds were pre-dominant (80%), followed by grassy (20%) weeds. *Digera arvensis* among the broad–leaved and *Eragrostis tannela* among the grassy weeds were dominant. Herbicidal treatments significantly influenced the population and dry matter production of weeds. Among the herbicidal treatments, significantly lowest weed density and dry weight was obtained under imezathapyr + pendimathlin (pre-mix) at 800,900 and 1000 g/ha as pre emergence followed by imezathapyr + imazamox (pre –mix) at 60 and 70 g/ha at 20 DAS (Table 1). The lower dose (800 g/ha) of imezathapyr + pendimathlin (pre-mix) were statistical at par with higher doses in controlling weeds. The results further revealed that application of imazethapyr + imazamox at 60 g/ha and imazethapyr alone at 50 g/ha significantly increased the yield attributes and seed yield of green gram compared to weedy check but statistically at par with pendimethalin at 1000 g/ha, the results are in close conformity with the findings of Punia *et al*. (2011). Higher net return (₹ 24,553) and B:C ratio (2.43) was also obtained in imazethapyr + pendimethalin (pre-mix) at 800 g/ha as pre-emergence followed by weed free and imazethapyr + imazamox at 60 g/ha at 2-3 leaf stage.

Table1. Effect of different weed control treatments on weeds, growth, yield and economics of green gram

Treatment	Dose (g/ha)	Weeds/m^2	Weed dry wt. (g/m^2)	Pods/ plant	Seed yield (t/ha)	Straw yield (t/ha)	Net return (x10^3₹/ha)	B:C ratio
Pendimethalin	1000	5.38 (27.94)	31.1	53.2	0.74	1.39	19.51	2.17
Imazethapyr	50	4.49 (19.16)	24.7	54.3	0.75	1.42	20.63	2.27
Imazethapyr	70	3.00 (8.0)	3.87	55.4	0.74	1.41	19.78	2.19
Imazethapyr+ Pendimethalin (Pre-mix)	800	1.33 (0.77)	0.33	62.4	0.85	1.56	24.55	2.43
Imazethapyr+ Pendimethalin (Pre-mix)	900	1.41 (0.99)	0.02	60.5	0.82	1.46	22.76	2.31
Imazethapyr+ Pendimethalin (Pre-mix)	1000	1.24 (0.53)	2.23	59.3	0.81	1.48	22.12	2.26
Imazethapyr+ imazamox (Pre-mix)	60	2.23 (3.97)	9.40	54.6	0.75	1.43	21.06	2.34
Imazethapyr+ imazamox (Pre-mix)	70	1.66 (1.75)	0.90	55.4	0.73	1.40	19.91	2.26
Weed free (hand weeding at 20 and 40 DAS)	-	1.00 (0.0)	0.00	61.4	0.86	1.50	24.13	2.36
Weedy check	-	7.91 (61.57)	49.0	44.6	0.62	1.18	15.61	2.05
LSD(P=0.05)	-	0.68	10.0	6.6	0.035	0.055	-	-

CONCLUSION

It was concluded that pre-emergence application of imazethapyr + pendimethalin (pre-mix) at 800 g/ha was most effective for controlling weeds, increasing grain yield and economics of green gram crop.

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Integrated weed management in mustard

V.S. Hooda*, Ashok Yadav, Samunder Singh and S.S. Punia
Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana 125 004
**E-mail: vshooda79@gmail.com*

Mustard is an important *Rabi* oil seed crop of Haryana. Crop is severely infested by both grassy and broadleaf weeds, particularly under irrigated conditions. Yield losses due to crop-weed competition in rapeseed and mustard have been estimated to the tune of 10-58% (Banga and Yadav 2001 and Malik *et al*. 2012) depending upon the type, intensity and duration of competition. With the increasing demand for food, cost reduction and high intensive management and increasing wages and scarcity of labour, the use of pesticide, particularly herbicides, has been increasing in modern agriculture. Use of a single weed management method is not always helpful for getting higher crop yield. So integration of two or more weed management methods is needed to control the weeds for higher crop yield (Malik *et al*. 2012). Keeping it in view, present investigation was planned to study the efficacy of different herbicides integrating with hand weeding in mustard.

METHODOLOGY

The field experiment was conducted during *Rabi* season of 2011-12 and 2012-13 at Research Farm of Department of Agronomy, CCS Haryana Agricultural University, Hisar. Various treatments included were trifluralin 750 g/ha PPI (pre plant incorporation), trifluralin 750 g/ha PPI + 1 HW (hand weeding) 45 DAS (days after sowing), trifluralin 1000 g/ha PPI, trifluralin 1250 g/ha PPI, pendimethalin 750 g/ha PPI, pendimethalin 750 g/ha PPI + 1 HW 45 DAS, pendimethalin 1000 g/ha PPI, pendimethalin 1250 g/ha PPI, pendimethalin 750 g/ha PRE (pre emergence), pendimethalin 750 g/ha PRE + 1 HW 45 DAS, pendimethalin 1000 g/ha PRE, pendimethalin 1250 g/ha PRE, 1HW 30 DAS, 2 HW 30 and 60 DAS, Weedy and Weed free check. The herbicides were applied in irrigated mustard with flat fan nozzle using 500 liter of water per hectare.

RESULTS

The grain yield and various yield attributes of irrigated mustard were increased when trifluralin (PPI) or pendimethalin (PPI and PRE), each at 750 g/ha integrated with 1 HW at 45 DAS, and these were comparable to the treatment of 2HW (30 and 60 DAS) (Malik *et al*. 2012) and also to the weed free conditions. In mustard, the PPI application of pendimethalin was superior over PRE application; however there were no significant differences in yield (Fig. 1).

CONCLUSION

Integration of one hand weeding at 45 DAS with pendimethalin (PPI & PRE) or trifluralin (PPI), each at 750g/ha, resulted into higher mustard yield comparable to weed free conditions.

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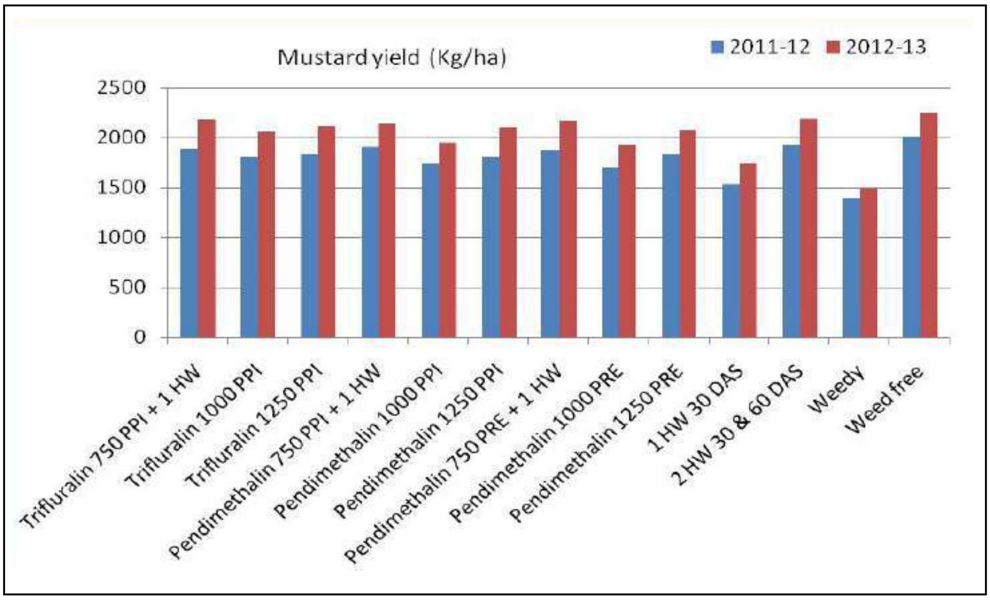

Weed management in fodder and seed production of berseem

Brajkishor Prajapati*, Pravamanjari Giri and Kewalanand

Department of Agronomy, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 263 145

**Email: brajkishorprajapati1@ gmail.com*

Berseem is one of the most important winter forage legume crop grown in India. Weeds reduce the fodder yield because competition for light, moisture, space and nutrient with crop plants. Reduction in yield due to weeds has been reported to be 23.3% by Joshi and Bhilare (2006). Higher weed control efficiency of oxyflourfen + imazethapyr indicated that these herbicides where highly effective in controlling weeds thereby enhancing herbage. Most of the weeds remain uncontrolled due to use of traditional herbicides. In view, it was thought to conduct appropriate study to evaluated new herbicides for safe weed management and performance of berseem under different herbicides.

METHODOLOGY

Keeping the above facts in mind the field experiment was carried out in Forage Agronomy block of Instructional dairy farm (IDF), Nagla, G.B.Pant University of Agriculture & Technology, Pantnagar during winter season of 2011-2012. The experiment site was silty clay loam having soil pH 7.2, organic carbon 0.86%, 278.48 kg / ha nitrogen, 27.80 kg P / ha, and 232 kg K / ha available respectively. The experiment consisted of 10 treatments, *i.e.* T1-weedy check, T2-weed free,T3-one hoeing at 3 week after sowing and one hand weeding 5 weeks after sowing,T4 - pendimethalin at1.0 kg / ha-PPI, T5-pendimethalin at 1.0 kg / ha-PPI + one hand weeding at 5 week after sowing, T6- oxyflourfen at 0.10 kg / ha –PPI, T7-oxyflourfen at 0.10 kg / ha –PPI + one hand weeding at 5 week after sowing, T8- pendimethalin at 1.0 kg / ha + imazethapyr at 0.15 kg / ha (immediate after 1st cut), T9- oxyflourfen at 0.10 kg / ha + imazethapyr at 0.15 kg / ha (immediate after 1st cut), T10-imazethapyr at 0.15 kg / ha (immediate after 1st and 2nd cut) in RBD design with 3 replications. Berssem variety *Mascavi* was sown on November 1, 2011, using 30 kg / ha seed rate at row spacing 20 cm (row to row). Crop was fertilized with 30:60 kg N, P_2O_5 / ha; and cuttings where taken manually with the help of sickle at an interval of 30 days till 6th cut, respectively.

RESULTS

Oxyflourfen at 0.10 kg / ha + imazethapyr at 0.15 kg / ha (immediate after 1st cut) is gave significantly higher mean plant population / row length, mean Green forage yield (55.74 t / ha**)**, mean dry matter yield (8.04 t / ha), mean crude protein yield (1.78 t / ha), mean seed yield (125 kg / ha), lower mean weed index were found among herbicidal treatments.

Table 1. Yield affected by different herbicidal treatments

Treatment	Plant population / m. row length	Green forage yield (t / ha)	Dry matter yield (t / ha)	Crude protein yield (t / ha)	weed index	Seed yield (kg / ha)
Weedy check	38.7	42.97	5.47	1.11	31.06	83
Weed free	49.7	61.14	8.41	1.98	0.00	125
One hoeing at 3 week after sowing & one hand weeding 5 weeks after sowing	51.9	48.16	6.77	1.60	17.63	92
Pendimethalin at 1.0 kg / ha-PPI	41.1	36.29	5.29	1.29	45.40	72
Pendimethalin at 1.0 kg / ha-PPI + one hand weeding at 5 week after sowing	35.7	31.33	4.43	1.06	40.91	90
Oxyflourfenat 0.10 kg / ha –PPI	47.8	46.23	6.69	1.54	25.52	87
Oxyflourfen at 0.10 kg / ha -PPI + one hand weeding at 5 week after sowing	44.7	46.00	6.72	1.71	30.60	95
Pendimethalin at 1.0 kg / ha + imazethapyr at 0.15 kg / ha (immediate after 1st cut)	43.0	38.21	5.38	1.26	41.55	83
Oxyflourfen at 0.10 kg / ha + imazethapyr at 0.15 kg / ha (immediate after 1st cut)	60.4	55.74	8.04	1.78	11.37	125
Imazethapyr at 0.15 kg / ha (immediate after 1st and 2nd cut)	48.5	49.72	6.26	1.50	9.05	95
LSD(P=0.05)	1.33	7.2	4.5	1.53	0.48	0.21

CONCLUSION

On the basis of present investigation it is concluded that oxyflourfen at 0.10 kg / ha + imazethapyr at 0.15 kg / ha (immediate after 1st cut) can be used for chemical weed management in berseem.

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Efficacy of weed control measures on weeds and yield of cluster bean

S.P. Singh*, R.S. Yadav, Vikas Sharma and R.C. Bairwa

AICRP- Weed Control Centre, Agricultural Research Station, SK RAU, Bikaner, Rajasthan 334 006

**Email: spbhakar2010@gmail.com*

Cluster bean (*Cyamopsis tetragonoloba (L.) Taub)* commonly known as guar, is an important drought hardy leguminous crop. Guar is basically a crop that is cultivated mostly in the arid and semiarid areas. Its seeds contain 28-33% gum. Guar is the main raw material for gum industries. Cluster bean is mainly cultivated in marginal and rainfed areas where inadequate weed management is a major constraint in harnessing its production potential. Being a rainy season crop, it suffers badly due to severe competition by mixed weed flora. Yield reduction due to weed infestation is to the tune of 53.7 per cent has been observed (Saxena *et al.* 2004). Hand weeding is a traditional and effective method of weed control. But untimely rains, unavailability of labour at peak time and increasing labour cost are the main limitations of manual weeding. Under such situations, the only alternative that needs to be explored is the use of suitable herbicides which may be effective and economically viable.

METHODOLOGY

A field experiment was carried out during *Kharif* season of 2013 at SK Rajasthan Agricultural University Farm, Bikaner to test the efficacy of different weed control Measures against weeds. There are seven treatments consisting of Imazethapyr 40 g/ha, quizalofop-ethyl 37.5 g/ha, fenoxaprop-p-ethyl 50 g/ha,

imazethapyr + imazamox 40g/ha, pendimethalin 0.75 kg/ha PE, hand weeding twice at 20 and 40 DAS and Weedy check. The treatments were arranged in randomized block design (RBD) with three replications. Cluster bean variety *RGC-1066* was sown with recommended package of practices. Fertilizers were applied uniformly through urea and DAP with 20 kg N and 40kg P_2O_5/ha. Data on weed growth, yield performance and economics were recorded.

RESULTS

The major weed flora of experimental field consisted of *Amaranthus viridis, Gisekia poiedious, Digera arvensis, Cenchrus biflorus, Eragristis pilosa and Eragristis tannela*. Imazethapyr + imazamox (factory mix) 40 g/ha and Imazethapyr alone at 40 g/ha applied at 3-4 leaf stage significantly reduced the density and dry weight of broad leaf weeds in cluster bean as compared to weedy check, however grassy weeds were effectively controlled by quazalfop-ethyl 37.5 g/ha and fenoxaprop-ethyl 50 g/ha than Imazethapyr + imazamox, Imazethapyr alone at 40 g/ha. Density of grassy weeds was lower than broad leaved weeds in the experiment (Table 1). The results further revealed that application of imazethapyr + imazamox at 40 g/ha and Imazethapyr alone at 40 g/ha significantly increased the yield attributes and seed yield and net return of Cluster bean compared to weedy check but statistically at par with pendimethalin at 0.75 g/ha and two hand weedings, the results are in closed conformity with the finding of Punia *et al* (2011). The highest net return and B:C ratio were recorded with the application of 0.75 g/ha pendimethalin as pre emergence.

Table 1. Effect of weed control measures on weeds, yield and economics of Cluster bean

Treatment (*at 3-4 leaf stage)	Weed density (no./m²) (square root transformation)		Weed dry weight (g/m²)		Seed yield (t/ha)	Straw yield (t/ha)	Net return (x10³₹/ha)	B:C ratio
	Broad-leaved	Grassy	Broad-leaved	Grassy				
Imazethapyr 40g/ha*	3.42(10.4)	5.38(27.9)	13.45	9.98	1.19	1.85	39.87	3.33
Quizalofop-ethyl 37.5 g/ha*	5.50(29.2)	1.71(1.9)	77.55	1.10	0.74	1.15	17.85	2.01
Fenoxaprop-p-ethyl 50g/ha*	5.89(33.7)	1.75(2.1)	69.53	1.60	0.86	1.33	23.38	2.32
Imazethapyr +imazamox 40g/ha*	2.34(4.5)	2.95(7.7)	9.28	2.55	1.37	2.12	48.07	3.78
Pendimethalin 0.75kg/ha PE	2.63(5.9)	2.27(4.1)	7.43	1.75	1.47	2.28	52.21	3.90
HW*	1.65(1.72)	2.03(3.1)	2.33	1.20	1.44	2.23	49.34	3.53
Weedy check	8.59(72.8)	5.76(32.2)	84.30	10.63	0.79	1.23	21.48	2.30
LSD(P=0.05)	0.75	0.65	15.85	1.31	0.34	0.53	-	-

*Original values are in parentheses

CONCLUSION

It was concluded that application of imazethapyr 40g/ha, imazethapyr + imazamox (pre –mix) 40g/ha and pendimethalin at 0.75 g/ha were equally effective in controlling weeds, improving grain yield and profitability of Cluster bean.

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Effect of herbicides on soil microbial population in direct seeded rice

Simerjeet Kaur*, Surjit Singh and R.P. Phutela
Department of Agronomy,Punjab Agricultural University, Ludhiana, Punjab 141 004
**Email: simer@pau.edu*

Weeds are the main constraint for farmers practising direct seeding since the inherent weed control from standing water at crop establishment is lost. The chemical weed control through herbicides in direct seeded rice may affect the biological equilibrium of the soil and thus influence the nutrient status, health and productivity of the soil. In present study, effect of applied herbicides on bacteria, actinomycetes and fungi population were analysed.

METHODOLOGY

The experiment was conducted at Students' Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana during *Kharif* 2009. The soil was loamy sand in texture with normal pH and E.C., low in O.C. and available N and medium in available P and K. The crop was sown with drill at 20 cm row to row spacing with seed rate of 35 kg/ha using cv. *PAU 201*. Treatments included pre-emergence herbicides (pendimethalin 750, butachlor 1500, thiobencarb 1500, anilofos 375, pretilachlor 750, oxadiargyl 90 and pyrazosulfuron ethyl 15 g/ha) and unsprayed control in RCBD with 3 replications. All herbicides were applied with back mounted knapsack sprayer fitted with flat fan nozzle using 375 l/ha of water. The recommended dose of phosphorus (30 kg P_2O_5/ha), potassium (30 kg K_2O/ha) and zinc sulphate heptahydrate (62.5 kg/ha) were applied at the time of seedbed preparation. Nitrogen 187.5 kg/ha was applied in four equal splits at 2, 4, 7 and 10 weeks after sowing. Plant protection measures for insect-pest and disease control were taken care of. The composite soil samples were taken at 0 days after spray of pre-emergence herbicides and at harvest. The viable microbial counts were analyzed by the standard technique of serial dilution and pour plating.

RESULTS

The statistically similar viable microbial counts were found in different pre-emergence herbicides and control as shown in Table 1. Numerically higher microbial populations in the herbicidal treatments might be due to healthy and conducive environment for the microorganisms as compared to the control plots. There was increase in the biological properties of the soil in well aerated aerobic soil conditions found in direct seeded rice hence might be ascribed to the improvement in the nutrient status as well as physical conditions of the soil which resulted in better growth of the microorganisms. The microbial population started to regain after the weeds were also killed by the herbicides and got mixed in the soil during this period and these might have served to increase the nutrients. The degradation of herbicides may be serving as carbon source for growth of microbes. There was seasonal variation found in the microbial population observed at different periodical observation as most of the rainfall was received during the vegetative period. Raut *et al*. (1997) found that except for a slight initial suppressing effect for 0-3 days, butachlor stimulated the microbial activity of rice rhizosphere and increased significantly in 30 days. The pesticide degradation in rice fields was favoured by high temperatures which usually stabilize in range favouring high microbial activity and further accelerated by organic matter incorporation. Chen *et al* (2009) reported that microbial activity was suppressed shortly after butachlor application but was augmented after 37 days in both upper and lower soils.

Table 1. Effect of herbicides on microbial population of soil at 0 day after spray of pre-emergence herbicides and at harvest.

Treatment	Dose (g/ha)	Viable counts in soil (cfu/g)							
		At 0 day after spray of herbicides				At harvest			
		Fungi ($\times10^3$)	Actinomycetes ($\times10^4$)	Bacteria ($\times10^6$)	Soil moisture (%)	Fungi ($\times10^3$)	Actinomycetes ($\times10^4$)	Bacteria ($\times10^6$)	Soil moisture (%)
Pendimethalin	750	23.2	16.1	20.7	14.3	12.0	16.7	11.8	9.7
Butachlor	1500	17.8	16.0	17.2	15.3	11.1	14.1	13.0	15.1
Thiobencarb	1500	22.1	16.9	18.2	18.2	10.6	16.2	12.7	12.7
Anilofos	375	21.0	14.6	19.8	17.8	9.1	14.3	13.0	10.9
Pretilachlor	750	24.0	14.0	20.2	12.9	11.2	13.8	11.2	13.4
Oxadiargyl	90	17.1	14.7	17.5	14.5	12.1	12.2	11.2	10.1
Pyrazosulfuron-ethyl	15	20.0	14.3	17.7	13.7	14.5	13.9	11.6	9.1
Unsprayed	-	15.5	13.9	15.8	16.1	9.7	14.9	12.3	10.4
LSD(P=0.05)		NS	NS	NS	-	NS	NS	NS	-

CONCLUSION

The microbial populations in the herbicide treated plots were more or less similar to the unsprayed control plots thus indicating that herbicides have no detrimental effect on soil health at the applied doses.

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Efficacy of herbicides for weed management in *Bt* cotton

A.D. Pandagale*, G.L. Kadam, V.K. Khargkharate and S.S. Rathod
Cotton Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Nanded, Maharashtra 431 604
**Email: arvindpandagale78@gmail.com*

Cotton faces servere weed problem as it is widespaced crop and its growth is slow in initial period. It faces diverse type of weed flora consisting of grasses, sedges and broad leaf weeds. Introduction of new post emergence herbicides may help to have a wide spectrum of weed control and may be an effective tool for specific weed management during labour scaricity. Keeping this in view, the present experiment was undertaken to evaluate the pre-emergence and post emergence herbicides either alone or in combination for effective weed management.

METHODOLOGY

A field experiment was conducted during *Kharif* 2012-13 at Cotton Research Station, Nanded. The site of experimental site was deep black cotton having low N, medium P_2O_5, high K_2O content with neutral pH. Nine weed control treatments were laid out in randomized block design with four replications (Table 1). *Bt* cotton hybrid *NCS 145* was sown at 120 x 45 cm spacing on July 16th, 2012. Experiment was conducted under rainfed condition and rainfall 549 mm was received during the season. One hoeing was done at 9 WAS in all treatments except weedy check.

RESULTS

Directed spray of Glyphosate 1.0 kg/ha at 30-45 DAS was on par with weed free check for monocot and dicot weed count as well as weed dry matter at 9 WAS. Among the selective herbicides, pyrithiobac-Na 62.5 g/ha PoE + quizalofop-ethyl 50 g/ha PoE was found to be effective to reduce weed dynamics which controlled dicot as well as monocot weeds effectively. The treatments pendimethalin PE, quizalofop-ethyl PoE and pyrithiobac-Na PoE either alone or in combination were found effective to increase seed cotton yield. Directed spray of glyphosate was equally effective as weed free check. Ali *et al.* (2005) reported that Round Up 490 g/L in combination with inter-culturing provided 93% broad leaf weeds and 80% narrow leave weeds control over untreated check. Among selective weedicides, pyrithiobac-Na post emergence had better weed control efficiency against dicot weeds as well as monocot weed. Wilicut (1996) reported reduction in yellow and purple nutsedge shoot number, shoot regrowth, and root-tuber dry weight due to pyrithiobac-Na.

Table 1. Seed cotton yield, weed dynamics and weed control efficiency as influenced by different treatments

Treatment	Seed cotton yield (t/ha)	Weed count at 9 WAS		Weed dry matter at 9 WAS		Weed control efficiency (%) at 9 WAS	
		Monocot	Dicot	Monocot	Dicot	Monocot	Dicot
Pendimethalin1.0 kg/ha as PE	1.20	14.25 (3.83)	14.25 (3.83)	8.53 (2.99)	14.25 (3.83)	69.49	57.03
Trifluralin 1.2 kg/ha as PPI + one hoeing	1.10	30.25 (5.54)	28.50 (5.38)	11.75 (3.48)	16.50 (4.19)	57.64	50.46
Quizalofop-ethyl 50 g/ha at 2-4 weed leaf stage	0.94	37.75 (6.81)	78.75 (8.90)	16.75 (4.15)	23.88 (4.94)	39.43	28.35
Pendimethalin 1.0 kg/ha as PE + quizalofop-ethyl 50 g/ha	1.22	18.5 (4.35)	52.00 (4.23)	9.13 (3.09)	14.63 (3.87)	66.76	56.00
Pyrithiobac-Na 62.5 g/ha 20-30 DAS	1.25	10.25 (3.27)	14.50 (3.87)	7.13 (2.76)	8.88 (3.05)	74.14	73.80
Pyrithiobac-Na 62.5 g/ha + quizalofop-ethyl 50 g/ha	1.29	7.00 (2.73)	13.50 (3.73)	6.63 (2.67)	8.63 (3.02)	75.95	74.45
Glyphosate 1.0 kg/ha as directed spray at 45 DAS	1.31	6.50 (2.64)	7.50 (2.81)	3.63 (2.02)	4.25 (2.18)	86.64	87.37
Weed free check	1.38	4.50 (2.22)	6.50 (2.64)	3.13 (1.90)	2.75 (1.80)	88.90	91.93
Weedy check	0.46	76.00 (8.74)	110.7 (10.50)	28.13 (5.34)	33.88 (5.85)	0.00	0.00
LSD (P=0.05)	0.18	0.44	0.54	0.40	0.39	-	-
Grand mean	1.13	4.39	5.44	3.15	3.63	62.11	57.71

* Figures in paranthesis are $\sqrt{x+0.5}$ transformed values

CONCLUSION

Among weedicide treatments, directed spray of glyphosate 1.0 kg/ha at 30-45 DAS was profitable for higher seed cotton yield and lower weed dynamics followed by pyrithiobac-Na 62.5 g/ha 20-30 DAS + quizalofop-ethyl 50 g/ha at 2-4 weed leaf stage + one hoeing.

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Weed management in *Bt* cotton based intercropping system by stale seedbed technique

V.K. Khargkharate*, A.D. Pandagale, G.L. Kadam, and S.S. Rathod
Cotton Research Station, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Nanded, Maharashtra 431 604
**Email: vilaskhargkharate@gmail.com*

Cotton being a wide spaced and relatively slow growing crop during its initial stages is very sensitive to weed competition. Many a times, timely weed management practices can't be undertaken due to continuous rainfall and labour shortage at initial growing stage. Depletion of weed seed bank will result to lower weed menance during the crop growth. The stale seedbed technique is a weed management practice in which weed seeds just below the soil surface are allowed germinate and then killed prior to planting (Buehring *et al*. 2006). Hence, present experiment was conducted to evaluate weed control efficiency and economics of either selective, non selective or combination of weedicides in cotton + green gram intercropping system.

METHODOLOGY

Field experiment was conducted during *Kharif* 2010-11 at Cotton Research Station, Nanded. Six treatments were evaluated in randomized block desing with four replications (Table-1). The sowing of cotton was done on in vertisol with low nitrogen, medium P_2O_5 and high K_2O. Stale seed beds were prepared using weedicides one week after irrigation and one week before sowing as per treatements. One hand weeding was followed in all treatments at 35 DAS. Weed control was evaluated in terms of dry matter reduction and weed control efficiency.

RESULTS

Weed control by stale seedbed using paraquat 1.0 kg/ha + pendimethalin 1.0 kg/ha (spraying herbicide mixture once one week after the irrigation and one week before sowing was on par to hand removal of germinated weeds for seed cotton yield, green gram yield and seed cotton equivalent yield.

Stale seedbed using weedicides was not comparable to lower number of weeds and its dry matter with hand removal of weeds. However, stale seed bed using paraquat 1.0 kg/ha alone or in combination with pendimethalin were statistically effective for minimizing weed count and dry matter over Pre-emergence application of pendimethalin and unweeded check. Preparation of stale seedbeed by using combination of paraquat 1.0 kg/ha + pendimethalin 1.0 kg/ha followed by one hand weeding had reduced weed index (6.75%) and improved weed control efficiency (90.17%) at six weeks after sowing.

Table 1. Seed cotton yield, intercrop yield, seed cotton equivalent yield, weed dynamics, weed index and weed control efficiency as influenced by different treatments

Treatment	Seed cotton yield (t/ha)	Green gram yield (t/ha)	Seed cotton equivalent yield (t/ha)	Weed count at 6 WAS (no./m^2)	Weed dry matter at 6 WAS (g/m^2)	Weed index (%)	Weed control efficiency (%) at 6 WAS
Stale seed bed – paraquat 1kg/ha	1.60	0.67	2.05	12	5.38	13.52	85.89
Stale seed bed technique using pendimethalin 1.5 kg/ha	1.35	0.53	1.71	15	9.38	26.79	75.40
Stale seed bed - paraquat 1.0 kg/ha + pendimethalin 1.0 kg/ha	1.72	0.69	2.18	8.25	3.75	6.74	90.17
PE pendimethalin 1.5 kg/ha *fb* HW	1.27	0.40	1.54	20	10.38	30.99	72.78
Removal of germinated weeds One week after irrigation *fb* HW	1.84	0.76	2.35	3.75	2.93	-	92.32
Unweeded check	0.68	0.26	0.86	65	38.13	62.99	-
LSD (P=0.05)	0.27	0.13	0.31	6.59	8.84	-	-
Grand mean	1.41	0.55	1.78	20.67	11.65	23.51	69.43

CONCLUSION

Weed control by stale seed bed using paraquat 1.0 kg/ha+ pendimethalin 1.0 kg/ha followed by ne hand weeding reduced weed count, weed dry matter and weed index. The increased weed control efficiency resulted to higher cotton equivalent yield in cotton + green gram intercropping system.

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Evaluation of pre and post emergence herbicides in chickpea

P.V. Patil, A.K. Gore and S.M. Gobade

College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharahtra 431 402

Chickpea, being slow in its early growth and short stature plant, is highly susceptible to weed competition and often considerable losses may occur if weeds are not controlled at proper time. Weeds are serious constraint to increase production and easy harvesting in chickpea. Yield losses as due to weeds were observed to vary between 40-90 per cent Hand weeding is practiced in traditional production areas, but is impractical in the extensive production areas. Hand weeding is labour-intensive and therefore an expensive operation when done by hired labour and, if delayed, the operation does not prevent adverse effect of the weeds on crop yield. The use of appropriate herbicides can eliminate this early weed competition and prevent yield losses Herbicides are selective, cost effective, easy to apply, and offer flexibility in application time. (Hoseiny *et al.* 2011).

METHODOLOGY

A field experiments were conducted at PG research farm of Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Rabi* 2011-12 to find out the effective and economical weed control methods in chickpea the experiment was conducted on vertisols, in a randomized block design with eleven treatments four pre emergence herbicides. The gross and net plot sizes were 5.4 x 4.5 m and 4.5 x 3.6 m, respectively. The seeds of variety Vijay were sown by dibbling method at spacing 45 x 10 cm.

RESULTS

Number of pods/plant were found significantly improved with Weed free treatment and it was followed by the application of 1 Hoeing (30 DAS) + (2 hand weedings), Mechanical weedings (2 HWs) and Pendimethalin (PE) 0.75 kg/ha. This might be due to less crop-weed competition through out the growing period of crop. Moreover due to less competition for nutrients, moisture, sunlight, it resulted into strengthening of individual plants and later on it was reflected in improving various yield attributing characters in above treatments.

The treatment Weed free (weeding at 20 days interval up to 80-90 DAS) recorded highest grain yield, straw yield and biological yield. It was followed by application of 1 Hoeing (30 DAS) + (2 hand weedings), Mechanical weedings (2 hand weedings) and Pendamethalin (PE) 0.75 kg/ha. Weedy check recorded the lowest grain and straw yield. Thus the effective weed control achieved in the earlier mentioned treatments resulted in enhancing various growth and yield attributing characters of chickpea and finally gave significantly higher grain and straw yield over Weedy check. Low yield in Weedy check may be due to poor root growth and higher weed population could have competed with chickpea crop for space, water and nutrients, there by adversely affecting grain and straw yield, Similar trend was observed Ratnum *et al* (2011).

Table 1. Effect of different weed management treatments on yield and yield attributing characters, weed control efficiency, weed index and B:C ratio of chickpea.

Treatment	Number of pods/plant	Grain yield (t/ha)	Weed control efficiency at harvest (%)		Weed index at harvest (%)	B:C ratio
			Monocot	Dicot		
Pendimethalin (PE) 0.75 kg/ha	80.80	2.79	69.76	76.14	6.04	3.64
Trifluralin (PE) 1.0 kg/ha	79.26	2.45	63.67	75.73	17.67	3.23
Metribuzin (PE) 0.75 kg/ha	73.00	2.01	73.24	75.44	32.45	2.72
Oxyfluorfen (PE) 0.125 kg/ha	74.06	2.22	68.02	74.81	25.30	3.08
Mechanical weedings (2 hand weedings)	81.93	2.81	74.71	76.89	5.47	3.40
Imazethapyr (POE) 0.75 kg/ha	73.66	2.15	74.44	74.40	27.65	2.86
Quizalofop-p-ethyl (POE) 40 kg/ha	78.26	2.43	76.98	73.19	18.17	3.23
Propaquizafop (POE) 0.75 kg/ha	74.60	2.39	76.92	50.89	19.55	3.12
1 Hoeing (30DAS) + (2 hand weedings)	83.13	2.95	78.72	82.09	0.87	3.33
Weed free (weeding at 20 days interval up to 80-90 DAS)	84.13	2.97	85.35	85.09	-	3.10
Weedy check	71.20	1.54	0.0	0.0	48.25	2.17
LSD (P=0.05)	3.40	0.41	--	--	--	0.38

In general among all the weed control treatments weed free recorded highest weed control efficiency at all the growth stages for dicot as well as monocot weeds. Among herbicidal treatments it was highest in Pendimethalin (PE) 0.75 kg/ha for dicot weeds and in Quizalofop-p-ethyl (POE) 40 g/ha for monocot weeds at all the stages of observations. These results are in conformity with the findings of Ratnam *et al.* (2011).

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Effect of different seed rate and weed management practices on yield and economics of direct seeded rice

Rakesh Kumar*, A.P. Singh, M.R. Meshram, Pravir Pandey and Devidas Ransing

Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh 492 012

**Email: rakeshunforgetable@gmail.com*

Rice (Oryza *sativa* L.) has the distribution of being the most extensively cultivated crop in the world and important staple food of more than 60% of the world population. India is second largest producer of rice after China and has an area of over 45.5 m ha with production of 105.31 m t and average productivity is 2393 kg/ha of rice in 2012. Weeds, being a serious negative factor in crop production are responsible for reduction on yield of rice (*Oryza sativa* L.) and weed management is considered as a positive factor in trapping the production potential. For control of weeds, several methods have been tried in the past with varying degree of success, which include hand hoeing, intercropping etc. are the environmentally safe and more effective practices of weed removal in cereals. These practices have certain limitations like non-availability of labours at right time and higher wages. Under such situation, the use of selective herbicides may provide more effective and economical control of weeds as compared to manual weeding.

METHODOLOGY

The experiment investigation was carried out at the Instructional-cum-Research Farm of IGKV, Raipur during *kharif* season of 2011, in split plot design with three replications. The four main plots consisting of weed management practices and four sub-plots consisting of different seed rates. The treatments consisted in main plots are fenoxaprop 60 g/ha + ethoxysulfuron 15 g/ha, PoE, at 23 DAS + one hand weeding at 35 DAS (M1), fenoxaprop 60 g/ha + ethoxysulfuron 15 g/ha, PoE, at 18 DAS *fb* bispyribac-Na 20 g/ha at 35 DAS (M2), Hand weeding twice at 18-20 and 35 DAS (M3) and control (M4) and the treatments consisted in sub-plots are 20 kg/ha (S1), 30 kg/ha (S2), 40 Kg/ha (S3) and 80 kg/ha (S4) seeding rate. Rice variety *MTU-1010* was grown as test crop with row to row spacing of 20 cms. The total rainfall of 1216.3 and 1382.1 mm were received during *Kharif* 2011 and the average maximum temperature for different months varied from 29.80^{o}C to 32.00^{o}C, while monthly average minimum temperature ranged between 18.40^{o}C to 25.12^{o}C. The observation on yield attributes, yield, weed density and economics were recorded, computed and were subjected to statistical analysis.

RESULTS

Plant height increased with the advancement of crop age. Among weed management practices, maximum plant height was observed under the treatment of hand weeding twice (M3) closely followed by fenoxaprop 60 g/ha + ethoxysulfuron 15 g/ha, PoE, *fb* bispyribac-Na 20 g/ha (M2) and were significantly superior. Among seeding rates, it was recorded maximum under seeding rate of 80 kg/ha (S4) followed by 40 kg/ha (S3) and 30 kg/ha (S2), respectively. The results also revealed that the number of filled grains /panicle was observed highest under the application of fenoxaprop 60 g/ha + ethoxysulfuron 15 g/ha, at 18 DAS *fb* bispyribac-Na 20 g/ha at 35 DAS (M2) and this was followed by hand weeding twice (M3). The seed yield (5.22 t/ha), and straw yield and net monetary return were also observed to be the maximum in the above treatment. However, among different seeding rate treatments, the results indicated that yield attributes, *viz.* number of filled grains/panicle seeding rate of 20 kg ha (S1), however, the highest seed yield (4.54 t/ha) and straw yield were recorded under 80 kg/ha (S4) but, it was found to be at par to 40 kg/ha (S3) and 30 kg/ha (S2). The yield difference between 80 kg/ha to 40 kg/ha is hardly 1.67% and 80 kg/ha to 30 kg/ha 6.50% yield difference despite of difference of more than double as far as seed rate is concern.

CONCLUSION

Studies on various weed management and seed rates reveals that, though, the highest seed yield, net return and B:C ratio were obtained under the application of fenoxaprop 60 g/ha + ethoxysulfuron 15 g/ha, at 18 DAS *fb* bispyribac-Na 20 g/ha at 35 DAS (M2) and 80 kg/ha seed, but with very meager margin over 40 and 30 kg/ha *i.e.* 1.67 and 6.5% in seed yield, 1.85 and 8.76% in net return, respectively, whereas, quantity of seed under 80 kg/ha was 50 and 62.5% higher over 40 and 30 kg/ha .

Treatment	Numbers of effective tillers (/m^2)	Number of filled grains /panicle	Seed yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (x10^3₹/ha)	Net return (x10^3₹/ha)
M1- PoE application of fenoxaprop 60 g/ha, + ethoxysulfuron 15 g/ha, at 23 DAS + hand weeding at 35 DAS	333.2	60.3	4.72	5.94	17.21	38.36
M2- Post-emergence application of fenoxaprop 60 g/ha + ethoxysulfuron 15 g/ha, at 18 DAS *fb* bispirybac-Na 20 g/ha at 35 DAS	342.7	66.4	5.22	6.53	15.75	45.69
M3-Hand Weeding at 18-20 and 35 DAS	338.5	64.0	5.20	6.37	20.50	40.48
M4-Control	227.9	40.3	1.93	2.53	13.90	8.93
LSD (P=0.05)	14.9	7.5	0.36	0.48		
S1-20 kg/ha	256.0	60.3	3.81	4.62	16.61	28.13
S2-30 kg/ha	296.8	59.1	4.25	5.26	16.71	33.21
S3-40 Kg/ha	338.8	56.3	4.47	5.59	16.81	35.73
S4-80 Kg/ha	350.7	55.3	4.54	5.89	17.21	36.40
LSD (P=0.05)	11.00	NS	0.32	0.24		

Efficacy of post-emergence herbicides in soybean

A.K. Gore*, D.A. Kulal, S.R. Kadam
Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra 431 401
**Email: kswati7807@yahoo.com*

The productivity of soybean (*Glycine max*) in Marathwada region is found low as compared to Maharashtra state. One of the limiting factors for low yield was found to be weed competition. The reduction in the yield due to weed varies from 35 to 50 per cent, depending upon the type of weeds, their intensity and time of crop weed competition (Chandel *et al.* 1995). The effectiveness and economic weed control may not be possible through manual or mechanical means due to heavy and continuous rainfall in *Kharif,* labour shortages, declining efficiency under uncongenial conditions and high wages. Therefore, considering critical crop-weed competition period in soybean in addition to above problems several pre-emergence herbicides have seen recommended controlling weeds. Post emergence herbicides may be applied as per need of time and place saving time, money and labour. Therefore, there is need of testing new post emergent herbicides which have broader spectrum of activity. Recently, some new post emergent herbicides have been released in India and weed evaluation for field use. The present investigation was undertaken to find out suitable effective post-emergence herbicides for weed control in soybean.

METHODOLOGY

A field experiment was conducted during *Kharif* of 2010-11 at Agronomy farm, college of Agriculture, Parbhani. The soil of the experimental site was black , clayey in texture and neutral in reaction (pH 7.72). It was medium in available nitrogen (207.13 kg/ha), phosphorus (14.55 kg/ha) and high in available potassium (666.40 kg/ha). Twelve treatments were tested under randomised block design with three replications (Table 1). Soybean variety *MAUS-71* was sown on July 8, 2010 in line at 45 cm row to row and 5 cm plant to plant distance to a depth about 2.5 to 3.5 cm and covered with moist soil and fertilized with 30:60:30 kg N, P_2O_5 and K_2O/ha with urea, single super phosphate, murate of potash, respectively. The total rainfall received during the field experimentation was 1120 mm and was well distributed pattern in 50 rainy days. The percentage of weed flora was estimated from weedy check plot. Weed control efficiency (WCE) was estimated by the formula given by Mani *et al.* (1973).

RESULTS

The major weed flora in the experimental field comprised of *Phylanthus medraspetansis,Acalypha indica, Euphorbia geniculata, Leagaceae mollis, Cynadon dactylon, Brachiria eruciformis, Dinebra retraflexa, Cyperus rotundus L.* All the weed control treatments significantly reduced the dry weight of weed when compared with weedy check . Among the herbicide application weed free check recorded lowest dry weight (monocot and dicot) and found significantly lower than rest of treatments. Among herbicides, pendamethalin PE 750 g/ha + 1 HW and imazethapyr POE 75 g/ha were found efficient to manage both type of weeds. Different weed control treatments in respect of seed yield differs significantly (Table 2). The treatment weed free check (2 HW + 2 Hoeing 3rd and 5th WAS) recorded highest seed yield /ha. However, it was at par with treatment pendimethalin PE 750 g/ha +1 HW at 30 DAS and imazethapyr POE 75g/ha at 21 DAS and tank mix quizalfop- ethyl POE 40 g/ha + chlorimuron-ethyl POE 12 g/ha at 20 DAS significantly superior over rest of the treatments. The lowest straw yield (2.70 t/ha) was observed in weedy check treatment because the straw yield varied materially due to weed control treatments.

Table 1. Influence of herbicides on yield attributing characters of seed and straw yield of soybean.

Treatment	Number of pods/plant (at harvest)	100 Seed weight (g)	Seed yield (t/ha)	Straw yield (t/ha)
Trifluraline POE 125 g/ha at 15 DAS	33.9	11.4	2.32	3.08
Trifluraline POE 150 g/ha at 15 DAS	35.0	11.4	2.36	3.28
Propaquizafop POE 625 g/ha at 10-12 DAS	30.6	11.0	2.30	3.01
Fenaxaprop-P-ethyl POE 12 g/ha 10-12 DAS	31.6	11.0	2.33	2.91
Chlorimuron-ethyl POE 40 g/ha at 10-12 DAS	35.0	11.5	2.44	3.19
quizalofop-ethyl POE 40 g/ha at 10-12 DAS	36.1	11.1	2.47	3.13
Tank mix (quizalofop-ethyl POE 40 g/ha + chlorimuron-ethyl POE 12 g/ha) at 20 DAS	37.1	11.9	2.69	3.33
Imazethapyr POE 75 g/ha at 21 DAS	38.3	12.1	2.70	3.42
Pendimethaline PE 750 g/ha + 1 HW at 30 DAS	38.7	12.5	2.82	3.50
Weeed free check (2 HW + 2 Hoeing) at 3rd and 5th WAS	40.6	13.5	2.89	3.57
Farmers practice (1 HW + 1 Hoeing) at 30 DAS	37.0	11.8	2.51	3.30
Weedy check	28.6	10.3	1.75	2.70
LSD (P=0.05)	2.4	NS	0.26	0.15

CONCLUSION

From above table it is proved that pendimethalin PE 750 g/ha + one HW at 30 DAS or imazethapyr PoE i 75 g/ha at 21 DAS or tank mixture of (quizalofop-ethyl POE 40 g/ha + chloriumuron-ethyl POE 12 g/ha) at 20 DAS can be used to control weeds effectively and economically to get higher seed yield of soybean without any phytotoxic effects.

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Effect of metsulfuron methyl on microbial population of wheat rhizosphere

Vikas Sharma*, R.S. Yadav, S.P. Singh and R.C. Bairwa
AICRP on Weed Control Centre, Agricultural Research Station, SK RAU Bikaner, Rajasthan 334 006
**Email: vikas.sharma2407@gmail.com*

A wide variety of pesticides are used in modern agriculture, even though the long-term environmental impact of their widespread application is unknown. Therefore, if prevailing agricultural practices are to be ecologically sustainable, the future and impact of herbicides in agricultural soils must be monitored and studied. Herbicides are biologically active compounds and their application may lead to significant changes in the populations of microorganisms and their activities also influence the microbial ecological balance in the soil as well as affecting the productivity of soils. The addition of herbicides can cause qualitative and quantitative alterations in the soil microbial populations and their enzyme activities. Herbicide application may also kill species of bacteria, fungi and protozoa that combat disease causing microorganisms, thereby upsetting the balance of pathogens and beneficial organisms and allowing the opportunist, disease causing organisms to become a problem (Zhang *et al.* 2010). Considering this the study was conducted to study the effects of metsulfuron-methyl, a sulfonylurea herbicide, on the wheat soil microorganisms at Agricultural Research Station, Bikaner.

METHODOLOGY

The population of total heterotrophic bacteria and fungi was counted using serial dilution and plating technique. Nutrient agar medium was used for count of total heterotrophic bacteria. The population of fungi was estimated on Martin's Rose Bengal agar medium with 1.25 g of streptomycin and 0.033 g of Rose Bengal in a litre of the medium. After allowing for development of discrete bacterial colonies during incubations under suitable conditions, the colonies were counted and the number of viable bacteria [expressed as colony forming units (CFU)] per gram dry weight of soil was estimated by taking into account the soil dilutions.

RESULTS

Microbiological studies revealed that in wheat, the highest total bacterial count was recorded in the treatment mechanical weeding at 25 and 50 DAS and the lowest total count was observed in the treatment metsulfuron-methyl 4 g/ha treated plots in all three stages of the crop indicating slight decrease in bacterial population by metsulfuron application (Table 1). At harvest, the total bacterial count in two hand weeding and weedy check treatments were at par to each other (42.3 x 10^6 and 39.6x10^6 CFU respectively) but it was almost double than the other two treatments. In total fungal count at 10 DAS, it was recorded highest in the treatment metsulfuron-methyl 4 g/ha + MW 50 DAS (35.8 x 10^4 CFU) and lowest in two manual weeding at 25 and 50 DAS (22.6x10^4 CFU). At harvesting fungal population was recorded at par in the treatments viz. two manual weeding and metsulfuron-methyl 4 g/ha + manual weeding 50DAS (40.2 x10^4 and 37.3x10^4 CFU respectively) showing no considerable effect of the herbicide on fungal population. These results are in confirmation with the results of He *et al*. 2006.

Table 1. Effect of different control treatments on microbial population in wheat

Treatment	Bacteria (x10^6 CFU)			Fungi (x10^4 CFU)		
	10 DAS	30 DAS	Harvest	10 DAS	30 DAS	Harvest
Weedy check	25.8	35.4	39.6	27.0	34.8	33.7
Mechanical weeding at 25 and 50 DAS	28.7	26.9	42.3	22.6	38.1	40.2
Metsulfuron-methyl 4 g/ha 30 DAS	13.8	14.4	21.7	33.5	14.0	32.0
Metsulfuron- methyl 4 g/ha *fb* MW 50DAS	17.5	19.0	23.7	35.8	25.8	37.3

CONCLUSION

It was concluded that post-emergence application metsulfuron-methyl 4 g/ha followed by one mechanical weeding at 50 DAS in wheat was having least effect on microbial population in the soil.

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Economics of different herbicides in chickpea

A.K. Gore*, K.C. Pedde, P.V. Patil, S.M. Gobade

College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharahtra 431 402

**Email: kswati7807@yahoo.com*

Chickpea (*Cicer arietinum* L.) is one of the most important pulse crop grown in the rainfed farming system throughout India. It is highly susceptible to weed competition and often considerable losses may occur if weeds are not controlled at proper time. Weeds are serious constraint to increase production and easy harvesting in chickpea. Yield losses as due to weeds were observed to vary between 40-90%. Hand weeding is practiced in traditional production areas, but it is impractical in the extensive production areas. Hand weeding is labour-intensive and, therefore, an expensive operation when done by hired labour and, if delayed, the operation does not prevent adverse effect of the weeds on crop yield. The use of appropriate herbicides can eliminate this early weed competition and prevent yield losses Herbicides are selective, cost effective, easy to apply, and offer flexibility in application time. (Peterson *et al*. 2001 and Hoseiny *et al.* 2011).

METHODOLOGY

A field experiments were conducted at PG research farm of Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani during *Rabi* 2010-11. It was conducted on vertisols, in a randomized block design with nine treatments replicated three times (Table 1). The gross and net plot sizes were 5.4 x 4.5 m and 4.5 x 3.6 m, respectively. The seeds of variety *Vijay* were sown by dibbling method at spacing 45 x 10 cm. Observations on growth, weed parameter were recorded periodically at an interval of 30 days. Whereas the observation on yield attributing characters and yield were recorded at harvest.

RESULTS

Weight of pods per plant, number of seeds per pod, number of seeds per plant and 100 grain weight were found significantly improved with weed free treatment and it was followed by the application of 1 hoeing (30 DAS) + 2 hand weeding (HW), mechanical weeding (2 HW) and pendamethalin (PE) 0.75 kg/ha. The treatment weed free (weeding at 20 days up to 80-90 DAS) recorded highest seed yield, bhoosa yield and biological yield. It was followed by application of 1 hoeing (30 DAS) + 2 HW, mechanical weeding (2 HW) and pendamethalin (PE) 0.75 kg/ha. Weedy check recorded the lowest grain and bhoosa yield. Thus the effective weed control achieved in the earlier mentioned treatments resulted in enhancing various growths and yield attributing characters of chickpea and finally gave significantly higher grain and straw yield over weedy check. Low yield in weedy check may be due to poor root growth and higher weed population could have competed with chickpea crop for space, water and nutrients, there by adversely affecting grain and straw yield. Application of trifluralin (PE) 1.0 kg/ha recorded highest harvest index. It was followed by weed free treatment. Maximum gross monetary returns were observed in weed free treatment because growth of crop was favored in better partitioning of assimilates and their relative accumulation which finally results into higher yields. While highest net monetary returns and B:C ratios were recorded with the application of pendimethalin 0.75 kg/ha may be due to higher yield and comparatively lower cost of cultivation as compared to weed free treatment.

Table 1. Economics of chickpea cultivation as influenced by various treatments

Treatment	Grain yield (t/ha)	Bhoosa yield (t/ha)	Biological yield (t/ha)	Harvest index (%)	Gross monetary returns (x10³₹/ha)	Cost of cultivation (x10³₹/ha)	Net monetary returns (x10³₹/ha)	B:C ratio
Pendimethalin 0.75 kg/ha (PE)	2.17	2.43	4.64	46.6	49.91	15.46	34.45	3.20
Trifluralin 1.0 kg/ha (PE)	1.65	1.95	3.60	45.8	39.98	14.94	25.04	2.67
Imazethapyr 0.75 kg/ha (POE)	1.59	1.87	3.29	48.6	38.83	14.54	24.09	2.67
Quizalofop-p-ethyl 40 g/ha (POE)	1.70	1.90	3.50	48.5	40.10	14.52	25.59	2.76
Propaquizafop 0.75 kg/ha (POE)	1.64	1.85	3.31	49.6	39.93	14.52	25.40	2.74
1 Hoeing (30DAS) + (2 HW)	2.26	2.44	4.84	46.6	54.64	21.04	33.60	2.59
Mechanical weeding (2 HW)	2.24	2.52	4.81	48.7	53.28	20.44	33.18	2.60
Weed free (weeding at 20 days up to 80-90 DAS)	2.33	2.47	4.99	46.6	56.44	27.44	29.00	2.05
Weedy check	1.51	1.84	3.26	46.3	36.98	13.44	23.54	2.75
LSD (P=0.05)	0.24	0.40	0.51	-	5.42	-	3.74	-
General mean	1.90	2.12	4.00	-	45.56	17.37	28.19	2.67

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Efficacy of bispyribac-sodium against weeds in transplanted rice

Priya Singh[1]*, Anay Rawat[1], V.P. Singh[2] and M.K. Tarwariya[1]
[1]Department of Agronomy, JNKVV; [2]DWSR, Jabalpur, Madhya Pradesh 482004
**Email: Chauhanpriyasingh1804@gmail.com*

Rice (*Oriza sativa* L.) being a major food crop of Madhya Pradesh is cultivated on 1.68 million ha with production of 1.56 million tones (Anonymous 2009). Weeds are a major cause of yield reduction in rice. Transplanted rice (*Oriza sativa* L.) is infested with heterogeneous group of weeds consisting of grassy, broad-leaved and sedges. Competition of weeds brought about 15-76% reduction in grain yield of rice (Mishra 1997). Effective control of these weeds had increased the grain yield by 85.8% (Mukherjee and Singh 2004). Bispyribac-Na is new herbicide, known to be effective against many annual and perennial grasses, sedges and broad-leaved weeds in rice (Yadav *et al.* 2009). Pre–emergence herbicides available for weed control is no so effective. Hence, the present investigation was carried out to test the bio-efficacy of bispyribac-Na against complex weed flora of transplanted rice.

METHODOLOGY

A field experiment was conducted during the *Kharif* season of 2010 under edaphic and climatic condition of Jabalpur (M.P.) at Agronomy Research Farm, Krishi Nagar, Adhartal, JNKVV, Jabalpur. The experiment was laid out in randomized block design with nine treatments replicated thrice. The 21 days old seedling '*Pusa Sugandha*' was transplanted with recommended dose of fertilizer and irrigation.

RESULTS

The experimental field was infested mainly with *Cyperus iria* among the sedges and *Lindernia ciliata* among the broad-leaved weeds. Herbicidal treatments significantly influenced the population and dry matter production of weeds. Among the herbicidal treatments, the lowest weed density(5.2/m²) was observed under bispyribac-Na 80 g/ha at 40 DAS, followed by bispyribac-Na 40 g/ha (7.6/m²) (Table 1). The minimum weed dry weight was also recorded in these treatments, which was significantly lower than all other treatments. These results are in conformity with findings of Yadav *et al*. (2009). Maximum weed index (84.1%) was recorded in unweeded check. Among the herbicidal treatments, bispyribac-Na 20 g/ha recorded minimum weed index (17.69%). This clearly indicated that weeds were controlled effectively under bispyribac-Na 20 g/ha. Here higher dose of bispyribac-Na from 40 g/ha onward, show the phyto toxic effect on rice plants. The highest grain yield (5.1 t/ha) was recorded with hand weeding (20 and 40 DAS) and the lowest (0.81 t/ha) was under unweeded check. Among the herbicidal treatments, bispyribac-Na 20 g/ha recorded maximum grain yield (4.21 t/ha), which was at par with other dose of bispyribac-sodium , except 10 g/ha, but significantly higher as compared to cyhalofop-butyl and butachlor. cyhalofop-butyl and butachlor produced 11.3 and 11.6% lesser grain yield as compared to bispyribac-Na 20 g/ha. Herbicidal treatments resulted in considerably higher net monetary return comparable with hand weeding. B:C ratio was also found maximum with bispyribac-Na 20 g/ha followed by bispyribac-Na 30 and 40 g/ha, cyhalofop-butyl 75 g/ha and butachlor 1500 g/ha.

Table 1. Influence of bispyribac-Na on weed growth weed index, yield and economics of the treatment

Treatment	Weed density (no./m²)	Weed dry matter (g/m²)	Grain yield (t/ha)	Weed index	Net returns (x10³₹/ha)	B:C ratio
Bispyribac-Na 10 g/ha	4.3(19.5)*	1.4(1.71)*	2.60	49.1	8.52	1.41
Bispyribac-Na 20 g/ha	2.8(12.3)	0.8(0.102)	4.21	17.7	25.80	2.22
Bispyribac-Na 30 g/ha	2.8(9.7)	0.8(0.18)	3.86	24.5	21.36	1.98
Bispyribac-Na 40 g/ha	2. 5(7.6)	0.7(0.04)	3.50	31.5	16.80	1.75
Bispyribac-Na 80 g/ha	1.9(5.2)	0.7(0.03)	3.11	39.2	9.95	1.40
Cyhalofop-butyl 75 g/ha	6.3(71.8)	2.0(4.01)	3.70	27.6	20.23	1.96
Butachlor 1500 g/ha	5.4(32.8)	1.5(1.91)	3.60	29.6	19.27	1.93
Hand weeding	1.2(1.7)	0.9(0.44)	5.11	0.0	26.77	1.89
Weedy check	10.4(122.2)	3.3(12.44)	0.81	84.1	-10.82	0.45
CD(P=0.05)	0.8	0.3	0.89	5.1		

*Values in parantheses are original. Data transformed to square root transformation

CONCLUSION

It was concluded that post-emergence application of bispyribac-Na at 20 g/ha may give effective weed control, higher yield and net returns per unit area.

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Weed management in *Bt* cotton in upper krishna project command

G.S. Yadahalli*, Rajanand Hiremath, B.M. Chittapur, V.G. Yadahalli, Ayyanna Siddapur

College of Agriculture, Bheemarayanagudi, UAS, Raichur, Karnataka 584 102

**Email:guruyadahalli@gmail.com*

The production of cotton (*Gossypium hirsutum* L.), a commercial crop, suffers due to many constrains like weeds, insects pests and diseases etc. Weeds are responsible for losses in cotton yield to an extent of 60% (Moolchand *et al*. 2012). Presently, to enhance the productivity, weeds are controlled by cultural, mechanical, biological, chemical and integrated methods. Importantly, the critical period of weed competition is from 15 to 60 days and weed management systems during this period should prevent weed interference, be economical and sustainable, reduce weed seed bank in soil, prevent weed resistance, and neither injure cotton nor reduce quantity of lint yield. Weedicides are crop/species specific and their dose and time of application is location and crop specific. Therefore, the current research is envisioned to develop an integrated weed management technique involving pre and post emergence herbicides either singly or in sequence along with intercutlivation as an economically viable alternative in cotton production.

METHODOLOGY

The field experiment was conducted during growing period of 2012-13 at Agricultural College Farm, Bheemarayanagudi, Shahapur (Karnataka) falling under UKP Command area. The experiment was laid out in a randomized complete block design with three replications with fourteen treatments (Table 1). Cotton "cv. *Arya Bt BG II*" was sown on 10th July of 2012 with a spacing of 90 cm between rows and 60 cm between plants within the row.

RESULTS

Weed dry matter per unit area is a better index than weed count to evaluate the impact of weeds on crops. In the present investigation, the dry weight of weeds reduced significantly due to different weed management practices (Table 1). Treatments receiving pendimethalin *fb* quizalofop-ethyl + IC (2.33 t/ha) and pendimethalin *fb* propaquizafop + IC (2.36 t/ha) were also on par with weed- free check. The lowest seed cotton yield was obtained in unweeded check (1.47 t/ha). Maximum gross return (₹ 1,13,187/ha) was obtained in weed-free check and was on par with integrated practice of pendimethalin + pyrithiobac sodium + IC (₹ 1,07,885/ha); both were superior to other all treatments. The net return per rupee spent was also the highest in weed-free check (3.65) and was on par with pedimethalin followed by pyrithiobac sodium coupled with one intercultivation (3.35) (Table 1). Eventhough the weed-free check had higher B:C ratio, farmers do not able to maintain the weed-free condition throughout the cropping period. The alternative left would be the integrated weed management practice involving pendimethalin 38.7 CS at 0.68 kg/ha PRE fb Pyrithiobac sodium 10WP at 0.125 kg/ha or quizalofop ethyl 5EC at 0.05 kg / ha or propaquizafop 10EC at 0.1 kg /haPOST at 30-35 DAS *fb* IC at 60 DAS.

Table 1. Weed dry weight, weed index, plant height, plant dry matter accumulation in plants, seed cotton yield, gross return and B:C ratio as influenced by different weed control treatments in *Bt* cotton

Treatments	Dry weight of weeds (g/m²)				Weed index (%)	Dry matter accumulation (g/plant)	Seed cotton yield (t/ ha)	Gross return (x10³₹ /ha)	B:C
	20 DAS	40 DAS	60 DAS	At harvest					
Weedy check	1.54(32.7)*	2.23(168)	2.35(224)	2.23 (167)	45.15	328.77	1.47	62.07	2.30
Weed free	0.30(0.0)	0.30(0.0)	0.30(0.0)	0.30(0.0)	0.00	471.30	2.69	113.18	3.06
Diuron 80 WP at 1 kg/ha	1.22(14.5)	1.56(34.3)	2.00(98.7)	1.87(75.3)	26.61	421.34	1.97	83.04	2.81
Pendimethalin 38.7 CS at 0.68kg/ha	1.27(16.5)	1.95(86.2)	2.07(116)	1.94(86.1)	31.65	426.50	1.83	77.23	2.74
Propaquizafop 10 EC at 0.1kg/ha.	1.53(31.8)	1.69(47.5)	1.65(42.4)	1.63(41.1)	25.56	381.44	2.00	84.27	2.70
Quizalofop-p-tefuryl 4.41 EC at 0.044 kg/ha	1.54(32.3)	1.81(62.9)	1.70(48.3)	1.69(46.7)	36.88	360.32	1.70	71.44	2.47
Fenoxaprop-p-ethyl 9.3 EC at 0.1kg/ha	1.52(31.4)	1.83(65.9)	1.72(50.0)	1.69(47.7)	38.25	355.39	1.65	69.50	2.26
Quizalofop ethyl 5 EC at 0.5 kg/ha	1.52(30.8)	1.68(46.5)	1.67(44.9)	1.64(42.2)	24.67	380.91	2.02	84.84	2.89
Pyrithiobac sodium 10 EC at 0.125 kg/ha	1.51(30.6)	1.62(40.2)	1.58(36.3)	1.51(30.6)	20.89	394.29	2.12	89.35	2.60
Pendimethalin *fb* propaquizafop	1.26(16.2)	1.29(17.5)	1.52(31.6)	1.46(27.4)	12.35	447.06	2.36	99.17	3.23
Pendimethalin *fb* quizalofop-p-tefuryl	1.28(17.2)	1.42(24.6)	1.63(40.9)	1.59(37.8)	24.25	428.86	2.03	85.34	2.89
Pendimethalin *fb* fenoxaprop-p-ethyl	1.26(16.5)	1.40(25.9)	1.66(44.2)	1.62(39.8)	25.06	424.96	2.01	84.76	2.79
Pendimethalin *fb* quizalofop-ethyl	1.29(17.5)	1.27(16.9)	1.49(29.6)	1.45(26.1)	9.69	451.54	2.33	97.97	3.29
Pendimethalin *fb* pyrithiobac-sodium	1.30(17.9)	1.08(10.1)	1.43(25.9)	1.34(20.1)	7.19	461.35	2.56	107.88	3.35
LSD(P=0.05)	0.06	0.14	0.10	0.11	11.39	20.20	3.05	12.81	0.42

*Figures in the parenthess are original values, Data subjected for transformation using $(\sqrt{x+1})^{1/2}$, where x is weed dry matter, For T_{10} to T_{14} dosages remain same

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Integrated weed management in soybean under North Maharashtra condition

P.M. Chaudhari, P.S. Bodake S.B. Patil, M.R. Patil and P.P. Pawar

College of Agriculture, Dhule, Mahatma Phule Krishi Vidyapeeth, Rahuri,Maharashtra 413 722

**Email: omrutusan@gmail.com*

Soybean is mainly grown in rainy (*Kharif*) season in Maharashtra. Among the various factors responsible for low productivity of soybean, weed infestation during early stages of growth is major one. The losses caused by weeds much higher than from any other category of biotic factors like insects, nematodes, rodents, etc. The crop yield losses may occur up to the extent of 20 to 77 per cent (Kuruchania *et al.* 2001). Although herbicides give better and timely weed control, but due to its high costs prohibits their use by the average cultivar. A judicious combination of chemicals and cultural methods of weed control would not only reduce the expenditure on herbicide but would benefit the crop timely by providing proper aeration.

METHODOLOGY

The present investigation "Integrated weed management in soybean under North Maharashtra condition" was conducted during *Kharif* 2012 at P.G. Research Farm, Agronomy Section, College of Agriculture, Dhule. Experiment consisted of seven treatments laid out in randomized block design with four replications. The different weed control treatments comprised of weed free , hoeing at 15 DAS and hand weeding (HW)at 30 DAS and weedy check . The chemical methods of weed control comprised the post emergence application of quizalofop-ethyl at 100 g / ha at 15 DAS and imazethapyr at 100 g / ha at 15 DAS . The integrated methods of weed control comprised the application of quizalofop-p-ethyl at 100 g / ha at 15 DAS + HW at 30 DAS and imazethapyr at 100 g / ha at 15 DAS + HW at 30 DAS.

RESULTS

The predominant weed species observed in soybean were monocot weeds, *viz. Cynodon dactylon, Digitaria sanguinalis, Echinochloa colona, Panicum isachmi, Sorghum halepense* and dicot weeds, *viz. Digera arvensis, Commelina benghalensis, Parthenium hysterophorus, Celocia argentea, Melilotus alba* and *Corchorus ascutangulus.*

All the growth parameter of soybean *viz*., plant height, number of branches, leaf area / plant and leaf area index were significantly higher in weed free check. This was followed by hoeing at 15 DAS and HW at 30 DAS, post-emergence application of imazethapyr at 100 g / ha and quizalofop-p-ethyl 100 g / ha each coupled with hand weeding, application of imazethapyr at 100 g / ha and quizalofop-p-ethyl at 100 g / ha were next in order of merit for above character.

The highest net returns of ₹ 55,613 / ha was recorded under hoeing at 15 DAS and HW at 30 DAS followed by weed free check, post-emergence application of imazethapyr at 100 g / ha coupled with HW at 30 DAS and quizalofop-p-ethyl at 100 g / ha + HW at 30 DAS which recorded ₹ 54,649, 50415 and 45488 net returns / ha, respectively. The benefit cost ratio was maximum in hoeing at 15 DAS and HW at 30 DAS (3.07) followed by post emergence application of imazethapyr at 100 g / ha + HW at 30 DAS (2.84) and imazethapyr at 100 g / ha at 15 DAS (2.84).

Table 1. Weed dynamics, growth and yield attributes, yield and economic of soybean as influenced by different treatments

Treatment	Dry weight of weed (kg / ha)	Weed control efficiency (%) at Harvest	100 seed weight (g)	Seed yield (t / ha)	Straw yield (t / ha)	Net returns (x10³₹ / ha)	B:C ratio
Weed free	0.71 (0.0)	90 (100)	16.38	3.70	4.88	54.65	2.51
Quizalofop-ethyl at 100 g / ha at 15 DAS (POE)	29.66 (879)	42.33 (48.8)	11.25	2.64	3.70	40.66	2.67
Quizalofop-p-ethyl at 100 g / ha at 15 DAS (POE) *fb* HW at 30 DAS	18.14 (329)	62.70 (78.9)	13.05	3.01	4.20	45.49	2.59
Imazethapyr at 100 g / ha at 15 DAS (POE)	25.88 (670)	49.03 (57.0)	11.40	2.67	3.74	42.59	2.84
Imazethapyr at 100 g / ha at 15 DAS (POE) at *fb* HW at 30 DAS	15.19 (230)	64.86 (81.9)	14.30	3.16	4.28	50.41	2.84
Hoeing at 15 DAS and hand weeding at 30 DAS	12.30 (152)	67.60 (85.4)	14.70	3.36	4.45	55.61	3.07
Weedy check	38.77 (1502)	0.00 (0.00)	9.81	1.52	2.15	16.13	1.76
LSD (P=0.05)	1.32	2.09	1.62	0.32	0.32	-	-

* Figures in parentheses are original values. All figures subjected to arcsin transformed

CONCLUSION

It can be concluded that in integrated weed management of soybean post-emergence application of herbicide *viz.*, imazethapyr at 100 g / ha at 15 DAS followed by H.W. at 30 DAS and quizalofop-p-ethyl at 100 g / ha at 15 DAS followed by H.W. at 30 DAS be adopted for effective weed control and higher soybean production.From the economic point of view hoeing at 15 DAS and hand weeding at 30 DAS could be economical and viable treatment based on B:C ratio.

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Influence of integrated weed management practices on weeds and yield of *Bt* cotton

B.D. Patel*, R.B. Patel, B.T. Sheta, V.J. Patel and D.J. Parmar

DWSR- Anand Centre, B. A. College of Agriculture, Anand Agricultural University, Anand, Gujarat 388 110

**E-mail: bdpatel62@yahoo.com*

Cotton is one of the most important commercial crops of India and ranks 2nd in production and 1st in area. Cotton contributes 30% of the GDP of Indian agriculture and 3 per cent of total GDP. The productivity of cotton in India is the lowest with 462 kg/ha as against world average of 642 kg/ha. The reduction in yield of cotton depends upon biotic and abiotic stresses. Among biotic stress, during the early growth stages weeds removes 5 to 6 times nitrogen, 5 to 12 times phosphorus and 2 to 5 times potash than that of cotton crop and thereby reduce the seed cotton yield to the tune of 54 to 85% (Jain *et al*. 1981). Weeds also interfere with harvesting of cotton and they may reduce lint quality too. Effective weed management is one of critical components of successful cotton production. The present investigation was carried out to know the effect of different herbicides in conjunction with cultural practices in *Bt* cotton.

METHODOLOGY

The present investigation was conducted in *Kharif* season of the year 2010 to 2012 at the farm of DWSR-Anand Centre, B.A. College of Agriculture, Anand Agricultural University, Anand (Gujarat). The soil was sandy loam in texture having low in available nitrogen and medium in available phosphorus and high in potassium with pH 8.15. The study involved twelve treatments and was arranged in randomized complete block design with three replications. The herbicides were applied using knapsack sprayer fitted with flat fan nozzle by mixing in 500 liters of water/ha. The *Bt.* cotton cv. *'VICH-5 BG-II'* was sown manually with recommended package of practices.

RESULTS

Significantly lower weed dry weight was recorded in IC *fb* HW carried out at 15, 30 and 45 DAS treatment which was at par with treatment Pre-emergence application of pendimethalin at 900 g/ha *fb* IC+HW carried out at 30 and 60 DAS, quizalofop-ethyl at 50 g/ha as POE *fb* IC+HW at 30 DAS and quizalofop-ethyl at 50 g/ha as POE *fb* IC+HW at 30 DAS (Patil *et al.* 2007). Whereas, significantly the highest weed dry weight was noticed under weedy check. The highest WCE (87 %) was recorded under treatment IC *fb* HW carried out at 15, 30 and 45 DAS.

Seed cotton and stalk yield of *Bt* cotton were significantly higher in treatment of IC *fb* HW carried out at 15, 30 and 45 DAS followed by pre-emergence application of pendimethalin at 900 g/ha *fb* IC+HW at 30 and 60 DAS, quizalofop-ethyl at 50 g/ha as POE *fb* IC+HW at 30 DAS, quizalofop-ethyl at 50 g/ha POE *fb* IC+HW at 30 DAS, fenoxaprop-p-ethyl at 50 g/ha as POE *fb* IC+HW at 30 DAS, fenoxaprop-p-ethyl at 100 g/ha as POE *fb* IC+HW at 30 DAS and IC+HW at 30 DAS *fb* glyphosate at 1000 g/ha as POE (protected spray) at 70 DAS.

Table 1. Yields, weed dry weight, WCE and economics as influenced by different weed management practices in *Bt*. cotton (Three years pooled data 2010, 2011 and 2012)

Treatment	Seed cotton yield (t/ha)	Stalk yield (t/ha)	Weed dry weight (kg/ha) at harvest	WCE at harvest (%)	Additional Profit over Control (x10³₹/ha)	ICBR
Pendimethalin 900 g/ha PE *fb* IC+HW at 30 and 60 DAS	3.09[a]	5.35[ab]	229[gh]	83	45.07	1:8.35
Quizalofop-ethyl 50 g/ha POE *fb* IC+HW at 30 DAS	3.01[ab]	5.14[abc]	309[efgh]	78	43.29	1:11.70
Quizalofop-ethyl 100 g/ha POE	2.34[cd]	4.65[d]	702[b]	50	16.54	1:5.17
Quizalofop-ethyl 100 g/ha POE *fb* IC+HW at 30 DAS	3.06[a]	5.23[abc]	287[fgh]	80	44.03	1:8.80
Fenoxaprop-p-ethyl 50 g/ha POE *fb* IC+HW at 30 DAS	2.83[abc]	5.11[abc]	390[def]	72	36.57	1:11.80
Fenoxaprop-p-ethyl 100 g/ha POE	2.30[cd]	4.56[d]	734[b]	48	15.89	1:7.94
Fenoxaprop-p-ethyl 100 g/ha POE *fb* IC+HW at 30 DAS	2.89[abc]	5.10[abc]	364[defg]	74	38.27	1:10.07
IC+HW at 30 DAS *fb* glyphosate 1000 g/ha POE (protected spray) at 70 DAS	2.64[abc]	5.04[bc]	456[de]	68	28.33	1:7.38
Paraquat 500 g/ha POE (protected spray) *fb* IC+HW at 30 DAS	2.32[cd]	4.95[c]	630[bc]	55	15.51	1:4.16
Glyphosate 1000 g/ha POE(protected spray) *fb* IC+HW at 30 DAS	2.41[bcd]	4.99[c]	510[cd]	64	19.16	1:4.98
IC+HW at 15, 30 and 45 DAS	3.12[a]	5.40[a]	174[h]	87	46.37	1:8.59
Weedy check	1.89[d]	2.79[e]	1415[a]	-	-	
S.Em. ±	97	94	46			
LSD (P=0.05)	S	S	S			
CV %	8.9	5.8	16.7			
Y x T S.Em. ±	184	265	50			
LSD (P=0.05)	NS	NS	141			

CONCLUSION

It was concluded that inter culturing *fb* hand weeding carried out at 15, 30 and 45 DAS was most profitable in cotton production.

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Relative efficacy of certain new herbicides on *Parthenium* and profitability of spring planted sugarcane

R.K. Singh* and H.R. Choudhary

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005
**Email: rksingh_agro@rediffmail.com*

Uttar Pradesh ranks first both area (2.21 mha) and production (130.51 mt) of sugarcane contributing 43.68 and 39.01 per cent, respectively at the national level. This gap in the acreage and production is because of poor cane productivity in the state being 59.00 t/ha which is even less than the national average. Identification of new herbicides is vital and urgently needed to reduce the possibility of evolution of resistant biotype of weeds and getting higher sugarcane yield.

METHODOLOGY

A field experiment was conducted during two consecutive spring seasons of 2011-12 and 2012-13 at the Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, India. Twelve combinations *viz.* T_1-weedy, T_2-conventional practice (three hoeings) at 30, 60 and 90 DAP, T_3- ametryne 1.6 kg/ha at 30 DAP, T_4- ametryne 2.0 kg/ha at 30 DAP, T_5- ametryne 2.4 kg/ha at 30 DAP, T_6- atrazine 1.0 kg/ha at 30 DAP, T_7- ametryne 1.6 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP, T_8- ametryne 2.0 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP, T_9- ametryne 2.4 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP, T_{10}- atrazine 1.0 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP, T_{11}-atrazine 1.0 kg/ha at 30 DAP *fb* carfentrazone + glyphosate 1.0 kg/ha at 60 DAP and T_{12}- carfentrazone + glyphosate 1.0 kg/ha at 60 DAP were allotted to plot.

RESULTS

The data related (Table 1) to density of *Parthenium hysterophorus* increased up to 90 DAP then declined afterwards. The results revealed that three hoeings at 30, 60 and 90 DAP of sugarcane recorded minimum density of *Parthenium hysterophorus* at 60, 90 DAP and at harvest. It was significantly superior over rest of the treatments during both the years. Sole and sequential application of ametryne and atrazine at different doses followed by 2,4-D was at par with each other at 60 DAP during the first year (2011-12). In the second year (2012-13), Sole and sequential application of ametryne was at par with each other at 60 DAP of crop growth stage. The second best treatment was sequential application of ametryne 2.4 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP significantly reduced density of *Parthenium hysterophorus* than other herbicide treatments and it was statistically at par with ametryne 2.0 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP, ametryne 1.6 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP and atrazine 1.0 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP at the crop growth of 90 DAP and at harvest during both the years of experimental.

CONCLUSION

Conventional practice; three hoeings at 30, 60 and 90 DAP is the most effective weed management practice for controlling *Parthenium hysterophorus* and profitability of spring planted sugarcane under the agro-climatic condition of eastern Uttar Pradesh. Nevertheless, ametryne 2.4 kg/ha at 30 DAP *fb* 2,4-D 1.0 kg/ha at 60 DAP may be a viable and choice for farmers in case of non-availability or scarcity of labour at peak periods of crop-weed competition.148.

Table 1. Density of *Parthenium hysterophorus* and profitability of sugarcane as influenced by weed control treatments

Treatment	Dose (kg/ha)	Time (DAP)	Density of *Parthenium hysterophorus* (no./m^2) 60 DAP		90 DAP		At harvest		Cost of cultivation (x10^3₹/ha)
			2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	
Weedy			11.67(135)a	11.30(127) a	12.84(164) a	12.56(157) a	9.21(84.3) a	8.94(79.3) a	92.22
Conventional practice (Three hoeings)		30, 60&90	2.05(3.7) e	1.71(2.4) d	1.63(2.1) f	1.60(2.05) g	1.14(0.8) g	1.09(0.69) h	97.07
Ametryne	1.6	30	3.49(11.6) bcd	2.81(7.3) bc	4.64(21.0) c	4.30(17.9) cd	3.96(15.2) cd	3.89(14.6) c	93.70
Ametryne	2.0	30	3.32(10.5) bcd	2.71(6.8) bc	4.51(19.8) c	3.98(15.3) d	3.81(14.0) cd	3.59(12.3) de	93.93
Ametryne	2.4	30	3.18(9.6) cd	2.48(5.6) c	4.35(18.4) c	3.93(14.9) d	3.66(12.9) d	3.38(10.9) e	94.15
Atrazine	1.0	30	3.65(12.8) b	2.99(8.4) b	4.71(21.6) c	4.49(19.6) c	4.03(15.7) c	3.83(14.2) cd	93.44
Ametryne *fb* 2,4-D	1.6 *fb* 1.0	30 *fb* 60	3.46(11.4) bcd	2.75(7.1) bc	2.56(6.1) de	2.19(4.30) ef	2.01(3.5) ef	1.57(1.9) fg	94.65
Ametryne *fb* 2,4-D	2.0 *fb* 1.0	30 *fb* 60	3.34(10.6) bcd	2.61(6.2) bc	2.45(5.5) de	2.07(3.8) f	1.89(3.1) ef	1.48(1.7) fg	94.87
Ametryne *fb* 2,4-D	2.4 *fb* 1.0	30 *fb* 60	3.16(9.4) d	2.43(5.4) c	2.28(4.7) e	1.98(3.4) f	1.77(2.6) f	1.40(1.46) g	95.10
Atrazine *fb* 2,4-D	1.0 *fb* 1.0	30 *fb* 60	3.62(12.6) bcd	2.95(8.2) b	2.61(6.3) de	2.26(4.6) ef	2.03(3.6) ef	1.62(2.1) fg	94.39
Atrazine *fb* CARFEN+GLYPHO†	1.0 *fb* 1.0	30 *fb* 60	3.64(12.7) bc	2.97(8.3) b	2.73(6.9) d	2.47(5.6) e	2.13(4.0) e	1.74(2.5) f	95.35
CARFEN+GLYPHO†	1.0	60	11.71(136) a	11.50(131) a	6.2(37.57) b	5.70(31.9) b	5.66(31.5) b	5.22(26.8) b	94.13
LSD (P=0.05)	---	---	*	*	*	*	*	*	NS

Carfentrazone + Glyphosate (Ready mix formulation) – CARFEN+GLYPHO, Values are subjected to square root transformation ($\sqrt{X+0.5}$), Original data given in parenthesis, Means with same letters are not statistically significant by DMRT (P d" 0.05), NS Non Significant, * Significant

Bio-efficacy of penoxsulam for weed management in transplanted rice

M.C. Dhara*[1], Malay K. Bhowmick[1] and Buddhadeb Duary[2]
[1]*Rice Research Station, Chinsurah, Hooghly, West Bengal 712 102*
[2]*Institute of Agriculture (Palli Siksha Bhavana), Visva-Bharati, Sriniketan, Birbhum West Bengal 731 236*
**Email: madhab.dhara@gmail.com*

Rice is the principal crop with its maximum acreage during *Kharif* (*aman*) season in West Bengal. But the crop suffers heavily due to weed infestation that not only causes yield reduction but also impairs quality of the produce. Though herbicides do well, many times their pre-emergence (PE) application is not possible because of sowing pressure and unfavorable climate. Use of post-emergence (POE) herbicide may be an effective alternative to the farmers. Penoxsulam is a broad-spectrum herbicide that can be used for controlling annual grasses, sedges and broadleaved weeds in rice culture. It is especially effective against *Echinochloa* species and *Cyperus difformis*, compared with butachlor (Singh *et al*. 2009). Hence, it is imperative to evaluate herbicidal efficacy against complex weed flora in transplanted *Kharif* rice.

METHODOLOGY

A field experiment was conducted during *Kharif* season of 2006 and 2007 at Rice Research Station, Chinsurah, Hooghly. There were eight treatments including butachlor (PE), different doses of penoxsulam (PE and POE), weed free, hand weeding (twice) and weedy check. The experiment was laid out in a randomized complete block design with four replications. The crop variety *'NDR 8002* (*IET 15848)*, was raised with a common fertilizer dose of 60 : 30 : 30 kg N : P_2O_5 : K_2O/ha along with other recommended package of practices. Herbicides were sprayed using knapsack sprayer fitted with a flat fan nozzle at a spray volume of 500 l/ha. Observations were recorded on weed flora, weed biomass, grain yield and yield attributes at harvest.

RESULTS

Weed flora in weedy check plots consisted of *Cynodon dactylon*, *Cyperus difformis*, *C. iria*, *C. rotundus*, *Commelina benghalensis*, *Digitaria sanguinalis*, *Echinochloa colona*, *E. crusgalli*, *Fimbristylis littoralis*, *Ludwigia parviflora*, *Monochoria vaginalis* and *Sagittaria sagittifolia*. All the weed management treatments resulted in significant increase in grain yield over weedy check (Table 1). Though the highest mean grain yield was recorded under weed free treatment (6.06 t/ha), followed by two rounds of hand weeding (5.95 t/ha), it was comparable with penoxsulam applied either as PE at 0.025 kg/ha (5.77 t /ha) or as POE at 0.020 kg/ha (5.71 t/ha), which was in conformity with the findings of Yadav *et al.* (2008). The herbicide penoxsulam at higher dosage of 0.025 kg/ha as PE (92.39%) and at lower dosage of 0.020 kg/ha as POE (92.45%) exhibited better weed control efficiency (WCE) by keeping all types of weeds under control and lowering their biomass (Table 1). Pal *et al.* (2009) were of same opinion. The minimum yield attributes were recorded from weedy check, causing significant yield reduction to the tune of 28.68% due to prolific crop-weed competition since beginning.

Table 1. Weed control efficiency, grain yield and yield attributes of different treatments in transplanted rice

Treatment	Dosage (kg/ha)	Time of application (DAT)	Weed biomass (g/m^2)		WCE (%)		Panicles/ m^2		Panicle weight (g)		Grain yield (t/ha)	
			2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Butachlor 50 EC	1.5000	5	5.43	8.50	73.22	91.06	290	278	3.12	2.90	5.50	5.12
Penoxulam 24 SC	0.0225	5	4.37	7.57	92.56	92.03	309	286	3.24	2.97	5.57	5.47
Penoxulam 24 SC	0.0250	5	4.80	6.70	91.83	92.95	287	297	3.15	3.05	5.61	5.92
Penoxulam 24 SC	0.0200	10	4.67	6.80	92.05	92.84	303	291	3.14	3.08	5.66	5.75
Penoxulam 24 SC	0.0225	10	5.00	6.50	91.49	93.16	298	303	3.13	3.07	5.45	5.92
Weed free	-	-	0.00	0.00	100.0	100.0	320	321	3.31	3.30	6.01	6.10
Two HWs	-	20 and 40	2.87	4.53	95.11	95.23	312	313	3.26	3.16	5.82	6.08
Weedy check	-	-	58.73	95.03	-	-	256	254	2.87	2.79	4.48	4.14
LSD (P=0.05)	-	-	4.04	2.38	-	-	8.00	1.00	0.06	0.07	0.45	0.34

DAT: Days after transplanting; EC: Emulsifiable concentrate; HW: Hand weeding; SC: Suspension concentrate; WCE: Weed control efficiency

CONCLUSION

Application of penoxsulam 24 SC either as pre-emergence at 0.025 kg/ha or as post-emergence at 0.020 kg/ha proved to be effective in controlling weeds and producing higher grain yields in transplanted rice culture.

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Combination of imazethapyr with other herbicides against complex weed flora in blackgram

R.B. Patel, B.D. Patel and J.K. Parmar

B.A. College of Agriculture, Anand Agricultural University, Anand, Gujatat 388 110

**Email: rbpatel33@yahoo.com*

Pulses occupy a unique position in Indian agriculture. Black gram is one of the most important and extensively cultivated pulse crops. Quantitatively, blackgram is very good source of protein, carbohydrates, fats and minerals and it is said to be poor man's meat and rich man's vegetable. Weeds compete severally with crop for nutrients, moisture and light which reduced yield 30 to 50 per cent of blackgram (Bhan and Singh 1991). The critical period of crop weed competition in blackgram is found 15 to 45 DAS. There is enough information available on weed management in blackgram. With the reference to availability of new molecules and ready mixture of herbicides, the experiment is conducted to know the effect of herbicide applied alone and mixture with other herbicide on weeds under blackgram crop.

METHODOLOGY

A field experiment was conducted during *Kharif* season of the year 2012 at the farm of DWSR-Anand Centre, B.A. College of Agriculture, Anand Agricultural University, Anand (Gujarat). The soil of the experimental field was loamy sand in texture, low in available nitrogen, high in available phosphorus and medium in potassium with slightly alkaline in reaction. Pendimethalin at 1000 g/ha, pendimethalin + imazethapyr at 800, 900 and 1000 g/ha as ready mixture were applied as pre emergence, while Imazethapyr alone at 50 and 70 g/ha as well as ready mixture of imazethapyr + imazamox at 60 and 70 g/ha were applied as post emergence (3-4 leaf stage) using 500 litre water per hectre for weed management in *Kharif* blackgram. These herbicidal treatments were compared with hand weeding carried out at 20 and 40 DAS and weedy check. Experiment was laid out in randomized block design with four replications. All the recommended package of practices were adopted to raise the crop except application of herbicides.

RESULTS

The major monocot weeds observed in the experimental fields were *Eragrostis major, Eleusine indica, Digitaria sanguinalis, Cyperus rotundus, Cyperus iria* and *Cynodon dactylon.* The dicot weeds were *Euphorbia hirta, Amaranthus spinosus* and *Phyllanthus niruri* in black gram crop. Weed dry matter recorded at 40 DAS and at harvest in hand weeding carried out at 20 and 40 DAS showed significantly the lowest. Among herbicides, significantly lower weed dry matter was recorded in application of imazethapyr + pendimethalin at 1000 g/ha as pre emergence at 40 DAS which was at par with pre emergence application of Pendimethalin at 1000 g/ha and application of imazethapyr + pendimethalin at 800 and 900 g/ha. Among herbicide treatments at harvest, post emergence application of imazethapyr at 70 g/ha showed significantly lower weed dry matter which was at par with all the herbicidal treatments. Weed control efficiency varied between 96.5 to 76.1% and 87.4 to 73.8% at 40 DAS and at harvest, respectively. Seed and haulm yield of blackgram recorded at harvest showed significantly higher in hand weeding carried out at 20 and 40 DAS which was at par with pre emergence application of pendimethalin at 1000 g/ha, pre emergence application of imazethapyr + pendimethalin at 800, 900 and 1000 g/ha and post emergence application of imazethapyr at 50 g/ha.

Table 1. Effect of herbicides on yield and weed growth in blackgram

Treatment	Dry matter of weeds (g/m^2) at harvest	Weed Control efficiency (%)	Plant dry matter (g/plant) at 30 DAS	Plant height (cm) at 60 DAS	Seed yield (t/ha)	Haulm yield (t/ha)
Pendimethalin at1000 g/ha as PE	61.0	76.5	1.95	63.0	1.57	2.72
Imazethapyr at 50 g/ha at 20 DAS as POE	57.7	77.8	1.62	58.5	1.46	2.69
Imazethapyr at70 g/ha at 20 DAS as POE	54.7	78.9	1.56	56.2	1.20	2.40
Imazethapyr + pendimethalin at 800 g/ha as PE	68	73.8	2.15	63.0	1.41	2.44
Imazethapyr + pendimethalin at 900 g/ha as PE	65.5	74.8	2.04	64.2	1.51	2.52
Imazethapyr + pendimethalin at 1000 g/ha as PE	56.7	78.2	2.04	62.0	1.58	2.69
Imazethapyr + imazamox at 60 g/ha at 20 DAS as POE	62.5	75.9	1.51	51.7	1.20	2.30
Imazethapyr + imazamox at 70 g/ha at 20 DAS as POE	58.0	77.7	1.44	49.7	1.19	1.91
Hand Weeding at 20 and 40 DAS	32.8	87.4	2.18	64.5	1.59	2.73
Weedy check	260	-	1.80	63.8	0.92	1.34
LSD (P=0.05)	23.2	0.29	5.7	0.29	0.30	

CONCLUSION

It was concluded that pre emergence application of pendimethalin at 1000 g/ha or mixture of pendimethalin with imazethapyr at 800-1000 g/ha or post emergence application of imazethapyr at 50 g/ha is equally effective to non chemical hand weeding carried out at 20 and 40 days after sowing to management weeds without toxicity and reduction in yield of blackgram.

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Weed management in cowpea

K.S. Yadav*, R.L. Rajput, J.P. Dixit and A.M. Jaulkar
DWSR-C, Department of Agronomy, RVSKVV- College of Agriculture, Gwalior, Madhya Pradesh 474 002
**Email:aicrp_wcgwl@yahoo.in*

Cowpea is one of the most valuable legume crop grown in *Kharif* season throughout the country. Being a short duration crop. Cowpea is very much affected with weed problems in *Kharif* season. Weed deplete nitrogen moisture and height thus yield and quality of seed is reduced considerably. Manual weeding is costly, time consuming and some time not possible due to non availability of labour under such situation chemical weed control offers a better alternative to manual weeding during early stage. Hence the present study was under taken to find out with the objectives to identify the suitable weed management practices in cowpea.

METHODOLOGY

A field experiment was conducted at Research Farm, College of Agriculture, Gwalior during *Kharif* 2011 and 2012 on sandy clay loam soil. The experiment was laid out in randomized block design and replicated thrice. Twelve treatments comprised of different weed management practices (Table1). The cowpea *cv 'RC-101'* was sown at row spacing 30 cm apart on first week of July during experimental years. The experimental soil was low in available nitrogen and phosphorus and medium in available potassium with pH 7.4.

RESULTS

The major weed flora observed in the experimental plot were *Cyperus rotundus, Commelina benghalensis, Echinochloa crusgalli, Digera arvensis* and *Phyllenthus niruri*. The results revealed that all weed management practices significantly reduced the weed population and dry weight compared to weedy check. Significantly lower weed density and dry weight of weed was recorded in twice hand weeding at 20 and 40 DAS. Which was at par with post emergence application of imazethapyr 75 g/ha + hand weeding 40 DA, pendimethalin 1000 g/ha as PE + hand weeding at 40 DAS and quizalofop-ethyl as PoE 50 g/ha + one hand weeding at 40 DAS. Among the alone application of herbicide imazethapyr 75 g/ha PoE was found more effective to control most of weed than other. Maximum weed control efficiency (94.8%) was noted in twice hand weeding which was closely followed by imazethapyr 75 g/ha + hand weeding at 40 DAS (93.2%) and also recorded significantly higher seed yield 1.11 t/ha and 9.99 q/ha, respectively than other weed management treatments except twice hand weeding treatment. Further net returns and B:C ratio was also higher with imazethapyr 75 g/ha as PoE + hand weeding at 40 DAS and pendimethalin 1000 g/ha + hand weeding at 40 DAS and lowest in weedy check.

CONCLUSION

It can be concluded that post emergence application of imazethapyr 75 g/ha and pre emergence application pendimethalin 1000 g/ha + hand weeding at 40 DAS can be used to control weeds in cowpea.

Table 1. Effect of different weed management practices on dry weight of weeds, WCE, seed yield, weed index and economics of cowpea

Treatment	Dry weight (g/m²)		WCE (%)	Seed yield (t/ha)	WI (%)	Net return (x10³₹/ha)	B:C ratio
	30 DAS	60 DAS					
Pendimethalin at 1.0 kg/ha PE	9.20	25.29	73.66	0.72	43.10	11.15	2.04
Oxyfluorfen at 150 g/ha PE	10.79	28.14	70.69	0.62	50.86	8.05	1.75
Imazethapyr at 75 g/ha POE	6.55	17.41	81.87	0.81	35.97	13.72	2.27
Quizalofop E. at 50 g/ha POE	29.50	59.60	37.92	0.69	45.37	10.09	1.93
Pendimethalin at 1.0 kg/ha PE + 1 HW at 40 DAS	2.36	11.66	87.85	0.99	21.71	17.26	2.36
Oxyfluorfen at 150 g/ha PE+ 1 HW at 40 DAS	4.62	11.95	87.55	0.78	61.20	10.68	1.84
Imazethapyr at 75 g/ha POE + 1 HW at 40 DAS	2.31	6.51	93.22	1.11	12.85	20.63	2.62
Quizalofop E. at 50 g/ha POE + 1 HW at 40 DAS	14.65	8.15	91.51	0.92	27.50	14.93	2.16
1 HW at 20 DAS	4.03	42.40	55.84	0.80	37.30	12.44	2.02
1 Hoeing at 20 DAS + 1 HW at 40 DAS	7.03	8.77	90.86	1.06	16.69	19.02	2.48
2, H.W. at 20 and 40 DAS	2.58	5.02	94.77	1.27	-	24.39	2.75
Weedy check	47.40	96.01	-	0.50	60.50	5.27	1.53
LSD(P=0.05)	-	-	-	1.73	-	-	-

Integrated approach of weed control in okra

K.S. Yadav*, R.L. Rajput, J.P. Dixit and A.M. Jaulkar

Department of Agronomy, RVSKVV- College of Agriculture, Gwalior, Madhya Pradesh 474 002

**Email : aicrp_wcgwl@yahoo.in*

Okra is grown in *Kharif* season and suffer badly due to weeds to the tune of 50-60% reduction in yield in this region. The convential method of weed control (hoeing and hand weeding) is laborious, expensive, insufficient and some time causes damages to crop. Integrated weed control measures certainly has its merits over the existing methods. However, it is not so common as it should have been practiced in commercial scale. Under such circumstance integration of chemical with one hand weeding offers economically suitable alternative.

METHODOLOGY

An experiment was conducted at RVSKVV-Agriculture College Research Farm, Gwalior to study the effect of integrated weed management practices on okra crop growth, yield and weed flora during 2011 and 2012. The experiment consisted to 9 treatments (Table 1) were evaluated in randomize block design with three replications. The soil was sandy clay loam in texture, low in nitrogen, medium phosphorus and potassium with pH 7.3. Okra variety *'VRO-6'* was sown in 45 cm rows using a seed rate 20 kg/ha on 5th July, 2011 & 11th July 2012 and harvested on 8 October, 2011 and 25 September, 2012. Crop was raised as per recommended package of practices except weed control treatments. The species wise weed population was recorded at 30 and 60 DAS.

RESULTS

The predominant weeds of the experimental field during both season in okra were *Cyperus rotundus, Digera arvensis, Commelina benghalensis*, *Phyllanthus niruri,* and *Parthenium hysterophorus.* The pooled data of two years showed that all the weed control treatments brought out significant effects on weed population and dry weight of weeds. The lowest weed density and biomass was recorded with the weed free (2 HW and 30 and 50 DAS) and it was statistically at par with mulching 5 t/ha (applied after seed germination). Among the alone pre-emergence application of herbicides oxyfluorfen and pendimethalin reduced the weed population and dry weight of weed significantly compared to weedy check. Those herbicidal treatments also reduced the weed biomass significantly as compare to weedy check at both the crop stages. Weed control efficiency (94.88%) was highest under weed free treatment followed by mulching at 5 tonnes/ha (93.79%), pendimethalin PE (93.56%) and oxyfluorfen all compared with 1, hand weeding at 30 DAS (89.95%).

All weed control treatments significantly enhanced the seed yield and yield attributes of okra over weedy check. Maximum seed yield (0.97 t/ha) was recorded in 2 HW at 30 and 50 DAS, respectively during experimental years followed by mulching 5 t/ha applied after seed germination. Alone application of herbicide or combined with one hand weeding on pooled basis gave maximum seed yield under pendimethalin alone or combined with one hand weeding at 30 DAS .

CONCLUSION

On the basis of two year mean data among the different weed control measures 2 hand weeding at 30 and 50 DAS and mulching 5 t/ha (after seed germination) fetched maximum yield and net return as well as BCR .

Table 1. Effect of different treatment on dry weight at 30 and 60 DAS, WCE, seed yield, Weed index and economics in okra crop (Mean of two year 2011 and 2012)

Treatment	Dry weight (g/m^2)		*WCE (%)*	Seed yield (t/ha)	WI (%)	Net return (x10^3₹/ha)	B:C ratio
	30 DAS	60DAS					
Oxyfluorfen at 0.250 kg/ha as PE	12.61	26.31	73.65	0.58	40.20	7.24	1.44
Pendimethalin at 1.0 kg/ha as PE	15.18	24.04	75.93	0.70	28.00	10.81	1.86
Oxyfluorfen at 0.250 kg/ha + 1 HW at 30 DAS	4.04	10.03	89.95	0.68	29.95	8.34	1.36
Pendimethalin at 1.0 kg/ha + 1 HW at 30 DAS	2.95	6.43	93.56	0.84	13.64	12.91	1.80
Mulching (After seed germination) 5 t/ha	1.20	6.20	93.79	0.92	5.54	18.24	2.40
One hoeing at 30 DAS	11.52	21.73	78.24	0.65	32.72	11.24	1.95
One hand weeding at 30 DAS	2.42	13.78	86.20	0.75	23.08	10.54	1.78
Two hand weeding at 30 and 50 DAS	2.10	5.11	94.88	0.97	-	18.42	2.00
Weedy check	53.18	99.87	-	0.51	47.28	8.944	1.47
LSD (P=0.05)	-	-	-	128	-	-	-

Effect of different nutrient management and cropping system on weed intensity, weed biomass, grain yield and economics in different rice based cropping systems

Megha Dubey*, K.K. Agrawal, M.L. Kewat and Suchi Gangwar
College of Agriculture, Jawaharlal Nehru KrishiVishwaVidhyalaya, Jabalpur, Madhya Pradesh 482 004
**Email: meghadubey33@yahoo.com*

Madhya Pradesh is relatively underdeveloped with regards to agricultural productivity rural employment and economic status as compared to most of the Indian states. As it is observed that maximum infestation of weeds is observed in organic nutrient management plots in rice based cropping system. Thus, the severe infestation of weeds resulted in yield reduction as high as 40-60% depending upon the intensity and the type of weed flora (Singh *et al.* 2003). Thus, it was observed that if we make changes in different nutrient management and cropping systems it will affect the density of weeds. As weeds cause major loss to yield of rice. The organic manures result in increasing the infestation of different weeds in cropping system.

METHODOLOGY

The factors studied included 3 nutrient managenment practices, *viz.* organic manure (ONM), chemical fertilizers and integrated nutrient (50:50) (INM) and 4 cropping systems, *viz.* rice-durum wheat-green manuring, rice-chickpea-sesame,rice-berseem (fodder+seed), rice-vegetable pea-sorghum (fodder) in strip plot design with 3 replication. The crop varieties grown were Pusasugandha Basmati-5 in rice,MPO-1106 in durum wheat, JG-24 for gram, JB-1 for berseem, Arkel for vegetable pea during winter season and TKG-55 in sesame and MP Chari in sorghum during summer season. These crops were raised with recommended agronomic practices.

RESULTS

The presence of predominant weed flora was almost similar in all plots, when rice was grown under different rice based cropping system but under 100% organic nutrient management recorded the maximum infestation of weeds. The predominant weed in transplanted rice was *Echinoclovacrusgalli* which contributed 39% of the total weed intensity at most critical period 30 DAT. The next predominant weed was *Cyperusiria* with relative density of 33% at 30 DAT. The infestation of *Echinochlova colona* and *Cyperus iria* declined at maturity, while density of other weeds increased. During *Rabi* season *Medicago denticulata* was found to be more dominant in almost all crops. Its relative density was 42.3, 38.9, 22.8 and 46.9% in wheat, chickpea, berseem and vegetable pea. During summer sason *Portula caoleracea* was most dominating weed in all crops with relative density of 42.7 and 43.6% in sesame and sorghum.

Table 1. Effect of different nutrient management and cropping system on weed intensity/m² and weed biomass (kg/ha) during *Kharif, Rabi and* summer season

Treatment	Weed intensity / m²				Weed biomass (kg / ha)				Rice equivalent yield (t / ha)	Production efficiency (kg / ha / day)
	Kharif	*Rabi*	Summer	Total	*Kharif*	*Rabi*	Summer	Total		
M_1-100% Organic (1/3 N through each of FYM, Vermicompost and Neem oil cake)	120.2	134.2	98.2	352.6	470	390	323	1183	6.00	19.08
M_2 -100% Inorganic (100% NPK through fertilizers)	102.3	103.4	67.5	273.2	443	340	302	1085	6.93	22.07
M_3-Integrated Nutrient Management (50% through fertilizer + 50% through organic sources)	118.2	120.3	78.1	316.6	459	373	318	1150	6.61	21.03
LSD(P=0.05)	0.30	0.40	0.30	-	0.30	0.30	0.42		0.27	0.87
CS_1 – Green manuring (sunhemp)- rice (PusaSugandha 5)- wheat (MPO 1106)	104.5	134.0	-	238.5	462	341		803	6.39	20.16
CS_2- Rice (Pusa Sugandha 5)- chickpea (JG 322)- sesame (TKG 55)	99.2	120.5	97.9	317.6	440	398	321	1159	5.17	16.02
CS_3- Rice (PusaSugandha 5)-berseem (JB 5)	129.2	102.7	-	231.9	568	338	-	906	7.47	26.04
CS_4- Rice (PusaSugandha 5)-vegetable pea (Arkel)- sorghum (MP Chari)	118.3	106.9	102.3	327.5	523	352	331	1206	7.02	20.70
LSD(P=0.05)	0.39	0.27	0.42	-	4.6	4.1	4.6	-	1.62	5.37

Similarly, higher total weed biomass 100% organic nutrient management recorded significantly higher weed biomass of 1183 kg / ha which was significantly higher than INM (1151 kg / ha) and 100% inorganic nutrient management (1085 kg / ha).

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Effect of rates and time of application of bispyribac- sodium on weeds in direct drilled and transplanted rice

R.K. Singh*, Santosh Kumar and Aarti Singh

Department of Agronomy,Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005

**Email: rks1660bhu@gmail.com*

Rice is most important rainy season crop of Eastern Indo Gangetic Plains. It suffers from severe weed competition which reduces its yield to the tune of 25-75%, depending up on rice culture. Herbicides provide an excellent opportunity to the farmers to manage weeds during critical period of crop weed competition and also at lower cost. The most widely used rice herbicides are used as pre-emergence and often fail to control weeds emerging during late vegetative phases of the crop.Therefore, the present study was undertaken to evaluate the bio-efficacy of bispyribac- sodium as post-emergence treatment, against important weeds of rice under agro-climatic conditions of Varanasi in Eastern Uttar Pradesh.

METHODOLOGY

Two experiment were conducted during monsoon *Kharif* season of 2011 at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi The soil of the experimental field was sandy clay loam, low in available N (168.9 kg/ha) medium in P (26.6 kg P_2O_5/ha) and K (242.5 kg K_2O/ha) having neutral reaction (pH 7.2). Treatments consist of three rates, *viz.* 15,20,25 g/ha of bispyribac-sodium 10% SC applied at 1-3 and 4-6 leaf stage of weeds in direct seeded and transplanted rice and was compared with anilophos at 450 g/ha in transplanted and untreated control in a randomized block design with three replication. Rice variety '*HUR-105*' was directly drilled on July 2 at 20cm row spacingand 21 days old seedlings were transplanted on July 16,2011 with 20 x10 cm row spacing. Weeds from quadrate (0.25 m^2) were collected randomly from four places in each treatment at 30 days after spraying. Weed species were separately counted from each sample and their density was recorded as average no./m^2. The composite weed sample was air dried in a hot air oven at 70^{0}C. Crops wasraised with the recommended agronomic package for the region.

RESULTS

The major weeds in experimental crop were *Echinochloa* spp. and *Cyperus* spp. among narrow leaved weeds and *Ammania bacifera, Phyllanthus niruri, Caesulia axillaris,* and *Commelina benghalensis* were major broad leaf weed. The density of narrow and broad leaf weeds was significantly affected by herbicides treatments. The data (Table 1) revealed that most weeds were effectively controlledby bispyribac-sodium 10 % SC at 25g/ha as post-emergence in both direct seeded and transplanted rice.

The maximum per cent control of narrow and broad leaf weeds recorded with bispyribac-sodium 10% SC at 40 g/ha applied at 4-6 leaf stage of weeds, but did not differed significantly from bispyribac- sodium at 20or 25g/ha. This can be attributed to more herbicide interception by weeds due to high foliage area at 4-6 leaf stage compared to 2-3 leaf stage.In both direct seeded and transplanted rice, the maximum grain was recorded with bispyribac-sodium 10% SC at 40 g/ha applied at 4-6 leaf stage of weeds, but was comparable to its lower rates at 20 and 25 g/ha. This might be due to better weed control under these treatments when compared with lower rate of the herbicide and application at early stages of weeds. Chauhan and Abugho (2012) reported 97% control of barnyard grass and jungle rice when bispyribac-sodium was applied at 4 leaf stage of weeds.

Table 1. Effect of different rates of bispyribac sodium and stage of application on weed density weed control (%) efficiency and yield in direct seeded and transplanted rice

Treatment (dose g/ha)	Weeds stage	Density (no./m^2) of narrow leaf weeds		Density (no./m^2) of broad-leaved weeds		Weed control (%) of narrow leaf weeds		Weed control (%) of broad leaf weeds		Grain yield (t/ha)	
		Direct seeded	Transplanted	Direct seeded	Transplanted	Direct seeded	Transplanted	Direct seeded	Transpl-anted	Direct seeded	Transplanted
Bispyribac 15	2-3 leaf	8.7 (74.6)	6.6(42.7)	6.7 (49.9)	5.4 (28.3)	23.01	69.2	30.52	64.3	3.1	3.2
Bispyribac 20	2-3 leaf	6.2 (37.9)	4.8 (21.9)	4.9 (23.9)	4.4 (18.6)	60.85	84.2	66.74	76.5	3.3	3.9
Bispyribac 25	2-3 leaf	6.1 (39.9)	4.7 (21.9)	4.9 (32.6)	4.3 (18.1)	58.82	84.2	67.12	77.1	3.6	3.9
Bispyribac 15	4-6 leaf	8.8 (77.5)	7.0 (48.6)	6.7 (45.5)	5.7 (32.8)	19.98	65.0	36.69	58.6	3.2	3.6
Bispyribac 20	4-6 leaf	6.3 (40.0)	5.2 (25.9)	5.0 (24.5)	4.6 (20.8)	58.72	81.3	65.91	73.7	3.8	4.1
Bispyribac 25	4-6 leaf	6.2(38.67)	5.2 (26.3)	4.9 (24.3)	4.6 (20.8)	60.09	81.0	66.18	73.7	4.2	4.4
Bispyribac 40	4-6 leaf	6.2(37.4)	5.2 (26.3)	4.9 (23.9)	4.5(20.3)	61.37	81.1	66.64	74.3	4.3	4.6
Weed free		0.71(0.00)	0.71(0.00)	0.71 (0.00)	0.71 (0.00)	100	100	100	100	4.6	5.1
Weedy check		9.8 (96.9)	11.8(138)	8.51 (71.8)	8.93(79.30	0.0	0.0	0.0	0.0	1.5	2.1
LSD (P=0.05)		1.6	1.4	1.5	1.1	-	-	-	-	0.3	0.5

CONCLUSION

Bispyribac-sodium 10 SC 25 g ha as post emergence at 4-6 leaf stage of weeds was found to be optimum rate for the control of narrow and broad leaf weeds in direct seeded and transplanted rice.

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Integrated weed management in castor under irrigated conditions

J.S. Yadav*[1], Ashok Yadav[2] and Virender Kumar[1]
[1]*CCSHAU Regional Research Station, Bawal, Rewari, Haryana*
[2]*IRRI, Patna, Bihar 123 501*
**Email: jsyadav21@rediffmail.com*

Castor (*Ricinus communis* L.) is an important non-edible oilseed crop of India with a premier and dominant position in its production and supplies. Being hardy crop, it can be grown under rainfed conditions and thrives well on a variety of soil and climatic conditions provided timely and effective weed management is ensured (Yadav and Singh, 2007). Being slow in emerging (1 to 2 weeks) and shading the ground, it encounters frequent infestation of broad leaf weeds, *viz. Digera arvensis, Solanum nigrum, Trianthema monogyna, Celosia argentea* and *Digitaria sanguinalis* in Haryana. Therefore, to standardize the effective weed management strategies for castor cultivation, a field investigation was carried out for three consecutive years under irrigated conditions.

METHODOLOGY

A field experiment was conducted at CCSHAU Regional Research Station, Bawal in district Rewari of Haryana from 2010 to 2012 to find out the most suitable integrated weed management option in castor. Soils of the experimental field were loamy sand in texture with very low fertility and rainfall around Bawal (S-W Haryana) remains scanty. The experiment comprising 10 treatments (Table 1) was conducted in a randomized block design keeping three replications. Castor variety '*DCH 177*' was sown at row to row and plant to plant spacing of 120 and 60 cm, respectively. The crop was raised with all other recommended package of practices in Haryana. Data on weed control efficacy and seed yield was recorded at harvest and economics was computed.

RESULTS

Pre-emergence application of pendimethalin at 1 kg/ha supplemented with one inter-cultivation at 40 DAS resulted into very efficient weed management (WCE 97.6 %) producing castor yield (3.22 t/ha) statistically similar to weed free conditions (3.26 t/ha) and farmers' practice (3 inter-culture, 3.01 t/ha), and it was distinctly superior to all other treatments except trifluralin 1 kg/ha (PPI) followed by I HW at 40 DAS (Table 1). Pendimethalin (PRE) was in general better than trifluralin (PPI). The results are in close conformity with earlier findings elsewhere (Dungarwal *et al*. 2002). The pooled analysis over three years further revealed that pre-emergence application of pendimethalin at 1 kg/ha + inter cultivation at 40 DAS was the most remunerative with B: C ratio of 3.87 (Table 1). WCE, seed yield and economics of castor as influenced by different weed control treatments under irrigated conditions (pooled data 2010 to 2012)

CONCLUSION

Pre-emergence application of pendimethalin 1 kg/ha integrated with one HW at 40 DAS proved most effective and economic weed control option in castor under irrigated conditions of Haryana.

Treatment	Weed control efficacy (%)	Seed yield (t/ha)				Gross returns (x10³₹ /ha)	Cost of cultivation (x10³₹ /ha)	B:C
		2010	2011	2012	Pooled			
Trifluralin 1.0 kg/ha(PPI)	85.3	1.46	4.29	2.84	2.86	104.0	28.6	3.55
Trifluralin 1.0 kg/ha + 1 HW at 40 DAS	96.7	14.9	45.5	30.6	30.3	110.4	30.1	3.67
Pendimethalin 1.0 kg/ha (PRE)	87.6	15.55	47.1	29.0	30.6	111.2	28.6	3.81
Pendimethalin 1.0 kg/ha + 1 HW at 40 DAS	97.6	15.6	48.2	32.5	32.1	116.9	30.1	3.87
Intercropping of castor + mungbean (1:3)	80.4	13.75	37.2	28.4	26.4	95.75	30.0	3.12
Weed free conditions (3 HW at 20, 40 and 60 DAS)	98.2	16.0	48.3	33.3	32.5	118.3	30.6	3.78
Farmer's practice (1 HW 25 DAS+2 Inter culture at 45, 60 DAS)	96.3	14.4	43.8	32.1	30.1	109.4	30.2	3.53
Clodinafop 0.05 kg/ha(POE)	76.7	13.4	36.4	27.14	25.6	92.9	28.6	3.17
Fenoxaprop 0.05 kg/ha(POE)	78.8	13.8	35.1	26.3	25.1	90.6	28.6	3.10
Unweeded check	0	6.2	28.9	15.86	17.0	62.6	28.1	2.17
LSD (P =0.05)	-	1.7	6.6	3.1	2.8	-	-	-

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Influence of long term application of herbicides on productivity of rice-rice cropping system

M.T.Sanjay, T.V. Ramachandra Prasad, R. Devendra and G.R. Hareesh

AICRP on Weed Control, MRS, Hebbal, University of Agricultural Sciences, GKVK, Bangalore, Karnataka 560 065

**Email: mt.sanjay@gmail.com*

Weeds represent one of the major resource consuming and limiting factor in rice production. Due to labour constraints and escalating cost of labour prices, farmers are resorting to use of herbicides which not only gives higher productivity but only saves investment on manual weeding (Srivastava *et al*. 2009). But farmers have their own apprehensions about the impact of long term application of herbicides on the productivity of crops, soil fertility status and its influence on the soil physic-chemical and biological properties.

METHODOLOGY

The 29th rice crop in the sequence of rice-rice cropping system was taken up following recommended agronomic practices using rice cv. *'JGL- 1798'*. The crop was planted on 20-07-2013 and harvested on 36-11-2013. The three weed control treatments tested were butachlor 0.75 kg/ha + 2,4-D EE 0.4 kg/ha (pre- emergence, within 3 days after planting {3 DAP}, applied in sequence) both during *Kharif* and summer,butachlor 0.75 kg/ha + 2,4-D EE 0.4 kg/ha (pre-emergence, within 3 DAP, applied in sequence) during *kharif* followed by pretilachlor 0.75 kg/ha (pre-em, within 3 DAP) during summer and hand weeding twice (20 and 45 days after planting, DAP) during both the seasons along with two sources of fertility *i.e.*, 75% NPK supplied through fertilizer + 25% NPK supplied through FYM (with organic matter, + OM).and 100% NPK supplied through fertilizers only (without organic matter, – OM). The gross and net plot sizes were 10.0 x 11.4 m and 3.6 x 3.0 m, respectively.

RESULTS

Major weed flora observed in the experimental plots was *Cyperus difformis, Fimbristylis miliacea, Scirpus* sp. (sedges), *Panicum dilatatum* and *Echinochloa colona,* (grasses), *Ludwigia parviflora, Dopatrium junceum, Spillanthus acmella, Marselia quadrifoliata. Eclipta alba* and *Glinus oppositifolium* (among broad-leaved weeds). The paddy grain yield recorded in hand weeding treatment (6.11 t/ha) was significantly higher compared to herbicide applied treatments (Table 1). Among herbicide applied plots butachlor + 2, 4-D EE during both *Kharif* followed by pretilachlor 0.75 kg/ha during summer recorded numerically higher grain yield compared to application of butachlor + 2,4-D EE during both summer and *Kharif* indicating the efficacy of the herbicides in effectively controlling sedges and broad leaf weeds (Raju and Gangwar 2004). The sources of fertility levels did not significantly influenced the grain yield of paddy, however continuous application of FYM + fertilizer treatments for the past 29 seasons resulted in higher yield compared to application of only inorganic source of nutrients (Table 1). The interaction effect was not significant.

Table 1. Long term application of herbicides on grain yield, straw yield (t/ha), number of panicles/m^2 and average yield (1999 to 2013) in transplanted rice

Treatment	Paddy yield (t/ha)		Straw yield, t/ha	No. of panicles/m^2
	2013	Average (1999–2013)		
Butachlor 0.75 kg + 2,4-D Na salt 0.4 kg – 3 DAP + With OM	5.69	4.89	9.40	368
Pretilachlor 0.75 kg – 3 DAP + With OM	5.86	5.11	10.32	379
Hand weeding (20 and 45 DAP) + With FYM	6.18	5.13	10.77	398
Butachlor 0.75 kg + 2,4-D Na salt 0.4 kg – 3 DAP + Without OM	5.57	4.83	9.14	359
Pretilachlor 0.75 kg – 3 DAP + Without OM	5.75	5.05	9.96	371
Hand weeding (20 & 45 DAP) + Without FYM	6.02	5.16	10.38	390
LSD(P - 0.05)	NS	NA	NS	NS
Weed management practices				
Butachlor 0.75 kg + 2,4-D Na salt 0.4 kg – 3 DAP	5.63	4.86	9.27	364
Pretilachlor 0.75 kg/ha – 3 DAP	5.80	5.08	10.14	375
Hand weeding (20 and 45 DAP)	6.10	5.14	10.57	394
LSD(P - 0.05)	0.38	NA	1.47	37
Fertility sources				
FYM + Fertilizer dose	5.91	5.05	10.16	382
Fertilizer dose	5.78	5.01	9.82	373
LSD (P - 0.05)	NS	NA	NS	NS

CONCLUSION

Use of herbicides was cheaper than manual weeding and treatment involving application of pretilachlor during summer followed by butachlor + 2,4-D EE during *Kharif* resulted in a saving in weeding cost of ₹ 9,600 compared to manual weeding without much sacrifice in paddy grain yield also no detrimental effects on soil physico-chemical and biological properties.

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Effect of new early post-emergence herbicides on crop growth and weed control in maize

Veeresh Hatti*[1], M.T.Sanjay[2], T.V. Ramachandra Prasad[2], K.N. Kalyana Murthy[1], Basavaraj Kumbar[1] and Gururaj Kombali[1]

[1]*Department of Agronomy, University of Agricultural Sciences, GKVK, Bangalore, Karnataka 560065,* [2]*AICRP on Weed Control, MRS, Hebbal, Bangalore, Karnataka 560 065*

**Email: veereshshatti@gmail.com*

Maize is an important cereal and becoming popular in majority of irrigated areas of Karnataka because of its higher profitability with its higher yield potential. In maize, most dominant factor for yield reduction are weeds which competes for various growth resources with crop for nutrients, water, sunlight and space. Thus yield losses due to season long weed infestation range from 30 per cent to complete crop failure in maize (Pandey *et al*. 2001). At preset days, the farmers are facing very difficulty in finding laborers at their affordable prices and time. Under these circumstances use of herbicides to manage weeds forms an appropriate alternative strategy to manual weeding.

METHODOLOGY

An experiment was carried out during *Kharif* 2012 at University of Agricultural Sciences, Hebbal, Bangalore, Karnataka, India to study the effect of new early post-emergence herbicides on crop growth and weed control in maize. The experiment was laid out in RCBD with fourteen treatments replicated thrice. The treatments were pre-emergence (atrazine, oxyflurofen and pendimethalin), post-emergence (topramezone, 2, 4-D and tembotrione) herbicides and their combinations (topramezone + atrazine with and without adjuvants) which were compared with farmer's practices of intercultivation, hand weeding and weedy check.

The seeds of Nityashree '*NAH 2049*' maize hybrid released by UAS, Bangalore were sown at a spacing of 60 cm between rows and 30 cm between seed to seed within the row with the seed rate of 15 kg /ha. Recommended dose of FYM at 10 t/ ha, $ZnSO_4$ at 10 kg/ ha and inorganic fertilizers (150: 75: 40 kg N, P_2O_5 and K_2O /ha) were applied to maize.

RESULTS

Significant difference has been found in leaf, stem, cob, total dry weight and kernel yield due to the application of different weed management practices (Table 1). Significantly higher leaf, stem, cob and total dry weight of plants at harvest were observed in treatment oxyflurofen 23.5 EC – 200 g /ha at 3 DAS followed by 2, 4-D Na salt 80 WP – 500 g / ha at 30 DAS (27.23, 54.67, 233.07 and 314.97 g /plant, respectively

Significantly higher kernel yield and net returns were noticed in oxyflurofen at 200 g /ha followed by 2,4-D at 500 g/ha (6.11 t/ha and ₹ 61,013/ ha, respectively) which was found on par with two hand weeding (6.08 t/ha and ₹ 57,790/ ha, respectively), topramezone 33.6 SC -25.2 g /ha+ atrazine 50 WP - 250 g/ha with (5.86 t/ha and ₹ 58,877/ha, respectively) and without MSO adjuvant at 2 ml/l (5.70 t/ha and ₹ 56,688/ha, respectively) when compared to weedy check (2.16 kg/ha and ₹ 8,238/ha, respectively). This higher dry matter production and kernel yield are attributed to reduced crop weed competition which improved crop growth and yields have resulted in higher net returns. These findings are in confirmatory with the Ahmed and Susheela (2012).

Table 1. Dry matter accumulation, distribution (g/ plant) and kernel yield (t/ha) in maize as influenced by weed management practices

Weed management practices	Kernel yield (t/ha)	Net returns (x10³₹ /ha)
Topramezone 33.6 SC at 16.8 g/ha + atrazine 50 WP at 250 g/ha	4.89	45.43
Topramezone 33.6 SC at 21.0 g/ha + atrazine 50 WP at 250 g/ha	5.31	51.40
Topramezone 33.6 SC at 25.2 g/ha + atrazine 50 WP at 250 g/ha	5.70	56.68
Topramezone 33.6 SC at 16.8 g/ha + atrazine 50 WP at 250 g/ha + MSO adjuvant at 2 ml/ l	4.63	41.89
Topramezone 33.6 SC at 21.0 g/ha + atrazine 50 WP at 250 g/ha + MSO adjuvant at 2 ml /l	5.36	52.02
Topramezone 33.6 SC at 25.2 g/ha + atrazine 50 WP at 250 g/ha + MSO adjuvant at 2 ml /l	5.86	58.87
Topramezone 33.6 SC at 25.2 g/ha	2.97	18.85
Atrazine 50 WP at 1000 g/ha	4.63	41.98
Oxyflurofen 23.5 EC at 200 g/ha + 2,4-D Na 80 WP at 500 g / ha	6.10	61.01
Pendimethalin 30 EC at 750 g/ha+ 2,4-D Na 80 WP at 500 g /ha	5.46	49.16
Tembotrione 42 SC at 105 /ha + isoxadifen-ethyl 21 SC at 52 g/ha + stefes mero adjuvant at 2.5 ml/l	5.59	53.67
Two intercultivations at 20 and 40 DAS	5.41	50.72
Two hand weedings at 20 and 40 DAS	6.08	57.79
Weedy check	2.15	8.23
LSD(P=0.05)	0.68	

DAS-Days after sowing, NA-Not Analyzed

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Effect of weed management practices on barrenness per cent, growth physiology and kernel yield of maize

Veeresh Hatti*[1], M.T.Sanjay[2], T.V. Ramachandra Prasad[2], K.N.Kalyana Murthy[1], Basavaraj Kumbar[1] and Gururaj Kombali[1]

[1]*Department of Agronomy, University of Agricultural Sciences, GKVK, Bangalore, Karnataka 560065, [2]AICRP on Weed Control, MRS, Hebbal, Bangalore Karnataka 560 065*

**Email: veereshshatti@gmail.com*

Maize (Zea mays L.) is one of the most important cereal crops used as both food and fodder crop. Maize kernels are used for human consumption, feed for poultry and livestock, extraction of edible oil and also for starch and glucose industry. The presence of weeds reduces the photosynthetic efficiency, dry matter production and distribution to economical parts and there by reduces sink capacity of crop resulting in poor kernel yield. Thus, the extent of reduction in kernel yield of maize has been reported to be in the range of 33 to 50 per cent depending on the intensity and persistence of weed density in standing crop (Sharma *et al*. 2003).

METHODOLOGY

An experiment was carried out during *Kharif* 2012 at Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore, Karnataka, India to study the effect of weed management practices on barrenness per cent, growth physiology and kernel yield of maize. The experiment was laid out in RCBD with fourteen treatments replicated thrice. The treatments were pre-emergence (atrazine, oxyflurofen and pendimethalin), post-emergence (topramezone, 2,4-D and tembotrione) herbicides and their combinations (topramezone + atrazine with and without adjuvants) which were compared with farmer's practices of intercultivation, hand weeding and weedy check. The seeds of Nityashree (*NAH 2049*) maize hybrid released by UAS, Bangalore were sown at a spacing of 60 cm between rows and 30 cm between seed to seed within the row with the seed rate of 15 kg/ha

RESULTS

Among different treatments, pre-emergence application of oxyflurofen 23.5 EC–200 g/ha at 3 DAS followed by post-emergence application of 2,4-D Na salt 80 WP – 500 g/ha at 30 DAS, recorded significantly higher kernel yield (6107 kg/ha) and detailed in Table 1.

The higher kernel yield obtained in oxyflurofen at 200 g/ha at 3 DAS + 2,4-D at 500 g/ha was due to higher growth attributes such as LAI, LAD, NAR with lower barrenness per cent followed by two hand weeding at 20 and 40 DAS owing to minimum crop-weed competition throughout the crop growth period. As a result of this, maize showed maximum utilization of nutrients, moisture, light and space which had influence the growth and yield components as quoted by Patel *et al.* (2006).

Table 1. Barrenness per cent, LAI, LAD (Days), NAR (10^{-4} g /cm^2/day) and kernel yield (kg/ha) in maize as influenced by weed management practices

Weed management practices	Barrenness (%)	LAI at 60 DAS	Between at 60-90 DAS: LAD (Days)	Between at 60-90 DAS: NAR (10^{-4} g/ cm^{-2}/ day)	Kernel yield (t/ha)
Topramezone 33.6 SC at 16.8 g/ha + atrazine 50 WP at 250 g/ha	0.60	2.65	84.99	3.46	4.89
Topramezone 33.6 SC at 21.0 g/ha + atrazine 50 WP at 250 g/ha	0.48	2.78	87.59	3.63	5.31
Topramezone 33.6 SC at 25.2 g/ha + atrazine 50 WP at 250 g/ha	0.26	2.94	93.96	4.17	5.70
Topramezone 33.6 SC at 16.8 g/ha + atrazine 50 WP at 250 g/ha + MSO adjuvant at 2 ml/l	0.16	2.63	82.41	3.35	4.63
Topramezone 33.6 SC at 21.0 g/ha + atrazine 50 WP at 250 g/ha+ MSO adjuvant at 2 ml/l	0.41	2.81	90.06	3.61	5.36
Topramezone 33.6 SC at 25.2 g/ha + atrazine 50 WP at 250 g/ha+ MSO adjuvant at 2 ml/l	0.20	3.06	97.46	4.21	5.86
Topramezone 33.6 SC at 25.2 g/ha	0.22	2.18	71.35	2.98	2.97
Atrazine 50 WP at 1000 g/ha	0.68	2.57	80.95	3.47	4.63
Oxyflurofen 23.5 EC at 200 g/ha + 2,4-D Na 80 WP at 500 g/ha	0.11	3.62	114.11	3.85	6.10
Pendimethalin 30 EC at 750 g/ha + 2,4-D Na 80 WP at 500 g /ha	0.31	3.33	103.94	3.38	5.46
Tembotrione 42 SC at 105 g/ha + isoxadifen-ethyl 21 SC at 52 g /ha + stefes mero adjuvant at 2.5 ml/l	0.29	2.99	96.58	3.92	5.93
Two intercultivations at 20 and 40 DAS	0.17	3.33	103.64	3.08	5.41
Two hand weedings at 20 and 40 DAS	0.15	3.50	107.48	3.89	6.08
Weedy check	1.05	1.61	52.73	3.09	2.15
LSD(P=0.05)	0.05	0.42	12.23	0.56	0.685

DAS-Days after sowing, LAI-Leaf Area Index, LAD-Leaf Area Duration, NAR-Net assimilation Rate

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Effect of imazethapyr and pendimethalin on nodulation and yield in groundnut

C. Sudharshana*[1] and T Ram Prakash[2]

[1]*Department of Soil Science and Agriculture Chemistry UAS Raichur, Karnataka 584 101.*
[2]*AICRP on Weed Control Rajendra Nagar, Hyderabad Andhra Pradesh 500 030.*
**Email: sudi.gc@gmail.com*

Weeds are a persistent menace in cropping systems. With labor getting expensive, farmers have turned to use of herbicides for managing weeds. Other than helping farmers, herbicides can affect other processes lie nodulation, knowledge of which is less. The present experiment was proposed to study the effect of Imazethapyr and Pendimethalin on nodulation and yield in groundnut.

METHODOLOGY

The experiment was conducted during *Kharif,* 2011 on sandy clay loam soil at College of Agriculture, Rajendranagar, Hyderabad. The experiment was laid out in split plot design with 2 main treatments as *Rhizobium* un inoculated and inoculated at recommended dose (1 kg / ha). Sub treatments as herbicide dosages, *viz.* weedy check, pendimethalin at two doses 750 g/ha and 1500 g /ha, Imazethapyr at two doses 75 g /ha and 150 g /ha. Five plants that were collected were used to count number of nodules and the number of active nodules at an interval of 15, 30, 45, 60 and 90 DAS. The pod yield and haulm yield was also recorded.

RESULTS

The total number of nodules per plant increased up to 60 DAS with a rapid increase between 30 and 60 DAS. After 60 DAS the increase in nodule number was low up to 90 DAS. Application of pendimethalin doses did not adversely affect the total nodule count or active nodule count and application imazethapyr at double dosage resulted in significantly lower total nodule and active nodule up to 45 DAS. *Rhizobium* seed inoculation had positive impact on total number of root nodules up to 45 DAS and positive effect could be witnessed in case of active nodules through crop growth period. Highest pod yield was recorded with Imazethapyr at recommended dosage of inoculated main treatment. *Rhizobium* seed inoculation did not influence the pod yield (Table 1). In spite of better weed control in imazethapyr double dose treatment the phytotoxicity observed during 1-2 weeks after spray might have resulted in lower nodulation, nitrogen fixation and consequently lower yields.

Table 1. Pod yield and haulm yield of groundnut as influenced by inoculation and herbicide treatments

Treatment Inoculation (M)	Herbicide treatments (S)				
Pod yields in t/ha	S_1	S_2	S_3	S_4	S_5
Un inoculated (M_1)	0.64	1.49	1.54	2.12	2.08
Inoculated (M_2)	0.82	1.61	1.64	2.28	2.16
Mean	0.73	1.55	1.59	2.20	2.12
	LSD(P=0.05)				
Main(M)	N.S				
Sub(S)	0.11				
S at same level of M	N.S				
M at same level of S	N.S				
Haulm yield in kg/ha					
Un inoculated (M_1)	0.56	2.02	2.16	2.44	2.59
Inoculated (M_2)	0.59	2.08	2.26	2.46	2.63
Mean	0.57	2.05	2.21	2.45	2.61
	LSD (P=0.05)				
Main(M)	N.S				
Sub(S)	0.08				
S at same level of M	N.S				
M at same level of S	N.S				

CONCLUSION

Seed treatment with *Rhizobium* in groundnut significantly influences the total nodule number up to 45 DAS and active nodules throughout the crop growth period. Despite better weed control achieved in imazethapyr double dose treatment, highest pod yield was recorded in Imazethapyr at recommended dose where seed inoculation was done compared to Imazethapyr double dose.

Integrated weed management in raya

Tarundeep Kaur*, Rajender Kumar, U S Walia, Rupinder Kaur and M S Bhullar
Department of Agronomy, PAU, Ludhiana, Punjab 141 004
**Email: tarundhaliwal@pau.edu*

Indian mustard (*Brassica juncea*) is an important *Rabi* oilseed crop. Weeds pose serious threat to seed yield due to competition for nutrients, moisture, light and space which may go up to 62% (Singh 1992). Hand weeding is not feasible being costly and difficult affair as the operation coincides with sowing of other *Rabi* crops. Moreover, wages are also sky rocketing these days. So an experiment was planned with the objective to work out a suitable weed control measure in Indian mustard.

METHODOLOGY

The experiment was laid out on the Research Farm, Department of Agronomy, Punjab Agricultural University, Ludhiana during *Rabi* 2010 with ten treatments in Randomized Block Design to evaluate the bioefficacy of different herbicides in raya. The crop was sown on 19.11.2010 with variety *'RLM 619'* by using 3.75 kg / ha seed and harvested on 18.4.2011. The herbicide treatments were UPH 1110 at 0.75, 1.0, 1.25, 1.5 and 2.5 kg / ha (post), clodinafop 400g / ha (post), isoproturon 1.0 kg / ha (pre), treflan 1.0 l / ha (pre plant)+HW, two hand weedings (after third week of sowing and thereafter) and unweeded control. The herbicides were applied with knap sack sprayer fitted with flat fan nozzle. The data on dry matter accumulation were recorded from two spots at harvest using 50 × 50cm quadrat.

RESULTS

The weed flora in the experimental field were *Phalaris minor*, *Anagallis arvensis, Lepidium sativa, Medicago denticulate, Melilotus alba, Rumex dentatus.* Post-emergence application of UPH 1110 at 0.75, 1.0, 1.25, 1.5 and 2.5 kg / ha resulted in significant reduction in dry matter of weeds as compared to unweeded control. All the doses of UPH herbicide showed higher toxicity on raya crop due to which no dry matter of weeds was observed in these treatments. The maximum seed yield was observed in treflan at 1.0 l / ha integrated with one hand weeding (55 DAS) and was at par with two hand weedings which was statistically at par with isoproturon at 1.0 kg / ha. The seed yield was at par in case of isoproturon and clodinafop treatments. All the doses of UPH recorded significantly lower seed yield as compared to recommended herbicide treatments due to toxic effect of this herbicide on crop. Significantly more dry matter was recorded in unweeded control as compared to other treatments. These results confirm the findings of Yadav *et al.* (1999).

CONCLUSION

The use of UPH 1110 at 0.75, 1.0, 1.25, 1.5 and 2.5 kg / ha was not safe in raya.

Table 1. Effect of different herbicide treatments on raya

Treatment	Dose (kg / ha)	Total weed dry wt. at harvest (t / ha)	Seed yield (t / ha)
Treflan + HW (55 DAS)	2.5	5.6 (31.3)	1.81
UPH 1110	0.750	1.0 (0.0)	1.42
UPH 1110	1.0	1.0 (0.0)	1.27
UPH 1110	1.25	1.0 (0.0)	0.95
UPH 1110	1.5	1.0 (0.0)	0.88
UPH 1110	2.5	1.0 (0.0)	0.73
Clodinafop	0.400	7.7 (57.7)	1.48
Isoproturon	1.0	5.7 (32.0)	1.73
Two hand weedings	-	1.0 (0.0)	1.80
Unweeded Control	-	11.1 (123.3)	1.38
LSD (P=0.05)	-	0.9	0.3

Figures within brackets are original means and data is subjected to square root transformation

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Efficacy of weed management practices in mungbean production

C.B. Khairnar, V.V.Goud*, H.N.Sethi and A.N.Patil

Pulses Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104

**Email: vikasgoud08@yahoo.com*

Weed management is an important factor for enhancing the productivity of mungbean as weeds compete for nutrients, water, light and space with crop during early growth period. Yield losses in mungbean due to weeds have been estimated to range between 30-50% (Kumar *et al*. 2004). Mechanical practices such as hand weeding and inter culturing are effective but unavailability of labour, and incessant rains during the early crop season normally limit the weeding operations. Therefore chemical weeding under such circumstances become indispensible and can be the excellent alternate. Pendimethalin is only recommended pre-emergence herbicide in mungbean and controls weed by inhibiting seedling development, it will not control the established weeds. Higher the moisture content of soil, better the control efficacy of pre-emergence herbicides. Manual weeding is some time difficult in rainy season for efficient weed control. This warrants the use of pre- and post-emergence herbicides for weed control, therefore, herbicides were used in alone and in combinations to widen the weed-control spectrum, including grasses and broad-leaf weeds and their phytotoxicity, if any, to the crop. The present study was, therefore, conducted to evaluate the effect of different herbicides for mungbean, which can be cost effective and acceptable to the growers of this crop.

METHODOLOGY

A field experiment on mungbean cultivar '*PKV Green gold''AKM-9911'* during the *Kharif* season. The soil of experimental site is clayey with pH 7.8, medium in available nitrogen, phosphorous, potassium and organic carbon. All the herbicides alone or in mixture were applied 20 days after sowing (DAS) with knapsack sprayer fitted with flat-fan nozzle using 500 litres water / ha. The phytotoxicity scoring was taken as per the method suggested by Rao (2000). The total rainfall received during the crop growth was 552.3 mm in 28 rainy days during 2010-11.

RESULTS

The maximum increase in seed yield occurred at 0.100 kg / ha (1.24 t / ha) of imazethapyr followed by 0.075 kg / ha of imazethapyr (1.19 t / ha) whereas imazethapyr + imazamox at both the levels decreased the seed yield. Imazethapyr 0.100 and 0.075 kg / ha, imazethapyr + imazamox 0.100 kg / ha produced 70.77, 67.71 and 67.62 per cent weed efficiency, respectively). Imazethapyr 0.100 kg / ha increased the number of nodules found per plant followed by imazethapyr 0.075 kg / ha at 20-25 days after seeding the mungbean. In contrast, the tested dose rates of imazethapyr + imazamox significantly reduced the nodulation. Imazethapyr 0.100 kg / ha gave more economic profit (₹ 30,370 / ha) followed by imazethapyr 0.075 kg / ha (₹ 28,776 / ha), however, higher BCR was

obtained with imazethapyr 0.100 kg / ha (2.29) followed by imazethapyr 0.075 kg / ha (2.24). Among the herbicides tested, imazethapyr + imazamox as post-emergence showed a large degree of phytotoxicity to the crop and inhibiting its vegetative growth and thus incompatible with mungbean. Amid pre-emergence herbicides pemdimethalin + imazethapyr recorded slight degree of phytotoxocity like stunted growth over pemdimethalin treated plot but which in return proves to be advantageous as the cultivar is tall growing prevent its lodging at maturity. The microbial population at harvest of mungbean due to different herbicides did not influenced significantly. Quizalofop-ethyl and fenoxoprop-ethyl did not provide satisfactory weed control in mungbean fields.

CONCLUSION

It was concluded that imazethapyr 0.075 kg / ha applied 20-25 days after sowing was the most remunerative and effective herbicide for controlling the complex weed flora in mungbean under eastern Maharashtra conditions.

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Evaluation of clodinafop against grassy weeds in wheat

S. S. Punia*, Anil Dhaka and V. S. Hooda

Department of Agronomy, CCS Haryana Agricultural University, Hisar, Haryana 125 004

Email: puniasatbir@gmail.com

Wheat is an important crop of Haryana grown on around 25 lakh ha area. *Phalrais minor* and *Avena ludoviciana* are the most important grassy weeds of wheat responsible for reducing productivity of wheat. *P. minor* developed resistance to isoproturon herbicide in early 90's (Malik and Singh 1995) and its efficacy against *A. ludoviciana* is poor if applied at 30-35 DAS. So, alternate herbicides *viz.* clodinafop, sulfosulfuron, fenoxaprop were recommended in 1998 for the control of resistant *P. minor* and other grassy weeds. In the present experiment, new formulation of clodinafop (Clodinafop 24% EC) manufactured by Chemtura Chemicals India Pvt. Ltd. was evaluated against grassy weeds in wheat and compared with clodinafop (Topik 15 WP) already recommended for use in Haryana state.

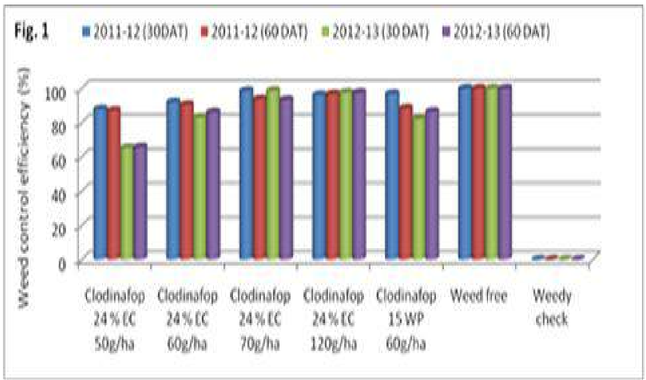
METHODOLOGY

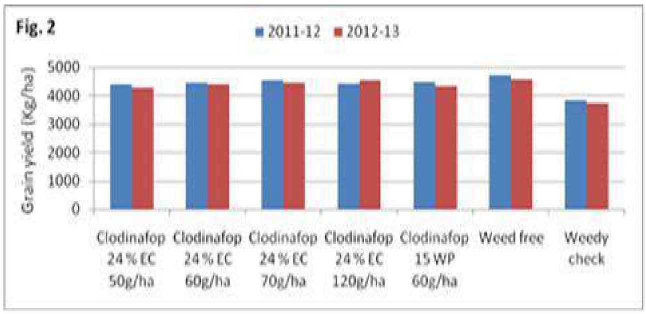
To evaluate the bioefficacy and phytotoxicity of herbicide clodinafop 24% EC against grassy weeds in wheat, a field experiment as per protocol consisting of eight treatments replicated thrice in a randomized block design was conducted at CCS HAU, Hisar during *Rabi* 2011-2012 and 2012-13. Soil of the experimental field was sandy loam in texture, low in available N, medium in P_2O_5 and high in available K_2O, with slightly alkaline in reaction (pH 8.2). Wheat variety '*PBW 502*' was sown on 2.12. 2011 and WH 542 was sown on 25.11. 2012 using a seed rate of 100 kg/ha. All the herbicidal treatments were applied at 35 DAS with the help of knapsack sprayer fitted with flat fan nozzle using a spray volume of 375 l/ha. The crop was raised as per recommended package of practices of wheat for Haryana state. The data on density and dry weight of weeds was recorded at 30 and 60 DAT (days after treatment) and yield attributes and grain yield of wheat were recorded at harvest. Based on dry wt. of *P. minor*, weed control efficiency (WCE%) was calculated.

RESULTS

Weed flora of the experimental field consisted of both grassy and broad leaf weeds. Among grassy weeds *P. minor* and *A. ludoviciana* were found to infest experimental area constituting 70% of the total weed population. Among broad leaf weeds were C*henopodium album, Rumex dentatus* and *Coronopus didymus*.

Clodinafop 24% EC at all application rates (50-120 g/ha) was very effective in controlling *P. minor* and *A. ludoviciana* (Fig. 1). WCE calculated on the basis of dry weight of weeds at 30 DAT revealed that clodinafop 24% EC at 60 g/ha exhibited 92% and 83.2% control of grassy weeds as against 96.9% and 79.9% control by clodinafop 15% WP (Topik) during 2011-12 and 2012-13, respectively, which remained consistent up to 60 DAT (Punia *et al.* 2012). Presence of weeds throughout the crop season caused 18.7% reduction in grain yield of wheat. Grain yield with use of clodinafop 24% EC at 60 g/ha





was 4.46 kg/ha and 4388 kg/ha which was at par with recommended brand of clodinafop 15% WP (Topik) with 4.49 t/ha and 4.44 t/ha during 2011-12 and 2012-13, respectively.

CONCLUSION

Based on bioefficacy studies, it was realized that post emergence application of a new brand of clodinafop 24% EC at 60 g/ha was very effective to control *P.minor* and *A. ludoviciana* in wheat crop and its efficacy was at par with already recommended clodinafop 15% WP (Topik).

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Evaluation of imazethapyr and quizalofop-ethyl herbicides in chickpea

V.V. Goud*, N.B.Murade, M.S. Khakre and A.N. Patil

Pulses Research Unit, Dr.Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104

**Email: vikasgoud08atyahoo.com*

Chickpea is well adapted to black soil zone of Maharashtra mostly in rotation with soybean, mungbean and urdbean. Increasing irrigation potential owing to use of sprinkler method of irrigation and lack in pragmatic use further exacerbates the weed problem and growers in those areas are still challenged by limited options for weed management. Chickpea, however, is a poor competitor to weeds because of slow growth rate and limited leaf area development at early stages of crop growth and establishment. Excessive weed competition may adversely affect seed size which is an important quality parameter in *kabuli* chickpea or macrocarpa type chickpea. The predominant method of weed control by mechanical hoeing and manual weeding over extensive scale is found decline because of escalating wages. There is, therefore, an urgent need to move from the costly manual-mechanical weed control to chemical weed control for winter sowing. The study was done to evaluate performance of imazethapyr and quizalofop-ethyl herbicides in chickpea.

METHODOLOGY

A field experiment was conducted during *Rabi* season of 2009-10 and 2010-11 on growth and yield of *kabuli* chickpea cultivar '*KAK-2'*. The soil of experimental site is clayey in texture, medium in available nitrogen, phosphorous, potassium and organic carbon. The N and P through urea and diammonium phosphate were applied as basal at sowing. Two protective irrigations at branching and pod filling stage were given excluding pre-sowing irrigation for establishment of optimum plant stand. The total rainfall received during the crop growth was 148.4 and 40.5 mm in 7 and 2 rainy days during 2009-10, 2010-11, respectively.

RESULTS

Among herbicides, highest yield and yield attributes, viz. branches / plant, pods / plant, seed weight / plant and 100-seed weight were recorded with application of imazethapyr (IM) and quizalofop-ethyl (QE) 0.075 kg / ha at 25 and 35 DAS, respectively, over weedy check. However, application of higher dose of same herbicides (0.100 kg / ha) reduced the plant height, branches / plant, pods / plant, seed weight / plant and root nodules over lower doses of herbicides (0.050 kg / ha), on the contrary 100-seed weight increased over application of reduced doses. The post-emergence application of IM and QE 0.050 kg / ha at 25 and 35 DAS was inefficient in effective control of weeds but at higher rate of application 0.075 and 0.100 kg / ha was effective.. Toxicity was more with IM as compared to QE at all rates of application. Chickpea injury was minimal at 35 days after application at all rates, which was insignificant with lower dose of 0.050 kg / ha, however, which was inefficient for effective weed control.

CONCLUSION

It can be concluded that at higher concentration, IM and QE affect growth and yield of chickpea cv '*KAK-'2* and lower concentrations were inefficient for effective weed control. The results obtained from the current study indicated that there is need to change in herbicide selection or application method in order to have better weed control particularly weeds like *Cyperus rotundus* and *Convolvulus arvensis* without any phytotoxicity on chickpea.

Table 1. Yield, ancillary parameters and phytotoxicity scoring of chickpea as influenced by different treatments (Mean of two years)

Treatment	Yield (t / ha)	Phytotoxicity scoring at 40DAS	No of root nodule	Fresh weight of nodule (mg / plant)	Dry weight of nodule (mg / plant)	Pods / plant	Seed weight / plant (g)	100-seed weight (g)
Weedy check	1.67	00	17.3	178	65	43.6	12.0	37.32
HW twice at 25 and 35 DAS	2.49	00	18.7	175	68	56.5	20.5	40.51
Quizalofop-ethyl at 0.050 kg / ha at 25 DAS	1.99	00	15.8	162	48	48.4	17.0	39.27
Quizalofop-ethyl at 0.050 kg / ha at 35 DAS	1.99	00	20.4	166	53	46.7	16.7	37.64
Quizalofop-ethyl at 0.075kg / ha at 25 DAS	2.12	0.50	14.0	153	40	54.7	17.3	38.92
Quizalofop-ethyl at 0.075 kg / ha at 35 DAS	1.96	0.50	18.0	158	42.5	52.9	18.5	38.69
Quizalofop-ethyl at 0.100 kg / ha at 25DAS	1.90	1.0	6.6	65	32.5	50.1	17.7	39.45
Quizalofop-ethyl at 0.100 kg / ha at 35DAS	1.85	1.0	13.7	80	40	47.3	17.0	39.10
Imazethapyr at 0.050 kg / ha at 25 DAS	1.94	00	15.0	126	33	47.6	16.8	38.73
Imazethapyr at 0.050 kg / ha at 35 DAS	1.81	00	19.6	139	48	45.2	15.9	38.65
Imazethapyr at 0.075 kg / ha at 25 DAS	2.09	0.5	13.7	75	25	51.2	17.6	38.81
Imazethapyr at 0.075 kg / ha at 35 DAS	2.00	0.5	18.7	102	40	48.5	16.7	38.73
Imazethapyr at 0.100 kg / ha at 25 DAS	2.09	1.0	5.0	13.5	4.8	49.8	16.6	39.14
Imazethapyr at 0.100 kg / ha at 35 DAS	2.11	1.0	12.0	47	14	46.7	16.0	38.75
LSD (P=0.05)	0.053	--	4.14	0.01	0.01	2.9	2.84	NS

Weed management with post-emergence application of imazethapyr in lentil and field pea

Guriqbal Singh* and Navneet Aggarwal
Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, Punjab 141 004
**Email: singhguriqbal@pau.edu*

Weeds are the major constraint to increase lentil (*Lens culinaris*) and fieldpea (*Pisum sativum*) yield. No post-emergence herbicide has been identified for both the crops in India. Imazethapyr has both soil and foliar activity, which allows flexibility in its application timing (Tan *et al.* 2005). Post-emergence application of imazethapyr has the potential for weed control in field pea (Fraser *et al*. 2003). Cultivars of a crop may differ in tolerance to herbicides. Therefore, the present investigation was carried out to study weed management with imazethapyr in different cultivars of lentil and field pea.

METHODOLGY

Two field experiments were conducted at Punjab Agricultural University, Ludhiana during winter season of 2008-09 on loamy sand soil in a split plot design. The experiment comprised eight weed control treatments [Imazethapyr at three doses, *i.e.* 50, 75 and 100 g/ha sprayed 30 or 45 days after sowing (DAS), two hand weedings (30 and 60 DAS) and unweeded control] in the main plots and three lentil cultivars ('*LL 147*', '*LL 699*' and '*LL 931*') in first experiment and two field pea cultivars ('*Field pea 48*' and '*PG 3*') in second experiment in the sub plots. The sowing was done in 14th November 2008. All the production and protection technologies were adopted as per the recommendations. Data on weed growth, phytotoxicity, yield performance and economics were recorded.

RESULTS

In lentil as well as field pea, visual observations showed that when imazethapyr was sprayed at 30 or 45 DAS 50, 75 or 100 g/ha, it caused toxicity, which increased with increase in the dose. However, the crop recovered later on. All lentil and field pea cultivars showed similar response to imazethapyr. Post-emergence application of imazethapyr 50 g/ha has been found safe to field pea

The major weed flora included *Medicago denticulata, Anagalis arvensis, Spergula arvensis* and *Lepidium sativum*. In both the crops, the dry matter of weeds was reduced with increasing dose of imazethapyr from 50 to 100 g/ha sprayed at 30 or 45 DAS (Table 1). In lentil, two hand weedings (30+60 DAS) recorded significantly higher grain yield than all other treatments, whereas in fieldpea, imazethapyr 100 g at 30 DAS gave statistically similar grain yield as recorded in two hand weedings. In lentil, compared to 1536 kg/ha grain yield in two hand weeding treatment, the highest yield (1.30 t/ha) among imazethapyr treatments was with 75 g/ha 45 DAS. In fieldpea, two hand weeding provided 2.22 t/ha grain yield whereas highest yield (1.94 t/ha) among imazethapyr treatments was with imazethapyr 100 g/ha 30 DAS. Amongst lentil cultivars, '*LL 931*' and between fieldpea cultivars, '*Fieldpea 48*' gave significantly higher grain yield than other cultivars. The highest net returns were recorded with two hand weedings in both the crops.

Table 1. Effect of dose and timing of application of imazethapyr on weeds, yield and economics of lentil and fieldpea

Treatment	Dry weight of weeds at harvest (t/ha)		Biological yield (t/ha)		Grain yield (t/ha)		Net returns (x10³₹/ha)	
	Lentil	Fieldpea	Lentil	Fieldpea	Lentil	Fieldpea	Lentil	Fieldpea
Imazethapyr 50 g/ha 30 DAS	1.56	1.95	3.58	6.11	1.01	1.57	20.05	27.18
Imazethapyr 75 g/ha 30 DAS	1.43	1.50	4.23	6.01	1.25	1.66	28.30	29.58
Imazethapyr 100 g/ha 30 DAS	1.56	1.30	3.42	6.25	1.04	1.94	20.87	37.05
Imazethapyr 50 g/ha 45 DAS	2.43	2.60	3.88	4.49	1.00	1.34	19.70	20.82
Imazethapyr 75 g/ha 45 DAS	1.83	1.85	4.67	4.35	1.30	1.57	30.12	27.03
Imazethapyr 100 g/ha 45 DAS	1.66	1.50	3.58	5.00	0.96	1.57	18.32	26.88
2 Hand weeding (30+60 DAS)	0.60	1.05	5.71	6.62	1.53	2.22	34.51	41.05
Unweeded check	2.90	2.55	2.70	3.61	0.83	0.99	14.41	11.80
LSD (P=0.05)	0.23	0.43	0.87	0.81	0.15	0.30		

CONCLUSION

In field pea, post-emergence application of imazethapyr was found promising.

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Weed management in maize based intercropping system

Gajanan Laxmanrao Kadam* and A.D. Pandagale
Rajiv Gandhi Agriculture college, Affiliated to VNMKV, Parbhani, Maharashtra 431 401
**Email: kadam.gajananat@gmail.com*

Maize is an important crop. Being produced all over the world, it still faces competition by weeds in the field. Though well known that hand weeding gives the best results, current status of expensive manpower does not permit it. This has made famers use herbicides for managing weeds

METHODOLOGY

The research trial was conducted at Agriculture College Farm, Dept. of Agronomy, Marathwada Agriculture University, Parbhani. The experiment was laid out in split plot design with three replications (Table 1).

RESULTS

The grain yield (t/ha) of maize was also influenced by sole cropping systems. Significantly higher maize grain yield (t/ha) was recorded by sole maize compared to maize intercropped with soybean or black gram. Intercropping of maize with blackgram was next best which was significantly superior over maize yield (t/ha) in maize + soybean intercropping system. The lowest values of weed count and weed dry matter were recorded in maize + soybean and maize + blackgram than sole maize. In case of the weed smothering efficiency between soybean and blackgram the soybean crop was found to be highest (65.47 per cent) in smothering weeds as compared to the blackgram (46.20 per cent). The highest weed control efficiency (WCE) was recorded by application of fluchloralin 1.35 kg/ha 91.41 and 90.51 per cent during 2005-06 and 2006-07 respectively. Highest weed index was recorded by weedy check (57.77 and 60.28 per cent) which indicated the highest grain yield loss recorded by the treatment.

CONCLUSION

In cropping system sole maize recorded significantly higher growth, yield attributes and grain yield than maize intercropped with soybean or black gram and Maize + blackgram intercropping system was on par with maize + soybean and recorded significantly higher maize equivalent yield and monetary returns (₹/ha) than sole maize. In weed management Pre-plant incorporation of fluchloralin 0.90 kg/ha *fb* 1 HW and H at 6 WAS was on par with fluchloralin 1.35 kg/ha and recorded significantly higher growth, yield attributes and grain yield than rest of the weed management practices.

Table 1. Grain yield of maize (t/ha) as influenced by different treatments 2005-06, 2006-07 and pooled

Treatment	Grain yield (t/ha)		
	2005-06	2006-07	Pooled
Cropping systems			
M_1- Sole maize	7.28	7.62	7.45
M_2- Maize + Soybean	6.27	6.68	6.48
M_3- Maize + Black gram	6.80	7.14	6.97
LSD (P=0.05)	0.31	0.41	0.36
Weed management			
W_1- Fluchloralin at 1.35 kg/ha	7.98	8.46	8.22
W_2- Fluchloralin at 0.90 kg/ha *fb* 1 HW and H at 6 WAS	8.20	8.58	8.39
W_3- Pendimethalin at 1.00 kg/ha	7.10	7.55	7.32
W_4- Pendimethalin at 0.75 kg/ha *fb* 1 HW and H at 6 WAS	7.44	7.88	7.66
W_5- 2 H + 2 HW at 3 & 6 WAS	6.63	6.84	6.73
W_6- Weed free	6.88	7.10	6.99
W_7- Weedy check	3.25	3.62	3.44
LSD(P=0.05)	0.40	0.60	0.49
Interaction (M x W)			
LSD(P=0.05)	N.S.	N.S.	N.S.
General mean	6.78	7.15	6.96

Effect of weed management on productivity of transplanted rice

Sumana Ghosh*, G.C.Malik and Mahua Banerjee

Institute of Agriculture, Visva-Bharati, Sriniketan, Birbhum, West Bengal 731 236

**E-mail: sumana.agroatgmail.com*

Rice, the most important staple food crop of India is cultivated under various ecosystems. In transplanted rice, weed infestations reduce the grain yield and quality. Though many pre-emergence herbicides are available for controlling weeds, the need for post-emergence herbicide is often realized to combat the weeds emerged during later stages of crop growth specially under scarcity of labour. Keeping this in view, an experiment was carried out to study the effect of weed management on productivity of transplanted rice.

METHODOLOGY

A field experiment was conducted during *Kharif* 2011 at Chella, Kamarpara, Birbhum district of West Bengal. The experiment was laid out in randomized complete block design replicated three timesand consisted of twelve weed management treatments (Table 1). The recommended dose of fertilizers (N:P:K-80:40:40) was used for the experiment. The seedlings of variety *'MTU-7029* and *Swarna'* were transplanted at 20 x 15cm spacing.

RESULTS

All the weed management practices significantly reduced total weed density and dry weight compared to weedy check. The weed controlling effect of bispyribac sodium applied plot was higher than all pre-emergence application of pendimethalin and post-emergence application of orthosulfamuron applied plot as evidence from the total weed density and dry weight. Among the weed control treatments, post-emergence application of bispyribac sodium 25 g/ha at 30 DAT recorded highest weed control efficiency and minimum weed index%. Among various weed management practices higher yield was recorded from bispyribac sodium applied plots. Weed free plot recorded highest grain and straw yield which was at par with bispyribac sodium 25 g/ha at 30 DAT, pendimethalin 0.75 kg/ha + bispyribac sodium 25 g/ha at 30 DAT and pendimethalin 0.75 kg/ha + bispyribac sodium 50 g/ha at 30 DAT, same results also found by veeraputhiran *et al*. (2013) of effective weed control along with higher grain yield by Bispyribac sodium against mixed weed flora in transplanted rice were in confirmative with the present investigation. In case of harvest Index%, there was no significant difference observed among weed management practices, but highest harvest index% was recorded with pendimethalin 0.75 kg/ha + bispyribac sodium 25 g/ha at 30 DAT.

Table 1. Effect of weed management treatments on weed growth and grain yield in transplanted rice

Treatment	Total weed density at 45 DAT(no./m^2)	Total weed dry weight (g/m^2)	Weed control efficiency (%)	Weed index (%)	Grain yield (t/ha)
T_1- Pendimethalin at 0.75 kg/ha	16.67	19.66	28.89	10.31	6.37
T_2- Pendimethalin at 0.75 kg/ha +hand weeding at 50 DAT	12.33	14.49	47.76	7.45	6.57
T_3- Bispyribac at 25 g/ha at 30 DAT	10.67	7.71	54.94	2.81	6.90
T_4 -Pendimethalin at 0.75 kg/ha + bispyribac at 25 g/ha at 30 DAT	12.67	8.77	46.54	3.30	6.87
T_5 - Bispyribac at 50 g/ha at 30 DAT	13	8.63	44.63	6.50	6.60
T_6- Pendimethalin at 0.75 kg/ha + bispyribac at 50 g/ha at 30 DAT	11.67	9.23	50.66	3.75	6.83
T_7-Orthosulfamuron 50% WG at 80 g/ha at 12 DAT	16	10.29	32.22	10.32	6.37
T_8 -Pendimethalin at 0.75 kg/ha + orthosulfamuron 50% WGat 80 g/ha at 12DAT	18.33	14.50	21.75	6.55	6.63
T_9- Orthosulfamuron 50%WG at 150 g/ha at 12 DAT	13.33	11.06	43.45	8.44	6.50
T_{10}- Pendimethalin at0.75 kg/ha + orthosulfamuron 50% WGat 150g/ha at 12DAT	16.33	9.26	30.41	7.93	6.53
T_{11} - Weed free	0.00	0.00	100.00	-	7.10
T_{12} -Weedy check	23.67	40.97	-	30.55	4.93
LSD (P=0.05)	3.47	1.57	-	-	0.37

CONCLUSION

Bispyribac sodium can be used for weed management in transplanted rice under lateritic belt of West Bengal.

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Optimizing rate of propaquizafop + oxyfluorfen inonion

R.K. Singh*, Aarti Singh and Santosh Kumar

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi Uttar Pradesh 221 005

**Email: rks1660bhu@gmail.com*

Onion has very poor competitive ability with weeds due to its inherent characteristics like short stature, non branching habit, sparse foliage, shallow root system and extremely slow growth during initial stage. Yield losses due to weed infestation in onion have been reported to the tune of 40 to 80% (Channapagoudar and Biradar 2007). The conventional methods of weed control like hoeing or hand weeding are laborious, expensive, insufficient and sometimes causes damage to crop. Most studies on chemical weed control in onion are with the single herbicide and information on herbicides mixture in onion are limited. Keeping this in view, the experiment was conducted to find out the optimum rate of propaquizafop 5% + oxyfluorfen 12% on for weed management in onion.

METHODOLOGY

Two season field trials were conducted during year 2011-12 and 2012-13 to evaluate the effect of different rates of Propaquizafop 5% + oxyfluorfen 12% EC in winter (*Rabi*) onion .The soil was sandy loam in texture with pH 7.4, deficient in nitrogen and medium in phosphorus and potassium. The treatments comprised of three rates propaquizafop 5% + oxyfluorfen 12% EC at 37.5+90, 43.75+105 and 50+120, propaquizafop 10% EC at 75 g and oxyfluorfen 23.5% EC 200 g applied at 15 days after transplanting and pendimethalin 30% EC at 1000 g as pre emergence treatment.. These were compared with weed free (hand weeding) and untreated (weedy) treatments in a randomized complete block design replicated thrice. onion variety '*Agrifound light red*' was the test variety. The crop was grown with recommended package of practices for onion in the region.. Species wise weed count was recorded using 0.25 m^2 quadrate in marked area.. The weed samples were sun dried for four days and then transferred to hot air oven for drying at 60^0C and weeds dry weight of each samplewas recorded in g/m^2. The crop was harvested at maturity and bulb weight was recorded in kg/plot and converted to t/ha. The data so obtained were subjected to standard statistical analysis.

RESULTS

The major weeds in crop were *Chenopodium album, Anagallisarvensis, Melilotus sp*. All the herbicidal treatments caused significant reduction in total weed density and dry weight of weeds as compared to unweeded control during both the years.Maximum weed control efficiency was recorded with propaquizafop 5% + oxyfluorfen 12% EC at 50 + 120 g/ha which was on pa to propaquizafop 5% + oxyfluorfen 12% EC at 43.75+105 g/ha was non-significant in respect of weed control efficiency in both seasons. Maximum yield of onion bulb was also recorded with propaquizafop 5% +oxyfluorfen 12% EC at 50 + 120 g, but did not differed significantly from propaquizafop 5% + oxyfluorfen 12% EC at 43.75+105 g. These results are in conformity with the findings of Chopra and Chopra (2007). Highest B C ratio was observed with the application of propaquizafop 5% + oxyfluorfen 12% EC at 43.75 + 105 g/ha.

Table 1. Weed dynamics, yield and economics of onion as influenced by herbicide treatments (two seasons mean).

Treatment	Rate	Weed dry weight (g/m²)	Weed control efficiency (%)	Bulb yield (t/ha)	Net return (x10³₹/ha)	B:C ratio
Propaquizafop 5% + oxyfluorfen 12% EC	37.5+90	46.06	56.39	24.29	3618	2.58
Propaquizafop 5% + oxyfluorfen 12% EC	43.75+105	11.05	89.53	24.61	6362	4.04
Propaquizafop 5% + oxyfluorfen 12% EC	50 + 120	10.21	90.32	24.62	6422	3.67
Pendimethalin 30% EC	1000	30.03	71.56	24.43	4840	2.49
Propaquizafop 10% EC	75	51.86	50.91	23.95	781.5	0.46
Oxyfluorfen 23.5% EC	200	37.39	64.59	24.36	4204	1.97
Hand weeding	-	0.00	100.00	24.70	-	-
Untreated control	-	105.64	0.00	23.87	-	-
LSD (P=0.05)	-	0.56	-	0.29	-	-

CONCLUSION

Based on the present study. propaquizafop 5% EC+ oxyfluorfen 12% EC at 43.75+105 g as post emergence is recommended for weed control in onion crop. 12% EC at 43.75+105 g as post emergence can be recommended under Agro-Climatic conditions of Varanasi.

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Weed control studies in transplanted rice

B.D. Singh*, B.S. Karki, R.K. Sharma and V.P. Singh
Associate Director, Extension (Agronomy) KrishiVigyan Kendra, Matela (Kosi), Almora, Uttarakhand 263 643
**Email: bdsingh5@gmail.com*

Weeds are the major constraints in successful crop productionand are expected to result in a loss of about 18-20 million tonnes of food grains each year. Proper weed management, therefore,is essential to minimize the losses caused by weeds and to realize higher crop yield (Gopinath *et al*. 2007). Rice (*Oryza sativa* L.) is one of the main crop grown during *Kharif* season in low and mid hills of Almora District of Utarakhand. The yield obtained from the crop is very poor mainly because of uncontrolled weeds. Apart from this, the use of traditional seed, FYM and only nominal use of fertilizers also favour reduced yield. In hilly areas, farmers do not use any herbicide except a few where Butachlor is usedby mixing in sand and broadcasting, while, in rest area, manual weeding is common. This technique is less efficient, labour intensive, expensive and often not done in time due to adverseweather condition. Introduction of herbicides for weed control has emerged as a big boon for hill area farming community. Herbicides have several advantages over other weed control methods *e.g.* easy and convenient use, less labour intensive, covers relatively larger area in very less time, control weeds more efficiently and often more economical .

METHODOLOGY

Realizing the problem of weeds,the on farm trail (OFT) was conducted in *Kharif* of 2013 at fivefarmer's field of District Almora. The soil of trail site was sandy loam. The trail was consisted of three treatments *i.e.* Farmers practice e.g. manual weeding at 25-30 DAT, Pretilachlor 1500 ml/ha 0-3 DAT followed by Almix 20 g/ha 30 DAT and Anilofos 1200 ml/ha 7-10 DAT followed by Almix 20 g/ha 30 DAT. The plot size of each treatment was 400 m^2. The treatments were replicated five times inrandomized block design. The two years old seed of transplanted rice variety VL 85 was sown in the nursery on May 10-12 and harvested during October 2-5.Herbicides provided by KVK as critical intervention were sprayed with the help of Knapsack sprayer using flat fan nozzle as per treatments schedule. Weed count/m^2 area was recorded at 60 DAT. All the standard agronomic management practices were followed as and when required.

RESULTS

The dominating weed floras observed during the trail were *Echinichloa colonum, Echinochloa crusgalli, Digitaria sanguinalis, Oxalis latifolia, Commelina benghalensis* and *Agera-tum conyzoides etc.* However, maximum weed number was of *Echinichloacolonum* and minimum was *Ageratum conyzoides* (Gopinath *et al*. 2007). Table 1 clearly showed that weed density was maximum in Farmers practice while, minimum in treatment Anilofos 1200 ml/ha 7-10 DAT followed by Almix 20 g/ha 30 DATindicating the best performance. Similarly, the yield was also maximum withAnilofos 1200 ml/ha 7-10 DAT followed by Almix 20 g/ha 30 DAT *i.e.* 3.11 t/ha (Patra *et al*. 2011). Nextbest treatment in this order wasPretilachlor 1500 ml/ha 0-3 DAT followed by Almix 20 g/ha 30 DAT. The treatments Anilofos 1200 ml/ha 7-10 DAT *fb* Almix 20 g/ha 30 DATandPretilachlor 1500 ml/ha 0-3 DAT *fb* Almix 20 g/ha 30 DAT recorded 27.98 and 17.95% more yield over check. Net return and B:C Ratio were also maximum with treatment Anilofos 1200 ml/ha 7-10 DAT *fb* Almix 20 g/ha 30 DAT. Herbicidal treatments resulted in considerably higher net returncompared with manual weeding.In general, after July and onwards relatively low rain fall affected the yield adversely.

Table 1. Weed count, yield and economics of transplanted rice as influenced by different treatments

Treatment	Weed density/m^2	Yield (t/ha)	% increase in yield over check	Net return (x10^3₹/ha)	B:C Ratio
Farmers practice e.g. manual weeding 25-30 DAT	28	2.43	-	10876	1.60
Pretilachlor 1500 ml/ha 0-3 DAT *fb* Almix 20 g/ha 30 DAT	12	2.85	17.95	14796	1.76
Anilofos 1200 ml/ha 7-10 DAT *fb* Almix 20 g/ha 30 DAT	05	3.11	27.98	17370	1.87

The associated farmers showed their happiness with the result of herbicides. Earlier, where they spent a lot of time in manual weeding, in spite of that efficient result was not obtained. They believed that new technology was quite effective in terms of effective weed control, higher yield and drudgery reduction of women.

CONCLUSION

It was found that use ofAnilofos 1200 ml/ha 7-10 DAT followed by Almix 20 g/ha 30 DAT was most effective for controllingweeds, improving grain yield and enhancing the net return of transplanted rice.

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Bioefficacy of WDG and WP formulations of carfentrazone + sulfosulfuron for control of complex weed flora in wheat and their residual carry over effect on succeeding sorghum crop

S.S. Punia*, Samunder Singh and Anil Duhan
Department of Agronomy, CCS HAU Hisar, Haryana 125 004
**Email: puniasatbir@gmail.com*

Little seed canary grass (*Phalaris minor*), which is a very serious weed of wheat in rice-wheat cropping system in N-W India has developed resistance against isoproturon (Malik and Malik 1994). To tackle the isoproturon resistance problem in *P. minor*, clodinafop, fenoxaprop and sulfosulfuron have been recommended during 1997 but due to continuous use of fenoxaprop and clodinafop for the last 12 years, weed flora of wheat has now been shifted towards broadleaf weeds especially *Rumex dentatus* and *Malva parviflora* which cannot be controlled by use of 2,4-D. Secondly many wheat cultivars show malformed spikes due to use of 2,4-D. Hence, there is strong need for an herbicide mixture which can provide effective control of complex weed flora in wheat. Keeping these points in view, present investigation was planned.

METHODOLOGY

Present investigation entitled "Bioefficacy of WDG and WP pre-mix formulations of carfentrazone 20% + sulfosulfuron 25% for the control of complex weed flora in wheat" was conducted during winter (*Rabi*) seasons of 2008 and 2009, in randomized design with three replications, keeping a plot size of 6.0 x 4.2 m^2 at Agronomy Research Area of CCS HAU Hisar. Crop was raised as per package of practices recommended by CCS HAU Hisar except herbicide treatments.

RESULTS

Experimental field was infested with grassy and broadleaf weeds, *viz. P. minor* Retz. (54.5%), *Chenopodium album* L. and *Convolvulus arvensis* L. Effect of surfactant use on enhancing control of *P. minor* was visible with all doses of carfentrazone+ sulfosulfuron used. WDG formulation of carfentrazone + sulfosulfuron at 45 and 54 g/ha proved very effective in minimizing population of *P. minor* as shown by density and dry weight of weeds at 30 and 45 DAT. This mixture provided 81-99% control of *P. minor* and 86.7- 99.3% control of broad-leaved weeds. Pre-mix combination of carfentrazone + sulfosulfuron at 45 and 54 g/ha either gave almost complete control of *C. arvensis* and *C. album* and density and dry weight of weeds in these treatments was statistically at par with sulfosulfuron+metsulfuron (RM), a recommended herbicide. Although, chloretic symptoms in terms of brownish speckles appeared due to application but these symptoms disappeared within 15 days after treatment without any loss in grain yield. Among herbicide treatments, ready mix combination of carfentrazone+ sulfosulfuron at 45 g/ha along with use of leader surfactant treated plots by virtue of providing a favorable environment registered maximum grain yield (4.71 and 4.66 t/ha) during 2008-09 and 2009-10, respectively which was at par with treatments of carfentrazone + sulfosulfuron at 54 g/ha. Higher dose of carfentrazone-ethyl 20% + sulfosulfuron 25% along with surfactant at 90 g/ha although provided complete control of both grassy and broadleaf weeds but caused suppression to crop resulting in significantly less number of tillers/m^2 and significantly lower yield as compared to 45 and 54 g/ha application rates and weed free check. All the herbicide combinations of carfentrazone + metsulfuron at 36 and 45 g/ha in either with or without surfactant did not show any residual activity on sorghum crop but its higher doses at 54 and 90 g/ exhibited residual activity on succeeding sorghum crop as shown by significantly less number plants and fodder yield as compared to untreated check and carfentrazone-ethyl 20% + sulfosulfuron 25% (RM) at 45 g/ha.

CONCLUSIONS

WDG formulation of carfentrazone + sulfosulfuron at 45 g/ha proved very effective in minimizing population of *P. minor* and dry weight of weeds at 30 and 45 DAT. This mixture provided 81-99% control of *P. minor* and 86.7- 99.3% control of broadleaf weeds without any residual carry over effect on succeeding sorghum crop.

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Long term effect of herbicides on weed dynamics and soil micro flora in pearl millet - chickpea cropping system

S.S. Punia*, Sunita Suneja, Dharambir Yadav and Anil Duhan

Department of Agronomy, CCS HAU Hisar, Haryana 125 004

**Email: puniasatbir@gmail.com*

Due to limited irrigation facilities in south-western part of Haryana, pearl millet-chickpea is one of the major cropping sequences for economic returns. Atrazine along with one hoeing is used to control weeds in pearl millet crop. To control weeds in chickpea, pendimethalin use has been found promising. Therefore to study the feasibility of herbicide use in both crops and its long term effect on weed seed bank and soil micro flora, present long term experiment was planned.

METHODOLOGY

To study the long term effect of herbicides on weed seed bank and soil micro flora in pearl millet-chickpea cropping system, this experiment was initiated at Agronomy Research Area of CCS HAU, Hisar in 2007 in split plot design with five main treatments, *viz.* weedy check, mechanical weeding (2), atrazine at 0.75 kg/ha as pre-emergence *fb* 2,4-D at 500 g/ha, atrazine at 1.0 kg/ha and atrazine 0.75 kg/ha one day after sowing in pearl millet and four treatments, *viz.* pendimethalin 1.0 kg/ha *fb* mechanical weeding, mechanical weeding (2), pendimethalin 1.0 kg/ha pre-emergence and weedy check in chickpea. Plot size was 43 x 3 m^2 in pearl millet and 10x 3 m^2 in chickpea. After 4 years of experimentation, after harvest of chickpea, during *Kharif* 2010, pearl millet hybrid *'HHB-67'* was planted. After pearl millet harvest, chickpea variety '*HC-5*' was planted and raised as per recommendations of CCS HAU Hisar. Weed count and dry weight in both the crops was recorded with the help of 50 x 50 cms quadrant. Grain yield of both crops were recorded at harvest of crop. To know the effect of herbicides on microbial population, periodic soil samples were taken and analyzed in the laboratory. After harvest of pearl millet, soil samples were collected from 0-5 and 5-10 cm soil depths and put on trays to study weed emergence pattern of weeds.

RESULTS

Presence of weeds throughout the season resulted in 58.9% decrease in grain yield of chickpea as compared to mechanical weeding twice and 58.4% as compared to pendimethalin at 0.75 kg/ha + one hoeing treatment. In chickpea rhizosphere, at 3 DAT bacterial population in pendimethalin treated plot was very low (25.0 x 10^6/g dry soil) as compared to mechanical weeding (107.6 x 10^6/g dry soil). Same is the case with actinomycetes population. Later on at 10 DAT, 30 DAT and at harvest it was almost same. There was no change on fungal and free living diazotrophs population at all the stages.

Highest grain yield (1.89 t/ha) of pearl millet was recorded in mechanical weeded plots which was at par with atrazine 0.75 kg/ha *fb* 2,4-D 0.5 kg/ha and atrazine at 1.0 kg/ha as pre-emergence. In pearl millet rhizosphere, immediately after atrazine use at 1.0 kg/ha, bacterial, actinomycetes and fungal population was not affected. However 30 DAT, bacterial population (30.0 x 10^6/ g dry soil) was less in herbicide treatments as compared to weedy control (43.0 x 10^6/g dry soil). Actinomycetes population was also slightly lower (33.0-39.7 x 10^6/g dry soil) in herbicide treatments as compared to weedy check (52.6 x 10^6/g dry soil) at 30 DAT but Later on population of all these microbes increased in herbicide treatments and it was almost same in different treatments. Free living diazotrophs population at all stages was slightly lower in herbicide treatments as compared to weedy check. Weed dynamics studied after 4 years of experimentation indicate that maximum number of weeds were present in 0-5 cm soil layer as compared to 5-10 cm layer. Broadleaf weeds, *viz. C.album, Fumaria, Medicago denticulata* and *Lathyrua aphaca* constituting 88.3% of weed flora in weedy check

CONCLUSIONS

Premergence application of atrazine at 0.75 kg/ha in pearl millet and pendimethalin at 0.75 kg/ha + one hoeing in chickpea helped to increase grain yields of both pearl millet and chickpea. In pearl millet, bacterial, fungal and actinomycetes population although decreased immediately after herbicide population but at 30 DAT and harvest it was same as compared to untreated check but population of free living diazatrophos was less at all stages. In chickpea, soil micro flora was same in treated and untreated plots after 10 days of pendimethalin application.

Effect of mulching and herbicides on weed and tomato yield in alluvial plains of West Bengal

P. Adhikary*, S. Shil, R.K. Ghosh, R. Podder, R. Das and D. Shamurailatpam

Department of Agronomy, Faculty of Agriculture, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, West Bengal 741 252

**Email: pabitra.bdp@gmail.com*

Tomato (*Lycopersicon esculentum* L.), an important vegetable crop, belongs to family solanaceae, grown in most home gardens and by market and truck gardeners. It is also produced as off-season vegetable in green-houses. Tomato, being its high nutritional value and different types of culinary use, it is imperative to improve the quality and quantity of crop (Wales 2011). Tomato production systems typically utilize conventional tillage, a bedded crop and weed mulch culture, and multiple herbicide applications to keep fields weed free. Intensive use of synthetic chemical in their production has raised consumer and ecological concerns. Use of residue mulches in sustainable or organic production systems is also universally perceived as sustainable. Therefore, alternative production practices that decrease tomato production inputs while maintaining yields and quality are desired. Use of crop residues combined with reduced tillage systems may produce such results. Crop residues can enhance overall productivity and soil quality by increasing organic matter and nitrogen content, as well aid in water conservation by increasing soil water infiltration rates. Additionally, previous research has shown that weed control can be provided by using crop residues in both field and vegetable crops. Mulching can affect subsequent early season weed suppression (Saini *et al*. 2006).

METHODOLOGY

The experiment was conducted during *Rabi* season of 2011 and 2012 at the "INSTRUCTIONAL FARM" (latitude: 22°93'E, longitude: 88°53'N and altitude: 9.75 m) of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experimental soil was well drained, alluvial in nature and sandy loam in texture, having pH 6.95, organic carbon 0.673%, available nitrogen 253.57 kg/ha, available phosphorus 20.49 kg/ha and available potassium 117.42 kg/ha respectively (Jackson 1973). The variety used in this experiment was *Arka Meghali* with 5 treatments replicated four times with Randomized Block Design. Each plot size was of 10 x 4 m. 25 days old seedlings were transplanted in the main field. Water was applied to all the plots immediately after transplanting. Thereafter, the plots were irrigated every other day as needed. General production practices were followed as required. The treatments were as follows: T_1: Control, T_2: Up rooted weed mulch, T_3: Paddy straw mulch; T_4: Pendimethalin 30 EC at 1000 g/ ha + Mechanical Weeding at 20 DAT; T_5: Oxyfluorfen 23.5 EC at 100 g /ha + Mechanical Weeding at 20 DAT; Spraying was done with knapsack sprayer with floodjet deflector WFN 040 nozzle with 500 Littre of water/ha. Herbicide treatments included as pre – emergence (PE) application at 2 DAT.

RESULTS

The results showed that regarding weed control efficiency, from 30 DAT to 60 DAT, maximum was recorded from treatment T_4 (80.40 %) followed by T_5 (79. 23%), T_3 (59.84 %) and T_2 (53.23 %) over unweeded check (control). The maximum tomato yield (7.07 t/ha) was observed in plots where herbicide Pendimethalin 30 EC at 1000 g/ha (T_4) was applied followed by Oxyfluorfen 23.5 EC at 100 g/ ha (6.99 t/ha) as compared to up rooted weed mulch (T_2) and paddy straw mulch (T_3), 6.69 t/ha, 6.41 t/ha respectively while the lowest fruit yield was calculated (3.21 t/ha) in the control plots. Lowest tomato yield in control plots may be due to weed competition with plants. While high fruit yield in Pendimethalin 30 EC and Oxyfluorfen 23.5 EC might be attributed to better weeds control that made better utilization of the resources like nutrients, solar radiation, water and space.

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Effect of organic nutrient sources on weed dynamics under rice based cropping systems

Suchi Gangwar*, K.R. Naik and Megha Dubey
Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidhyalaya, Jabalpur, Madhya Pradesh 482 004
**Email: singh.suchi40@gmail.com*

In India rice (*Oryza sativa* L) - Wheat (*Triticum aestivum* L) is the dominant cropping system in Indo-Gangatic plains. Rice and wheat are the world's two most important cereal crops contributing 45% of the digestible energy and 30% of total protein in the human diet. Approximately 12.5 mha. Organic nutrient practices implies a farming system that primarily aims at cultivating land and raising crops under ecologically favourable conditions. The use of locally available agro-inputs in agriculture by avoiding or minimizing the use of synthetically compound of agro-chemicals appears to be one of the probable options to sustain the agricultural productivity. Addition of organic manures such as FYM, recycling of organic wastes through composting, green manures and biological inputs like vermicomposts and biofertilizers etc. constitute important components for plant nutrition in organic farming. Organic manure improves soil physical condition including soil porosity and water holding capacity and microbial environment.

METHODOLOGY

Field experiment was conducted on effect of organic nutrient sources on weed dynamics under rice based cropping systems during the year 2011-12 and 2012-13 in Jabalpur (M.P.) Jabalpur is situated in the central part of Madhya Pradesh at 23^0 90' North latitude and 79^0 58' East longitude with an altitude of 411.78 metres above the mean sea level. The soil of the experimental field was sandy clay loam in texture, slightly alkaline in reaction (pH 7.70) with normal EC (0.48 dS/m) and low OC contents (0.68%), medium in available N (266 kg/ha), low in available P (9. 2 kg/ha) and medium in available K (300 kg/ha) contents. The treatment consist of two cropping systems (gm-basmati rice-wheat and basmati rice-berseem) and five organic nutrient managements (1/3 FYM+ 1/3VC + 1/3NEOC, Panchagvya, 1/3 FYM +1/3VC+1/3 NEOC+ Panchagvya, BD-501, BD-501 + Panchagvya).

RESULTS

Relative weed density in *Kharif* season

In rice, the dominating weeds were *Echonochloa crusgalli* (38.4%), *Cyperus irria* (30.2%), *Eclipta alba* (16.8%) with other weeds (14.6%) at 30 DAT. At maturity stage, the relative density of all weeds was changed. *Echinochloa crusgalli* (35.3%), *Eclipta alba* (13.6%) and other weeds (12.3%) were reduced but relative density of *Cyperus irria* (338.8%) increased at final stage over their relative density at 30 DAT.

Relative weed density in *Rabi* season

During *Rabi* season, relative density of weeds varied between different crops. *Chenopodium album* was found to be more serious weed in almost all *Rabi* crops. It relative density was 32.4% and 23.8% in wheat and berseem at 30 DAS. This change as 30.2% and 20.0% at maturity stage. While

Table 1 Relative density of weeds at 30 DAS and at maturity of various crops

Crop	Predominated weeds	Relative density (%)	
		30 DAS	At maturity
Rice	*Cyperus iria*	30.2	38.8
	Eclipta alba	16.8	13.6
	Echinochloa crusgalli	38.4	35.3
	Others	14.6	12.3
	Total	100	100
Wheat	*Phalaris minor*	28.2	25.8
	Chenopodium album	32.4	30.2
	Vicia sativa	17.2	15.4
	Others	22.2	28.6
	Total	100	100
Berseem	*Trifolium flagiferim*	24.3	25.1
	Chenopodium album	23.8	20.0
	Chichorium intybus	30.3	32.0
	Others	21.6	22.4
	Total	21.6	22.4

phalaris minor severely dominated to wheat (28.2%) at 30DAS and (25.8) at maturity. But relative weed density of *chichorium intybus* severely dominated to berseem (30.3%) at 30 DAS and (32.0%) at maturity (Soni *et al*. 2012).

CONCLUSION

Among the two rice based cropping systems under *Kharif*, in rice *Echinochloa crusgalli* was the most dominating weed contributing 38.4% of total weed intensity at most critical period (30 DAT) while *Cyperus iria* at harvest stage (38.8%). During *rabi*, in wheat *Chenopodium album* was the most dominating weed contributing at 30 DAS and maturity stage (32.4, and 30.2%). In berseem, *Chichorium intybus* was the most dominating weed contributing at 30 DAS and maturity (30.3 and 32.0%).

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Effect of post emergence herbicides on microbial activity at different moisture level in irrigated wheat

Vinamarta Jain*[1], Namrata Jain[2] and M.L.Kewat[3]
[1]*College of Agriculture, Rajnandgaon, Chhattisgarh 492 010,* [2]*College of Agriculture, Tikamgarh, Madhya Pradesh 472 001*
[3]*College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh 482 004*
**Email: vinamarta_jain@rediffmail.com*

Wheat is the second most important cereal crop being next to the rice. Wheat crop contributes substantially to the national food security by providing more than 50% of the calories to the people who mainly depend on it. Wheat production in India contributes to about 12 % of total wheat production. The productivity of wheat depends on several factors, *viz*. varieties, time of sowing, irrigation, fertilizer, weed management. Of the important factors responsible for higher productivity, moisture is of prime importance in promoting the growth and development of the crop. Moisture at the time of herbicide application is also important because it affects absorption and translocation of herbicides at the site of action. Weed control is generally excellent in moist soil conditions because more herbicide is available for plant uptake in the soil solution or gaseous phase (Porwal and Dadheech 2008). An appropriate adjustment of time of herbicide application in relation to suitable soil moisture seems desirable for proper activity of herbicides.

METHODOLOGY

The field experiment was conducted at Livestock Farm, JNKVV, Jabalpur, M.P. during the *Rabi* seasons of 2008-09 and 2009-10. Twenty treatment combinations consisting of five moisture levels 100, 95, 90, 85 and 80% available soil moisture (ASM) and four weed control practices, *viz.* weedy check, isoproturon 750 g/ ha, clodinafop alone 60 g/ha and clodinafop 60 g /ha *fb* 2,4-D 500 g/ha were laid out in split plot design and replicated four times. Wheat variety *GW-273* was sown in the experimental field with seed rate of 125 kg/ ha during both the years. Fertilizers were given uniformly at the rate of 100 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha during both the years. Five irrigations were given to the crop at all the critical stages, *viz*. crown root initiation, maximum tillering, late jointing, flowering and milk stage.

RESULTS

Changes in microbial properties

It is evident from the data that the different microbial population did not vary much from their initial values due to different moisture levels at the time of herbicides application during both the years. Total bacteria, *Azotobactor*, actinomycetes and fungal population did not differ significantly under various moisture levels at the time of herbicides application during both the years. However, 100% ASM had numerically higher microbial population than 80 % ASM.

Weed control treatments caused considerable variation on microbial population during both the years although the differences were non significant. Application of post emergence herbicides clodinafop *fb* 2,4-D, isoproturon and clodinafop registered numerically lower population of microbes during both the years over weedy check plots where weeds were not controlled either by herbicides or through hand weeding. The interaction was not found to be significant during both the years on the population of micro flora.

Grain yield of wheat

The presence of 100 per cent ASM registered significantly higher grain yield of wheat (0.599 and 0.619 t/ha) and proved significantly superior over 85 and 80% ASM but found at par with 95 and 90% ASM during both the years. Among the weed control treatments, clodinafop *fb* 2,4-D proved significantly superior and produced 4.28 and 5.44%; 5.17 and 6.47% higher grain yield over isoproturon, clodinafop and 17.94 and 18.93% higher over weedy check during 2008-09 and 2009-10, respectively. Among interactions, grain yield was significantly higher under all the plots receiving clodinafop *fb* 2,4-D at different moisture levels being the maximum at 100% ASM than isoproturon, clodinafop and weedy check. Application of isoproturon and clodinafop was also found equally well at all the ASM levels and proved significantly superior over weedy check.

CONCLUSION

On the basis of above findings it may be concluded that the microbial activity did not vary significantly with different moisture level at the time of herbicide application but Weed control treatments caused numerical variation on microbial population during both the years. Application of clodinafop *fb* 2,4-D at 90 to 100% available soil moisture gave higher crop yield in irrigated wheat.

Table 1. Effect of moisture levels at the time of herbicides application and weed control practices on microbial population and yield of wheat

Treatment	Total Bacteria (cfu x 10^5)	*Azotobactor* (cfu x 10^3)	Actinomy -cetes (cfu x 10^3)	Total Fungi (cfu x 10^3)	Yield (t/ha)
Moisture level					
100% ASM	33.85	27.77	71.96	20.31	0.60
95% ASM	33.67	27.54	71.62	20.08	0.59
90% ASM	33.56	27.42	71.57	19.63	0.56
85% ASM	33.45	27.28	71.41	19.36	0.54
80% ASM	33.28	27.09	71.09	19.07	0.52
LSD (P=0.05)	NS	NS	NS	NS	0.00
Weed control practice					
Weedy Check	33.96	27.795	72.12	20.34	0.49
Isoproturon	33.61	27.5	71.53	19.69	0.58
Clodinafop	33.47	27.28	71.34	19.46	0.57
Clodinafop *fb* 2,4-D	33.21	27.16	71.125	19.35	0.61
LSD (P=0.05)	NS	NS	NS	NS	0.02
Initial status	33.81	27.75	71.96	20.30	

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Bioefficacy of herbicides on weeds and yield of soybean

Namrata Jain* and Varsha Meshram
College of Agriculture, Tikamgarh, Madhya Pradesh 472 001
**Email: j_namrata1@rediffmail.com*

Soybean, the number one oilseed crop in the world has recently occupied an important place in the edible oil and agricultural economy of the country. India occupies premier position in global oilseed scenario accounting for about 19% area and 9% production. soybean owing to its high potential plays an important role in boosting oilseed production in the country. The soil and climate of Madhya Pradesh are congenial for soybean production but being a rainy season crop it suffers severely due to competitional stress of grasses, sedges and broadleaved weeds. Despite of the best management practices the poor weed management practices deprive the crop of its major requirement of nutrients, soil moisture, sunlight and space. The stress is mainly due to presence of dominating grassy weeds, *viz. Echinochloa crusgalli, Cyperus spp.* and broad leaved weeds, *viz. Commelina benghalensis, Commelina communis and Phyllanthus niruri.* (Tiwari and Kurchania 1990). Weed management through hand weeding although effective in reducing the weed competition but it has certain limitations such as rainfall, unavailability of sufficient manpower during peak periods, high labour cost and time consuming. These problems can be overcome by adopting herbicidal weed control, which is effective, easier, cheaper and many a times faster than the conventional practices of weed control.

METHODOLOGY

The study was conducted at 'The farm' College of Agriculture, Tikamgarh during *Kharif*, 2012 with the objective to study the efficacy of herbicides on weed density and weed biomass, yield and economics of soybean. The present experiment was carried out on cleyey soil which was medium in organic carbon, low in available nitrogen and phosphorus and medium in potassium content and neutral in reaction. The experiment was laid out in "Randomized block design" with twelve treatments replicated thrice. The treatments comprised of pre emergence herbicides, *viz* pendimethalin (1 kg/ha) and post emergence treatments quizalofop-ethyl at 50 g/ha, chlorimuron-ethyl at 9 g/ha, imazethapyr at 50 g/ha, hand hoeing and their combinations, two hand weeding at 20 and 40 DAS and weedy check. The soybean variety "*JS-335*" was sown with seed rate of 80 kg/ha with fertilizer dose of 20:60:30 kg/ha. Pre emergence herbicides were applied on next day of sowing.

RESULTS

The major weed species observed in the experimental area were *Cynodon dactylon*, *Cyperus rotundus, Convolvulus arvensis, Saccharam spontaneum, Phyllanthus niruri* and *Commelina benghalensis*. The relative density of monocots was 62.71% while dicots were to the extent of 30.60% of the total weed population.

All the herbicidal treatments, hand weeding and hand hoeing reduced the weed intensity as well as weed biomass compared to weedy check. Hand weeding twice was most effective and recorded minimum weed intensity and biomass among all the treatments. Hand weeding superseded over all the treatments and attained minimum weed biomass of (9.97 g/m^2) with weed control efficiency of 90.89% followed by pendimethalin *fb* one hand weeding at 20 DAS (86.51%).

Table 1. Effect of herbicides on weed density, dry weight and seed yield of Soybean

Treatment	Weed Intensity (m^2)	Dry weight (g/m^2)	Weed control efficiency (%)	Seed yield (t/ha)
Pendimethalin at 1 kg	23.00 (4.84)	37.00 (6.12)	65.38	1.588
Pendimethalin at 1 kg *fb* one hand weeding at 20 DAS	10.47 (3.31)	14.41 (3.80)	86.51	1.791
Pendimethalin at 1 kg *fb* quizalofop-ethyl at 50 g at 20 DAS	18.02 (4.30)	27.98 (5.33)	73.75	1.745
Pendimethalin at 1 kg *fb* imazethapyr at 50 g at 20 DAS	19.87 (4.51)	27.84 (5.32)	73.96	1.722
Pendimethalin at1 kg *fb* chlorimuron-ethyl at 9 g at 20 DAS	19.62 (4.48)	28.46 (5.38)	73.35	1.640
Quizalofop-ethyl at 50 g at 20 DAS	30.64 (5.58)	44.86 (6.73)	57.09	1.533
Quizalofop-ethyl at 50 g at 20 DAS *fb* one hand hoeing at 40 DAS	12.22 (3.55)	23.07 (4.85)	78.36	1.732
Chlorimuron-ethyl at 9 g at 20 DAS	31.84 (5.68)	76.47 (8.77)	28.46	1.385
Chlorimuron-ethyl at 9 g at 20 DAS+ quizalofop-ethyl at 50 g at 20 DAS	14.87 (3.89)	22.12 (4.76)	78.93	1.740
Chlorimuron-ethyl at 9 g at 20 DAS *fb* one hand hoeing at 40 DAS	13.49 (3.73)	21.89 (4.73)	79.17	1.729
Two hand weeding at 20 DAS and 40 DAS	7.42 (2.78)	9.97 (3.30)	90.89	1.834
Weedy check	51.02 (7.18)	107.15(10.37)	0.00	0.739
LSD (P=0.05)	(0.57)	(0.30)	4.75	0.041

*values in parenthesis are square root transformed

Seed yield was significantly higher under all the weed control practices over weedy check. Two hand weeding at 20 & 40 DAS recorded the higher seed yield (1.834 t/ha) among all the treatments. Among the herbicides, application of pendimethalin *fb* quizalofop-ethyl (1.745 t/ha) and chlorimuron-ethyl + quizalofop-ethyl (1.740 t/ha) produced significantly higher yield over alone application of pendimethalin, quizalofop-ethyl and chlorimuron-ethyl.

CONCLUSION

The seed yield per hectare of soybean was significantly higher under two hand weeding at 20 and 40 DAS followed by pendimethalin 1 kg/ha *fb* one hand weeding at 20 DAS, pendimethalin *fb* quizalofop-ethyl and combination of post-emergence application of quizalofop-ethyl 50 g/ha + chlorimuron-ethyl 9 g/ha.

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Efficacy of herbicides on yield and economics of sesame

Anamika Jain Badkul*, Namrata Jain and S.K. Chaurasia

College of Agriculture, Tikamgarh, Madhya Pradesh 472 001

**Email :anamika.badkul@rediffmail.com*

Sesame [*Sesamum indicum* (L.)] is one of the important edible oilseeds cultivated in India. Its oil content generally varies from 46 to 52% and protein between 20-26%. Severe weed competition is one of the major constraints in lower productivity of sesame. Prevalence of high temperature with less relative humidity and frequent rainfall during the crop season coupled with slow plant growth particularly, during early growth stages favour luxuriant weed growth since seedling emergence causes about 50 - 75% reduction in seed yield of sesame (Dungarwal *et al.* 2003). Therefore, the present experiment was carried out to evaluate the efficacy of herbicides for weed control in sesame.

METHODOLOGY

The experiment was carried out at 'Til Research farm' College of Agriculture, Tikamgarh during *Kharif*, 2012 with the objective to find out the efficacy of herbicides on weed density, weed dry weight, yield and economics of sesame. The soil of the experimental area were low in organic carbon, available nitrogen and medium in phosphorus and high in potassium content and neutral in reaction. The experiment was laid out in "Randomized block design" with ten treatments replicated thrice. The treatments comprised of pre emergence herbicides, *viz*. oxyfluorfen (250 and 500 g/ha), pendimethalin (200, 400, 600, 800 and 1000 g/ha), one hand weeding at 15 DAS + one hand hoeing at 30 DAS, two hand weeding at 15 and 30 DAS and weedy check. The sesame variety "*JTS-8*" was sown with seed rate of 3 kg/ha with fertilizer dose of 60:40:20 kg/ha. Pre emergence herbicides were applied on next day of sowing with knapsack sprayer using flat fan nozzle.

RESULTS

The major weed species observed in the experimental area were *Cyperus rotundus, Echinochloa crusgalli, Digitaria adscendens, Euphorbia hirta* and *Phyllanthus niruri*. The relative density of monocots was 75.50% while dicots were to the extent of 22.99% of the total weed population.

All the herbicidal treatments, hand weeding and hand hoeing reduced the weed intensity as well as weed biomass compared to weedy check. Hand weeding twice was most effective and recorded minimum weed intensity and biomass among all the treatments. Application of oxyfluorfen at 250 g/ha and oxyfluorfen at 500 g/ha recorded lower weeds than all doses of pendimethalin whereas in pendimethalin at 600 to 1000 g/ha registered significantly lower weed intensity than 200 and 400 g/ha. Hand weeding superseded over all the treatments and attained minimum weed biomass of (4.43 g/m^2) with weed control efficiency of 96.79% followed by one hand weeding + one hand hoeing at 15 and 30 DAS (96.00%).

Seed yield was significantly higher under all the weed control practices over weedy check. Two hand weeding at 15 & 30 DAS recorded the higher seed yield (0.308 t/ha) among all the treatments followed by one hand weeding at 15 DAS + one hoeing at 30 DAS (0.26 t/ha). Among the herbicides, pre emergence application of oxyfluorfen at 500 g/ha (0.25 t/ha) and 250 g/ha (0.24 t/ha) produced significantly higher yield over all the rates of application of pendimethalin. Ghanavel and Anbhazhagan (2006) also reported the effectiveness of oxyfluorfen in increasing the seed yield due to higher weed control efficiency.

Table 1. Effect of herbicides on weed density, dry weight, seed yield and economics of sesame.

Treatment	Mean Weed Intensity (/m^2)	Mean Dry weight (g/m^2)	Weed control efficiency (%)	Seed yield (t/ha)	Net monetary return (x10^3 ₹/ha)	B:C Ratio
Oxyfluorfen 250 g/ ha	36.67 (6.08)	16.64(4.13)	86.78	0.244	13483	2.24
Oxyfluorfen 500 g/ha	33.00(5.74)	10.86(3.36)	91.14	0.249	12707	2.04
Pendimethalin 200 g/ha	184.00(13.58)	80.10(8.94)	36.51	0.153	5443	1.55
Pendimethalin 400 g/ha	175.33(13.26)	71.87(8.50)	42.24	0.182	8060	1.79
Pendimethalin 600 g/ha	172.00(12.30)	52.72(7.26)	58.14	0.209	10577	2.02
Pendimethalin 800 g/ha	151.00(11.74)	42.46(6.55)	65.82	0.211	10527	1.99
Pendimethalin 1000 g/ha	137.33(11.34)	33.36(5.81)	72.72	0.212	10377	1.95
One hand weeding at 15 DAS + One hoeing at 30 DAS	24.67(5.01)	4.99(2.33)	96.00	0.266	12010	1.82
Two hand weeding at 15 and 30 DAS	19.33(4.43)	4.05(2.09)	96.79	0.308	13993	1.83
Control (weedy check)	265.33(16.30)	125.23(11.19)	0.00	0.102	860	1.09
LSD(P=0.05)	(0.81)	(0.80)	6.74	0.096		

*values in parenthesis are square root transformed

The highest net monetary return obtained with two hand weedings whereas the B:C ratio was the highest with the application of oxyfluorfen at 250 g/ha followed by oxyfluorfen at 500 g/ha and pendimethalin at 600 g/ha.

CONCLUSION

The application of hand weeding twice at 15 and 30 DAS recorded significantly the lowest weed density as well as weed biomass and the highest seed yield followed by followed by one hand weeding + one hoeing and oxyfluorfen at 250 & 500 g/ha than pendimethalin and weedy check.

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Weed control method under direct seeded rice in relation to applied nitrogen levels

R.K. Tiwari[1], C.L. Rai[1], S.K. Singh[1], B.S. Dwivedi[2], A.K. Jha[2], G. Mahajan[1], M.K. Tarwariya[1] and S.K. Tirpathi[1]

[1]*Jawaharlal Nehru Krishi VIshwavidyalaya, College of Agriculture, Rewa, Madhya Pradesh 486 006*

[2]*Jawaharlal Nehru Krishi VIshwavidyalaya, College of Agriculture, Jabalpur, Madhya Pradesh 482 004*

Direct seeded rice allows early establishment of the succeeding wheat crop reduces methane emissions and ensures higher profit in areas with assured water supply. But crop weed competition in this system is more severe reducing the yield by 20 -95% (Gogai 1998). Manual weeding is expensive, laborious and time consuming as well as difficult in early stage of crop growth. Use of pre-emergence herbicides has been found effective in early stage only but the second flush of weeds at 25-30 days after sowing become problematic. Hence integrated weed management practice is the only effective alternative.

METHODOLOGY

The experiment was conducted at research farm, college of agriculture, Rewa (MP) under All India Coordinated Rice improvement Project. The experimental soil was sandy loam having 0.70% organic carbon and 0.25 t/ha available nitrogen 15.6 kg/ha available phosphorus 0.34 t/ha available potash with 7.7pH of soil. The experimental design was split plot, three nitrogen levels *i.e* N_1-75 kg/ha, N_2- 0.10 t/ha and N_3 0.12 t/ha where taken as main plot treatments and five weed control methods W_1- butachlor + dhaincha (1:1)+one hand weeding (60 DAS), W_2 butachlor+ two mechanical weeding(20 DAS and 40 DAS) ,W_3- butachlor+ cowpea(1:1)+one hand weeding (60 DAS), W_4-Two hand weedings (20 DAS and 40 DAS), W_5 unweeded control. The rice variety was taken in *'JR-201'* with three replications.

RESULTS

Maximum weed population (72.02/m^2) and weed biomass (0.49 t/ha) were observed under the treatment N_3 while minimum weed control efficiency (80.74%) was also recorded under this treatment. In respect to grain yield and straw yield W_1 was found superior significant with highest grain yield (0.27 t/ha) and straw yield (0.47 t/ha).However W_5 produced lowest grain and straw yield (10.30 and 0.28 t/ha respectively) and highest net return (₹ 12,736)/ha was recorded by W_1.

Table1. Yield attributes and economics of rice inducted by different treatments

Treatment	Number of filled grain/ panicle	Number of Unfilled grain/ panicle	Test weight (g.)	Grain Yield (t/ha)	Straw Yield (t/ha)	Harvest Index (%)	Weed control Efficiency (%)	Cost of Cultivation (x10^3₹/ha)
Nitrogen levels (kg/ha.)								
N_1-75kg/ha	91.20	20.06	19.38	0.20	0.36	35.91	81.07	15.05
N_2-100kg/ha	95.60	18.38	20.10	0.21	0.38	35.89	81.34	15.32
N_3-125kg/ha	96.31	17.35	20.63	0.23	0.42	33.60	80.74	15.60
LSD(P=0.05)	0.45	0.60	0.05	0.06	0.02	0.25	N.S	-
Weed control treatment								
W_1-Butachlor+dhaincha(1:1)+one hand weeding(60DAS)	102.53	13.64	20.45	0.27	0.47	36.52	85.39	16.54
W_2-Butachlor+ two mechanical weeding(20 DAS and 40 DAS)	96.35	17.95	20.09	0.22	0.38	38.40	79.38	14.73
W_3-Butachlor+ cowpea(1:1)+one hand weeding (60DAS),	99.32	14.76	20.54	0.25	0.42	37.54	76.34	16.84
W_4-Two hand weedings (20 DAS and 40 DAS),	95.41	16.83	20.40	0.23	0.39	29.91	83.09	15.33
W_5-Unweeded control	78.23	29.79	18.71	0.10	0.28	26.60	0	13.17
LSD(P=0.05)	1.51	0.84	0.06	0.71	0.99	1.16	1.01	-
Interaction	2.63	1.46	0.71	10.23	1.72	0.50	N.S.	-

CONCLUSION

The wheat control treatment W_1 Butachlor + Dhaincha(1:1) + one hand weeding (60DAS), proved better and produced highest grain yield (0.27 t/ha) and net return (₹ 12,736/ha). Among the interaction N_3 W1 performed better by producing highest grain yield (0.29 t/ha) and net return (₹ 14,604/ha).

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Effect of day time application of post emergence herbicides on weeds and yield of transplanted rice

Monika Soni* and K.K. Jain

Jawaharlal Nehru Krishi Vishwa, Vidyalaya, Jabalpur,Madhya Pradesh 482 004

**Email: monika.soni8@gmail.com*

Rice is one of the most important food grains crop for human consumption. It is the most commonly and widely grown in India including Madhya Pradesh during *Kharif* season. Madhya Pradesh contributes 3.45% in the production of India. The production of Madhya Pradesh is 1106 kg/ha (Anonymous 2012). Mainly herbicides are being used for effective control of herbicides but the herbicides efficacy was affected by various factors, *viz*. rate, temperature, weed height, adjuvant, relative humidity, day time (morning afternoon and evening) and dew. Among these the day time also important for controlling the efficacy of herbicides because the day time also indirectly controlled the temperature in the atmosphere and soil. The herbicide molecule also affected by the day time application of herbicide.

METHODOLOGY

The present investigation was carried out at the Research Farm of Krishi Nagar, J.N. Krishi Vishwa, Vidyalaya, Jabalpur (M.P.) during 2010 and 2011. The soil of the experimental field was neutral in reaction (pH 7.12), medium in organic carbon (0.68%) and available N (0.27 t/ha), and P (15.50 kg P_2O_5/ha) and high in available K (0.29 t K_2O/ha). The treatments were consisted with 6 weed control practices weedy check, bispyribac sodium, penoxsulam, pyrazosulfuron-ethyl, cyhalofop-butyl + almix and fenoxaprop-p-ethyl + almix as main plot treatment and three day time application (morning, afternoon and evening) as sub plot treatment were laidout in split plot design with three replications. The spraying of herbicides was done by mixing the required quantity of herbicide in measured quantity of water at the rate of 500 liters/ha using Kapsnake sprayer with flat fan nozzle. Various studies were carried out on weeds and crop.

RESULTS

The field showed the predominance of *Cyperus iria* , *Fimbristylis miliacea, Alternanthera philoxeroides, Echinochloa colona, Paspalum distichum* and *Eclipta alba*. The weed control practices marked identical influence on weed density, dry weight and finally weed control efficiency. Post emergence application of pyrazosulfuron-ethyl had significantly minimal total weeds density at harvest (6.18 and 5.62/m^2) and dry weight at harvest (48.69 and 44.34 kg/ha) and proved more effective than all the post emergence herbicides and over weedy check at harvest (11.21 and 10.36/m^2 and 86.71 and 84.05 kg/ha) during both the years. Similar trends were found at 30, 60 and 90 DAT during both the years. Excellent weed control of grassy, broad leaf weeds and sedges due to application of pyrazosulfuron-ethyl and results lowest weed density and dry weight. The application of pyrazosulfuron-ethyl in evening and morning time was found superior for weed density at 30 and 60 DAT and, weed dry weight at harvest. The application of pyrazosulfuron-ethyl also registered higher weed control efficiency (65.9 and 68.6 %) among other treatments. The grain and straw yield also showed that the weed control treatments caused significant variations. The post emergence application of pyrazosulfuron-ethyl proved significantly superior for higher yield (6.35 and 6.48 t/ha) over weedy check during both the years. The post emergence application of pyrazosulfuron-ethyl also recorded higher net monetary returns (₹ 59,700 and 61,459/ha).

Table 1. Effect of day time application different post emergence herbicides on weeds, crop yield and economics of rice

Treatment	Total weed dry weight (kg/ ha)		Weed control efficiency		Grain yield (t /ha)		Straw yield (t /ha)		Net monetary returns (x10³₹ / ha)	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Herbicides										
Bispyribac- sodium	69.03(536)	66.15(494)	35.9	37.1	5.36	5.48	10.34	10.64	45.22	46.83
Penoxsulam	61.77(431)	56.73(372)	48.4	52.7	5.67	5.78	10.95	11.30	49.59	51.25
Pyrazosulfuron-ethyl	48.69(285)	44.34(246)	65.9	68.6	6.35	6.48	12.28	12.41	59.70	61.45
Cyhalofop-butyl + almix	64.92(474)	60.30(413)	43.2	47.4	5.38	5.73	10.40	11.03	44.50	49.29
Fenoxaprop-p-ethyl + almix	54.86(345)	48.79(287)	58.7	63.4	6.17	6.26	11.93	12.00	56.20	57.32
Control	86.71(836)	84.05(786)	0.0	0.0	4.26	4.63	6.48	7.10	30.31	35.33
LSD (P=0.05)	2.54	2.00	4.54	2.94	0.13	0.14	0.33	0.60	1.75	2.00
Time of application										
Morning	62.79(464)	58.17(411)	44.5	47.5	5.53	5.75	10.38	10.76	47.54	50.51
Afternoon	68.19(536)	64.30(484)	35.8	38.5	5.49	5.67	10.39	10.60	47.13	49.44
Evening	62.00(453)	57.71(405)	45.7	48.6	5.57	5.76	10.42	10.88	48.09	50.78
LSD)P=0.05(	1.29	1.53	2.12	2.07	NS	NS	NS	NS	NS	NS
Interaction	1.09	1.29	1.78	1.13	0.07	0.08	0.15	0.26	0.83	1.07
LSD (P=0.05)	3.17	3.75	5.20	3.40	NS	NS	NS	NS	NS	NS

CONCLUSION

It was concluded that the application of pyrazosulfuron-ethyl at 25 ml/ha after 10 days as post emergence in transplanted rice showed higher efficacy for controlling the broad spectrum weeds, *viz*. grassy, broad leaf and sedges and resulted highest grain yield and economics among all the post emergence herbicides. Evening time application of different post emergence herbicides was found the suitable time of application for better activity in transplanted rice.

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Effect of weed control practices on the fodder and seed productivity of berseem under irrigated condition of Madhya Pradesh

***A.K. Jha[1], Arti Shrivastva[1], N. S. Raghuvansi[1] and S.R. Kantawa[2]**
[1]AICRP on Forage Crops , JNKVV, Jabalpur , Madhya Pradesh 482 004
[2]Project Coordinating Unit, IGFRI, Jhansi, Uttar Pradesh 284 003
**Email: amitagcrewa@rediffmail.com*

Berseem is an important forage crop for irrigated areas of Kymore plateau and Satpura hills of the state, where dairy farming is one of the main occupations of the farmers. Among the different weeds, *Cichorium intybus* is one of the major obnoxious weed found associated with berseem and used to give more competition stress. Consequently, it causes substantial reduction (30-40%) in tonnage beside deteriorating the quality of seeds. Manual removal and frequent inter row cultivation are the usual control measures. However, these methods laborious and often not effective. Therefore, the present study was conducted to find out the most selective and potent herbicide for in curbing the menace of *Cichorium intybus*, *Medicago denticulate*, *Medicago hispida* and other weeds in berseem.

METHODOLOGY

Field experiments were conducted during *Rabi* season 2012 and 2013 under All India Coordinated Project on Forage Crops at JNKVV, T1-weedy cheek, T2 -Week free cheek, T3 -One hoeing at 3 WAS and one HW at 5 was, T4-Pendimethalin at 1.00 kg /ha, T5- Pendimethalin at 1.00 kg / ha + one HW at 5 WAS, T6- Oxyflourfen at 1.00 kg /ha, T7-Oxyflourfen at 1.00 kg/ha + one HW at 5 WAS, T8-Pendimethalin at 1.00 kg /ha + Imazethapyr at 1.50 g /ha (Immediate after harvest of 1st cut), T9 -Oxyflourfen at 1.00 kg /ha + Imazethapyr at 1.50 kg (Immediate after harvest of 1st cut), T10 Imazethapyr at 1.50 kg /ha (Immediate after harvest of 1st & 2nd cut), and T11- hand weeding twice at 20 and 40 DAS treatments were tested in a randomized block design with three replications.

RESULTS

All the treatments were receiving weed control treatments effectively in curbing the weed population and dry matter of all the dicots and other associated weeds over weedy check during the both years. The highest weed density (14.94/m^2) and dry weight (10.98/m^2) were recorded when weeds were not controlled thought the crop season. Among the herbicidal treatments, the pre emergence application of oxyflourfen 0.100 kg/ha+ imazethapyr 0.15 kg/ha (Immediate after harvest of 1st cut) was found to be more effective in reducing the density (6.175.92/m^2) and dry weight (5.92 /m^2) of weeds. The maximum green and dry matter yield (0.640 and 0.97 t/ha, respectively) was recorded when weeds were controlled with oxyflourfen 0.100 kg/ha+ imazethapyr 0.15 kg/ha (mmediate after harvest of 1st cut) follower by hand weeding at 20 and 40 DAS and oxyflourfen at 0.100 kg/ ha + one HW at 5 WAS. The maximum value of length of head (2.70 cm), No. of capsules (16.25), No. of seeds /capsule (30.21) and seed yield (42.4 kg/ha) The pre emergence application of with oxyflourrfen 0.100 kg /ha+ imazethapyr 0.15 kg/ha (Immediate after harvest of 1st cut) followed by hand weeding at 20 and 40 DAS and oxyflourrfen at 0.100 kg/ha + one HW at 5 WAS.

Table 1. Effect of different weed control treatments on green fodder, dry matter, seed and stover yield of berseem

Treatment	Green Fodder Yield (t/ha)		Dry matter yield (t/ha)		Seed yield (kg/ha)		Weed Index
	2011-12	2012-13	2011-12	2012-13	2011-12	2012-13	
Weedy cheek	26.8	26.3	0.35	0.34	15.5	15.8	63.09
Weed free	64.0	63.9	0.97	0.96	43.0	41.8	0.00
One hoeing at 3 WAS and one HW at 5 WAS	61.6	60.8	0.91	0.89	42.0	32.7	11.91
Pendimethalin at 1.00 kg/ha	53.4	52.8	0.75	0.74	30.7	21.0	39.03
Pendimethalin at 1.00 kg/ha + one HW at 5 WAS	54.6	54.0	0.78	0.76	39.9	34.6	12.15
Oxyflourfen at 0.100 kg/ha	57.5	56.5	0.83	0.81	40.8	30.8	15.57
Oxyflourfen at 0.100 kg/ha ha + one HW at 5 WAS	60.2	59.53	0.88	0.86	41.4	32.0	13.44
Pendimethalin at 1.00 kg/ha + Imazethapyr at 0.150 kg/ha (Immediate after harvest of 1st cut)	55.9	55.0	0.80	0.78	40.8	31.0	15.33
Oxyflourefen at 0.100 kg/ha + Imazethapyr at 0.150 kg/ha (Immediate after harvest of 1st cut)	63.5	63.0	0.96	0.94	42.3	41.1	1.65
Imazethapyr at 0.150 kg /ha (Immediate after harvest of 1st and 2nd cut)	57.8	56.8	0.83	0.82	40.9	31.3	14.86
Hand weeding 20 and 40 DAS	62.7	62.0	0.94	0.93	43.2	33.8	9.20
LSD (P=0.005)	0.30	0.29	0.14	0.12	0.21	0.31	-

HW- hand weeding , WAS- week after sowing , DAS- days after sowing

Effect of integrated weed management on seed yield of fodder maize

Pratik Sanodiya, A. K. Jha *, Arti Shrivastava and A. Chouhan
Department of Agronomy, JNKVV, Jabalpur, Madhya Pradesh 482 004
**Email: amitagcrewa@rediffmail.com*

The seed production of fodder maize has much concern, because fodder varieties of maize are mostly bred for high vegetative growth and the crops are harvested before maturity of seeds. The season-long weed competition causes considerable yield losses in maize. The predominant weed flora were *Echinochloa crusgalli* L. and *Cynodon dactylon* L. among monocots; *Cyperus rotundus* L. among sedges; and *Amaranthus viridis* L., *Digera arvensis* L., *Portulaca oleracea* L., *Alternenthara sessili* L. and *Trianthema spp.* among dicots (Arvadiya *et al* . 2012). The infestation of these weeds is increasing day by day in the maize growing belt of the state especially where the farmers are using atrazine year after year. So, in order to widen the weed control spectrum, it is desirable to use tank mix combinations of two herbicides having different mode of action and integrated weed management practices for better weed control. Hence, systematic investigations on these aspects are important.

METHODOLOGY

Field experiment was conducted at Research Farm, AICRP on Forage Crops, Department of Agronomy, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh) during *Kharif* season, Ten treatments consisted with pre emergence application of atrazine 1.0 kg/ha, pendimethalin 1.0 kg/ha and alachlor 2.5 kg/ha alone and with hand weeding at 30 DAS, combined application of atrazine 0.75 kg/ha + pendimethalin 0.75 kg/ha and atrazine 0.75 kg/ha + alachlor 2.25 kg/ha, hand weeding twice at 20 and 40 DAS and weedy check were tested in a randomized block design with three replications. Sowing of maize cv. *African Tall* was done on 13th July, 2012 by using the seed rate 40 kg/ha as per treatments in the rows 60 cm apart.

RESULTS

The WCE was maximum with 2 hand weeding closely followed by T_6 -alachlor 2.5 kg/ha + hand weeding at 30 DAS, T_6 -atrazine 1.0 kg/ha + hand weeding at 30 DAS, combined application of atrazine 0.75 kg/ha + pendimethalin 0.75 kg/ha and atrazine 0.75 kg/ha + alachlor 2.25 kg/ha but lowest WCE found with pre emergence application of atrazine 1.0 kg/ha, pendimethalin 1.0 kg/ha and alachlor 2.5 kg/ha alone. The seed and stover yields was lowest (1.13 t/ha and 12.03 t/ha, respectively) in the plots receiving no weed control measures. The maximum seed and stover yields (2.25 t/ha and 1.40 t/ha, respectively) was noted in T_9- hand weeding at 20 and 40 DAS followed by T_4 atrazine 1.0 kg/ha + hand weed at 30 DAS (2.20 and 1.38 f/ha, respectively) than other treatments . The weed index was lowest (2.20) in plots receiving pre emergence application of atrazine 1.0 kg/ha + hand weeding at 30 DAS followed by T_6 and T_5. The lower weed index values under aforesaid treatments are attributed to the reduced competitional stress by weed.

Table 1. Effect of different treatments on yield attributes, yield, weed control efficiency and economics in fodder maize

Treatment	Seed yield (t /ha)	Stover yield (t/ha)	Harvest index (%)	Weed index (%)	WCE (%) At 60 DAS
Atrazine 1.0 kg/ha	1.76	1.33	11.6	21.70	70.50
Pendimethalin 1.0 kg/ha	1.71	1.29	11.7	23.70	60.30
Alachlor 2.5 kg/ha	1.74	1.32	11.6	22.30	67.20
Atrazine 1.0 kg/ha + hand weeding at 30 DAS	2.20	1.38	13.7	2.20	80.10
Pendimethalin 1.0 kg/ha+ Hand weeding at 30 DAS	1.95	1.36	12.5	13.20	74.70
Alachlor 2.5 kg/ha + hand weeding at 30 DAS	2.08	1.37	13.2	7.20	79.00
Atrazine 0 .75 kg/ha + Pendimethalin 0 .75 kg/ha tank mixed	1.93	1.34	12.6	14.20	72.50
Atrazine 0 .75 kg/ha + Alachlor 2.25 kg/ha tank mixed	2.02	1.35	13.0	9.90	74.10
Hand weeding at 20 and 40 DAS	2.25	1.40	13.8	0.00	81.90
Weedy check	1.13	1.20	8.60	49.50	0.00
LSD (P=0.05)	0.20	0.15	0.39	-	0.77

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Efficacy of Chlorimuron-ethyl against weeds in soybean

Bhavna Saharan, Girish Jha*, K.R. Naik, J.K. Sharma and A.K. Jha
JNKVV, Adhartal, Jabalpur, Madhya Pradesh 482 004
**Email:girishagcrewa@rediffmail.com*

Soybean is an important oilseed crop and playing a vital role in sustaining the oilseed production in India over the past few years. In the different constraints, the weed management assumes the major importance for increasing the productivity of soybean. Intensive use of agro-chemicals coupled with congenial edaphic and weather conditions during *Kharif* season further aggravate the weed menace, resulting into low yields of soybean, if weeds are not controlled during proper time. Hand weeding is widely practiced for eliminating the weeds, though it is costly and time consuming. Hence, since last two decades chemical weed control has become the potential tool for curbing the weed menace. Use of Chlorimuron-ethyl 25% WP as early post- emergence is very common to get rid of weed notoriety in soybean. Very meager information is available about the activity of chlorimuon at lowest dose against weeds in soybean, as the latter herbicide has been launched in recent past in India. Keeping the above facts in view, the present investigation was under taken to find out suitable dose of chlorimuron-ethyl for effective control of weeds and higher seed yield of soybean.

METHODOLOGY

The experiment carried out on clayey soil which was neutral in reaction, medium in organic carbon, available nitrogen and phosphorus and high in available potassium. The investigation was aimed to study the efficacy of herbicide as early post-emergence for weed control and to determine economic viability of treatments. The experimental area has the natural weed flora comprising of grassy as well as broad leave weeds. Nine treatments comprised of chlorimuron-ethyl 12, 24, 36, 48 and 72 g/ha, weed free treatment (Hand weeding at 20 and 40 DAS), mechanical weeding at 20 DAS, combined application of Chlorimuron-ethyl 24 g/ha + mechanical weeding, and weedy check were laid out in RBD with three replications.

RESULTS

Pre-dominant weed infesting the soybean crop were *Echinochloa colona, Cyperus iria* among monocot while *Alternanthera philoxiroides, Eclipta alba, Commelina benghalensis and Phyllanthus niruri* among the weeds. Application of Chlorimuron-ethyl 24 g/ha as early post-emergence along with mechanical weeding was most effective in paralyzing the weed growth to that of chlorimuron-ethyl (12, 24, 36, 48 and 72 g/ha) and mechanical weeding at 20 DAS. Application of Chlorimuron-ethyl herbicide at 24 g/ha as early post-emergence along with mechanical weeding was significant superior for growth parameters, yield attributes and seed yield (1.61 t/ha) of soybean than rest of the treatments without any phytotoxicity on soybean plants. Kothawade *et al.* (2007) also conducted that Chlorimuron-ethyl at 0.8 and 1.0 litre/ha gave the highest seed yield (3.01 and 3.02 t/ha) of soybean.

Table 1. Influence of weed control treatments on seed yield, stover yield, harvest index and weed index and weed control efficiency of soybean

Treatment	Seed yield (t/ha)	Stover yield (t/ha)	Harvest index (%)	Weed index	Weed control efficiency (%)
Chlorimuron-ethyl 12g/ha	1.18	2.97	28.90	30.2	71.9
Chlorimuron-ethyl 24g/ha	1.48	3.19	31.77	12.4	74.8
Chlorimuron-ethyl 36g/ha	1.51	3.23	31.80	11	75.8
Chlorimuron-ethyl 48g/ha	1.52	3.24	31.97	10.4	77.2
Chlorimuron-ethyl 72g/ha	1.53	3.26	32.00	9.7	78.1
Hand weeding (20 and 40 DAS)	1.69	3.49	32.70	0	97.3
Mechanical weeding (20 DAS)	1.49	3.25	31.50	12.2	75.5
Chlorimuron-ethyl24g/ha +MW (40 DAS)	1.60	3.40	32.10	5.3	79.2
Weedy check	1.08	2.70	28.65	36	0
LSD (P=0.05)	0.147	0.08	-	-	-

Application of Chlorimuron-ethyl herbicide at 24 g/ha as early post-emergence along with mechanical weeding was found more remunerative in terms of NMR (₹ 20,023) and B-C ratio (2.06) than application of Chlorimuron-ethyl herbicide at 12 g/ha to 72 g/ha, as early post-emergence.

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The impact of floor management practices on soil quality parameters of a newly planted citrus orchard

Ajay Verma, K.K. Barman*, V.P. Singh and M.S. Raghuvanshi

Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004

**Email: barmankk@gmail.com*

High cost of establishing an orchard necessitates cropping the trees early and harvesting the maximum amount of quality fruit that the tree will support. The orchard floor management system can greatly affect soil health parameters, and thereby earliness of bearing and yield. An ideal orchard floor would be easy to maintain, help the growth of the trees and fruit, maintain the soil structure, reduce soil erosion, and not harbor insects and other pests. In practice, no single orchard floor management system accomplishes all of these goals but rather a balance of the above factors should be achieved. The age-old practice of frequent tillage to keep the orchard floor weed free is costly and also results in poor soil structure and reduced soil microbial activity reduced leaf-N content of orchard trees (Chauhan *et al*. 1999), soil erosion, *etc.* The presence of cover crops or weeds on the orchard floor may show beneficial effects on soil nitrogen and soil organic matter content, soil enzymatic activity. but no effect on tree leaf nutrient content (Wright *et al*. 2003). The chemical method of weed management is the cheapest, but the use of herbicides has become a great concern due to increased environmental awareness; and it has become imperative to study the impact of herbicides on soil health. The use of herbicide to manage orchard floor was found beneficial in terms of leaf N content of orchard trees (Kumar and Chauhan 2003), but resulted in poor enzymatic activity in soil .The current investigation was undertaken with the objective of studying the impact of cultural, chemical and mechanical weed management practices on different soil health indicators in a newly planted citrus orchard.

METHODOLOGY

Citrus seedlings were planted during *Kharif* 2008 in a site of the DWSR research farm by following a square grid of 5 m plant to plant distance. The each plant received 5 kg FYM on dry weight basis and 100 g DAP once in a year in their basins. The floor of the orchard was subjected eight management treatments comprising of applications of herbicides (metribuzin and glyphosate), tillage, intercroppings (cowpea-pea-cowpea and mungbean-pea-mungbean) with or without pendimethalin, and a weedy control. Observations on soil physical, chemical and biological parameters were recorded during winter season 2012-13 by following standard procedures.

RESULTS

Managing weeds in the newly established citrus orchard by using cultural, chemical and mechanical means favoured the trees to achieve better growth, although the soil the highest values of soil organic C and available N content were recorded in the permanently weedy plots.

The tillage treatment, *i.e.* repeated rotavator operation to mange weeds, and the treatments involving sole chemical weed control measures, *i.e.* application of metribuzin and glyphosate, adversely affected soil physical quality in terms of infiltration rate. Besides that the chemical treatments also affected soil biological health in terms of soil microbial biomass carbon. In absence of any weed control measure, *i.e.* in permanent weedy plots, profuse growth of perennial grasses increased the penetration resistance of the surface soil. Growing legumes, with recommended doses of N and P, as intercrops in the orchard floor improved soil physical health in terms of infiltration rate and penetration resistance. These treatments also maintained good soil biological health in terms of soil microbial biomass carbon, and improved soil available P status. Application of pendimethalin to intercrop, however, adversely affected the nodulation parameters and soil microbial biomass carbon.

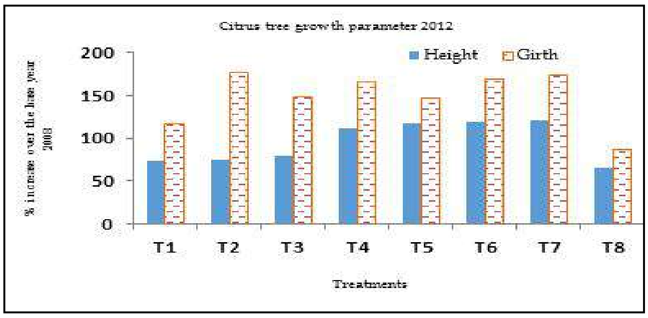

Fig. 1. Effect of weed management treatments in orchard on citrus tree growth

T_1: Cowpea-pea-cowpea intercropping, T_2: - Moong -Pea-Moong intercropping, T_3: T_1+ Pendimethalin, T_4: T_2+ Pendimethalin, T_5: Metribuzin 0.5 kg per season, T_6: Glyphosate 2 kg per season, T_7: Rotavator twice per season, T_8: Weedy check

CONCLUSION

Controlling weeds is essential to obtain healthy growth of orchard trees. Keeping in view the soil quality and the tree growth parameters, it is concluded that the treatment of growing moong-pea-moong intercrops with recommended doses of N and P, and pendimethalin as a weed control measure was better than the sole tillage and sole chemical measures for management of newly planted citrus orchard floor.

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Influence of post emergence herbicide on economics of soybean

D.A. Kulal , N.K. Kalegore, S.R. Kadam

Department of Agronomy, College of Agriculture, VNMKV, Parbhani, Maharashtra 431 401

The productivity of soybean in Marathwada region is found low as compared to Maharashtra state. One of the limiting factors for low yield was found to be weed competition. The reduction in the yield due to weed varies from 35 to 50 per cent, depending upon the type of weeds, their intensity and time of crop weed competition (Chandel *et al.* 1995). The effectiveness and economical weed control may not be possible through manual or mechanical means due to heavy and continuous rainfall in *Kharif,* labour shortages, and high wages of labour. Therefore, considering critical crop-weed competition period in soybean in addition to above problems several pre-emergence herbicides have seen recommended controlling weeds. Post emergence herbicides may be applied as per need of time and place saving time, money and labour. Therefore, there is need of testing new post emergent herbicides which have broader spectrum of activity. Recently, some new post emergent herbicides have been released in India and weed evaluation for field use. Keeping these facts in view, the present investigation was undertaken to find out suitable effective post-emergence herbicides for weed control in soybean.

METHODOLOGY

A field experiment was conducted during *Kharif* 2010-11 at Agronomy farm, college of Agriculture, Parbhani. Twelve treatments were tested under randomised block design with three replication (Table 1). Each experimental unit was repeated three times having 5.4 x 5.4 m gross plot size and 4.8 x 4.5 m net plot size. Soybean variety MAUS-71 was sown on July 8, 2010 in line at 45 cm row to row and 5 cm plant to plant distance to a depth about 2.5 to 3.5 cm and covered with moist soil and fertilized with 30:60:30 kg N, P_2O_5 and K_2O / ha with urea, single super phosphate, murate of potash, respectively. The total rainfall received during the field experimentation was 1120 mm and was well distributed pattern in 50 rainy days. Data on the important biometric observations were collected on five randomly selected and neatly labelled plants in each treatment throughout the crop life. Statistical analysis was done by analysis of variance method, wherever the result were found to be significant, was also calculated for comparison of treatment means at 5% level of significance (LSD P=0.05).

Higher relative income was recorded in weed free check (2 HW + 2 hoeing at 3rd and 5th WAS) *i.e.* ₹ 53951 / ha and significantly superior over rest of the treatments. The higher relative income was due to higher yield and it was observed due to favoured growth and development due to higher weed control efficiency recorded in these treatments. These results are in conformity of those Reddy *et al*. (2003).

Addition returns over weedy check was highest in treatment weed free check (2 HW + 2 hoeing at 3rd and 5th WAS) *i.e.* (₹ 22,659 / ha)' which was at par with treatments pendimethaline PE 750 g / ha + 1 HW at 30 DAS (₹ 21,219 / ha) and significantly superior over rest of the treatments. Higher additional income generated because of additional yield observed in these treatments the higher weed control efficiency and lower dry weight contributed to higher additional yield and lower cost of treatment. These results are in conformity with the results of Reddy *et al.* (2003).

Table 1. Economics of weed control treatments in soybean (*Glycine max* L.)

Treatment	Yield (t / ha)	Gross income (x10³₹ / ha)	Relative income (x10³₹ / ha)	Additional returns over weedy (x10³₹ / ha)	Treatment cost (x10³₹ / ha)	B:C ratio
Trifluraline POE 125 g / ha at 15 DAS	2.32	52.53	43.51	12.22	9.02	1.35
Trifluraline POE 150 g / ha at 15 DAS	2.36	53.65	44.60	13.30	9.05	1.47
Propaquizafop POE 625 g / ha at 10-12 DAS	2.31	52.22	42.25	10.95	9.97	1.09
Fenaxaprop-P-ethyl POE 12 g / ha 10-12 DAS	2.33	52.67	41.77	10.48	10.89	0.96
Chlorimuron-ethyl POE 40 g / ha at 10-12 DAS	2.44	55.30	45.81	14.52	9.48	1.53
Quizalofop-ethyl POE 40 g / ha at 10-12 DAS	2.47	55.93	45.98	14.69	9.95	1.47
Tank mix (quizalofop-ethyl POE 40 g / ha + chlorimuron-ethyl POE 12 g / ha) at 20 DAS	2.69	60.84	50.28	18.99	10.56	1.79
Imazethapyr POE 75 g / ha at 21 DAS	2.71	61.22	51.26	19.97	9.96	2.00
Pendimethalin PE 750 g / ha + 1 HW at 30 DAS	2.82	63.79	52.51	21.22	11.28	1.88
Weeed free check (2 HW + 2 hoeing) at 3rd and 5th WAS	2.89	65.32	53.95	22.66	11.37	1.99
Farmers practice (1 HW + 1 hoeing) at 30 DAS	2.51	56.87	46.95	15.66	9.92	1.57
Weedy check	1.75	39.76	31.29	-	7.47	-
LSD (P=0.05)	0.26	-	0.59	2.13	-	-
General Mean	2.47	55.84	45.84	15.51	-	-

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Effect of weed management practices on growth and yield of rice under transplanted Lowland

Abhishek Chauhan*
Department of Agronomy, JNKVV, Jabalpur,
**Email: abhishekagron15@gmailcom*

System of rice intensification (SRI) holds the key for increasing the productivity with least inputs, as it saves 80 % seeds and 40 to 50 % irrigation water but due to square planting, rice crop faces a heavy infestation of weeds, *viz.* grasses, sedges and broad leaved weeds during initial stage of its growth, which cause a major threat to its production. The average loss in grain yield by unchecked growth of weeds in transplanted rice is reported to be 20 to 27% (Singh *et al.* 2007). In view of the above facts, the present investigation was undertaken to find out the most suitable method of weed management in rice grown under transplanted lowland conditions.

METHEDOLOGY

A field experiment was conducted during *kharif* season of 2010 at the Crop Research Farm, Department of Agronomy, Sam HigginbottomInstitute of Agriculture, Technology and Sciences, Allahabad. The experiment was laid out in Randomized Block Design (RBD) with ten treatments, replicated thrice. The treatments consisted of pre-emergence application of butachlor and metsulfuron methyl along with post-emergence application of 2,4-D EE or conoweeding at 20 DAT, which was compared with two hand weedings at 20 and 40 DAT and weedy check control. Twelve days old seedlings of the variety 'Pro-Agro 6444' was transplanted at 25 x 25 cm spacing on 26 July 2010, after basal placement of half of the recommended dose of N (60 kg/ha) and full doses of P_2O_2 (60 kg/ha) and K_2O (40 kg/ha) before transplanting and remaining N (60 kg/ha) was top-dressed in two equal splits, half at active tillering and the rest half at panicle-initiation stage.

RESULTS

The major weed flora observed in the experimental field was *Echinochloa crussgalli, Echinochloa colonum, Cyperus rotundus, Cyperus iria, Cynodon dactylon, Sorghum halepense* etc. All the treatments registered significantly lower number of weed biomass and weed index than control, but the efficiency in controlling different types of weeds varied significantly. Among the weed control measures, pre-emergence application of metsulfuron methyl at 6 g/ha followed by an application of 2,4-D EE 500 g ha^{-1} at 35 DAT recorded the least weed biomass (30.68 g/m^2), highest weed control efficiency (76.7%) and lowest weed index (9.40%), although, the weed biomass (35.32 g/m^2) recorded under the treatments T_9 (butachlor at 1.5 kg/ha as pre-emergence + 2,4-D EE at 500 g ha^{-1} as post-emergence) was found to be statistically on par to that obtained under treatment T_{10} and higher weed control efficiency (76.70%) was also recorded in treatment T_{10}. The probable reasons for above findings might be due to the phytotoxicity of metsulfuron methyl on germinating weeds which inhibits the cell division in the meristematic tissues, resulting in death of most of the weeds within a few days of their emergence and an effective broad leaf weed control at later stages of growth by a post-emergence application of 2, 4-D EE.

Table 1. Effect of weed management practices on weed control

Treatment	Weed biomass (g/m^2)	Weed control efficiency (%)	Weed index (%)
Control	119.32		54.93
Hand Weeding at 20 and 40 DAT	39.48	69.1	10.52
Weed free (Up to 90 DAT)			0.00
Conoweeding 20 and 40 DAT	40.28	66.7	18.27
Butachlor 1.5 kg/ha (pre-emergence)	54.00	55.0	26.72
Metsulfuron methyl 6 g/ha (pre-emergence)	45.32	60.8	16.91
Butachlor 1.5 kg/ha (pre-emergence) + Conoweeding at 20 DAT	41.32	66.1	13.13
Metsulfuron methyl 6 g/ha (pre-emergence) + Conoweeding at 20 DAT	43.35	72.7	12.12
Butachlor 1.5 kg/ha (pre-emergence) + 2,4-D EE 500 g/ha at 35 DAT	35.32	70.5	11.47
Metsulfuron-methyl 6 g ha^{-1} (PE) + 2,4-D EE 500 g/ha at 35 DAT	30.68	76.7	9.40
LSD (P=0.05)	6.72		

CONCLUSION

It can be concluded from the present study that for getting an effective weed control and higher productivity from rice sown under lowland transplanted conditions, pre-emergence application of Metsulfuron methyl at 6 g ha + 2,4-D EE at 500 g/ha as post-emergence application can be recommended.

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Influence of weed management practices in blackgram under guava based agri-horti system in Vindhyan region

Suresh Chand Yadav, U.P. Singh*, J. Padmavathi, H.S. Ravi Kumar, Lakhapati Singh and Himanshu Singh
Department of Agronomy, Institute of Agricultural sciences, B H U, Varanasi, Uttar Pradesh 221 005
**Email:udaipratap.singh1@gmail.com*

Blackgram (*Vigna mungo* L.) is an important pulse crop under guava based agri-horti system in *Vindhyan* region of India. With increasing weed problem and crisis of labour, an effective weed management option is needed for this system. Hence, the present investigation was carried to evolve appropriate weed management option for Vindhyan region under blackgram+guava agri-horti system.

METHODOLOGY

An experiment was conducted in *Kharif* 2011 at the Agricultural Research Farm, Rajiv Gandhi South Campus, B.H.U., U.P. in 5 year old guava field at spacing of 7 x 7 m. Eight weed management treatments were evaluated in randomized block design with three replications. Blackgram variety '*T-9*' was sown in sandy soil with a spacing of 30 x 10 cm with recommended package of practices.

RESULTS

All the weed management treatments showed significant effect and had lower total weed density at 50 DAS as compared to weedy check, which had maximum total weed density and weed dry weight. Minimum total weed density and weed dry weight was recorded under weed free treatment, the next best treatment was pendimethalin (1 kg/ha) + one mechanical weeding at 25 DAS followed by imazethapyr (60 g/ha) + one mechanical weeding at 25 DAS. These results are in conformity with the findings of Modak *et al*. (1995). Pendimethalin (1 kg/ha) + one mechanical weeding at 25 DAS recorded maximum weed control efficiency followed by imazethapyr (60 g/ha) + one mechanical weeding at 25 DAS. The minimum weed index (6.64) was recorded with pendimethalin (1 kg/ha) + one mechanical weeding at 25 DAS. Whereas, maximum weed index (51.96) was recorded under weedy check alone (Table 1). The maximum grain and straw yields were recorded under weed free treatments followed by the pendimethalin (1 kg/ha) + one mechanical weeding at 25 DAS due to higher dry matter accumulation, yield attributes and better weed control efficiency. Results are in agreement with the findings of Rathi *et al*. (2004). The maximum net return was obtained in weed free, followed by and imazethapyr (60 g/ha) + one mechanical weeding at 25 DAS, pendimethalin (1 kg/ha) + one mechanical weeding at 25 DAS. However benefit: cost ratio was obtained maximum in imazethapyr (60 g/ha) at 15 DAS + one mechanical weeding at 25 DAS followed by imazethapyr 60 g/ha at 15 DAS and pendimethalin (1 kg/ha) + one mechanical weeding at 25 DAS.

Table 1. Weed growth, yield and economics of blackgram as influenced by different methods of weed management

Treatment	Total Weed density (no/m^2)	Weed dry weight (g/m^2)	Weed control efficiency (%)	Weed index (%)	Grain yield (t/ ha)	Straw yield (t/ha)	Net return (x10^3₹/ha)	B:C
Weedy check	7.5* (56.0)	5.0	0.0	52.0	0.47	1.62	14.66	0.98
Weed free	0.7 (0.0)	0.0	100.0	0.0	0.99	2.18	36.73	1.66
Pendimethalin 1 kg/ha PE	3.1 (9.3)	3.0	45.8	28.3	0.71	1.94	26.12	1.56
Pendimethalin 1 kg/ha PE one mechanical weeding at 25 DAS	1.9 (3.1)	1.4	74.2	6.6	0.92	2.09	34.95	1.74
Pendimethalin 1 kg/ha PE + straw mulching 15-20 DAS	2.7 (6.6)	2.5	60.2	18.4	0.81	1.99	25.55	1.11
Imazethapyr 60 g/ha at 15 DAS	2.8 (7.4)	2.5	49.4	23.1	0.76	1.96	29.50	1.81
Imazethapyr 60 g/ha at 15 DAS + one mechanical weeding at 25 DAS	2.3 (4.6)	1.8	68.1	8.0	0.91	2.05	35.16	1.85
Imazethapyr 60 g/ha at 15 DAS + straw mulching at 15-20 DAS	2.4 (5.4)	2.1	62.0	15.6	0.84	2.02	26.87	1.19
LSD (P=0.05)	0.99	0.4			0.09	0.17		

* Values in parantheses are original. Data transformed to square root transformation

CONCLUSION

Application of pendimethalin (1 kg/ha) + one mechanical weeding at 25 DAS and imazethapyr (60 g/ha) + one mechanical weeding at 25 DAS can be used for minimizing weed growth, maximizing crop growth, yield, net returns and benefit: cost ratio in blackgram under guava based agri-horti system in Vindhyan region.

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Weed management in rice nursery and cumulative effect in main field

J. Deka, N. Borah, I.C. Barua and N.C. Deka

DWSR-AAU Centre, Department of Agronomy,Jorhat, Assam 785 013

Email: jayantadeka.2008@rediffmail.com

The weeds at very actively growing stage in the rice nursery are also uprooted along with seedlings and get transplanted in the main field. The herbicides applied to rice main field are mostly of pre-emergence type; therefore they are not effective against the weeds which are already in rapid vegetative stage. An experiment was therefore under taken with the objectives to study the effect of weed management on rice nursery weeds and rice seedlings as well as cumulative effect on the rice crop in the main field.

METHODOLOGY

A field experiment was undertaken during the *Kharif* seasons of 2011 and 2012 at the ICR Farm of Assam Agricultural University, Jorhat. The soil of the experimental site was acidic (pH 5.30) with available N 0.22 kg/ha, P_2O_5 18.68 kg/ha and K_2O 0.14 kg/ha. The treatments to rice nursery comprised of five weed control practices, *viz.* i) pretilachlor 0.5 kg/ha pre-emergence, ii) oxyflourfen 90 g/ha pre-emergence, iii) oxadiargyl 60 g/ha pre-emergence, iv) oxadiargyl 90 g/ha pre-emergence and v) weedy check and three weed control practices to the rice main field, viz., i) recommended herbicide (pretilachlor 0.75 kg/ha pre-emergence), mechanical weeding twice at 15 and 45 days after planting and weedy check. The experiment was laid out in RBD with four replications in rice nursery and split plot with three replications in rice mainfield. The rice variety '*Srimanta*' was sown on 20th June in 2011 and 27th June in 2012 and 28 days old seedlings were uprooted and transplanted in the main field. Herbicide treatments were applied 2 days after seed sowing in the nursery and 4 days after transplanting in the main field.

RESULTS

Sedges were the most prevalent weeds in the rice nursery beds. Two most frequent species were *Eleocharis acutangula* and *Cyperus iria.* Other sedges recorded were *Cyperus difformis* and *Fimbristylis littoralis.* Grasses like *Echinochloa crusgalli* and *Sacciolepsis interrupta* became rather prominent at least two weeks after emergence of the crop. However among the broadleaved weeds, *Ludwigia decurrens* and *L. linifolia* were most dominant. The linking weed species between the nursery and the main field were *Eleocharis acutangula* and *Cyperus* spp. and their introduction in the main field was primarily as seedling contaminants. The other commonly associated weeds in the main field were *Fimbristylis littoralis* in sedge, *Manochoria vaginalis, Sagittaria guayanansis* and *Sphenoclea zeylanica* in broadleaved species and grasses like *Echinochloa crusgalli*, *Sacciolepsis interrupta* and *Leersia hexandra.* Pretilachlor 500 g/ha applied to nursery resulted lowest values of density and dry weight of weeds at all stages in 201. However during 2010, weed dry weight due to pretilachlor 500 g/ha, oxadiargyl 80 WP 60g/ha and oxadiargyl 80 WP 90 g/ha was significantly lower than that in weedy check. Treatments with pretilachlor 500 g/ha or oxadiargyl 80 WP 90 g/ha in nursery resulted lowest density and dry weight during main field rice crop. Application of pretilachlor 500 g/ha as pre emergence in main field resulted lowest values in both the years and significant reduction of weed density and dry weight beyond 30 DAT onwards as compared to hand weeding during 2011. Nursery treatments did not affect plant height and yield attributes of rice in both the years other than the number of grains/panicle which significantly increased due to pretilachlor 500 g/ha and oxadiargyl 80 WP 90 g/ha over weedy check in both the years. Application of pretilachlor 750 g/ha in the main field significantly increased the number of grains as compared to weedy check in both years. Hand weeding twice caused significant increase in number of grains/panicle over weedy check during 2010. Treating rice nursery with pretilachlor 500 g/ha, oxadiargyl 80 WP 60 g/ha and oxadiargyl 80 WP 90 g/ha resulted significant increase in grain yield in main field as compared to weedy check in both the years. In the main field, the treatments with pretilachlor 750 g/ha and hand weeding twice significantly increased grain yield of rice as compared to weedy check. Efficacy of pretilachlor with safener has been reported by Rao and Moody (1988). The results of on farm trials in two locations in Nagaon district revealed an average grain yield of 7.5 t/ha and benefit: cost ratio of 3.32 with treatment combination of pretilachlor 500 g/ha in rice nursery and Pretilachlor 750 g/ha in the main field against grain yield of 7.1 t/ha and benefit: cost ratio of 3.19 with single treatment of pretilachlor 750 g/ha in the main field.

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Chemical weed management in jute and its residual effect on succeeding black gram

S. Dalal* and B. Duary

Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal 731 236

**Email- dalal.souvik@gmail.com*

Jute plays an important role in Indian economy in terms of its significant contribution to agriculture and industry as well as foreign exchange earning. Raw jute farming provides employment of 10 million man days in rural sector (Mahapatra *et al.* 2009). Weed infestation is a great obstacle in achieving higher productivity in jute. In terms of expenditure, weed management constitutes one third of total cost of cultivation. The magnitude of yield loss due to weeds in jute ranges between 52 and 70% in *C. capsularis* and 59-75% in *C. olitorius*. Among the existing weed management recommendations, application of grass killer like quizalofop-p-ethyl as early post emergence with or without hand weeding is most common. Application of pendimethalin and propaquizafop alone or with hand weeding may be effective in jute. Again it is essential to study the residual effect of applied herbicides on succeeding crops. With this perspective the present experiment was conducted to study the efficiency of chemical weed management on weed growth and productivity of jute, economics of jute cultivation and the residual effect of herbicides applied in jute on succeeding blackgram.

METHODOLOGY

A field experiment was conducted at the Agricultural Farm of the Institute of Agriculture, Visva-Bharati, Sriniketan, during the pre-*Kharif* and post *Kharif* season of 2012 in a randomized block design with ten treatments replicated thrice (Table 1). The farm is situated at about 23^{0}392 N latitude and 87^{0}422 E longitude with an average altitude of 58.9 m above the mean sea level. The soil of the experimental field was sandy loam (*ultisol*) in texture having medium to low fertility with acidic reaction (pH 5.58). The jute variety '*JRO-524'* was sown on 27 April, 2012 in plots of size 4 x 3 m. Herbicides were sprayed with Knapsack sprayer fitted with flat fan nozzle. The succeeding blackgram crop was sown as residual crop on the same layout.

RESULTS

The experimental jute field was infested with three categories of weeds, *viz*. grassy, broadleaved and sedges. *Digitaria sanguinalis,* among the grasses; *Cyperus iria,* among the sedges and *Malvastrum coromandelianum* among the broadleaved weeds were predominant throughout the cropping period. Among the weed management treatments propaquizafop at 50 ml and 62.5 mL/ha at 15 DAS, one hand weeding + pendimethalin at 0.50 L/ha at 15 DAS, quizalofop-p-ethyl at 50 ml/ha at 15 DAS, pendimethalint 0.50 L/ha at 2 DAS registered significantly the lower number of grassy weeds. Propaquizafop at 62.5 mL/ha at 15 DAS +one hand weeding at 30 DAS, one hand weeding + pendimethalin at 0.50 L/ha at15 DAS recorded significantly the lowest number of sedges. One hand weeding + pendimethalin at 0.50 L/ha at 15 DAS and propaquizafop at 62.5 mL/ha at 15 DAS + one hand weeding at 30 DAS registered significantly lower density and dry weight of total weeds than that of all other treatments except weed free check (Table 1). Lower values of weed density, total weed dry weight and weed index, higher values of growth and yield attributes of jute, weed control efficiency, net return as well as return per rupee invested were registered with propaquizafop at 62.5 mL/ha at 15 DAS + one hand weeding at 30 DAs and one hand weeding + pendimethalin at 0.50 L/ha at 15. The loss of fibre yield of jute due to weed infestation was to the tune of 86.6%. No residual effect of applied herbicides in jute was observed in succeeding blackgram.

Table 1. Weed growth, yield and economics of jute as influenced by different weed control treatments

Treatment	Weed density (no./m^2) at 45 DAS	Weed dry matter (g/m^2) at 45 DAS	Weed index	Fibre yield (x10^3₹ /ha)	Gross return (x10^3₹ /ha)	Net return (x10^3₹ /ha)	Return per rupee invested
Propaquizafop 50 mL/ha	10.12(102.0)	6.34(39.7)	38.54	1.74	56.04	33.54	2.49
Propaquizafop62.5 mL/ha	8.96 (80.0)	6.04(35.9)	19.95	2.27	71.65	48.97	3.16
Propaquizafop 75 mL/ha	9.54(90.7)	6.57(43.6)	20.37	2.26	71.75	48.87	3.14
Propaquizafop 125 mL/ha	8.70(75.3)	6.12(36.9)	20.30	2.26	71.33	47.70	3.02
Propaquizafop 62.5 mL/ha + one Hand weeding	6.41(40.7)	3.84(14.3)	2.28	2.78	87.25	60.36	3.24
Pendimethalin 0.50 L/ha	4.88(23.3)	4.38(19.8)	24.63	2.14	68.95	46.56	3.08
Quizalophop-p-ethyl 50 mL/ha	9.91(98.3)	7.80(61.6)	35.17	1.84	58.03	35.08	2.53
One hand weeding + pendimethalin at 0.50 L/ha at 15 DAS	1.17(1.0)	0.94(0.4)	4.42	2.72	84.72	58.14	3.19
Unweeded control	10.78(115.7)	7.68(58.8)	86.57	0.38	13.78	-7.69	0.64
Weed free check	0.71(0.0)	0.71(0.0)	0.00	2.84	89.52	59.65	3.0
LSD (P=0.05)	0.76	1.34		0.37			

Figures in parentheses are the original values. The data was transformed to [(x+0.5)] transformation.

CONCLUSION

Propaquizafop at 62.5 ml /ha at 15 DAS + one hand weeding at 30 DAS or one hand weeding + pendimethalin at 0.50 lit /ha at 15 DAS appeared to be promising for managing weeds obtaining higher fibre yield and net return of *olitorius* jute in the lateritic belt of West Bengal.

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Effect of post emergence herbicides on weed management and seed yield of soybean in vertisols

M.R. Patil*, P.M. Chaudhari, P.S. Bodake, S.B. Patil, and P.P. Girase, P.M. Chaudhari, P.S. Bodake, S.B. Patil and P.P. Girase

College of Agriculture, Dhule, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra 413 722

**Email: mrpatil_stat@yahoo.co.in*

Soybean (*Glycine max* (L.) Merrill.) often designated as miracle crop of the twenty first century, contains about 20% of oil, 40% high quality proteins, 23% carbohydrates and reasonable amounts of minerals, vitamins and dietary fibers. Since the yield per unit for many conventional crops has perhaps come to a plateau, search for unconventional source of protein rich food and edible oil supply is a necessity and soybean seems the only crop at present, which has the potential to meet the present and future needs of the world for protein and edible oil. The losses caused by weeds much higher than from any other category of biotic factors like insects, nematodes, rodents, etc. The crop yield losses may occur up to the extent of 20 to 77%. Although herbicides give better and timely weed control, but due to its high costs prohibits their use by the average cultivar. A judicious combination of chemicals and cultural methods of weed control would not only reduce the expenditure on herbicide but would benefit the crop timely by providing proper aeration.

METHODOLOGY

The present investigation was conducted during *Kharif* 2012 at P. G. Research Farm, Agronomy Section, Dhule. Experiment consisted of seven treatments laid out in randomized block design with four replications (Table 1). The soil of the experimental field was clay in the texture, with low in available nitrogen and available phosphorus and rich in available potassium. The soil was slightly alkaline in reaction with pH of 7.8. The experimental crop was sown by the dibbling at 45 x 5 cm on 3 July, 2012.

RESULTS

The weed species observed in soybean were monocot weeds, *viz. Cynodon dactylon, Digitaria sanguinalis, Echinochloa colona, Panicum isachmi, Sorghum halepense* and dicot weeds, *viz. Digera arvensis, Commelina benghalensis, Parthenium hysterophorus, Celocia argentea, Melilotus alba and Corchorus ascutangulus.* After weed free check, the best treatment was hoeing at 15 DAS and hand weeding at 30 DAS followed by post-emergence application of imazethpyr 100 g/ha and quizalofop-p-ethyl 100 g/ha each coupled with one hand weeding was found effective against both monocot and dicot weeds. Application of imazethapyr 100 g/ha at 15 DAS was found better than quizalofop-p-ethyl 100 g/ha at 15 DAS with respect to weed intensity. Numerically lower weed index was found in hoeing at 15 DAS and HW at 30 DAS. Lower weed index was found under application of imazethapyr 100 g/ha at 15 DAS followed by HW at 30 DAS. The weedy check recorded the maximum weed index. Post emergence application of imazethapyr 100 g/ha was observed best treatment in controlling weeds. After 30 DAS onward WCE was improved by combine use of herbicide and HW as compared to herbicide alone. These results are in agreement with the results reported by Venkatesha *et al.* (2008). The seed yield of soybean was found to be significantly higher (3705 g/ha) in weed free treatment. This was followed by hoeing at 15 DAS and hand weeding at 30 DAS (3365 g/ha) which was found at par with imazethapyr 100 g/ha at 15 DAS + HW at 30 DAS (3168 g/ha). Among the IWM treatment tried in the experiment, post emergence application of imazethapyr 100 g/ha at 15 DAS + HW at 30 DAS and quizalofop-p-ethyl 100 g/ha at 30 DAS + HW at 30 DAS were found at par with each other in respect of seed yield of soybean and found significantly better than their application alone. The seed yield was significantly lowest under weedy check treatment. These results corroborate with the finding of Yadav *et al.* (2009).

Treatment	Weed intensity (no./m)			Weed control efficiency (%)			Weed index (%)	Seed yield (t/ha)
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	at harvest		
Weed free	0.71 (0)	0.7 (0.0)	0.7 (0.0)	90 (100)	90 (100)	90 (100)	0.00	3.71
Quizalofop-p-ethyl 100 g/ha 15 DAS (POE)	4.9 (24)	7.4 (54)	8.09 (65)	60.2 (75)	47.28 (54)	42.33	28.5	2.65
Quizalofop-p-ethyl 100 g/ha 15 DAS (POE) *fb* HW 30 DAS	4.5 (20)	5.1 (25)	5.2 (26)	63.0 (79)	62.19 (78)	62.70 (78)	18.8	3.01
Imazethapyr 100 g/ha 15 DAS (POE)	4.5(19)	6.38 (44)	7.4 (54)	63.2 (79)	52.32 (62)	49.03 (57)	27.7	2.68
Imazethapyr 100 g/ha 15 DAS (POE) *fb* HW 30 DAS	4.26 (17)	4.66 (21)	4.85 (23)	64.9 (82)	64.94 (82)	64.9 (81)	14.4	3.17
Hoeing 15 DAS and HW 30 DAS	3.96 (15)	4.2 (17)	4.35 (18)	66.9 (84)	67.37 (85)	67.6 (85)	9.2	3.37
Weedy check	9.9 (98)	10.9 (118)	11.3 (127)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	48.2	1.52
LSD (P=0.05)	0.5	0.5	0.4	3.2	2.7	2.1	-	0.33

* Figures in parentheses are original values. All figures subjected to transformed values to square root ($\sqrt{x+0.5}$).

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Weed management in turmeric

Suresh Kumar*, S. S. Rana and Neelam Sharma

CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, Himachal Pradesh 176 062

**Email: skg_63@yahoo.com*

Low and mid hills of Himachal Pradesh are the important turmeric growing areas. This crop is grown during rainy season. It is a long duration slow growing crop. Moreover this crop is finding an important place in *Kharif* season as an alternative to maize particularly in wild boars, stray animals and porcupines infested areas. It has poor initial growth rate and shallow root system there by, invaded by a variety of weeds. Weeds compete with crop for nutrients, moisture and space and cause considerable yield reduction. They cause 35-75% yield reduction. Slow initial growth and its poor canopy development provide an ideal environment for weeds to grow and compete with the crop, which adds to the cost of weed management. Non availability of labour hinders the timely removal of weeds. Straw mulch is another approach adopted by farmers that conserve soil moisture and modify soil temperature for benefit of crop, besides controlling weeds. However, controlling weeds chemically is the need of the hour. Thus the present investigation was undertaken.

METHODOLOGY

A field experiment was conducted at Palampur during *Kharif* 2012 to study the efficacy of different herbicides against weeds and their effect on growth and yield of turmeric in randomized block design with ten treatments replicated thrice (Table 1). The experimental soil was silty clay loam in texture, acidic in reaction, medium in available nitrogen, phosphorus and high in available potassium. Turmeric variety '*Palampur Pitamber*' was planted on 2 June 2012 with recommended package of practices except treatments. Herbicides were applied with knapsack power sprayer using 600 L water per hectare. Data on density and dry weight of weeds were recorded at 90 DAS and at harvest which were subjected to square root transformation. The crop was uprooted on 4 January 2013.

RESULTS

The major weeds of the experimental field were *Echinochloa colona, Digitaria sanguinalis, Panicum dichotomiflorum, Commelina benghalensis, Cyperus iria, Ageratum conyzoides, Polygonum* sp., *Physallis minima, Eragrotis* spp and *Aeschynomene indica.* All the weed control treatments except pendimethalin 1.0 kg/ha *fb* fenoxaprop 67 g/ha + metsulfuron-methyl 4 g/ha behaving statistically similar resulted in significantly lower total weed count and total weed dry weight at harvest. All the weed control treatments except those where post emergence application of fenoxaprop 67 g/ha + metsulfuron-methyl was made with any of herbicide resulted in significantly taller plants of turmeric. Weeds in unweeded check reduced the rhizome yield of turmeric by 78.8% over the best treatment i.e. metribuzin 0.7 kg/ha *fb* straw mulch 10 t/ha *fb* 1 hand weeding (HW). However, metribuzin 0.7 kg/ha *fb* straw mulch 10 t/ha *fb* 1 hand weeding was statistically alike with pendimethalin 0.7 kg/ha *fb* straw mulch 10 t/ha *fb* 1 HW and atrazine 0.75 kg/ha *fb* straw mulch 10 t/ha *fb* 1 hand weeding. All the weed control treatments where post emergence application of fenoxaprop 67g/ha + metsulfuron-methyl 4 g/ha was made with any of herbicide, caused phytotoxicity to the crop and resulted in significantly lower turmeric yield. Atrazine 0.75 kg/ha *fb* straw mulch 10 t/ha *fb* 1 HW and metribuzin 0. 7 kg/ha fb straw mulch 10 t/ha *fb* 1 HW gave the similar net profit/rupee invested. It was followed by pendimethalin kg/ha *fb* straw mulch 10 t/ha *fb* I HW.

Table 1. Effect of different treatments on total weed count, total dry weight, plant height and rhizome yield in turmeric

Treatment	Total weed count (no./m^2)	Total weed dry weight (g/m^2)	Plant height	Rhizome yield (t/ha)
Metribuzin 0.7kg/ha *fb* 2 hoeing	6.1 (37.3)	3.9 (14.5)	48.4	5.4
Metribuzin 0. 7 kg/ha *fb* fenoxaprop 67 g/ha + metsulfuron-methyl 4g/ha	6.0 (38.0)	4.0(15.8)	25.2	2.8
Metribuzin 0. 7 kg/ha *fb* straw hutch 10 t/ha *fb* 1 HW	5.0 (25.3)	3.4 (13.4)	50.6	13.7
Pendimethalin 1.0 kg/ha *fb* 2 hoeings	5.2 (26.7)	3.2 (9.6)	46.7	6.3
Pendimethalin 1.0 kg/ha *fb* fenoxaprop 67 g/ ha + metsulfuron-methyl 4 g/ha	7.4 (56.0)	4.7 (21.8)	26.4	2.8
Pendimethalin kg/ha *fb* straw hutch 10 t/ha *fb* IHW	4.1 (16.0)	2.7 (7.1)	50.1	13.4
Atrazine 0.75 kg *fb* fenoxaprop 67 g/ha + metsulfuron-methyl 4 g/ha	6.1 (37.3)	4.1 (15.5)	24.3	2.3
Atrazine 0.75 kg/ha *fb* straw much 10 t/ha *fb* 1HW	5.4 (29.3)	2.9 (7.7)	51.4	12.0
Weed free	6.6 (42.7)	4.2 (18.1)	49.4	7.0
Weedy check	10.8 (116)	7.7 (58.3)	42.3	2.9
LSD (P=0.05)	2.2	1.7	7.4	2.4

Values given in the parentheses are the original. *fb* = followed by, DAS= days after sowing, HW= hand weeding

CONCLUSION

Metribuzin 0.7 kg/ha *fb* straw mulch 10 t/ha *fb* 1 HW and pendimethalin 0.7 kg/ha *fb* straw mulch 10 t/ha *fb* 1 HW and atrazine 0.75 kg/ha *fb* straw mulch 10 t/ha *fb* 1 HW were the most effective weed control treatments in turmaric.

Bioefficacy of different herbicides in fenugreek

Suresh Tehlan, S.S.Punia* and Anil Duhan
Department of Microbiology, CCS HAU, Hisar, Haryana 125 004
**Email: puniasatbir@gmail.com*

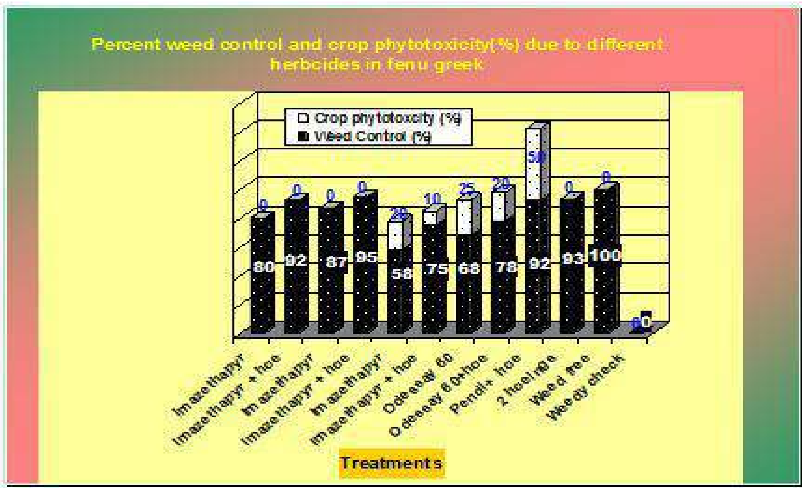
Fenugreek is a leguminous grown for spices and green vegetable purpose. Crop suffers due to weeds in the initial stages due to slow initial growth and wider spacing. Pendimethalin has been recommended to control weeds but it efficacy is for short period and is inconsistent. Weeds which come up after first irrigation also cause huge losses. Keeping it in view, present experiment was planned to study effectiveness of imazethapyr and its ready mix combination applied as PPI, pre or post emergence.

METHODOLOGY

Present studies were conducted at vegetable research area of CCS HAU Hisar during *Rabi* 2012-13. Experiment consisted of 10 herbicide treatments replicated thrice in a plot size of 7x 3.6 m^2. Variety 'HM 58' was planted on November, with a seed rate of 20 kg/ha. Herbicide pendimethalin at 1000g/ha as PRE, imazethapyr was used as PPI, pre emergence at 80 g/ha and at 2-4 leaf stage at 70 g/ha. Ready mix combination of imazethapyr and imazamox was also applied at 2,-4 leaf stage at 60 g/ha by using 750 litres of water/ha. Phytotoxic effect on crop was recorded at 60 DAS by using 0-100 scale .Visual weed control was also assessed at harvest on 0-100 scale. Data on weed dry weight was recorded at 60 DAS which was subjected to ANOVA for analysis. To study residual effect of these herbicides on succeeding crops, after harvest of fenugreek, 2 lines each of sorghum, bitter guard, okra, cowpea, cotton and bottlegourd were planted on the same layout with slight disking of plots.

RESULTS

Experimental field was infested with broadleaf weeds such as *C. album, C. murale, Coronopus didymus, Melilotus indica and Rumex dentatus.* Pre-emergence or pre-plant incorporation of Imazethapyr at 80 g/ha either alone or in combination with one hoeing at 45 DAS provided 80-95% control of *C.album, C.murale, Coronopus didymus and Rumex dentatus* without any adverse effect on fenugreek. Post emergence application of this herbicide at 70 g/ha or its ready mixture with imazamox (Odessay) although provided 58-78% control of weeds but caused suppression in crop growth with yield penalty of 28-33% as compared to weed free check. Pre-emergence application of pendimethalin (standard check) at 1000 g/ha along with hoeing although gave 92% control of weeds but crop remained stunted even up to 80 DAS with seed yield of 780 kg/ha which was minimum among herbicide treatments. Residual effect of these herbicides applied in fenugreek was studied on succeeding sorghum, bitter guard, okra, cowpea, cotton and bottle gourd. Post mergence application treatments of imazethapyr +imazamox (RM) caused suppression in cotton and okra crops.



CONCLUSIONS

Pre-emergence or pre-plant incorporation of imazethapyr at 80 g/ha either alone or in combination with one hoeing at 45 DAS provided 80-95% control of *C. album, C. murale, Coronopus didymus and Rumex dentatus* without any adverse effect on succeeding sorghum, bitter guard, okra, cowpea, cotton and bottle gourd.

Bioefficacy of prometryn alone and in combination with other herbicides in *Kharif* maize

Bhagirath Kamboj, Baldev Kamboj and S.S.Punia
Department of Agronomy, CCS HAU, Hisar, Haryana 125 004

Maize is an important *Kharif* crop of Kandi region in Panchkula, Ambala and Yamuna Nagar districts of Haryana. Although atrazine has been recommended for control of weeds, but weeds emerging in later stages are not controlled by use of this herbicide. However, poor efficacy against complex weed flora and residual toxicity at higher doses are other problems associated with this herbicide (Pandey and Parkash 2002). Keeping it in view, present experiment was planned to study the bioefficacy of prometryn alone and in combination with other herbicides.

METHODOLOGY

To study the bioefficacy of prometryn alone and in combination with other herbicides, a field experiment was conducted at Krishi Vigyan Kendra, Yamuna Nagar during *Kharif* 2004. Experiment consisted of fifteen treatments *viz.* prometryn at 1.0 and 1.25 kg/ha as Preemergence and 21 DAS, prometryn *fb* paraquat and glyphosate, one hoeing flowed by prometryn, paraquat and glyphosate each, atrazine at 05 and 0.6 kg/ha alone and in sequential application with glyphosate and paraquat were compared with weed free and weedy check in randomized block design with three replicates. Experiment was laid out on July 15, 2004, keeping a plot size of 7.0 x 6.0 using cultivar *HQM-1*. Data on weed density, weed dry weight and grain yield was collected and analyzed as per procedure.

RESULTS

Weed flora of experimental field consisted mainly of grassy weeds, *viz.* Goose weed (*Eluesine indica)*, Barn yard grass (*Echinochloa colona*) and crow foot grass (*Dactyloctenium aegyptium*). All herbicide treatments proved very effective in minimizing density of weeds as compared to weedy check (Table 1). Prometryn at 1.0 and 1.25 kg/ha applied either as pre-emergence or post emergence at 21 DAS gave 60-67% control of weeds which was at par with atrazine at 500 and 600 g/ha . Density of weeds decreased significantly and percent control increased when use of prometryn or atrazine was integrated with post emergence application of either glyphosate (0.5%) or paraquat (0.3%). Glyphosate use was more effective than paraquat. One hoeing at 21 DAS followed by protected spray of glyphosate or paraquat also provided effective control of all the weeds. Grain yield differed significantly among treatments. Maximum grain yield (2.37 t/ha) was obtained in weed free treatment which was significantly higher than all other treatment. Among herbicidal treatments, pre-emergence application of prometryn at 1.0 kg *fb* protected spray of glyphosate(0.5% product basis) gave maximum grain yield which was at par with prometryn at 1.0 kg/ha fb by paraquat (0.3%) , pre-emergence application of atrazine at 0.5 kg/ha integrated with glyphosate at 45 DAS and one hoeing at 21DAS fb glyphosate at 45 DAS. Sreenivas and Satyanarayana (1994) during studies at Andhra Pradesh Agricultural University, Hyderabad, also recorded higher grain yield of maize with use of atrazine at 1.0 kg/ha + glyphosate 1.0 kg/ha.

Table 1. Effect of different weed control treatments on density, visual control of weeds and grain yield of kharif maize

Treatment	Dose (g/ha)	Time of application	Weed density (no./m^2)	Visual weed control (%)	Maize yield (t/ha)
Prometryn	1000	Pre-emergence	31.07	60	1.63
Prometryn	1250	Pre-em.	25.67	67	1.66
Prometryn	1000	21 DAS	25.60	65	1.66
Prometryn	1250	21 DAS	24.97	67	1.79
Prometryn *fb* paraquat	1000 *fb* 0.5%	Pre-em. & 45 DAS	7.60	80	2.20
Prometryn *fb* glyphosate	1000 *fb* 1.0%	Pre-em.& 45 DAS	4.27	92	2.23
One hoeing *fb* paraquat	0.5%	21&45 DAS	4.87	87	2.11
One hoeing *fb* glyphosate	1.0%	21 &45 DAS	4.53	89	2.19
Prometryn *fb* one hoeing	1000	Pre-em. and 30 DAS	3.37	75	1.97
Atrazine	500	Pre-em.	25.33	68	1.71
Atrazine	600	Pre-em.	24.57	70	1.74
Atrazine	500 *fb* 1.0% glyphosate	Pre-em. and 45 DAS	6.53	90	2.16
Atrazine	500 *fb* 0.5 % paraquat	Pre-em. and 45DAS	10.50	78	1.99
Weedy check			70.67	0	1.18
Weed free			0.00	100	2.37
LSD(P - 0.05)			3.57		0.19

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Integrated weed management studies in cotton

Kuldeep Singh, Satyavan and S.S. Punia
Department of Agronomy, CCS HAU Hisar, Haryana 125 004

Cotton (*Gossypium hirsutum* L.) is an important cash crop of Haryana, grown in an area of 0.63 m ha. Unfortunately, herbicides available for weed control in cotton provide narrow spectrum of weed management. Hence, application of one or more herbicides is required for efficient management of different types of weeds. To manage weeds significantly, the herbicides should be supplemented with either mechanical or cultural means of control and vice-versa. Therefore, there is need to study the development of the most efficient, eco-friendly and economically viable integrated weed management practices in cotton.

METHODOLOGY

Present investigation was carried out at research area, CCSHAU, Hisar during *Kharif* 2002. The soil of experimental field was slightly alkaline in reaction, low in organic carbon, nitrogen, phosphorus and medium in potassium. The experiment consisted of fifteen treatments, namely pre-plant incorporation of trifluralin at 750,1000 and 1225 g/ha, dry hoeing at 30-45 DAS followed by trifluralin at 750,1000 and 1225 g/ha followed by irrigation, pre-emergence application of trifluralin at 750, 1000 and 1225 g/ha followed by hoeing at 30-45 DAS, post emergence application of trifluralin at 750,1000 and 1225 g/ha followed by glyphosate 0.5% directed spray), two hoeings (30 and 60 DAS), weedy check and weed free. Treatments were replicated thrice in randomized block design keeping a plot size of 4.5 × 4.2 m.

RESULTS

Weed control efficiency and other yield attributing characters were significantly influenced by all weed management practices over weed check. On an average, pre-emergence application of trifluralin at 1225 g/ha followed by one hoeing at 30-45 DAS, dry hoeing 30-45 DAS followed by trifluralin at 1225 g/ha followed by irrigation and two hoeing at 30 and 60 DAS were found at par among themselves but all these treatments were found superior in seed cotton yield. Pre-emergence application of trifluralin at 1225 g/ha followed by one hoeing resulted in higher nutrient uptake by cotton crop (N-37.21 and P-10.41 kg/ha), this has resulted in significantly higher dry matter production (124.30 g/plant) which was at par with two hoeings at 30 and 60 DAS. The significantly lower weed population, dry weight of weeds and nutrient uptake by weeds was observed in pre-emergence application of trifluralin at 1225 g/ha integrated with one hoeing which result in higher production of seed cotton yield (1.48 t/ha). Trifluralin as PPI and post emergence followed by glyphosate (0.5% directed spray) was able to effective control of weeds and significantly increase seed cotton yields over weedy check. also found excellent control of weeds with pre-emergence application of pendimethalin at 1.5 kg/ha supplemented with protected spray of glyphosate (0.5%) at 65 DAS which was at par with treatment of two hoeings at 25 and 50 DAS. Maximum net returns were obtained from trifluralin at 1225 g/ha as pre emergence integrated with one hoeing at 30-45 DAS and two hoeing at 30 and 60 DAS (₹ 11003 /ha and 10344/ha respectively).

CONCLUSIONS

Based on the finding of a one year experiment it may concluded that under the agro climatic conditions of Hisar (Haryana), application of trifluralin at 1225 g/ha as pre-emergence followed by one hoeing at 30-45 DAS proved most efficient for controlling weeds like *Trianthema portulacastrum*, *Echinochloa crusgalli*, *Digera arvensis* and *Phyllanthus niruri*, in situation where labour was scarce or incessant rain did not allow mechanical weeding and gave high seed cotton yield of cotton cv. '*HS-6'*.

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Study the effectiveness s of new herbicide – penoxulam on growth and yield of transplanted rice

C. Ramachandra, M.P. Rajanna, D.S. Poornima and G.K. Ningaraju

A field experiment was conducted during rainy seasons of 2008-09 at Zonal Agricultural Research Station, V.C. Farm, Mandya, Karnataka, to develop economic methods of the new herbicide for transplanted rice. The treatment consists Butachlor 50 EC (1. kg/ha) applied at 5 DAT, penoxulam (1.02% w/v)+cyhalofop-butyl w/w (5.1% w/w) (5.0wv) (120 gm /ha) applied at 15 DAT, Penoxulam (1.02% w)+Cyhalofop-butyl w/w (5.1% w) (5.0wv) (135 gm /ha) applied at 15 DAT, bispyribac sodium (100g LSC) (35 gm/ha) applied at 15 DAT, two hand weeding and non weeded control. The field trail was laid out in randomized Complete Block design with four replication. Among weed management practices chemical weed control by making use of new herbicides, which are of proven value in transplanted rice culture. The application of Penoxulam (1.02% w) + Cyhalofop-butyl w/w (5.1% w) 5.0 w herbicide 135 gm /ha at 15 DAT found to be effective against lower number of weeds (3.49), lower weed dry weight (2.49 g), higher panicle number /m^2 (455), higher panicle weight (4.25 g) and higher grain yield (6.64 t/ha) and found to be significantly superior over all other treatments. The lowest grain yield (3.83t/ha), panicle number/m^2 (285), panicle weight (3.28 gm), higher number of weeds (5.71) and higher weed dry weight (4.1 gm) was observed with non-weeded control. Weed control efficiency was higher in hand weeding at 20 and 40 DAT (42.44 %) and which was followed by penoxulam (1.02% w/v) + cyhalofop-butyl w/w (5.1% w/w) 5.0 w/v herbicide135 g/ha at 15 DAT (39.27%) and the lowest weed control efficiency was noticed in application of Butachlor 50 EC (20.98%). The study revealed that combined application of penoxulam + cyhalofop-butyl herbicide 135 gm /ha at 15 DAT was found to be effective against control the weeds in transplanted rice.

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Efficacy of metsulfuron-methyl against broad-leaved weeds in wheat

A.N. Singh Ninama, NidhiVerma, Deepak KhendeM.S. Shah and Aruna D. Ahirwar
Zonal Agriculture Research Station, Powarkheda, Madhya Pradesh

Wheat is one of the most important cereal crops of the world. In India it is second important staple food crop, rice being the first. The irrigated wheat is infested with several broad leaf weeds which create competitive stress resulting in yield losses varying from 7 to 50% depending upon their density (Sharma *et al.* 2001). At present, 2,4-D as post emergence is an effective herbicide to control the broad leaf weeds in wheat, but has sown little control of several non grassy weeds.Therefore, there is urgent need to have alternative herbicides which may provide wide range of weed control. In this direction, some new sulfonyl urea herbicides were tested alone and in and in combination to find out their efficacy.

METHODOLOGY

The investigation reported here was carried out at the Research Farm of the Department of Agronomy, Collage of Agriculture, Gwalior (M.P.) during the rabi season of 2006-07. The soil of experimental area was sandy loam with 7.78 pH, Organic carbon (0.41%). Ten weed control treatments (Table 1) were laid out in randomized block design with three replications. Wheat variety '*MP-4010*' was sown on November 14, 2006 at 22.5 cm row to row spacing and using 100 kg seed per hectare. The quantity of herbicides as per treatment was sprayed by hand sprayer in respective plots with flat-fan nozzle. The water was used 600 litre per hectare.

RESULTS

Weed density and dry weight of broad-leaf weeds was reduced drastically with the use by weed free check treatment fallowed by metsulfuron-methyl 8g + 0.2% surfactant/ha at all stages of observations. The next herbicidal treatments in respect of reducing broad-leaf weed population more or less effective were metsulfuron-methyl 5g and 4g with 0.2% surfactant per hectare, 2,4-D sodium salt at 500g/ha and metsulfuron-methyl 4g with other combinations over control. Post emergence application of metsulfuron-methyl 8g + 0.2% sulfosulfuron/ha resulted in higher grain yield (4.62 and 4.52 t/ha), respectively among the herbicides and both were also comparable to weed free treatments having the maximum value (4.63 t/ha). Similarly maximum weed control efficiency (89.21%) was exhibited by weed free treatment, fallowed by metsulfuron-methyl at 8g (87.36%) and 4g (83.02%) with 0.2% surfactant/ha.

Application of metsulfuron methyl at the rate of 8g + 0.2% surfactant/ha was found most effective to control the weeds and for reducing their dry weight.

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Table 1. Weed dry weight, WCE and grain yield of wheat as affected by herbicide treatments

Treatment	Weed dry weight (g/m^2) 30 days after sowing	At harvest	WCE (%)	Grain yield (kg/ha)
Metsulfuron-methyl 3g + 0.2% surfactant/ha POE	3.61	1.53	79.86	3370
Metsulfuron-methyl 4g + 0.2% surfactant/ha POE	3.40	1.29	83.02	3827
Metsulfuron-methyl 5g + 0.2% surfactant/ha POE	3.25	1.59	79.07	4434
Metsulfuron-methyl 8g + 0.2% surfactant/ha POE	3.03	0.96	87.36	4620
Metsulfuron-methyl 4g/ha POE	3.37	1.69	77.76	3709
2, 4-D Sodium Salt 500g/ha POE	3.61	1.70	77.63	4043
Metsulfuron-methyl 4g + 0.2% urea/ha POE	3.46	1.64	78.42	3771
Metsulfuron-methyl 4g + 25g sulfosulfuron/ha POE	3.63	1.75	76.97	4518
Hand weeding – weed free check (25 and 50 DAS)	1.24	0.82	89.21	4628
Untreated control	3.71	7.60	-	-
LSD (P=0.05)	0.72	0.54	-	1234.08

Evaluation of odyssey 70% WG against weeds of soybean in Niwar region

M.S. Shah, M.L. Kewat, R.K. Rai, S.K. Vishwakarma and Nidhi Verma

Zonal Ariculture Research Station Khargon, RVSKVV, Gwalior, Madhya Pradesh

METHEDOLOGY

A field experiment was conducted during *Kharif* season of 2010 at ZARS Khargon to evaluate the "Efficacy of odyssey 70% WG against weeds of soybean (*Glycine max* L.)" The present experiment was carried out on medium black clay – loam soil. The soil was slightly alkaline with low in organic carbon, available N, medium in P_2O_5 and K_2O. The 11 treatments comprising of odyssey at 75, 87.5 and 100 g/ha, its application with adjuvant (1000 ml/ha), imazetphapyr at 1000 ml/ha, imazamox at 350 ml/ha, chlorimuron-p-ethyl at 37.5 g/ha and fenoxaprop-ethyl at 750 ml/ha as early post-emergence, including weedy check, were laid out in randomized block design with 3 replications. Yield attributing traits viz., pods per plant, seeds per pod and seed index (100-seed weight) were recorded treatment wise. Weed control efficiency, harvest index and economic viability of treatments were determined from the data generated; tabulation and statistical analysis of data were done for testing the significance among the different treatments.

RESULTS

Among the odyssey treatments, activity of odyssey at highest dose of 100 g/ha as early post-emergence was not well marked against most of the weeds, but when applied between 75 and 87.5 g/ha and application with adjuvant (1000 ml/ha) as early post-emergence, controlled most of the associated weeds. Similar views were also endorsed by several research workers (Shete *et al.* 2008).

Weed control efficiency of treatments has strong negative relationship with weed biomass. Therefore, the trend of treatments for increased WCE was in order of reduction of weed biomass. The weed control efficiency (46.62 and 85.93%) of treatment-6 was found highest followed by T_3 (40.55 and 69.52%) and T_4 (33.77 and 58.80%) in descending order due to less dry matter produced by weed flora as comparison to remaining chemicals used under investigation. This was because of high dose applied at particular time span of crop growth period (early post-emergence). The views are in close conforming to finding of Shete *et al*. 2008. The lowest weed control efficiency of T_9 (chlorimuron-p-ethyl 37.5 g/ha) was noticed as 14.85 and 24.26% due to non lethal as odyssey at site of action. The views are in close conforming to finding of Shete *et al*. 2008.

Influence of odyssey on pods per plant, seed per pod and seed index of soybean

Treatment	Pods/plant	Seeds / pod	Seed index	Grain Yield (t/ha)	Stover Yield (t/ha)	Harvest Index (%)
Odyssey 75 g	102.35	1.93	8.81	1.60	4.62	25.70
Odyssey 87.5g	106.89	2.05	9.35	1.73	4.78	26.67
Odyssey 100 g	115.82	2.47	9.52	1.92	4.90	28.19
Odyssey + adjuvant 75 g + 2 ml	106.96	2.17	8.98	1.70	4.71	26.62
Odyssey + adjuvant 87.5 g + 2 ml	111.67	2.24	9.41	1.85	4.82	27.71
Odyssey + adjuvant 100 g + 2 ml	120.93	2.67	10.49	2.10	5.14	28.98
Imazethapyr + adjuvant 1000 ml + 2 ml	97.44	2.18	8.52	1.55	4.52	25.50
Imazamox + adjuvant 350 ml + 2 ml	92.39	1.98	8.52	1.47	4.60	24.29
Chlorimuron-ethyl 37.5 g	86.93	1.83	8.20	1.37	4.43	23.65
Fenoxoprop-ethyl 750 ml	93.55	1.76	8.30	1.45	4.52	24.25
Weedy check	83.67	1.60	8.04	1.15	4.35	20.96
(LSD=0.005%)	4.69	NS	NS	0.72	0.71	

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Studies on bioefficacy of bispyribac sodium 10% SC against weeds in transplanted rice

D. Shamurailatpam*, P. Adhikary, S. Mallick, R. K. Ghosh, R. Podder and R. Das
Department of Agronomy, Faculty of Agriculture,Bidhan Chandra Krishi Viswavidyalaya (BCKV)
Mohanpur, West Bengal 741252
**Email: dia_bie@yahoo.com*

Rice is cultivated in India in a wide range of ecosystems from irrigated to shallow lowlands, mid-deep lowlands and deep water to uplands. Transplanting is the major method of rice cultivation in India Singh *et al.* 2011. Weeds are a major impediment to rice production through their ability to compete for resources and their impact on product quality. Though weeds are largely managed by herbicide use, their efficacy needs to be tested in varying ecosystems and cropping patterns. In this aspect this study was done to assess effect of bispyribac sodium 10% SC against weeds in transplanted rice

METHODOLOGY

The experiment was conducted during *Kharif*, 2011 and 2012 at the "INSTRUCTIONAL FARM" of Bidhan Chandra Krishi Viswavidyalaya, Nadia, West Bengal. The experimental soil was well drained, alluvial in nature and sandy loam in texture, having pH 6.87, organic carbon 0.573%, available nitrogen 241.57 kg/ha, available phosphorus 22.90 kg/ha and available potassium 111.22 kg/ ha respectively. The variety used in this experiment was '*IET-4786*'. A set of seven treatments was laid out in randomized block design with three replications. Twenty-five days old seedlings were transplanted at a spacing of 20 × 15 cm. Each plot size was of 6 m x 4 m and treatment details given in Table 1. Treated plots were maintained water level static as far as possible thereafter. Half the recommended dose of N (40 kg/ha) and full dose of P_2O_5 and K_2O (40 kg/ha) were applied before transplanting at final land preparation, and the remaining N (40 kg/ha) was top-dressed in two equal splits, half at active tillering and the rest half at panicle-initiation stage. All the other recommended agronomic and plant protection measures were adopted to raise the crop and the intercultural practices were taken as need based. The data on weed counts and dry matter production (DMP) were recorded at 15 and 30 DAA and weed control efficiency (WCE) of different treatments was computed using data on weed DMP. The grain and straw yield were recorded at harvest.

RESULTS

All the treatments registered significantly lower number of weeds and total dry matter production than weedy check (Table 1). All the three doses of Bispyribac Sodium 10% SC were found effective in arresting the weed population and their growth compared with the traditional recommended herbicide, Pretilachlor. Among the treatments, higher dose of Bispyribac Sodium 10% SC i.e. treatment T_3 reduced the weed population most effectively at every growth stages than the lower doses (T_2 and T_1). Application of Bispyribac Sodium 10% SC 30 g/ha as early post-emergence herbicide increased the WCE (87.06%) at 15 DAA. While the highest WCE was recorded in weedy check (94.51 %) plots. Similar trends were observed at 30 DAA. The maximum grain yield was recorded from Weed free check (3.996 t/ha) while the minimum was from the unweeded control (2.11 t /ha). The testing herbicide Bispyribac Sodium 10% SC applied at higher different dosages from 20 to 30 g / ha recorded at par grain yield with weedy check. The biological yield also showed similar variations among the treatments as found in grain yield of transplanted rice.

Table 1. Effect of treatments on weed control efficiency, weed index and yield of transplanted rice

Treatment	Dose (g/ha)	Weed control efficiency (%)		Weed Index (%)	Yield (t/ha)	
		15 DAA	30 DAA		Grain	Straw
Bispyribac Sodium 10% SC	10	71.34	64.96	12.39	3.50	4.39
T_2 :Bispyribac Sodium 10% SC (x)	20	85.56	68.07	2.55	3.89	4.74
Bispyribac Sodium 10% SC	30	87.06	80.71	1.68	3.92	4.83
Bispyribac Sodium 10% SC (Standard)	20	85.60	80.01	6.43	3.73	4.05
Pretilachlor 50% EC	750	74.79	68.35	19.99	3.19	4.34
Weedy Check	-	94.51	90.07	0.00	3.99	4.99
Unweeded Control	-	0.00	0.00	47.22	2.10	2.37
LSD (P=0.05)	-	-	-	-	0.15	0.35

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Weed management in chilli + onion + cotton intercropping system

Ningappa*, Ramesh Babu and B. N. Aravind Kumar
Department of Agronomy, College of Agriculture, Dharwad
University of Agricultural Sciences, Dharwad, Karnataka-580005
E mail: 4441nings@gmail.com

In Karnataka, cotton and chilli are the most extensively grown commercial crops in drylands under intercropping systems. Onion is also grown in mixtures in this intercropping system. This system is most assured and paying intercropping system of the northern dry zone of Karnataka (Dharwad and Gadag districts). Least competition exists among the component crops especially when cotton variety '*Jayadhar*' was used (Kumaraswamy and Hosmani 1978). Among these three crops, onion is a poor competitor to weeds due to its short stature, non branching habit and extremely slow growth in the initial stages, enabling quick and rapid growth of weeds. Hence, it is necessary to control weeds at the early stages of crop growth to achieve the desired productivity. It is a common practice with the farmers to take up 4-5 manual weedings depending on intensity of weed infestation and availability of labour. Presently labour is costly and scare. Hence a trial was conducted in farmer's field on participatory basis to find out the optimum weed management strategies in chilli+onion+cotton intercropping system through sequential application of pre and post emergence herbicides compared to farmers' practice.

METHODOLOGY

The experiment was conducted in farmer's field of village Mugali, Ron taluka, Gadag district in randomized block design with three replications consisting of 7 treatments (details in table). '*Byadagi Dabbi'* of chilli, '*Bellary Red'* of onion and '*Jayadar'* of cotton were used in the trial. Onion and chilli were hand drilled simultaneously. After every four rows of onion one row of chilli was hand drilled 1250 g / ha. Distance between two chilli rows was 120 cm. Two rows of cotton were hand dibbled in between two rows of chilli (30 cm away from chilli row). Recommended fertilizer for chilli was applied at the time of sowing.

RESULTS

Among the herbicides treatments, pendimethalin 1 kg / ha fb oxyfluorfen 0.15 kg / ha recorded significantly lower weed density and total weed dry weight (4.66 and 6.19 g / m^2, respectively) and it was on par with butachlor 1 kg / ha fb oxyfluorfen 0.15 kg / ha (4.81 and 6.41 g / m^2) and oxadiargyl 90 g / ha *fb* oxyfluorfen 0.15 kg / ha (5.06 and 6.66 g / m^2) compared to farmers' practice (5.30 and 7.13 g / m^2). This treatment also recorded significantly higher weed index and which was on far with other herbicide treatments except the treatment receiving alachlor 1 kg / ha *fb* oxyfluorfen. 15 kg / ha (29.3%).

Table 1. Weed parameters, crop yield and economics as influenced by different weed management practices in chilli + onion + cotton intercropping system

Treatment	Weed index (%)	Red dry chilli yield (t / ha)	Onion bulb yield (t / ha)	Seed cotton yield (t / ha)	Cost of cultivati on (x10³ ₹ / ha)	Net return (x10³ ₹ / ha)	B:C ratio
Pendimethalin (PRE)1 kg / ha *fb* Oxyfluorfen (POST) 0.15 kg / ha	53.7	1.27	2.20	0.81	36.63	110.11	4.01
Butachlor (PRE) 1 kg / ha *fb* Oxyfluorfen (POST) 0.15 kg / ha	50.5	1.22	2.13	0.78	35.44	105.68	3.98
Oxadiargyl (PRE)90 g / ha *fb* Oxyfluorfen (POST) 0.15 kg / ha	46.3	1.19	2.10	0.74	35.51	101.34	3.85
Alachlor (PRE) 1 kg / ha fb Oxyfluorfen (POST) 0.15 kg / ha	29.3	0.88	1.50	0.52	35.79	64.41	2.80
Weedy check	--	0.19	0.35	0.14	31.41	-8.41	0.73
Weed free	89.0	1.44	2.76	0.98	37.41	136.04	4.64
Farmers' practice	36.0	1.06	1.92	0.66	34.41	88.12	3.56
LSD (P=0.05)	9.02	0.17	0.29	0.11	-	17.40	0.49

Treatment 1 to 4 received hand weeding at 45 days after sowing (chilli/cotton rows only), PRE - Pre-emergence, POST - Post-emergence, DAS - Days after sowing, fb - Followed by. Figures in the parenthesis are original values (X + 0.5) transformation, Market price: Red chilli ('80/kg); onion (' 9/kg); cotton ('30/kg)

The yield of chilli, bulb onion and seed cotton was significantly higher with application of pendimethalin 1 kg / ha fb oxyfluorfen.15 kg / ha (1.28, 2.20 and 0.82 t / ha, respectively) compared to farmers' practice (1.06, 1.92 and 0.66 t / ha, respectively) and was on par with other herbicide treatments except alachlor 1 kg / ha *fb* oxyfluorfen 0.15 kg / ha (0.88, 1.50 and 0.53 t / ha, respectively).

CONCLUSION

It can be concluded that application of either pendimethalin 1 kg / ha or butachlor 1kg / ha or oxadiargyl 90 g / ha followed by post emergence application of oxyfluorfen0.15 kg / ha is effective and economical in controlling the weeds and producing higher yield and monitory returns of component crops in intercropping system and was better than farmers' practice.

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Study of effect of pyrazosulfuron-ethyl on soil fungi

Uzma Waseem*[1] and Shobha Sondhia[2]

[1]*Mata Gujri Girls College, Jabalpur, Madhya Pradesh 482 001*

[2]*Directorate of Weed Science Research, Adhartal, Jabalpur, Madhya Pradesh 482 004*

**Email: uzmakhandwsr@gmail.com*

Pyrazosulfuron-ethyl is a sulfonylurea herbicide useful in controlling weeds in paddy fields. To date very little information is available on its adverse effect on the soil microbial community. Microorganisms are of importance as they play a vital role in herbicide dissipation because they consume the herbicide molecules and utilize them as a source of energy and nutrients for growth and reproduction (Sondhia *et al.* 2013; Xu *et al.*2009). This study was conducted with an aim to study effect of pyrazosulfuron-ethyl on soil fungi under laboratory conditions.

METHODOLOGY

Experiment was conducted in nonsterilized and sterilized soil under laboratory conditions. To estimate effect of pyrazosulfuron-ethyl on fungal population, control soil were collected from Directorate of Weed Science Research (DWRS), Jabalpur and air-dried, passed through a 3 mm sieve, and remoistened with distilled water to 20 % to permit good aeration. The pyrazosulfuron-ethyl was dissolved in distilled water and applied to the each set of soil surface according to three treatments (2 mg/kg, 4 mg/kg doses and one control 0mg/kg). Three replicates were prepared for each treatment. Fungal population was recorded at 0, 5, 10, 20, and 30 days intervals by serial dilution method. Degradation products of pyrazosulfuron-ethyl in soil were identified by LC/MS/MS.

RESULTS

Several filamentous fungi like *Alternaria alternata , Aspergillus niger, Aspergillus flavus, Trichoderma harzianum, Trichoderma viridae, Penicillium chrysogenum, Rhizopus* sp., *Mucor* sp., and *Helminthosporium* sp. were found able to grow with pyrazosulfuron-ethyl as sole source of carbon and energy. However *Alternaria alternata, Aspergillus flavus, Trichoderma viridae, Rhizopus* sp., *Mucor* sp., and *Helminthosporium sp.* were found sensitive toward pyrazosulfuron-ethyl resulting less CFU counts. *Penicillium chrysogenum, Aspergillus niger* and *Trichoderma harzianum* were found less affected by pyrazosulfuron-ethyl application at two doses and high CFU counts at 0 to 30 days were recorded in nonsterilized soil. Fungi were identified based on colony morphology, cultural properties and microscopic characteristics. At 0 day the concentration of pyrazosulfuron-ethyl was high and not utilizedimmediately by fungi but as the time increased the growth of fungi was also increased with passage of time and utilized pyrazosulfuron-ethyl successively. The growth of fungi was more in 2mg/kg treatment than 4mg/kg treatment, because it contained double dose of pyrazosulfuron-ethyl that affected the growth of fungi (Fig. 1). Three major degradation products of pyrazosulfuron-ethyl namely ethyl-5-[(4,6-dimethoxypyrimidin-2-ylcarbamoyl)sulfamoyl]-1-methylpyrazole-4-carboxylic acid; ethyl 1-methyl-5-sulfamyl-1H-pyazole-4-carboxylate and 4,6-dimethoxypyrimidin-2-amin were identified.

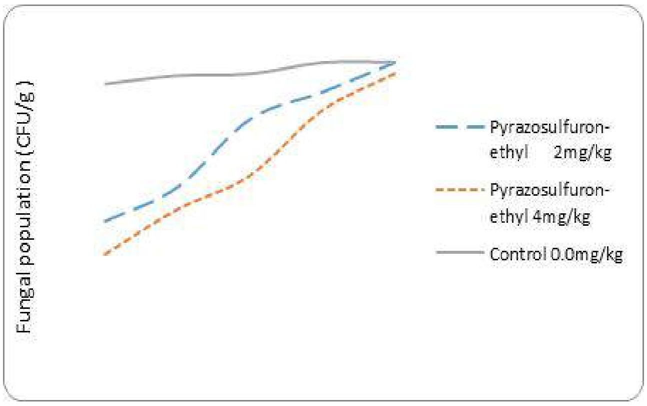

Fig. 1. Fungal population (10^5 CFU/g) at different days in non-sterilized soil

CONCLUSION

The toxic effect of pyrazosulfuron-ethyl on total fungal population disappeared by 30 days after its application. It can be concluded that fungal population was not adversely affected by the use of pyrazosulfuron-ethyl in soil.

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Effect of penoxsulam on fungal population in rhizospheric soil

Smita Rajput* and Shobha Sondhia
Mata Gujri Girls College, Jabalpur, Madhya Pradesh 482 001
**Email: smitarajputdwsr@gmail.com*

Owing to reported effect of penoxsulam on soil microbes present investigation was undertaken. Penoxsulam is a post-emergence herbicide and acts by inhibiting the acetolactate synthase enzyme (ALS) in annual grasses, sedges, and broadleaf weeds (Lassiter *et al.* 2006). Microorganisms use herbicides as sources of biogenous elements. The population levels and activity of microorganisms depend on food supply, temperature, soil moisture, oxygen, soil pH and organic matter content (Sondhia *et al.* 2013).

METHODOLOGY

The analysis was carried out under laboratory conditions. The soil sample was collected from Directorate of Weed Science Research (DWSR). Soil was divided into two sets, these are sterilized and unsterilized. Penoxsulam was applied according to three treatments (4 mg/kg, 8 mg/kg and one control 0mg/kg). Plating was performed at 0, 5, 10, 20 and 30 days interval by serial dilution method for observed the fungal growth in the presence of penoxsulam herbicide and the experiment was done in three replicates. Fungi were characterized by cultural and microscopic observations.

RESULT

Results indicated that fungal populations significantly affected by herbicide treatments in the soil and the degree of effect closely related to the rates of their applications and varied with the types of fungi. Soil fungus, *viz. Aspergillus flavus, Aspergillus niger* were found effective to degraded penoxsulam in soil. *Trichoderma* sp., *Penicillium* sp., *Rhizopus* sp. *Mucor* sp. was found sensitive to herbicide application. The numbers of their colonies decrease considerably in the period of 0-30 days after herbicide application but the number of colonies of *Aspergillus flavus* and *Aspergillus niger* increase at 0-30 days indicated that they were less affected by herbicide treatments. Growth of fungus was found to more in 4mg/kg treatment then 8mg/kg treatment because it contained double dose of herbicide.

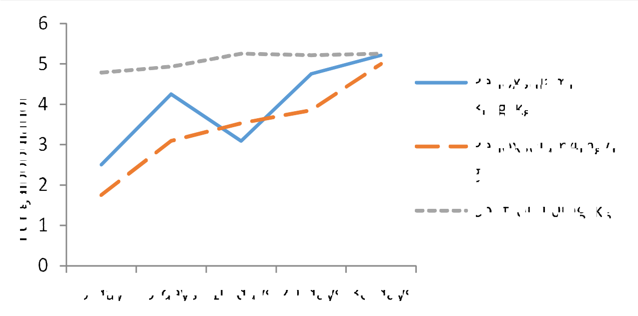

Fig. 1. Fungal population found in days soil at 0 to 30 days under lab conditions

CONCLUSION

Aspergillus niger and *Aspergillus flavus* were found more resistant to penoxsulam indicated that they were less affected by penoxsulam then other fungi such as *Trichoderma* sp., *Penicillium sp., Rhizopussp.and Mucor* sp. etc.

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Integrated weed management in aerobic rice

P. Saravanane*, S. Mala and V. Chellamuthu

Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry Union Territory - 609 603

**Email: psaravanane@rediffmail.com*

Rice (*Oryza sativa* L.) is the world's most important wetland crop. The global grain provides 35-80% of total calorie uptake to more than 2.7 billion people.The looming global water crisis threatens the sustainability of irrigated rice, which is the biggest water user in Asia. Aerobic rice is the new concept of growing rice in non-puddled and non flooded aerobic soil. The weeds are reported to cause yield losses between 30 and 98% in aerobic rice (Oerke and Dehne 2004). Considering the above facts, a field experiment was conducted to study the effect of pre emergence application of herbicides on diverse weed spectrum in aerobic rice in Karaikal, Puducherry UT, India.

METHODOLOGY

A field experiment to study the effect of pre emergence herbicides on the diverse weed spectrum in aerobic rice was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, Puducherry U.T during *Kharif* (June –September) 2011 on sandy clay loam soil. The soil had pH of 6.94, low in available nitrogen (119 kg/ha) and high in available phosphorus (24 kg/ha) and potassium (366 kg/ha). The experiment was laid out in randomized block design with seven treatments (Table 1). The recommended fertilizer dose for rice is 100: 50: 50 kg NPK /ha during *kharif* season (June-September month).A common handweeding at 30 days after sowing (DAS) was given to all treatments except the unweeded control. The rice cultivar PMK 3 was dibbled on 3rd June, 2011 with the spacing of 20 x 10 cm. The data on weed density and dry weight was transformed using $\sqrt{x+0.5}$.

RESULTS

Maintaining weed free condition throughout the crop growth significantly reduced the total weed density and dry weight. Application of pendimethalin 1.0 kg/ha restricted the weed density and dry weight (219.3 no./m^2 and 180.4 g/m^2, respectively) .

Table 1. Weed growth and yield of rice as influenced by different weed management treatments

Treatment	Total weed density (no./ m^2)	Total weed dry weight (g/ m^2)	Weed index	Productive tillers (no.)	Grain yield (t/ha)
Butachlor 1.25 kg/ha	15.1 (213.7)	14.9 (219.4)	49.5	4.9	1.55
Pendimethalin 1.0 kg/ha	15.1 (219.3)	13.8 (180.4)	14.8	5.5	2.63
Pretilachlor with safener 0.45 kg/ha	15.9 (246.3)	16.7 (262.1)	21.5	5.0	2.42
Anilophos 0.4 kg/ ha	15.7 (239.7)	16.5 (257.0)	46.2	4.5	1.65
Hand weeding twice	13.0 (159.7)	11.9 (135.5)	14.6	5.9	2.62
Weed free	3.6 (10.0)	0.8 (4.0)	0.0	6.3	3.10
Unweeded control	19.6 (372.0)	19.9 (381.1)	80.7	3.1	0.60
LSD(P=0.05)	3.94	4.27	-	0.90	0.45

Figures in parentheses are original values. Data transformed to square root transformation

Uncontrolled weeds cause poor crop growth and lowest yield with unweeded control (0.60 t/ha) with a yield reduction of 80.7% due to severe weed competition (Table 1). The effective control of weeds under weed free condition resulted in highest number of productive tillers (6.3) which had a positive impact on rice yield (3.1 t/ha). It was followed by the application of pendimethalin and hand weeding twice, respectively.

CONCLUSION

From the results, it can be concluded that maintaining weed free condition throughout crop period or pre- emergence application of pendimethalin 1.0 kg/ha super imposed with one hand weeding at 30 DAS was effective in reducing weed growth and increased grain yield of aerobic rice.

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Forecasting herbicide consumption in India

YogitaGharde*
Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004
**Email: yogitagharde@gmail.com*

Nowadays, it is very difficult for farmers to employ sufficient hand labour to keep their fields clear of weeds, making herbicides the most logical alternative. Hence, day by day herbicide consumption is increasing. The Indian herbicide market is experiencing a growth spurt of epic proportions. With manufacturing facilities popping up across the country and consumption soaring on operations of all sizes, companies are reorganizing to take advantage of the growth opportunity (Farm chemicals international, Oct 2013). According to the Federation of Indian Chambers of Commerce and Industry (FICCI), the nation currently consumes approximately 0.58 kilogram per cubic meter of agrochemicals per hectare compared to the United States' 7 and Japan's 10.8. It is observed that yearly data on herbicide consumption is not easily available even after 2-3 years, having main source of the data as only the concerned industry. In this situation, it is difficult for policy maker and Industry person to take appropriate measures in this regard. Therefore, it becomes necessary for companies and policy makers to predict the consumption of herbicide in advance. In the present study, an attempt has been made to forecast the herbicide consumption for consecutive three years based on the past data.

METHODOLOGY

India's herbicide consumption data from 1990 to 2010 were collected from www.faostat.fao.org. Data from 1990 to 2008 were used for model building and 2009 and 2010 for model validation. Box-Jenkins Autoregressive Integrated Moving Average (ARIMA) model was used for forecasting time-series (Koutroumanidis *et al*. 2009, Sarika *et al*. 2011). Forecasting is performed in four steps: Model identification, model estimation, Model validation and forecasting. To test the stationarity of the series, augmented Dickey Fuller (ADF) test was applied. Model was selected based on the Akaike Information Criterion (AIC) and Schwarz's Bayesian Criterion (SBC). Modelling and forecasting was done using SAS Enterprise Guide 4.3 (SAS Institute Inc., USA). After identifying the model, parameter estimates were obtained for chosen model. Residual analysis was also done to check the independency of the white noise residuals.

RESULTS

Augmented Dickey Fuller test (ADF) revealed the non-stationarity of the data. Therefore, first differencing was applied to the data. After taking the first difference, data series became stationary. ARIMA model (0, 1, 1) was selected after taking minimum AIC and SBC criteria for selecting model. In this model, parameter values were obtained using conditional least square method. Parameter estimates along with standard error are given in table 1 for fitted ARIMA (0, 1, 1) model $\ddot{Y}_t = c + Y_{t-1} - \theta e_{t-1}$, where c is constant, θ is the constant associated with moving average term. $\ddot{Y}_t$ and Y_{t-1}, are the data points associated with time t and t-1. Forecast values were obtained for the year 2011, 2012 and 2013 as 6623.89, 6580.78 and 6562.47 tonnes respectively.

Table 1. Parameter estimates along with standard error

Conditional Least Squares Estimation					
				Approx	
Parameter	Estimate	Standard Error	t Value	Pr > |t|	Lag
c	-24.82610	30.81051	-0.19	0.8516	0
??	0.50513	0.21713	2.33	**0.0319**	1

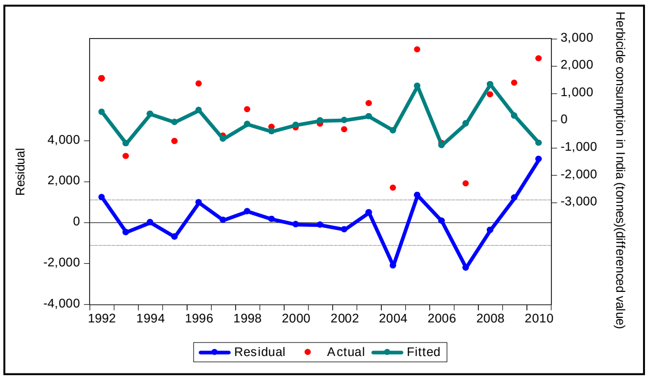

Fig 1. Fitted ARIMA (0, 1, 1) model along with actual value and forecast error (values are 1st difference of actual values).

CONCLUSION

The study revealed that ARIMA (0, 1, 1) model is found to be best for modelling and forecasting the herbicide consumption data in India. Forecast values obtained for consecutive three years using selected model. Forecasting may be done for further many more years but since forecast is associated with standard error, which gradually increase with increase in number of years which has to be forecasted.

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Effect of pre-emergence herbicides on weed flora and yield of sesame

Raghwendra Singh* and Dibakar Ghosh

Directorate of Weed Science Research, Jabalpur,Madhya Pradesh 482 004

**Email: singhraghu75@gmail.com*

Sesame (*Sesamum indicum* L.) is one of the oldest crops known to humans. There are archeological remnants of sesame dating to 5500 BC in the Harappa Valley in the Indian subcontinent. India ranks first in area and second in sesame production bycontributing 23.2% and 18.5% of the world area and production respectively. In India, it is cultivated in an area of about 1.80 million hectares with a production of 0.64 m ha.The presence of weeds can negatively influence sesame yield. Upadhyay (1985) reported weed-induced reductions of sesame yield up to 135% and a need for a critical weed-free period up to 50 days after planting. The initial growth of sesame is slow; therefore, the suppression of weed growthat early period of crop growth is critical. Hence, this study was designed to evaluate the effectiveness of different pre emergence herbicides (alone and in combination) on weed flora of summer sesame.

METHODOLOGY

A field experiment was conducted at experimental farm (23°132 N, 79°582 E, and 390 m above mean sea level) with plot size of 12 m^2 of Directorate of Weed Science Research (ICAR), Jabalpur (M.P.) India wheat during summer season of 2013. The soil of experimental field was clay loam in texture, neutral(7.2) in reaction medium in organic carbon (0.79%), available nitrogen (312 kg N/ha) and phosphorus (18 kg P_2O_5 /ha) but high in available potassium (291 kg K_2O /ha). The experiment was laid out in randomized block design, replicated thrice, comprises 8 treatments, *viz*. Pendimethalin 750g/ha, oxyfluorfen 150 g/ha, imazethapyr 60 g/ha metribuzin 200 g/ha,pendimethalin750 + imazethapyr 50 g/ha,imazethapyr 35 g/ha + imazemox 35 g/ha, two handweeding (2HW) and weedy check. Sesame variety '*TKG-22*' was sown with recommended package of practices. Fertilizers were applied through urea, di-ammonium phosphate and muriate of potash 60 kg N, 40 kg P_2O_5 and 20 kg K_2O/ha

RESULTS

The pre-emergence herbicides have varied response over broad and narrow leave weeds. Pendimethalin750 + imazethapyr 50 g/ha showed better control over *Alternanthra philoxeroides* and was at par with other herbicides tried, except imazethapyr 35 g/ha + imazemox 35 g/ha,which shows that lower dose of imazethapyr have lesser impact on *Alternanthra philoxeroides*. Metribuzin controlled *Cichorium intybus* effectively and was statistically similar tooxyfluorfen 150 g/ha, imazthapyr have very less effect on this weed. Emergence of *Euphorbia geniculata*was checked by almost all the herbicides. Minimum dry weight of broad leave weeds was recorded with combination ofpendimethalin750 + Imazethapyr 50 g/ha. The population of *Digitaria sanguinalis*was significantly reduced with the application of imazethapyr 60 g/ha and oxyfluorfen 150 g/ha. Though the herbicides reduced the population of *Dinebraretroflexa but* the difference was not upto the level of significance. *Echinocloa colona* the major narrow weed was effectively controlled by pendimethalin750 + Imazethapyr 50 g/ha,metribuzin 200 g/ha,and pendimethalin750g/ha. The minimum dry weight of narrow leaf weed was recorded with the application of pendimethalin750 + Imazethapyr 50 g/ha (Table1). The effective control of weeds in sesame was also reported by Grichar and Dotray (2007) with the use of pendimethalin at 750 g/ha. The maximum yield was harvested with two handweeding and it was significantly superior over all other treatments. Though all the preemergence herbicides suppressed the weeds significantly over weedy check but they also have negative effect on sesame seed germination. Among the herbicides the best yield was recorded with the treatment pendimethalin 750g/ha.

CONCLUSION

It may be concluded that pendimethalin 750 controlled the broad leave as well as narrow leave weeds and recorded better yield among preemergence herbicides in summer sesame.

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Effect of different herbicides on soil microbial population in transplanted rice

M.M. Behera*, R. Dash and M.M. Mishra
All India Coordinated Research Project on Weed Control, OUAT, Bhubaneswar Orissa751 003
**Email: behera_2004@rediffmail.com*

The effect of herbicides on soil physical, chemical and biological properties are quite pertinent. The growth of different microbial activities have been reduced due to applications of different herbicides (Shukla and Mishra 1999). Butachlor and Pretilachlor are the widely used herbicides in transplanted rice in the state. The herbicide application in combination *i.e.* butachlor + 2,4-D is also being applied in rice. Therefore, the present investigation was carried out to evaluate the effect of different herbicides in combination on the soil microbial population in sandy loam soil of Bhubaneswar.

METHODOLOGY

Field experiment were conducted at Central Farm OUAT, Bhubaneswar during the *Kharif* of 2011 in the transplanted rice to evaluate the effect of different herbicides in combination with or without organic matter on the soil microbial population. Six different treatments consisting of two sole applications of pretilachlor 0.75 kg/ha with and without organic matter, two herbicide combinations i.e butachlor 0.75 kg/ha + 2, 4- DEE 0.4 kg/ha with or without organic matter along with two hand weedings with or without organic matter. The rice crop variety "*Khandagiri*" was sown on 21.06.2011 after following all standard packages of practices. Organic matter (OM) in the form of green manure crop *Sesbania aculeata* (of 35 days old) was incorporated at the rate of 6 t/ha in the required treatments. After harvest the surface soil (0-15cm) was collected from the trial plots, air dried and ground to pass through 5 mm sieve.

RESULTS

The bacterial population of the soils varied from 20.0 to 25.0 x 10^9/g soil. The weed control measures followed in *Kharif* rice significantly changed the bacterial population in soils. Application of butachlor with 2, 4-D EE and its rotation with pretilachlor reduced the bacterial population by 9.0 % and 7.0% over hand weeded treatments. Application of organic matter did help in stabilizing the bacterial population (24.2 x 10^9) and recorded an increase of 9.0% over the treatments without organic matter .The population of fungi varied from 69.0 to 84.2 x 10^5/g soil. Similarly, application of herbicides decreased the fungal population by 6.4 % to 9.5 % over hand weeded treatments and addition of organic matter enhanced the fungal population (79.2 x 10^5/g soil) by 8.4 %. The variations in fungal population due to herbicide application in *Kharif* were not significant (Table 1).

Table 1. Soil microbial population as influenced by different weed control measures

Treatment	Bacterial Population (10^9 cfu/g soil)	Fungal Population (10^5 cfu/g soil)
Hand Weeding (Twice) - OM + Inorg. Fert.	20.15	74.41
Hand Weeding (Twice) + OM + Inorg. Fert. (N adjusted for OM)	25.12	84.33
Butachlor 0.75 kg/ha + 2,4-DEE 0.4 kg/ha - OM + Inorg. Fert.	18.70	68.34
Butachlor 0.75 kg/ha + 2,4-DEE 0.4 kg/ha + OM + Inorg. Fert. (N adj.)	18.74	72.57
Pretilachlor 0.75 kg/ha - OM + Inorg. Fert.	17.88	69.04
Pretilachlor 0.75 kg/ha + OM + Inorg. Fert. (N adj.)	19.21	72.40
LSD(P=0.05)	1.01	5.46

CONCLUSION

The microbial population with respect to treatments were in the order: Hand weeding (twice) > butachlor 0.75 kg/ha + 2, 4-D EE 0.4 kg/ha > butachlor + 2, 4-D EE in rotation with pretilachlor 0.75 kg/ha

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Weed management practices for higher productivity and profitability in aerobic rice

M.T.Sanjay*, T.V.Ramachandra Prasad, G.N.Dhanapal, G.R.Hareesh
P.Ashoka and V.Madhukumar
AICRP on Weed Control, MRS, Hebbal, University of Agricultural Sciences, GKVK, Bangalore 560 065
**Email: mt.sanjay@gmail.com*

In aerobic method of rice cultivation both weed seeds and rice seedlings germinate simultaneously and there will be severe crop weed competition which may result in significant reduction in rice yields (Jaya Suria *et al.* 2011). So suitable weed management practices to combat weed problem is a pre- requisite for advocating cultivation of aerobic rice. The main objective of the this study is to find out the efficacy of different pre and post emergence herbicides for efficient management of weeds under aerobic method of rice cultivation for getting more yield and returns

METHODOLOGY

Field experiments were conducted for four consecutive seasons (2009 *Kharif*, 2010 summer and *Kharif*, 2011 summer) at Main Research Station, UAS, Hebbal, Bengaluru with the following treatments in a Randomized complete block design replicated three times, T_1= butachlor 750 g/ha, T_2= bensulfuron methyl 60 g+ pretilachlor 600 g/ha, T_3= oxadiargyl 80 g/ha, T_4= pretilachlor + safener 300 g/ha, T_5= pyrazosulfuron ethyl 25 g/ha T_6= cyhalofop butyl 100 g/ha + ethoxysulfuron 60 g/ha, T_7=chlorimuron ethyl + metsulfuron methyl 4 g/ha, T_8=oxyfluorfen 90 g/ha – 3 DAS fb 2, 4-DEE – 25 DAS 500 g/ha, T_9= pyrazosulfuron ethyl 25 g/ha – 3 DAS + chlorimuron ethyl + metsulfuron methyl 4 g/ha – 30 DAS , T_{10}=passing of cycle hoe 3 times at 15, 30, and 45 DAS, T_1 = three hand weedings at 20, 40 and 60 DAS, T_{12}= unweeded Check. Treatments T_1, T_2, T_3, T_4 T_5, were applied as pre-emergence spray at 3 days after sowing (DAS) whereas treatments, T_6, T_7 as post emergence spray at 20 DAS.

RESULTS

Mean data of four seasons indicated that three hand weedings at 20, 40 and 60 DAS (T_{11}), recorded significantly higher grain yield (4.18 t/ha) compared to all other treatments except T_2 *i.e.,* pre emergence application of bensulfuron methyl 60 g+ pretilachlor 600 g/ha (3.93 t/ha). The higher grain yield was attributed to better control of weeds during early stage of crop growth which resulted in better availability of nutrients, moisture, space and light resulting in significantly higher number of productive tillers per hill. . However, unweeded check lowered the grain yield by 89% due to severe weed competition from initial stages (Mathew *et al.* 2013).

Among use of herbicides, application of bensulfuron methyl 60g+ pretilachlor 600 g/ha as pre-emergence spray recorded significantly higher grain yield, net returns and B:C ratio (3.93 t/ha, ₹ 32463/ ha and 2.94, respectively) followed by oxyfluorfen 90 g/ha as pre-emergence spray + 2, 4-DEE as post emergence spray 500 g/ha at 25 DAS (3.72 t/ha, ₹ 29,920/ha, 2.80, respectively) which were on par with each other. Hand weeding and passing cycle hoe recorded lower net returns and B:C ratio due to higher cost of manual labour for weeding. Unweeded control recorded due to severe weed infestation showed negative net returns.

Treatment	Grain yield (t/ha)	Tillers / hill	COC	GR	NR	B:C
			(x10³₹/ha)			
T_1:Butachlor 50 EC at 750 g/ha– 3 DAS	2.27	16.3	15.80	28.38	12.58	1.80
T_2:Bensulfuron methyl 60 g + pretilachlor 600 g/ha (6.6 % G) – 3 DAS	3.93	22.9	16.75	49.21	32.46	2.94
T_3:Oxadiargyl 80WP at 80 g/ha – 3 DAS	3.44	21.3	16.00	43.11	27.11	2.69
T_4:Pretilachlor + safener at 300 g/ha – 3 DAS	3.11	19.8	15.95	38.90	22.95	2.44
T_5:Pyrazosulfuron ethyl10 WP at 25 g/ha – 3 DAS	3.30	20.9	16.20	41.26	25.06	2.55
T_6:Cyhalofop butyl 10 EC at 100 g/ha + ethoxysulfuron 15 WG at 30 g g/ha - 20 DAS	2.96	18.8	18.53	37.06	18.53	2.00
T_7: Chlorimuron ethyl + metsulfuron methyl (almix 20 WP) at 4 g/ha - 20 DAS	2.43	16.9	15.57	30.42	14.85	1.95
T_8:Oxyfluorfen 23.5 EC at 90 g/ha – 3 DAS fb 2,4-DEE 38 EC at 500 g/ha - 25 DAS	3.72	21.9	16.63	46.55	29.92	2.80
T_9 : T_5 fb chlorimuron ethyl + metsulfuron methyl at 4 g/ha - 30 DAS	3.60	21.8	16.80	45.02	28.22	2.68
T_{10}: Passing of cycle hoe at 15, 30, and 45 DAS	2.76	17.4	22.20	34.57	12.37	1.56
T_{11}: Three hand weedings at 20, 40 and 60 DAS	4.18	24.1	25.20	52.33	27.13	2.08
T_{12}: Unweeded check	0.39	6.8	15.20	4.97	-10.22	- 0.33
LSD (P =0.05)	0.32	0.27				

CONCLUSION

Under aerobic method of rice cultivation to combat severe weed infestation in the initial stages use of pre-emergence herbicides like bensulfuron methyl 60 g+ pretilachlor 600 g/ha, oxadiargyl 80 g ai/ha, oxyfluorfen 90 g/ha - 3 DAS followed by 2, 4-DEE – 25 DAS can be recommended to get better yields and returns.

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Non-chemical weed management practices in organic finger millet

Basavaraj Patil*, V. C. Reddy and M. T. Sanjay
Department of Agronomy, UAS, Dharwad, Bangalore 580 005
**Email: bspatil4504@gmail.com*

Organic farming is gaining momentum in India owing to the concerns expressed on the safety of environment, soil, water and food chain. A concern about the potential increase in weed population due to non use of herbicides is rated as serious problem in organic farming (Bond and Grundy 2001). Major constraint in production of organic finger millet was found to be weed management which was accomplished only through manual weeding. At present due to escalating labour wages and non availability farmers are not in a position to take up timely weed management.

METHODOLOGY

The field experiment was conducted during *Kharif* season 2012 at the Main Research Station, Hebbal, Bengaluru, to identify the suitable methods of managing weeds in organic finger millet. It was laid out in Randomized Complete Block Design (RCBD) with three replications. The soil of the experimental field was sandy loam having pH of 6.55 with 236 kg N, 27.2 kg P_2O_5 and 176.2 kg K_2O/ha.

RESULTS

Crop yield was significantly higher in hand weeding twice at 20 and 30 DAP (5.46 t/ha) as compared to unweeded control. However, the yield was on par with stale seedbed technique + inter cultivation twice (5.36 t/ha) and also with passing wheel hoe at 20, 30 and 45 DAP + one hand weeding (5.14 t/ha). Similar findings were obtained by Ramamoorthy *et al.* (2009) and Bhuvaneswari *et al.* (2010) in maize-sunflower cropping system. This might be due to better control of weeds at tillering stage of the crop resulted in higher number of productive tillers and other yield components and yield of the crop. Whereas, lower yield (2.73 t/ha) was obtained in unweeded control might be due to highest competition with the finger millet throughout the crop growth period .Nutrient uptake by finger millet was higher in hand weeding twice (95.3 N, 16.2 P and 68.2 K kg/ha) followed by stale seedbed technique combined with inter cultivation twice (93.7, 15.3 and 66.5, kg /ha respectively). Unweeded check resulted in yield reduction of 50% due to the lowest uptake of the nutrient by finger millet was in unweeded control treatment (56.4 N, 4.8 P and 40.1 K kg/ha). The stale seedbed technique with inter cultivation twice at 20 and 35 DAP followed by hand weeding twice at 20 and 30 DAP recorded the highest net return and B:C ratio (₹ 56,939 and 56,545 /ha and 2.61, and 2.56, respectively).

CONCLUSION

Hand weeding twice at 20 and 30 DAP is the best efficient method for the weed control which produces significantly highest yield and weed control efficiency. Since, the labour availability is a problem besides high cost involved in the hand weeding, stale seedbed technique in combination with inter cultivation twice at 20 and 35 DAP or passing wheel hoe at 20, 30 and 40 DAP with one hand weeding would be a viable alternative for weed management in organic finger millet production. Further there is need to develop and evaluation of mechanically operated weeders and standardisation of duration of stale seedbed technique for different types of soils is needed.

Table1 .Influence of weed management practices on grain, straw yield and harvest index of finger millet

Treatment	Grain yield (t/ ha)	Straw yield (t/ha)	Harvest index
T_1-Passing wheel hoe at 20, 30 and 40 DAP	4.09	6.56	0.38
T_2- Inter cultivation twice at 20 and 35 DAP	3.93	6.30	0.38
T_3 Stale seedbed technique	3.39	4.9	0.41
T_4 -T_1 + one hand weeding	5.14	7.10	0.42
T_5- T_2 + one hand weeding	4.22	6.20	0.41
T_6- T_3 + Inter cultivation twice at 20 and 35 DAP	5.36	7.53	0.42
T_7-Organic mulching 10 t/ha after transplanting	3.77	6.30	0.37
T_8- Growing cover crops (Horse gram/cowpea) and passing blade hoe	3.20	6.20	0.34
T_9- Spray of Eucalyptus leaf extract on weeds	2.92	5.26	0.36
T_{10}- Spray of cattle urine on weeds	3.30	5.60	0.37
T_{11}- Hand weeding twice at 20 and 30 DAP	5.46	7.20	0.43
T_{12}- Unweeded check	2.73	4.50	0.38
LSD(P=0.05)	0.94	0.63	NS

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Evaluation of integrated weed management with pre and post emergence herbicides in turmeric

E. Sathiyavani* and N.K. Prabhakaran

Department of Agronomy, TNAU, Coimbatore, Tamil Nadu 641 003

* *Email: sathiyavani.priyanga@gmail.com*

Turmeric is a major field spice crop of India, occupying 6% of the total area under spices and condiments in India. India leads in production of turmeric with 78% of global production; its average productivity is quite low, mainly due to the competition offered by weeds. Uncontrolled weed growth reduces the rhizome yield upto 30-75 per cent depending upon the nature of intensity and duration of weed competition in turmeric field. Chemical weed control is a better supplement to conventional methods and forms an integral part of the modern crop production. Under chemical method of weed management, the rotation of herbicides is more essential to prevent the weeds to develop resistance to herbicides.

METHODOLOGY

A Field experiment was carried out during *Kharif* season of 2012 in North Block Farm of Agricultural Research Station (ARS) Bhavanisagar, located at Western Zone of Tamil Nadu. The experiment was laid out in randomized complete block design with fifteen treatments and replicated thrice. Treatments consisted of pre-emergence application of metribuzin 0.7 kg, pendimethalin 1.0 kg and atrazine 0.75kg/ha, each integrated with two hand weeding (HW) at 45 and 75 days, POE application of fenoxaprop at 67 g/ha + metsulfuron at 4 g/ha, paddy straw mulch (SM) 10 t/ha + one hand weeding at 75 days; PE oxyfluorfen 0.3 kg/ha and oxadiargyl 0.25 g/ha, POE glyphosate 5.0 and 7.5 ml/lit, each integrated with two HW at 45 and 75 days; three hand weeding at 25, 45 and 75 days and unweeded check. The turmeric variety '*BSR 2*' was used for study.

RESULTS

The common weed flora of the experimental field consisted of grasses were *Echinochloa crus-galli* (L.), *Digitaria bicornis,* and *Panicum repens,* among the broad leaved weeds *Amaranthus viridis*, *Boerhaavia diffusa*, *Parthenium hysterophorus* and *Phyllanthus niruri* were the dominant weeds. *Cyperus rotundus* was the only sedge present in the experimental field. Pre-emergence application of metribuzin 0.7 kg/ha + HW at 45 and 75 DAP significantly recorded lowest weed population (8.67/m^2) and dry weight (6.68 g/m^2) than other herbicides (Table 1). Higher weed control efficiency (98.4%) and fresh rhizome yield (31.82 t/ha) of turmeric were significantly with pre-emergence application of metribuzin 0.7 kg/ha + HW at 45 and 75 DAP. Same result has been reported by Gill *et* al. (2000).

Table 1. Effect of weed management treatments on weed density and dry weight, weed control efficiency (WCE %) and fresh rhizome yield in turmeric

Treatment	Weed density (no./m^2)	Weed dry weight (g/m^2)	WCE (%)	Fresh rhizome yield (t/ha)
PE metribuzin 0.7 kg/ha + HW on 45 and 75 DAP	3.27* (8.67)	2.95* (6.68)	98.4	31.82
PE metribuzin 0.7 kg/ha + POE fenoxaprop 67 g/ha + metsulfuron 4 g/ha on 45 DAP	4.58 (19.00)	11.50 (130.21)	68.5	5.00
PE metribuzin 0.7 kg/ha + SM 10 t/ha on 10 DAP + HW on 75 DAP	4.80 (21.00)	12.58 (156.24)	62.2	20.93
PE pendimethalin 1.0 kg/ha + HW on 45 and 75 DAP	3.79 (12.33)	2.98 (6.86)	98.3	30.30
PE pendimethalin1.0 kg/ha + POE fenoxaprop 67 g/ha + metsulfuron 4 g/ha on 45 DAP	5.29 (26.00)	14.98 (222.46)	46.0	4.55
PE pendimethalin1.0 kg/ha + SM 10 t/ha on 10 DAP + HW on 75 DAP	5.35 (26.67)	15.62 (241.83)	41.5	28.79
PE atrazine 0.75 kg/ha + HW on 45 and 75 DAP	3.87 (13.00)	3.44 (9.85)	97.6	23.79
PE atrazine 0.75 kg/ha + POE fenoxaprop 67 g/ha + metsulfuron 4 g/ha on 45 DAP	5.45 (27.67)	13.97 (193.03)	52.7	5.12
PE atrazine 0.75 kg/ha + SM 10 t/ha on 10 DAP + HW on 75 DAP	6.08 (35.00)	17.70 (311.12)	24.8	25.48
PE oxyfluorfen 0.30 kg/ha + HW on 45 and 75 DAP	4.00 (14.00)	3.92 (13.35)	96.8	21.95
PE oxadiargyl 0.25 kg/ha + HW on 45 and 75 DAP	4.08 (14.67)	4.41 (17.45)	95.8	20.94
POE glyphosate 5.0 ml/lit + HW on 45 and 75 DAP	4.43 (17.67)	4.46 (17.91)	95.7	24.39
POE glyphosate 7.5 ml/lit + HW on 45 and 75 DAP	3.61 (11.00)	3.35 (9.23)	97.8	19.85
Hand weeding on 25, 45 and 75 DAP	4.93 (22.33)	5.35 (26.57)	93.6	29.70
Unweeded check	7.16 (49.33)	20.38 (413.48)	-	13.48
LSD (P=0.05)	1.00	0.70	-	4.79

*Figures in parenthesis are original values; Data subjected to square root transformation

CONCLUSION

It w concluded that pre-emergence application of metribuzin 0.7 kg/ha + HW at 45 and 75 DAP was most effective for controlling weeds and enhance the productivity of turmeric resulting in higher economic returns.

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Effect of long term herbicidal weed management integrated with two different sources of nitrogen under transplanted rice-rice cropping system

***M. Kandeshwari, C. Jayanthi and N.K. Prabhakaran**
Department of Agronomy, TNAU, Coimbatore , Tamil Nadu 641 003
**Email: aasir.lotus@gmail.com*

Weeds grow profusely in the rice fields and reduce crop yields drastically. Normally the loss in yield ranges between 15-20% yet in severe cases the yield losses can be more than 50%, depending upon the species and intensity of weeds. Herbicides are the most effective and economically acceptable means of weed management. The use of herbicides offers selective and economic control of weeds right from the beginning, giving crop an advantage of good start and competitive superiority. A number of pre-emergence herbicides like butachlor, pretilachlor and others have been recommended for the control of early flushes of weeds in transplanted rice field. Hence an attempt has been made to study the effect of long term herbicidal weed management integrated with two different sources of nitrogen under transplanted rice-rice cropping system.

METEDOLOGY

A field experiment was laid out with four replications in a randomized block design during *Kharif*, 2012 with six treatments viz., Hand weeding twice (K&R) with 100% inorganic N, Hand weeding twice (K&R) with 75% inorganic N and 25% N through organic source (*Sesbania aculeata*), Butachlor 0.75 + 2,4-DEE 0.4 kg/ha (K&R) with 100% inorganic N, Butachlor 0.75 + 2,4-DEE 0.4 kg/ha (K&R) with 75% inorganic N and 25% N through organic source (*Sesbania aculeata*), Butachlor 0.75 + 2,4-DEE 0.4 kg/ha (K) - Pretilachlor 0.75 + 2,4 DEE 0.4 kg/ha (R) with 100% inorganic N and Butachlor 0.75 + 2,4-DEE 0.4 kg/ha (K) - Pretilachlor 0.75 + 2,4 DEE 0.4 kg/ha (R) with 75% inorganic N and 25% N through organic source (*Sesbania aculeata*). During *Rabi* season 100% inorganic N is applied for all treatments. ADT 43 was used as a test variety.

RESULTS

The common weed flora of the experimental field consisted of grasses *viz., Echinochloa crusgalli* and *Panicum repens;* sedges *viz., Cyperus iria, Cyperus rotundus and Cyperus difformis* and broad leaved weeds (BLW) *viz., Marsilea quadrifolia, Ammania baccifera, Ludwigia parviflora* and *Eclipta alba*. Among the grasses *Echinochloa crusgalli* was dominant and the major sedge was *Cyperus difformis*. Among the broad leaved weeds *Marsilea quadrifolia* was the dominant species. The total weed density and dry weight was significantly influenced by different weed management practices. During 60 DAT, lower weed density and dry weight was observed with butachlor + 2,4-DEE (*Kharif*) and pretilachlor + 2,4-DEE (*Rabi*) with integration of nutrients in rice-rice cropping system (Table 1).

Table 1. Weed density and dry weight at 60 DAT and grain yield as influenced by long-term herbicide and sources of N in rice-rice cropping system

Treatment	Sources of nitrogen		Weed density (no/m^2)	Weed dry weight (g/m^2)	Grain yield (t/ha)
	Inorganic	Organic			
W_1N_1-Hand weeding twice	100 %	-	6.34 (38.25)	3.83 (12.64)	3.861
W_1N_2-Hand weeding twice	75 %	25 %	5.52 (28.50)	3.39 (9.50)	5.891
W_2N_1-Butachlor 0.75 + 2,4-DEE 0.4 kg/ha	100 %	-	5.59 (29.25)	3.44 (9.86)	4.195
W_2N_2-Butachlor 0.75 + 2,4-DEE 0.4 kg/ha	75 %	25 %	5.02 (23.25)	2.81 (5.87)	5.981
W_3N_1-Butachlor 0.75 + 2,4-DEE 0.4 kg/ha -Pretilachlor 0.75 + 2,4-DEE 0.4 kg/ha	100 %	-	5.32 (26.25)	3.01 (7.08)	5.225
W_3N_2-Butachlor 0.75 + 2,4-DEE 0.4 kg/ha -Pretilachlor 0.75 + 2,4-DEE 0.4 kg/ha	75 %	25 %	3.92 (13.5)	2.33 (3.42)	5.414
LSD (P=0.05)			0.64	0.23	749

*Values in parentheses are original. Data transformed to square root transformation

The maximum grain yield was recorded in the plot which received Butachlor 0.75 + 2,4-DEE 0.4 kg/ha and integration of nutrients which is on par with hand weeding twice with integration of nutrients, butachlor + 2,4-DEE - pretilachlor rotation with integration of nutrients and butachlor + 2,4-DEE - pretilachlor rotation with 100% inorganic nitrogen) during *Kharif,* 2012. Increased in rice grain yield with split application of nutrients along with effective weed management increased the crop yield due to lower density, dry matter accumulation in weeds which helped in providing favorable growing environment resulting into better expression of potential yield (Singh *et al.* 2003).

CONCLUSION

It was concluded that rotational use of herbicides (butachlor in *Kharif* and pretilachlor in *Rabi*) with integration of nutrients was most effective for weed control and maximum yield was recorded with integration of weed control by butachlor + 2,4-DEE with integration of nutrients.

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Effect of post-emergence herbicides on weed flora of soyabean

S.R. Kadam ,D.A.Kulal , A.K.Gore , Satish Gobade

Department of Agronomy, College of Agriculture, VNMKV, Parbhani (Maharashtra) 431 401

Soybean crop face heavy weed competition especially in the early growth stages. The effectiveness and economical weed control may not be possible through manual or mechanical means due to heavy and continuous rainfall in *Kharif,* thus aberrant weather condition, labour shortages, declining efficiency under uncongenial conditions and high wages lead to delayed weeding. Therefore considering critical crop-weed competition period in soybean in addition to above problems several pre-emergence herbicides have seen recommended controlling weeds. Post emergence herbicides may be applied as per need of time and place saving time, money and labour. Therefore, there is need of testing new post emergent herbicides which have broader spectrum of activity (Kumar *et al*. 2008).

METHEDOLOGY

The present field investigation was conducted during *Kharif* of 2010-11 at Agronomy farm, college of Agriculture, Parbhani. Chemical formulations of herbicides used in experiments were T_1 – Trifluraline POE 125 g / ha at 15 DAS, T_2 – Trifluraline POE 150 g / ha at 15 DAS, T_3 – Propaquizafop POE 625 g ha at 10-12 DAS, T_4 – Fenaxaprop-P-ethyl POE 12 g / ha 10-12 DAS, T_5 – Chlorimuron ethyl POE 40 g / ha at 10-12 DAS, T_6 – Quyizalofop ethyl POE 40 g / ha at 10-12 DAS, T_7 – Tank mix (Quizalofop ethyl POE 40 g / ha + chlorimuron ethyl POE 12 g / ha) at 20 DAS, T_8 – Imazethapyr POE 75 g / ha at 21 DAS, T– Pendimethaline PE 750 g / ha + 1 HW at 30 DAS, T_{10} – Weed free check (2 HW + 2 hoeing) at 3rd and 5th WAS, T_{11} – Farmers practice (1 HW + 1 hoeing) at 30 DAS, T_{12} – Weedy check.

RESULTS

weed control treatments significantly reduced the dry weight of weed when compared with weedy check (Table 1) Among the herbicide application Treatment T_{10} i,e weed free check recorded lowest dry weight (monocot and dicot) and found significantly lower than rest of treatments. The weed control efficiency of weed control by different treatments in weedy check (WCR). Treatment (T_{10}) weed free check (2 HW+2 Hoeing at 3rd and 5th WAS) recorded highest WCE (98.43, 98.73 and 96.19, 95.93%) in case of monocot and dicot at 40 and at harvest followed by (T9) pendamethalin PE 750 g / ha+ 1 HW at 30 DAS (97.10,97.23% and 89.40, 85.55%) monocot and dicot at 40 and At harvest respectively, and (T8) Imazethaper POE 75 g / ha at 21 DAS (96.02,96.42% and 86.05,81.68%) for monocot dicot weeds at 40 S and At harvest.

Treatment	Mean weed count m^2		Dry weed weight		Weed control efficiency (%)		Weed index (%)
	Monocot	Dicot	Monocot	Dicot	Monocot	Dicot	
T_1 – Trifluraline POE 125 g / ha at 15 DAS	67.00	47.66	56.05	39.88	77.10	69.66	19.73
T_2 – Trifluraline POE 150 g / ha at 15 DAS	50.33	46.00	43.39	45.41	82.27	65.45	18.14
T_3 – Propaquizafop POE 625 g / ha at 10-12 DAS	79.00	59.33	62.00	54.00	74.67	58.91	20.18
T_4 – Fenaxaprop-P-ethyl POE 12 g / ha 10-12 DAS	72.00	53.33	60.87	52.05	75.13	60.40	19.39
T_5 – Chlorimuron ethyl POE 40 g / ha at 10-12 DAS	66.00	26.66	63.03	24.07	74.25	81.13	15.47
T_6 – Quyizalofop ethyl POE 40 g / ha at 10-12 DAS	44.33	39.33	39.59	39.12	83.82	70.23	14.43
T_7 – Tank mix (Quizalofop ethyl POE 40 g / ha + chlorimuron ethyl POE 12 g / ha) at 20 DAS	42.33	29.33	36.84	25.54	84.95	80.57	6.85
T_8 – Imazethapyr POE 75 g / ha at 21 DAS	26.66	18.66	34.14	24.80	86.05	81.68	6.33
T_9 – Pendimethaline PE 750 g / ha + 1 HW at 30 DAS	23.67	17.33	25.93	18.99	89.40	85.55	2.35
T_{10} – Weeed free check (2 HW + 2 Hoeing) at 3rd and 5th WAS	21.00	12.33	9.33	5.47	96.19	95.83	-
T_{11} – Farmers practice (1 HW + 1 Hoeing) at 30 DAS	46.33	25.33	52.74	24.20	78.45	81.58	13.08
T_{12} – Weedy check	280.33	175.67	244.79	131.45	-	-	39.54
LSD (P=0.05)	6.34	4.80	3.44	0.78	-	-	-
General Mean	68.25	45.99	60.72	40.41	82.02	75.54	15.95

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Study of different weed control treatment on economics of soybean

H.S. Moghal , N.K. Kalegore, S.R. Kadam

Department of Agronomy, College of Agriculture, VNMKV, Latur, Maharashtra 413 512

Soybean suffers from heavy weed competition especially in the early growth stages hence early herbicidal control seems to be a must in this crop for harvesting acceptable yields. Spraying of pre-emergence herbicides helps to minimize the crop weed competition during such critical growth stages resulting in higher crop yields. In soybean, there are few pre-emergence herbicides which are well adopted by farmers like pendimethalin. In cases where application of pre-emergence herbicides is not possible due to frequent rains, work load of farmer or unavailability of labour and labour cost increases. Therefore, farmers are facing problems in controlling weeds in soybean.

METHEDOLOGY

The field investigation entitled 'Efficacy of herbicide on growth and yield of soybean" was conducted at Department of Agronomy, College of Agriculture, Latur. The expérimental field was levelled and well drained. The experiment was laid out in randomized block design with three replications and variety '*MAUS-71*' as a test crop along with seven treatments.T_1- pendimethalin 0.75 kg/ha as pre-emergence.,T_2- pendimethalin 0.75 kg/ha as pre-emergence + one hoeing., T_3- imazethapyr 0.1 kg/ha as post- emergence application (21 DAS), T_4- two hoeing, T_5 -two hoeing + one hand weeding, T_6- weed free, T_7- control (unweeded).

RESULTS

Weed free recorded significantly higher growth, yield contributing characters followed by application of Imazethapyr 0.1 kg/ha as post emergence application (21 days) was found beneficial in comparison with the other treatments. Highest net monetary return and Gross monetary return were obtained in (T_6) weed free *i.e.* ₹ 70,810/ha and ₹ 1,04,539/ha which was followed by (T_6) (T_3) Imazethapyr 0.1 kg/ha as post emergence application (21 days). ₹ 66,475/ha and ₹ 93,76/ha and (T_5) two hoeing + one hand weeding *i.e.* ₹ 61,567/ha ₹ 89,693/ha and (T_2) Pendamethalin 0.75 kg/ha as pre emergence + one hoeing ₹ 59,248 ha and ₹ 825,42/ha and significantly superior over rest of the treatments, the higher benefit: cost ratio was recorded by the application of (T_3) Imazethapyr 0.1 kg/ha as post-emergence application (21 days) (3.4). While treatment T_7 control (unweeded) recorded lowest benefit: cost ratio (2.5), these results are in conformity with the results of Reddy *et al.* (2003).

Table 1. Economics of weed control treatments in soybean

Treatment	Gross monetary returns (x10³₹/ha)	Cost of cultivation (x10³₹/ha)	Net monetary returns (x10³₹/ha)	B:C ratio
Pendamethalin 0.75 kg/ha as pre-emergence	73.71	25.68	48.02	2.8
Pendamethalin 0.75 kg/ha as pre-emergence + one hoeing	82.54	26.29	59.24	3.1
Imazethapyr 0.1 kg/ha as post-emergence application (21 days)	93.76	27.28	66.47	3.4
Two hoeing	73.16	24.38	48.77	3.0
Two hoeing + one hand weeding	89.69	28.12	61.56	3.1
Weed free	104.53	33.72	70.81	3.0
Control (unweeded)	58.84	23.53	36.64	2.5
LSD (P=0.05)	8.511	-	8.51	-

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Yield and yield attributes of maize as influenced by weed management practices

A. Geetha Kumari[1], M.T. Sanjay[2], T.V. Ramachandra Prasad[2], R.D. Devendra[2], M.B. Rekha[1] and C.M. Munirathnamma[1]

[1]Department of Agronomy, College of Agriculture, UAS, Bangalore [2]MRS, UAS, Hebbal, Bangalore 560024
**Email: akkarekodi@gmail.com*

Maize is one of the most extensively cultivated cereal crops on Earth. Maize being a widely spaced crop gets infested with variety of weeds and subjected to heavy weed competition. Herbicide usage is the best option for control of weeds in maize due to labour problems. Because maximum weed competition in maize occurs during the period of 2 to 6 weeks after sowing, use of pre emergence and post emergence herbicide in combination is found to be better choice (Mallikarjun 2008).

METHODOLOGY

A field experiment was conducted during *Kharif* 2013 at MRS, University of Agricultural Sciences, Hebbal, Bangalore following recommended agronomic practices. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications consisting of 10 treatments *viz*.,T_1 - acetochlor 900 EC 2250 g/ha – 2 DAS, T_2 - atrazine 50 WP 1250 g/ha – 2 DAS, T_3 - alachlor 50 EC 1250 g a.i./ha – 2 DAS, T_4- topramezone 336 g/L SC 25.2 g/ha + atrazine 50 WP 250 g/ha – 15 DAS, T_5 - tembotrione 42 SC 105 g/ha + isoxadifen – ethyl 21 SC 52 g/ha + Stefes mero adjuvant 2.5 ml/lt – 15 DAS, T_6 - acetochlor 900 EC 2250 g/ha – 2 DAS followed by (*fb*) 2,4-D Na salt 80 WP 500 g/ha – 40 DAS , T_7 - atrazine 50 WP 1250 g/ha- 2 DAS fb 2,4-D Na salt 80 WP 500 g/ha – 40 DAS, T_8 - alachlor 50EC 1250 g/ha – 2 DAS *fb* 2,4-D Na salt 80 WP 500 g/ha – 40 DAS, T_9 - two hand weedings at 20 and 40 DAS, T_{10} - Unweeded control. The present investigation was carried out to find out the effect of different pre, post, combination of pre and post emergence herbicides on weed management and productivity of maize.

RESULTS

Weed density and weed dry weight at 60 DAS was significantly lower in pre-emergence herbicide followed by post-emergence herbicide application treatments (28.7 - 40.7 / m^2 and 6.9–14.2 g/m^2, respectively) compared to application of pre-emergence herbicides alone (64 – 73.3/m^2 and 39.7–50.4 g/m^2, respectively). Significantly higher weed density and dry weight was recorded in unweeded control (128/m^2 and 143.4 g/m^2, respectively). As a consequence of this significantly higher kernel yield, number of kernels/cob, 100 kernel weight and kernel weight/cob was recorded in alachlor 50EC 1.25 t/ha–2 DAS *fb* 2,4-D Na salt 80 WP 500 g/ha – 40 DAS (8.28 t/ha, 648, 37.3 and 199.3 g, respectively) compared to all other treatments except acetochlor 900 EC 2250 g/ha – 2 DAS followed by (*fb*) 2,4-D Na salt 80 WP 500 g /ha – 40 DAS (8.10/t/ha, 0.63, 36.3 and 195.9 g, respectively), two hand weedings at 20 and 40 DAS (7.92 t/ha, 621.7, 35.7 and 192.4 g, respectively), atrazine 50 WP 1250 g/ha- 2 DAS fb 2,4-D Na salt 80 WP 500 g/ha – 40 DAS (7.69 t/ha, 605.7, 36 and 189.9 g, respectively) and tembotrione 42 SC 105 g/ha + isoxadifen – ethyl 21 SC 52 g/ha + Stefes mero adjuvant 2.5 ml/l – 15 DAS (7.68 t/ha, 605.5, 35.7 and 188.1g, respectively) with which it was at par.

Table 1. Weed density (no./m^2), weed dry weight (g/0.25m^2), kernel yield (t/ha), number of kernels per cob (g), 100 kernel weight (g) and kernel weight per cob (g) in maize as influenced by weed management practices

Treatment	Weed density at 60 DAS #	Weed dry weight at 60 DAS #	Kernel yield (t/ha)	Number of kernels /cob	100 kernel weight (g)	Kernel weight /cob (g)
Acetochlor 900 EC 2250 g/ha – 2 DAS	1.83(66.0)	1.64 (42.2)	7.08	556.1	31.3	171.3
Atrazine 50 WP 1250 g/ha – 2 DAS	1.85(73.3)	1.70(50.4)	6.90	535.3	31.7	162.9
Alachlor 50 EC 1250 g/ha – 2 DAS	1.80(64.0)	1.60(39.7)	7.13	564.0	32.7	173.6
Topramezone 336 g/L SC 25.2 g/ha + atrazine 50 WP 250 g/ha – 15 DAS	1.73(53.3)	1.33(20.3)	7.40	571.7	33.7	175.0
Tembotrione 42 SC 105 g/ha + isoxadifen – ethyl 21 SC 52 g/ha + Stefes mero adjuvant 2.5 ml/l – 15 DAS	1.76(56.0)	1.39(23.0)	7.68	605.5	35.7	188.1
Acetochlor 900 EC 2250 g/ha – 2 DAS followed by (fb) 2,4-D Na salt 80 WP 500 g/ha – 40 DAS	1.44(28.7)	0.92(6.9)	8.10	634.7	36.3	195.9
Atrazine 50 WP 1250 g/ha- 2 DAS fb 2,4-D Na salt 80 WP 500 g/ha – 40 DAS	1.63(40.7)	1.21(14.2)	7.69	605.7	36.0	189.9
Alachlor 50EC 1250 g/ha – 2 DAS *fb* 2,4-D Na salt 80 WP 500 g/ha – 40 DAS	1.50(30.7)	0.98(7.7)	8.28	648.0	37.3	199.3
Two hand weedings at 20 and 40 DAS	1.55(34.7)	0.98(7.6)	7.92	621.7	35.7	192.4
Unweeded control	2.10(128.0)	2.15(143.4)	2.53	208.7	24.7	61.6
LSD (P=0.05)	0.27	0.24	811	0.63	3.3	30.8

NA - Not analysed; Data within parentheses are original values; # - data analysed using log($\sqrt{x+2}$) transformation; DAS – Days after sowing.

CONCLUSION

Pre-emergence application of alachlor 50EC 1250 g/ha/ acetochlor 900 EC 2250 g/ha followed by 2,4-D Na salt 80 WP 500 g/ha was found to be the best weed management practice to get higher yield in maize by controlling weeds more effectively.

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Effects of sowing dates and weed management in direct seeded rice

Rajashekhar Rajaput*, B.N. Aravinda Kumar, Ramesh Babu and N.G. Hanamaratti
Department of Agronomy, College of Agriculture, Dharwad, University of Agricultural Sciences, Dharwad, Karnataka 580 005
**Email: rajarajaput7@gmail.com*

Rice (*Oryza sativa* L.) is the world's most important crop and is a staple food for more than half of the world's population. India is the second largest country of rice production and rice continues to hold the key to sustain food production by contributing 20-25 per cent of agriculture and assures food security in India for more than half of the total population. Weed competition would be less severe under transplanting than those under direct-seeding because (i) emerging DSR seedlings are less competitive with concurrently emerging weeds and (ii) the initial flush of weeds is not controlled by flooding in Wet- and Dry-DSR (Rao *et al*. 2007).

METHODOLOGY

The experiment was conducted during *Kharif* 2012 at Agricultural Research Station, Mugad, University of Agricultural Sciences, Dharwad. The experiment was laid out in factorial RCBD design with two sowing dates in the main factor and six weed control treatments to the sub-factor and two control treatments weed free and farmer practice having three replications (details in table). The experiment was carried out in clay loam soil (31.4% sand, 38.1% silt and 30.5% clay) with pH of 7.03, using rice variety MGD-101 with the seed rate 100 kg/ha was sown on 2nd June and 80 kg/ha was sown on 29th June, respectively. Basal dose of fertilizers at the rate of 50:50:50 kg of $N:P_2O_5:K_2O$/ha, respectively was applied through complex fertilizer containing 20:20:20 of $N:P_2O_5:K_2O$/ha, respectively. Remaining 50 kg of nitrogen was applied through urea as two equal split doses one at maximum tillering stage (40 DAS) and another at panicle initiation stage (60 DAS).

RESULTS

Dominant weed flora in the trial was *Cynodon dactylon, Echinochloa colona, Ageratum conyzoides, Corchorus aestuans, Physalis minima, Cyanotis cristata, Mimosa invosa, Stachytarpheta indica, Croton bonplandianum, Ipomea alba, Cyperus rotundus* and *Cyperus iria.*

In different dates of sowing the 2nd June sowing recorded significantly lower weed density, total weed dry weight and weed index (91.9 no./m^2, 51.58 g/m^2 and 29.01%, respectively) as compared to 29th June sowings (103.8 no./m^2, 57.04 g/m^2 and 32.91%, respectively). Among the herbicide treatment bispyribac sodium *fb* one intercultivation recorded significantly lower weed density, total weed dry weight and weed index (49.1 no./m^2, 23.61 g/m^2 and 8.33%, respectively) as compared to weedy check (252.3 no./m^2, 177.1 g/m^2 and 72.79%, respectively). This clearly indicated that weeds were controlled effectively under bispyribac sodium *fb* one intercultivation.

The highest gain yield and straw yield (3.21 t/ha and 4.74 t/ha/ha, respectively) was recorded with 2nd June sowing as compared to 29th June sowings (3.04 t/ha and 4.4 t/ha, respectively). Among the herbicide treatment bispyribac sodium fb. one intercultivation recorded significantly higher gain yield and straw yield (4.15 t/ha and 5.99 t/ha, respectively) and lower in weedy check (1.22 t/ha and 2.16 t/ha, respectively). The B: C ratio was found maximum in 2nd June sowing (3.01) and in herbicide treatments bispyribac sodium *fb* one intercultivation recorded higher B: C ratio (3.96).

Table 1. Weed parameters, crop yield and economics as influenced by different dates of sowing and weed control treatments in direct seeded rice

Treatment	Weed density (no./m^2)	Weed dry weight (g/m^2)	Weed index (%)	Grain Yield (t/ha)	Straw yield t/ha)	B:C ratio
Factor - I (Date of sowing)						
D_1- Before onset of monsoon (2nd June)	9.61 (91.9)	7.22 (51.58)	29.01	3.27	4.74	3.01
D_2- After onset of monsoon (29th June)	10.21 (103.8)	7.59 (57.04)	32.91	3.04	4.49	2.90
LSD (P=0.05)	0.088	0.087	0.79	0.38	0.60	0.02
Factor - II (Weed control)						
W_1- Butachlor 1.5 kg/ha + 2 HW	7.58 (57.0)	5.24 (26.95)	10.79	4.04	5.845	3.38
W_2- Pretilachlor 0.5 kg/ha + 1 IC	9.64 (92.5)	6.93 (47.49)	28.26	3.24	4.635	3.24
W_3- Chlorimuron + metsulfuron methyl (Almix) 4 g/ha + 1 IC	9.02 (80.9)	6.37 (40.01)	22.79	3.50	5.147	3.48
W_4- Bispyribac Sodium 25 g/ha + 1 IC	7.04 (49.1)	4.91 (23.61)	8.33	4.15	5.989	3.96
W_5- Cyhalofop butyl 0.1 kg/ha + Pyrazosulfuron 0.025 kg/ha + 1 IC	10.28 (105.3)	7.64 (57.83)	42.76	2.60	3.939	2.20
W_6- Weedy check	15.90 (252.3)	13.33 (177)	72.79	1.22	2.162	1.49
LSD (P=0.05)	0.265	0.260	2.37	0.11	0.18	0.06

Note: IC - Inter-cultivation, HW – Hand weeding, DAS- Days after sowing, NS- Non Significant, * Transformed values [$(\sqrt{x+0.5})$], Figures in the parenthesis indicate original values

CONCLUSION

It can be concluded that, in different dates of sowing, before onset of monsoon sowing (2nd June) was effective for weed control, higher grain yield, straw yield and benefit cost ratio. Among the weed control treatments, effective weed control, higher grain yield, straw yield and benefit cost ratio of direct seeded rice can be obtained with post emergence application of bispyribac sodium 25 g/ha at 17 DAS + one intercultivation at 45 DAS. This treatment produced on par yield as that of weed free check indicating the advantages of this herbicide along with cultural method.

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Integrated weed management in onion

B.T.Sinare*, R.P.Andhale and Gautam M.
Mahatma Phule Krishi Vidyapeeth, Rahuri, Ahmednagar Maharashtra 413 722
**Email:sinare_babasaheb@rediffmail.com*

Onion (*Allium cepa* L.) is the most important species of *Allium* group. It is regarded as the single most important vegetable spices in the world and is top most export commodity among vegetables. Onion exhibits greater susceptibility to weed competition as compared to other crops due to its inherent characteristics such as slow germination, extremely slow growth in the initial stages, non-branching habit, sparse foliage and shallow root system. Spraying of pre-emergence herbicides keep the crop in weed free conditions during early stages.

METHOLOGY

The field experiment was conducted at PGI farm, M.P.K.V., Rahuri Dist. Ahmednagar (MS) during *Kharif,* 2012.The treatments consisted of different weed control methods *viz*. weed free, weedy check (control), pendimethalin 1.0 kg/ha (PE) *fb* 1 HW at 45 DAT, oxyfluorfen 0.150 kg/ha (PE) *fb* 1 HW at 45 DAT, quizolofop-ethyl 0.05 kg/ha at 21 DAT (PoE) *fb* 1 HW at 45 DAT, pendimethalin 1.0 kg/ha (PE) *fb* oxyfluorfen 0.25 kg/ha at 45 DAT (PoE), pendimethalin 1.0 kg/ha (PE) *fb* quizolofop-ethyl 0.05 kg/ha at 45 DAT (PoE), pendimethalin 1.0 kg/ha (PE) *fb* quizolofop-ethyl 0.037 kg/ha + oxyfluorfen 0.18 kg/ha at 45 DAT (PoE), quizolofop-ethyl 0.037 kg/ha + oxyfluorfen 0.18 kg/ha at 21 DAT (PoE) *fb* 1 HW at 45 DAT. The onion,

RESULTS

The lowest weed population and weed dry matter were recorded in weed free check and were at par with application of quizolofop ethyl 0.037 kg /ha + oxyfluorfen 0.18 kg /ha at 21 DAT (PoE) *fb* 1 HW at 45 DAT and followed by spraying of pendimethalin 1.0 kg/ha (PE) *fb* quizolofop ethyl 0.037 kg /ha + oxyfluorfen 0.18 kg /ha at 45 DAT, These treatments, in similar order recorded the highest WCE and reverse trend was observed in respect of the weed index and the weed dry matter. (Patel *et al.* 2011).

Table 1. Weed dynamics, growth and yield attributes, yield and economic of onion as influenced by different treatments

Treatment	WCE (%)	WI (%)	Weed dry matter (kg/ ha)	Plant height at harvest (cm)	Number of leaves at harvest	Dry matter at harvest (g)	Polar diameter (cm)	Equatorial diameter (cm)	Fresh wt. of bulb (g)	Dry wt. (g/ bulb)	Bulb yield (t/ ha)	Net monetary returns (x10^3₹ /ha)
Weed free	100	0	0.0	65.85	11.80	15.00	6.08	6.77	73.23	10.49	24.42	167.098
Weedy check (control)	0	72.16	194.0	55.34	8.60	11.19	3.81	4.31	19.77	5.38	7.06	7.792
Pendimethalin 1.0 kg/ha (PE) *fb* 1 HW at 45 DAT	73.36	8.09	53.0	62.82	10.93	13.93	4.92	5.53	69.65	9.81	22.90	159.103
Oxyfluorfen @ 0.150 kg/ha (PE) *fb* 1 HW at 45 DAT	65.19	13.21	54.0	61.29	10.33	13.74	4.58	4.94	66.57	9.64	21.62	147.505
Quizolofop ethyl 0.05 kg/ha at 21 DAT (PoE) *fb* 1 HW at 45 DAT	60.62	16.52	67.0	60.10	10.07	13.28	4.45	4.68	65.31	9.58	20.78	138.176
Pendimethalin 1.0 kg/ha (PE) *fb* Oxyfluorfen 0.25 kg/ha at 45 DAT (PoE)	72.09	10.35	77.0	62.39	10.67	13.88	4.86	5.44	68.05	9.71	22.34	156.955
Pendimethalin 1.0 kg/ha (PE) *fb* Quizolofop ethyl 0.05 kg/ha at 45 DAT (PoE)	58.45	22.16	81.0	58.83	9.67	12.53	4.28	4.38	62.58	9.12	19.41	127.182
Pendimethalin 1.0 kg/ha (PE) *fb* Quizolofop ethyl 0.037 kg/ha + Oxyfluorfen 0.18 kg/ha at 45 DAT	76.12	4.86	46.0	64.77	11.27	14.70	5.56	6.20	72.68	9.84	23.50	167.578
Quizolofop ethyl 0.037 kg/ha + Oxyfluorfen 0.18 kg/ha at 21 DAT (PoE) *fb* 1 HW at 45 DAT	88.49	4.42	22.0	65.03	11.33	14.77	5.69	6.25	72.91	9.95	23.80	167.839
LSD(p=0.05)	0.72	5.44	0.97	2.75	0.77	0.98	0.59	0.63	2.04	0.10	1.31	13.192

CONCLUSION

The use of quizolofop ethyl 0.037 kg /ha + oxyfluorfen 0.18 kg/ha at 21 DAT (PoE) *fb* 1 HW at 45 DAT as an effective weed control measure under *Kharif* season.

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Efficacy of propaquizafop and imazethapyr mixture against weeds in black gram

M.L. Kewat*, Tarun Suryavanshi and Shyam Lal

Department of Agronomy, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh 482 004

**Email: mlkewat1958@rediffmail.com*

Grassy as well as broad leaved weeds competes with the black gram for residual moisture,nutrients and reduces the black gram yield to extent of 49% (Rao and Rao,2003).Imazethapyr is reportedly very effective post emergence herbicides for controlling grassy andsome broad leaf weeds in *kharif* pulses including black gram. But its efficacy has not been judged in combination with propaquizafop for wide spectrum weed control in black gram. Therefore, a comprehensive field study was undertaken to find out the suitable dose of propaquizafop and imazethapyr mixture for effective control of weeds in black gram.

METHODOLOGY

A field experiment was undertaken during *Kharif* season of 2013 at live stock farm JNKVV, Jabalpur, to evaluate the efficacy of propaquizafop and imazethapyr mixture against weeds in black gram. Nine treatments comprising of five doses of propaquizafop and imazethapyr mixture (47+66, 50+70, 53+74, 56+78 and 100+140 g/ha), alone application of propaquizafop 100 g/ha and imazethapyr 100 g/ha, hand weeding twice (20 and 40 DAS) including weedy check, were laidout in randomized block design with three replications. Black gram variety LBG-20 was grown in the experimental field with recommended package of practices. Fertilizers were applied uniformly through Urea, single super phosphate and muriate of potash at the rate of 20,60 and 20 kg N, P, and K/ ha, respectively.

RESULTS

It is obvious from the data given in the Table 1 that grassy weeds were predominant (70.71%) in black gram followed by broad-leaved (18.24%) and sedges (11.01%). *Echinochloa colona (33.22%)* and *Ecliptaalba (9.20%)* were predominant among the grassy and broad-leaved weeds respectively. Herbicidal treatments significantly influenced the density and dry matter production of weeds. Among the herbicidal treatments, the reduction in weed density and weed biomass was less when propaquizafop was applied with imazethapyr at low dose (47+66 g/ha) but the values of both the parameters were increased identically with the corresponding increase in dose of both the herbicide in mixture being the maximum when propaquizafop and imazethapyr mixture was applied at the highest dose (100+140 g/ha) and proved significantly superior over weedy check, other mixtures including both the check herbicides propaquizafop 100 g/ha and imazethapyr 100 g/ha. However, none of the herbicidal treatment whether applied alone and in combination, surpassed the manual hand weeding twice which curbed the weed growth to the extent of 98.58%. The unchecked weed growth throughout the season, caused 43.67% reduction in yield of black gram but it was improved when weeds were controlled through hand weeding or herbicides.

Seed and Stover yields of black gram were minimum in weedy plots where weeds were not controlled throughout the crop season. However, both the parameters were improved when propaquizafop and imazethapyr were applied alone at 100 and 100 g/ha and in mixture being the higher under propaquizafop and imazethapyr mixture applied at the rate of 53+74 g/ha and proved significantly super over weedy check, alone application of propaquizafop (100 g/ha)and imazethapyr (100g/ha) and lower doses of propaquizafop and imazethapyr mixture (47+66 and 50+70 g/ha),but found at par to higher doses of propaquizafop and imazethapyr mixture (56+78 and 100+140 g/ha) including hand weeding twice.

Table 1. Effect of different treatments on density, dry weight of weeds and Yield of black gram

Treatment	Dose (g/ha)	Weed density (no./m^2)	Weed dry matter (g/m^2)	Weed control Efficiency (%)	Weed Index	Seed Yield (t/ha)	Stover Yield (t/ha)
Propaquizafop+Imazethapyr	47+66	(115.33)10.76	(232.35)15.26	63.86	29.31	1.23	3.82
Propaquizafop+Imazethapyr	50+70	(94.33)9.74	(190.67)13.83	70.34	22.98	1.34	3.96
Propaquizafop+Imazethapyr	53+74	(75.33)8.71	(151.78)12.34	76.39	1.72	1.71	4.33
Propaquizafop+Imazethapyr	56+78	(55.33)7.47	(109.81)10.50	82.98	1.14	1.72	4.35
Propaquizafop+Imazethapyr	100+140	(22.00)4.74	(38.79)6.27	93.97	0.57	1.73	4.36
Propaquizafop	75	(121.67)11.05	(212.84)14.61	66.89	25.86	1.29	3.84
Imazethapyr	100	(89.00)9.46	(189.85)13.80	70.48	21.26	1.37	3.98
Hand weeding	at (20&40 DAS)	(18.33)4.34	(9.13)3.10	98.58	0.00	1.74	4.41
Weedy check	-	(257)16.05	(642.98)25.37	0.00	43.64	0.98	3.23
LSD (P=0.05)	-	0.34	0.71	-	-	0.01	0.02

CONCLUSION

It was concluded that post-emergence application of propaquizafop along with imazethapyr at 53+74 g/ha was most effective for controlling weeds and scaling up the seed yield of black gram.

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Efficacy of propaquizafop alone and in combination with imazethapyr against weeds in soybean

Shyam Lal, M.L.Kewat* and TarunSuryavanshi

Department of Agronomy, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh 482 004

**Email: shyamlalsahujnkvv@gmail.com*

Weeds infestation is one the major constraints in the cultivation of soybean (Bhan *et al*. 1974). If weeds are not controlled during critical periods of crop-weed competition, there is identical reduction in the yield of soybean from 58 to 85 %, depending upon the types and intensity of weeds (Kewat *et al*. 2000).Presently, imazethapyr is reportedly very effective post emergence herbicide for controlling grassy and some broad leaf weeds in soybean but its efficacy has not been tested with propaquizafop for wide spectrum weed control in soybean. Therefore, a comprehensive field study was under taken to find out the suitable dose of propaquizafop and imazethapyr mixture for effective control of weeds in soybean.

METHODOLOGY

A field experiment was conducted during *Kharif* seasons 2013 at Live stock Farm, JNKVV, Jabalpur, to evaluate the efficacy of propaquizafop and imazethapyr mixture against weeds in soybean. Nine treatments comprising of five doses of propaquizafop and imazethapyr mixture (47+66, 50+70, 53+74, 56+78 and 100+140 g/ha), alone application of propaquizafop 75 g/ha and imazethapyr 100 g/ha, hand weeding twice (20 and 40 DAS) including weedy check, were laidout in randomized block design with three replications. Soybean variety '*JS 97-52*' was grownin the experimental field with recommended package of practices. Fertilizers were applied uniformly through Urea, single super phosphate and muriate of potash at the rate 20,60 and 20 kg N, P, and K/ha, respectively.

RESULTS

It is obvious from the data given in the Table 1 that Grassy weeds were predominant (72.73%) in soybean followed by broad-leaved (17.15%) and sedges (10.10%). *Echinochloa colona (39.20%)* and *Eclipta alba (8.88%)* were more pre dominant among the grassy and broad-leaved weeds respectively. Herbicidal treatments significantly influenced the density and dry matter production of weeds. Among the herbicidal treatments, the reduction in weed density and weed biomass was less when propaquizafop was applied with imazethapyr at low dose (47+66 g/ha) but the values of both the parameters were increased identically with the corresponding increase in dose of both the herbicides in mixture being the maximum when propaquizafop and imazethapyr mixture was applied at the highest dose (100+140 g/ha)and proved significantly superior over weedy check, other mixtures including both the check herbicides propaquizafop 75 g/ha and imazethapyr 100 g/ha applied alone. However, none of the herbicidal treatment whether applied alone and in combination, surpassed the manual hand weeding twice which curbed the weed growth to the maximum extent (98.01%).

Seed and stover yields of soybean were minimumwhen weeds were not controlled throughout the crop season. However, both the parameters were improved when propaquizafop and imazethapyr were applied alone 75 and 100 g/ha and in mixture being the higher under propaquizafop and imazethapyr mixture applied at the rate

Table 1. Weed growth, yield attributes and yield of soybean as influenced by different weed control treatments

Treatment	Dose (g/ha)	Weed density (no./m²)	Weed biomass (g/m²)	Weed Control Efficiency (%)	Weed Index	Seed Yield (t/ha)	Stover yield (t/ha)
Propaquizafop+Imazethapyr	47+66	10.63 (112.47)	14.50 (209.70)	67.53	31.22	1.52	3.31
Propaquizafop+Imazethapyr	50+70	9.56 (90.80)	13.25 (175.19)	72.87	25.33	1.65	3.61
Propaquizafop+Imazethapyr	53+74	8.65 (74.37)	11.87 (140.42)	78.25	2.26	2.16	4.29
Propaquizafop+Imazethapyr	56+78	7.27 (52.40)	9.95 (98.60)	84.73	1.35	2.18	4.31
.Propaquizafop+Imazethapyr	100+140	4.95 (24.0)	6.0 (35.47)	94.50	0.90	2.19	4.32
Propaquizafop	75	11.08 (122.18)	14.57 (211.71)	67.22	38.91	1.35	3.09
Imazethapyr	100	9.65 (92.67)	13.74 (188.34)	70.84	28.05	1.59	3.21
Hand weeding	20&40DAS	4.53 (20.0)	3.65 (12.83)	98.01	0.00	2.21	4.31
Weedy check	-	16.46 (270.33)	25.42 (645.89)	0.00	52.48	1.05	2.87
LSD (P=0.05)	-	0.40	0.68	-	-	0.13	0.37

*Values in parentheses are original.

of 53+74 g/ha and proved significantly super over weedy check, alone application of propaquizafop (75 g/ha)and imazethapyr (100g/ha) and lower doses of propaquizafop and imazethapyr mixture (47+66 and 50+70 g/ha) being at par to higher doses of propaquizafop and imazethapyr mixture (56+78 and 100+140 g/ha) including hand weeding twice.

CONCLUSION

It was concluded that post-emergence application of propaquizafop and imazethapyr mixture at the rate of 53+74 g/ha was most effective for controlling weeds and improving seed yield of soybean.

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Integrated weed management in sunflower

R.P. Dubey*and Yogita Gharde

Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004

**Email: dubeyrp@gmail.com*

Sunflower (*Helianthus annuus* L.) occupies the fourth position among edible oilseed crops in India in terms of cultivated area and production. During 2010-11, it was cultivated in about 0.93 m ha area with total production of 0.65 mt at an average productivity of 700 kg/ha. The major states growing sunflower in India are Karnataka, Maharashtra and Andhra Pradesh. Weed infestation is a serious constraint to its cultivation. Renukaswamy *et al.* 2012 reported that weed competition in sunflower reduced the seed yield by 33.5 percent. Therefore, effective weed control at proper stage of crop growth is important for realizing higher seed yield of sunflower. Cultural and chemical methods of weed control can reduce the weed competition, however; integration of several factors of weed control may be advantageous for obtaining higher yields. Hence, a study was conducted to know the effect of sunflower hybrids, planting methods, time of sowing and weed control methods on the control of weeds and productivity of sunflower.

METHODOLOGY

A field experiment was conducted during summer season of 2013 at the Directorate of Weed Science Research, Jabalpur (M.P.) to know the effect of 2 sunflower hybrids *'KBSH-41* and *KBSH-44'*, 2 dates of sowing, 3 planting methods (ridge bed, flat bed and flat *fb* ridge bed) and 4 weed control methods (pendimethalin 1.0 kg/ha pre-emergence, quizalofop ethyl 100 g/ha as post-emergence at 30 DAS, 2 hand weedings and weedy check). Treatments were laid out in split-split-plot design with 3 replications; the net plot size was 3 m x3 m. The soil of the experimental site was clay loam with neutral pH, medium OC, low in N and P_2O_5, and high in K_2O. A fertilizer dose of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O/ha was applied uniformly to all the plots (basally and/or as top dressing). Total 6 number of irrigation was applied to the crop. The crop was affected by wilt disease at initial stages and necrotic disease at later stages.

RESULTS

The major weed flora in the experimental plot comprised of *Cynodon dactylon, Cyperus rotundus, Digitaria sanguinalis, Alternanthera sessilis, Melilotus alba* and *Euphorbia geniculata*. The effect of sunflower hybrids on weed biomass was not significantly different. Delayed sowing (28-2-2013) recorded higher weed biomass (17.4 g/m^2) compared to sowing on 12 -2-2013 (13.5 g/m^2).Weed dry biomass at 60 days after sowing (DAS) was comparatively less with sowing on flat-bed *fb* ridging (14.6 g/m^2), flat bed (14.7 g/m^2) than ridge-beds (17.1 g/m^2). Among weed control methods, 2 hand weeding recorded the lowest weed biomass (9.2 g/m^2) compared to weedy check (25.0 g/m^2).

Both hybrids '*KBSH-44*' and '*KBSH-41*' performed equally well with respect to seed yield (1.49 and 1.50 t/ha, respectively). Sowing on 12 February resulted in higher seed yield (1.69 t/ha) than delayed sowing on 28 February (1.30 t/ha). The seed yield of sunflower was higher and similar with flat-bed sowing (1.59 t/ha) and flat-bed *fb* ridging (1.53 t/ha) as compared to ridge-bed (1.37 t/ha). Among the weed control treatments, the significantly highest sunflower seed yield (1.73 t/ha) was obtained with the application of quizalofop–ethyl 100 g/ha POE, which was 56.7% more than weedy check. Channapagoudar *et al*. 2008. Have reported effective weed control and higher seed yield by herbicides *viz*. oxadiazon 1.0 kg/ha and butachlor 1.5 kg/ha. Unchecked weed infestation reduced the sunflower seed yield by 36%.

CONCLUSION

The study revealed that uncontrolled weeds caused 36 % loss in sunflower seed yield. Performance of '*KBSH'- 44* and *KBSH*'- 41 was equal in terms of weed suppression and seed yield. Delayed sowing on 28 Feb resulted in more weed infestation and lower yield compared to sowing on 12 Feb. Planting sunflower on flat beds *fb* ridges was better for weed control and seed yield. When grassy weeds are dominant, quizalofop 100 g/ha at 30 DAS can be applied to obtain good weed control and higher seed yield.

Table 1. Analysis of variance for weed biomass and seed yield

Source	Weed Biomass		Grain yield	
	F Value	Pr > F	F Value	Pr > F
Planting method	0.59	0.5952	0.36	0.7198
Hybrids	0.01	0.9188	0.14	0.7244
Planting method*hybrids	0.15	0.8641	5.06	0.0515
Sowing_date	4.63	0.0525	19.94	0.0008
Planting method*Sowing_date	0.68	0.5242	2.28	0.1443
Planting method*Sowing_date	1.83	0.2005	2.76	0.1226
Planting method* hybrids*Sowing_date	0.05	0.9511	1.47	0.2693
Weed control	38.33	<.0001	25.97	<.0001
Planting method*weed control	0.76	0.6035	1.92	0.0883
Hybrids*weed control	0.10	0.9599	1.20	0.3171
Planting method*hybrids*weed control	1.10	0.3731	2.00	0.0762
Sowing_date*weed control	0.72	0.5462	0.96	0.4141
Planting method*Sowing date*weed control	0.58	0.7425	2.24	0.0488
Hybrid*Sowing date*weed control	0.77	0.5159	1.89	0.1381
Planting method*hybrids*Sowing_date* weed control	0.35	0.9048	0.90	0.4980

Values in 'bold' are significant at 5%

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Effect of integrated weed management practices on lentil mustard intercropping system under rainfed condition in Terai region of eastern India

Ashim C. Sinha* and Biswapati Sinha

Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal 736 165

**E-mail: ashim_sinha50@rediffmail.com*

Pulses are the basic ingredients in the diets of a vast majority of Indian population as they provide a perfect mixture of high biological value when supplemented with cereals. The countries demand for edible oils is expected to rise more than double from the current level in the next 12 years, according to the projections made by the National Council of Applied Economic Research (NCAER). Weed management research in intercropping is still in its infancy, probably because no systematic and coordinated research to improve the efficiency and productivity of intercropping has been undertaken, hence the present investigation was undertaken.

METHODOLOGY

A field experiment was carried out during the *Rabi seasons of* 2008-09 and 2009-10 at Instructional Farm of UBKV, Coochbehar, West Bengal in sandy loam soil to study the effect of integrated weed management practices on lentil + mustard intercropping system under rainfed condition. The experiment comprised 10 treatments of 2 intercropping systems(sole lentil and lentil intercropped with mustard) in main plots and 5 weed control methods in subplots with three replications in split-plot design (Table-1). Lentil variety '*Asha (B-77)*' was sown in 30 cm apart with mustard variety "*Sharama (RW-85-59)*" in 3:2 row ratio. Fertilizers were applied uniformly through urea, single super phosphate and muriate of potash (20 kg N, 60 kg P_2O_5 and 40 kg K_2O, respectively for lentil and 60 kg N, 40 kg P_2O_5 and 40 kg K_2O, respectively for mustard). For proper grain filling borax 7.5 kg/ha was applied to both the crops along with the fertilizers. Data on weed growth, plant growth, yield performance and economics were recorded.

RESULTS

Intercropping systems significantly reduced the density and dry matter production of weeds at harvest compared to sole lentil (Table 1). The lowest density and dry matter production of weeds under intercropping systems may be ascribed probably due to higher crop canopy than sole lentil. Extensive canopy of intercrops precluded penetration of solar radiation up to the weeds and smothered them leading to lower weed dry weight. All the weed control methods significantly reduced the total weed population and total dry weight of weeds over unweeded control (Table-1). Hand weeding (twice) at 25 and 45 DAS recoded significantly lower weed population and dry weight of total weeds at harvest compared to rest of the weed control methods (Table 1).

Table 1. Weed density, weed dry weight, Leaf area index, Dry matter accumulation, yield attributes, yield and economics of Lentil as influenced by cropping systems and methods of weed control

Treatment	Weed density (no./m²)	Weed dry weight (g/m²)	Leaf area index (LAI) at 75 DAS	Dry matter accumulation (DMA) at harvest	No. of pods /plant	No. of seeds /pod	1000 seed wt.(g)	Sole crop Lentil (t/ha)	Inter crop mustard(t/ha)	B:C ratio
Cropping System(C)										
Lentil (L)	51.5	29.3	2.41	283.1	24.2	3.6	18.3	0.98	-	2.33
Lentil + Mustard	47.9	25.8	2.11	275.5	17.9	2.7	16.2	0.53	0.43	2.32
C.D. (P=0.05)	2.03	2.19	0.13	4.09	2.75	NS	1.89	0.23		
Weed control methods(M)										
Glyphosate@2.5l/ha as PPA(1DBS)+ PEA at 25 DAS	45.6	22.3	2.29	290.3	22.9	3.3	17.1	0.86	0.49	1.24
Glyphosate@2.5l/ha as PPA(1DBS)+ HW at 25 DAS	43.1	19.8	2.36	277.9	23.6	3.4	19.9	0.92	0.51	1.32
Hoeing (twice) at 25 & 45 DAS	55.4	32.7	2.21	268.4	21.7	3.1	15.8	0.65	0.33	1.17
Hand weeding (twice) at 25 & 45 DAS	40.3	16.5	2.49	321.7	26.3	3.8	21.6	1.07	0.59	1.40
Un weeded control	64.5	46.4	1.97	238.1	10.7	2.1	11.7	0.23	0.25	0.09
LSD (P=0.05)	1.71	1.92	0.11	3.78	1.67	0.33	1.15	0.12		

Average of two years Data, DBS=Days before sowing, DAS=Days after sowing, PPA= Pre-plant application, PEA=Post-emergence application

CONCLUSION

When lentil is intercropped with mustard in 3:2 row ratio with hand weeding (twice) at 25 and 45 DAS, it proved to be beneficial to achieve and sustain higher productivity . But when labour is limited, gyphosate 2.5 lit/ha as PPA integrated with one hand weeding at 25 DAS may be used for effective control of weeds in lentil + mustard intercropping system.

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Bio-efficacy of flucetosulfuron for weed management in transplanted summer rice

Malay K. Bhowmick*[1], Sourav Singh[2], Madhab C. Dhara[1] and Ratikanta Ghosh[3]
[1]*Rice Research Station (Government of West Bengal), Chinsurah (R.S.) 712 102, Hooghly, West Bengal*
[2]*Oriental Institute of Science and Technology, Dewandighi, Mirjapur 713 102, Burdwan, West Bengal*
[3]*Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur 741 252, Nadia, West Benga*
**Email: bhowmick_malay@rediffmail.com*

Rice (*Oryza sativa* L.) is an important staple crop in India and its productivity is declining due to many constraints. Weeds are a major impediment to rice production, causing 15-45% yield losses in transplanted culture. Manual removal of weeds is labour-intensive, tedious, back breaking and does not ensure weed removal at critical stage of crop-weed competition. Herbicides appear to be the suitable alternatives under all situations. Flucetosulfuron is a new sulfonylurea herbicide for the control of broadleaf weeds, some grasses and sedges (Kim *et al*. 2003). Hence, the present study was taken up.

METHODOLOGY

A field experiment was carried out during dry (*boro*) season of 2011-12 at Rice Research Station, Chinsurah, Hooghly (W.B.) to evaluate the bio-efficacy of flucetosulfuron against complex weed flora in transplanted rice. The soil of the experimental field was a typical Gangetic Alluvium (Entisol) with clay loam texture, good water holding capacity and moderate soil fertility. Eight treatments including different doses of flucetosulfuron along with penoxsulam, pretilachlor, hand weeding and unweeded control were assigned in a randomized block design with three replications. The crop variety '*Anjali (IET 16430)*' was transplanted in the experimental field with recommended package of practices including a common fertilizer dose of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha. Herbicides were sprayed using knapsack sprayer fitted with a flat fan nozzle at a spray volume of 500 l/ha. Data on weed growth, crop growth, yield attributes and grain yield were recorded at harvest.

RESULTS

Weed flora in unweeded plots consisted of *Cynodon dactylon*, *Digitaria sanguinalis*, *Echinochloa colona*, *E. crusgalli*, *Leersia hexandra* (grasses); *Cyperus difformis*, *C. rotundus*, *Fimbristylis littoralis* (sedges); *Blainvillea latifolia*, *Commelina benghalensis*, *Eclipta alba*, *Ludwigia parviflora* and *Monochoria vaginalis* (broad-leaved). Weed problem was moderate as evidenced from weed growth in unweeded plots (Table 1), causing 39.33% yield loss when compared with two rounds of hand weeding. Herbicidal treatments significantly influenced the density and biomass of weeds. Amongst them, lower weed densities were observed under pre-emergence (PE) application of flucetosulfuron 20.0-22.5 g/ha (82.00-91.33/m^2), pretilachlor 625.0 g/ha (92.67/m^2) and post-emergence (POE) application of flucetosulfuron 25.0 g/ha (108.67/m^2). These treatments also significantly recorded minimum weed biomass, compared with the others excluding hand weeding (twice). All the doses of flucetosulfuron (either PE or POE) were comparable with hand weeding (15 and 30 DAT) and significantly superior to penoxsulam (22.5 g/ha) in improving grain yield and crop stand for its broad spectrum activity (Kim *et al*., 2006). The minimum yield attributes along with the lowest grain yield (3.01 t/ha) were recorded in unweeded plots due to the fact that weeds robbed off different growth-limiting resources meant for rice crop (Bhowmick *et al*. 2002).

Table 1. Weed growth, crop growth, grain yield and yield attributes as influenced by different weed management treatments

Treatment	Weed density (no./m^2)	Weed biomass (g/m^2)	Plant height (cm)	Tillers /m^2	Panicle weight (g)	Panicles/ m^2	Grain yield (t/ha)
Flucetosulfuron 10 WG 17.5 g/ha (PE)	117.33	108.48	100.87	367.33	2.64	261.00	4.21
Flucetosulfuron 10 WG 20.0 g/ha (PE)	91.33	91.60	105.47	411.00	2.93	294.00	4.55
Flucetosulfuron 10 WG 22.5 g/ha (PE)	82.00	90.00	105.80	414.33	3.09	327.00	4.61
Flucetosulfuron 10 WG 25.0 g/ha (POE)	108.67	98.68	102.60	376.33	2.66	261.00	4.28
Penoxsulam 25 OD 22.5 g/ha (POE)	126.67	117.08	100.47	376.33	2.61	253.33	4.16
Pretilachlor 50 EC 625.0 g/ha (PE)	92.67	95.63	103.40	406.00	2.87	272.00	4.38
Hand weeding (15 and 30 DAT)	76.00	83.95	107.53	462.67	3.18	363.00	4.96
Unweeded control	208.67	332.93	95.47	300.00	2.14	206.00	3.01
LSD (P=0.05)	31.44	16.85	5.42	77.25	NS	51.08	0.79

DAT: Days after transplanting; NS: Not significant; Oil dispersion (OD); PE: Pre-emergence (2 DAT); POE: Post-emergence (15 DAT); WG: Water dispersible granule

CONCLUSION

It was concluded that flucetosulfuron 10 WG either as pre-emergence at 20.0-22.5 g/ha or as post-emergence at 25.0 g/ha would be an effective tool for weed management in transplanted summer rice.

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Efficacy of quizalofop-ethyl in the management of grassy weeds in rainfed *Bt* cotton

N. Ananda*, B.M. Chittapur, M.R. Umesh, Vinayak Hosamani and G.M. Keshava Murthy
Department of Agronomy, College of Agriculture, UAS, Raichur-584 104, Karnataka
**Email: clkananda@gmail.com*

Cotton (*Gossypium hirsutum* L.) known as 'white gold' is an important natural fibre of commercial importance grown extensively in the world particularly in India and more so in Karnataka. In Karnataka, cotton occupies an area of 0.54 m ha with a production of 1.4 m bales and productivity of 434 kg lint per ha (Anon.,2011).Yield level in this crop keeps fluctuating year after year depending upon the prevailing climate and managerial issues such as weeds, sucking pest and disease incidence associated with the climatic conditions of the region and crop nutrition. Weeds represent one of the major resource consuming and limiting factors in *Bt* cotton production. Among weeds, grasses are more difficult to control due to their narrow and oblique leaf, erect growth and competitive ability. Availability of graminicides these days, however, make weeding a affordable practice and hence a field investigation was undertaken to study the bio-efficacy of quizalofop- ethyl -5% EC in management of grassy weeds in rainfed *Bt* cotton.

METHODOLOGY

A field experiment was conducted during *Kharif* 2012, on black cotton soil of Agronomy field unit, College of Agriculture, UAS, Raichur coming under North eastern dry zone of University of Agricultural Sciences, Raichur. Different doses (750,1000,2000 and 3000 ml /ha) of quizalofop- ethyl -5% EC -20 DAS (days after sowing (formulated by M/s Atul Limited, Atul, Gujarat) quizalofop- ethyl -5% EC were evaluated for bio-efficacy in the control of grassy weeds and seed cotton yield in comparison to other standard herbicide, pendimethalin 30 EC, 1 kg/ha as pre emergence(1 DAS) and that of pendimethalin 1 kg/ha (1DAS) followed by quizalofop-ethyl -5% EC - 1000 ml/ha at 20 DAS , hand weeding (3 HW at 15, 30 and 45 DAS) and unsprayed control. Nine treatments were replicated thrice in a randomised complete block design experiment using cv. *'MRC 7351 BG II'*. Pre emergence herbicide was applied on 1 day after sowing using a spray volume of 750 liters of water/ha, with flat fan nozzle (WFN 72) attached to the knapsack sprayer, whereas post emergence herbicides were sprayed on 20^{th} day after sowing coinciding with 2-4 leaf stage of weeds using a spray volume of 500 l/ha with flat fan nozzle (WFN 60) attached to the knapsack sprayer. The gross and net plot sizes were 7.2 x 5.4 m and 3.6 x 4.2 m, respectively.The soil type was deep black soil with OC of 0.52%, available P_2O_5 of 29.75 kg/ha and K_2O of 179.45 kg/ha.

RESULTS

The major grassy weeds observed in the experimental fields were *Cynodon dactylon, Dactyloctenium aegyptium, Paspalum distichum* and *Digitaria marginata.* The other weeds observed in lower density were *Celosia argentea Digitaria ciliaris*, and *Dinebra retroflexa.*

Application of graminicide, quizalofop-ethyl -5% EC at 1000 to 3000 ml/ha at 20 DAS recorded significantly higher cotton yields (1.43 to 1.46 t/ha, respectively) compared to unweeded control (610 kg/ha). Similarly, pre-emergence application of pendimethalin 1 kg/ha-1DAS followed by quizalofop-ethyl -5% EC - 1000 ml/ha at 20 DAS and pendimethalin 30 EC alone 1 kg/ha - 1 DAS recorded significantly higher seed cotton yield (1.51 and 1.32 t/ha, respectively) as compared to unweeded control (0.61 t/ha). However, quizalofop-ethyl -5% EC at lower dose of 750 ml/ha-20 DAS produced slightly lower seed cotton yield (1.37 t/ha) mainly due to less control of grasses. Nevertheless, it is comparable with the recommended practice of sole application of pendimethalin 30 EC 1 kg/ha at 1 DAS (1.32 kg/ha). Unweeded control lowered the seed cotton yield due to severe weed competition particularly by grasses.

CONCLUSION

Use of quizalofop-ethyl -5% EC at 1000 ml per ha as post-emergence at 20 DAS, was effective against grassy weeds and overall benefits were comparable to that of hand weeding or dual herbicide usage of pendimethalin 1 kg/ha- 1DAS followed by quizalofop-ethyl -5% EC - 1000 ml/ha at 20 DAS .

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Management of weed through propaquizafop + oxyflourfen in onion and its impact on soil microflora

***Ratneswar Poddar, R.K. Ghosh, R. DAS, S. Sentharagai and D. Shamurailatpam**
Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal 741 252
**Email: ratneswar89@gmail.com*

Onion is an important multipurpose usable vegetable and spice in all over India besides having its medicinal properties. Because of its thinner leaves different types of weeds infestation is an important phenomenon in onion crop which ultimately reduce the yield of the crop. The yield may be reduced to the tune of 40-80% depending upon the nature of intensity and duration of weed competition in onion field (Prakash *et al.* 2000). Though hand weeding is the most promising option for weed management but due to higher cost it has become unsuccessful to the farmers. So, farmers are now in searching of new strategy of weed management among them chemical weed management is the promising one. Researchers at present are trying to develop new molecules of herbicides so that the weed can be control effectively without harming the soil and crops.

METHODOLOGY

The experiment was conducted at Kalyani 'C' Block Farm of Bidhan Chandra Krishi Viswavidyalaya during two consecutive *Rabi* season 2011-12 and 2012-13 and laid out with eight treatments replicated thrice in Randomised Block Design. Among the different treatments there were a control plot and hand weeding twice at 15 and 30 DAT in combination with propaquizafop 5% + oxyflourfen 12% EC applied in three different doses like 37.5+90, 43.75+87.5 and 50+120 g/ha along with pendimethalin 30% EC 1000 g/ha, propaquizafop 10 EC 75 g/ha, oxyflourfen 23.5% EC 200 g/ha. The variety sukhsagar was used in the experiment. Weed population and weed biomass data were collected at before spraying, 15, 30 and 45 days after application (DAA). For microflora analysis composite soil samples were collected on different dates *viz.* initial (pretreatment), 3, 10, 30 and 60 DAA of applying treatments. By using serial dilution technique and pour plate method the population of total bacteria, fungi and actinomycetes were counted with the help of agar plants containing appropriate media. The statistical analysis was done by using analysis of variance method (Gomez and Gomez 1984).

RESULTS

The major weed species in the experimental field were *Echinochloa colona*, *Digitaria sanguinalis*, *Cyperus rotundus*, *Chenopodium album, Amaranthus viridis* and *Melilotus alba*. Weed population and weed biomass was recorded lowest in case of also resulted at par result among themselves (Table 1). All the chemicals recorded 10.37% to 49.40% higher onion bulb yield over the control (16.09 t/ha). The effects of different herbicides on population of soil micro-flora *viz.* total bacteria, actinomycetes and fungi recorded at different times showed little bit variation among themselves at initial stage but after the application of herbicides the population of all the three soil microflora reduced considerably and at 60 DAA it was observed that the total number of bacteria, actinomycetes and fungi's status were higher than the initial one because of the breakdown of organic carbon which is released by the chemicals.

Table 1. Effect of different weed management practices on total weed density/m^2, dry weight (g/m^2), WCE (%) at 45 DAA, bulb yield (t/ha) and soil microflora (Pooled data)

Treatment	Total weed density/m^2	Dry weight (g/m^2)	WCE (%)	Bulb Yield (t/ha)	Soil microflora: Bacteria (CFU x 10^6 /g of soil)		Fungi (CFU x 10^4 /g of soil)		Actinomycetes (CFU x 10^5 /g of soil)	
					Initial	60 DAA	Initial	60 DAA	Initial	60 DAA
T_1	*9.55 90.88)**	43.67	63.53	21.07	39.19	92.85	31.51	71.51	53.75	82.75
T_2	8.57 (73.11)	32.27	73.05	27.04	40.19	110.85	32.23	81.51	54.42	92.75
T_3	7.30 (52.89)	25.09	79.04	28.52	38.52	117.85	31.48	85.2	52.15	97.42
T_4	9.21 (84.33)	42.82	64.24	25.13	38.19	121.55	29.89	82.13	54.68	88.13
T_5	7.47 (55.33)	25.12	79.02	26.41	41.56	117.54	30.68	78.36	54.42	78.11
T_6	7.39 (54.21)	25.18	78.97	25.98	40.26	122.87	33.57	80.42	52.89	82.54
T_7	5.71 (32.12)	14.83	87.61	28.82	42.23	69.85	33.23	52.51	53.75	69.75
T_8	15.91 (252)	119.73	-	19.09	41.34	59.74	32.74	48.85	53.23	68.42
SEm (±)	0.14	0.77	-	0.37	0.59	1.48	0.47	1.05	0.79	1.19
LSD(P=0.05)	0.42	2.34	-	1.12	1.80	4.50	1.41	3.19	2.40	3.62

T_1- Propaquizafop 5% + oxyflourfen 12% EC 37.5+90 g/ha, T_2- Propaquizafop 5% + oxyflourfen 12% EC 43.75+87.5 g/ha, T_3- Propaquizafop 5% + oxyflourfen 12% EC 50+120 g/ha, T_4- Pendimethalin 30% EC 1000 g/ha, T_5- Propaquizafop 10 EC 75 g/ha, T_6- Oxyflourfen 23.5% EC 200 g/ha, T_7=Hand weeding twice at 15 & 30 DAT, T_8- Unweeded control. *square root transformed "(x+1) value;**Figures in the parenthesis are original values.

CONCLUSION

From this experiment, it may be concluded that for weed management in onion - propaquizafop 5% + oxyflourfen 12% EC applied 50+ 120 g/ha and other herbicides in alone can be used as against of two hand weeding. It also showed no harmful effect to the soil microflora.

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Effect of weed flora and yield on irrigated chickpea

P.V. Patil, A.K. Gore and S.M. Gobade
College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharahtra 431 402

Gram (*Cicer arietinum*) is one of the most important pulse (*Rabi*) crop grown in the rainfed farming system throughout India. It is used for human consumption as well as animal feeding. It contains 21.1 per cent protein, 61.5 per cent carbohydrates, 4.55 per cent fat besides rich in Ca, Fe, niacin. It's leaves secrete malic acid (90-95 per cent) and oxalic acid (5 to 10 per cent), which have medicinal importance against stomach ache, intestinal disorder and blood purification. In Maharashtra state the area was 13.95 lake ha and production was 13.01 lakh tonnes with productivity of 933 kg/ha during the year 2011-12. (Anonymous 2011). *Chenopodium album* also one of the dominant weed in chickpea and causes maximum reduction in grain yield. (Mailk and Balyan., 1988).

METHODOLOGY

A field experiments were conducted at PG research farm of Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, parbhani during *Rabi* 2010-11 to find out the effective and economical weed control methods in chickpea the experiment was conducted on vertisols, in a randomized block design with nine treatments four pre emergence herbicides *viz.* pendimethalin (PE) 0.75 kg/ha and Trifluralin (PE) 1.0 kg/ha, metribuzin (PE) 0.75 kg/ha, oxyfluorfen (PE) 0.125 kg/ha and three post-emergence herbicides *viz*. imazethapyr (POE) 0.75 kg/ha, Quizalofop-p-ethyl (POE) 40 g/ha, propaquizafop (POE) 0.75 kg/ha and three cultural treatments *viz.* 1 Hoeing (30 DAS) + (2 hand weedings), Mechanical weedings (2 hand weedings), weed free (weeding at 20 days for up to 80-90 DAS), and weedy check. They were replicated three times. The gross and net plot sizes were 5.4 x 4.5 m and 4.5 m x 3.6 m, respectively. The seeds of variety '*Vijay*' were sown by dibbling method at spacing 45 x 10 cm. Observations on growth, weed parameter were recorded periodically at an interval of 30 days. Whereas the observation on yield attributing characters and yield were recorded at harvest.

RESULTS

At harvest the significantly lowest weed count was observed in weed free treatment in which it was found at par with mechanical method *i.e.* [1 hoeing (30DAS) + 2HWs] and quizalofop-ethyl (POE) 40 g/ha. Among various herbicidal treatments application of quizalofop-p-ethyl (POE) 40 g/ha recorded significantly lowest weed count. Pendimethalin (PE) 0.75 kg/ha recorded significantly lowest weed count of dicot weeds. At harvest significantly lowest dry matter of monocot weed was observed in T_{10} (weed free) which was at par with T_8 (propaquizafop (POE) 0.75 kg/ha), T_7 (quizalofop-p-ethyl (POE) 40 g/ha), T_5 (mechanical weedings (2 HWs) and T_6 (Imazethapyr (POE) 0.75 kg/ha) and significantly lowest than weedy check. treatments pendimethalin (PE) 0.75 kg/ha recorded significantly lowest dry matter of dicot weeds than rest of the herbicidal treatments. In general among all the weed control treatments weed free recorded highest weed control efficiency at all the growth stages for dicot as well as monocot weeds. Among herbicidal treatments it was highest in Pendimethalin (PE) 0.75 kg/ha for dicot weeds and in Quizalofop-p-ethyl (POE) 40 g/ha for monocot weeds at all the stages of observations. The highest weed index of 48.25 percent was recorded in weedy check. Quizalofop ethyl (POE) 40 g/ha (18.17%), pendimethalin (PE) 0.75 kg/ha (6.04%), Mechanical weedings (2HWs) (5.47%) and 1 hoeing (30 DAS) + 2 hand weedings (0.87%). The treatment weed free recorded highest seed yield, bhoosa yield and biological yield. It was followed by application of 1 hoeing (30 DAS) + 2 hand weedings, mechanical weeding (2 hand weedings) and pendamethalin (PE) 0.75 kg/ha. Weedy check recorded the lowest grain and bhoosa yield.

Table 1. Weed growth yield and economics of chickpea as ifluenced by different weed control treatments.

Treatment	Number of monocot weeds (no./m²)	Number of dicot weeds (no./m²)	Weed dry matter monocot (g/m²)	Weed dry matter dicot (g/m²)	Weed control efficiency monocot (%)	Weed control efficiency dicot (%)	Weed Index (%)	Grain yield (t/ ha)	B:C ratio
Pendimethalin (PE) 0.75 kg/ha	28.93	16.10	4.52	4.13	69.76	76.14	6.04	2.79	3.64
Trifluralin (PE) 1.0 kg/ha	35.50	18.20	5.43	4.20	63.67	75.73	17.67	2.45	3.23
Metribuzin (PE) 0.75 kg/ha	28.20	20.90	4.00	4.25	73.24	75.44	32.45	2.01	2.72
Oxyfluorfen (PE) 0.125 kg/ha	34.50	18.60	4.78	4.36	68.02	74.81	25.30	2.22	3.08
Mechanical Weedings (2 hand weedings)	24.80	15.80	3.78	4.00	74.71	76.89	5.47	2.81	3.40
Imazethapyr (POE) 0.75 kg/ha	24.90	19.50	3.82	4.43	74.44	74.40	27.65	2.15	2.86
Quizalofop-p-ethyl(POE) 40 g/ha	22.50	23.50	3.44	4.64	76.98	73.19	18.17	2.43	3.23
Propaquizafop(POE) 0.75 kg/ha	24.50	31.50	3.45	8.50	76.92	50.89	19.55	2.39	3.12
1 Hoeing (30DAS) + (2 hand weedings)	20.50	14.50	3.18	3.10	78.72	82.09	0.87	2.95	3.33
Weed free (weeding at 20 days interval up to 80-90 DAS)	19.33	14.00	2.19	2.58	85.35	85.09	-	2.97	3.10
Weedy check	37.50	38.40	14.95	17.31	0.0	0.0	48.25	1.54	2.17
LSD (P=0.05)	4.96	4.50	1.65	1.78	--	--	--	0.41	0.38

CONCLUSION

It was concluded that pre-emergence application of Pendamethalin (PE) 0.75 kg/ha was most effective for controlling weeds, improving grain yield and profitability of irrigated chickpea.

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Evaluation of pre- and post-emergence herbicides in soybean

Dibakar Ghosh*, V.P. Singh, Raghwendra Singh, P.P. Choudhury and K.K. Barman

Directorate of Weed Science Research, Adhartal, Jabalpur, Madhya Pradesh 482 004

**Email: dghoshagro@gmail.com*

Soybean [*Glycine max* (L.) Merrill] is the most important oilseed crop grown in India and World. Soybean-wheat is an important cropping system on the Vertisol soils of Madhya Pradesh, and become an important alternative to the pre-dominant rice-wheat cropping system. Due to initial slow growth, weed infestation is more in soybean, reduces its productivity up to 35-80% (Gupta *et al.* 2006). In soybean weed is generally managed through manual weeding and hoeing but due to intermittent rainfall during rainy season and scanty labour, timely inter culture becomes a very difficult task. Under such situations, different pre- and post-emergence herbicides can control annual grass and broad-leaved weeds effectively in soybean (Vyas and Jain 2003). Thus, an experiment was conducted with an objective to identify a judicious combination of pre- and post-emergence herbicides for controlling weeds in soybean.

METHODOLOGY

A field experiment was conducted during the *Kharif* 2012 at the Directorate of Weed Science Research, Jabalpur, Madhya Pradesh. The experiment was laid out in a randomized complete block design with ten weed control treatments (Table 1) replicated thrice. Treatments comprise of pre-emergence herbicides (pendimethalin and metribuzin) and post-emergence herbicides (imazethapyr and chlorimuron-ethyl). The post-emergence herbicides were applied at 30 DAS. Soybean '*JS- 9560*' was sown at a row spacing 30 cm with a seed rate of 100 kg/ha with recommended package of practice. For weed count and weed biomass, four permanent quadrates (0.25 m^2) were earmarked in each plot after soybean sowing and then weed data were taken from these areas. Individual weed species were grouped into grass, sedge, broad leaved and total weed at 60 DAS (days after sowing). Crop yield was recorded at harvest.

RESULT

Major weed flora were: *Cyperus rotundus*, *Echinochloa colona*, *Physalis minima*, *Phyllanthus niruri*, *Macardonia procumbens*, *Dinebra retroflexa* and *Paspaladium flavidum*. During initial growth stages *C. rotundus* was the main dominating weed, but at latter stages of crop growth (60 DAS) the dominant weed species was *E. colona*. Pre-emergence herbicides were less effective to suppress the population of *C. rotundus* at 25 DAS. Imazethapyr in combination with PE herbicides and sole application of chlorimuron-ethyl effectively reduce the biomass of *C. rotundus* at 60 DAS as compare to sole application of imazethapyr. Dry weight of *E. colona* was effectively reduce by imazethapyr and chlorimuron-ethyl in combination with PE herbicides and sole application of imazethapyr at higher dose (150 g/ha), but sole application of chlorimuron-ethyl was not effective to control *E. colona* at 60 DAS. All the weed management measures significantly reduced total weed population and dry weight at 60 DAS as compared to weedy check. Among weed management practices the maximum yield was recorded with 2 hand weeding (1.69 t/ha) which was at par with imazethapyr 150 g/ha (1.54 t/ha) and metribuzin (PE) 500 g/ha *fb* imazethapyr 100 g/ha (1.47 t/ha) (Table 1).

Table 1. Effect of weed management practices on weed density and dry weight, and soybean yield.

Treatment	Population of *C. rotundus* (no./m^2) at 25 DAS	Dry weight of *C. rotundus* (g/m^2) at 60 DAS	Dry weight of *E. colona* (g/m^2) at 60 DAS	Total weed population /m^2 at 60 DAS	Total weed dry weight (g/m^2) at 60 DAS	Grain Yield (t/ha)
Pendimethalin750 g/ha *fb* imazethapyr 100 g/ha	4.97 (24.67)	1.33	8.40	7.32 (53.33)	12.85	1.13
Pendimethalin750 g/ha *fb* chlorimuron 9 g/ha	5.74 (32.67)	0.88	14.53	9.53 (90.67)	20.57	1.17
Metribuzin 500 g/ha *fb* imazethapyr 100 g/ha	6.05 (36.67)	1.13	4.67	9.19 (85.33)	10.52	1.47
Metribuzin 500 g/ha *fb* chlorimuron 9 g/ha	5.50 (30.67)	0.22	17.47	7.84 (64.00)	20.64	1.13
Imazethapyr 100 g/ha	8.24 (68.00)	2.13	43.33	12.71 (161.33)	61.20	1.11
Imazethapyr 150 g/ha	6.62 (47.33)	3.30	6.87	11.02 (121.33)	17.20	1.54
Chlorimuron 9 g/ha	7.53 (56.67)	0.29	46.93	12.44 (158.67)	69.42	0.98
Chlorimuron 13.5 g/ha	7.53 (56.67)	1.60	50.53	12.63 (161.33)	71.20	0.93
2 hand weeding at 25 and 45 DAS	5.55 (31.33)	0.53	4.86	9.12 (85.33)	12.15	1.69
Weedy check	8.95 (82.67)	1.53	63.01	16.08 (258.67)	80.23	0.68
LSD (P=0.05)	2.24	1.69	23.61	2.68	29.85	0.40

Weed density data were subjected to square-root ($\sqrt{x+0.5}$) transformation before analysis and original values of weed density are shown in parentheses.

CONCLUSION

It may be conclude from this study that the application of imazethapyr at higher dose (150 g/ha) at 30 DAS and sequential appliaction of metribuzin (PE) 500 g/ha *fb* imazethapyr 100 g/ha applied at 30DAS may give higher soybean yield due to significant reduction in weed growth.

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Long-term impact of herbicides on weed dynamics and productivity in DSR-wheat cropping system under vertisol

V.P. Singh*, K.K. Barman, C. Sarathambal and A.R. Sharma
Directorate of Weed Science Research, Jabalpur Padhya Pradesh 482 004
**Email: vpsinghnrcws@gmail.com*

Rice-wheat cropping system, one of the most important cropping systems for food security in India, is being practiced in 12 million ha area of the country. One way to reduce the water and labor demand is to grow dry-seeded rice (DSR) instead of puddle transplanted rice (Chauhan *et al*. 2012). Dry tillage and aerobic soil conditions favours quick and profuse growth and results in reduction of grain yield by 50-90% (Rao *et al*. 2007, Prasad 2011), as compared to transplanted rice. Similarly in wheat, weed competition caused average reduction in grain yield about 30%. Several post-emergence herbicides, *viz*. bispyribac-sodium, chlorimuorn-ethcyhalofop and fenoxaprop-methyl in rice (Singh *et al*. 2005) and clodinafop-proargyl, sulfosulfuron and fenoxaprop-p-ethyl in wheat have been found effective for weed control. Due to the continuous use of herbicides, there is likelihood of development of resistant biotypes of weeds which may pose problem in the crop production system.

METHODOLOGY

Field experiments were conducted during 2010–12 at the Directorate of Weed Science Research, Jabalpur (MP). The soil was clay loam (Typic chromusterts) in texure, low in available N (234 kg/ha), medium in available P (18 kg P/ha), and high in available K (314 kg/ha), with organic carbon 0.54% and pH 6.8. The experiment comprised of treatment combinations consisting of bispyribac-sodium 25 g/ha as post-emergence (20 DAS), cyhalofop-butyl 90 g/ha as pre-emergence and one HW at 30 DAS along with weedy check in direct-seeded rice (DSR) as main plot treatments, which were superimposed by post-emergence application (25 DAS) of isoproturon 1500 g/ha, sulfosulfuron 25 g/ha and clodinafop 60 g + 2,4-D 500 g/ha, one HW at 30 DAS and weedy check in wheat as sub-plot treatments. The experiment was laid out in split-plot design with 3 replications. Herbicides were applied at 20 DAS in aqueous medium at the rate of 500 litres water per hectare with flat fan nozzle of sprayer.

RESULTS

Echinochloa colona, *Alternanthera sessilis*, *Commelina communis, Physalis minima, Caesulia axillaris,* and *Cyprus iria* were the dominant weed flora during rainy season in rice. Whereas, *Phalaris minor* and *Avena ludoviciana* among grassy weeds, and *Chenopodium album*, *Medicago hispida, Physalis minima* and *Cichorium intybus* among broad-leaved weeds were dominant during winter season in wheat.

All the weed control treatments reduced the total weed density and weed dry biomass production significantly over weedy check. Application of bispyribac-sodium 25 g/ha significantly reduced the population of *E. colona* (90%), *C. iria* (97%), *C. communis* (98%) and *Caesulia axillaris* (58%) over weedy check. However, application of cyhalofop-butyl failed to check the growth of *C. iria*, *A. sessilis*, and *C. communis* but significantly reduced the population of *E. colona* by 96% over weedy check.

Growth parameters of rice, were not influenced significantly due to various weed control treatments. However, the highest reduction in leaf area index due to weed infestation was recorded in weedy plots, followed by cyhalofop-butyl treated plots. Application of bispyribac-sodium recorded 28% higher effective tillers/m row length and 44% higher grain yield over weedy check. The lowest grain yield of rice (2.35 t/ha) was obtained under weedy check. Application of clodinafop + 2,4-D in wheat caused significant reduction in *A. sterilis, P. minor* and *P. minima*, whereas the lowest populations of *C. intybus, M. hispida* and *C. album* were recorded with sulfosulfuron. Application of isoproturon failed to check growth of *A. sterilis* and *P. minor,* but was very effective against *C. intybus* and *C. album*. Clodinafop + 2,4-D caused 53 and 64% reduction in total weed population and weed dry biomass, respectively over weedy check. This was followed by application of sulfosulfuron. Both the herbicide treatments, *viz.* sulphosulfuron and clodinafop + 2,4-D were effective in reducing population of almost all weed species and weed biomass production. Presence of weeds throughout the growing season caused 31% reduction in yield. The grain yield recorded with application of sulfosulfuron was 21 and 31% higher than isoproturon and weedy check, respectively. Preceding treatments applied to rice did not influence the weed distribution, crop growth, yield attributes and grain yield of wheat. No significant effect of the applied herbicides was recorded on the observed soil parameters so far, *i.e.* after completion of the second cycle of the experiment.

Effect of herbicide application on functional soil microbial population was assessed, which shows that application of bispyribac-sodium enhanced the total bacterial count. Similarly the application of cyhalofop butyl also enhanced the free-living diazotrophs, ammonia oxidizer and nitrite oxidizer in rice crop.

CONCLUSION

The study suggested that continuous use of bispyribac-sodium in DSR and clodinafop-propargyl + 2 4-D in wheat for a longer period of time could provide broad-spectrum weed control without any weed shift, development of resistance in weed, adverse effect on soil fertility and soil biology, and crop productivity.

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Non-puddled direct seeded and mechanical transplanted rice sequentially with no-till wheat to sustain higher productivity and profitability inrice-wheat cropping system in India

Ashok Yadav*[1], Dharam Bir[1], Gurjeet Gill[3], R.K. Malik[4], B.R. Kamboj[2], Virender Kumar[4], R.K. Jat[5] and Ajeet Singh[1]

[1]International Rice Research Institute, IRRAS- CRS, Patna, Bihar 800013, [2]CCS Haryana Agricultural University, Hisar, Haryana 125 004, [3]University of Adelaide, Waite Campus, Australia, [4]CSISA-CIMMYT, Patna, Bihar, [5]BISA, Pusa, Samastipur, Bihar 848125

**Email:aky444@gmail.com*

Reduced labour costs, saving in irrigation water and energy use coupled with higher productivity and profitability have recently attracted the attention of Indian farmers for direct seeded rice (DSR) and mechanical transplanted rice (MTR) in non-puddled situations. However, weed management due to more intense and diverse weed flora, still tends to be much more challenging in non-puddle fields because of absence of continuous flooding, and situation often becomes more complex in DSR than MTR because of absence of a seedling size advantage. It necessitated concerted research efforts on weed dynamics studiesunder DSR and MTR, and integrated weed management to achieve higher and sustained system productivity and profitability in rice-wheat cropping system (RWCS).

METHODOLOGY

A large number of "On Station" (CCSHAU Regional Research Station, Karnal), "On Farm" (KVKs) and "Farmers'Field" (in Farmers Participatory Approach) trials were undertaken during 2005 to 2013 at multi-locations in Haryana to evaluate the performance of DSR and MTR under non-puddled situations compared to traditional puddled transplanted rice (PTR) basically targeting weed dynamics for their integrated management to achieve consistent and higher system productivity on long-term basis in RWCS. Such basic studies further helped in propagating these two resource conserving technologies in different parts of India besides extending platform for multi-disciplinary team to generate valuable data related to weeds, residue management, soil health, insect-pest and diseases scenario, grain quality, productivity and economics in a cropping system mode under different planting methods (Table 1). DSR became more popular in Haryana and Punjab due to its simplicity and availability of proper machinery while MTR is catching interest of farmers in NE India due to custom hiring.

RESULTS

Aerobic grass weeds which were minor weeds in puddle transplanted rice (PTR) became major weeds in DSR (data not given) even in the initial first two years of introducing DSR. Integrated weed management strategies based on herbicides combinations (primarily and most popularly pendimethalin at 1000 g/ha as pre-emergence followed by bispyribac-Na 25g/ha as post-emergence) and some hand-roguing were realized very effective and essential particularly in DSR. Whereas, in case of MTR, all other recommended herbicides in PTR were found useful. Rice grain yields under DSR and MTR over the years were similar or higher than PTR (Table 1). Kamboj *et al.* (2013) also reported similar findings. Wheat performed better after DSR than PTR and gave 0.6-0.7 t/ha higher yields. Similarly, productivity of wheat was more in sequence with MTR than PTR. Infestation of all type of weeds in rice was less under puddle systems of rice establishment. Aerobic grasses were more under zero-till conditions and unpuddled DSR. Broadleaf weeds were more under zero-till systems and unpuddled-MTR. Addition of residues under zero-till systems reduced the infestation of aerobic grasses and BLWs, but not the sedges. The system productivity of rice-wheat cropping system was also better under DSR as compared to PTR. Economics and other benefits (data not given) also strongly support DSR and MTR followed by ZR-wheat.

Table 1. Grain yields of rice and wheat under different establishment methods of rice-wheat cropping system

Treatment*	Grain yield of rice (t/ha)				Grain yield of wheat (t/ha)		
	2010	2011	2012	2013	2010-11	2011-12	2012-13
ZT-DSR (+) Residue *fb* ZTW	2.87	2.86	3.22	3.87	5.46	5.06	6.49
ZT-DSR (-) Residue *fb* ZT W	2.98	2.78	3.20	3.73	5.34	5.03	6.48
Unpuddle DSR *fb* ZTW	2.87	3.03	3.11	4.31	5.35	5.15	6.43
ZT-MTR*fb* ZTW	2.93	2.47	3.18	3.94	5.41	5.12	6.55
Unpuddle-MTR *fb* ZTW	2.86	2.75	3.29	3.40	5.18	5.14	6.46
Puddle-MTR *fb* ZTW	2.45	3.07	3.29	3.64	4.86	4.74	6.01
PTR (manual) *fb* ZTW	2.80	3.01	3.15	4.07	4.79	4.69	5.98
PTR (manual) *fb* CTW	-	-	3.14	4.06	-	5.06	5.85
LSD(P=0.05)	0.18	0.23	NS	0.22	0.28	0.06	0.12

*DSR, direct seeded rice; ZT, zero-till, MTR, machine transplant rice; PTR, puddle transplant rice; ZTW, zero-till wheat; CTW, conventional till wheat

CONCLUSION

Integrated weed management in DSR and MTR and growing of ZT-wheat in sequence would provide high and sustained system productivity and profitability in RWCS besides savings of other natural resources. Availability of suitable machinery, frequent trainings for skill improvement through HRD and custom hiring will help in scaling out these technologies in different parts of the country.

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Integrated weed management in spring planted sugarcane variety *Co 8014.*

L.G. Pawar, S.T. Thorat, SA Chavan, V.N .Shetye, U.V. Mahadkar and M.J. Mane
College of Agriculture, Dapoli, Maharashtra 415712

Slow germination and initial slow growth of sugarcane coupled with wider row spacing, frequent irrigations, heavy manuring and fertilizer applications provide ample scope to weedsfor their growth in sugarcane fields especially during the initial period of 2-3 months after planting. In general, none of the single, either mechanical or chemical method proves to be effective and economical for control of weeds. However, weed infestation did not affect juice sucrose contents (Rana and Singh 2004). Therefore, present investigation for use of herbicides and their integration with hand weeding was taken up as detailed below.

METHODOLOGY

An experiment was conducted at the Agronomy Farm, College Agriculture *Dapoli* during 2003 – 2006 to study effects of various pre emergence (PE) herbicides (*Ametryn* and metribuzin) and post emergence (PoE) herbicides(2,4-D, MSM and glyphosate) besides their integration with hand weeding at different growth stages of spring planted sugarcane variety *Co 8014* which were replicated thrice.

RESULTS

Amongst these effective treatments, PoE application of glyphosate 1.5 kg/ha integrated with hand weeding once at 60 DAP topped the rank in exhibiting highest weed control efficiency when compared with the most effective treatment of farmer's practice involving four hand weedings at 30, 60,90 and 120 DAP. Accordingly millable cane population and cane yield was significantly influenced due to different weed control treatments. Compared to the best treatment of 4 HWs 30,60, 90 and 120 DAP, weed competition index (WCI) was lowest in case of the treatment of PoE application of glyphosate at 1.5 kg/ha + 1 HW 60 DAP followed by the treatments, *viz .* PE application of Metribuzin + 2 HWs 60 and 90 DAP and PE application of Ametryn + 2 HWs 60 and 90 DAP. Quality of sugarcane in terms of its brix per cent juice, sucrose per cent juice and percentage of commercial cane sugar did not vary much due to different weed controls treatments. However, yield of commercial cane sugar followed similar trend as that of yield of millable canes. As compared to the best treatment of farmer's practice, reduction in yield of commercial cane sugar was least in case of the treatment, *viz.* glyphosate + 1HW 60 DAP *fb* use of metribuzin +2 HWs60 and 90 DAP and use of Ametryn +2 HWs60 and 90 DAP

Table 1. Effect of weed control measures on mean weed growth, cane population, cane yield, quality attributes and yield of sugar

Treatment	Weed growth(g/m^2)				Mean Cane Yield and Yield attributes of sugarcane						
	First year		Mean of 2nd & 3rd year 120 DAP		Millable canes (no./ha)	Cane Yield (t /ha)	Brix %	Sucrose %	CCS %	CCS (t/ha)	WCI (%)
	At harvest	WCE (%)	Pooled	WCE (%)							
Ametryn 1.0 kg/ha (PE) (fb) hand weeding twice at 60 and 90 DAP	32.9	93.28	31.3 (5.66)	85.3	87,346	79.55	20.6	18.2	12.4	9.9	13.3
Metribuzin 0.5 kg /ha (fb) hand weeding twice at 60 and 90 DAP	72.0	85.30	26.0 (5.22)	87.8	84,106	83.71	20.9	18.1	12.3	10.3	9.5
Glyphosate 1.5 kg/ha before crop emergence (fb) hand weeding once at 60 DAP	20.6	95.79	28.0 (5.38)	86.8	88,422	89.85	21.4	18.3	12.4	11.1	2.4
Farmers practice hand weeding four times at 30, 60, 90 and 120 DAP	12.3	97.49	88.3 (8.94)	72.5	89,820	91.21	20.7	18.3	12.5	11.4	--
Weedy check	489.7	--	212 (14.44)	--	46,579	36.56	20. 8	17.9	12.3	4.49	60.6
LSD(P=0.05)	71.5	--	1.14	--	3918	5.49	--	--	--	--	--

Highest net returns were obtained in case of post emergence of application of glyphosate in combination with hand weeding once at 60 DAP followed by farmer's practice where hand weeding was done four times 30, 60, 90 and 120 DAP. The B : C ratio was also maximum in case of glyphosate + 1 HW followed by the treatments, *viz*. pre emergence application of metribuzin + 2 HWs 60 and 90 DAP and farmers practice of four hand weedings 30, 60, 90 and 120 DAP.

CONCLUSION

For effective and economical weed management in seasonal sugarcane, it is recommended to give directed post emergence spray of glyphosate at 1.5 kg/ha (20 days after planting in combination with hand weeding once at 60 days after planting (DAP) or follow hand weeding four times at 30, 60, 90 and 120 DAP.

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Studies on continuous and rotational application of herbicides on soil micro- flora in transplanted rice-wheat cropping sequence

Rajinder Kumar*, Dinesh Badiyala, Neelam Shrama and Suresh Gautam
College of Agriculture, CSK HPKV, Palampur, Himachal Pradesh 176 062
**Email: rajinder.kumar226@gmail.com*

The effects of herbicides on soil microbial communities are conventionally studied by techniques based on cultivation of the soil microorganisms or by measuring their metabolic activities. The effects of long-term applications of the herbicides on rice-wheat sequence have been assessed after 34 years by studying the beneficial microbial population, microbial biomass, dehydrogenase activity and phosphatase enzyme activity.

METHODOLOGY

A long-term effect of continuous use of herbicides on shift in weed flora in transplanted rice-wheat rotation under All India Coordinated Research Project was initiated in 1978 at Agriculture University, Palampur. The studies on effect of herbicides application

on soil micro flora and soil activity was assessed after 35 years in terms of their population and enzymatic activity. The long term experiment on effect of continuous use of herbicides comprising 9 treatments replicated three times in randomized block design was established in 1978 at the experimental farm of the CSK Himachal Pradesh Agricultural University, Palampur, following a rice-wheat crop sequence. The rice-wheat crops grown in 2012-13 studied for herbicides effect on soil microflora.

RESULTS

The effect of herbicides on soil microflora and other soil parameters in long-term effect of continuous use of herbicides on shift in weed flora in transplanted rice-wheat rotation during the harvesting of wheat crop reveals that the beneficial soil microflora population. *Azotobacter* and Phosphate solublising microorganism as well as bacteria and fungi population were not affected significantly by various treatments.

However, the population of *Azotobacter* was numerically less over farmer practice in all the treatments. But the treatment i.e. T_3, (Clodinafop 75 g/ha fb 2,4-D 0.75 kg/ha/ Isoproturon* 1.0 kg/ha + 2,4-D 0.75 kg/ha) showed highest population of Azotobacter per gram dry soil basis (91.47×10^4) next to T_1, Farmer's practice. The highest population of phosphate solublising microorganism (64.56×10^4) was found inT_1 (Farmer's Practice). The microbial count of *azotobacter*, phosphate solublising microorganism and bacteria showed that the application of herbicide influences their population after the treatment of herbicides

The herbicides and their different concentrations affected the fungal population but no significant differences were observed in fungal population counted at different days after herbicide application both in wheat and rice cropping system. No significant interaction effect was observed for the fungal population. The control showed the highest population of fungi in both the crops.

Deshmukh and Srikhande (1974) observed that 2,4-DEE at field application rate did not exert any effect on bacteria, fungi, actinomycetes after 40 days of application. Similar effect was also seen in the herbicide treatment in both wheat and rice cropping system in the present experiment wherein the microbial population after 30 days of application was numerically different to the control treatment. As it was observed in the current study, herbicide in the soil showed temporary inhibition of Azotobacter and Phosphate solublising microorganism as well as bacteria and fungi population within the early period of application of herbicides followed by a recovery during the later period in rice and wheat.

CONCLUSION

The results of present study shows that there is a temporary suppression in population of beneficial microorganism were observed but with the passage of time (30 DAT) the population again recovered in these biological soil environments.

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Determination of weed competition critical period inn *Kala zeera* in gurez valley of Kashmir

Parmeet Singh, Purshotam Singh, Z.A. Badri, Fayaz Bahar, Faroq Pir and Rihana Habib
Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu and Kashmir- 191 121

Kashmir Himalayan region is by far one of the most enriched natural ecosystem where a large number of highly valued medicinal and aromatic plants grow. *Kala zeera* (*Bunium persicum* L) is an important culinary spice cum medicinal plant and has immense potential in *Gurez* valley of temperate Kashmir. It is highly priced (₹ 3,000-3,500), low volume non perishable commodity. Agronomic information of *Kala zeera* is meager. Due to slow initial growth, crop came across a very still weed competition. Weeds compete with crop for environmental resources available in limited supply- nutrients, water and light. As a consequence, weeds may significantly reduce yield and impair crop quality resulting in financial loss to the grower / farmer. Before going for weed management it is required to have knowledge of effects of weed competition on crop yield and it is required to have development of tool that can aid farmers' decision about weed control (Kropff and Spitter 1992). The critical period is useful in defining the crop growth stage most vulnerable to weed competition. In this study an attempt has been made to determine critical period for weed competition in *Kala zeera* growing under gurez valley conditions of Kashmir region.

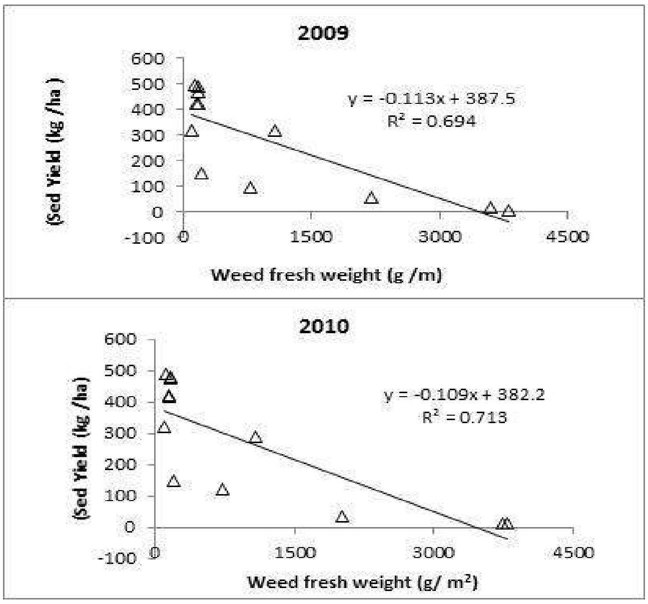
METHODOLOGY

The field experiment was conducted at Mountain Agriculture Research and Extension Station (MAR and ES) previously Zeera Research Sub Station gurez (78°, 20' N Longitude and 31° 20' E Latitude and at 2393 m amsl) *of* Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Jammu & Kashmir during *Rabi* seasons of 2007-08 and 2008-09 on a flat narrow valley land. Planting material consisting of root tubers already planted in fields one year before (Being perennial crop) planted in 6 m^2 raised plots area at a spacing of 25 x 25 cm. The experiment consists of 12 treatments in which six treatments were kept weed free with week enhancement of 2, 4, 6, 8, 10, and 12 Weeks after Germination (WAG) of *Kala zeera.* While, next 6 treatments are those in which plots are kept weedy with week enhancements of 2, 4, 6, 8, 10, and 12 WAG. After harvesting *Kala zeera* crop was sundried until its moisture content was reduced to 14%. Regression analysis were performed to determine the relationship between weeds fresh weight and seed yield.

RESULTS

Here impact of weed fresh weight, on *Kala zeera* seed yield, which is accumulated during common period of growth, is described by regression equations. During two years of study strong negative effect of weed fresh weight on *Kala zeera* seed yield was obtained (R^2 = 0.694, 0.713, respectively). Lindquuist *et al.* (1999) also pointed out that the relative time of weed and crop emergence and densities of both crop and weed may explain the variation in the crop weed interference relations among years and location.

Weed competition which lasted for more than 4 weeks after germination (WAG) of *Kala zeera* was most harmful to its seed yield. Weed competition in the first 10-12 WAG reduced *Kala zeera* yield by 97%. Competition in the first 8 WAG reduced yield by 92%. Weeds which grow in the crop after 4 weeks of *Kala zeera* germination didn't decrease its productivity significantly. If the competition remains after 4 weeks, *i.e.* upto 6 WAG, there is very less reduction in *Kala zeera* seed yield. When the crop was weedy for 4, 6, 8, 10 and 12 WAG, *Kala zeera* seed yield was at par and smallest in comparison with that when the crop weeding was done during first 2, 4 , 6, 8, 10 and 12 WAG. A period of weeding for 4, 6, 8, 10 and 12 WAG provided a yield similar to that achieved when the crop weeding was done after 4 weeks after *Kala zeera* germination. According to average data of two years investigation, the critical competition period in *Kala zeera* lasts for 4 weeks. For such period *Kala zeera* crop should be kept weed free so that yield losses should not exceed 5%. Weeds emerging later do not appear to be detrimental to *Kala zeera* growth and yield. Thus, critical competition period in the crop *Kala zeera* lasted for 4 weeks. So that weeds should be managed to keep them below the economic threshold.



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Effect of integrated weed management in turmeric

Ashok Jadhav*and Sanjay Pawar

Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra 431402

The experiment was carried out during 2012-13 in Randomized block design with three replications on medium black soil with slightly alkaline in reaction (pH 8.1), low in nitrogen, medium in phosphorus and high in potassium content at Weed Science Research Station ,Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani, which falls within 19^0 16' N latitude and 76^0 47' E longitude. The turmeric variety Selum was planted on raised beds at 90 x 30: 120 cm spacing on 19 June 2012. The recommended dose of FYM at 10 t/ha and 200:150:150 kg NPK was applied in equal three splits at planting, 60 and 120 days after planting.

The treatments were given in table 1.The herbicides were applied as per treatments, using a spray volume of 500 L for pre-emergence and 300 L/ha for post emergence with knapsack sprayer with flat fan nozzle. The economics was worked out based on cost of cultivation at ₹ 79,000/ha and average sale price of raw turmeric at ₹ 200/t.

RESULTS

Effect on weeds

A persual of data indicated that all the weed control treatments significantly reduced Dry weed weight and weed control efficiency significantly over weedy check (Table 1). Among the various treatments metribuzin at 0.7 kg/ha PE *fb* straw mulch 10 t/ha fb one HW recorded lowest dry weed weight and highest WCE(75%) at both the observations as compared to all other treatments.

Effect on crop

Among the various treatments Metribuzin at 0.7 kg/ha PE *fb* straw mulch 10 t/ha *fb* one HW recorded significantly highest fresh rhizome yield (12.16 t/ha) as compare to other treatments except the treatments included the straw mulch application. The increase in yield with straw mulch included treatments may be due to season long effective control of weeds due to suppressing weed growth in later stage and due to herbicide during early stage. Un weeded check recorded the lowest fresh rhizome yield (3.02 t/ha) with a yield loss of 80%. Similar results were also reported by Ratnum *et al* (2012).

Table 1. Rhizome Yield, Dry weed weight and weed Control efficiency in Turmeric as influenced by weed control treatments

Treatment	Fresh Rhizome yield (t/ha)	Dry weed weight (g/m^2) Grassy 30	Grassy 60	Broad-leaved 30	Broad-leaved 60	Weed Control efficiency (%) 30	Weed Control efficiency (%) 60	Finger no. /plant 30	Finger Wt. /plant 60	Net returns (x10³₹/ha)	B:C ratio
Metribuzin at 0.7 kg/ha PE fb two hoeings	10.16	4.7	8.9	14.6	14.1	60	65	24	320	120.64	1.46
Metribuzin at 0.7 kg/ha PE fb Fenoxaprop at 67 g/ha + Metsulfuron 4g/ha POE	8.11	4.1	7.5	10.1	18.6	62	70	20	230	89.65	0.99
Metribuzin at 0.7 kg/ha PE fb straw mulch 10 t/ha fb one HW	12.16	2.0	6.1	13.2	18.2	68	75	28	370	144.63	1.47
Pendimethalin at 0.7 kg/ha PE fb two hoeings	9.75	5.1	6.5	20.4	21.8	55	58	18	218	111.76	1.34
Pendimethalin at 0.7 kg/ha PE fb Fenoxaprop at 67 g/ha + Metsulfuron 4g/ha POE	8.06	3.1	3.8	18.2	26.4	64	71	15	198	78.85	0.95
Pendimethalin at 0.7 kg/ha PE fb straw mulch 10 t/ha fb one HW	10.28	5.7	8.4	16.1	20.8	68	64	21	338	105.88	1.06
Attrazine at 0.75 kg/ha PE fb Fenoxaprop at 67 g/ha + Metsulfuron 4g/ha POE	7.66	3.1	5.3	10.1	14.3	56	62	16	205	71.56	0.87
Attrazine at 0.75 kg/ha PE fb straw mulch 10 t/ha fb one HW	9.74	5.1	6.0	8.1	14.6	65	72	20	285	97.88	0.96
Weed free (6 HW as per req)	10.94	3.2	5.0	15.2	11.2	70	78	18	336	118.43	1.18
Weedy check	3.02	6.1	7.0	18.2	25.1	-	-	8	86	19.10	0.24
LSD(P=0.05)	2.79	2.01	4.85	5.16	5.80	-	-	9	87	53815	-

Among the weed management treatments highest net monitory returns (Rs. 144630) and B:C ratio (1.47) were recorded with metribuzin at 0.7 kg/ha PE fb straw mulch 10 t/ha fb one HW owing to lower weed growth and highest turmeric yield. Effective and economic weed management in turmeric can be undertaken with IWM treatment of metribuzin at 0.7 kg/ha PE fb straw mulch 10 t/ha fb one hand weeding.

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Influence of varying planting methods and weed control measures on yield of rainfed lowland rice of Eastern Uttar Pradesh

R.K. Singh*, A.K. Singh, V.B. Singh and S.K. Kannaujia

Krishi Vigyan Kendra, Azamgarh, Faizabad, Uttar Pradesh 224 133

**Email: rksagronat@gmail.com*

Uttar Pradesh is important rice growing state with broad-spectrum agro-ecosystems where transplanting method persist as the major practice of rice planting under puddle condition. Often the farmers fail to transplant the seedlings in time either due to prolonged dry spell or intense rainfall resulting lower yields. Paucity of labours and increasing cost of transplanting encouraged many rice growers to switch over from transplanting to other planting methods of rice. Under these circumstances, the direct seedling of sprouted seeds, unpuddled transplanting and unpuddled stale transplanting appears to be the alternate practices. (Singh and Singh 1996). Thus to avoid yield loss and to kept weed under threshold's level, timely of weeds through varying planting methods become therefore, a practice of paramount importance. The information for location specific is still lacking about the efficacy of weed management practices on the performance of rice grown under various cultures. Hence, the present investigation was carried out under rainfed lowland shallow favorable situations.

METHODOLOGY

A field experiment was conducted at demonstrational farm of Krishi Vigyan Kendra, Kotwa, Azamgarh (N.D. University of Agriculture and Technology, Faizabad) during rainy season of 2007 and 2008 in sandy clay loam having 7.3 pH, organic carbon 0.45%, available N, P and K were 210, 14.6 and 230.7 kg / ha, respectively. A set of 24 treatment combinations consisting of four rice establishment techniques given in table 1.

Rice cultivar *Godawari* was used at 60 and 30 kg / ha for direct seeding and nursery raising at same day in last week of June. As per spacing, thinning was done at 15 DAS to keep intra space 10 cm during both the years of study. For transplanting of seedlings in unpuddled culture, a basic ploughing followed by planking was done by rotavator after which water level maintained for the purpose. Cyhalofopbutyl was applied at 25 DAS / DAT, weeds were collected four times for count and dry weight (m^2) through 0.25 m^2 quadrate. Observations related to crops, yield attributes, yields and other parameters were recorded carefully to interpret interferences during both the years of experimentation.

RESULTS

The dominant weeds observed in the experimental field were *Echinochloa colonum* (L.) Link; *E. crusgalli* (L.) Beauv; *Cynodon dactylon* (L.) Pers; and *Paspalum distichum* L. in grasses; *Cyperus rotundus* L. and *C. iria* L. in sedges and *Trianthema monogyna* L. and *Commelina beghalensis* L. in broad-leaved group. These three weed groups constitute 25, 60 and 15 per cent of total weed population in experimental plots.

Results presented in Table 1 reveal that paddy transplanted under puddle condition produced significantly higher effective tillers per meter row length, more filled grains panicle^{-1} and longest panicles. However, among the unpuddled culture, transplanting of raised nursery in well ploughed field being irrigated for transplanting had proved its superiority in enhancing yield enhancing parameters than direct seeding. The highest mean grain yield (3.89 t / ha) was recorded under puddle transplanted method, followed by unpuddled transplanting (3.51 t / ha) during 2008 and 2009, respectively. On an average, puddle transplanting increased the grain yield by 84.6, 37.8 and 10.7 per cent respectively over direct seeding, drum seeding and transplanting under unpuddled situation.

CONCLUSION

On the basis of above findings, it may be concluded that higher grain yield of rice can be achieved under puddle transplanting method of paddy establishment coupled with the application of pretilachlor 750 g / ha applied at 48 hours of DAS / DAT combined with cyhalofopbutyl at 60 g / ha post emergence herbicide. As per the economic evaluations of both factors that the same culture of rice production is found more profitable to the rice growers under rainfed lowland rice situations in eastern Uttar Pradesh. The production of weed dry matter is inversely related with subsequent growth and yield of crop.

Treatment	Effective Tillers (running^{-1} m)	Filled grains (panicle^{-1})	Grain Yield (t / ha)	BCR
Planting Methods				
Direct seeded rice (DSR)	36.8	99.3	2.110	1.19
Direct drum seeded rice (DSR)	35.3	126.5	2.820	1.17
Unpuddled TPR	49.7	134.7	3.510	1.25
Transplanted rice (TPR)	52.9	159.7	3.890	1.42
LSD (P= 0.05)	2.79	12.6	2.18.3	-
Weed Control Measures				
Weed free	51.8	156.0	3.600	1.35
Weedy check	27.5	94.1	2.230	1.00
Mechanical weeding twice	36.0	118.1	2.650	1.09
Pretilachlor	43.0	130.2	3.010	1.32
Pretilachlor *fb* mech. weeding	48.9	137.4	3.340	1.33
Pretilachlor *fb* cyhalofopbutyl	51.0	147.4	3.430	1.40
LSD (P= 0.05)	2.72	6.53	0.20	-

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Effect of imazathapyr on blackgram and residual effect on wheat and mustard crops

Jaibir Tomar* and Sandeep Singh Tomar[2], Raghuvir Singh[2], Vivek[2]
J.V.C. Baraut,CCSU Meerut, Uttar Pradesh 250 611
[2]SardarVallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh 250 110
**Email: dr.jaibirtomar@yahoo.in*

Blackgram is one of the major *Kharif* pulse in westerm U.P. slow initial growth of Blackgram coupled with favorable conditions for weed multiplication. Weed are acute problem in rainy season as they compete for nutrient, moisture, light and space and ultimately affect the growth and the yield of crops. Among various reasons like hungry and discarded soils, lack of promising cultivars, improper fertilization, pest and disease, poor weed management is one of the most important yield limiting factors. This crop receives low priority as it is grown by low income farmers on marginal lands Heavy weed infestation is the dominant reason for such a low yield of black gram(Rao *et al*. 2010) In general, yield loss due to uncontrolled weed growth in black range from 27 to 100% (Singh and Singh 2010).

Field experiment was conducted at Crop Research Center, SardarVallabhbhai Patel University of Agriculture and Technology, Meerut U.P. during *Kharif* season of 2011 and 2012. The soil of the experimental field was sandy loam in texture, pH 7.9, low in available nitrogen, medium in phosphorus and potash. Evaluate the new formulation of early post emergence (EPOE) herbicide Imazethapyr on weed control in blackgram and their residual effect on succeeding wheat and mustard crops. Raised on two years field experiment, it was found that the application of Imazethapyr at 70 g / ha gave significantly lower total weed density and higher weed control efficiency. Application of new combination of velor (imazethapyr+pendimethalin) at 800 g / ha as pre emergence keep the weed density and dry weight below the economic threshold level and increased the growth and yield attributes significantly over control. After harvesting of the blackgram crop to know the residual effect of herbicides, succeeding wheat and mustard crops. Results revealed that germination on succeeding wheat and mustard recorded at 12 DAS was not significantly affected by residual effect of herbicide applied to blackgram. The plant population of wheat ranged from 91-98% and mustard from 84-90% under all the treatments. Yield of wheat and mustard showed no significant variation due to different dose of Imazethapyrcombination velor against most of the broad and narrow leaf weeds in blackgram. Yield of wheat mustard were not show any variation among the weed control treatment and there was no residual effect due to Imazethapyr and velor on the succeeding crops wheat and mustard

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Execution importance; herbicide application in soybean in raised bed system

Nikhil Kumar Singh, R.K. Jat, Jagmandeep Singh and V.K. Choubey

International Maize and Wheat Improvement Center, BISA, Jabalpur, Madhya Pradesh 482 005

Soybean has emerged as a potential crop for changing the economic position of the farmers in India particularly in Madhya Pradesh. The sowing time for soybean in rainy season is very short and farmers give first priority for sowing the crop rather than controlling the weeds. The poor weed management practices deprive the crop of its major requirement of nutrients, soil moisture, sunlight and space which results poor crop growth and yield. The weeds emerges simultaneously with the crop and compete with soybean causing loss in yield upto 35-55% depending upon the weed flora and density (Singh 2007). A rain in Jabalpur is much higher and it creates a problem for higher production in soybean. Manual weeding at right stage is difficult, time consuming and expensive due to intermittent rainfall during rainy season and scanty labour, therefore, farmers rarely adopt annual weeding for weed control. It is also very important to see the technology point of view for better execution. Under such situation, herbicides use with suitable dose remains the pertinent choice for controlling the weeds. Herbicides in isolation, however, are unable to do complete weed control because of their selective kill. So, integration of different herbicide may control the loss causes by weeds. Keeping the above fact into consideration, an experiment was conducted with an objective to identify the effect of raised bed establishment method and combination of chemical weed management methods for controlling weeds in soybean.

METHEDOLOGY

The experiment was conducted during rainy season of 2013 at Borlaug Institute for South Asia, Jabalpur, Madhya Pradesh, India to identify the effect of permanent raised bed and weed management method for managing weeds in soybean and also observe efficacy of imazethapyr over other herbicides and higher dose of imazethapyr. The experiment was laid out in randomized block design with 7 treatments replicated thrice. The soil of the experimental field was medium deep, with low in available nitrogen (210 kg/ha) medium in available phosphorus (39.4 kg/ha) and rich in available potash (313 kg/ha). The experimental plot size was 10.4 x 33 m. Soybean was sown by zero-till drill. The soil was neutral in reaction with pH 7.1. Seven different treatment were tried to evaluate over controlling weeds are as, imazethapyr (pursuit 10% SL) 750 ml/ha as post-emergence (POE) at 15 DAS, imazethapyr (pursuit 10% SL) 1000 ml/ha as POE at 15 DAS, imazethapyr + imazamox as POE at 15 DAS, fluazifop-P-Butyl 13.4% EC + chlorimuron-ethyl (Cloben) 25% WP 37.5 g/ha as POE, fenoxaprop-p-ethyl 9.3% EC 500 ml/ha + chlorimuron-ethyl (cloben) 25% WP 0.009 kg/ha as post-emergence at 15 DAS, weedy and weed free. Herbicides were applied with the help of a hand-operated knapsack sprayer fitted with flat-fan three boom nozzle and water as a carrier at 400 liters/ha. Data on weed density were subjected to square root transformation ($\sqrt{x+0.5}$) before statistical analysis to normalize their distribution. Data on dry weight of weeds were recorded by cutting weeds at ground level, washed with tap water, dried and then weighed.

RESULTS

All the weed control treatments significantly reduced the density, dry weight of weeds and increased the yield when compared with weedy check (Table 1). Among the herbicides, application of imazethapyr (recommended dose) significantly reduced the weed dry weight than the weedy check and other herbicides at 30 DAS. The higher dose of Imazethapyr and application of imazethapyr + imazamox

Table 1. Effect of herbicides on weed density, weed dry weight and grain yield

Treatment	Total weed density	Total weed dry weight (gm/m^2)	Grain yield (t/ha)
Pursuit alone (recommended dose)	8.18 (68.8)	24.79 (630)	3.63
Pursuit with high dose (1.25 lit/ha)	8.68 (78.7)	28.35 (804)	2.26
Imazethapyr + Imazamox	8.63 (76.7)	29.67 (888)	2.36
Fusilade + Chlorimuron	9.42 (89.2)	30.93 (995)	1.33
Whipsuper + Chlorimuron	8.96 (83.3)	33.05 (1115)	1.21
Weedy	10.44 (109.7)	41.09 (1736)	1.03
Weed free	-	-	3.85
LSD (P=0.05)	2.74	11.58	0.32

*Population and dry weight figures are transformed to "x+0.5 and actual figures are given in parentheses

(Odyssey) was effective for controlling the weeds but also give the toxic effect on the soybean resulted low grain yield. Imazethapyr recommended dose totally serve the purpose, controlling the weeds without affecting the grain yield. Results showed execution of any technology is very important if we not properly execute the same how we can determine the effect of treatment. Other herbicides only control single flush of weed pressure even in combination with chlorimuron. In Jabalpur weed pressure is very high and every 10 days you can get a new weed flush in rainy season. But, cannot conclude with one year of experiment; future research will need to conclude it.

CONCLUSION

In high rainfall area like Jabalpur must raise soybean crop on permanent raised beds to harvest good crop and effective herbicide application must be required.

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Chemical weed control in chrysanthemum

Madhu Bala, Pawan Kumar Sharma* and Tarundeep Kaur

Department of Floriculture and Landscaping, Punjab Agricultural University, Ludhiana, Punjab 141 004

**Email: pksharmapau62@pau.edu*

Chrysanthemum is a perennial plant, grown all over the world for its beautiful flowers. It is a short day plant, which makes vegetative growth only during rainy and post-rainy season. Therefore, it is infested with both *Kharif* and *Rabi* weeds. Its speedy growth is required for accumulation of sufficient dry matter so that it comes into flowering on commencement of short days. Therefore, control of weeds during crop season especially during initial stage of growth is of primary importance. With adoption of post emergence mechanical methods of weed control, weeds compete with crop for some time. Hence, methods which prevent germination of weed seeds and provide weed free environment during early period of crop growth are considered better. Therefore, an experiment on chemical weed control in *Chrysanthemuim morifolium* was conducted.

METHODOLOGY

Study was conducted during 2011-12 and 2012-13 in Department of Floriculture and Landscaping, Punjab agricultural University, Ludhiana on sandy loam soil . Terminal cuttings of chrysanthemum variety "*Reagan Emperor*" were planted in plug trays containing burnt rice husk as rooting media in the 2nd fortnight of June and the rooted cuttings were transferred to the field in the second fortnight of July each year. After transplanting four herbicides, *viz*. Butachlor (1.0 and 1.5 kg/ha), Pendimethalin (0.75 and 1.0 kg/ha), Fluchloralin (0.75 and 1.0 kg/ha) and Diuron (0.50 and 1.0 kg/ha) were applied as pre-emergence spray. An unweeded and a weed free control were also included in the treatments. Weed population and dry weight were recorded 25 days after transplanting the crop. Number and weight of flowers born by the crop were also recorded. Soil of the experimental field was sand loam in texture. Experiment had 3 replications.

RESULTS

Weed population and dry matter were reduced significantly by all weed control treatments over unweeded control. Lowest values were obtained with use of 1.0 kg /ha herbicide Pendimethalin. This treatment was significantly superior over all other herbicides. Application of this herbicide helped to produce flowers yield (number and weight) at par with weed free. Herbicide pendimethalin belongs to dinitroaniline group which is basically a germination inhibitor. It did not effect germination of the crop since rooted cuttings were planted. Use of other herbicides and Pendimethalin at the rate of 0.75 kg/ha, though reduced weed growth, but flower yield was observed to be sigificantly lower than weed-free control. Which may be due to less reduction in weed growth.

Table 1. Effect of herbicides on weed population and weed dry matter and number and flower yield of chrysanthemum (Pooled data of two years)

Treatment	Rate of application (kg/ha)	Weed population/ m^2	Weed dry matter g/m^2	Flowers/ plant (no.)	Flower yield /plant (g)
Butachlor	1.00	120.6	63.9	25.3	40.8
Butachlor	1.50	118.1	58.0	26.8	42.3
Pendimethalin	0.75	138.6	82.6	24.9	42.2
Pendimethalin	1.00	83.1	43.0	29.6	44.9
Fluchloralin	0.75	94.9	62.6	26.4	42.6
Fluchloralin	1.00	195.2	84.3	25.1	42.2
Diuron	0.50	132.1	64.0	22.9	41.8
Diuron	1.00	179.4	62.0	20.8	42.5
Weedy check	-	257.7	125.3	20.9	36.0
Weed-free	-	0.0	00.0	25.4	45.0
LSD(P=0.05)	-	1.6	1.1	3.6	1.8

CONCLUSION

Herbicide Pendimethalin as pre-emergence at the rate of 1.0 kg per hectare was found to be promosing herbicide for controlling weeds in chrysanthemum.

Impact of weed competition on crop growth and nitrogen harvesting of direct sown rice

B. Sreedevi, P. Krishna Murthy and S.P. Singh

Directorate of Rice Research, Rajendranagar, Hyderabad, Andhra Pradesh 500 030

**Email: sreedevi.palakolanu@gmail.com*

Direct sown rice is becoming popular,relatively cheaper, less labour and energy intensive under effective weed management practices. But weed control is most critical and difficult. Hand weeding and other mechanical methods being difficult and expensive, chemical weed control is the obvious alternative and most effective practice. Energetics approach in rice is comparatively new and research efforts are emphasized on determination of realistic relationship between energy inputs and crop productivity. Keeping this in view an experiment was conducted with the objectives of the Nitrogen harvesting of crop at critical growth stages (maximum tillering stage and panicle initiation stage), as influenced by weed competition.

METHODOLOGY

The field experiment was conducted during *Kharif* 2011and *Rabi* 2011-12seasons. The soil of the experimental site was clay in texture with pH 8.2. The experiment comprised of 10 combinations of herbicides, safeners/surfactants, *viz.* butachlor+safener 1 kg/ha, anilophos+ ethoxysulfuron two doses 0.312+0.012 and 0.375+0.015 kg/ha, fenoxaprop-p-ethyl two doses 0.056 and 0.075 kg/ha, butachlor+propanil three doses , almix+surfactant at two different times of application along with hand weeding and unweeded check. Rice cv. '*Krishnahamsa'* was sown in rows at 20 cm. spacing. Fertilizer dose of 100 kg N/ha, 50 kg P and 50 kg K/ha. Nitrogen was applied in two splits, half at the time of seeding rice along with P and K and the remaining N was applied at maximum tillering and panicle initiation stages. Herbicides were applied as per the treatment with knapsack sprayer fitted with flat-fan nozzle. The growth parameters and energy computations were done at critical growth stages namely, maximum tillering (MT) stage and panicle initiation (PI) stage. The nitrogen content in plants were estimated as per Jackson (1973).

RESULTS

Analysis of pooled data clearly shows that plant height of the crop significantly decreased in unweeded check at both 40 DAS and 70 DAS while it was significantly higher in two hand weeding treatment. At 40 DAS, treatments fenoxaprop-P-ethyl (lower dose), almix + surfactant both doses were found to be superior and at 70 DAS, anilophos + ethoxysulfuron, fenoxaprop-P-ethyl and butachlor + propanil were superior. Tiller no./m^2 was significantly low with non-weeded check where as higher number was observed with butachlor + propanil, two hand weeding treatment followed by butachlor+ safener treatment at 40 and 70 DAS respectively. Among the weed control treatments, butachlor + safener and butachlor + propanil were on par with each other**.**

Plant samples of crop were analyzed for Nitrogen (N) content, and uptake by crop was worked. At PI stage; butachlor + safener and butachlor + propanil were on par with hand weeding twice and superior over other treatments. The uptake of N was highly related to the dry matter produced.

CONCLUSION

Chemical weed control with butachlor combinations and anilophos+ ethoxysulfuron at right time and right dose are promising in direct seeded rice under puddled conditions with increased plant height, tiller number per square meter, dry matter production and made available more nutrients to rice crop at both MT and PI stages

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Integrated weed management in drum seeded rice

R. Naseeruddin*, D. Subramanyam, Y. Reddi Ramu and V. Sumathi

Department of Agronomy, S.V. Agricultural College, Tirupati, Andhra Pradsh 517 502

**Email: naseer116@gmail.com*

Rice (*Oryza sativa* L.) is an important food crop of India contributing 45% of the total food grain production. Severe weed infestation in drum seeded rice is the main constraint responsible for yield reduction up to 53% (Hussain *et al.* 2008) due to simultaneous germination of weeds and rice seeds. Pre-emergence application of herbicides alone cannot control the weeds in drum seeded rice throughout the crop growing period; there is a need to evaluate the post-emergence herbicides in drum seeded rice. Post-emergence application of azimsulfuron 30 g/ha was found superior in suppressing the annual sedges and broad-leaved weeds (Pratap Singh *et al.* 2009). In cognizance of the above, the present study was undertaken.

METHODOLOGY

A field investigation was carried out during *Kharif* 2012 at S.V. Agricultural College, Tirupati campus of Acharya N.G. Ranga Agricultural University, Andhra Pradesh to know the performance of pre- and post-emergence herbicides in drum seeded rice. The experimental field was sandy loam in texture with low in available nitrogen, phosphorus and organic carbon and medium in potassium. The field experiment was laid out in randomized block design with ten treatments with pre- and post-emergence herbicides including mechanical weeding with power weeder (Table 1). A sprouted seed of rice variety "*NLR-33358*" was sown with the help of drum seeder in the field with recommended packages of practices. A uniform fertilizer dose of 120-60-60 N, P_2O_5 and K_2O kg/ha was applied. Data on weed growth, yield performance and economics were recorded.

RESULTS

The predominant weed species observed in the experimental field were the sedges (71%), grasses (18.5%) and broad-leaved weeds (10.5%). Among the herbicidal treatments, pre-emergence application of oxadiargyl 75 g/ha followed by post-emergence application of azimsulfuron 30 g/ha very effective in controlling all categories of weeds with the higher weed control efficiency (Table 1) and it was comparable with pre-emergence application of oxadiargyl 75 g/ha followed by post-emergence application of bispyribac-Na 30 g/ha. The highest grain yield was recorded with pre-emergence application of oxadiargyl 75 g/ha followed by post-emergence application of azimsulfuron 30 g/ha, which was at par with hand weeding twice due to effective control of weeds, which lead to increased yield components and grain yield. These results are in conformity with those of Singh *et al.* (2010). The decrease in grain yield of drum seeded rice due to unchecked weed growth was 51% compared to the best weed management practice. The highest net returns and benefit-cost ratio were realized with pre-emergence application of oxadiargyl 75 g/ha followed by post-emergence application of azimsulfuron 30 g/ha due to increased grain and straw yield and reduced cost of weeding compared to the other weed management practices tried.

Table 1. Weed growth, yield and economics of drum seeded rice as influenced by weed management practices

Treatment	Dose (g/ha)	Time of application (DAS)	Weed density (no./m^2)	Weed dry weight (g/m^2)	WCE (%)	Grain yield (t/ha)	Straw yield (t /ha)	Net returns (x10^3 ` /ha)	B:C Ratio
Pretilachlor	500	7	8.9 (78)	7.5 (56)	75.0	3.81	5.50	39.97	2.50
Oxadiargyl	75	7	8.7 (75)	7.4 (54)	76.0	3.93	5.58	41.80	2.53
Pretilachlor *fb* power weeder	500	7+40	6.0 (36)	5.6 (30)	86.4	4.59	5.89	50.83	2.92
Oxadiargyl *fb* power weeder	75	7+40	5.9 (34)	5.5 (29)	86.8	4.60	5.94	52.27	2.91
Pretilachlor *fb* azimsulfuron	500+30	7+40	4.4 (18)	4.6 (20)	90.8	5.18	6.20	59.47	3.00
Oxadiargyl *fb* azimsulfuron	75+30	7+40	4.1 (16)	4.39 (18)	91.7	5.75	6.51	68.77	3.30
Pretilachlor *fb* bispyribac-Na	500+30	7+40	4.41 (19)	4.6 (20)	90.7	5.10	6.19	58.94	3.01
Oxadiargyl *fb* bispyribac-Na	75+30	7+40	4.1 (16)	4.4 (19)	91.6	5.20	6.21	60.42	3.08
HW twice	-	20+40	2.8 (7.3)	3.5 (12)	94.7	5.71	6.50	65.91	3.06
Unweeded check	-	-	16.5 (271)	15.0(225)	-	2.82	4.45	23.69	1.91
LSD (P=0.05)			0.20	0.16	0.7	0.14	0.09	2.90	0.04

Figures in parenthesis are original values. Weed Data were transformed to ($\sqrt{X+0.5}$).

CONCLUSION

It can be concluded that pre-emergence application of oxadiargyl 75 g/ha followed by post-emergence application of azimsulfuron 30 g/ha resulted in the broad spectrum weed control coupled with the highest grain yield and net returns in drum seeded rice.

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Response of *Kharif* groundnut to chemical and cultural weed management

Aniket Kalhapure*, Balasaheb Shete and Madhukar Dhonde
Seed Cell, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra 413722
**Email: aniketmpkv@gmail.com*

The major factor responsible for minimizing *Kharif* groundnut (*Arachis hypogaea*) production is severe weed infestation which compete with the main crop for resources *viz.* space, nutrients, moisture, sunlight etc. Weeding and hoeing are common cultural and manual weed management methods for groundnut; but considering the scarcity of labours, these methods are very costly and tedious. On the other hand, use of herbicides is also limited due to their selectivity and it cannot control all weeds in groundnut. Hence the agronomic investigation was conducted to find out response of *Kharif* groundnut in the view of weed control, crop growth, yield and economics to different chemical and cultural weed management methods and their combinations.

METHODOLOGY

The experiment was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri during the *Kharif* season of 2011 in randomized block design with 12 treatments replicated thrice. The treatments consist of combination of hand weeding with pre plant incorporation of 1.5 kg/ha fluchloralin, pre emergence application of 1.5 kg/ha pendimethalin and post emergence application of 0.150 kg/ha imazethapyr. Groundnut variety '*TAG- 24'* was sown in first fortnight of July with plant spacing of 45 x 15 cm^2 on flat beds. All the cultivation practices were followed in the same manner for groundnut except weed control. Fluchloralin was applied one day before sowing as pre plant incorporation in soil and pendimethalin was applied one day after sowing as pre emergence, whereas imazethapyr was applied 20 days after sowing as post emergence. Weed free check was achieved by two hand weedings at 20 and 40 DAS and manual uprooting of weeds at 60 DAS.

RESULTS

Highest weed control efficiency percentage was observed in pre emergence application of 1.5 kg/ha pendimethalin followed by post emergence 0.150 kg/ha imazethapyr and one hand weeding at 40 DAS. This might be due to pre emergence application of pendimethalin prevents emergence of monocot and grassy weeds, while imazethapyr is responsible for inhibition of acetolactate synthase (ALS) in broad leaf weeds which caused destruction of these weeds at 3-4 leaf stage. Remaining monocot weeds were controlled by hand weeding at 40 DAS. Higher weed control. integration of hand weeding with pre and post emergence herbicides.

Table 1. Effect of different weed management practices on various parameters in groundnut

Treatment	Weed Control Efficiency (%)	Plant height at 90 DAS (cm)	Plant dry matter at 90 DAS (g)	Pod yield t/ha	Net return (x10³₹/ha)	B:C ratio
Weed free check	100.00	29.35	59.01	2.47	60.52	2.23
Pendimethalin+ imazethapyr+ 1HW at 40 DAS	90.66	26.70	52.14	2.35	61.95	2.44
Fluchloralin+ imazethapyr+ 1HW at 40 DAS	88.53	25.57	49.54	2.03	47.34	2.10
Imazethapyr+ 1HW at 40 DAS	88.14	25.38	48.75	1.80	39.15	1.95
Pendimethalin+ 1HW at 20 DAS	83.19	25.10	46.67	1.59	30.08	1.73
Fluchloralin+ 1HW at 20 DAS	79.34	24.40	48.25	1.53	27.13	1.66
Fluchloralin+ imazethapyr	75.20	22.45	44.27	1.39	22.84	1.59
Pendimethalin+ imazethapyr	74.41	22.64	40.54	1.43	24.98	1.64
Imazethapyr	69.86	22.21	46.48	1.13	12.52	1.33
Pendimethalin	68.48	21.78	39.78	0.95	4.95	1.14
Fluchloralin	66.19	20.22	34.81	1.04	9.26	1.26
Control	0	16.97	29.86	0.71	-2.16	0.95
LSD (P= 0.05)	--	2.07	4.81	0.12	2.92	--

Combined application pendimethalin and imazethapyr with one hand weeding was also recorded taller plants and higher dry matter and pod yield. This might be due to minimizing the competition of weeds with main crop for resources with effective weed control. Singh and Giri (2001) has been also concluded that, proper weed control was responsible for increase in plant height and dry matter production in groundnut which facilitates better peg initiation and development resulting in higher pod yield. Higher net return (₹ 61,952) and B:C ratio (2.44) were recorded in combined application of pendimethalin, imazethapyr and one hand weeding at proper stages of crop growth due to the reduction of cost on human labours by using herbicides for effective control of weeds.

CONCLUSION

Considering the present scarcity and high cost of labours, *Kharif* groundnut gives best response in terms of weed control, crop growth, pod yield, net return and B:C ratio to pre emergence application of 1.5 kg/ha pendimethalin followed by post emergence application of 0.150 kg/ha imazethapyr and one hand weeding at 40 DAS.

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Efficacy of weed management practices on the performance of organic finger millet

Basavaraj Patil*[1], V.C. Reddy[2], K.N. Kalyanamurthy[3] and T.V. Ramachandra Prasad[4]

[1,3]UAS, GKVK, Bangalore; [2]MRS, Hebbal, Bangalore; [4]AICRP on Weed Control, MRS, Hebbal, Bangalore

**Email: bspatil4504@gmail.com*

Organic farming is gaining momentum in India owing to the concerns expressed on the safety of environment, soil, water and food chain. A concern about the potential increase in weed population due to non use of herbicides is rated as serious problem in organic farming (Bond and Grundy, 2001). Finger millet needs a weed free period of first 30-40 days after sowing to overcome weed competition. Since its higher production under organic farming is achieved in previous studies through different organic nutrient sources and weed management is stated as major problem in organic cultivation. Hence, the present study was initiated to find out effective and economic weed management practices in organic finger millet.

METHODOLOGY

The field experiment was conducted during *Kharif* 2012 at the Main Research Station, Hebbal, Bengaluru. It was laid out in randomized complete block design with three replications. The soil of the experimental field was sandy loam. The experiment comprised of twelve treatments: T_1 - Passing wheel hoe at 20, 30 and 40 DAP; T_2 - Inter cultivation twice at 20 and 35 DAP; Stale seedbed technique; T_3 - T_1 + one hand weeding at 45 DAP; T_4 - T_2 + one hand weeding at 45 DAP; T_5 - stale seedbed technique + inter cultivation twice at 20 and 35 DAP; T_6 - organic mulching 10 t/ha after transplanting; T_7 - growing cover crops (horse gram/cowpea) and mulching at 55 DAP; T_8 - directed spray of *Eucalyptus* leaf extract on weeds; T_9 - directed spray of cattle urine on weeds; T_{10}- hand weeding twice at 20 and 30 DAP; T_{11} - Unweeded check. Seedlings were raised in nursery bed prepared one month before transplanting of the crop. Neem cake was applied equivalent to 50 kg N/ha at the time of transplanting. Cattle urine was top dressed in three splits at 15, 30 and 40 DAP to meet remaining 50 kg N/ha. Stale seedbed treatment was initiated 15 days before transplanting of the crop. One irrigation was given to stale seedbed plots and weeds were allowed to germinate. The germinated weeds were removed by passing cultivator cris-cross one day before transplanting the crop. Organic mulching was done with crop residues (paddy straw) and dried grasses one week after transplanting. Seed mixture of cowpea and horse gram was sown in between two rows of finger millet. These cover crops were mulched between rows at 55 DAP.

RESULTS

Total weed density was significantly lower in hand weeding twice at 20 and 30 DAP (26.32/m^2) treatment and was on par with stale seed bed technique + inter cultivation twice at 20 and 35 DAP (29.67/m^2) and T_1 + one hand weeding (41.26/m^2). Whereas, stale seedbed alone and spray of cattle urine on weeds were not significantly control the total weed density, which were on par with unweeded control (279.68/m^2). Crop yield and yield parameters were significantly higher in hand weeding twice at 20 and 30 DAP like grain yield (5.4 t/ha), straw yield (7.2 t/ha), as compared to unweeded control. However, they were on par with stale seedbed technique + inter cultivation twice and also with passing wheel hoe at 20, 30 and 45 DAP + one hand weeding. The results are in conformity with the findings of Ramamoorthy *et al.* (2009).

Table 1. Weed density, weed dry weight, yield and economics of finger millet as influenced by weed management practices

Treatment	Weed density (no./m^2)	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (x10^3₹/ha)	Gross return (x10^3₹/ha)	B:C
T_1	1.7 (50.2)	4.0	6.5	35.76	71.28	1.99
T_2	1.9 (81.0)	3.9	6.3	33.72	68.51	2.03
T_3	2.3 (177.5)	3.3	4.9	32.76	58.31	1.78
T_4	1.6 (41.26)	5.1	7.1	36.96	87.80	2.38
T_5	1.7 (47.3)	4.2	6.2	36.36	72.63	2.00
T_6	1.5 (29.7)	5.3	7.5	35.46	91.78	2.59
T_7	2.1 (124.0)	3.7	6.3	33.66	66.12	1.96
T_8	1.9 (76.1)	3.2	6.2	32.34	57.39	1.77
T_9	2.2 (165.6)	2.9	5.2	31.80	51.72	1.63
T_{10}	2.3 (185.8)	3.3	5.6	31.68	57.93	1.83
T_{11}	1.5 (26.3)	5.4	7.2	36.06	92.70	2.57
T_{12}	2.5 (279.7)	2.7	4.5	31.26	47.70	1.53
LSD(P=0.05)	0.20	0.94	0.64	NA	NA	NA

Data in parentheses are original values; data transformed to log(x+2) transformation ; NA – Not analyzed statistically

CONCLUSION

Hand weeding twice at 20 and 30 DAP is the best efficient method for the weed control. Since, the labour availability is a problem besides high cost involved in the hand weeding, stale seed bed technique in combination with inter cultivation twice at 20 and 35 DAP or passing wheel hoe at 20, 30 and 40 DAP with one hand weeding would be a viable alternative for weed management in organic finger millet production.

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Weed control efficiency of non chemical weed management practices in transplanted organic finger millet

Basavaraj*[1] Patil, V.C. Reddy[2], K.N. Kalyanamurthy[3], R. Devendra[4] and B.C. Shankaralingappa[5]

[1,3,5]Department of Agronomy, UAS, GKVK, Bangalore; [2]Department of Agronomy, MRS, Hebbal, Bangalore; [4]AICRP on Weed Control, MRS, Hebbal, Bangalore

**Email:bspatil4504@gmail.com*

Cultivating crops organically, and at the same time maintaining higher production levels is a big challenge. Finger millet is one of the major staple food of farming communities of southern Karnataka. The crop needs a weed free period of first 30-40 days after sowing to overcome weed competition (Channa Naik *et al.,* 2000). Since its higher production under organic farming is achieved through different organic nutrient sources and weed management is stated as major problem in organic cultivation. Non-chemical weed control and high labour requirement for the hand weeding are considered as the major constraints for the conversion of fields to organic farming (Verieijken and Kroff, 1996). Hence, the present study was initiated to find out effective weed management practices in organic finger millet.

METHODOLOGY

The field experiment was conducted during *Kharif* 2012 at the Main Research Station, Hebbal, Bengaluru. It was laid out in randomized complete block design with thrice replicated twelve treatments: T_1 - passing wheel hoe at 20, 30 and 40 DAP; T_2 - inter cultivation twice at 20 and 35 DAP; stale seedbed technique; T_3 - T_1 + one hand weeding at 45 DAP; T_4 - T_2 + one hand weeding at 45 DAP; T_5 - stale seed bed technique + inter cultivation twice at 20 and 35 DAP; T_6 - organic mulching 10 t/ha after transplanting; T_7 - growing cover crops (horse gram/cowpea) and mulching at 55 DAP; T_8 - directed spray of *Eucalyptus* leaf extract on weeds; T_9 - directed spray of cattle urine on weeds; T_{10} - hand weeding twice at 20 and 30 DAP; T_{11} - unweeded check. Seedlings were raised in nursery bed prepared one month before transplanting of the crop. Neem cake was applied equivalent to 50 kg N/ha at the time of transplanting. Cattle urine was top dressed in three splits at 15, 30 and 40 DAP to meet remaining 50 kg N/ha. Stale seed bed treatment was initiated 15 days before transplanting of the crop. One irrigation was given to stale seedbed plots and weeds were allowed to germinate. The germinated weeds were removed by passing cultivator cris-cross one day before transplanting of the crop. Organic mulching was done with crop residues (paddy straw) and dried grasses 10 t/ha one week after transplanting. Seed mixture of cowpea and horse gram was sown in between two rows of finger millet. These cover crops were mulched between rows at 55 DAP.

RESULTS

The WCE was higher with hand weeding twice at different growth stage of the crop (92.8, 93.2 and 91.0% at 30, 60 DAP and at harvest respectively) owing to the fact that it produced lesser weed dry weight. WCE of stale seedbed technique combined with inter cultivation twice (91.3, 91.6 and 90.1% at 30, 60 DAP and at harvest respectively) and passing wheel hoe at 20, 30 and 45 DAP with one hand weeding (68.5, 88.7 and 68.3% at 30, 60 DAP and at harvest respectively,). Grain yield of finger millet was significantly higher in hand weeding twice at 20 and 30 DAP (5.4 t/ha) as compared to unweeded control. However, it was on par with stale seedbed technique + inter cultivation twice and also with passing wheel hoe at 20, 30 and 45 DAP + one hand weeding (5.3 t/ha). Whereas, lower grain yield (2.7 t/ha) was obtained in unweeded control. This reduction in yield might be due to highest competition with the finger millet throughout the crop growth period.

Table 1. Weed control efficiency at different growth stages, yield and harvest index and of finger millet as influenced by weed management practices.

Treatment	WCE % at 30 DAP	WCE % at 60 DAP	WCE % at harvest	Grain yield (kg/ha)	Straw yield (t/ha)	Harvest index
T_1	33.0	58.2	57.5	4.0	6.5	0.38
T_2	18.6	41.3	47.0	3.9	6.3	0.38
T_3	26.6	15.8	14.4	3.3	4.9	0.41
T_4	68.5	88.7	68.3	5.1	7.1	0.42
T_5	31.5	54.9	61.3	4.2	6.2	0.41
T_6	91.3	91.6	90.1	5.3	7.5	0.42
T_7	84.4	45.2	44.4	3.7	6.3	0.37
T_8	8.5	43.7	57.8	3.2	6.2	0.34
T_9	12.5	14.5	18.1	2.9	5.2	0.36
T_{10}	18.5	28.8	21.8	3.3	5.6	0.37
T_{11}	92.8	93.2	91.0	5.4	7.2	0.43
T_{12}	0.0	0.0	0.0	2.7	4.5	0.38
LSD(P=0.05)	NA	NA	NA	0.94	0.64	NS

NA – Not analyzed statistically NS – non significant

CONCLUSION

Since, the labour availability is a problem besides high cost involved in the hand weeding, stale seedbed technique in combination with inter cultivation twice at 20 and 35 DAP or passing wheel hoe at 20, 30 and 40 DAP with one hand weeding would be a viable alternative for weed management in organic finger millet production.

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Effect of tillage and weed management in maize-sunflower cropping system

N. Sakthivel*, M. Revathi and S. Bhuvana Devi
AICRP on Weed Control, Department of Agronomy, TANU, Coimbatore, Tamil Nadu 641 003
**Email: sakthi_agr@yahoo.com*

Intensive tillage systems result in increased soil compaction and decreased soil organic matter and biodiversity. Sub-soil compaction due to repeated tillage leads to reduced water and nutrient use efficiency (Ishaq *et al*. 2001). Reduced tillage is gaining more attention in recent years with increasing concerns about natural resource degradation; however weed control can become a limiting factor in crop production when tillage is decreased. The optimum tillage methods combined with effective weed control practice is to be identified for efficient weed management. Hence an attempt has been made to study weed population dynamics in maize – sunflower cropping system as influenced by tillage and weed management methods under irrigated condition.

METHODOLOGY

Field experiments were conducted during *Rabi* 2012-13 and *Kharif* 2013 at the Eastern Block Farm, Tamil Nadu Agricultural University, Coimbatore. The soil of the experimental field is sandy loam with slight alkaline reaction (pH 8.52), low in organic carbon (0.31%), low in available N and medium in available P and K. The experiment was laid out in split plot design and replicated thrice. The main plot treatments consisted of two tillage methods split as four treatments, *viz.* zero tillage, zero tillage, conventional tillage and conventional tillage for maize; and zero tillage, conventional tillage, zero tillage and conventional tillage for sunflower and sub plot treatments composed of three weed management practices, *viz.* hand weeding on 25 and 45 days after sowing (DAS) for both crops, Pre emergence (PE) atrazine 0.5 kg/ha + hand weeding on 45 DAS for maize, PE pendimethalin 1.0 kg/ha + hand weeding on 45 DAS for sunflower and un-weeded control. Weed control efficiency was worked out from weed dry weight. Grains and seeds from each net plot were cleaned, sun dried and expressed in kg/ha.

RESULTS

Major weeds of the experimental fields were *Trianthema portulacastrum, Digera arvensis, Cleome gynandra, Parthenium hysterophorus* and *Datura metal, Dactyloctenium aegyptium, Echinochloa colonum, Setaria verticillata* and *Dinebra retroflexa. Cyperus rotundus.* Among tillage methods, significantly lower total weed density and lower weed dry weight were recorded in conventional tillage - conventional tillage (CT-CT) and this was closely followed by conventional tillage - zero tillage (CT-ZT) in both the crops at 60 DAS. Among weed management practices, significantly lower total weed density and dry weight were recorded in atrazine PE 0.5 kg/ha + hand weeding on 45 DAS in maize and pendimethalin PE 1.0 kg/ha + hand weeding on 45 DAS in sunflower and it was followed by hand weeding twice (HWT) on 25 and 45 DAS in both the crops at 60 DAS.

In maize, higher weed control efficiency (76.25%) and grain yield (5.03 t/ha) were recorded in conventional tillage system. Among weed management practices, higher weed control efficiency (64.41%) and higher grain yield of maize (5.29 t/ha) was comparable with hand weeding twice (Table 1)

In sunflower, conventional tillage method recorded significantly higher weed control efficiency (74.34%) grain yield of 2150 kg/ha and PE application of pendimethalin 1.0 kg/ha + HW on 45 DAS recorded seed yield of 1995 kg/ha which was comparable with HWT (1854 kg/ha) (Table 1).

Table 1. Effect of tillage and weed management practices on weed control and yield of maize and sunflower

Treatment	Weed density (no./m²)	Weed dry weight (g/ m²)	WCE (%)	Yield (t/ha)
Maize				
T_1 (ZT-ZT)	5.7 (32.56)	4.2 (16.0)	68.4	4.27
T_2 (ZT-CT)	5.0 (25.33)	4.9 (22.0	56.5	4.06
T_3 (CT-ZT)	5.3 (29.07)	4.7 (19.9)	60.8	4.75
T_4 (CT-CT)	4.2 (18.0)	3.7 (12.0)	76.3	5.04
LSD (P=0.05)	0.4	0.3	-	0.54
W_1 (HWT)	5.0 (25.0)	5.06 (23.6)	53.3	5.05
W_2 (Herbicide)	4.3 (19.0)	4.5 (18.5)	64.4	5.30
W_3 (UWC)	5.9 (34.7)	7.3 (50.6)	-	3.02
LSD (P=0.05)	0.3	0.4	-	0.52
Sunflower				
T_1 (ZT-ZT)	7.4 (60.0)	5.8 (31.3)	46.0	1.64
T_2 (ZT-CT)	6.3 (40.3)	4.5 (18.6)	67.9	1.95
T_3 (CT-ZT)	6.9 (49.2)	4.77 (20.8)	64.1	1.73
T_4 (CT-CT)	5.3 (28.8)	4.1 (14.85)	74.3	2.15
LSD (P=0.05)	0. 6	0.4	-	0.21
W_1 (HWT)	6.6 (44.1)	4.3 (16.9)	70.8	1.85
W_2 (Herbicide)	4. 9 (24.1)	3.8 (12.5)	78.4	2.00
W_3 (UWC)	8.0 (65.5)	7.7 (57.9)	-	0.99
LSD (P=0.05)	0.9	0.4	-	0.18

Figures in parenthesis are original values. Data transformed to $\sqrt{(X+2)}$ transformation.

CONCLUSION

Conventional tillage with pre-emergence application of atrazine 0.5 kg/ha + hand weeding on 45 DAS for maize. Similarly, conventional tillage with pre emergence application of pendimethalin 1.0 kg/ha on 45 DAS for sunflower recorded higher yield which was comparable with hand weeding twice.

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Influence of tillage and integrated nitrogen supply on weed flora and yield of pigeonpea

Vijaymahantesh*, H.V. Nanjappa, B.K. Ramachandrappa and M.T. Sanjay
University of Horticultural Sciences, Udyanagiri, Bagalkot-587 103
**Email: vijay3526@yahoo.co.in*

Tillage is one of the most important and essential field operations in crop production. Tillage, among various crop production factors contributes 20 per cent of crop production cost (Lal 1997). Therefore, integrated use of both chemical fertilizers and organic manures is needed to check the improvement of soil health and enhance the yield levels. The present investigation was therefore undertaken with a view to find out the effect of tillage and integrated nutrient management on growth and yield of pigeonpea

METHODOLOGY

The experiment was conducted during *Kharif* 2010 at DLAP, UAS, GKVK, Bengaluru. The treatments comprised of combination of 3 tillage practices {Conventional Tillage (CT)-3 ploughings + 3 inter cultivations, Reduced Tillage (RT)-2 ploughings + 2 inter cultivations and Minimum Tillage (MT)-1 ploughing + 1 inter cultivation} and 3 nutrient management practices {100% N through urea, 100% N through organic source (50% N through FYM+50% N through *Glyricidia*) and Integrated supply of N (50% N through urea+ 25% N through FYM+ 25% N through *Glyricidia*)} carried out in split plot design with three replications. The pigeonpea variety '*TTB-7*' was sown on 21st May 2010. The experimental plots were ploughed by a bullock pair.

RESULTS

The leaf area differed significantly due to various treatments. Among different tillage practices, CT recorded significantly higher leaf area (1705.89 cm^2) compared to RT (976.62 cm^2) and lowest plant height was observed in MT (556.56 cm^2). Among nutrient management practices 100% N through organic source recorded significantly higher plant height (183.44 cm) and leaf area per plant (1416.5 cm^2) at harvest over other nutrient management practices. This was attributed to continuous supply of nutrients to the crop throughout its life cycle. Similar result was obtained by Sheshadri reddy (2003).

Higher pigeonpea seed yield (1.02 t/ha) was recorded in CT compared to RT (0.81 kg/ha). However lowest yield was noticed in MT (0.64 t/ha). Similar trend was noticed with number of pods per plant. Because CT has created better seed bed, *viz.* better physical environment in terms of lower bulk density, penetration resistance and also due to better weed control in turn there was an enhanced growth and productivity of pigeonpea.

Table 1. Effect of tillage and integrated nutrient management practices on weed density growth and yield of pigeonpea

Treatment	Weed Density (no./m^2)	Leaf area (cm^2) per plant at harvest	Number of pods per plant	Seed yield (t/ha)	B:C ratio
Tillage practices (M)					
M_1:3Ploughings + 3 intercultivations	1.62 (39.87)	1705.89	101.89	1.02	2.96
M_2:2 Ploughings+ 2 intercultivations	1.76 (56.29)	976.62	84.39	0.80	2.51
M_3:1 Ploughing+ 1 intercultivation	1.92 (80.88)	556.56	65.56	0.64	2.16
LSD (0.05)	0.10	376.94	7.44	1.48	
Nutrient management practices(F)					
F_1:50% N through FYM+ 50 % N through glyricidia	1.78 (61.73)	1416.5	91.45	1.19	3.47
F_2:25% N through FYM+ 25 % N through glyricidia+ 50 % N through Urea	1.76 (58.91)	1034.5	83.45	0.78	2.47
F_3: 100 % N through urea	1.75 (56.48)	788.07	76.93	0.49	1.69
LSD (0.05)	NS	244.18	6.43	1.08	

* Figures in parenthesis indicate original values, NS- Non significant, Data transformed by using log $\sqrt{(X+2)}$ transformations

CONCLUSION

From the above study it can be inferred that among tillage practices, Conventional tillage found to be better in reducing weeds and also increases yield. Among nutrient management practices 100 per cent N supplied through organic sources found to be better in getting higher yield and monetary benefit.

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Influence of integrated weed management practices on soil microflora and grain yield in black gram

Kavita D. Rajput, A.S. Kamble*, R.K. Sonawane and V.M. Bhale

Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola-444 104 (MS), India.
**Email: ashitoshagronomist@gmail.com*

Black gram (*Phaseolus mungo* L.) is one of the important pulse crop grown in the rainfed farming system throughout India. It is grown over an area of 31.69, 4.90 and 1.21 lakh ha with a production of 13.26, 2.00 and 0.66 lakh tonnes annually and average productivity of 0.41, 0.40 and 0.56 t/ha in India, Maharashtra and Vidarbha region respectively (Anonymous, 2007). During *Kharif* at initial stage growth and the extent of damage due to weeds is high as compared to other season resulting in yield loss. To overcome this problem, an effective method which is less costly and environmentally safe in comparison to costly hand weeding method was attempted.

METHODOLOGY

Experiment was carried out on clay loam and slightly alkaline soil with low in nitrogen, medium in organic carbon and phosphorus and high in potassium during *kharif* season of 2010-11 at Agronomy Farm, Department of Agronomy, Dr. PDKV, Akola. Thirteen treatments consisting different cultural and herbicidal combinations replicated thrice in randomized block design. Black gram (var. TAU-1) was sown with 30 x 10 cm spacing and fertilizer was applied 20:40:00 NPK kg/ha through urea and diammonium phosphate. The enumeration of the microbial population was done on agar plates containing appropriate media as described by Dhingra and Sinclair (1993).

RESULTS

Before spraying of herbicide treatments difference for microbial count (bacterial, fungal and actinomycetes) was non-significant. But after spraying of herbicide, the bacterial count was reduces in all herbicidal treatments in descending order of T_{11}, T_{12}, T_9, T_7, T_{13}, T_{10}, T_8, T_5 and T_6 over all cultural methods of weed control treatments. Similar trend was observed in case of fungal and actinomycetes count. Bacterial count was more than actinomycetes and fungal count which showed that herbicide had no toxic effect on total bacterial count in rhizospheric soil and microorganisms are able to degrade some herbicides and utilize them as a source of biogenic elements. As reported by Barman (2008). In respect of grain yield, pre-emergence application of pendimethalin 1500 PE g/ha and Fenoxyprop-p-ethyl 125 g/ha POE gave higher yield as compared to cultural methods except weedy free treatment which showed highest microbial count over all the treatments.

Table 1. Microbial count before and after spraying of herbicide and yield of black gram as influenced by different weed control treatments.

Treatment	Bacterial count (x 10^7 cfu/g soil)		Fungal count (x 10^4 cfu/g soil)		Actinomycetes count (x 10^6 cfu/g soil)		Grain Yield (t/ha)
	Before spraying	After spraying	Before spraying	After spraying	Before spraying	After spraying	
T_1 - Weed free	26.50	-	20.30	-	22.60	-	1.26
T_2 - Weedy check	26.90	-	20.60	-	23.98	-	0.51
T_3 - 2 Hand weeding (15 *fb* 30 DAS)	26.44	-	20.20	-	23.50	-	0.93
T_4 - 2 Hoeing (10 *fb* 20 DAS)	25.95	-	19.80	-	22.10	-	0.68
T_5 - Imazethapyr 50 g/ha PE (at sowing)	26.33	18.00	19.98	12.35	23.35	18.30	0.61
T_6 - Imazethapyr 75 g/ha PE (at sowing)	25.11	17.10	19.50	10.84	22.30	16.10	0.82
T_7 - Pendimethalin 1000 g ha^{-1} PE (at sowing)	26.00	21.63	20.00	15.36	23.31	20.40	0.99
T_8 - Pendimethalin 1500 g/ha PE (at sowing)	26.86	19.52	20.50	13.11	23.80	19.33	1.00
T_9 - Fenoxyprop-p-ethyl 100 g/ha POE (15 DAS)	26.35	22.73	20.10	17.20	23.40	20.92	0.88
T_{10} - Fenoxyprop-p-ethyl 125 g/ha POE (15 DAS)	25.30	20.16	19.40	16.00	23.11	20.60	0.98
T_{11} - Quizalofop-p-ethyl 50 g ha POE (15 DAS)	26.10	23.54	20.05	17.80	22.80	21.20	0.77
T_{12} – Quizalofop-p-ethyl 75 g/ha POE (15 DAS)	25.15	22.99	19.20	16.99	22.00	20.98	0.85
T_{13} - Imazethapyr 50 g/ha PE *fb* POE quizalofop-p-ethyl 50 g/ha (at sowing *fb* 15 DAS)	26.20	21.16	20.00	15.60	22.98	19.84	0.82
LSD (P=0.05)	-	3.59	-	2.44	-	2.86	0.25

CONCLUSION

Taking account the black gram seed yield and soil health, combined chemical methods can replace twice hand weeding or hoeing. However in spite of 22.18% reduction in yield treatment Fenoxyprop-p-ethyl @ 125 g/ha POE was superior over hand weeding or hoeing.

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Integrated weed management in rice under modified system rice intensification (SRI) method

P.V. Mahatale* and N.K. Patke
Krishi Vigyan Kendra, Sindewahi, Dist. Chandrapur, Dr. Panjabrao Deshmukh Krishi Vidyapeeth Akola (M.S)
**Email : mahatale1978@rediffmail.com*

Maharashtra is one of the important rice growing state in the country. It has share of 3.30% (25.90 t) annual production and 3.45% (14.56 lakh ha) in area under rice cultivation (Anonymous 2012). While in Vidarbha it is grown on area of 6.47 lakh ha with an average productivity of 1234 kg /ha. Integrated weed management practices need to increase productivity of paddy in Vidarbha region., hence the present investigation was undertaken.

METHODOLOGY

The experiment was conducted in RBD design with eight treatments were T1 : Un weeded check T2 : two hand weeding at 20 and 40 DAT T3 : butachlore 3.75 kg / ha (upto 5 DAT) T4 : Cono weeder at 20 and 40 DAT (mechanical method) T5 : butachlore + one hand weeding at 40 DAT T6 : butachlore + cono weeder at 30 DAT T7 : butachlore + cono weeder at 20 DAT +One hand weeding at 40 DAT T8 : touchigurma at 20 DAT and 40 DAT replicated thrice. The gross and net plot size were 5.40 X 5.0 m^2 and 5.40 X 5.0 m^2 respectively. The crop variety PKV HMT was sown at 25 x 25 cm with 15 days old paddy seedling used for transplanting (modified seedling age in SRI). The RDF 100:50:50 NPK kg / ha was used. The 50 per cent nitrogen and entire P_2O_5 and K_2O were applied as basal dose and remaining dose of nitrogen was given in two equal splits that at tillering (30DAT) and internode elongation stage (60 DAT). Urea (46%), SSP (16% P_2O_5) and muriate of potash (60 % K_2O) respectively. The weedicide Butachlore 3.75 kg / ha, mechanical Cono Weeder and Touchigurma used, respectively.

Table 1. Pooled data of grain yield, straw yield and weed index influenced by different treatments during 2009-10 to 2011-12

Treatment	Grain yield (t / ha)	Straw yield (t / ha)	Weed Index (%)
T1 : Un weeded check	2.03	2.83	55.7
T2 :Two hand weeding at 20 and 40 DAT	4.35	4.48	5.05
T3 : Butachlore 3.75 kg / ha (upto 5DAT)	3.97	4.25	13.4
T4 : Cono weeder at 20 and 40 DAT (mechanical method)	3.89	3.93	15.1
T5 : Butachlore + one hand weeding at 40 DAT	4.22	4.43	7.90
T6 : Butachlore + cono weeder at 30 DAT	4.10	4.35	10.4
T7 : Butachlore + cono weeder at 20 DAT +one hand weeding at 40 DAT	4.59	4.77	0.0
T8 : Touchigurma at 20 DAT and 40 DAT	3.67	3.71	19.8
LSD (P=0.05)	5.53	0.55	

RESULTS

The pooled grain yield, straw yield and economics were significantly influenced by different treatments. Pooled data of three year concluded that treatment (T_2) *i.e* butachlore + cono weeder at 20 DAT + one hand weeding at 40 DAT recorded superior higher grain yield (4.59 t / ha) over remaining treatments and at par with treatments (T_2) *i.e* Two Hand Weeding at 20 and 40 DAT , (T_5) butachlore + One hand weeding at 40 DAT and (T_6) *i.e.* butachlore + cono weeder at 20 DAT. However higher GMR, NMR and B:C ratio under treatment T_7(₹ 59670 / ha) (₹35216 / ha) and (2.45) *i.e* butachlore + cono weeder at 20 DAT + one hand weeding at 40 DAT than other treatments.

CONCLUSION

It was concluded that integrated weed management i.e butachlore + cono weeder at 20 DAT + one hand weeding at 40 DAT was most effective for controlling weeds, improving grain yield and profitablility for Vidarbha region.

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Integrated weed management practices in sugarcane

Amit kumar patel and Damini Thawait
IGKV, Raipur, Chhattisgarh 495 001
Email: amitpatel5595@gmail.com

Weed management must aim at reducing the weed population to a level at which weedsoccurrence has no effect on farmers economic and ecological interests. By using different appropriate management practices against weeds, farmers have more options for controlling weeds, thereby reducing the possibility of escapes and weed adaptation to any single weed management tactic. IWM is a science-based decision-making process that coordinates the use of environmental information, weed biology and ecology, and all available technologies to control weeds by the most economical means, while posing the least possible risk to people and the environment (Sanyal, 2008).

METHODOLOGY

Follow the preventive measures for minimizing introduction and further spread of weeds.

Destroy the perennial weeds by digging such patches of weeds, collection and destruction of underground parts of weeds or by using translocated herbicides like Glyphosate.

Land preparation at optimum soil moisture level: After first deep ploughing expose the fields to the heat of the sun for two weeks or more periods if possible for destroying perennial weeds. Carry out ploughing at optimum moisture level for avoiding formation of big clods, proper pulverization of soil and exposing under ground parts of weeds to heat of the sun. Collection of weeds and vegetative parts and their destruction is necessary.

Maintain optimum plant population by using goof quality of seed and proper method of planting.

Follow the rotation of crops like cotton, soyabean, green gram, cow pea, sun hemp, dhaincha or groundnut, *etc.*

Keep the water channel, bunds and surrounding area clean or free from weeds for avoiding spread of weeds in field as sugarcane remains in the field for more than one year. Adopt drip irrigation to minimize weed population.

Use well decomposed FYM or compost for minimizing spread of weeds in the field. Bund application of fertilizer in optimum quantity and at proper time for stimulating crop growth and suppressing weeds.

Adopt intercropping of suitable crop as per planting season.

Atrazine or simazine 2 TO 2.5 kg/ha as pre-emergence spray about 3to 4 days after planting in the plant cane and after completion of basis requirements of ratoon management about 3 to 4 days after giving irrigation in ratoon crop. It required give one hand weeding after 30 to 40 days after planting depending upon weed intensity. Carry out light earthing up at 4 to 4.5 months after planting for suppressing late emerging weeds.

Adopt mulching of sugarcane trash in plant cane/ratoon to avoid the weed growth and save the cost on use of herbicides.

Whenever there is intercropping of sugarcane + vegetables like cabbage, okra, potato, oilseeds or pulse crops use Fluchloralin (Basaline) 1 to 1.5 kg/ha as pre emergence spray. Give one weeding if required after one month and carry out final earthing up after harvest of intercrops.

Nierves et al. ((SRA-LGAREC) evaluated the different integrated weed management practices in sugarcane ratoon by using the Randomized Complete Block Design (RCBD) from November 1999 to May 2000. They also identified the most effective weed management practices during WS and DS planting.

RESULTS

During the WS planting, sugarcane plants, under the treatment using late post-emergence spray in combination with manual weeding and plow cultivation, gave cane tonnage and sugar yield of 71.46 TC/ha and 159.08 L kg/ha; respectively.

Plants under the treatment of early post-emergence spray + manual weeding + plow cultivation had similar cane tonnage and sugar yield of 63.37 TC/ha and 158.10 L kg/ha, respectively with the other weed management practices.

Based on direct agricultural cost, the use of late and early post-emergence spray in combination with manual weeding and plow cultivation resulted in plants yielding the highest cane tonnage and sugar during Ws and DS, respectively. The experiment done by Nierves et al. in 2000 shows that the incorporation of mechanical weeding is beneficial then us of chemical herbicides sole, it helps in increases yield.

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Sustainable weed management practices in SRI method of rice cultivation

Damini Thawait, Amit K.Patel, Manish K. Sharma and Srishti Pandey
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh 492 012
Email:daminithawait@gmail.com

Rice is the second most important cereal crop in the world covering 155 mha with the annual production of 596 mt. Rice is one of the most important cereals that hold the key for food security. Increasing water scarcity is becoming a real threat for rice cultivation. About 80 per cent of fresh water is being used for agriculture and out of this more than 50 per cent is consumed by the rice crop alone. System of Rice Intensification (SRI) emerged as an alternative in paddy cultivation with core principles like using less seed, less water, and less fertiliser requirement. In addition, weeds are the bounding factors of agricultural production, which compete crop plants (especially rice) with their rapid growth. Weeds decrease about 25% of ground's potential yield in the developing countries like Iran and they are serious threat for agricultural products. Besides, weeds compete to crop plants in catching vapor, light and food in growth season and causing disturbance in cultivation, maintenance, yield withdrawal and reduction in quality and quantity of products. In SRI, weeds are not seen as a problem, but as an opportunity. As the weeds are incorporated into the soil by way of mechanical weeder, it helps build up of soil organic matter and subsequently large and diverse microbial population in the soil. Thus mechanical weeding operation facilitates the process of aeration in the soil.

METHDOLOGY

As there is no standing water in SRI method, weeds would be more. There are several advantages of turning the weeds into the soil by using an implement called 'weeder'. Use the weeder on the 10th and 20th day after transplanting. The weeding problem is addressed to a large extent with this effort.

Absence of standing water provides a congenial environment for weed to proliferate in SRI. If these weeds are incorporated into the soil, they serve as green manure. The weeds in the vicinity of hills which could not be reached by the weeder have to be removed by hand.

In SRI, the first weeding is done after 10-12 days of transplantation. Subsequent weedings are done every 10 days, until the crop permits operation. Weeding at 10 day interval is necessary, even if the weeds seem to be small. If there is delay in the operation there would be problem in incorporating the weeds into the soil. The 2-4 weeding should be done mechanically with the cono weeder. The cono weeder churns the soil thereby more root growth, reduced weed competition, increased soil biological activity, increased soil aeration, prevent cracking and better nutrient availability.

Types of weeders used: Cono weeder Single row weeder Two row weeder Kollur weeder Three row raichur weeder Japan weeder English weeder Single drum weeder Tamilnadu weeder Nepali tarai weede

RESULTS

These results showed the components of SRI are as more important than the traditional methods of rice cultivation in this trial. The more weed exist, the more competition would be on the light and appropriate condition which causes increase in height of rice plant to get the appropriate condition.

Table 1. contributions of weed management and other SRI practices on grain yield

Seedling age (days)	No. of seedlings per hill	Weeding practice	Irrigation practice	Grain yield (kg/ha)
15	1	Inter culture	Intermittent	7,061
25	1	Inter culture	Intermittent	5,864
15	3-4	Inter culture	Intermittent	6,138
25	3-4	Hand weeding	Flooding	4,745

CONCLUSIONS

In SRI, weeds are seen as growth promoters when they are appropriately managed. As the weeds are more in SRI due to intermittent wetting, it is important to manage the weeds regularly. This is done by both mechanical and manual processes. The using of weeder is the control of weeds and also adding organic matter to the soil. This gives the benefits of cultivating a green manure crop. Further, the soil gets aerated and the roots are exposed to air. This results in profuse growth of diverse soil micro organisms which make nutrients available to the plant. Enhances the utilization of biomass.

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Integrated weed management practices in soybean, an ecofriendly approach for sustainable agriculture

Bhumika Patel and Damini Thawait
Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh 492 012
Email:daminithawait@gmail.com

Integrated Weed Management uses all available weed control options in the best possible way to manage weed populations. Such options include crop rotation, cover crops, intercropping, manipulation of nitrogen fertility, planting pattern, tillage systems, critical period of weed control, and alternative weed management strategies in conservation tillage systems and economic thresholds. All these practices are components of an IWM system and none of these control measures on their own can be expected to provide acceptable levels of weed control. Therefore, instead of banking on a particular method of weed control, an IWM system uses a mixture of methods of weed control; it reduced rates of herbicides can be combined with mechanical tillage for improved weed control. In general, IWM systems exert various selection pressures on the weeds so that the economic impact of the weeds can be minimized. By following the principles of an IWM system we can reduce the use of herbicides applied into the environment and at the same time provide optimum economic returns to the grower.

Inadequate weed control is one of the main factors related to decrease in soybean production. Weeds compete with crops by resources (water, light and nutrients). This competition is important mainly in the initial stages of crop development, due to possible losses in production that can be up to 80% or even, in extreme cases, hinders harvest operations. Weeds have traits which confer them great aggressiveness even in adverse environments. High number of seeds, seed dormancy, discontinuous germination, effective dispersal mechanisms and population heterogeneity, are very important for weed establishment during crop development. The IWM approaches incorporate multiple tactics of prevention, avoidance, monitoring and suppression of weeds, undergirded by the knowledge of the agroecosystem biology.it provdes basic information about weed interference and weed management in the soybean crop, subsidizing technicians in the adoption of suitable positions regarding problems with weed control.

Crop Rotations - The major goal of the rotational crop for weed control is to reduce the number of weed seed available for germination the following season. Other benefits of crop rotation may include reduction in insects, diseases, and nematodes.

Crop Competition - Crop competition is one of the most important, but often one of the most overlooked tools in weed control. A good stand of soybeans, which emerge rapidly and shade the middles early, is helpful in reducing weed competition. This involves good management practices such as choosing a well-adapted variety, good fertility, maintaining proper soil pH, adequate plant populations, and using row spacing's as narrow as practical. Utilizing these good management practices is necessary for producing good soybean yields and is also an aid in weed control.

Cultivation - Cultivation is still a good and economical method of weed control; however, for cultivation to be effective in controlling weeds in the row, the soybeans must be taller than the weeds. The major reason for cultivation is weed control; therefore, if good weed control has been achieved with an herbicide, delay cultivation until weeds are present. Cultivate only deep enough to achieve weed control since deep cultivation may disturb soybean roots, bring weed seed to the surface, and disturb the layer of soil previously treated with an herbicide.

Observe weeds - Choose control methods that are effective for your specific weed problem. Generally, for preplant and preemergence applications, the weed problems must be anticipated since weeds may not have emerged at the time of application. This can best be done by observing the field in the fall and recording the weeds present and their location in the field.

Herbicides - Herbicides are one of the most effective tools for weed control in soybeans. Preemergence applications combined with the previously discussed management practices are important in ensuring that the soybeans have the initial competitive advantage.

Herbicide - Resistant Soybeans - Transgenic or herbicide-resistant soybeans are genetically altered to tolerate (the actual resistance is altered enzyme) herbicides that would normally kill or injure conventional or non-transgenic varieties. This genetic modification allows the use of broadspectrum herbicides over-the-top of soybeans and provides economical and efficient weed management.

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Weed and nitrogen management through dual cropping in direct seeded rice

Suryendra Singh*[1], S. Elamathi[2], Gautam Ghosh[1] and P. Anandhi[2]

[1]*Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh 211 007*
[2]*Agricultural Research station, TNAU, Kovilpatti, Tamil Nadu 628501*
**Email: suryendra_aligarh@yahoo.com*

Direct seeding is increasingly becoming important in present-day rice production systems as it saves time, labour and energy; improves profitability; increases cropping intensity (through reduced turnaround); and avoids arduous operations such as nursery preparation and transplanting (Subbaiah and Balasubramanian 2000). The change in crop establishment technique from transplanted to direct seeded rice culture, is subjected to greater weed competition than transplanted rice because both weed and crop seeds emerge at the same time resulting in severe yield reduction. Moreover weed menace is a major concern in direct seeded rice. To address the problems of weed infestation and low nitrogen use efficiency, the present investigation was undertaken to identify effective and feasible weed and nitrogen management practices for direct seeded rice.

METHODOLOGY

Field experiments were conducted during *Kharif* seasons of 2009 and 2010 at Sam Higginbottom Institute of Agriculture, Technology and Sciences, Allahabad, Uttar Pradesh. Sprouted rice seeds of *'Arize 6444'* were sown at 50 kg/ha using a drum seeder at a spacing of 20 cm in unpuddled soil on 10th June during both the years in the experimental field with recommended package of practices. The seeds of companion crop, *Sesbania* , was uniformly broadcasted by hand at a seed rate of 25 kg/ha in respective treatment. A dual crop of *Azolla* (*Azolla microphylla*) was inoculated 15 days after sowing (DAS) at 0.5 t/ha. *Sesbania* and *Azolla* were trampled into the soil manually at 37 DAS. Recommended levels of N, P, and K at 150:60:90 kg/ha were applied. The systems of planting with fertility level and weed management treatments (Table 1) were arranged in a split-plot design with three replications. Data on weed growth, yield performance and economics were recorded.

RESULTS

Pretilachlor plus 0.3 kg/ha at 2 DAS followed by *fb* hand weeding (HW) at 45 DAS was more effective than HW twice at 20 and 45 DAS in reducing weed density and weeds dry weight. The broad-spectrum weed control achieved with pretilachlor plus 0.3 kg/ha at 2 DAS *fb* HW at 45 DAS was evident from the far-reaching reduction in weed density (43 and 34 /m^2) as well as weeds dry weight (31 and 27 g/m^2) as compared to no weeding in both the years respectively (Table 1). Higher fertilizer N (100%) along with organic sources (*Sesbania* and *Azolla*) enhanced the yield attributes of rice and consequently resulted in higher grain yield than rice alone (DSR) during both years respectively. The B: C ratio was found maximum with pretilachlor plus 0.3 kg /ha at 2 DAS *fb* HW at 45 DAS as well as dual cropping (either with *Sesbania* or *Azolla*) in both the years.

Table 1. Influence of weed and N management on weed growth, yield and economics of direct seeded rice

Treatment	Weed density (no./m²)				Weeds dry weight (g/m²)				Grain yield (t/ha)		B : C Ratio	
	2009		2010		2009		2010		2009	**2010**	2009	2010
Transplanted rice+ 100% RDN	(6.56)*	59.66	(5.92)	49.88	(5.80)	37.00	(5.43)	32.83	3.88	4.27	1.72	1.87
Transplanted rice+ 75% RDN	(7.34)	72.77	(6.67)	61.33	(6.17)	41.33	(5.90)	38.11	3.73	4.11	1.68	1.82
Rice alone (DSR)+ 100% RDN	(14.99)	286.00	(13.85)	246.00	(12.35)	195.00	(11.89)	183.05	3.15	3.72	1.77	2.05
Rice alone (DSR)+ 75% RDN	(14.25)	259.77	(13.15)	223.11	(12.01)	186.77	(11.57)	175.44	2.99	3.52	1.71	1.98
(Rice + *Sesbania*)+ 100% RDN	(11.03)	139.66	(10.05)	116.22	(7.94)	69.77	(7.60)	64.50	3.81	4.29	2.02	2.24
(Rice + *Sesbania*)+ 75% RDN	(10.44)	127.00	(9.52)	106.11	(7.44)	60.55	(7.12)	55.94	3.66	4.05	1.98	2.16
(Rice + *Azolla*)+ 100% RDN	(9.34)	106.88	(8.50)	88.33	(6.81)	52.11	(6.53)	48.33	3.76	4.18	2.01	2.19
(Rice + *Azolla*)+ 75% RDN	(9.84)	115.44	(8.95)	96.00	(7.09)	56	(6.76)	51.77	3.64	3.98	1.98	2.13
LSD(P=0.05)	(0.46)	12.28	(0.39)	11.40	(0.60)	14.21	(0.61)	13.63	0.21	0.39	-	-
Weed management practices												
No weeding	(17.73)	336.33	(16.35)	286.83	(12.80)	189.45	(12.44)	179.22	2.06	2.15	1.11	1.14
Pretilachlor plus 0.3 kg/ha at 2 DAS *fb* HW at 45 DAS	(6.35)	43.54	(5.69)	34.95	(5.56)	31.87	(5.13)	27.12	4.43	5.20	2.02	2.33
HW twice at 20 DAS and 45 DAS	(7.34)	57.83	(6.68)	48.33	(6.24)	40.62	(5.98)	37.39	4.24	4.70	1.80	1.96
LSD (P=0.05)	0.34)	10.41	(0.29)	8.77	(0.43)	10.68	(0.43)	10.23	0.19	0.15	-	-

*Values in parentheses are the square root transformed values

CONCLUSION

It is concluded that pre-emergence application of pretilachlor plus 0.3 kg / ha at 2 DAS fb HW at 45 DAS, with dual cropping (either with *Sesbania* or *Azolla*) + 100% N was found better for improving productivity and profitability of direct seeded rice.

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Effect of weed management practices on yield attribution of urdbean under late sown condition

V.K. Tiwari*, S.K. Nagre, D.K. Chandrakar and M.K. Sharma

College of Agriculture, IGKV, Raipur, Chhattisgarh 492012

**Email: vrajantiwari30@gmail.com*

Pulses are grown in Chhattisgarh the around 8.68 lakh hectare area, out of which 2.14 lakh hectare in *Kharif* and 6.54 lakh hectares in rabi. Urdbean is one of the major *Kharif* pulse of upland grown in 1.92 lakh hectare area with productivity of 396 kg/ha (Anonymous 2012). Slow initial growth of urdbean and favourable conditions for weed multiplication and a wide spectrum of heterogeneous weed flora, which gradually become a serious limitation for low productivity of urdbean. Most prominent weed species found in urdbean fields are *Trianthema portulacastrum, Cyperus rotendus, Euphorbia hirta, and Phyllanthus niruri*. Uncontrolled weeds at critical period of crop-weed competition reduce the yield of urdbean to the tune of 80-90% depending upon type and intensity of weed infestation (Kumar *et al*. 2001). Hence present investigation was under taken to identify suitable herbicide, their appropriate rate and time of application for urdbean during *Kharif* season.

METHODOLOGY

A field experiment was conducted during the rainy (*Kharif*) season of 2012 at Research Farm of Indira Gandhi Agriculture University, Raipur. The soil of the experimental field was clayey (Vertisols) in texture, low in available nitrogen, medium in available phosphorus and high in available potassium status coupled with neutral pH. The experiment was laid down in split plot design with three replication. There were three date of sowing assigned in main plot August 9 (D_1), August 18 (D_2) and August 27 (D_3) and the weed management practices assigned in sub plots. Sowing was done (cv. local spreading types) with a seed rate of 20 kg/ha with a spacing of 30 cm row to row. A basal dose 20 kg/ha N, 16 kg/ha P, 20 kg/ha K and 20 kg/ha S was applied uniformly.

RESULTS

Among various weed management practices, application of imazethapyr 35% + imazamox 35 % (odyssey 70 WG) at 75 g/ha + HW at 35 DAS (W_6) gave significantly highest seed yield (0.86 t/ha) with higher weed control efficiency (75.87%) followed by with pendimethalin (PE) + HW at 25 DAS (W_4) (653.27 kg/ha). While, the lowest seed yield was noted under weedy check (W_1) (312.5 kg /ha).The increase in the yield in above treatments is due to weed management from early crop growth and higher dry matter accumulation which resulted in greater translocation of food materials to the reproductive parts and reflected in superiority of yield attributing characters and ultimately to higher yield. The lower weed density and higher weed control efficiency also resulted in higher seed yield. The highest net return and B:C ratio was obtained in imazethapyr 35% + imazamox 35% at 75 g/ ha + HW at 35 DAS (W_6).

Table1. Effect of weed management practices on yield attribution of urdbean

Treatment	Seed Yield (kg/ha)	Weed dry weight (g/m^2)		Weed control efficiency (%)	Net Return (x10^3 ₹/ha)	B : C Ratio
		40 DAS	60 DAS			
W_1-Weedy check	0.31	65.89	114.44	-	2.95	0.25
W_2-Hand weeding at 20 DAS	0.58	11.72	29.11	69.25	14.04	1.10
W_3-Pendimethalin (PE) at1 kg/ha	0.52	25.17	35.80	64.58	10.45	0.76
W_4- W_3 + HW at 25 DAS	0.65	9.10	20.10	75.53	15.07	1.00
W_5-Imazethapyr 35% + Imazamox 35%(Odyssey 70 WG) at 75 g/ha 20 DAS	0.54	12.00	29.11	67.23	11.95	0.92
W_6- W_5 + HW at 35 DAS	0.86	8.61	19.61	75.87	25.31	1.78
W_7- (W_3+W_5),	0.60	11.44	22.61	73.78	12.73	0.85
W_8- Chemical stale seed bed (Glyphosate at1200 g/ha 10 days before sowing)	0.48	27.17	37.83	49.11	10.01	0.80
LSD(P=0.05)	0.05	1.74	1.63	-	-	-

CONCLUSION

Application of imazethapyr 35% + imazamox 35% (odyssey 70 WG) at 75 g/ha + HW at 35 DAS was the most appropriate weed management practices for maximization of growth, yield attributes and seed yield of urdbean.

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Effect of integrated weed management on weed dynamics and productivity of long duration pigeonpea under rainfed condition

I.B. Pandey*, Sunil Kumar and K.K. Sinha
Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar 843 121
**Email: indubhushanpandey@gmail.com*

Pigeonpea being grown during *Kharif* season and initial growth of this crop is very slow thus severely suffers heavily due to severe weed infestation sowing to congenial weather conditions for weed growth. A single factor weed, if left uncontrolled, mitigates the benefits obtainable from different agricultural inputs. Season long infestation of composite weed flora in pigeonpea results in yield reduction up to 68% (Rana and Pal 1997). In general weeds in pigeonpea are managed either manually or by pre-emergence herbicides but unavailability of human labour at critical period of crops weed competition and the herbicides used might not be able to provide substantial period of weed control and weed emerging later in the season get escaped. There facts necessitate the use of integrated approach of weed management practices to manage the weeds effectively season long in pigeonpea. Keeping these in view, an experiment was undertaken to find out the effect of integrated weed management on weed dynamics and productively of pigeonpea.

METHODOLOGY

An experiment was conducted at Tirhut College of Agriculture, Dholi, Muzaffarpur of Rajendra Agricultural University, Pusa, Samastipur, Bihar during *Kharif* 2012-13 on sandy loam soil low in organic carbon (0.36%), available nitrogen (162.4kg/ha), phosphorus (12.16 kg/ha) and potassium (56.2kg/ha) with pH 8.1 the treatment comprised weedy check, hand weeding (25 and 50 DAS), pendimethalin 0.75 kg/ha (pre-emergence) + 1 H.W. at 50 DAS, imazathapyr 100g/ha (20 DAS), imazathapyr 100g/ha (20 DAS) + 1 H.W. at 50 DAS, quizalofop ethyl 100g + 1 H.W. at 50 DAS, Pendimethalin 0.75 kg (pre-emergence) + imazathapyr 100g/ha (30 DAS) and pendimethalin 0.75 g (pre-emergence) + quizalofop-ethyl 100 g (30 DAS) were tested in randomized block design and replicated thrice. The pigeonpea variety '*Bahar'* was sown in raw 60 cm apart in the last week of July, using the seed rate of 20kg/ha.

RESULTS

Weed count and weed dry biomass reduced significantly in weed control treatments than weedy check. Hand weeding twice recorded lowest weed count and weed dry-biomass and highest weed control efficiency at both 30 and 75 DAS. The weed count and weed dry-biomass increased at later growth stage in the plots treated with imazathapyr and quizalofop ethyle alone might be due to reduced phyto-toxicity of these herbicides in the soil. Imazathapyr and quizalofop-ethyl 100g/ha was found most effective for controlling predominant perennial weed *Soghum helepense.* Among the herbicides, post emergence application of imazathapyr 100g/ha at 20 days after sowing followed by one hand weeding at 50 DAS recorded lowest weed count and weed dry-biomass and produced similar grain yield to hand weeding twice at 25 and 50 days after sowing.

Table 1. Integrated weed management in pigeonpea

Treatment	No. of weeds/m^2		Weed dry weight (g/m^2)		WCE (%)		Grain yield (t/ha)
	30 DAS	75 DAS	30 DAS	75 DAS	30 DAS	75 DAS	
Weedy Check	26.02(715.5)	22.80(598.0)	13.94(193.6)	16.99(282.4)	-	-	1.18
Pendimethalin 0.75 kg/ha (3 DAS) + 1 H.W. at 50 DAS	18.75(328.4)	11.42(139.6)	11.11(122.9)	7.97(63.2)	36.52	77.62	1.76
Imazathapyr 100g/ha (20 DAS)	14.90(220.8)	17.29(277.4)	8.62(73.9)	11.22(125.6)	61.82	54.46	1.36
Imazathapyr 100g/ha (20 DAS) + 1 H.W. at 50 DAS.	15.56(234.4)	11.02(122.5)	8.99(80.3)	7.67(58.9)	58.51	79.14	1.84
Quizalofop ethyl 100g/ha (20 DAS)	17.62(312.2)	18.67(349.0)	10.90(118.7)	14.09(198.4)	38.69	29.75	1.28
Quizalofop 100g/ha + 1 H.W. at 50 DAS.	18.95(322.3)	12.29(153.5)	11.46(131.2)	8.89(78.5)	32.23	72.20	1.72
Pendimethalin 0.7 5kg/ha (3 DAS) + Imazathapyr 100g/ha (30 DAS)	17.63(365.1)	14.72(197.7)	11.69(136.8)	9.39(87.6)	29.34	68.98	1.55
Pendimethalin 0.7 5kg/ha (3 DAS) + Quizalofop ethyl 100g/ha (30 DAS)	19.24(361.8)	17.23(260.9)	11.94(142.0)	10.26(105.2)	26.65	62.75	1.45
H.W. (25 and 50 DAS)	9.69(80.2)	10.48(134.0)	5.98(30.6)	6.23(38.4)	84.19	86.39	2.01
LSD (P=0.05)	1.77	2.12	0.88	1.02	-	-	0.29

CONCLUSION

Post-emergence application of imazathapyr 100g/ha at 20 days after sowing + one hand weeding at 50 days after sowing was found equally effective for reducing the weed count and weed dry-biomass and producing the similar grain yield to hand weeding twice at 25 and 50 days after sowing in long duration pigeonpea.

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Efficacy of different herbicides against weed flora in onion

Raju Panse*[1], P.K. Jain[2], Avneesh Gupta[3] and Anchal Sharma[2]

[1]*Project Coordination Unit Sesame and Niger, JNKVV, Jabalpur Madhya Pradesh 482 004*

[2]*Department of Horticulture, JNKVV, Jabalpur Madhya Pradesh 482 004*

[3]*Department of Plant Breeding and Genetics, JNKVV, Jabalpur Madhya Pradesh 482 004*

**Email: rkpanse_jnkvv@yahoo.com*

The weed problem in onion is very serious due to frequent irrigation, which provides congenial condition for weed growth. High reduction in bulb yield of onion was observed due to weeds infection. Hand weeding is a common method of weed control adopted by farmers but comparatively this method is costly and time consuming. This problem assumes added significance due to non – availability of adequate labours during peak period of operation. Whereas, post – emergence herbicides kill weeds and keep the hardy weeds under control by arresting their growth through various kinds of deformities in foliage and growing point.

METHODOLOGY

The experiment was carried out at Vegetable Research Farm, Maharajpur, Horticulture, JNKVV, Jabalpur during 2009-12 to find out the efficacy of different herbicides in randomized block design with three replication, each in 3x2m plots keeping 15X10 cm row to plant distance. The observations on weed parameters, morphological characters, yield parameters with phytotoxic sypmptoms were recorded on ten randomly selected plants from each plots.

RESULTS

The results revealed that the maximum weed control efficiency, plant height, number of leaves, marketable yield and B:C ratio were recorded with oxyfluorfen 23.5% EC (Goal) before planting + quizalofop-ethyl 5 %EC (targa super) at 30 DAT. These findings are in confirmation with finding Bhutia *et al*. (2005) and Dalayai *et al*. (2008).

Table1. Morphological and yield attributing characters under various herbicidal treatments in onion

Treatment	Plant height (cm)	Number of leaves	Average bulb weight (g)	Marketable yield (t/ha)	Weed control efficiency (%)	Phytotoxic Symtom	B:C ratio
Weedy check	56.15	9.78	50.93	0.23	85.83	1.97	1:1.82
Combined spray of oxyfluorfen 23.5% EC and quizalofop-ethyl 5 %EC at the time of transplanting and at 30 DAT,	56.28	9.35	48.67	0.24	88.37	1.60	1:1.75
Pendimethalin 30% EC (stomp) application before planting and second at 30 DAT,	55.63	9.31	41.50	0.25	87.64	1.57	1:1.74
Pendimethalin 30% EC application before planting + quizalofop-ethyl 5%EC at 30 DAT	55.69	10.00	49.23	0.24	85.41	1.23	1:1.89
Combined spray of pendimethalin 30% EC + quizalofop-ethyl 5%EC at the time of planting and second at 30 DAT	57.25	9.67	42.12	0.26	82.65	1.47	1:1.96
DOGR recommended practices (qxyfluorfen 23.5% EC before transplanting + one hand weeding at 40-60 DAT	55.77	9.80	47.57	0.28	82.10	1.60	1:2.04
Oxyfluorfen (23.5% EC (goal) before Planting + quizalofop-ethyl 5 %EC (Targa super) at 30 DAT.	57.91	10.97	57.87	0.28	89.86	1.77	1:2.30
LSD(P=0.05)	3.09	1.55	13.74	0.33	4.29	0.29	-

CONCLUSION

Among the various treatments, application of oxyfluorfen 23.5% EC before planting + quizalofop ethyl 5 % EC at 30 days after transplanting recorded best herbicides for the effective control of onion weeds.

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Weed Control in Clusterbean

M.K. Kaushik*, S.L. Yadav and S.L. Mundra

Department of Agronomy, Maharana Pratap University of Agriculture & Technology, Udaipur, Rajasthan 313 001

**Email: mkk101061@yahoo.com*

Clusterbean (*Cyamopsis tetragonoloba*) is being grown in India since ancient time for vegetable and fodder purposes. In the recent years, besides its conventional uses, it has emerged as an industrial crop, due to presence of galactomannan (gum) in its endosperm, which is around 30-35 per cent of seed weight. Guar gum has several diversified uses in textile, food processing, cosmetics, mining, explosive, oil and pharmaceutical industries, printing, toilet goods etc. Being a rainy season crop, it suffers badly due to severe competition by mixed weed flora. Yield reduction due to weed infestation is to the tune of 53.7 per cent has been observed (Saxena *et al.* 2004). Although weeds pose problem during entire crop growth period, however initial one month of the crop is especially critical. Usually one hand weeding about 25-30 days after sowing is followed by farmers in this crop. Therefore, weed control needs to be restored to exploit the yield potential of this crop.

METHODOLOGY

A field experiment entitled -Studies on Weed Control in Clusterbean (*Cyamopsis tetragonoloba*) was conducted on clay loam soils, at Instructional Farm, Rajasthan College of Agriculture, Udaipur during *Kharif*, 2010 with objectives to find out the suitable method of weed control for clusterbean. The experiment comprises of 12 treatment combinations, *i.e.* weedy check, weed free check, one hand weeding 40 DAS, two hand weedings (20 and 40 DAS), imazethapyr 100 g/ha 20 DAS, imazethapyr 100 g/ha 20 DAS + hand weeding 40 DAS, quizalofop-ethyl 60 g /ha 20 DAS, quizalofop-ethyl 60 g/ha 20 DAS + hand weeding 40 DAS, pendimethalin 1.0 kg/ha PE, pendimethalin 1.0 kg/ha PE + hand weeding 40 DAS, alachlor 2.0 kg/ha PE, alachlor 2.0 kg/ha PE + hand weeding 40 DAS. These treatments were replicated thrice in randomized block design.

RESULTS

The results showed that weed control methods markedly reduced crop-weed competition. Amongst methods, two hand weedings (20 and 40 DAS) and imazethapyr 100 g/ha 20 DAS + hand weeding 40 DAS significantly reduced density and dry matter of weeds. Post emergent imazethapyr was more effective on broad leaf weeds and grassy weeds while quizalofop-ethyl was more effective in controlling only grassy weeds specially *Echinichloa colona.* The maximum seed yield (1.84 t/ha) was recorded under weed free check and found at par with two hand weedings (20 and 40 DAS) and imazethapyr 100 g/ha 20 DAS + hand weeding 40 DAS and significantly superior to rest of treatments. Two hand weedings (20 and 40 DAS) and Imazethapyr 100 g /ha 20 DAS + hand weeding 40 DAS gave the higher values of growth characters as well as yield attributes and yield. All weed control treatments increased seed yield of clusterbean significantly compared to weedy check (0.51t/ha).

Table 1. Effect of weed control on clusterbean seed yield, harvest index, weed control efficiency and weed index

Treatment	Clusterbean		Weed control	Weed
	Seed yield(t/ha)	Harvest index (%)	efficiency (%)	index (%)
Weedy check (T_1)	0.51	26.13	0.00	71.78
Weed free check (T_2)	1.84	30.57	100.00	0.00
One HW 40 DAS (T_3)	1.25	28.94	82.84	31.80
Two HW 20 and 40 DAS (T_4)	1.72	29.48	90.94	6.57
Imazethapyr 100 g/ha 20 DAS (T_5)	1.33	30.35	83.19	27.59
T_5 + HW 40 DAS (T_6)	1.71	29.97	89.36	6.93
Quizalofop-ethyl 60 g/ha 20 DAS (T_7)	1.21	31.43	41.48	33.81
T_7 + HW 40 DAS (T_8)	1.47	29.93	85.59	20.08
Pendimethalin 1.0 kg/haPE (T_9)	1.23	28.94	80.15	32.94
T_9 + HW 40 DAS (T_{10})	1.46	30.08	85.90	20.54
Alachlor 2.0 kg/ha PE (T_{11})	1.25	29.90	80.53	32.00
T_{11} + HW 40 DAS (T_{12})	1.45	29.88	84.93	20.77
LSD(P=0.05)	0.23	NS	-	-

Two hand weedings (20 and 40 DAS) and imazethapyr 100 g/ha 20 DAS + hand weeding 40 DAS were recorded at par and found significantly superior over rest of treatments in enhancing seed and haulm yield. Two hand weedings 20 and 40 DAS, imazethapyr 100 g/ha 20 DAS + hand weeding 40 DAS, quizalofop-ethyl 60 g/ha 20 DAS + hand weeding 40 DAS, pendimethalin 1.0 kg/ha PE + hand weeding 40 DAS, alachlor 2.0 kg/ha + hand weeding 40 DAS registered 1.72, 1.71, 1.47, 1.46 and 1.45 t/ ha seed yield, respectively as against the seed yield of 0.51 t/ha under weedy check. The enhancement in seed yield due to two hand weedings 20 and 40 DAS compared to imazethapyr 100 g/ha, quizalofop-ethyl 60 g /ha, pendimethalin 1.0 kg/ha, alachlor 2.0 kg/ha and weedy check was 29.32, 41.46, 39.83, 37.54 and 231.83 per cent while under imazethapyr 100 g /ha 20 DAS + hand weeding 40 DAS the respective increase in seed yield compared to these treatments was 28.62, 40.60, 39.07, 36.79 and 230.03 %.

CONCLUSION

On medium fertility clay loam soils maximum significant seed yield (1.71 t/ha) and harvest index (29.97%) of clusterbean realized with imazethapyr 100 g/ha 20 DAS + hand weeding 40 DAS.

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Influence of herbicides and cultural practices on uptake of nutrients by weeds and black gram

D. Kavita , A.S. Rajput, Kamble*, R.K. Sonawane and V.M. Bhale

Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104

**Email: ashitoshagronomist@gmail.com*

India is one of the known a premier pulse growing country than the other country. Pulses are pulses are an excellent source of dietary, nutritious feed for livestock and a mini nitrogen plant having profound ameliorative effect on the soil. Black gram is important rainfed pulse crop grown throughout India. It has high nutritive value and consist high content of proteins, vitamins and minerals. Black gram is an important (*Kharif*) pulse crop of Maharashtra and it is recommended for cultivation mainly in *Kharif* season under Vidarbha condition. Weeds compete with the crop plants more during *kharif* season for essentials of water, plant nutrients, air, space and light thus adversely affected production. So to control weeds broad spectrum herbicides or herbicidal combinations are used.

METHODOLOGY

Field investigation carried out at Agronomy Farm, Department of Agronomy, Dr. PDKV, Akola during *kharif* season of 2010-11 on clay loam soil. Thirteen treatments consisting different cultural and herbicidal combinations replicated thrice in randomized block design. Black gram (var. *TAU*-1) was sown with 30 x 10cm spacing and fertilizer was applied at 20:40:00 NPK kg/ha through urea and diammonium phosphate. Data on weed growth and yield performance were recorded frequently.

RESULTS

Treatment weed free recorded significantly highest nutrient uptake and weedy check recorded lowest nutrient uptake both by crop and weeds among all the treatments. The maximum nutrient uptake was found in pre-emergence application of pendimethalin at 1500 g/ha treatment followed by 2 Hand weeding, Pendimethalin at 1000 g/ha PE, Fenoxyprop-p-ethyl at125 g/ha POE, Fenoxyprop-p-ethyl at100 g/ha POE and Quizalofop-p-ethyl at 75 g/haPOE. Treatment Imazethapyr at 50 g/ha PE recorded significantly lower nutrient uptake than pendimethalin and fenoxyprop-p-ethyl and other weed control treatments. Treatment weed free showed maximum removal of nutrient as less weed competition. Similar results were obtained by Naidu *et al.* (1982) in groundnut crop. In respect of nutrient uptake by weeds treatment weedy check recorded significantly maximum nitrogen, phosphorus and potassium uptake than other weed control treatment.

Table 1. Uptake of N,P and K by weeds and black gram influenced by different weed control treatments

Treatments	Nutrient uptake by seed (kg/ha)			Nutrient uptake by straw (kg/ha)			Total nutrient uptake by plant (kg/ha)			Nutrient uptake by weed (kg/ha)		
	N	P	K	N	P	K	N	P	K	N	P	K
Weed free	43.95	8.37	43.45	66.18	11.42	63.01	110.1	19.79	106.4	3.90	2.50	3.00
Weedy check	15.81	1.35	7.50	26.11	3.23	19.94	41.92	4.58	27.44	25.60	9.00	20.10
2 Hand weeding (15 fb 30 DAS)	32.24	6.06	30.00	60.08	10.00	57.48	92.33	16.06	87.48	7.49	5.80	5.88
2 Hoeing (10 fb 20 DAS)	21.45	3.69	20.45	44.90	8.00	39.95	66.35	11.69	60.40	10.20	9.41	9.39
Imazethapyr at 50 g/ha PE (At sowing)	19.07	2.39	15.82	41.63	5.94	34.51	60.70	8.33	50.32	16.00	11.00	10.50
Imazethapyr at 75 g/ha PE (At sowing)	27.21	3.55	21.00	47.21	7.22	39.35	74.42	10.77	60.35	13.33	10.00	9.40
Pendimethalin at 1000 g/ha PE (At sowing)	34.13	5.95	28.19	57.49	9.35	53.12	91.61	15.30	81.31	7.90	6.45	6.70
Pendimethalin at 1500 g /ha PE (At sowing)	34.92	6.50	34.16	63.26	10.60	57.60	98.18	17.10	91.76	6.55	5.33	5.30
Fenoxyprop-p-ethyl at 100 g/ha POE (15 DAS)	29.41	4.45	23.13	52.94	8.13	43.16	82.36	12.58	66.29	10.00	8.00	8.13
Fenoxyprop-p-ethyl at 125 g/ ha POE (15 DAS)	33.60	5.73	26.77	57.51	9.37	47.80	91.11	15.10	74.57	8.35	6.48	7.20
Quizalofop-p-ethyl at 50 g/ha POE (15 DAS)	23.91	2.97	20.28	41.15	5.59	37.98	65.06	8.56	55.26	17.10	12.13	12.00
Quizalofop-p-ethyl at 75 g/haPOE (15 DAS)	28.21	3.85	22.93	50.09	7.27	40.77	78.31	11.12	63.70	14.30	10.37	10.10
Imazethapyr at 50 g ha PE *fb* POE Quizalofop-p-ethyl at 50 g /ha (At sowing *fb* 15 DAS)	25.63	3.20	21.37	43.77	5.85	36.38	69.40	9.05	57.74	14.98	11.80	11.40
LSD(P=0.05)	8.32	1.27	5.10	12.19	1.89	7.91	11.99	2.13	8.87	1.69	1.59	1.52

CONCLUSION

Nutrient (N, P and K) uptake by black gram was found superior in weed free treatment due to less weed competition and it was followed by Pendimethalin at 1500 g/ha PE and two hand weeding at 15 DAS and 30 DAS while nutrient uptake by weeds were observed highest in weedy check.

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Effect of post-emergence herbicide in *Kharif* groundnut

P.V. Mahatale*, S.N. Sabale, V.L. Gawande, M.Y. Ladole and A.R. Bhuyar
Oilseeds Research Unit, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 001
**Email: mahatale1978@rediffmail.com*

Groundnut is grown mainly in *Kharif* season in India. Where in it encounters severe weed problem of weed infestation especially in the early stages of growth, because the seedling emerges 7 to 10 days after sowing coupled with the slow growth in the initial stages. The weeds emerge fast and grow rapidly competing with the crop severely for the resources namely nutrients, light, and space and also transpire lot of valuable conserved water from the soil. On an average the loss of groundnut production in the country due to weeds has been estimated to the tune of 33% and 70%. Thus, weed control during initial stage is essential to get optimum crop yield. Weed competition in early stages of crop growth affects the yield potential of the crop. Knowledge about competitive aspects of weeds and the critical stages at which the weeds compete to the maximum extent with the crop is an important aspect which needs to be understood for effective weed control. The coexistence of weeds with the crop plants causes considerable reduction in yield in crop plants by affecting both the growth and yield components. Though, physical methods of weed control are very effective, but they have certain limitations such as non-availability of labour during peak period, high labour cost, and unfavourable environmental conditions, such as rainfall during peak period. Under such conditions, the chemical weed control plays an important role in groundnut and enhances the groundnut yield substantially. Looking to the above facts the experiment is planned to manage the weeds in groundnut with post emergence herbicides. Keeping this in view, the present studies on "Effect of post emergence herbicides in *kharif* groundnut (*Arachis hypogaea* L.)" was initiated.

METHODOLOGY

The experiment was conducted in RBD design with nine treatments replicated thrice (Table 1).

The gross and net plot size were 3.60 x 3.0 m and 3.0 x 2.80 m, respectively. The crop variety '*AK 159*' was sown at 30 x 10 cm. The RDF 25:50:50 NPK kg / ha was used. The 100% nitrogen and entire P_2O_5 and K_2O were applied as basal dose.

RESULTS

Herbicidal treatments significantly influenced the population and dry matter production of weeds. Among the herbicidal treatments, the lowest weed index (3.26%) was observed under propaquizafop 100 g / ha followed quizalofop-ethyl 100 g / ha (9.74%).The minimum weed dry weight was also recorded in these treatments, which was significantly lower than all other treatments. These results are in conformity with the findings of Patil *et al.* (2012). Maximum weed control efficiency (96.4%) was recorded in propaquizafop 100 g / ha and minimum weed control efficiency recorded under pre emergence application of pendimethalin 1000 g / ha (81.64%). This clearly indicated that weeds were controlled effectively under post emergency herbicide. The highest dry pods yield (29.27 kg / ha) was recorded with hand weeding (20 and 40 DAS) and the lowest (15.20 kg / ha) was under unweeded check. The yield loss due to uncontrolled growth of weeds as compared to hand weeding. Among the herbicidal treatments, in propaquizafop 100 g / ha recorded maximum GMR, NMR which was at par with quizalofop-ethyl 100 g / ha but significantly higher as compared to other treatments. Herbicidal treatments resulted in considerably lower cost of cultivation compared with hand weeding. The B:C ratio was found maximum with propaquizafop 100 g / ha, followed by quizalofop-ethyl 100 g / ha than other treatments.

Table 1. Weed growth, yield and economics of *Kharif* groundnut as influenced by different weed control treatments

Treatment	Weed index (%)	Weed control efficiency (%)	Dry pods yield (t / ha)	Haulm yield (t / ha)	GMR ($x10^3$ ₹ / ha)	COC ($x10^3$ ₹ / ha)	NMR ($x10^3$ ₹ / ha)	B:C Ratio
Weeded check	48.1	0.0	1.52	3.13	48.64	24.74	23.90	1.97
Weed free check	0.00	100	2.93	3.92	93.67	32.51	61.16	2.88
Propaquizafop 10 EC PoE 100 g / ha	3.3	96.4	2.83	3.54	90.62	27.81	62.81	3.26
Quizalofop-ethyl 5 EC PoE 50 g / ha	17.1	87.3	2.44	3.30	78.19	27.33	50.87	2.86
Quizalofop-ethyl PoE 5 EC PoE 100 g / ha	9.7	94.6	2.69	3.38	86.05	27.73	58.32	3.10
10 % SL PoE 50 g / ha	14.2	89.9	2.55	3.35	81.47	27.41	54.06	2.97
Imazethapyr 10 % SL PoE 100 g / ha	12.8	92.6	2.60	3.47	83.29	27.88	55.40	2.99
Imazamox 10 % SL PoE 100 g / ha	17.0	88.3	2.49	3.22	79.55	27.57	51.98	2.89
Pendimethalin 30 EC PoE 1000 g / ha	31.6	81.6	2.14	3.15	68.52	27.54	40.98	2.49
LSD (P=0.05)	7.0	11.3	0.31	0.56	79.93			

CONCLUSION

It was concluded that post-emergence application of propaquizafop 100 g / ha was most effective for controlling weeds, improving dry pods yield and profitability of *Kharif* groundnut**.**

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Efficacy of penoxsulam on weed growth and grain yield of transplanted rice

V. Pratap Singh*, Akshita, S.K. Guru, Abnish Kumar, Neeta and R.P. Singh

G.B. Pant University of Agriculture & Technology,Pantnagr, U.S. Nagar, Uttarakhand 263 145

**Email: vpratapsingh@rediffmail.com*

The major area of rice in India is under transplanted rice system. Weeds are one of the major constraints to rice production. Weeds reduce rice grain yield up to the extent of 32% (Singh *et al*. 2007) by competing for space, nutrients, water and light. The use of herbicides is one way to eliminate crop weed competition easily and cost effective technology. Hence, the present study was conducted to evaluate the efficacy of different doses of Penoxsulam on growth of weeds and yield of transplanted rice.

METHODOLOGY

The field experiments were conducted during the *Kharif* season of 2011 and 12 at N.E.Borlaugh Crop Research Center of the GBPUAT, Pantnagar to see the influence of different doses of penoxsulam against weeds and yield of rice. The experiment was laid out in Randomized block design with seven treatment as in Table 1.Twenty five days old seedlings of "*Sarjoo 52*" were transplanted with 3 seedlings $hill^{-1}$ in puddled situation field at a spacing of 20 x 10 cm on July 14th ,2011 and 6th,2012 respectively. Pre emergence herbicide pretilachlor was sprayed three DAT. Post emergence herbicide penoxsulam and bispyribac Na were sprayed at 21 DAT with knapsack sprayer with the volume of 500 L/ha. The data on weed density and dry matter accumulation were recorded at 60 DAT and weed control efficiency (WCE%) of different treatments was computed using data on weed dry matter.

RESULTS

The most dominant weed species found in the weedy plots were *Echinochloa colona* (5.9,20.9%), *Caseulia axillari* (0.9,23.6%), *Ammania baccifera* (35.3,24.3%), *Alternanthera sessilis* (27.8,3.3%) and *Cyperus difformis* (11.4,4.1%), respectively 2011-12. All the weed control treatments registered a reduction in total weed population over the weedy check (Table 1). It was further observed that among all the herbicidal treatments, post emergence application of bispyribac Na 25 g/ha followed by penoxsulam 25 g/ha effectively control the weeds might be due to better efficacy against above mentioned spp. On the other hand, penoxsulam 20 g/ha showed a lower efficacy towards the weeds and recorded highest total weed density. The total density of weeds reduced due to increase in the doses of penosuxlam from 20 to 22.5 g/ha during both the years of experimentation. Thus it appears that application of penoxsulam at 25 g/ha was more effective than its lower doses.

The total weed dry matter accumulation indicated significant differences during both the years. Weed biomass is a better parameter to measure the competition than weed density as it precisely measures the quantity of growth related factors utilized by weeds. In 2011, lowest weed biomass was recorded with application of penoxsulam 25 g/ha followed by twice hand weeding done at 20 and 40 DAT. Among the different weed control measures, bispyribac Na 20 g/ha recorded the lowest weed dry matter during 2012.The WCE which reflects the efficiency of herbicides for controlling weeds was highest with application of in penoxsulam 25 g/ha in the year of 2011 while in 2012 it was with bispyribac Na 25 g/ha.T his indicated that these treatments can be used safely for the effective control of weeds in transplanted rice.

Among the herbicidal treatments, maximum grain yield during 2011 were obtained with the application of penoxsulam 25 g/ha and recorded an increase of 30.6 % yield over weedy check, however, in 2012 it was with bispyribac Na 20 g/ha being at par with application of penoxsulam 25 g/ha applied as post emergence. This increase in yield could be due to lower weed count that resulted in efficient utilization of available resources by the crop. Crop yield and weed control efficiency were positively correlated. One percent increase in weed control efficiency caused increase in grain yield. This increase in grain yield by increasing WCE was also reported by Singh and Singh (2006).

Table 1. Effect of various doses of penoxsulam on density and dry weight of weeds in transplanted rice

Treatment	Dose (g/ha)	Total weed (No./m^2)		Total weed dry weight (g/m^2)		WCE (%)	
		2011	2012	2011	2012	2011	2012
Penoxsulam2.5%OD	20	62.6	102.7	25.3	63.5	68.9	89.1
penoxsulam2.5% OD	22.5	40.0	77.3	16.8	46.4	79.4	92.0
penoxsulam2.5% OD	25	29.4	62.7	8.5	30.5	89.5	94.8
BispyribacNa10%SC	20	16.1	44.3	12.7	5.2	84.4	99.1
Pretilachlor 50%EC	750	69.3	57.4	41.9	48.4	48.6	91.7
Hand weeding	20&40 DAT	46.7	114.6	10.0	24.9	87.7	95.7
Untreated	-	124.6	220.9	81.6	5836.2	0.0	0.0
LSD (P=0.05)	-	-	-	16.5	30.7	-	-

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Bio-Efficacy studies of butachlor in transplanted rice under foothills of Uttarakhand

V. Pratap Singh*, Varsha Joshi, T.P. Singh, Abnish Kumar and Rekha

G.B. Pant University of Agriculture & Technology, Pantnagr, U.S.Nagar Uttarakhand 263 145

**Email: vpratapsingh@rediffmail.com*

Rice is predominant crop of India contributing 45% of the total food grain production. Uncontrolled weeds cause a reduction of 35 to 55% grain yield under transplanted conditions (Saikia and Purshotahamam 1996). Timely weed control is imperative for realizing desired level of productivity. Therefore, there is necessity that butachlor (2-chloro-2,6-di ethyl-N-butoxy methyl-acetanilicle) known as pre-emergence herbicide should be used for the control of annual grasses, sedges & broad leaved weeds in transplanted rice.

METHODOLOGY

A field experiment was conducted during *Kharif* season of 2010 and 2011 at N.E. Borlaug, Crop Research Center, Pantnagar with an objective to find out the efficacy of butachlor 50% EC at various doses (new molecule) under transplanted rice. The experiment was laid out in Randomized Block Design (RBD) combined with eight treatments at various doses and replicated thrice. The soil of experimental area was clay loam in nature. Twenty five days old seedling of rice variety '*Sarjoo 52*' was transplanted with a spacing of 20 × 10 cm. Pre emergence application of Butachlor (market as well as sponsor sample) and chlorimuron ethyl 10% + metasulfuron methyl 10% WP (Almix 20%WP) was applied at five days after transplanting. Weed density was recorded at crop harvest stage. For dry weight, weeds were removed from the each quadrate at harvest stage and dried in oven at 70^{0}C for 72 hrs. After drying the weeds were weighted and expressed in g/m^2.

RESULTS

All the doses of butachlor 50% EC (sponsor sample) have complete control over the population of *E. colona* during both the years. Sponsor sample of butachlor 50% EC was found equally effective to control the weed species as well as its market sample in transplanted rice. The doses of butachlor 50% EC (2000 and 4000 g/ha) were found marginally more effective in controlling different types of weeds as compared to its lower dose (1250 g/ha). But there was no significant advantage of its higher (4000 g/ha) dose. The highest grain yield was obtained with application of butachlor 50% EC (sponsor sample) at 2000 g/ha and its 32.0 and 18.0% maximum grain yield over the weedy check in 2010 and 2011, respectively.

Table 1. Effect of herbicidal treatments on density and total dry weight of weeds at harvest stage and grain yield of crop (2010 and 2011)

Treatments	Dose (g/ha)	Weed density (no./m^2)								Weed dry wt. (g/m^2)		Grain yield (t/ha)	
		E. colona		*E. crusgalli*		*I. rugosum*		*A. sessalis*					
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Butachlor 50% EC (SS)	1250	0.0 (0.0)	0.0(0.0)	2.3(9.3)	1.0(2.0)	1.3(4.0)	0.4(0.7)	2.0(6.7)	1.8(5.3)	50.3	78.5	4.13	4.65
Butachlor 50% EC (SS)	2000	0.0 (0.0)	0.0(0.0)	2.4(10.7)	0.7(1.3)	0.0 (0.0)	0.0(0.0)	2.3(9.3)	1.8(5.3)	51.5	64.6	4.47	5.05
Butachlor 50% EC (SS)	4000	0.0 (0.0)	0.0(0.0)	2.0(6.7)	0.4(0.7)	0.0 (0.0)	0.0(0.0)	2.2(9.3)	2.0(6.7)	24.3	57.2	4.08	4.81
Butachlor 50% EC (MS)	1250	0.5(1.3)	0.7(1.3)	2.7(14.7)	1.3(2.7)	0.5(1.3)	0.4(0.7)	2.5(12.0)	1.6(4.0)	74.5	81.3	4.16	4.58
Butachlor 50% EC (MS)	2000	0.5(1.3)	0.0(0.0)	2.1(8.0)	0.4(0.7)	0.0 (0.0)	0.0(0.0)	2.5(12.0)	1.7(4.7)	68.3	75.4	4.42	4.92
Almix 20% WP	4	2.0(6.7)	1.4(3.3)	3.2(24.0)	1.7(4.7)	1.5(5.3)	1.4(3.3)	1.6(1.3)	0.4(0.7)	150.4	128.1	3.28	4.34
Weed free	-	0.0 (0.0)	0.0(0.0)	0.0 (0.0)	0.0(0.0)	0.0 (0.0)	0.0(0.0)	0.0 (0.0)	0.0(0.0)	0.0	0.0	4.50	4.97
Weedy	-	2.3(9.3)	1.8(5.3)	3.1(21.3)	1.8(5.3)	1.7(8.0)	1.6(4.0)	1.6(6.7)	2.0(6.7)	239.2	228.9	3.01	4.09
LSD (P=0.05)		0.8	0.5	1.4	0.8	NS	0.6	1.2	0.5	55.7	10.1	0.35	0.27

CONCLUSION

It is concluded that butachlor 50% EC (sponsor sample) at 1250-2000 g/ha may be used effectively for the control of weeds in transplanted rice as there is no additional advantage to use the product at higher dose 4000 g/ha.

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Post-emergence application of penoxsulam + cyhalofop–butyl on growth and yield of direct (dry) seeded rice

V. Pratap Singh*, Rekha, S.P. Singh, Abnish,Varsha and R.P. Singh
G.B. Pant University of Agriculture & Technology,Pantnagar, U.SNagar, Uttarakhand 263 145
**Email: vpratapsingh@rediffmail.com*

Rice (*Oryza sativa L.*) is the leading cereal of the world and more than half of the human race depend on rice for their daily sustenance (Chauhan and Johnson 2011). Heavy infestation of weeds is one of the major constraints for successful cultivation of direct (dry) seeded rice(DSR). Direct seeded rice DSR is becoming popular as an alternative to transplanting. Various herbicides have been used for controlling weed control in DSR but efficacy of chemical methods based on a single herbicide treatment may be unsatisfactory because of their narrow spectrum and specific weed species management with application of herbicides. For instance, application of pendimethalin, pretilachlor and butachlor may suppress the grassy weeds, in DSR, by 70% with improvement in the paddy yield by 7-19% over the control**.** Therefore, its need to identify the ready mix herbicide which effectively controls the grassy and non-grassy weeds by the single window application.

METHODOLOGY

The study was conducted at Norman. E. Borlaug Crop Research Centre, of G.B. Pant. University of Agriculture & Technology Pantnagar during *Kharif* seasons 2011 and 2012 to evaluate the efficacy of herbicide, *viz.* penoxsulam + cyhalofop–butyl 6% OD in direct seeded rice. Ten treatments comprises, *viz.* Penoxsulam + Cyhalofop –butyl 6% OD at 105, 120, 135 and 150 g / ha, Penoxsulam 24% OD at 22.5 g / ha, Cyhalofop 10% EC at 80 g / ha , bispyribac Na 10% EC at 20 g / ha , oxyflurofen 23.5% EC at 150 g / ha, weed free and weedy check. The experiment was laid out in Randomized Block Design and replicated thrice. The rice variety "*Sarjoo 52*" was sown on July 10th, 2011 and June 16th, 2012.The crop was harvested on November 16th, 2011 and November 5th, 2012. The observation on density and dry matter weight of weeds was taken at 60 DAS. Quadrate was placed at four randomly selected spots in each plot for observation of weed and crop plant. The weeds were recorded species-wise and total biomass was weighed after drying the weed sample at 70°C for 72 hrs.

RESULTS

The major weed flora in the experimental field consisted of grasses; *Echinochloa colona*(40.7 and 19.2%) , *Echinochloa japonica*(11.9 and 9.0%)*, Leptochloa chinensis* (2.9 and 2.5%)and *Elusine indica* (7.4 and 0.5%) *Alternanthera sessilis* (7.4 and 2.0%),*Caesulia axillaris* (5.8 and 0.7%) and *Cyperus rotundus* (29 and 65%) in the year of 2010 and 2011 respectively. The application of penoxsulam + cyhalofop-butyl 6% OD at various doses (105 to 150 g / ha) had better control over the grassy , non-grassy and sedges as compared to its alone application(Table1). Combination of penoxsulam + cyhalofop-butyl 6% OD at 150 g / ha recoded lowest dry matter accumulation and highest weed control efficiency(72.8 and 68.5%) over the standard check and weedy check during both the years.The highest grain yield was obtained at higher dose of penoxsulam + cyhalofop – butyl 6% OD . These treatments resulted in 75 and 84% maximum rice yield than untreated plots in 2010 and 2011, respectively. Therefore, application of penoxsulam and cyhalofop- butyl alone were less effective against the weeds but in combination because of being compatible with each other appeared to be more effective against mixed weed flora in rice crop.

Table 1. Effect of treatments on density and total dry weight of weed, weed control efficiency and on yield in direct seeded rice.

Treatments	Dose (g / ha)	Total weed species(m2) *Grassy*		Total weed species(m2)*BL Ws*		Total Weed Dry Weight (g / m^2)		WCE (%)		Grain yield (t / ha)	
		2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Penoxsulam + cyhalofop- butyl 6% OD	105	52.0	35.4	6.6	4.0	108.9	194.1	52.3	51.8	3.96	3.10
Penoxsulam + cyhalofop- butyl 6% OD	120	42.6	25.4	2.7	1.3	88.5	153.9	61.7	61.7	4.47	3.79
Penoxsulam + cyhalofop- butyl 6% OD	135	34.0	17.3	1.3	1.3	72.8	139.0	68.5	65.4	4.78	4.27
Penoxsulam + cyhalofop- butyl 6% OD	150	25.4	17.3	1.3	0.0	63.3	126.8	72.8	68.5	4.85	4.06
Penoxsulam 24 % SC	22.5	48.0	34.6	5.3	5.3	76.4	169.7	66.7	57.8	3.93	3.49
Cyhalofop-butyl 10 % EC	80	47.4	53.4	9.3	1.3	147.7	258.6	36.1	35.8	1.57	1.50
Bispyribac-Na 10 % EC	20	38.7	29.4	0.0	0.0	106.0	183.9	54.0	54.3	3.87	3.14
oxyflurofen 23.5 % EC	150	44.0	58.6	10.7	10.6	91.9	314.8	59.9	21.8	2.98	1.32
Weedy check	-	51.4	82.7	12.0	8.0	234.3	402.7	0.0	0.0	1.16	0.65
Weed free	-	-	-	-	-	0.0	0.0	100.0	100.0	4.82	4.47
LSD (P= 0.05)		-	-	-	-	38.7	34.7			0.19	0.43

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Use of herbicide mixtures for weed control in transplanted rice

V. Pratap Singh*, Neeta Tripathi, Abnish Kumar and Akshita Banga
G.B. Pant University of Agriculture & Technology, Pantnagr, U.S. Nagar Uttarakhand 263 145
**Email: vpratapsingh@rediffmail.com*

In rice cultivation, weeds are the major cause of yield reduction and considerable portion of production cost is involved to overcome this problem. Hand weeding and other traditional methods involve high labour cost. Herbicidal weed control methods offer an advantage to save labour and money (Ahmed *et al*. 2000). Since the use of herbicides with same mode of action has develop herbicide resistance problem. Thus the new herbicides of different composition are desirable to reduce this problem (Saha *et al.* 2006). Thus the present study was undertaken to evaluate the ready mixture of penoxsulam (1.02% w/w) + cyhalofop- butyl (5.1% w/w) 6%OD for weed control in transplanted rice.

METHODOLOGY

The present field study was conducted at Norman. E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture & Technology Pantnagar during to evaluate the efficacy of herbicide, *viz*. penoxsulam + cyhalofop–butyl 6% OD in transplanted rice during *Kharif* season of 2010 and 2011. Ten treatments comprises, *viz*. penoxsulam + cyhalofop–butyl 6% OD at 105, 120, 135 and 150 g/ha, penoxsulam 24% SC at 22.5 g/ha, cyhalofop 10%EC at 80 g/ha, bispyribac Na 10%SC at 20 g/ha, pretilachlor 50% EC at 750 g/ha, untreated and weed free. The experiment was laid out in Randomized Block Design and replicated thrice. The rice variety "*Sarjoo 52*" was transplanted in mid July and harvested in last week of October during both the season. The ready mix herbicides were applied at 20 DAT where as the alone herbicide was applied at 20 DAT. Bispyribac Na and pretilachlor was applied at 10 and 1 DAT. The observation on density and dry matter weight of weeds was taken at 60 DAS. The weeds were recorded species-wise and total biomass was weighed after drying the weed sample at 70°C for 72 hrs.

RESULTS

Echinochloa crusgalli and *Echinochloa colona* was major among grassy weeds during first and second year, respectively whereas *Alternenthera* and *Ammenia* in *Kharif* 2011 and *Ammenia* was only was major broad leaved weeds during second year. *Cyperus difformis* was only sedge during both the years.

Among the herbicidal application the lowest dry weed biomass of weeds at 60 DAT, was recorded with application of penoxsulam+cyhalofop-butyl at 150 g/ha followed by its lower dose applied at 135 g/ha and these treatments were at par with each other and significantly superior over alone application of both these herbicides and standard check bispyribac Na and pretilachlor during both the years except alone application of penoxsulam and bispyribac Na during *Kharif* 2011. Application of penoxsulam+cyhalofop-butyl both at 150 and 135 g/ha recorded the highest grain yield during first year whereas spray of bispyribac Na recorded the highest grain yield followed by penoxsulam+cyhalofop-butyl both at 135 g/ha which were at par with each other. Application of penoxsulam+cyhalofop-butyl both at 150 and 135g/ha recorded significantly higher grain yield as compared to cyhalofop- butyl and pretilachlor in the first year whereas it was found at par with application of other herbicides in the second year. Weedy plot recorded 27 and 21% lower grain yield as compared to weed free during both the years, respectively (Table 1).

Table 1. Effect of different treatments on weed dry weight at 60 DAT and grain yield of transplanted rice

Treatments	Dose (g/ ha)	Weed dry weight (g /m²)		Weed control Efficiency		Grain yield (t/ha)	
		2010	2011	2010	2011	2010	2011
Penoxsulam+Cyhalofop- butyl	105	37.3	12.7	73.8	79.53	4.68	6.37
Penoxsulam+Cyhalofop- butyl	120	31.5	8.2	83.1	82.72	4.71	6.51
Penoxsulam+Cyhalofop- butyl	135	15.3	7.6	84.3	91.6	4.79	6.59
Penoxsulam+Cyhalofop- butyl	150	7.7	2.5	94.8	95.77	4.79	6.55
Penoxsulam	22.5	20.5	4.1	91.5	88.75	4.68	6.46
Cyhalofop- butyl	80	79.7	22.8	53	56.28	3.80	6.09
Bispyribac- sodium	20	37.1	2.5	94.8	79.64	4.63	6.59
Pretilachlor	750	88.8	21.2	56.3	51.28	4.37	6.37
Untreated	-	182.3	48.5	0	0	3.49	5.18
Weed free	-	0.0	0.0	100	100	4.79	6.55
LSD (P=0.05)		31.4	5.0			0.39	0.53

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Weed management inirrigated wheat

B.D. Singh*[1], B S Karki[2], Rajesh Kumar[1] and V P Singh[2]

[1]*KrishiVigyan Kendra, Matela (Kosi), Almora, Uttarakhand 263 643* [2]*G B Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 263 105*

**Email: bdsingh5@gmail.com*

Wheat (*Triticumaestivum*) is one of the major *Rabi* season crop grown on the hills of Uttarakhand. The area, production and productivity of wheat in Uttarakhand is 3.58 Lakh ha, 8.38 Lakh tonns and 23.41 kg/ha. The irrigated valleys of hills has great potential but the same is yet not harvested primarily due to use of traditional seed which is low yielder and only use of FYM which israrely well decomposed. Furthermore, weeds are not controlledand they are used as green fodder after uprooting from the field in February-March. However, to feed our ever growing population, it is necessary to enhance the productivity by the adoption of improved agricultural practices. Among the critical crop production factors, Weed are the major constraints and are expected to reduce the yield by 20-60%. Proper weed management, therefore, is essential to minimize the losses caused by weeds and to realize higher crop yield.

METHODOLOGY

Realizing the heavy infestation of weeds in wheat,the on farm trial (OFT) was conducted in *Rabi* 2012-13 at fivefarmer's field of District Almora. The soil of trail site was sandy loam. The trial was consisted of three treatments, *i.e.* Farmers practice (uprooting of weeds in February-March from the field and used as green fodder),Vesta (clodinafop + metsulfuron-methyl) at 400g/ha at 35 DAS and Satasat (sulfosulfuron + metsulfuron-methyl) at 40g/ha at 40 DAS. The plot size of each treatment was 400m^2. The treatments were replicated five times inrandomized block design. The two years old seed of wheat variety *UP 2572* was sown in well prepared field on November 3-5, 2012 and harvested during May 8-11, 2013.Herbicides were sprayed with the help of Knapsack sprayer using flat fan nozzle as per treatments schedule. Weed count/m^2 area was recorded at 120 DAS. All the standard agronomic management practices were followed as and when required.

RESULTS

The weed floras adversely affected the yield during trial were *Ranunculus arvensis, Anagallis arvensis, Oxalis latifolia, Convolvulus arvensis, Chenopodium album* and *Melilotus*spp.etc. However, maximum weed number was of*Ranunculus arvensis*and minimum was *Melilotus* spp (Table 1) clearly showed that weed density was maximum in Farmers practice while, minimum in treatment Satasat (sulfosulfuron + metsulfuron-methyl) at 40 g/haindicating the best performance. Similarly, the yield was also maximum with Satasat (sulfosulfuron + metsulfuron-methyl) at 40 g/ha *i.e.* 3.35 t/ha (Punia *et al*. 2005). The treatment Vesta (clodinafop + metsulfuron-methyl) at 400g/haalso performed well and recorded 2.98t/ha yield.Both the treatments under study, *i.e.* Vesta (clodinafop + metsulfuron-methyl) at 400 g/ha and Satasat (sulfosulfuron + metsulfuron methyl) at 40 g/ha recorded 41.90 and 59.50% more yield over Farmers practice. Net return and B:C Ratio were also maximum with treatment Satasat (sulfosulfuron + metsulfuron-methyl) at 40g/ha.

Table 1. Weed count, yield and economics ofirrigated wheat as influenced by different treatments

Treatments	Weed density/m^2	Yield (t/ha)	% increase in yield over check	Net Return (x10^3₹/ha)	B:C Ratio
Farmers practice (uprooting of weeds in February-March from the field and used as green fodder)	42	2.10	-	10.900	1.58
Vesta (Clodinafop + Metsulfuron methyl) at400g/ha at 35 DAS	15	2.98	41.90	19.170	1.85
Satasat (Sulfosulfuron + Metsulfuron methyl) at 40g/ha at 40 DAS	06	3.35	59.50	24.350	2.08

*Grain selling/price. 14/kg

The associated farmers showed their happiness with the result of herbicides. Earlier, where they spent a lot of time in manual weeding, in spite of that efficient result was not obtained. They believed that new technology was quite effective in terms of effective weed control, higher yield and drudgery reduction of women.

CONCLUSION

It was found that use of herbicide-Satasat (sulfosulfuron + metsulfuron-methyl) at 40g/hawas most effective for controllingweeds, improving grain yield and enhancing the net return ofirrigated wheat.

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Effect of rice based cropping systems on weed dynamics and crop productivity

S.P. Singh*, V.P. Singh, Akshita, Rekha, Varsha, Neeta and Abnish

G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 263 105

**Email: spdrsingh@gmail.com*

In South Asia, rice-based cropping systems accounts for more than half of the total acreage where rice is grown in sequence with rice or upland crops like wheat, maize or legumes. Rice based cropping systems provides food security and livelihoods for millions. Rice-wheat cropping systems alone occupy 13.5 million hectares in the Indo-Gangetic Plains (IGP) of South Asia**.** DSR seeded with a planter or a seed cum fertilizer drill have many advantages over conventional puddled transplanting, *viz.* easier and timely planting, reduced labour burden at least 50% (Fujisaka *et al.* 1993), 8-10 days earlier crop maturity (helpful in timely planting of succeeding crop), higher water and nutrient use efficiency, efficient root system development that enhance drought tolerance reduced lodging problem and higher yield of succeeding upland crops. In rice-wheat system, yield reduction in rice due to weeds has been reported to the extent of 45 per cent depending upon the soil type and rainfall pattern of a particular area . Weed seed bank dynamics regulate communities of many of our most important weed species. Direct seeded rice may be sequenced with different crops due to dynamics in DSR what type of crops should be planted are of more interest.

METHODOLOGY

A long term trial was conducted to study the effect of weed management practices on weed dynamics and crop productivity in direct seeded rice based cropping system at N. E. Borlaug C.R.C. The trial was initiated from *Kharif* 2008 in split plot design consisting of seven direct seeded rice based cropping system in which rice was followed by wheat, chickpea, field pea, mustard, linseed, potato and berseem as main plot and two weed control treatment *i.e.* hand weeding (20 & 40 DAS) and weedy check as sub plot treatment. Direct dry seeding of rice variety "*Sarjoo 52*" was done on 26th June 2008 and 25th June 2009. The succeeding crops were sown on 8th November 2008 and 2nd December 2009 respectively.

RESULTS

The major weeds infesting rice were *Echinochloa colona, Digera arvensis* and *Eleusine indica.* Significant effect of different cropping systems on dry weight and grain yield of rice was observed in both the years. In weedy plots, significantly lower dry weight was recorded in Rice –wheat cropping system, among hand weeded plots, lower dry matter of weeds was recoded in rice chick pea in 2008 while in 2009 it was with Recorded- wheat. In the hand weeding treatments among the different cropping systems, significantly higher grain was recorded in Rice field Pea and it was followed by Rice-Chick pea.

Among the weed control treatments, twice hand weeding at 20 and 45 days controlled all the weeds effectively and recorded lower dry weight as compared to weedy plot during both the years. Significant effect on grain yield of *rabi* crops was observed during both the years. Hand weeding done at 20 and 45 days in direct seeded rice – potato gave highest grain yield followed by rice-wheat. Among the systems DSR – mustard and DSR – potato was found more profitable with twice hand weeding.

Table 1. Effect of different treatments on weed dry weight and grain yield in direct seeded rice dring 2008-09

Treatment	Weed dry weight (g/m^2) 60 DAS		Yield (t/ ha)	
	2008	2009	2008	2009
Cropping System				
Direct seeded rice – wheat				
Hand weeding (20 and 45 DAS)	50.6	82.3	4.34	3.45
Weedy	1013.3	695	0.15	2.76
Direct seeded rice – chickpea				
Hand weeding (20 and 45 DAS)	29.3	127.7	4.50	4.166
Weedy	1360.0	709.3	0.08	2.11
Direct seeded rice – field pea				
Hand weeding (20 and 45 DAS)	40.0	108.0	4.75	4.54
Weedy	1106.6	1052.0	0.13	0.15
Direct seeded rice – mustard				
Hand weeding (20 and 45 DAS)	73.3	92.7	4.41	3.70
Weedy	1040.0	103.20	0.16	0.17
Direct seeded rice – linseed				
Hand weeding (20 and 45 DAS)	166.6	215	4.62	3.66
Weedy	1297.3	1362	0.04	0.20
Direct seeded rice – potato				
Hand weeding (20 and 45 DAS)	52.0	127.3	4.45	4.20
Weedy	1040.0	1046.7	0.16	0.20
Direct seeded rice – berseem				
Hand weeding (20 and 45DAS)	62.7	207.3	4.08	4.37
Weedy	1266.7	1046.7	0.08	0.19
LSD (P=0.05)	265.9	203.1	0.87	0.21
Average				
Hand weeding	67.8	137.2	4.454	4.01
Weedy	1060.5	976.6	0.0118	0.18

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Effect of weed management on productivity of lentil under rainfed condition of North Bihar

K.K. Sinha, I.B. Pandey and Sunil Kumar
Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar 843 121

Weed control is one of the most important component of production package of lentil. Weeds growing in association with the crop deprive it from a considerable amount of nutrients, moisture and light and prevent the crop's full yield potential. Reduction in yield of lentil resulting from severe invasion of weeds ranging from 20 to 90% has been reported by Saini and Singh (1981). The manual weeding besides being expensive and pain staking, can not be practiced until weeds put forth sufficient vegetative growth. Selectivity of herbicides between weed species may lead to serious infestation of more noxious weeds normally of secondary importance. Combination of herbicides is likely to prove effective and eco-friendly approach. Hence, the present investigation was under taken to find out the effect of weed management on productivity of lentil.

METHODOLOGY

A field experiment was conducted at Tirhut College of Agriculture, Dholi, Muzaffarpur of Rajendra Agricultural University, Pusa, Samastipur during three consecutive *rabi* seasons from 2010-11 to 2012-13 on sandy loam soil low in organic carbon (0.34%), available nitrogen (158 kg/ha), phosphorus (18 kg/ha) and potassium (150 kg/ha) with pH 8.3. The treatment comprised weedy check, hand weeding at 20 and 40 DAS, quizalofop-ethyl 50 g/ha at 30 DAS, imazethapyr 37.5g/ha at 30 DAS, chlorimuron ethyl 4g/ha before sowing, pendimethalin 1.0 kg/ha (pre-emergence), pendimethalin 1.0 kg/ha + quizalofop-ethyl 50g/ha at 30 DAS and pendimethalin 1.0 kg/ha + imazethapyr 37.5 g/ha at 30 DAS. The lentil variety '*KLS-218*' was sown in row 30 cm apart in the second week of November in each year.

RESULTS

All the weed control treatments reduced the weed count and weed dry biomass and produced higher grain yield than weedy check except post-emergence application of quizlofop ethyl 50g/ha and pre-plant incorporation of chlorimuron ethyl 4g/ha. Among the weed control treatments, pre-emergence application of pendimethalin 1.0 kg/ha followed by imazethapyr 37.5g/ha at 30 DAS or pre-emergence application of pendimethalin 1.0 kg/ha followed by quizalofop ethyl 50g/ha at 30 DAS was found most effective herbicides combination for reducing the weed count and weed dry biomass and producing the more or less similar grain yield to hand weeding twice at 20 and 40 DAS. These herbicides combination controlled compact weed flora of lentil and also recorded higher weed complex efficiency among the herbicides.

Table 1 Effect of weed management on weed dynamics and yield of lentil

Treatment	Weed count/m^2 (35 DAS)	Weed dry weight (g/m^2) (35 DAS)	WCE (%)	Grain yield (t/ha)
Quizalofop ethyl 50g/ha at 30 DAS	177	82	21.1	1.37
Imazethapyr 37.5 g/ha at 30 DAS	131	54	48.1	1.55
Chlorimuron ethyl 4g/ha before sowing.	168	64	38.5	1.46
Pendimethalin 1.0 kg/ha (Pre-emergence)	156	60	42.3	1.58
Pendimethalin 1.0 kg/ha + Quizalofop ethyl 50g/ha at 30 DAS	119	51	51.0	1.65
Pendimethalin 1.0 kg/ha + imazethapyr 37.5 g/ha at 30 DAS	105	48	53.9	1.73
Hand weeding at 20 and 40 DAS.	38	15	85.6	1.84
Weedy check.	216	104	-	1.26
LSDs (P=0.05)	-	-	-	0.24

DAS – Days After Sowing

CONCLUSION

Pre-emergence application of pendimethalin 1.0 kg/ha followed by imazethapyr 37.5g/ha at 30 DAS or pre-emergence application of pendimethalin 1.0 kg/ha followed by quizalofop ethyl 50 g/ha at 30 DAS was worked out to be viable option to hand weeding twice for weed control in lentil.

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Herbicide–compost-fertilizer mixture for weed and nutrient management in transplanted summer rice

N. Borah, J. Deka, N.C. Deka, I.C. Barua and K. Goswami
DWSR-AAU Centre, Department of Agronomy, Jorhat, Assam 785 013

Farmers are now motivated towards use of herbicides due to shortage of agricultural workers. Pre-emergence herbicides are applied in transplanted rice 3-5 days after transplanting in standing water mixing with dry sand or soil. Possibility of washing away of herbicides and nutrients due erratic rainfall behavior prompted to undertake a field experiment to evaluate efficacy of herbicide and effect of nutrients in transplanted autumn rice through possible increase in their retention in soil by applying as herbicide-compost-fertilizer mixture.

METHODOLOGY

A field experiment was conducted in the ICR Farm of Assam Agricultural University, Jorhat during *Kharif* 2013. The soil of the site was acidic (pH 5.4) having high organic carbon (8.1 g/kg), medium available nitrogen (282.5 kg/ha), available P_2O_5 (22.8 kg/ha) and K_2O (178.2 kg/ha) content. Twenty five days old seedlings of rice variety '*Kanaklata*' were transplanted with a spacing of 20 x 15 cm on 05-02-2013. Treatments were applied as detailed below: 1. Unfertilized, pretilachlor 750 g/ha as sand mixture followed by hand weeding (HW) 30 DAT, 2. Recommended dose (RD) fertilizer (40:20:20 N:P_2O_5:K_2O kg/ha), without weed management, 3. RD fertilizer, pretilachlor 750 g/ha as sand mixture followed by HW 30 DAT, 4. RD fertilizer, pretilachlor 750 g/ha with vermicompost (200 kg/ha) mixture followed by HW 30 DAT, 5. RD fertilizer, pretilachlor 750 g/ha as sand mixture followed by HW 30 DAT, urea top-dressed as vermicompost (600 kg/ha) mixture at tillering and PI stage, 6. Sixty per cent RD fertilizer as vermicompost (2 t/ha) mixture in 3 splits (3, 30 and 60 DAT), pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAT, 7. Seventy five per cent RD fertilizer as vermicompost (2 t/ha) mixture in 3 splits, (3, 30 and 60 DAT) pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAT, 8. Ninety per cent RD fertilizer as vermicompost (2 t/ha) mixture in 3 splits (3, 30 and 60 DAT), pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAT.

RESULTS

The pH of the vermicompost was unaffected due to mixing with fertilizer or herbicide or both, however the population of *Azospirillum* and PSB significantly decreased irrespective of doses of fertilizer. Among the *comlizers*, lowest population for both the bacteria was recorded at 90% RD fertilizer with 2 t/ha vermicompost. Mixing of pretilachlor 750 g/ha with 2 t vermicompost significantly reduced the population of bacteria. The experiment was dominated by broadleaved weeds like *Alternanthera philoxeroides, Cuphea balsamona, Eichhornia crassipes, Hydrolea zeylanica, Marsilea minuta, Spnoclea zeylanica* and *Spilanthes paniculata* in the first month of cropping. Grasses like *Echinochloa crusgalli* and *Sacciolepis interrupta*, and the only sedge *Scirpus juncoides* were also associated at this stage. All these weeds prevailed in the field for a tleast couple of months. *Cyperus halpan* and *C. pilosus* emerged late and recorded after 50 days of transplanting. The lowest population of weeds and dry weight per unit area was observed through application of pretilachlor as vermicompost mixture with RDF both at 30 and 60 DAT. The plant height at harvest was not affected by the treatments. Application of 75% RD fertilizer-vermicompost (2 t/ha) mixture with pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAT resulted in longest panicle, highest number of panicle/hill and filled grains/panicle. However, the weight of thousand grains was not affected by the treatments. Highest grain and straw yield was obtained due to application of 75% RD fertilizer-vermicompost (2 t/ha) mixture with pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAT. Maximum benefit: cost ratio was recorded with recommended practice for weed and nutrient management (0.89), closely followed by 75% RD fertilizer-vermicompost (2 t/ha) mixture with pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAT. Rama Lakshmi *et al.* 92012) reported that application of 75 per cent chemical fertilizers + vegetable market waste vermicompost 2.5 t/ha was the highest profitable treatment in a *Kharif* rice-*Rabi* green gram sequence. The lowest uptake of N, P and K by weeds was recorded under 75% RD fertilizer-vermicompost (2 t/ha) mixture (3,30 and 60 DAT), pretilachlor 750 g/ha mixed with the first split + HW 30 DAT. Highest uptake of N, P and K by crop was observed with 75% RD fertilizer-vermicompost (2 t/ha) mixture with pretilachlor 750 g/ha mixed with the first split followed by HW 30 DAT and differed significantly to rest of the treatments.

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Effect of tillage systems and integrated weed management on weed density of summer cowpea

P.D. Chendge*, L.S. Chavan and V.N. Game

Department of Agronomy, College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra 415 712

**Email: pravindchendge@gmail.com*

Cowpea is the most important grain legume in the world. It is commonly known as *Lobia*, China pea and marbled pea. In India cowpea production was 0.5 million tonnes from an area of 1.5 million hectares (Anonymous 2007). In Maharashtra, area under cowpea was 11800 hectares with average productivity of 390 kg/ha (Anonymous 2007). The control of weeds has always been one of the greatest resource consuming operations in crop production. The selection of a method or methods for controlling weeds is influenced by the type and age of the crop, the type and size of the weeds, time and the equipment available. Good weed management usually involves a combination of the available methods plus timeless and good cultural practices.

METHODOLOGY

An experiment was conducted on coastal lateratic soil of *Konkan*to study effect of tillage systems and integrated weed management on growth, yield and qualityof summer cowpea (variety- *Konkan Sadabahar*) during summer 2011 at Agronomy Department Farm, College of Agriculture, Dapoli. The experiment was laid out in split plot design with three replications. The main plot treatment consisted of tillage systems and the sub plot treatments consisted of weed management treatments (Table 1).

RESULTS

The minimum weed density was observed in conventional tillage which was at par with minimum tillage and both the tillage systems recorded significantly lower weed density as compared to strip tillage and zero tillage from 25 DAS to harvest. This is obviously due to efficient control of weeds under both the tillage systems that provided better soil physical environment in rhizosphere which resulted in higher crop growth. The higher plant growth might have smothered the weeds by limiting the density of weeds at critical crop-weed competition period. Among the weed management methods, hand weeding at 25 DAS (W_2), combination of W_2 and W_3 (W_4) and integration (W_5) treatments, hand weeding was done at 25 DAS. Therefore, in these treatments the weed density was nil at 25 DAS. Similarly, in weed free check (W_1) the plots were kept weed free throughout the crop growth period. Hence, the weed density recorded in weed free check (W_1) treatment was zero at 25 DAS and significantly lower as compared to rest of the treatments from 50 DAS to harvest. The weed density recorded under unweeded control (W_0) was maximum and significantly higher as compared to rest of the treatments throughout the crop growth period. The weed density under pre-emergence application of pendimethalin 1 kg/ha (W_3) were significantly lower than unweeded control (W_0) and significantly higher over rest of the treatments at 25 DAS and at harvest except weed density recorded under hand weeding at 25 DAS (W_2) at harvest which was at par with (W_3). This is due to heavy weed infestation in unweeded control (W_0) and pre-emergence application of pendimethalin 1 kg/ha (W_3) during the crop growth. The results resemble the finding of Hussaini and Lado (2010).

Table 1. Mean weed density in 0.25 m² area as affected periodically by different treatments

Treatment	Days after sowing (DAS) 25	Days after sowing (DAS) 50	At harvest
Tillage systems			
T_1: Zero tillage	10.9* (2.33)**	17.78 (3.91)	18.60 (4.02)
T_2: Strip tillage	9.65 (2.23)	16.09 (3.69)	17.00 (3.80)
T_3: Minimum tillage	6.52 (1.91)	12.27 (3.17)	13.12 (3.27)
T_4: Conventional tillage	5.78 (1.84)	11.24 (3.04)	12.01 (3.14)
F. test	(Sig)	(Sig)	(Sig)
LSD (P=0.05)	(0.08)	(0.19)	(0.18)
Weed management			
W_0: UnweededControl	34.97 (5.87)	39.51 (6.27)	41.78 (6.45)
W_1: Weed free check	0.00 (0.71)	0.48 (0.95)	0.65 (1.02)
W_2: One hand weeding at 25 DAS	0.00 (0.71)	12.13 (3.49)	13.79 (3.71)
W_3: Pre-emergence application of Pendimethalin 1 kg/ha	14.24 (3.75)	15.48 (3.90)	14.90 (3.82)
W_4: Combination of W2 and W3 treatments	0.00 (0.71)	9.65 (3.11)	10.40 (3.24)
W_5: Integration (One hoeing at 20 DAS + W2 + W3)	0.00 (0.71)	8.82 (2.99)	9.57 (3.10)
F. test	(Sig.)	(Sig.)	(Sig.)
LSD (P=0.05)	(0.07)	(0.19)	(0.20)
General mean	- (2.08)	- (3.45)	- (3.56)

* Original values, **Figures in parentheses are subjected to $\sqrt{X+0.5}$ transformations

CONCLUSION

Conventional tillage recorded significantly lower weed density of weeds over rest of the tillage systems, however, minimum tillage was at par with conventional tillage at all growth stages Weed free check (W_1) recorded significantly the lowest weed density of weeds over rest of treatments. Integration (W_5) and combination of W_2 and W_3 (W_4) treatments remained at par with each other and recorded significantly lower weed density of weeds over rest of weed management treatments.

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Effect of tillage systems and integrated weed management on weed control efficiency and weed index of summer cowpea

P.D. Chendge*, L.S. Chavan and V.N. Game

College of Agriculture, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, Maharashtra 415 712

*Email: pravindchendge@gmail.com

Cowpea is the most important grain legume in the world. It is commonly known as *Lobia*, China pea and marbled pea. It is an important source of dietary protein in developing countries of Asia and Africa. It is used as fodder, vegetable pulse and green manure crop. The economic importance of cowpea is difficult to ascertain, since production statistics no longer kept separate from those of other pulses. In India cowpea production was 0.5 million tonnes from an area of 1.5 million hectares (Anonymous 2007). In Maharashtra, area under cowpea was 11800 hectares with average productivity of 390 kg/ha (Anonymous 2007). The control of weeds has always been one of the greatest resource consuming operations in crop production. The selection of a method or methods for controlling weeds is influenced by the type and age of the crop, the type and size of the weeds, time and the equipment available. Good weed management usually involves a combination of the available methods plus timeless and good cultural practices.

METHODOLOGY

An experiment was conducted on coastal lateratic soil of *Konkan*to study effect of tillage systems and integrated weed management on growth, yield and qualityof summer cowpea (variety- *Konkan Sadabahar*) during summer 2011 at Agronomy Department Farm, College of Agriculture, Dapoli. The experiment was laid out in split plot design with three replications. The main plot treatment consisted of tillage systems and the sub plot treatments consisted of weed management treatments (Table 1).

RESULT

Conventional and minimum tillage systems recorded higher weed control efficiency compared to strip and zero tillage systems. However, the lower weed index values were recorded due to conventional and minimum tillage systems over strip and zero tillage systems. This is because of lower weed density and weed growth under conventional and minimum tillage systems. Results conform to the findings of Buhler and Oplinger (1990). Unweeded control (W_0) recorded the lowest weed control efficiency. Weed free check (W_1) had the highest weed control efficiency followed by integration (W_5) and combination of W_2 and W_3 (W_4) treatments, respectively. However, weed free check (W_1) recorded the lowest weed index followed by integration (W_5) and combination of W_2 and W_3 (W_4). The highest weed index was recorded in unweeded control (W_0). Results conform to the findings of Rathi *et al.* (2004).

Table 1. Weed control efficiency and weed index as influenced by different treatments at harvest

Treatment	Weed control efficiency	Weed index
Tillage systems		
T_1: Zero tillage	28.52	34.96
T_2: Strip tillage	37.29	30.80
T_3: Minimum tillage	55.76	26.65
T_4: Conventional tillage	58.96	25.84
Weed management		
W_0: UnweededControl	-	67.84
W_1: Weed free check	100	-
W_2: One hand weeding at 25 DAS	39.58	39.66
W_3: Pre-emergence application of Pendimethalin 1 kg/ha	28.52	55.19
W_4: Combination of W2 and W3 treatments	49.45	14.00
W_5: Integration (One hoeing at 20 DAS + W2 + W3)	53.20	0.45

CONCLUSION

Conventional tillage recorded the highest weed control efficiency followed by minimum tillage and strip tillage. The lowest weed index value was recorded due to conventional tillage followed by minimum tillage and strip tillage. Unweeded control (W_0) recorded the lowest weed control efficiency. Weed free check (W_1) had the highest weed control efficiency followed by integration. The highest weed index was recorded in unweeded control (W_0) while, weed free check (W_1) recorded the lowest weed index followed by integration (W_5).

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Weed management in direct seeded rice under double no-till rice-wheat cropping system of eastern Indo-Gagnatic Plains

Raj Kumar Jat*[1], Ravi Gopal Singh[2], Ashok Yadav[3], Gurjeet Gill[4] and Raj K. Gupta[1]
[1]*Borlaug Institute for South Asia (BISA)-CIMMYT, NASC Complex, DPS Marg, New Delhi-110 012,*
[2]*Bihar Agricultural University, Sabour, Bhagalpur;*[3]*International Rice Research Institute (IRRI), Patna, India*
[4]*Waite Campus, University of Adelaide, Australia*
**Email: r.jat@cgiar.org*

Most of farmers of this Eastern India are marginal and resource poor that would mean, farmers need technologies that reduce their costs of cultivation and improve their returns such as direct seeded rice (DSR). However, weeds are a major concern in DSR, especially in eastern IGP. Weeds infestation with more intensity and diversity in DSR results in yield losses in the range of 30 to 90%, reduces grain quality and enhances the cost of production (Singh *et al*.2009). Direct seeded Rice (DSR) is an alternate options to traditional transplanted rice which can be rotated with zero till wheat for timely planting of both crops enabling farmers to produce more at less cost instead of puddle transplanted rice and conventionally tilled wheat.

METHODOLOGY

A field experiment was conducted at Regional Maize and central Seed Production Center, Kushmohat (Begusarai), Bihar during kharif season of 2010 to evaluate different herbicidal treatments (Table 1) in zero-till-DSR grown in sequence with zero-till (ZT) wheat. The soil of the experimental field was silty loam in texture with medium fertility. Rice variety *'PAU 201'* was sown with zero-till seed drill at 20 cm row to spacing using seed rate of 20 kg/ha on 15th June, 2010. The plot size was 5.0 m x 4.0 m and experiment was conducted in randomized block design replicated thrice . The crop was raised with all recommended package of practices and herbicides were applied with knapsack sprayer attached with multi-nozzle boom as per treatment protocols in a spray volume of 300 L water/ha. The crop was severely infested with complex weed flora including grasses, broadleaf weeds, sedges and other aerobic grassy weeds (data not given).

RESULTS

Pre-emergence (PRE) application of pendimethalin either emulsifying concentration (EC) 1000-1250 g/ha or capsulated suspension (CS) 1000 g/ha followed by bispyribac-sodium 25 g/ha at 20 days after sowing as post-emergence (POE) was very effective against complex weed flora in DSR resulting into better economic productivity (Table 1).

CONCLUSION

Weed management due to intense and more diversified weed flora is crucial in DSR more particularly in eastern India. Pendimethalin 1000 g/ha as pre-emergence followed by sequential application of bispyribac-sodium 25 g/ha could be effective herbicidal combination to effectively manage most of the weeds. However, integration with more herbicides depending upon weeds case by case and also additional manual weeding may be required to rouge left over weeds in the season. In general, on an average the productivity of wheat under ZT after DSR was 1-3 t/ha higher over the years both at Research Farm as well as at multi-locational farmers' fields in Bihar as well as in other parts of NW of India including Haryana and Punjab (data not given) and as such would be very profitable and sustainable preposition in R-W cropping systems besides being eco-friendly.

Table 1. Effect of different herbicidal combinations on weeds and rice yield under ZT- DSR

Treatment	Dose (g/ha)	Total weeds (no./m^2)		Weed dry weight (g/m^2)		Grain yield (t/ha)
		40DAS	80DAS	40DAS	80DAS	
Bispyribac	25 (POE)	62.6	49.0	52.2	82.1	2.6
Pendimethalin EC	750 (PRE)	72.4	55.8	72.4	134.5	2.4
Pendimethalin EC	1000(PRE)	67.0	61.9	60.5	84.2	2.8
Pendimethalin EC	1250(PRE)	72.4	67.0	64.8	86.4	3.0
Pendimethalin CS	750(PRE)	84.2	56.9	100.4	172.8	2.8
Pendimethalin CS	1000(PRE)	85.3	77.8	81.0	109.1	2.8
Pendimethalin EC *fb* bispyribac	750(PRE) and 25(POE)	27.0	32.8	43.2	56.2	3.0
Pendimethalin EC *fb* bispyribac	1000(PRE) and 25(POE)	25.9	26.3	37.8	49.7	3.2
Pendimethalin EC *fb* bispyribac	1250(PRE) and 25(POE)	14.0	18.0	34.6	58.8	3.4
Pendimethalin CS *fb* bispyribac	750(PRE) and 25(PRE)	29.2	38.2	46.4	65.1	3.2
Weedy check	-	103.7	110.5	136.1	367.2	1.5
weed free	-	0.0	0.0	0.0	0.0	4.2
LSD (P=0.05)		22.3	5.3	9.7	32.1	0.4

Integrated weed management in transplanted rice

Vimal Raj Yadav* , V. Pratap Singh and Abnish kumar
College of Agriculture, G.B.Pant University of Agriculture & Technology Pantnagar, Uttarakhand 263 145
**Email: vimalrajyadav31990@rediffmail.com*

Rice (*Oryza sativa* L.) is one of the most important food crop of India contributing about 40 per cent of the total food grain production. Out of the total 43 Mha area under rice cultivation, puddled rice culture occupies 56 per cent (Anonymous, 2005). Among several production constraints, weeds are most important, causing enormous losses in yield and quality of produce**.** Infestation of weeds led to a yield reduction of 50 per cent (Mukherjee and Singh 2005). Thus, timely and effective management of weeds is pivotal to augment the productivity of rice .Being a long duration crop, pre-emergence application of herbicides alone will not provide effective control of all type of weeds in long run and thus, integration of pre-emergence with sequential application of post-emergence herbicides or hand weeding or other options of weed management is needed for effective weed management in standing crop of rice. In cognizance of the above facts, the present study was planned to develop a suitable weed management practice in rice.

METHODOLOGY

A field experiment was conducted during *Kharif* season of 2012 at N.E.Borlaug Crop Research Center of GBPUAT, Pantnagar to develop an appropriate integrated approach for managing weeds in transplanted rice. The experiment was laid out in randomized block design with twelve treatments (Table 1). Twenty five days old seedlings of variety "*Sarjoo 52*" were transplanted in puddled situation at spacing of 20 x 10 cm on 6 July, 2012. Pre-emergence application of pretilachlor was applied at 3 days after transplanting of seedling while post-emergence application of penoxsulam and bispyribac-Na were sprayed at 20 and 14 DAT, respectively by knapsack sprayer with the volume of 500 l/ha of water. The data on weed density and dry matter accumulation were recorded at 60 DAT and weed control efficiency (WCE%) of different treatments was computed using data on weed dry matter. Rice crop was harvested manually with help of sickle at height of 10-15 cm from ground level on 3rd November 2012.

RESULTS

The most dominant weed species found in the weedy plots were *Echinochloa colona* (16.1%), *E. crus-galli* (8.9%), *Leptochloa chinensis* (9.9%) and *Ischaemum rugosum* (11.4%) among the grasses and *Ammania baccifera* (18.7%), *Caesulia axillaris* (18.2%) and *Alternanthra sessilis* (5.2%) among the broad leaf weeds and *Cyperus difformis* (11.7%) among the sedges. Among all weed control treatments, pre-emergence application of pretilachlor 750 g/ha without water stagnation in field up to one week *fb* post-emergence application of bispyribac-Na 20 g/ha brought significant reduction in total weed density and dry weight, followed by alone application of bispyribac-Na 20 g/ha as post-emergence and twice hand weeding (20 and 40 DAT) over rest of the treatments. The better performance of this treatment could be ascribed to reduced crop-weed competition at initial stage by suppression of the late emerged weeds by sequential application of bispyibac-Na as post-emergence. The WCE which reflects the efficiency of herbicides for controlling weeds was highest with pretilachlor 750 g/ha without water stagnation in field upto 1 week *fb* post-emergence application of bispyribac-Na 20 g/ha. Grain yield remained at par with each other under all the treatments but was significantly superior over the weedy check (Table 1). Pre-emergence application of pretilachlor 750 g/ha without water stagnation in field up to one week than the application of bispyribac-Na 20 g/ha as post-emergence was found superior over rest of the treatments and produced the maximum grain yield. Among the different doses of penoxsulam 25 g/ha followed by its lower dose applied at 22.5 g/ha recorded the maximum grain yield owing to enhanced number of panicles and number of grains/panicle.

Table 1. Effect of weed control treatments on weed density, dry weight and yield of rice crop

Treatment	Dose (g/ha)	Total weed density (no./ m²) 60 DAT	Total weed dry weight (g/m²) 60 DAT	WCE (%) 60 DAT	Grain yield (t/ha)
Penoxsulam post-emergence	20.0	4.7(106.7)	4.1(58.9)	64.5	4.90
Penoxsulam post-emergence	22.5	4.3(76.0)	3.8(42.4)	74.5	5.16
Penoxsulam post-emergence	25.0	3.5(32.0)	3.2(23.8)	85.7	5.26
Bispyribac-Na post-emergence	20.0	3.3(26.7)	2.7(14.0)	91.6	5.63
Pretilachlor pre-emergence	750	4.5(93.3)	4.1(59.1)	64.4	4.84
Pretilachlor *fb* 1 H.W (45 DAT)	750	3.5(33.3)	2.8(15.9)	90.5	5.39
Penoxsulam *fb* 1 H.W (45 DAT)	22.5	3.6(34.7)	3.0(20.3)	87.8	5.36
Pretilachlor + without water stagnation in field upto one week	750	4.7(108.0)	4.2(66.6)	59.9	4.64
Pretilachlor + without water stagnation in field upto one week *fb* bispyribac-Na	750 *fb* 20.0	2.1(8.0)	0.8(2.2)	98.7	5.73
One mechanical weeding through cono weeder *fb* 1 HW	15 *fb* 45 DAT	4.9(140.0)	4.5(88.2)	46.9	4.48
Hand weeding twice	20 and 40 DAT	3.4(29.3)	2.7(13.4)	92.0	5.63
Untreated (weedy check)	-	5.5(256.0)	5.1(166.2)	0.0	2.29
LSD (P=0.05)	-	0.27	0.5	3.3	0.70

Original values are given in parentheses.

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Effect of weed management practices on crop physiology, weed growth and soil micro flora of rice

P. Chandola, K. Bhandari and S.K. Guru

College of Basic Science and Humanities, G.B. Pant University of Agricultural and Technology, Pantnagar

The productivity of rice in India is (2.8 t/ha) lower as against world average (3.9 t/ha). Among the various factors responsible for low rice production, weeds as a big constraint cause upto 37% yield loss. They compete with crop plants for nutrients, soil moisture space and sunlight as well as canopy development of crop (Kalyansunderam *et al.* 2006, Yaduraju 2006). Proper weed controls plays a key role in increasing the productivity of crop and maintain the quality.

METHODOLOGY

The field experiment was carried out during the rainy season of 2009 and 2010, at the N. E. Borlaug Crop Research Centre of GBPUAT, Pantnagar to evaluate the effectiveness of weed management practices against weeds and their effects on physiological parameters and yield of rice. The field experiment was laid out in randomized split plot design with three replications. 21 days after sowing transplanted in to field with a spacing of 20 × 15 cm. Five sub plot treatments in previous crop wheat were consisted of weedy (W_1), hand weeding (W_2), Isoproturon (W_3), Isoproturon+tank mix 1% urea (W_4) and Isoproturon+ tank mix 0.1% surfactant (W_5) while main plot consisted of four rice crop treatments *viz.* weedy check (T_1), hand weeding (T_2), butachlor 1.5 kg/ha (T_3) and anilofos 0.5 kg/ha (T_4). The data on weed biomass, crop photosynthetic rate, grain yield and biological yield were recorded. Microbial count of the rice was also recorded.

RESULTS

The populations of weeds consisted mostly of grasses, sedges and broadleaf species. Hand weeding treatment recorded lowest weed dry weight at all the growth stages. Both the herbicide treatments (butachlor and anilofos) recorded lower weed dry weight at 30 and 60 DAT as compared to weedy plot. Photosynthetic rate of rice (Fig.1), biological yield and grain yield (Table 2 was recorded lowest in weedy check, as compared to hand weeding and both the herbicide treatments due to weed competition and shading effect of weeds (Prajapati *et al*. 2003)

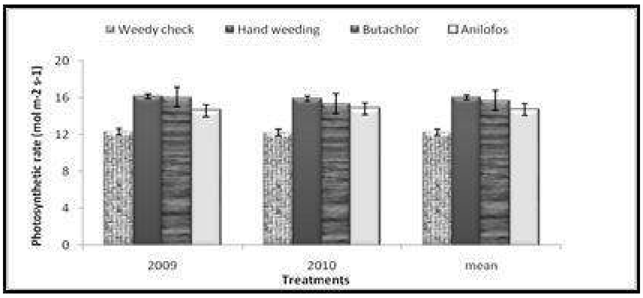

Fig. 1. Photosynthetic rate of rice (Narendra 359) under different weed management practices in a rice wheat cropping system.

Bacterial population in soil was significantly higher in the herbicide (butachlor and anilofos) treated plots as compared to weedy and hand weeding. This increase of bacterial population may be attributed to increased soil nutrients, as herbicides also act as a nutrient source for microbes (Raut 1997)

Table 1. Biological yield, Grain yield and microbial flora of rice (Narendra 359) under different weed management practices in a rice- wheat cropping system (pooled data of 2 years)

Treatment	Biological yield(t/ha)	Grain yield (t/ha)	Bacterial count at harvesting (cfu)
Weedy check	11.71	3.58	[illegible].32×10^9
Hand weeding (30, 60 DAT)	13.61	4.27	[illegible].61×10^9
Butachlor (1.5 kg/ha)	13.72	4.01	[illegible].91×10^9
Anilofos (0.5 kg/ha)	13.30	3.91	[illegible].96×10^9
LSD (P=0.05)	0.62	0.61	.054×10^9

Table 2. Weed dry weight at different growth stages in rice (Narendra 359) under different weed management practices in a rice- wheat cropping system (pooled data of 2 years)

Treatment	Weed dry weight (g/m²)		
	30 DAT	60 DAT	90 DAT
Weedy check	22.37	44.86	36.07
Hand weeding (30, 60 DAT)	1.36	7.44	13.64
Butachlor (1.5 kg/ha)	10.11	32.25	29.15
Anilofos (0.5 kg/ha)	7.03	23.28	31.24
LSD (P=0.05)	3.92	9.43	9.25

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Effect of weed management by herbicides and wheel hoe on weed control and yield of Indian mustard

Jetendra Yadav*, R.S. Singh, D. Singh, I.B.Pandey, D.K. Dwivedi and Ravikant Kumar
Department of Agronomy, Rajendra Agricultural University,Bihar – 843 121
**Email: jyjetendrayadav@gmail.com*

Indian mustard (*Brassica juncea*) is the most important edible oilseeds crop of Bihar where it is mainly grown on poor soils with poor management practices which are mainly responsible for its low productivity. Among them, yield reduction due to weed infestation is major constraint accounting for 24.5% yield loss (Singh *et al*. 2012). Generally, farmers are going for manual weeding and that too, not at proper stage of crop growth may be due to unavailability of labourers, increased wages and time taking process. Therefore, it is high time to look for an alternative which is cost effective and timely weed control. Keeping this in view, this experiment was conducted.

METHODOLOGY

The experiment was conducted at Research Farm of Tirhut College of Agriculture, Rajendra Agricultural University, Pusa, Samastipur, Bihar during 2012-13 in *Rabi* season. The soil of the experimental plot was sandy loam having organic carbon (0.473%), available nitrogen (250.6 kg/ha), phosphorus (30.42 kg/ha), and potassium (157.3 kg/ha); with pH value of 8.6. There were thirteen treatments i.e., Pendimethalin 0.75 kg/ha (P.E); pendimethalin 1.0 kg/ha(P.E); pendimethalin 0.75 kg/ha (PE); oxadiargyl 0.09 kg/ha (PE); Trifluralin 0.75 kg/ha (PPI); oxyfluorfen 0.15 kg /ha (P.E); quizalofop 0.06 kg/ha (20-25 DAS); clodinafop 0.06 kg/ha (20-25 DAS); Isoproturon 1.0 kg/ha(P.E); Isoproturon 1.0 kg/ha (30 DAS); Isoproturon 0.75 kg/ha (30 DAS); Weed free; Weedy check and Wheel hoe. Variety of Indian mustard was Rajendra Sufalam. Recommended dose of fertilizers i.e., 80:40:40:20 kg N: P_2O_5 : K_2O : S/ha were applied uniformly in all the treatments and the experiment was laid out in randomized block design with three replications

RESULTS

Weed count, weed dry biomass, weed control efficiency and yield of mustard were significantly influenced by different herbicides applied and weeding by wheel hoe. Although, lowest weed count, dry weight and maximum weed control efficiency were recorded under isoproturon 1.0 kg/ha (30 DAS) but the yield recorded by this treatment was found to be lower than yields recorded by pendimethalin treatments because isoproturon 1.0 kg/ha (30 DAS) had suppressing effect on mustard crop also. It was also found that irrigating the field immediately after application of isoproturon 1.0 kg /ha (30 DAS) had phyto-toxic effect on crops resulting in slower growth of crop as well as its chlorotic effect on leaves. Mustard yield (1.87 t/ha) recorded by the plots where weeding was done by wheel hoe was found similar to yield realized under weed free (1.98 t/ha) condition which may be due to interculturing operation caused by wheel hoe while weeding was being done and increased aeration and automatic earthing up of mustard plants to some extent.

Table 1. Effect of herbicides on weed dynamics and yield of Indian mustard.

Treatment	Weed count/m²	Dry Wt. (g/m²)	WCE (%)	Mustard Yield (t/ha)
Pendimethalin 0.75 kg /ha (P.E)	299	17.1	57.0	1.71
Pendimethalin 1.0 kg /ha(P.E)	293	16.9	57.5	1.69
Pendimethalin(*Stomp Extra CS)* 0.75 kg/ha/ha	269	17.4	56.3	1.71
Oxadiargyl 0.09 kg/ha (PE)	351	26.6	33.2	1.49
Trifluralin 0.75 kg/ha (PPI)	363	27.7	30.4	1.46
Oxyfluorfen 0.15 kg/ha(P.E)	277	19.9	50.0	1.66
Quizalofop 0.06 kg /ha (20-25DAS)	296	24.5	38.4	1.58
Clodinafop 0.06 kg/ha (20-25 DAS)	305	28.6	28.1	1.47
Isoproturon 1.0 kg /ha(P.E)	246	16.3	59.0	1.60
Isoproturon 1.0 kg/ha (30 DAS)	124	10.3	74.1	1.60
Weeding by Wheel hoe	136	11.7	70.6	1.87
Weedy free	00	00	100	1.98
Weed check	474	39.8	--	9.35
LSD(P=0.05)	68	7.3		0.32

CONCLUSION

Weeding by wheel hoe after 30-35 of sowing was found to be most effective for weed management good yield realization in mustard.

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Tillage and weed control methods on crop yield and weed growth under rice based conservation agriculture system

R. Govindan*[1], C. Chinnusamy[2] and N.K. Prabhakaran[2]

[1]TNAU, Coimbatore, [2]AC&RI Madurai, TNAU, and [3]Professor, Department of Agronomy, TNAU, Coimbatore 641 003

**Email:govindan.agr@gmail.com*

Rice istraditionally grown by manual transplanting of seedlings into puddled soil (Chauhan 2012). Transplanted rice and conventional tillage require large amount of water, energy and labour, which are becoming increasingly scarce and expensive. Therefore, over the past few years in many countries, there has been increasing trend towards conservation agriculture (CA).Conservation tillage, a practice that was introduced initially to reduce wind erosion was slowly transformed into conservation agriculture (CA). Conservation agriculture minimize soil disturbance, permanent residue for soil cover, and rotation of main crops. Weed control in CA is a greater challenge than in conventional agriculture.The behaviour of weeds and their interaction with crops under CA tend to be complex and not fully understood. Hence, field experiments were conducted to develop information on weed population, weed dynamics and crop productivity in rice based conservation agriculture system.

METHODOLOGY

Field experiment was carried out during kharif 2012 in wetland farm at Tamil Nadu Agricultural University, Coimbatore to study the weed management in rice based conservation agriculture system. Treatment consists of six tillage methods as horizontal strips and three weed management practices as vertical strips. The experiment was laid out in strip plot design with three replications. The rice variety ADT (R) 45 was used. Soil was clay loam in texture, low in available nitrogen, medium in available phosphorus and high in available potassium.

RESULTS

The experimental field was dominated weed species were *Echinochloa crusgalli* and *Echinochloa colonum* among grasses, *Cyperus difformis* under sedge and *Eclipta prostrate, Marsilia quadrifoliata* and *Monochoria vaginalis* under broad leaved weeds. Significantly, lower total weed density observed in transplanted rice with conventional tillage - conventional tillage – zero tillage system (T_1) (Chhokar *et al.* 2007) Significantly, higher total weed density was recorded in direct sown rice with zero tillage + crop residue - zero tillage + crop residue - zero tillage (T_6). Among the weed management practices, integrated weed management (W_2) recorded significantly, lower total weed density. Transplanted rice conventional tillage - conventional tillage – zero tillage system with integrated weed management (T_1W_2) practice recorded lower total weed density.The transplanted rice with conventional tillage - conventional tillage – zero tillage system (T_1) produced distinctly more grain yield of 5103 kg/ha. Among the weed management practices, integrated weed management (W_2) recorded significantly higher grain (5.42 t/ha). Combination of transplanted rice conventional tillage - conventional tillage – zero tillage system with integrated weed management practice (T_1W_2) statistical supremacy by recording higher grain yield (6.07 kg/ha).

Table 1. Effect of tillage and weed management practices on total weed density (no/m²) in rice at 60 DAS/T under conservation agriculture system

Treatment	Transplanted rice (CT-CT-ZT)	Transplanted rice (CT-ZT-ZT)	Transplanted rice (ZT +CR –ZT +CR -ZT)	Direct sown rice (CT-CT-ZT)	Direct sown rice (CT-ZT-ZT)	Direct sown rice (ZT +CR –ZT +CR -ZT)	Mean
W_1 (Chemical)	4.38(17.3)	4.40(17.3)	5.51(28.3)	5.16(24.7)	5.44(27.7)	6.00(34.0)	5.15(24.9)
W_2 (IWM)	2.92(6.7)	3.56(10.7)	4.79(21.0)	4.60(19.3)	4.72(20.3)	5.32(26.3)	4.32(17.4)
W_3 (Unweeded check)	9.41(86.7)	10.32(104.7)	10.99(119.0)	11.28(125.3)	11.10(121.3)	11.74(136.0)	10.81(115.5)
Mean	5.57(36.8)	6.09(44.2)	7.10(56.1)	7.01(56.4)	7.09(56.4)	7.69(65.4)	
	T	W	T at W	T at W			
LSD (P=0.05)	0.33	0.50	0.55	0.66			

Figures in parentheses are mean of original values; Data subjected to square root transformation

Table 2. Effect of tillage and weed management practices on grain yield of rice under conservation agriculture system

Treatment	Transplanted rice (CT-CT-ZT)	Transplanted rice (CT-ZT-ZT)	Transplanted rice (ZT +CR –ZT +CR -ZT)	Direct sown rice (CT-CT-ZT)	Direct sown rice (CT-ZT-ZT)	Direct sown rice (ZT +CR –ZT +CR -ZT)	Mean
W_1 (Chemical)	5693	5245	4818	5193	4370	4225	4924
W_2 (IWM)	6073	5851	5192	5557	5062	4814	5425
W_3 (Unweeded check)	3543	3376	2973	3496	3098	2867	3226
Mean	5103	4824	4328	4749	4176	3969	
	T	W	T at W	T at W			
LSD (P=0.05)	401	182	550	467			

CONCLUSION

Adoption of transplanted rice conventional tillage - conventional tillage – zero tillage system with pre emergence of Butachlor 1.0 kg/ha + Inter crop daincha incorporation with mechanical weeding on 35-45 DAT/S was efficient in controlling weeds and improving the rice yield.

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Efficacy of chlorimuron-ethyl against weeds in transplanted rice

***Ashita Rathore, K.R. Naik, Alpana Tiwari, Megha Dubey and Suchi Gangwar**
Department of Agronomy, College of Agriculture, JNKVV, Jabalpur, Madhya Pradesh 482 004
**Email:ashitajnkvv@gmail.com*

In general, rice is preferably transplanted under irrigated agro-ecosystem but weeds are the serious constraints for higher yields, which reduce the yield upto 57-61% (Mukherjee *et al.* 2008). The new herbicide molecule *i.e.* chlorimuron ethyl has been launched for controlling broad-leaved weeds in rice. However, very meager information is available about the selectivity and bio-efficacy of this herbicide, hence the present investigation was undertaken.

METHODOLOGY

A field experiment was carried out during *Kharif* season of 2013 at Jawaharlal Nehru KrishiVishwaVidhyalaya, Jabalpur (M.P.) to test the efficacy of chlorimuron ethyl against weeds. Seven treatments consting of chlorimuron ethyl at varying doses along with hand weeding and weedy check were arranged in a randomized block design with three replications. Rice variety 'IR 64' was transplanted in the experimental field with recommended package of practices. Data on weed growth and yield performance were recorded.

RESULT

The results showed that twice hand weeding at 20 and 40 DAT was found best for weed control in transplanted rice. The weed density and weed dry weight at 30 DAT and harvest was significantly reduced under the different doses of chlorimuron-ethyl in comparison to control plot. The weed density and dry weight was found lowest under the hand weeded treatments. Among different weed control practices, hand weeding at 20 and 40 DAT found significantly superior for reducing broad-leaved weed density and dry weight of dominated weed flora at 25 DAT and harvest stages, respectively. However, the higher dose of chlorimuron-ethyl 24 g/ha was found significant for reducing density (40.20 and 19.5/m^2) and dry weight (29.57 and 26.45 g/m^2) of broad-leaved weeds at 30 DAT and at harvest, respectively. Grain yield of rice was higher (3.05 t/ha) under two hand weeding done at 20 and 40 DAT which was followed by chlorimuron-ethyl 24 g/ha (2.56 t/ha).

Table 1. Effect of different treatments on weed density, weed dry weight and grain yield in transplanted rice

Treatment	Broad-leaved weed (/m^2)				Grain Yield (t/ha)	Weed Control Efficiency (%) at harvest
	Weed density		Weed dry weight(g/m^2)			
	30 DAT	At Harvest	30 DAT	At Harvest		
Chlorimuron-ethyl 3 g/ha	9.14 (83.1)*	8.42 (70.45)	8.30 (68.5)	7.14 (50.5)	1.58	53.03
Chlorimuron-ethyl 6 g/ha	8.88 (78.4)	8.11 (65.4)	7.58 (57.1)	7.07 (49.5)	1.85	56.40
Chlorimuron-ethyl 9 g/ha	7.80 (60.45)	6.37 (40.2)	7.08 (49.7)	6.61 (43.2)	2.26	73.20
Chlorimuron-ethyl 12 g/ha	7.11 (50.15)	5.73 (32.42)	6.14 (37.23)	5.38 (28.45)	2.38	78.39
Chlorimuron-ethyl 24 g/ha	6.37 (40.20)	4.47 (19.5)	5.48 (29.57)	5.19 (26.45)	2.56	87.00
Hand weeding (20a nd 40 DAT)	5.53 (30.14)	0.71 (0.0)	3.5 (12.1)	1.22 (1.0)	3.05	96.66
Weedy Check	13.10 (171.3)	12.26 (150.0)	12.14 (147.0)	11.83 (139.5)	1.41	-
LSD (P=0.05)	0.78	0.93	2.16	0.21	0.81	-

*Figures in parentheses are original values.

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Effect of metribuzin in combination with clodinafop, sulfosulfuron and carfentrazone on weed population and yield of wheat

Nishant*, Suchi Gangwar and Pratibha Singh

Crop Research Centre of SardarVallabhbhai Patel University, Meerut Uttar Pradesh 250 110

Wheat (*Triticum aestivum* L.) is the second most important cereal crop of India next to rice and accounts for 31.5% of the total food grain basket of the country. India is the second largest wheat producing country in the world after China, It covers an area of 29.25 million hectare with total production of 93.90 million tones and average productivity of 3.05 t/ha (Ministry of Agriculture Government of India 2011-12). The prominent weeds noted in wheat field are *Phalaris minor, Cyperus rotundus, Cynodon dactylon, Chenopodium album, Anagallis arvensis, Avena fatua, Convolvulus arvensis and Lathyrus spp* etc, which alone causes 33 per cent reduction in wheat yield.

METHODOLOGY

The experiment was conducted at crop research Centre of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, in *Rabi* season of 2011-12.The soil of experimental fied was sandy loam in texture for soil analysis. The experiment was laid out in randomized block design with different combinations of herbicide. The details of the treatment description are (clodinafop 15% WP, sulfosulfuron 75% WG, metribuzin 70% WP, carfentrazone 40% WG, clodinafop 15% WP+ metribuzin 70% WP, clodinafop 15% WP+ metribuzin 70% WP, sulfosulfuron 75% WG + metribuzin 70% WP, Sulfosulfuron 75% WG+ carfentrazone 40% WG, weed free, Weedy).

RESULTS

At 60 DAS stage weed population of the different weed species affected significantly due to different weed control treatment. Lowest weed population observed (0.75) with Sulfo. + Metri. 25+105 g/ha (T_7), followed by sulfo. + carfen. 25+40 g/ha (T_8) and Clodi. + Metri. 60 + 122.5 g/ha (T_5), being at par. Highest weed population of *P. minor* observed (15.4) with weedy (T_{10}), Significantly lower weed population was foundthan weedy T_{10}), lower weed population of*C.album* (1.1), was recorded with sulfo.+metri. 25+105 g/ha (T_7) followed by sulfo.+carfen.25+40 g/ha (T_8) and Clodi.+ Metri. 60+105 g/ha (T_6), being at par. Significantly lower weed population were recorded remaining treatment than weedy (T_{10}), At harvest stage weed population of the different weed species affected significantly due to different weed control treatment. In case of *P. minor* significantly highest weed population of *P. minor* was observed (15.2%) with weedy T_{10} and lowest weed population was observed (0.0%) with Sulfo.+ metri. 25+105 g/ha (T_7) followed by clodi.+ metri. 60 + 122.5 g/ha (T_5) sulfo. + carfen. 25+40 g/ha (T_8) and clodi.+ metri. 60+105 g/ha respectively. remaining treatment recorded lower weed population than weedy (T_{10}). In case of *C. album,* lowest population (1.0), was recorded sulfo.+metri. 25 + 105 g/ha(T_7) at par with clodi.+ metri. 60 + 122.5 g/ha (T_5) and sulfo. + carfen. 25+40 g/ha (T_8) respectively. Highest grain yield (5.5t/ha) was recorded in herbicidal weed control treatment under sulfo.+ metri.25+105 g/ha (T_7), followed by clodi. + metri.60+122.5g/ha (T_5), and sulfo. +carfen.25+40 g/ha (T_8) being statistically at par respectively.

Table 1. Effect of various weed control treatment on weed population and grain yield of wheat

Treatment		At 60 DAS		At harvest		Grain yield
		P. minor	***C. album***	***P. minor***	***C. album***	(t/ha)
T_1	Clodinafop 60 g/ ha	8.2	15.3	8.5	13.5	4.4
T_2	Sulfosulfuron 25 g/ha	6.5	8.2	6.1	7.8	4.8
T_3	Metribuzin 175 g/ ha	2.5	4.1	2.5	3.1	4.6
T_4	Carfentrazone 50 g/ha	7.2	5.4	5.3	4.4	4.2
T_5	Clodi.+Metri.60+ 122.5g/ha	1.5	2.0	1.0	1.9	5.4
T_6	Clodi.+Metri. 60+105 g/ha	1.7	2.2	2.1	2.0	5.2
T_7	Sulfo.+Metri. 25+105 g/ ha	0.75	1.1	0.9	1.0	5.5
T_8	Sulfo.+Carfen.25+ 40 g/ ha	1.0	1.2	1.3	2.0	5.1
T_9	Weed free	0.0	0.0	0.0	0.0	5.6
T_{10}	Weedy	15.4	24.6	15.2	26.2	3.8
LSD(p=0.05)		1.00	1.11	1.54	2.93	3.16

CONCLUSION

Thus, it may be concluded that application of Sulfosulfuron metribuzin 25 + 105 g/ha as post emergence followed by clodinafop.+ metribuzin 60 + 122.5 g/ha as post emergence proved superior than other treatment with respect to grain yield and economics of wheat.

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Bio-efficacy of halosulfuron methyl against *Cyperus* spp. in no-tilled dibbling maize

Pijush Kanti Mukherjee
Department of Agronomy, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal -736 165
**Email:pkm_agronomy@yahoo.co.in*

Among the sedges *Cyperus rotundus* is the most aggressive weeds (53 to 57% of total sedge population) during the *pre-Kharif* (summer season) and *Kharif* season (rainy season) in the upland condition along with *Cyperus iria, Cyperus flavidus, Cyperus difformis, Fimbristylis miliacea, Fimbristylis dichotoma.* These weeds have been considered as one of the major constraints in the crops grown during summer and rainy seasons. Maize is not a popular crop among the farmers during summer and rainy season because of high rainfall and therefore, maize has not been introduced so far in these seasons. In addition to high rainfall as a characteristic feature of *tarai* region, Weed infestation is becoming a major constraint in maize production systems and it is reported that weeds cause significant reduction of maize yield. Control of weeds in maize is, therefore, very essential for obtaining a good crop harvest.

METHODOLOGY

The field experiments were carried out during rainy season (*Kharif*) seasons of 2012-13 and 2013-14 at the research farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal. The experiment was laid out in a complete randomised block design with three replications. 6 treatments were assigned as weed control treatment. The weed control treatments were Halosulfuron methyl 52.5 g/ha, Halosulfuron methyl 67.5 g/ha, 2,4-D ethyl ester 900 g/ha, atrazine 500 g/ha, farmers' practice *i.e.* two hand weeding at 20 and 40 days after sowing (DAS) and weedy control treatment. Two doses of Halosulfuron methyl and 2,4-D ethyl ester were applied at 17 DAS i.e. at 3-4 leaf stage of *Cyperus* where as atrazine was applied as per-emergence herbicide. The plot size was 7 x 2.5 m^2. The soil of the experimental field was sandy loam in texture having a pH ranging from 5.32 to 5.64, 0.58% organic carbon content, low in available nitrogen (124.32 kg/ha), medium in available phosphorus (19.14 kg/ha) and low in available potassium (83.42 kg/ha). Maize variety JKMH-1001 (Hybrid Maize) having 70 x 20 cm spacing was sown in 26th July and 15th July and crop was harvested on 24th November and 18th November in the year 2012-13 and 2013-14, respectively. Glyphosate 1.5 kg/ha was applied seven days before sowing as pre-plant desiccators to kill the existing weed flora. The NPK ratio of 150:60:60 kg/ha was applied. Phosphorus and potassium was applied during sowing in form of granular fertilizer at the NPK ration of 10:26:26. Remaining N was top dressed twice in the form of urea fertilizer at 20 DAS and 40 DAS. In no-tilled dibbling crop establishment technique a hole of approximate 6 cm depth was created with the help of a very small spade fitted with long bamboo handle especially prepared for dibbling in no-tilled condition. Measured amount of NPK (10:26:26) and maize seeds were placed inside the hole followed by gentle covering of seeds and fertilizers with soil.

RESULTS

No-tilled dibbling technique caused successful germination and further establishment of maize crop. Sedges were predominant (64%) followed by grasses (32%) and broadleaved weeds (4%). Sempra 75% WG (Halosulfuron - methyl) 90 g/ha recorded significantly less weed bio-mass in comparison to remaining treatments. Sempra 75% WG (Halosulfuron - methyl) 90 g/ha recorded highest weed control efficiency (97%), closely followed by two hand weeding (87 to 90%). Sempra 75%WG (halosulfuron-methyl) 90 g/ha (8.01 to 8.06 t/ha) and farmer practice (8.03 to 8.15 t/ha) recorded significantly more grain yield in comparison to remaining treatments and both the treatments were at par with each other (Table 1). Application of Sempra 75% WG (Halosulfuron methyl) 90 g/ha at 17 DAS (3-4 leaf stage of *Cyperus*) effectively controlled the sedges mainly *Cyperus sp.*, which in turn reduced weed-crop completion for nutrients significantly during critical period. Crop treated with Sempra 75% WG (halosulfuron-methyl) 90 g/ha got the edge over weeds and that resulted in higher grain yield.

Table 1. Effect of treatment on weed dry weight, weed control efficiency and grain yield

Treatment	Dose g/ha		Weed dry weight at 50 DAS (g/m^2)		Weed Control efficiency (%) at 50 DAS		Grain Yield (t/ha)	
	a.i. (g)	Formulation (g/L)	2012-13	2013-14	2012-13	2013-14	2012-13	2013-14
Sempra 75% WG (Halosulfuron-methyl)	52.5	70	2.70	3.2	69.83	74.26	7.30	7.50
Sempra 75% WG (Halosulfuron-methyl)	67.5	90	0.23	0.31	97.43	97.51	8.01	8.06
2,4-D ethyl easter 38% EC	900	2.38	3.57	4.12	60.11	66.85	7.20	7.32
Atrazine 50% WP	500	1000	8.43	11.36	5.81	8.61	5.10	5.15
Farmers' Practice (2 hand weeding)			1.13	1.28	87.37	89.7	8.03	8.15
Unweeded check			8.95	12.43			4.80	4.30
LSD (P=0.05)			2.32	2.62			0.64	0.50

CONCLUSION

No-tilled dibbling technique has been found out as a successful crop establishment technique under high rainfall *terai* region during rainy season. Maize crop can be grown successfully in upland condition during rainy season through this crop establishment technique. Among the weed control treatments Sempra 75% WG (Halosulfuron methyl) 90 g/ha was found effective in controlling weeds especially *Cyperus sp.* and also providing higher grain yield of maize.

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Tillage and weed management strategies for wheat in odisha

D.P. Modak*, B. Behera[1] and S.N. Jena

College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar, Odisha 751 003

**Email: bdbehera1@rediffmail.com*

Wheat crop is subjected to keen weed infestation. Weeds reduce grain yield of wheat by 20-40%. The weeds emerging with the crop compete with for nutrients, utilize these in larger amounts than the crop and grow faster resulting in poor crop yield. The problem can be mitigated by use of various herbicides. Application of pre-emergence and post-emergence herbicides can provide weed free conditions in the wheat field. Greater growth and yield of wheat has been reported in zero till methods with use of herbicides. An experiment was conducted at Bhubaneswar to find out effective tillage and weed management strategy for wheat.

METHEDOLOGY

The experiment was conducted at Agronomy Main Research Farm, Orissa University of Agriculture and Technology, Bhubaneswar with latitude of 20^0 15'N, longitude of 85^0 52 E and an altitude of 25.9 m above the mean sea level. It is situated at about 64 km away from the Bay of Bengal. The station falls under East and South Eastern Plains Zone. The treatments comprised two factors viz. tillage methods with three levels i.e. T_1 zero-tillage, T_2 : glyphosate + zero tillage and T_3 : conventional tillage and weed management practices with five levels i.e. W_1 - Metribuzin 0.4 kg/ha as pre-emergence application , W_2 : W_2- Clodinafop 0.06 kg/ha+ 2-4 D Na salt 1.5 kg/ha-Post-emergence, W_3 : W_3- W_1+W_2, W_4- Hand weeding and W_5- Weedy check. The treatments were tried in split plot design with three replications. Wheat cv. 'Kalyan Sona' was used for experimentation. The sowing was done on 08 December 2012 in zero till and glyphosate + zero till plots and on 23 December 2012 in conventional plots with seed rate of 120 kg/ha, row spacing of 15 cm and fertilizer dose of 120-50-50 N-P_2O_5-K_2O kg/ha. The herbicides were applied by knapsack sprayer using a flat fan nozzle to have uniform spray. Glyphosate 1.0 kg/ha was sprayed weeds and ratoon rice in glyphosate + zero tillage(C_2) plots 10 days before sowing. Clodinafop and 2,4-D were applied at 30 days after sowing as post-emergence spray.

RESULTS

At all the stages of observation, glyphosate + zero tillage recorded the minimum dry weight of weeds. Both zero tillage only and conventional tillage recorded significantly higher dry weight of weeds. Weedy check under the conventional tillage registered the maximum dry weight of weeds at all the stages of observation (Table 1). Bhullar and Walia (2004) reported efficacy of clodinafop 60g/ha. Among tillage practices, glyphosate + zero tillage recorded the maximum values of yield attributes viz. effective tillers/m^2 gains/panicle and 1000-grain weight. Among the weed management practices, Metribuzin 0.4 kg/ha as pre-emergence application coupled with clodinafop 0.06 kg/ha+ 2-4,D Na salt 1.5 kg/ha as post-emergence spray registered the maximum vlues of these yield attributes. Interaction effects of tillage and weed management practices on yield attributes *viz.* effective tillers/m^2 and gains/panicle were found significant. Among tillage practices, glyphosate + zero tillage recorded the maximum grain yield of 3.19 t/ha and only zero tillage remained statically at par with it. Among the weed management practices, Metribuzin 0.4 kg/ha as pre-emergence application coupled with clodinafop 0.06 kg/ha+ 2-4 D Na salt 1.5 kg/ha as post-emergence spray gave the maximum grain yield of 3.81 t/ha.

Table 1. Main and interaction effects of tillage and weed management practices on dry weight of weeds

Treatment	W1	W2	W3	W4	W5	Mean
Dry weight of weed(g/m^2) at 30 DAS						
T1	6.59	6.80	5.34	2.19	11.52	6.49(50.27)
T2	4.75	7.19	3.96	2.22	8.76	5.38(33.31)
T3	7.08	9.44	5.41	2.46	12.55	7.39(65.40)
Mean	6.14(37.80)	7.81(61.33)	4.90(23.53)	2.29(4.63)	10.94(121.28)	6.42(49.67)
LSD (P=0.05) for T = 0.51		LSD (P=0.05) for T within same or different W = 0.77				
LSD (P=0.05) for W = 0.22		LSD (P=0.05) for W within T = 0.38				
Grain yield(t/ha)						
T1	2.843	2.380	3.920	3.259	1.703	2.821
T2	3.150	2.810	4.327	3.817	1.847	3.190
T3	2.313	1.953	3.173	3.097	1.723	2.452
Mean	2.769	2.381	3.807	3.391	1.758	2.821
LSD (P=0.05) for T = 0.388		LSD (P=0.05) for T within same or different W = 0.633				
LSD (P=0.05) for W = 0 .199		LSD (P=0.05) for W within T = 0.345				

Original values in parentheses, value prior to parentheses are ($\sqrt{x+1}$) transformed values.

CONCLUSION

Metribuzin 0.4 kg/ha as pre-emergence application coupled with clodinafop 0.06 kg/ha+ 2-4 D Na salt 1.5 kg/ha as post-emergence spray under glyphosate + zero tillage recorded the minimum value of weed dry weight, the maximum values of yield attributes and gave the maximum grain yield of wheat.

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Tillage and weed management in winter maize

S. Majhi*, S.N. Jena and B. Behera

College of Agriculture, Orissa University of Agriculture and Technology, Bhubaneswar Odisha 751 003

**Email: bdbehera1@rediffmail.com*

Maize crop in rice-maize sequence in grown under conventional system comprising repeated tillage operations for seedbed preparation with disk-harrows. It has negative consequences on soil physical characteristics, *viz.* water stability of aggregates, porosity, infiltration capacity, hydraulic conductivity, water holding capacity, stratification of organic matter and nutrients, activity and diversity of edaphic flora and fauna, carbon biomass, soil water and temperature regime. In conventional tillage, greater soil disturbance accelerates oxidation of organic matter up to a greater depth and reduces organic matter content in the soil. The weeds emerging with the crop compete with for nutrients, utilize these in larger amounts than the crop and grow faster resulting in poor crop yield. The problem can be mitigated by use of various herbicides. Application of pre-emergence and post-emergence herbicides can provide weed free conditions in the maize field. Greater growth and yield of maize has been reported in zero till methods with use of herbicides (Chopra and Anigaras 2008).

METHEDOLOGY

The experiment was conducted at Agronomy Main Research Farm, Orissa University of Agriculture and Technology, Bhubaneswar. The treatments comprised two factors viz. tillage methods with 4 levels *i.e.* M_1: conventional tillage, M_2: reduced tillage, M_3 : glyphosate + zero tillage and M_4: zero-tillage and weed management practices with 4 levels *i.e.* W_1 : oxyfluorfen 0.03 kg/ha, W_2 : atrazine 1.0 kg/ha, W_3 : metolachlor 1.0 kg/ha, W_4 : hand weeding and W_5 : weedy check. The sowing was done on 16 December 2012 in zero till and glyphosate + zero till plots and on 2 January 2013 in conventional plots with recommended seed rate of 15 kg/ha and spacing of 60 x 30 cm. The herbicides were applied by knapsack sprayer using a flat fan nozzle to have uniform spray. Glyphosate 1.0 kg/ha was sprayed weeds and ratoon rice 15 days before sowing.

RESULTS

At maturity, the highest weed control efficiency was recorded with glyphosate + zero till. Among the weed control measures, higher weed control efficiency was observed with oxyfluorfen. Results are in agreement with the findings of Shekhawat *et al.* (2002). The highest grain yield was recorded with glyphosate + zero tillage followed by zero tillage and the lowest was recorded with conventional tillage. Glyphosate + zero tillage was found to be significantly superior to other tillage methods. Reason for better performance of glyphosate + zero tillage than other methods were due to less competition between crop and weeds and better yield attribute. Among the weed management practices, oxyfluorfen was found to be significantly superior to rest of the treatments. The maximum grain yield was recorded by oxyfluorfen. This might be due to maintenance of weed free environments leading to complete utilization of nutrients and other growth factors. The minimum grain yield was recorded in the weedy check. The results are in concordance with the findings of Seemantini (2006).

Table 1. Effect of tillage and weed management on weed dry weight. Weed control efficiency. Yield and harvest index

Treatment	Weed dry weight (g /m^2) at maturity	Weed control efficiency (%)	Grain yield (t/ha)	Stover yield (t/ha)	Harvest index (%)
Tillage methods					
M_1- Conventional	8.1 (64.8)	34.9	4.643	7.036	39.4
M_2- Reduced	7.4 (54.4)	39.3	4.728	7.039	39.9
M_3- Zero tillage	6.5 (42.0)	44.6	5.003	7.258	40.6
M_4- Glyphosate + zero tillage	6.1 (36.7)	46.7	5.272	7.463	41.2
LSD(P=0.05)	0.2	-	0.190	0.291	0.002
Weed management practices					
W_1- Oxyfluorfen 0.03 kg/ha	6.4 (40.3)	52.7	5.948	8.518	41.1
W_2- Atrazine1.0 kg/ha	6.4 (40.5)	52.5	5.418	7.674	41.4
W_3- Metolachlor1.0 kg/ha	6.5 (41.2)	51.4	5.081	7.117	41.6
W_4- Hand weeding	6.5 (41.9)	50.4	4.812	6.674	41.9
W_5- Weedy check	9.1 (83.5)	0	3.299	6.010	35.4
LSD(P=0.05)	0.2	-	0.209	0.284	0.002

CONCLUSIONS

Zero tillage and glyphosate + zero tillage recorded 8 and 13.5% higher grain yield of winter maize than the conventional tillage method of cultivation in maize.

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Efficacy of post emergence herbicides on weed flora and yield of zero till sown rice fallow black gram

K. Sasikala*, Ch. Kiran Kumar and P. Ashok

Horticultural College & Research Institute, V.R. Gudem, Andhra Pradesh 534 101

**Email: sasiagron@yahoo.in*

Poor yields in rice fallow black gram may probably due to severe weed infestation and poor plant population due to zero tilled conditions. It is reported that weed infestation in black gram may culminate in yield reduction up to an extent of 45 to 60 per cent. Weeds removal by manual weeding is difficult and uneconomical to practice in this system because of presence of dense rice stubbles and non-availability of labour in time. Application of either pre-sowing or pre emergence herbicides is also difficult due to lack of field preparation and limited period of their application.

METHODOLOGY

A field experiment was carried out during *Rabi* season of 2005 at Agricultural College and Research Institute, Madurai (Tamilnadu) to evaluate post emergence herbicides for their efficiency and selectivity in zero till sown rice fallow black gram. Black gram variety ADT 3 was direct seeded in the experimental field with recommended package of practices. All post emergence herbicides were applied at 15 DAS. Data on weed growth, yield performance and economics were recorded.

RESULTS

Among the weed management practices, post emergence application of fenoxaprop-p-ethyl 75 g/ha or cyhalofop butyl 100 g/ha on 15 DAS significantly reduced the dominant grassy weed population, increased the growth, yield of rice fallow black gram and were found at par with each other. These results are in conformity with the findings of Singh and Tripathi (2003). However, higher monetary returns was obtained in dibbling the seeds three days after pre-sowing application of Paraquat followed by fenoxaporp-pehtyl 75 g/ha. Application of post emergence herbicides was found to be superior over one manual weeding.

Table 1. Weed growth, yield and economics of zero till sown rice fallow black gram as influenced by different methods of sowing and weed management practices

Treatment	Weed density (no./m^2)	Weed dry matter (kg/ha)	Weed Index (%)	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (Rs/ha)	B:C ratio
Methods of sowing							
M_1: Broadcasting of seeds in the standing crop of rice	108.8 (2.0)	78.0	27.60	0.40	1.16	5797	1.46
M_2: M_1 followed by sand mix application of pendimethalin 1 kg/ha	79.22 (1.9)	58.6	23.59	0.56	1.46	7225	1.54
M_3: Dibbling the seeds immediately after harvest of rice	108.0 (2.0)	78.1	20.62	0.67	1.68	6097	2.17
M_4: M_3 followed by sand mix application of pendimethalin 1 kg/ha	79.3 (1.9)	58.6	16.07	0.86	1.97	7527	2.27
M_5: Pre-sowing application of Paraquat 0.5 kg/ha followed by dibbling the seeds three days after Paraquat application	35.8 (1.57)	25.4	14.80	0.94	2.08	6789	2.76
LSD (P=0.05)	0.05	3.3		0.4	5.6		
Weed management practices							
S_1: Fenoxaprop-p-ethyl 75 g/ha	58.0 (1.8)	41.8	2.70	0.80	1.85	6718	2.37
S_2: Imazethapyr 100 g/ha	70.0 (1.8)	51.9	10.79	0.74	1.76	6970	2.11
S_3: Cyhalofop-butyl 100 g/ha	57.9 (1.8)	40.9	0	0.82	1.88	7250	2.26
S_4: Manual weeding at 20 days after sowing of black gram	85.1 (1.9)	62.5	21.66	0.65	1.64	7036	1.84
S_5: Unweeded check	140.2 (2.1)	101.9	46.98	0.45	1.21	5460	1.63
LSD (P=0.05)	0.02	2.2		2.0	3.4		

Data in parenthesis were log ($\sqrt{x+2}$) transformed values

CONCLUSION

It was concluded that the best combination to manage the weeds effectively and efficiently and to exploit higher seed yield potential of zero till sown rice fallow black gram was dibbling the seeds three days after pre sowing application of Paraquat 0.5 kg/ha with post emergence application of either fenoxaprop-p-ehtyl 75 g/ha or cyhalofop-butyl 100 g/ha on 15 DAS.

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Influence of crop establishment methods and weed management practices on rice yield

Y.S. Parameswari*and A. Srinivas

College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh 500030

Email: samata.param @ gmail.com

Rice (*Oryza sativa* L.) is one of the most important cereal crops as it is the staple food of more than 70% of the world's population. The method of establishment in rice largely affects the initial stand and uniformity. Although, transplanting in rice is considered as best for higher productivity of crop, it is not much profitable due to higher labour wages and unavailability of labour during the peak period of operation. Some alternatives such as SRI and direct sowing of sprouted seeds under puddle condition must be explored to overcome these problems. Hence, the present experiment was conducted to find out an efficient weed management practice in relation to crop establishment methods.

METHODOLOGY

An experiment was conducted during *Kharif* seasons of 2010 and 2011 at College Farm, College of Agriculture, Acharya N.G. Ranga Agricultural University, Hyderabad. The soil was sandy loam with a pH of 7.8. The available N, P and K content in the soil was 234.5, 28.9 and 271.6 kg/ha respectively. The main treatments comprised of three crop establishment methods, *viz.* SRI, Direct sowing of sprouted seeds under puddle condition and transplanting, and four weed management practices in sub plots bensulfuron-methyl 60 g + pretilachlor 600 g/ha applied on 3 DAS/T *fb* mechanical weeding at 30 DAS/T, bispyribac sodium at 25 g/ha as early post emergence at 15 DAS/T, famer's practice (hand weeding twice at 20 and 40 DAS in direct-seeded rice and transplanted rice, cono weeding thrice with 10 days interval from 20 DAT in SRI) and weedy check. The experiment was laid out in split-plot design with three replications. The crop was fertilized with 120 kg N, 60 kg P_2O_5 and 40 kg K_2O/ ha. Rice variety *MTU1010* was sown.

RESULTS

The grain yield of transplanted crop during both the years, being at par with that of SRI, was found significantly greater to that of direct-seeded rice under puddle condition. Submerged conditions in transplanted rice facilitate availability of more nutrients by reducing leaching and keep the salt content under control which encouraged tiller production and thus contributing to higher dry matter production and grain yield. Similar findings were observed by Sreelatha (2011). The highest grain yield was registered with farmer' practice followed by application of bensulfuron methyl 60 g + pretilachlor 600 g /ha *fb* mechanical weeding at 30 DAS/T and both were at par. Sunil *et al*. (2010) found similar findings in his study.

Table 1. Influence of crop establishment methods and weed management practices on yield attributes and yield of rice during *Kharif* 2010 and 2011

Treatment	Weed density (no./m^2)		Weed dry weight (g/m)		Grains/panicle		Grain yield (t/ha)		B: C ratio	
	2010	2011	2010	2011	2010	2011	2010	2011	2010	2011
Main treatments										
SRI	8.1 (64.4)	7.6 (57.4)	6.2 (37.6)	5.97 (33.6)	92.1	95.6	4.27	4.44	2.1	2.5
Direct sown rice	8.8 (75.6)	8.3 (66.6)	6.7 (43.4)	6.44 (39.4)	82.5	88.3	3.89	4.08	1.9	2.2
Transplanting	7.6 (57.0)	7.2 (52.6)	5.9 (33.7)	5.85 (32.2)	94.4	98.0	4.41	4.59	2.1	2.4
LSD (P=0.05)	0.6	0.6	0.4	0.4	8.0	6.3	0.36	0.35	-	-
Sub treatment										
Bensulfuron methyl+ Pretilachlor *fb* mechanical weeding at 30 DAS/T	6.0 (34.6)	5.7 (31.4)	4.1 (15.3)	3.7 (11.8)	105.2	106.9	5.33	5.58	2.6	3.0
Bispyribac sodium	8.4 (69.9)	7.9 (60.8)	5.8 (32.1)	5.5 (29.0)	84.8	91.9	3.97	4.16	1.9	2.3
Farmer's practice	5.6 (29.3)	5.2 (25.6)	3.6 (11.2)	3.2 (8.7)	109.1	111.8	5.60	5.86	2.4	2.8
Weedy check	11.4 128)	10.9 (117)	9.8 (94.4)	9.6 (90.7)	59.5	65.3	1.85	1.87	1.2	1.3
LSD (P=0.05)	0.5	0.6	0.5	0.5	4.1	5.0	0.28	0.32	-	-

CONCLUSION

Transplanting method of establishment resulted in significantly higher grain yield and among weed management practices, farmer's practice of weeding recorded significantly higher grain yield of rice. However, higher B: C ratio was obtained with bensulfuron-methyl 60 g + pretilachlor 600 g ha *fb* mechanical weeding at 30 DAS/T.

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Productivity and economics of rice maize as affected by establishment methods and weed management practices

Y.S. Parameswari* and A. Srinivas

College of Agriculture, Acharya N.G. Ranga Agricultural University, Rajendranagar, Hyderabad, Andhra Pradesh-500030

Email: samata.param@gmail.com

Rice (*Oryza sativa* L.) is the predominant cropping sequence in Andhra Pradesh. Rice is grown mostly under transplanting method in India. The inadequacy of irrigation water and scarce labour coupled with higher wages during the peak period of farm operations, invariably lead to delay in transplanting. To overcome this problem, farmers are gradually switching over to direct seeding under puddled conditions. Further, replacement of rice with maize (*Zea mays* L.) in dry season is increasing to save water and for maximum system production. . Weed management is an important key factor in obtaining higher crop yield. Unchecked weed growth causes a reduction in grain yield by about 30-36% in transplanted rice and 61% in wet direct seeded rice. Residual effect of weed management practices of rice may influence weed flora in succeeding crops. When crops are grown under zero tillage conditions in rice fallows there is a chance of heavy infestation of weeds. The information on influence of various weed management practices in different rice establishment methods on succeeding zero till maize was meager. Keeping these facts in view, the present investigation was undertaken.

METHODOLOGY

A field experiment was conducted during 2010-11 and 2011-12 at College Farm, College of Agriculture, Rajendranagar, Hyderabad, Andhra Pradesh. The treatments in the experiment (Table 1) were laid out in split design during *Kharif* season and split-split design during *Rabi* season with three replications.

RESULTS

The highest grain yield was obtained with transplanting which was on par with SRI and significantly superior over direct sown rice under puddled condition. Among weed management practices in rice, farmer's practice of weeding gave significantly higher yield attributes and grain yield which was on par with application of bensulfuron methyl 60 g + pretilachlor 600 g /ha *fb* mechanical weeding at 30 DAS/T. The highest grain yield was due to higher availability of nutrients, lower weed dry matter which resulted in higher dry matter accumulation and higher yield attributes. Chandrapala (2009) also reported similar results. Among weed management practices in rice, farmer's practice of weeding resulted in higher yield and yield attributes of maize and which was on par with bensulfuron methyl 60 g + pretilachlor 600 g /ha *fb* mechanical weeding at 30 DAS/T. The treatments imposed on rice showed similar effect on weed dry matter and yield in both rice and succeeding maize. Even though farmer's practice of weeding in rice resulted in higher gross and net returns, but higher B: C ratio was observed under bensulfuron methyl 60 g + pretilachlor 600 g/ ha *fb* mechanical weeding at 30 DAS/T. Similarly, hand weeding twice at 20 and 40 DAS in maize registered higher gross and net returns. Application of atrazine at 1.0 kg/ha *fb* topramezone at 30 g a.ha recorded higher B: C ratio.

Table 1. Rice equivalent yields (REY) and economics of rice-maize system as influenced by rice crop establishment methods and weed management practices.

Treatment	Rice grain yield (t/ha)	Maize grain yield (t/ha)	REY of maize (t/ha)	Total REY (t/ha)	Gross returns (x10³₹/ha)	Net returns (x10³₹/ha)	B:C ratio
Main treatments -Rice							
SRI	4.43	5.43	4.93	9.37	101.2	58.7	2.3
Direct sown rice	4.07	5.12	4.65	8.75	94.2	51.1	2.1
Transplanting	4.59	5.84	5.30	9.89	106.8	62.7	2.4
Sub-treatments - Rice							
Bensulfuron methyl + pretilachlor *fb* mechanical weeding at 30 DAS/T	5.58	5.55	5.04	10.6	114.7	71.8	2.6
Bispyribac sodium	4.15	5.40	4.90	9.0	97.8	54.9	2.2
Farmer's practice	5.85	5.66	5.14	10.9	118.7	72.8	2.5
Weedy check	1.87	5.24	4.73	6.6	71.3	30.5	1.7
Sub-sub treatments -Maize							
Weedy check	4.36	2.07	1.85	6.22	67.1	25.9	1.6
Atrazine	4.36	6.15	5.58	9.95	107.4	65.1	2.5
Atrazine *fb* Topramezone	4.36	6.65	6.03	10.40	112.3	69.6	2.6
Weed free (hand weeding twice at 20 and 40 DAS)	4.36	6.99	6.34	10.71	115.7	69.3	2.5

CONCLUSION

Transplanting method of establishment and application of bensulfuron methyl 60 g + pretilachlor 600 g /ha *fb* mechanical weeding at 30 DAS/T in rice, application of atrazine at 1.0 kg/ha *fb* topramezone at 30 g /ha in maize is more beneficial to get higher productivity and profitability of the rice-maize system.

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Effect of weed control practices under system of crop intensification (SCI) on yield and quality of sesame

V. Divya*, K. Velayudham, N. Thavaprakaash and M. Daisy
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641003
**Email: divya.vulli@gmail.com*

In India, sesame (*Sesamum indicum* L.) ranks second in importance next to groundnut amongst oilseed crops. Being a slow growing crop during the early phase, weeds compete with sesame for growth resources and affect the growth of sesame and finally reducing the production per unit area. To reduce the weed competition we will go for practicing the some of the agronomical measures like higher plant density per hectare and timely weeding by using hand hoes and mechanical weeders, which can help to boost the production per unit area of the crop (Narkhede *et al*. 2000).

METHODOLOGY

A field experiment was conducted during the early summer season (January to May, 2013) at Wetland farms of Tamil Nadu Agricultural University, Coimbatore, to evaluate the System of Crop Intensification (SCI) practices in sesame. The soil of the experimental field was clay loam in texture belonging to *Typic Haplustalf*. The experiment was laid out in Randomized complete block design and comprised of ten treatments (Table 1) replicated thrice. The sesame variety *VRI (SV) 2* was used as test cultivar. The recommended dose of fertilizers, *i.e.* 35:23:23: NPK kg/ha was applied.

RESULTS

Treatments imposed had profound effect on weed density and weed dry weight due to SCI practices in sesame. Lesser weed density (7.3/m^2) and weed dry weight (1.4 g/m^2) were noticed at 60 DAS under 30 × 30 cm spacing + TIBA at 50 ppm at 30 DAS + Hand weeding over other treatments (Table 1). This was due to the quick growth of sesame than weeds after weeding at 35 DAS which resulted in higher plant dominance over weeds. Similar results were reported by Narkhede *et al*. (2000) in sesame.

Effect of SCI practices brought out a significant influence on seed yield of sesame. Among the treatments, 30 × 30 cm spacing + TIBA at50 ppm at 30 DAS + Hand weeding at 35 DAS had shown its superiority over other treatments in recording higher seed yield (30.25% higher over control). Higher seed yield could be due to better weed control during critical stage and more plant population/m^2. These results are in conformity with the findings of in pigeonpea.

Square planting with 30 × 30 cm spacing + TIBA at 50 ppm at 30 DAS + Hand weeding at 35 DAS gave higher oil yield than other treatments. Since, oil content values were not varied much; the impact of seed yield had a marked effect on oil yield of sesame.

Table 1. Effect of weed control practices under System of Crop Intensification (SCI) on weed growth, yield and quality parameters of sesame

Treatment	Weed density (mo./m^2) 60 DAS	Weed dry weight (g/m^2) 60 DAS	Seed yield (t/ha)	Oil yield (kg/ha)	Oil content (%)
30 × 30 cm spacing + no nipping + hand weeding at 35 DAS –Control	3.1 (8.0)	1.8 (1.5)	0.79	358	45.2
30 × 30 cm spacing + TIBA at 50 ppm at 30 DAS + Hand weeding at 35 DAS	3.0 (7.3)	1.8 (1.4)	1.13	502	44.2
40 × 40 cm spacing + nipping at 35 DAS + Hand weeding at 35 DAS	4.6 (20.0)	2.4 (3.9)	0.82	381	46.4
40 × 40 cm spacing + nipping at 35 DAS + mechanical at 35 DAS	4.1 (15.3)	2.1 (2.6)	1.02	468	45.8
40 × 40 cm spacing + TIBA at 50 ppm at 30 DAS + hand weeding at 35 DAS	4.9 (22.6)	2.4 (3.9)	0.76	345	45.2
40 × 40 cm spacing + TIBA at 50 ppm at 30 DAS + mechanical at 35 DAS	4.2 (16.0)	2.1 (2.4)	0.80	363	45.2
50 × 50 cm spacing + nipping at 35 DAS + Hand weeding at 35 DAS	5.4 (27.3)	2.6 (4.8)	0.77	353	45.6
50 × 50 cm spacing + nipping at 35 DAS + mechanical at 35 DAS	4.6 (20.0)	2.1 (2.7)	0.94	418	44.3
50 × 50 cm spacing + TIBA at 50 ppm at 30 DAS + hand weeding at 35 DAS	5.4 (28.0)	2.4 (4.1)	0.81	380	46.9
50 × 50 cm spacing + TIBA at 50 ppm at 30 DAS + mechanical at 35 DAS	4.8 (21.3)	2.1 (2.7)	0.99	459	46.1
LSD(P=0.05)	0.5	0.2	0.08	42	NS

*Values in parenthesis are original. Data transformed to square root transformation

CONCLUSION

Sesame grown under 30 × 30 cm spacing + TIBA at 50 ppm at 30 DAS + Hand weeding at 35 DAS recorded lower density and dry weight of weed at 60 DAS, higher seed and oil yield.

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Study of pre and post plant herbicidal weed management in transplanted rice

M. Kishor Jalindar*, A. Christopher Lourduraj, P. Murali Arthanari, C. Chinnusamy and M. Madhavi
Department of Agronomy, DWSRC, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641003
**Email: kishormote56@gmail.com*

Weed competition is one of the prime yield–limiting biotic constraints in rice. Although glyphosate has activity on a wide range of annual and perennial weeds, some weeds are more difficult to control with glyphosate than others (Jordan *et al.* 1997). Storrie *et al.* (2007) reported that glyphosate followed by a bipyridil herbicide five days later gave 100% control, while glyphosate or bipyridil alone gave a control of 90%. Though the effect of pre emergence herbicides in transplanted rice has been studied in detail, there are very few studies on the combined effect of pre plant application along with pre emergence / post emergence herbicides in transplanted rice.

METHODOLOGY

Field experiment was conducted from September 2011 to January 2012 at Wetland farm of Tamil Nadu Agricultural University, Coimbatore to study pre and post plant herbicidal weed management in transplanted rice. The experiment was laid out in a Factorial Randomized Block Design with three replications and two factors *viz.* pre-plant herbicide application (with and without glyphosate at 0.75 kg/ha) and pre emergence / early post emergence herbicide treatments (Table 1). The soil of the experimental field was clay loam in texture. Medium duration rice cv. *CO(R) 50* was used as a test variety.

Prior to land preparation, the field was divided into two equal plots by forming bund between them. The first plot was sprayed with pre-plant herbicide glyphosate (Factor A_1) and the second plot was without herbicide glyphosate (Factor A_2) the quantity of pre-plant (Factor A_1), pre emergence and early post-emergence herbicide were calculated as per the treatment schedule. The herbicides were applied keeping a thin film of water in the field.

RESULTS

Pre plant application of glyphosate 0.75 kg/ha recorded lower weed density compared to non application of glyphosate, because preplant glyphosate application eliminated most existing vegetation and prevented weed establishment.

Among the weed control methods, at 20 DAT, PE pretilachlor at 0.75 kg/ha+ HW at 40 DAT recorded higher weed control efficiency because of lesser weed biomass recorded in the treatment followed by butachlor 1.25 kg/ha + HW at 40 DAT and almix 20 g/ha + HW at 40 DAT. Among weed control methods, higher grain yield was recorded in EPOE Bensulfuron methyl + pretilachlor (6.6 GR) at0.06+0.60 kg/ha followed by pretilachlor 0.75 kg/ha + HW at 40 DAT because of less weed competition which led to better crop growth and yield parameters, ultimately resulting in increased crop yield.

Table 1. Effect of weed management practices on grain yield (t/ha)

Treatment	Grain yield		
	A_1	A_2	Mean
PE Butachlor 1.25 kg/ ha + HW on 40 DAT	6.20.	5.60	5.90
EPOE Bensulfuron methyl + Pretilachlor (6.6 GR) 0.06 + 0.60 kg/ha on 10 DAT	6.80	6.10	6.45
PE Pretilachlorat 0.75 kg /ha HW on 40 DAT	6.40	5.80	6.10
PEAlmix 20 g /ha + HW on 40 DAT	5.10	4.40	4.75
Hand weeding twice 20 and 40 DAT	6.10	5.40	5.75
Unweeded check	4.00	3.40	3.70
Mean	5.76	5.11	
	A	T	A*T
LSD (P=0.05)	0.27	0.47	NS

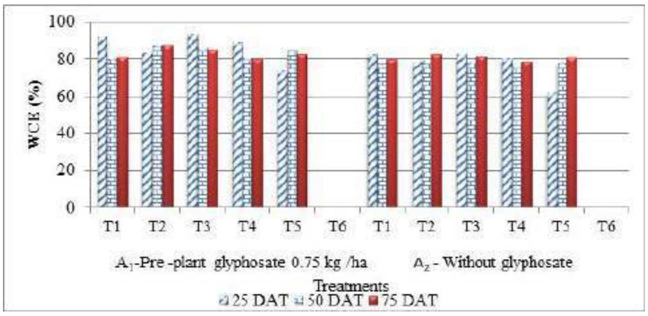

Fig. 1. Effect of weed management practices on weed control efficiency (%)

CONCLUSION

Pre-plant application of glyphosate at 0.75 kg/ha at 27 days before transplanting resulted in lesser weed density. Among the different herbicides and weed control methods tried, EPOE bensulfuron-methyl + pretilachlor (6.6 GR) at 0.06+0.60 kg/ha at 10 DAT resulted in better control of weeds and increased yield

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Efficacy of fusiflex for total weed control in soybean

Dheer Singh*, Nazim Hamid Mir and Nipendra Singh

College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 63145

**Email : singhdheer2011@gmail.com*

Yield reduction in soybean has been reported 30-80 % depending upon type of weeds, intensity of weeds and duration of infestation by various scientists in different location in India. Since, the soybean crop grown in *Kharif* season and weeds grow more luxuriantly due to high moisture, temperature and generally escape due to non applicability of PE or PPI herbicides and mechanical methods are some time are inadequate, hence some effective post-emergence herbicides are required to control weeds. However, some post emergence herbicides (Imazethapyr, Chlorimuron ethyl or Fomesafen are quite effective but they failed to control broad spectrum weeds (grasses, non-grasses and sedges). Hence the present study was undertaken to see the effectiveness of fusiflex (25% SL) a mixture of (Flauzifop-p-butyl 12.5% + Fomesafen 12.5%) to control total weeds in soybean.

METHODOLOGY

A field experiment was conducted for two consecutive years *i.e.* 2011 and 2012 in *Kharif* to see efficacy the of fusiflex (25% SL) against total weeds in soybean at Govind Ballabh Pant University of Agriculture & Technilogy, Pantnagar. Total 10 treatments (Table 1) were tested in randomized block design and each treatment was replicated three times. Soybean variety PS 1042 was sown on July 8 during 2012 and July 4 during 2013 at 45 cm row to row distance using 60 kg/ha seed. Crop was nourished by 100 kg di-ammonium phosphate (18% N and 46% P_2O_5) applied as basal at the time of planting. Data on weed population, weed dry matter, grain yield and other attributes were recovered. Data on weeds was transformed by log ($\sqrt{x+1}$) transformation. Crop was harvested on November 5, during 2011 and November 10, 2012. Crop was taken care to control insects and pests as and when necessary uniformly. All the herbicides were applied as post-emergence 20-25 days of crop (2-5 leaf stage).

RESULTS

Echinochloa colona (36%) among grasses and *Trianthma monogyna* (47%) among non-grasses were pre-domonant. *Cyperus rotundas* (15%) was the only sedge. Some other weeds *i.e. Panicum, Mollugo pentaphylla, Cynodon* and Cucumber were also present (6 %) of the total weeds but were irratic and low in nature. Weeds were reduced (15.66 per m^2) in fusiflex applied at 313.0 g/ha at 60 DAS. *Cyperus rotundas* was not controlled by any herbicide alone either chlorimuron ethyl, fomesafen or flauzifop-p-butyl at 60 DAS. Drastic reduction in total weed population was recorded in flauzifop-p-butyl applied at 313 g/ha. Herbicided flauzifop-p-butyl or fomesafen or chlorimuron-ethyl could not reduce the total weed population. However, imazathapyr at 100 was also effective upto some extent at 60 DAS. Weed dry matter was reduced with the increase in dose of different herbicides. The dry matter was reduced by flausiflex applied at 313 g/ha or 500 g /ha at 60 DAS. Reduction in grain yield was (63.49 %) in untreated check. Highest grain yield of soybean (2.21 t/ha) was recorded in weed free treatment which was significantly higher over rest of the treatments except fusiflex applied at 313 g/ha. Grain yield of soybean was increased with the increase in dose of fusiflex increased at 200 g/ha to 313 g/ha but was reduced in 500 g/ha.(due to toxic effect of crop).

Table 1. Weed population, growth of weeds and grain yield as influenced by Fusiflex in soybean (Average of two years 2011 and 2012)

Treatment	Total Weed population per m^2 at 60 DAS				dry matter (g/m^2) at 60 DAS	Seed yield (t/ha)	Weed index (%)	1000 grain weight (g)
	Grasses	Non-grasses	Sedges	Total				
Untreated	4.3(76.0)	3.9(53.0)	3.2(25.3)	4.0(171.7)	5.6(274.8)	0.81	63.5	118.0
Fusiflex at 200 g/ha	3.6(37.3)	3.3(26.7)	2.9(18.3)	3.4(100.4)	5.3(200.9)	1.63	26.1	121.1
Fusiflex at 250 g/ha	3.2(43.0)	2.4(10.7)	2.7(14.7)	3.1(66.7)	4.9(162.0)	1.86	15.8	122.7
Fusiflex at 313 g/ha	2.8(15.7)	1.7(5.0)	2.5(11.3)	2.8(49.7)	4.7(136.4)	2.03	7.8	123.0
Fusiflex at 500 g/ha	3.4(24.3)	3.3(28.0)	2.9(17.2)	2.2(29.3)	5.0(132.0)	1.85	16.1	114.6
Fluazifop-P-Butyl 13.4% EC at 125 g/ha	3.7(43.0)	3.3(27.3)	2.8(17.0)	3.3(80.3)	5.1(166.5)	1.77	19.7	121.1
Fomesafen (25%SL) at 250 g/ha	3.8(44.3)	3.5(34.7)	3.0(20.0)	3.5(105.0)	5.2(189.4)	1.61	27.3	119.9
Imazathapyr (10%SL) at100 g/ha	3.4(31.7)	3.1(23.3)	2.8(17.0)	3.2(78.0)	5.1(172.7)	1.85	15.9	121.4
Chlorimuron ethyl (25% WP) at 9.0 g/ha	4.0(58.3)	3.7(43.0)	3.2(25.0)	3.7(133.7)	5.3(219.9)	1.52	31.2	118.9
Weed free	0.0(0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	0.0(0.0)	2.21	0.0	124.0
LSD (P=0.05)	0.6	0.6	0.9	0.3	0.3	0.18	8.0	3.54

* Data on weeds was transformed in (log X+1) *Original data was Parentheses

CONCLUSION

Reduction in yield in soybean was recorded 63.8 % in unweeded control. Highest grain yield in soybean may be obtained by the application of fusiflex 25% SL (fluazifop-p-butyl 12.5% + fomesafen 12.5% SL) at 250 g /ha applied at 2-5 leaf stage of weed growth.

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Strategies to maximize the cane yield through proper weed management in Sugarcane

Dheer Singh*, Dharmendra Kumar Mahur, Vijendra Singh and R.D. Yadav
Department of Agronomy, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 630 145
**Email : singhdheer2011@gmail.com*

Yield losses in sugarcane have been reported to vary 15-75 % depending upon the nature and density of weeds. Yield losses due to weeds may be checked by adopting mechanical, cultural and chemical means. None of the chemical either pre or post emergence alone can take care of weeds for such a long period. This enunciates the use of more than one chemical of different nature, together in succession. On the other hand, mechanical means not only control weeds but also create favourable condition for the growth to crop plants making them more competitive to outgrow weeds. There is need to formulate an economically viable, practically favourable and ecologically sound weed management, hence the present investigation was under taken.

METHODOLOGY

A field experiment was carried out during 2010-11 and 2011-12 at Govind ballabh Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar (Uttarakhand) to formulate good strategies to control weeds and increase the cane yield in sugarcane. Different herbicides alone or in combination (10) treatments were tested in randomized block design in three replications. Three budded setts from healthy crop variety of *Co Pant 90223* were sown in 15 cm deep furrows opened at 75 cm distance keeping 4 setts per meter row length. Other recommended package and practices were adopted to raise the crop. Experimental soil was silty loam in texture having organic carbon 1.02 %. The soil was medium in N, P and K and pH of the soil was 7.3. Data on weed growth, yield performance and economics were recorded.

RESULTS

Grassy weeds (*Echinochloa colona*, *Echinochloa crusgalli, Eleusine indicia*, *Bracharia mutica*, *Digiteria sanguinalis*, *Dactyloctenium aegyptium* contributed 48.53 % during 2010-11 & during 2011-12, 45.03% and non-grasses (*Trianthma portulacastrum, Commelina benghalensis, Euphorbia hirta, Ipomea hederacea)* contributed 20.46% during 2010-11 and 18.84 5 during 2011-12. *Cyperus rotundas* was the only sedge and was recorded 40.3% during 2010-11 and 36.13 % during 2011-12.

Among chemical treatments lower weed population was recorded in Atrazin at 2.0 kg /ha applied after Ist irrigation followed by 2,4-D at 1.0 kg /ha applied at 75 DAP (202.7 at 90 DAP and 99.7/m^2 at 120 DAP). Lowest dry matter was recorded in three hoeing (30, 60 and 90 DAP) which was significantly lower than rest of the treatments except atrazin at 2.0 kg/ha applied after first irrigation followed by 2, 4-D at 1.0 kg/ha at 75 DAP. Among herbicidal treatments the cane yield was higher (95.2 t/ha) in the treatment of metribuzin at 1.25 kg /ha (PE) followed by almix 20 g /ha or dicamba 350 g/ha applied at 75 DAP. Lowest cane yield (80.2 ton/ha) was recorded in weedy check which was significantly lower over rest of the treatments in thus reduced cane yield 26.3% due to uncontrolled weeds. Benefit cost ratio was also higher in these two treatments, *i.e.* in three hoeing or in atrazin applied after first irrigation followed by 2, 4-D at 1.0 kg /ha at 75 DAP.

Table 1. Weed population, growth of weeds, cane yield, juice quality and economics as influenced by different weed control treatments (average of two years)

Treatment	Weed dry matter (g/m^2)		Weed index (%)	Cane yield (t/ha)	CCS (t/ha)	B:C ratio
	90 DAP	120 DAP				
Control (weedy check)	5.3(196.3)	5.7(284.3)	26.3	80.2	9.0	1.23
Hoeing at 30, 60, and 90 DAP	4.0(57.7)	3.7(41.3)	0.0	108.9	12.5	1.73
Atrazine at 2.0 kg/ha (PE) *fb* 2,4-D 1.0 kg/ha at 60 DAP	5.0(146.3)	4.4(82.0)	14.6	92.9	10.3	1.50
Atrazin at 2.0 kg/ha after Ist irrigation and hoeing *fb* 2,4-D at 1.0 kg/ha at 75 DAP	4.7(104.3)	3.9(49.3)	5.6	102.8	11.7	1.67
Metribuzine at1.25 kg /ha (PE) *fb* 2,4-D at 1.0 kg /ha at 75 DAP	4.9(131.7)	4.3(75.3)	14.5	93.0	10.4	1.44
Atrazine at 2.0kg/ha (PE) *fb* Almix at 20g /ha at 75 DAP	5.0(150.0)	4.5(86.7)	15.2	92.3	10.3	1.45
Metribuzine at1.25 kg /ha (PE) *fb* Almix at 20 kg/ha at 75 DAP	4.8(115.3)	4.2(67.0)	10.9	97.1	11.1	1.51
Atrazine at 2.0 kg/ha (PE) *fb* Ethoxysulfuron at 50 g/ha at 75 DAP	5.1(163.7)	4.6(96.0)	23.5	86.9	9.3	1.32
Atrazine at 2.0kg/ha (PE) *fb* Dicamba at350 g/ha at 75 DAP	5.1(159.3)	4.5(91.0)	17.5	90.5	10.2	1.44
Metribuzine at1.25 kg/ha (PE) *fb* Dicamba at 350 g/ha at 75 DAP	4.9(127.3)	4.2(67.0)	12.6	95.2	10.1	1.50
LSD (P=0.05)	0.1	0.2	6.0	7.0	1.0	-

* Data on weeds was transformed in (log X+1) *Original data in parentheses

CONCLUSION

Weeds in sugarcane may be controlled either by three hoeing (30, 60 and 90 DAP) or by application of atrazin at 2.0 kg/ha applied after first irrigation followed by 2,4-D at 1.0 kg /ha applied at 75 DAP for getting the higher cane yield and higher cost benefit ratio.

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Weed management in lentil

S.K. Nagre*, D.K. Chandrakar, Kusum Chandrakar and A.P. Singh
College of Agriculture, IGKV, Raipur, Chhattisgarh 492 012
**Email: sk.nagre07@gmail.com*

Lentil is an important legume, among more than a dozen pulse crops grown in Chhattisgarh. It is not only a rich source of improved nutrition for people but also provide nutritional straw for cattle. It is grown in around 14.90 thousand hectare area with the production of 5.0 thousand tonnes with average productivity 0.34 t/ha of too less in comparison to national average 0.79 t/ha (Anonymous 2012). Slow initial growth of lentil and favourable condition for weed multiplication and a wide spectrum of heterogeneous weed flora, which gradually become a serious limitation for low productivity of lentil. There are number of reasons of low production and productivity of lentil out of which weeds, being serious negative factors in crop production are responsible for reduction in the yield of lentil to a tune of 84 per cent (Mohamed *et al*. 1997).

METHODOLOGY

A field experiment was conducted during the *rabi* season of 2011-12 at Indira Gandhi Agriculture University, Raipur (Chhattisgarh). The soil of the experimental field was clayey in texture (Vertisols), neutral in pH and had low nitrogen, medium phosphorus and high potassium content. The experiment consisted of eight treatments T_1- quizalofop-ethyl at 50 g/ha at 30 DAS, T_2- imazethapyr at 37.5 g/ha at 30 DAS, T_3- chlorimuron-ethyl at 4 g/ha at pre plant incorporation, T_4- Pendimethalin 1.0 kg/ha at pre-emergence, T_5- pendimethalin + imazethepyr 0.75 kg/ha at pre-emergence, T_6- pendimethalin + imazethapyr 1.0 kg/ha at pre-emergence, T_7-Hand weeding twice at 20 and 40 DAS, T_8- weedy check, was laid out in randomize block design with three replications. Sowing was done (*cv. K-75*) with a seed rate of 40 kg/ha with a spacing of 25 cm row to row and 5 cm plant to plant. A basal dose 20 kg/ha N, 17 kg/ha P, 20 kg/ha K and 20 kg/ha S was applied uniformly.

RESULTS

Weed management treatments indicated that the significantly highest seed yield (1.26 t/ha), and maximum weed control efficiency (74.8%) of lentil were recorded in the treatment hand weeding twice at 20 and 40 DAS followed by pendimethalin + imazethapyr 1.0 kg/ha at pre emergence and pendimethalin + imazethapyr 0.75 kg/ha at pre emergence. Significantly the minimum values of above parameters were recorded in the treatment weedy check.

The predominant weeds observed in the experimental field were *Cynodon dactylon* among grasses, *Chenopodium album, Cirsium arvense*, *Melilotus alba*, *Euphorbia hirta*, *Anagalis arvensis*, *Xanthium strumarium, Convolvulus arvensis* among broad leaf and *Cyperus rotendus* among sedges during all the three years. The lowest dry matter production of weed (19.73 and 23.67 g/m² at 40 and 60 DAS, respectively) were recorded in the treatment hand weeding twice at 20 and 40 DAS followed by pendimethalin + imazethapyr 1.0 kg/ha at pre emergence (30.72 and 38.70.80 g/m² at 40 and 60 DAS, respectively) and pendimethalin + imazethapyr 0.75 kg/ha at pre emergence (32.65 and 40.21 g/m² at 40 and 60 DAS, respectively).

Table 1. Effect of different weed management practices on performance of lentil

Treatment	Seed Yield (t/ha)	Weed dry matter (g/m²) 40 DAS	Weed dry matter (g/m²) 60 DAS	Weed Index (%)	Weed Control Efficiency (%)	Net Return (x10³₹/ha)	B:C Ratio
T_1	0.79	43.6	54.6	37.3	42.0	20.62	1.65
T_2	0.87	36.2	44.3	31.0	52.9	24.43	2.02
T_3	0.70	60.3	65.9	44.4	29.9	17.74	1.52
T_4	0.83	40.2	48.7	34.2	48.2	21.68	1.64
T_5	0.95	32.6	40.2	24.9	57.3	27.02	2.12
T_6	0.99	30.7	38.7	21.2	58.9	28.44	2.15
T_7	1.26	19.7	23.6	-	74.8	37.02	2.35
T_8	0.49	77.6	94.2	61.2	-	9.50	0.87
LSD(P=0.05)	0.15	9.1	9.1	-	-	5.99	0.47

The highest net return (₹ 37, 024.00/ha) and B:C ratio (2.35) was obtained in the treatment hand weeding twice at 20 and 40 DAS followed by pendimethalin + imazethapyr 1.0 kg/ha as pre emergence (₹ 28,446.6/ha and 2.15, respectively) and pendimethalin + imazethapyr 0.75 kg/ha at pre emergence (₹ 27,020.8/ha and 2.12, respectively).

CONCLUSION

Hand weeding twice (20 and 40 DAS) and pre emergence application of pendimethalin + imazethapyr 1.0 kg/ha were the most appropriate weed management practices for maximization of growth, yield attributes and seed yield of lentil.

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Chemical weed management in black gram

D.K. Chandrakar, S.K. Nagre*, Kusum Chandrakar, A.P. Singh and S.K. Nair

College of Agriculture, IGKV, Raipur, Chhattisgarh 492 012

**Email: sk.nagre07@gmail.com*

In Chhattisgarh the pulse are grown in around 8.68 lakh hectare area, out of which 2.14 lakh hectare in *Kharif* and 6.54 lakh hectares in *Rabi*. Black gram is one of the major *kharif* pulse of upland grown in 1.92 lakh hectare area with productivity of 396 kg/ha . Slow initial growth of black gram and favourable conditions for weed multiplication and a wide spectrum of heterogeneous weed flora, which gradually become a serious limitation for low productivity of blackgram. Weed species infesting black gram vary according to the agro-ecosystem of growing region. *Trianthema portulacastrum, Convolvulus arvensis, Cyperus rotundus, Cynodon dactylon and Eleusine aegyptica* are the major weeds in black gram. Most prominent weed species found in blackgram fields are *Trianthema portulacastrum, Cyperus rote ndus, Euphorbia hirta, and Phyllanthus niruri*. Hence present investigation was under taken to identify suitable herbicide, their appropriate rate and time of application for black gram during *kharif* season.

METHODOLOGY

A field experiment was conducted during the rainy (*Kharif*) season of 2011 at Indira Gandhi Agriculture University, Raipur (Chhattisgarh). The soil of the experimental field was clayey in texture (Vertisols), neutral in pH and had low nitrogen, medium phosphorus and high potassium content. The experiment consist of eleven treatments *viz.* T_1 - Weedy Check, T_2 - hand weeding twice at 20 and 40 DAS, T_3- pendimethalin 1.0 kg/ha as pre-emergence, T_4- quizalofop-ethyl at 37.5 g/ha as post emergence (POE), T_5- fenoxaprop-p-ethyl at 50 g/ha as POE, T_6- pandimethalin 30 C + imazethapyr 2 EC at 0.75 kg/ha PE, T_7- pendimethalin 30 C + imazethapyr 2 EC 1.0 kg/ha as PE, T_8- imazethapyr at 25 g/ha as POE 15-20 DAS, T_9- imazethapyr 40 g /ha as POE 15-20 DAS, T_{10}- imazethapyr at 55 g/ha as POE 15-20 DAS, T_{11}- weed free plot, was laid out in randomize block design with three replications. Sowing was done (*cv. Indira Urd Pratham*) with a seed rate of 20 kg/ha with a spacing of 30 cm row to row. A basal dose 20 kg/ha N, 16 kg/ha P, 20 kg/ha K and 20 kg/ha S was applied uniformly.

RESULTS

Weed management treatments indicate that the highest seed yield of Blackgram was recorded in the treatment weed free plot (0.74 t/ha) (T_{11}) followed by hand weeding twice at 20 and 40 DAS (0.72 t/ ha) (T_2). The increase in the yield in above treatments is due to weed management from early crop growth and higher dry matter accumulation which resulted in greater translocation of food materials to the reproductive parts and reflected in superiority of yield attributing characters and ultimately to higher yield. The lower weed density and higher weed control efficiency also resulted in higher seed yield. Similar findings were also reported Chandel and Saxena (2001). Among the herbicide applied treatments the use of Imazethapyr at 40 g/ha as POE 15-20 DAS (T_9) gave significantly higher seed yield (662.33 kg/ha) with highest weed control efficiency though it was at par to pendimethalin 30 EC + imazethapyr 2 EC at 1.0 kg/ha - PE (T_7), imazethapyr at 25 g/ha as POE 15-20 DAS (T_8), pendimethalin 30 EC + imazethapyr 2 EC at 0.75 kg/ha - PE (T_6) and imazethapyr at 55 g/ha as POE 15-20 DAS (T_{10}).The highest net return and B:C ratio was obtained in manual weeding treatment followed by Imazethapyr at 40 g/ha as POE 15-20 DAS (T_9).

Table 1. Effect of different weed management practices on performance of blackgram

Treatment	Seed yield (t/ha)	Weed dry weight (g/m^2)		Weed control efficiency at 60 DAS (%)	Net returns (x10^3₹/ha)	B : C Ratio
		40 DAS	60 DAS			
T_1	0.38	84.4	128.0	-	7.02	0.5
T_2	0.71	11.9	28.3	77.8	20.65	1.2
T_3	0.55	37.6	58.4	54.3	14.16	0.9
T_4	0.52	40.0	64.0	50.0	13.20	0.9
T_5	0.50	43.2	69.9	48.4	11.48	0.7
T_6	0.60	25.0	47.1	63.1	16.15	1.0
T_7	0.63	21.6	42.0	67.1	17.63	1.1
T_8	0.61	34.3	53.6	58.0	18.46	1.3
T_9	0.66	15.3	38.0	70.3	20.58	1.5
T_{10}	0.59	30.4	48.5	62.0	16.96	1.2
T_{11}	0.74	0	0	100.0	20.40	1.1
LSD (P=0.05)	0.09	7.4	8.4		5.01	0.3

CONCLUSION

Hand weeding twice (20 and 40 DAS) and post emergence application of imazethapyr 40 g/ha at 15-20 DAS was the most appropriate weed management practices for maximization of growth, yield attributes and seed yield of black gram.

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Effect of different weed management practices on weed dynamics and performance of rajmash

D.K. Chandrakar, Kusum Chandrakar, S.K. Nagre* A.P. Singh and H.C. Nanda

College of Agriculture, IGKV, Raipur, Chhattisgarh 492 012

**Email: sk.nagre07@gmail.com*

Among the pulses, rajmash (*Phaseolus vulgaris* L.) is one of the high potential crop with a yielding potential of 18 to 20 q per ha. It is an important winter vegetable grown both for tender pods and dry seeds, which form a rich source of crude protein, fat and carbohydrates. Rajmash is more sensitive to weed competition during early stages of its growth. Weeds are become a problem and compete with it as it emerges simultaneously with the crop, leading to severe competition between them (Kandasamy 2000). To control weeds, generally hand weeding is in practice that is now costly as well as difficult because of non-availability of labour in peak period. With the advancement of agro techniques, chemical weed control has become an effective and cheap alternative to control weeds.

METHODOLOGY

A field experiment was conducted at IGKV, Raipur Chhattisgarh during *Rabi* season of 2010-11, 2011-12 and 2012-13 to find out the most effective herbicide, their appropriate dose and time of application for Rajmash. The experiment was laid out in randomized complete block design comprising of 10 treatments, *viz.* quizalofop-p-ethyl at 50 and 60 g/ha and imazethapyr at 50 and 75 g/ha at 30 DAS (both herbicides) applied at 30 DAS, chlorimuron ethyl at 4 g/ha as pre-plant incorporation, pendimethalin at 1.0 kg/ha as pre-emergence, pendimethalin 30 EC + imazethapyr 2 EC at 0.75 and 1.0 kg/ha as pre-emergence, hand weeding twice at 20 and 40 DAS and a weedy check in three replications.

RESULTS

Effect on weeds: Hand weeding twice at 20 and 40 DAS recorded the lowest weed biomass (23.7 g/m^2) over all the herbicide treatments by controlling weed population to the extent of 80.1%. Amongst the herbicides, lowest weed biomass (0.39 t/ha), minimum weed index (15.5%) and maximum weed control efficiency (81.1%) were recorded in pendimethalin 30 EC + imazethapyr 2 EC at 1.0 kg/ha over rest of the treatments. Similar findings were reported by Ram *et al.* (2012) on Rajmash.

Effect on crop yield and economics: Significantly maximum seed yield (1.63 t/ha), highest net return (₹ 58,970/ha) and benefit: cost ratio (2.3) were obtained with hand weeding twice at 20 and 40 DAS over rest of the treatments. Among the herbicides, application of pendimethalin 30 EC + imazethapyr 2 EC at 1.0 kg/ha as pre-emergence recorded maximum seed yield (1.38 t/ka), highest net return (₹ 48,475/ha) and benefit:cost ratio (2.11) which were obvious due to its higher values of yield attributes, weed control efficiency and lower weed index compared to the rest of the herbicide treatments. Least seed yield (0.58 t/ha), net return (₹ 9660/ha) and B:C ratio (0.47) was recorded with weedy check.

Table 1. Effect of different weed management practices on weed dynamics and performance of rajmash (pooled data of 3 years)

Treatment	Weed dry matter at 60 DAS (kg/ha)	Weed control efficiency at 60 DAS (%)	Seed yield (t/ha)	Weed index (%)	*Net return (x10^3₹ /ha)	B:C ratio
Quizalofob ethyl at 50 g/ha at 30 DAS	846	32.5	1.10	32.2	34.89	1.57
Quizalofob ethyl at 60 g/ha at 30 DAS	820	34.6	1.11	32.0	34.81	1.55
Imazethapyr at 50 g/ha at 30 DAS	622	50.4	1.24	24.1	42.27	1.94
Imazethapyr at 75 g/ha at 30 DAS	539	57.0	1.29	20.9	44.69	2.01
Chlorimuron ethyl at 4 g/ha as PPI	837	33.2	0.78	51.8	19.47	0.91
Pendimethalin at 1.0 kg/ha as PE	713	43.1	1.16	28.9	37.12	1.62
Pendimethalin30EC+Imazethapyr2EC 0.75 kg/ha-PE	456	63.6	1.34	17.9	46.91	2.09
Pendimethalin30EC+Imazethapyr2EC 1.0 kg/ha-PE	391	68.8	1.38	15.5	48.47	2.11
Hand weeding twice at 20 & 40 DAS	237	81.1	1.63	-	58.97	2.32
Weedy Check	1253	-	0.58	64.1	9.66	0.47
LSD (P=0.05)	143		0.20		10.08	0.45

* The cost of two hand weeding were ₹ 4,800/- for 30 mandays, Sale price Rajmash grain ₹ 50/kg & Stover ₹ 1/kg.

CONCLUSION

Thus, it may inferred from the above that hand weeding twice at 20 and 40 DAS could be recommended for effective control of mixed weed flora in rajmash for getting higher productivity and profitability. However, in case of unavailability of agricultural labour at appropriate time for manual weeding, pre emergence application of pendimethalin 30 EC+imazethapyr 2 EC at 1.0 kg/ha could be a good alternative to control the weeds effectively and economically.

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Response of herbicides and cultural practices on growth and yield of black gram

Kavita D. Rajput, V.M. Bhale, A.S. Kamble* and R.K. Sonawane

Department of Agronomy, Post Graduate Institute, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra 444 104

**Email: ashitoshagronomist@gmail.com*

Pulses are an integral part of the cropping system as they fit well in crop rotation and own a strategic position in intensive as well as subsistence agriculture. During 2009-10 area under total *Kharif* pulses in Maharashtra was 19.90 m ha with a production of 8.53 m tonnes and average productivity was 0.43 t/ha (Anonymous, 2009). Black gram is important rainfed pulse crop grown throughout India over 31.69 lakh ha with a production of 13.26 lakh tonnes annually and average productivity of 418.4 kg/ha. Efficiency of chemical based single herbicide treatment may be unsatisfactory because of their narrow spectrum of weed control and to obviate undesirable ecological shift in weed flora occurring due to the use of mono-herbicides. So it is now recommended to use herbicide combinations.

METHODOLOGY

A field experiment on black gram (*Phaseolus mungo* L.) was conducted at Agronomy Farm, Department of Agronomy, Dr. PDKV, Akola during *kharif* season of 2010-11 on clay loam soil. Thirteen treatments consist of different cultural and herbicidal combinations replicated thrice in randomized block design. Black gram (*var. TAU-1*) sown in field with recommended package of practices. Fertilizer was applied at 20:40:00 NPK kg/ha through urea and diammonium phosphate.

RESULTS

Pendimethalin at 1500 g/ha PE recorded significantly higher plant height and dry matter accumulation than rest of treatments except weed free and found at par with T_3, T_7, T_{10} and T_6. Significant reduction in plant height and dry matter was noticed in weedy check. Results conform to the findings of Sharma and Yadava (2006). Highest number of pods/plant, number of seeds/pod, grain yield and straw yield were recorded by weed free treatment. With respect to grain yield, pendimethalin at 1500 g/ha PE treatment followed by remaining treatments except T_6, T_{10} and T_{11} for straw yield. Similarly weedy check recorded significantly lowest number of pods/plant, grain and straw yield over other treatments.

Table 1. Growth and yield of black gram as influenced by different weed control treatments

Treatment	Plant height (cm)	Number of pods/ plant	Number of seeds/ pod	Grain (t/ha)
T_1 - Weed free	50.1	20.0	7.1	1.26
T_2 - Weedy check	39.2	8.3	5.9	0.51
T_3 - 2 Hand weeding (15 *fb* 30 DAS)	46.1	15.4	6.5	0.93
T_4 - 2 Hoeing (10 *fb* 20 DAS)	42.1	10.3	5.7	0.68
T_5 - Imazethapyr at 50 g ha^{-1} PE (At sowing)	42.0	10.4	5.2	0.61
T_6 - Imazethapyr at 75 g ha^{-1} PE (At sowing)	44.6	11.1	6.2	0.82
T_7 - Pendimethalin at1000 g /ha PE (At sowing)	45.8	13.2	6.0	0.99
T_8 - Pendimethalin at 1500 g/ ha PE (At sowing)	46.3	16.2	7.0	1.00
T_9 - Fenoxyprop-p-ethyl at 100 g/ ha POE (15 DAS)	43.7	11.6	5.7	0.88
T_{10} - Fenoxyprop-p-ethyl at 125 g/ ha POE (15 DAS)	45.3	14.0	6.5	0.98
T_{11} - Quizalofop-p-ethyl at50 g/ ha POE (15 DAS)	41.3	9.8	5.4	0.77
T_{12} – Quizalofop-p-ethyl at 75 g/ haPOE (15 DAS)	43.3	11.4	6.2	0.85
T_{13} - Imazethapyr at 50 g /ha PE *fb* POE Quizalofop-p-ethyl at 50 g/ ha (At sowing *fb* 15 DAS)	41.3	12.0	5.6	0.82
LSD(P=0.05)	2.4	3.5	1.0	0.25

CONCLUSION

Cultural weed management through hand weeding at 15 and 30 DAS and among herbicidal treatments, pre-emergence application of pendimethalin 1500 g/ha and 1000 g/ha were found effective in controlling weeds. The treatment weed free recorded highest yield followed by pendimethalin at 1500 g/ha PE.

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Integrated weed management in chickpea under irrigated condition

A.B. Kamble, S. A. Rawan, D.W. Thawal, S.H. Pathan and P.S. Bodake
Department of Agronomy, MPKV, Rahuri Dist. Ahmednagar, Maharashtra 413722

Chickpea is the most important pulse crop of India. In Maharashtra, the area, production and productivity was very low up to the year 1980 but has increased lately.. The cultivation of chickpea, is however, threatened by divergent weed flora. Under irrigated condition weed offer sever competition at the initial growth stages of the crop and yield losses of 40-80 per cent are quite common (Ahlawat *et al*. 1981). It is a well established fact that, only one weed control method would not be sufficient for effective weed control and thus requires an integrated approach (Bhan and Malik 1983). So it must go for integration of all effective, dependable and workable weed management practices.

METHODOLOGY

Present investigation was conducted during *Rabi* season, 2011-12 at Post Graduate Institute, Instructional Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra). The soil of experimental site was silty loam in texture, low in available nitrogen (191.30 kg/ha), medium in available phosphorus (18.00 kg/ha) and very high in potassium (0.45 t/ha), moderately alkaline in reaction (pH 8.49) with EC (0.35 dS/m) and organic carbon content (0.42%). The experiment was carried out in Randomized Block Design, replicated thrice with eleven treatments. The gross and net plot sizes were 4.00 × 3.60 m and 3.60 m × 3.00 m, respectively. The recommended package of practices was followed in experiment. The different weed indices were worked out as per the standard formulae.

RESULTS

The results revealed that, treatment weed free up to 60 days recorded significantly the lowest total weed count and weed dry matter at harvest as compared to rest of the treatments but it was at par with treatments pre-emergence application of pendimethalin 0.75 kg/ha *fb* one HW at 30 DAS, pre-emergence application of oxyfluorfen 0.100 kg/ha *fb* one HW at 30 DAS and one hoeing at 15 DAS and one HW at 30 DAS at all stages of observations. The similar trend was observed with respect to nutrient uptake by weed. However, early post emergence application of imazethapyr 0.03 and 0.06 kg/ha did not found effective in reducing the total weed count and weed dry matter compared to pre-emergence application of herbicides alone, integrated and mechanical weed control treatments. The important growth attributes, *viz.* plant height, plant spread, number of branches, total dry matter accumulation per plant and important yield contributing characters, *viz.* number of pods/plant, number seeds/plant, hundred seed weight and weight of seed/plant, grain and straw yield and nutrient uptake by the chickpea crop were significantly higher in the treatment weed free up to 60 days but it was found at par with treatments pendimethalin pre-emergence 0.75 kg/ha *fb* one hand weeding at 30 DAS, oxyfluorfen pre-emergence 0.100 kg/ha *fb* one hand weeding at 30 DAS and One hoeing at 15 DAS + one hand weeding at 30 DAS. Economic studies indicated significantly maximum net monetary returns.

CONCLUSION

For effective weed control and higher monetary benefits in chickpea crop, pre-emergence application of oxyfluorfen 0.100 kg/ha *fb* one HW at 30 DAS an integrated weed management approach is a better option under severe labour constraint problem.

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Effect of crop establishment and weed management practices on growth and yield of wheat

Manoj Kumar, Raghwendra Singh* and Dibakar Ghosh
Directorate of Weed Science Research, Jabalpur Madhya Pradesh 482 004
**Email: singhraghu75@gmail.com*

Wheat (*Triticum aestivum* L.) occupies prime position among the food crop in Madhya Pradesh, grown in 3.96 million hectare area with the production of 58.96 lakh tons. The productivity of wheat in the state is quite low (2.28 t/ha). Among all the factors weed infestation is one of the most serious causes of low yield of irrigated wheat. In present scenario, rapid labour migration from agriculture to non agriculture sectors like construction, industries etc drastically reduced availability of farm labour, Therefore it is needed to generate information on suitable weed control measures to address the weed problem in wheat. Continuous use of conventional tillage (CT) decrease wheat production in rice-wheat cropping system (RWCS), therefore, current tillage practices should be modified (Atreya *et al*. 2006). The behavior of herbicides may also vary in standing stubble, partial burning, zero tillage and bed planting techniques. Hence, in the light of such complexities, the present experiment was undertaken to assess the different crop establishment practices and efficacy of different herbicides under these conditions.

METHODOLOGY

A field experiment was conducted at experimental farm (23°132 N, 79°582 E, and 390 m above mean sea level) with plot size of 25 m^2 of Directorate of Weed Science Research (ICAR), Jabalpur (M.P.) India wheat during *Rabi* season of 2012-13. The soil of experimental field was clay loam in texture, neutral (7.2) in reaction medium in organic carbon (0.79%), available nitrogen (0.31 t N/ha) and phosphorus (18 kg P_2O_5 /ha) but high in available potassium (0.29 t K_2O/ha). The experiment includes four crop establishment methods *viz.* zero tillage (ZT), zero tillage + residue (ZT+R), conventional tillage (CT), zero tillage + residue burning (ZT+RB) in main plots and four weed management practices, weedy check, mesosulfuron + iodosulfuron (12 +2.4 g/ha), sulfosulfuron + metsulfuron (25 + 4 g/ha) and metribuzin (200g/ha) in sub plots was laid out in split-plot design with three replications. ZT plots were kept undisturbed after harvesting of rice crop. CT plots were prepared by using cultivator once and harrowing twice. The rice residue was applied 7 t/ha. Wheat variety 'GW-273' was sown with recommended package of practices. Fertilizers were applied through urea, di-ammonium phosphate and muriate of potash 120 kg N, 60 kg P_2O_2 and 40 kg K_2O/ha. Sowing under ZT and CT was done using 'Happy seeder' at seed rate of 100 kg/ha. Data on weed growth, yield performance were recorded.

Table 1. Weed growth, yield and economics of wheat as influenced by different crop establishment techniques and weed management practices

Treatment	Weed population (no/m^2) at 45 DAS	Weed dry weight (g/m^2) at 45 DAS	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index	B:C ratio
Crop establishment techniques						
Zero tillage (ZT)	6.88	4.73	3.09	4.76	39.4	2.27
Zero tillage with residue (ZT+R)	6.83	6.31	2.86	4.50	38.7	1.93
Conventional tillage (CT)	6.81	5.01	3.06	4.29	41.4	2.05
Zero tillage with partial burning (ZT + PB)	6.30	5.81	3.26	4.83	40.0	2.17
LSD (P= 0.05)	NS	NS	NS	NS		
Weed management practices						
Weedy check	17.59	14.65	2.51	4.24	37.1	1.85
Mesosulfuron + iodosulfuron	3.03	2.37	3.23	4.66	41.0	2.14
Sulfosulfuron + metsulfuron	2.84	2.15	3.27	4.79	40.6	2.17
Metribuzin	3.35	2.70	3.25	4.69	41.1	2.23
LSD (P=0.05)	1.26	1.32	0.45	NS		

RESULTS

The most dominant weeds among grassy and broad leave weeds were *Phalaris minor* and *Medicago denticulata* respectively. The crop establishment techniques did not showed significant variation in weed density, weed dry weight, grain and straw yield. However, the weed management practices differ significantly. The minimum weed population (2.84/m^2) and weed dry weight (2.15 g/m^2) was observed with the application of sulfosulfuron + metsulfuron (25+4 g/ha) (Table 1). The maximum grain yield (3.27 t/ha) of wheat was observed with the treatment sulfosulfuron + metsulfuron, Chhoker *et al.* (2007) also found higher grain yield with the application of sulfosulfuron + metsulfuron, however, it was at par with the application of mesosulfuron + iodosulfuron and metribuzin. All the three herbicides controlled the weeds effectively. Repeated use of same herbicide for weed control, may lead to development of herbicide resistance in weed, therefore these three herbicides can be used in rotation to avoid the herbicide resistant problem in wheat crop.

CONCLUSION

It may be concluded that any of the three herbicides [sulfosulfuron + metsulfuron (25+4 g/ha), mesosulfuron + iodosulfuron (12 +2.4 g/ha) and metribuzin (200 g/ha)] can be used for controlling weeds in wheat crop. For obtaining better monetary returns wheat should be sown through zero tillage and metribuzin can be applied for managing weed in wheat crop

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Bio-geographical studies of weed endemics in cropped areas in Leh region

M.S. Raghuvanshi[1]*, P.C. Moharana[2] and J.C. Tewari[3]

[1]Regional Research Station, Central Arid Zone Research Institute (CAZRI), Leh, Ladakh, Jammu & Kashmir 194 101
[2,3]Central Arid Zone Research Institute (CAZRI), Jodhpur, Rajasthan 342 003
Email: omsai.msr@gmai.com

Agriculture is the main occupation of the rural people of Ladakh despite the fact that the region experiences mean annual precipitation of 80-300 mm, which is scanty and negligible. The Himalayan Mountains and the Indus river system are two of the gigantic land features that limit the possibility of large scale agricultural activities in Leh region. However, it is unique and representative of the Tibetan plateau. Its agriculture in the past rendered the region self sufficient in food grains. Traditionally, the staple food is barley and wheat while harvest of the glacier water in the lap of Himalaya has developed a small-scale farming system adapted to this extreme environment. Families rely essentially on subsistence agriculture based on principal crops like wheat, barley and potato which are cultivated on their stone-built terraces. Its conservation of old land races of cultivated plants, especially of alfalfa, is of global importance. However, weeds are integral part of the cultivated lands which not only compete for space and moisture, but also reduce the yield and quality of produce to a significant level. In majority of situations, land holdings are only one to two hectares, but easily sufficient. In fact, in most of the situations, only limited plains within Indus valleys are utilized for agricultural activities.

METHODOLOGY

Keeping in view of the above features of Ladakhi agriculture, a bio-geographical survey was carried out by Regional Research Station, CAZRI, Leh during 2013 at different villages of Leh valley. Six villages (Saboo, 77^0 34' 48" E, 34^0 0' 12" N, Stakmo(77^0 42' 21.56" E, 34^0 01' 36.90" N), Nang (77^0 45' 06.34" E,34^0 02' 35.6" N) , Umla (77^0 23' 57" E, 34^0 14' 12.33" N), Phey (77^0 27' 56.99" E, 34^0 08' 0.6" N) and Stakna, 77^0 41' 06.33" E, 33^0 59' 44.06" N) were selected for the purpose for identifying the crop production systems. Survey was also made to understand the pasture ecology. The extent and characteristics of the grassy and broad-leaved weeds and associated flora were observed in different crops of above villages.

RESULTS

Our study indicated dominance of traditional methods in the crop production system. Distribution of improved crop seeds using public distribution system might be a major drawback for interception of more weed seeds into the system. The cropped areas are under severe pressure of weed dominance. In addition to this, higher seeding on adequate land preparation with less monitoring has led to the build-up of weed seed bank. Though organic farming is in practice for many decades, it is without using pesticides. In many crop fields, soils were hard and weed density was more.

During the survey, it was found that major weeds of the crop fields constituted of Amaranthaceae, Asteraceae, Poaceae and Fabaceae families in cropped areas. In wheat and barley, dominant weeds were *Amaranthus* spp., *Avena sativa, Bidens biternata, Chenopodium aibum, Convolvulus arvensis. Datura stramonium, Digitaria ischaemum, Hardeum vulgare, Medicago luplina, Medicago sativa, Melilotus officinalis, Polypogon monospeliensis, Setaria viridis, Stellaria media, Trifolium repens, Polygonum convolvulus* (wild buchwheat), and *Lolium* species. In pea, *Amaranthus* spp*, Bidens biternata, Chenopodium aibum, Convolvulus arvensis. Conyza Canadensis, Datura stramonium, Daucus carota, Digitaria ischaemum. Lactuca sativa, Medicago luplina, Medicago sativa, Melilotus officinalis, Setaria viridis, Trifolium repens, Polygonum convolvulus (*wild buchwheat*),* and *Lolium* species were recorded. While in potato, dominance of *Amaranthus* spp. *Chenopodium aibum, Convolvulus arvensis. Datura stramonium, Digitaria ischaemum. Medicago luplina, Medicago sativa, Melilotus officinalis, Polypogon monospeliensis,*

Setaria viridis, Trifolium repens and *Lolium* sp. was noted. Presence of such weeds in these crops resulted in 20-30 per cent crop yield losses and has attracted various insects, and diseases on the crop plants.

CONCLUSION

While planning the weed control, critical period for crop-weed competition in cropped areas is the major consideration. Therefore, proper weed management using improved agricultural practices is recommended for better productivity of staple crops and highest economic returns in Leh region.

A new record on association of phytoplasma with phyllody disease in *Parthenium* from Madhya Pradesh, India

***K.N. Gupta**

PC Unit, Sesame and Niger, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh 482 004
**Email: kngupta1@rediffmail.com*

Parthenium hysterophorus L. is an annual weeds exhibiting high competitiveness and adaptability to different climatic and soil conditions, it is thought to originate from middle America and is now widely spread in tropical regions, It was introduced to India in the mid 1956 and is now concerned as one of the most player noxious weeds species (Rao 1956). The aims of the present work was to investigate etiology of *Parthenium* phyllody. Taye *et al.* (2004) reports of phyllody disease of *P. hysterophorus* weeds in Ethiopia, Phyllody and withches' broom previously reported on *Parthenium hysterophorus* from Uttar Pradesh (Raj *et al*. 2008).

METHODOLOGY

A field survey was carried out during *Kharif* season at Jawaharlal Nehru Krishi Vishvidyalay Jabalpur, near Sesame, Niger and other side field to find out the natural occurrence of virescence and wiches' broom pathogen of *Parthenium hysterophorus*.

RESULTS

The natural occurrence of virescence and witches broom was observed of *P. hysterophorus*, plant growing widely along the sesame field and near threshing floor field. The infected plants showed excessive green branches, tiny narrow leaves, shorting, of internodes, reduced plant height and leaf size as well as modification petals in to leaf like structure that lead to study (phyllody) witches broom like symptoms (Fig 1). Phyllody and witches broom caused by Phytoplasma, *"Candidatus phytoplasma asters"*(16SrI) have been previously reported on *Parthenumn hysterophorus* from Uttar Pradesh (Raj *et al.* 2008). The present finding its in accordance with Taye *et al.* (2004). The observed symptomatology has clearly revealed the phyllody disease in parthenium is caused by phytoplasma.

CONCLUSION

Based on the symptoms recorded in the present investigation match with the symptoms described in Ethopia by Taye *et al.* (2004) and Raj *et al*. (2008) from India. It was concluded that the disease identified as either phyllody or witches' broom disease witch caused by Phytoplasma.

Fig. 1. Phyllody (witches' broom) affected *Parthenium* plant

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Surveillance of mung bean yellow mosaic (MYMV) in weed plants of Jabalpur, Madhya Pradesh

K.N. Gupta* and R.K. Verma

Department of Plant Pathology, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, Madhya Pradesh 482 004
**Email: kngupta1@rediffmail.com*

In soybean, mung bean, urd bean yellow mosaic is the most damaging and wide spread disease. The same disease affects many other pulse crops and its vector whitefly *Bemisia tabaci* Gennadius) can also breed on a large number of plant species (Chenulu 1979). Nene (1971) observed that certain weeds like *Brachia ramosa*, *Eclipta alba* naturally infected by MYMV were found to be source of disease agents transmitted by *B. tabasi* to several cultivated plants. Eravian *et al.* (1998) studied role of weeds as source of Mungbean yellow mosaic virus which was varying among the different weeds examined, *i.e. Acalypta indica,Croton, sparsiflorus, Eclipta alba* and *Matvastrum coromandlli aum.* Hence the present work has been carried out to study the role of weeds as source of Mung bean yellow mosaic virus among different weeds.

METHODOLOGY

Experiment was conducted at Jawharlal Nehru Krishi Visvidalaya Jabalpur by, visiting different selected fields located at different situation and seasons, *viz. Kharif, Rabi,* and *Summer* during the year 2013. The population of weed plant was monitored regularly and as soon as the disease symptoms were seen on any plant the area was marked for further observation during *Kharif, Rabi* and *Summer* season.

RESULTS

The incidence of disease was recorded in terms of date of initiation of symptoms, percentage incidence and stage of disease results are presented in (Table 1). The data indicate that yellow mosaic was harboured on ten plant species in addition to crops growing in different situations, The percentage of incidence ranged between 10 - 80% plant were found infected at all the three stage, *i.e.* growth stage, flowering and late stage of crop growth. Weeds like *Alternanthera Seassilus, Corchorus olituris, Sida rhombifolia,* and wild plant like *Paracalyx scubisus* were found to act as reservoirs of inoculum in all the three seasons. These results are in confirmation with the finding Eravin *et al.* (1998). Weeds plants were found to act as reservoir of inoculums and recipient of the infection further observation revealed that inoculam of yellow mosaic was surviving on wild host like *Paracalyx scubisus* (Roxb) Ali. Simultaneously weed like *Alternenthera sessillis* and *Corchorous olitorious* were found to help the multiplication and spread of inolulum.

Table 1. Surveillance of yellow mosaic in weed and wild plant of Jabalpur

Situation studied	Population of Plants/m2			Incidence%			Stage of growth		
	Kharif	*Rabi*	*Summer*	*Kharif*	*Rabi*	*Summer*	*Kharif*	*Rabi*	*Summer*
Ageratum conizoides	30	38	28	20	72	12	G	G	F
Alternanthera sessillis	27	23	15	15	3	8	G	G	G
Corchorus olitorious	28	-	-	80	-	-	G	-	-
Sida rhombifolia	42	-	30	58	-	18	G	-	G
Ageratum conizoides	38	38	-	20	68	-	G	G	-
Corchorus olitorious	32	-	-	80	-	-	G	-	-
Phaseolus trilobus	20	-	-	62	21	53	G	G	G
GParacalyx scubisus	TR	TR	TR	+	+	+	G	G	G
Ageratum conizoides	40	42	-	10	60	-	G	G	G
Corchorus olitorious	32	-	-	78	-	-	G	-	-
Eclipta alba	58	-	-	50	-	-	G	-	-
Ageratum conizoides	50	80	-	6	10	-	G	F	-
Alternanthera sessillis	60	42	25	58	-	-	G	-	-
Sida rhombifolia	60	-	-	18	-	-	G	G	G
Ageratum conizoides	33	28	-	10	18	-	G	G	G
Alternanthera sessillis	31	45	-	20	70	-	G	G	-
Field bunds									
Ageratum conizoides	40	32	-	20	78	-	G	G	G
Alternanthera sessillis	20	47	-	10	18	-	G	G	G
Corchorus olitorious	TR	-	TR	+	-	+	G	-	G
Phaseolus trilobus	32	-	-	72	-	22	G	-	G
Paracalyx scubisus	TR	TR	TR	+	+	-	G	G	G
Sida rhombifolia	30	-	27	65	22	-	G	-	G

+-Positive, - -Negative, TR-Traces, G-Growth stage, F-Flowering stage, M -maturity stage

CONCLUSION

It was concluded that yellow mosaic inoculm survived on weeds plants like *Corchorus olitrurious*, *Eclipta alba, Paracalyx scubisus* and *Sida rhombifolia,* July, November and February month where the period which were found most suitable for yellow mosaic incidence and development.

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Effect of elevated CO_2 on physiological, biochemical and molecular aspects in chickpea and associated weeds

Bhumesh Kumar*, Meenal Rathore, Partha P. Choudhury and Raghwendra Singh
Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004
**Email: kumarbhumesh@yahoo.com*

As a result of rapid industrialization, there is an increase in the production of greenhouse gases among which CO_2 is a major contributor, which can have a significant impact on plant metabolism. Although, there is broad agreement that higher atmospheric CO_2 levels stimulate photosynthesis in C3 crop plants, yet, no such consensus exists on how rising CO_2 levels will affect the physiology of associated weeds, which provide a tough competition to the crop plants (Hamid *et al.* 2009, Yan *et al.* 2010 and Ziska *et al.* 2010) . Efforts have been made to study the effect of elevated CO_2 on physiological and biochemical aspects and operation of ROS scavenging pathway in chickpea and associated weeds using Free Air CO_2 Enrichment (FACE) technique for CO_2 enrichment.

METHODOLOGY

An experiment was conducted to study changes in physiological, biochemical and molecular aspects in chickpea (*Cicer arietinum* L.) and associated weeds (*Lathyrus sativus* and *Medicago denticulata*) under high CO_2 environment in FACE system. Plants of the above three species were exposed to ambient CO_2 (380 ± 5 ppm) and elevated CO_2 (550 ±50 ppm) from emergence to maturity of chickpea during the photoperiod only. Observations were recorded at 21 and 42 DAT.

RESULTS

Elevated CO_2 resulted an increase in growth and development of chickpea and all the weed species at 21 and 42 DAT. High CO_2 resulted an increase in dry weight per plant in chickpea (45%), *Lathyrus sativa* (151%), and *Medicago* denticulata (55%) at 42 DAT as compared to that ambient CO_2. Relative growth rate (RGR) increased at elevated CO_2 as compared to ambient CO_2 in all the species being highest in *Lathyrus* (608 mg/plant/day) followed by chickpea (511 mg/plant/day). An increase in photosynthesis, activity of carbonic anhydrase was observed in all three species at both the growth stages and such increase was maximum in *Lathyrus sativus* as compared to two other species. In chickpea and *Lathyrus sativus,* high CO_2 concentration led to up-regulation of the peptide (26 kDa) as compared to that at ambient CO_2 while such response was not evident in *Medicago denticulata*. Differential regulation of different isoenzymes (Native PAGE) of superoxide dismutase (SOD) and glutathione reductase was noticed among species at elevated CO_2. Transcripts profile of genes involved in antioxidant defence system in chickpea revealed differential regulation of different genes at elevated CO_2.

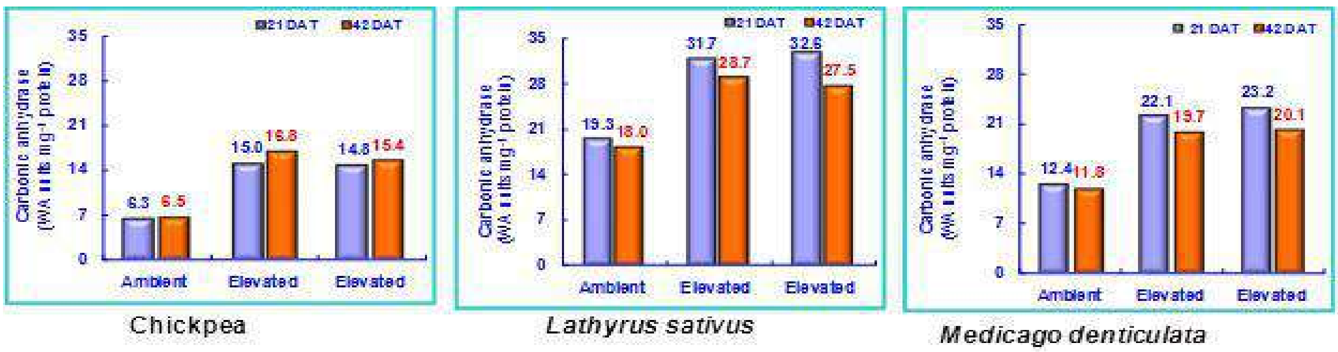

Fig.: Effect of elevated CO_2 on activity of carbonic anhydrase in chickpea and two weed species

CONCLUSION

Rise in CO_2 concentration had positive effect on photosynthesis, carbonic anhydrase and antioxidant defence mechanism defence mechanism in chickpea and two weeds. *Lathyrus sativus* being more responsive to elevated CO_2 may be dominating chickpea crop in futuristic high CO_2 atmosphere. Transcripts profile of genes involved in antioxidant defence system in chickpea revealed differential regulation of different genes at elevated CO_2 pointing out towards a possible role of antioxidant defence system.

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Bioefficacy of pinoxaden 5 EC in combination with broadleaf herbicides against complex weed flora in wheat

D.K. Roy* and Dharminder

Rajendra Agricultural University, Bihar, Pusa, Samstipur 848 125

**Email: dr_dhirendra_krroy@yahoo.com*

Wheat (*Triticum aestivum* L.) is most widely grown as winter cereal and is the backbone of food security in India. During last four decades, wheat production and productivity has increased almost 6-fold and it alone contributes about one-third of the total food grain production in India. In era of climate change and increasing biotic and abiotic stresses, maintaining yield up to required level is going to be formidable challenge in coming future. The important factor that reduces its productivity is severe weed infestation (Pandey *et al.* 2006). Under irrigated conditions wheat is infested with heavy population of *Avenafatua, Cynodondactylon, Phalaris minor, Cyperusrotundus, Anagalisarvensis, Chenopodium album, Cirsiumarvense, Convolvulus arvensis, Eclipta alba, Fumariapurviflora, Launiapinnatifida, Melilotus alba, Physalis minima, Rumexdentatus* and *Vicia hirsute.* Keeping in view the above facts, an investigation was carried out to keep the weeds in wheat below threshold level.

METHODOLOGY

The Field experiments were conducted during *Rabi* 2010-11 and 2011-12 at the Research farm of Rajendra Agricultural University Bihar, Pusa. The soil of experimental field was low in ongoing carbon (0.41%) and available nitrogen (206 kg/ha), available phosphorus (19.8 kg/ha) and potassium (109.5 kg/ha) and alkaline (pH 8.3). Wheat variety HD2733 was sown in rows 22 cm apart using 100 kg seeds/ha. Recommended dose of 120-60-40 kg N-P-K/ha was uniformly applied to all the treatments. Full dose of P and K besides half dose of N were applied at the time of sowing where as rest of the N was given in 2 equal splits by top dressing at crown root initiation and booting stage. Irrigation was applied at all the critical stages of crop growth during both the years of experimentation. The treatments consisted of pinoxaden 50 g/ha, metsulfuron-methyl 4 g/ha,pinoxaden + carfentrazone–ethyl 50+20 g/ha,pinoxaden + metsulfuron-methy l50+4 g/ha,pinoxaden + 2,4-D 50+500 g/ha,pinoxaden *fb* carfentrazone-ethyl50 and 20 g/ha, pinoxaden *fb* metsulfuron-ethyl 50 and 4 g/ha, pinoxaden *fb* 2,4-D 50 and 500 g/ha, carfentrazone-ethyl 20 g/ha, idosulfuron + mesosufuron 400 g/ha, 2,4-D 500 g/ha, weed free and weedy check and were arranged in randomized block deign with 3 replications. Herbicides were applied with the help of knapsack sprayerfitted with flat fan nozzle at a spray volume of 500 litres. Observations on weed population and weed dry matter were recorded from 2 random quadrate of 0.25 m^2 in each plot at 60 DAS.

Table. Bio efficacy of pinoxaden 5 EC in combination with broadleaf herbicides againstcomplex weed flora in wheat (Mean data of two years)

Treatment	Weed count (No./m^2)	Weed dry wt. at 60 DAS (g/m^2)	Grain yield (t/ha)	WCE (%)	Net Return ($x10^3$₹/ha)	B:C ratio
Pinoxaden 50	29.75	21.90	3.67	34.39	35.62	1.52
Metsulfuron-methyl 4	37.93	25.72	3.54	22.85	34.95	1.54
Pinoxaden + carfentrazone –ethyl 50+20	19.47	13.94	4.31	58.21	43.10	1.80
Pinoxaden + Metsulfuron-methyl 50+4	22.19	17.43	3.80	47.81	36.95	1.55
Pinoxaden + 2, 4-D 50+500	20.56	15.36	4.10	54.03	41.07	1.74
Pinoxaden*fb*Carfentrazone-ethyl 50&20	21.18	15.77	4.01	52.75	39.58	1.65
Pinoxaden*fb*metsulfuron-ethyl 50&4	24.39	19.09	3.76	42.88	36.10	1.51
Pinoxaden*fb* 2, 4-D 50&500	21.78	16.79	3.91	49.77	38.50	1.63
Carfentrazone-ethyl 20	20.58	15.11	4.15	54.78	42.56	1.86
Idosulfuron + Mesosufuron 400	21.16	15.52	4.12	53.51	41.19	1.75
2, 4-D 500	22.92	18.09	3.65	45.81	36.64	1.63
Weed free	7.36	3.65	4.39	89.14	28.32	0.71
Weedy check	47.62	33.39	2.97		26.71	1.19
LSD (P=0.05)	1.07	0.98	0.11	-	1.30	-

RESULTS

All the weed control treatments significantly reduced the dry weight of weeds when compared with weedy check. The lowest weed count and weed dry weight were recorded under weed free which were statistically at par with pinoxaden + carfentrazon ethyl 50 + 20 g/ha. The highest grain yield (4.39 t/ha) of wheat was recorded by the weed free treatment with was statistically at par with pinoxaden + carfentrazon ethyl 50 + 20 g/ha (4.31 t/ha) which were significantly superior over rest of the treatments. The highest net return (₹ 43100/ha) and Benefit: Cost ratio (1.80) were recorded under pinoxaden + carfentrazon ethyl 50 + 20 g/ha.

CONCLUSION

Application of pinoxaden + carfentrazon ethyl 50 + 20 g/ha at 28 DAS was equally effective for reducing the weed count and weed dry weight and producing similar grain yield to that of weed free plot.

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Herbicides combinations for control of complex weed flora in direct seeded rice under wet condition

D.K. Roy* and Dharminder

Rajendra Agricultural University, Bihar, Pusa, Samstipur 848 125

**Email: dr_dhirendra_krroy@yahoo.com*

In Bihar rice is cultivated in around 3.34 m ha with a production of 7.2 million tones and productivity of 2.15 t/ha (Agricultural Statistics at a Glance 2011).Wet- seeded rice (*Oryza sativa*) is gaining momentum in India due to high demand of labour during peak season of transplanting and availability of water for short periods. The transformation in crop-establishment technique from transplanted to wet-seeded rice cultivation has resulted in dramatic change in the type and degree of weed infestation. Weed menace is maximum in wet-seeded rice because of similarity in morphological characters of weeds and rice.Uncontrolled weeds reduce the yield by 96% in dry direct-seeded rice and 61% in wet direct-seeded rice (Maity and Mukherjee 2008). It is very difficult to control weeds by hand weeding in the early stage of crop growth. Though, the conventional method of manual weeding is widely practiced, herbicides aremore efficient in timely control of weeds in wet-seeded rice. Chemical weeding preferably the use of pre-emergence herbicide is vital for effective and cost-efficient weed control in such situations, where weeds compete with the main crop right since the date of germination.Therefore, pre-emergence and new post- emergence herbicides were tested to develop on effective and viable weed management practice for wet-seeded rice.

METHODOLOGY

A field experiment was conducted during *Kharif* section of 2010 and 2011 at Research farm of Rajendra Agricultural University Bihar, Pusa. The soil of the experimental plot was silt loam with pH 8.3 and organic carbon 0.42%. The fertility status of the soil was low in available nitrogen (210 kg/ha), phosphorus (18.9 kg P_2O_5/ha) and potassium (108.5 kg K_2O/ha). Sprouted seeds of rice variety *'Rajendra'* sweta were sown 80 kg/ha by using drum seeder to maintain a row spacing of 20cm in paddled soil. The total length of the drum seeder is 1.6 m and eight rows could be sown in single run. Recommended level of N, P and K 100-60-40 kg/ha was applied. Nitrogen was applied in three equal splits (sowing time, active tillering stage and panicle initiation stage). Single basal dose of P and K was applied along with N in three equal splits. There were 10 treatments in randomized block design with three replications. Weed samples were taken in each plot at four randomly selected spots, using a quadrate of 0.25 m^2 areas.

RESULTS

Under wet condition direct seeded ricewas infested with heavy population *of Echinocloac rusgalli, Echinocloa colonum, Digitariasanguinalis, Dactyloctenium aegyptium, Cynodon dactylon. Cyperus rotundus, Cyperus diformis, Fimbristylis milliaceae. Caesulia axillaris, Lippia nodiflora, Ammonia bacifere, Eclipta alba, Phyllanthus niruri.*

The lowest weed count and weed dry weight were recorded under treatment Three mechanical weedings (cono/rotary weeder) which was statistically at par with weed free (HW at 20,40 and 60 DAS) and pendimethalin* *fb* bispyribac *fb* manual weeding which were significantly superior over rest of the treatments. The highest grain yield of rice (4.00 t/ha) was recorded under treatment Three mechanical weedings (cono/ rotary weeder) which was statistically at par with weed free (HW at 20,40 and 60 DAS) and pendimethalin* *fb* bispyribac *fb* manual weeding and which were significantly superior over rest of the treatments. There were not any phytotoxic effects on the rice crop. The highest weed control efficiency was achieved by the application of pendimethalin (1.0 kg/ha) followed by bispyribac Na followed by manual weeding, which was comparable with Weed free check. This could be attributed to greater reduction of dry weight of weeds by combined effect of herbicides and hand weeding.

Table 1. Herbicides combinations for control of complex weed flora in direct seeded rice under wet condition (Mean data of Two years)

Treatment	Weed density/m^2 (60 DAS)	Weed biomass (g/m^2) at 60 DAS	Grain yield (t/ha)	WCE (%)
Bispyribac-Na 25 g/ha at 20DAS	16.13	35.74	3.05	44.92
Pendimethalin* *fb*bispyribac Na 1000*fb* 25 g/ha at 0-2 fb 25 DAS	10.21	22.01	3.24	66.08
Oxadiargyl*fb*Bispyribac Na 100 *fb* 25 at 0-2 *fb* 25 DAS	15.55	32.12	2.76	50.51
Pyrazosulfuron*fb*bispyribac Na 20 *fb* 25 g/ha at 0-3 *fb* 25 DAS	9.28	19.62	3.30	69.76
Pendimethalin* *fb*bispyribac Na *fb* manual weeding 1000*fb* 25 g/ha at 20 DAS	5.04	12.16	3.77	81.26
Pendimethalin* *fb* manual weeding 1000 g/ha at 25-30 DAS	8.27	18.07	3.33	72.15
Bispyribac Na + (Chlorimuron + Metsulfuron) 20+4 g/ha 20 DAS	13.45	30.38	3.06	53.19
Three mechanical weedings (cono/rotary weeder) 20,40,60 DAS	3.88	9.20	4.00	85.73
Weed free (HW at 20,40 and 60 DAS)	4.33	9.70	3.89	85.13
Weedy check	33.91	64.89	2.25	
LSD (P=0.05)	1.18	3.07	0.45	

*Pendimethalin (stomp Xtra 38.7% CS)

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Herbicides combinations for control of complex weed flora in transplanted rice

D.K. Roy* and Dharminder

Rajendra Agricultural University, Samstipur, Bihar 848 125

**Email: dr_dhirendra_krroy@yahoo.com*

In Bihar rice is cultivated in around 3.34 m ha with a production of 7.2 million tones and productivity of 21.58 q/ha. Despite the significant achievement in food grain production since independence, Indian agriculture continues to face challenges from ever increasing population. India would need about 300 million tons of food grains by 2020. The cultivation of dwarf high yielding crop varieties responsive to fertilizers and irrigation and the intensive cropping system has aggravated the problem of weeds. Weeds have been persistent problems in rice since the beginning of the settled agriculture. Besides reduction in yield, weeds remove a large amount of plant nutrients from the soil. An estimate shows that weeds can deprive the crops by 47 per cent N, 42 per cent P, 50 per cent K, 39 per cent Ca and 24 per cent Mg of their nutrient uptake as well as reduce the yield potential by harbouring number of crop pests (Balasubramaniyan and Palaniappan 2001). Hence successful weed control is essential for obtaining optimum yield of rice. The mechanical and cultural methods are not possible to be adopted on account of scarcity of labour in the peak period of transplanting. In these situation herbicides plays a major role in increasing rice production by decreasing weed intensity. The use of proper herbicide at the correct dose, at the appropriate time and in appropriate manner is essential for avoiding any possible build up of toxic residues in soil. In view of the current availability of the herbicides in the Indian market and their effectiveness against grasses, sedges and broad leaf weeds, pre emergence and new post-emergence herbicides were taken to study the influence of pre- emergence and post-emergence herbicides on weed flora, crop yield, nutrient uptake and economics under transplanted rice ecosystem.

METHODOLOGY

A field experiment was conducted to evaluate the bio-efficiency of combination of herbicides against complex weed flora, and their effect on growth and yield of transplanted rice at crop research centre, RAU pusa in Randomized Block Design replicated thrice during *Kharif* seasons of 2012 and 2013. The variety used was *'Rajendra Sweta'*. The recommended dose of fertilizers i.e. 120-60-40 kg N- P_2O_5- K_2O/ha was applied. Half dose of Nitrogen and full dose of phosphorus and potassium were applied as basal and remaining dose of Nitrogen was applied in two equal splits at Active tillering and Panicle initiation stages. Herbicides were applied with the help of Knapsack sprayer fitted with flat fan nozzle. Data were recorded on weeds and yield of rice crop.

RESULTS

Weed flora found in the experimental field were *Echinocloa crusgalli, E. colonum, Digitaria sanguilis, Dactyloctenium aegyptium, Cynodon dactylon,Cyperus rotundus, Cyperus diformis, Fimbristylis milliaceae nalis, Caesulia axillaris, Lippia nodiflora, Ammonia bacifera, Eclipta alba and Phyllanthus niruri.* The lowest weed population and weed dry weight were recorded in weed free (hand weeding at 25 and 45 DAT) which were significantly superior over rest of the treatments. Among the different herbicides, the lowest weed count and weed dry weight were recorded by the treatment pyrazosulfuron 20 g/h at 0-3 DAT *fb* manual weeding at 25 DAT which were statistically at par with bispyribac + ethoxysulfuron 25+18.75 g/ha at 25 DAT and significantly superior over rest of the treatments. The highest grain yield of rice (4.51 t/ha) was recorded by the treatment weed free (hand weeding at 25 and 45 DAT) which was statistically at par with pretilachlor *fb* (chlorimuron + metsulfuron),bispyribac + ethoxysulfuron, pretilachlor *fb* ethoxysulfuron, pyrazosulfuron *fb* manual weeding, bispyribac + (chlorimuron + metsulfuron) and pretilachlor (6%) + bensulfuron (0.6%) 6.6% GR. The highest weed control efficiency (70.37%) was recorded under the treatment weed free (hand weeding at 25 and 45 DAS) which was followed by pyrazosulfuron *fb* manual weeding (58.23%), bispyribac + ethoxysulfuron (52.85%) and pretilachlor *fb* (chlorimuron + metsulfuron) (41.43%). There were not any phytotoxic effects on rice crop.

Table 1. Herbicides combinations for control of complex weed flora in transplanted rice (Mean data of two years).

Treatment	Weed density/m2 (60 DAS)	Weed biomass (g/m2) at 60 DAS	Grain yield (t/ha)	WCE (%)
Bispyribac-Na 25 g/ha at 25 DAT	11.46	22.78	3.88	35.61
Pretilachlor/Butachlor 1000/1500 g/ha at 0-3 DAT	10.84	22.31	3.93	36.95
Penoxsulam 22.5 g/ha at 8-12 DAT	13.58	26.77	3.44	24.32
Pyrazosulfuron 20 g/ha at 0-3 DAT	12.17	21.57	3.80	38.98
Bispyribac + ethoxysulfuron 25+18.75 g/ha at 25 DAT	8.17	16.68	4.43	52.85
Bispyribac + (Chlorimuron + Metsulfuron) 20+4 g/ha at 25 DAT	9.52	21.72	4.28	38.60
Pretilachlor fb Ethoxysulfuron 750/18.75 g/ha at 25 DAT	9.10	21.78	4.36	38.45
Pretilachlor fb (Chlorimuron + Metsulfuron) 750/4 g/ha at 25 DAT	9.76	20.73	4.45	41.43
Pyrazosulfuron 20 g/h at 0-3 DAT *fb* manual weeding at 25 DAT	6.97	14.78	4.36	58.23
Pretilachlor (6%) + bensulfuron (0.6%) 6.6% GR 660 g/ha at 0-5 DAT	10.96	22.28	4.27	37.06
Weed free (hand weeding at 25 and 45 DAT)	5.08	10.49	4.51	70.37
Weedy check	22.81	35.38	2.94	
LSD (P=0.05)	1.21	1.98	0.39	

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Integrated weed management in summer maize

Ranjana Kumari, D.K. Roy* and Dharminder
Department of Agronomy,Rajendra Agricultural University, Bihar, Pusa, Samstipur 848 125
**Email: dr_dhirendra_krroy@yahoo.com*

Maize in Bihar is cultivated in 0.64 m ha producing 1.71 million tonnes of grains at a productivity level of 2.67 t/ha. Summer maize in Bihar is cultivated in 0.17 m ha producing 0.42 million tones grains with productivity of 2.43 t/ha. Weed control is of prime importance to save the wasteful loss of plant food nutrients and to harvest higher yields. The extent of losses caused by weeds depends upon weed density. Density of weeds in maize crop has been found to range between 28-100% (Pandey *et al.* 2001). However, considering the severity of weed problem, no single method of weed control could be said to provide desired level of efficiency and economic feasibility under all situations. In view of these facts it is necessary to develop integrated weed management practices involving manual methods, mechanical weeding and use of herbicides which may provide a wide spectrum weed control technology in maize without any residual toxicity to the succeeding crops in rotation and less involvement of money.

METHEDOLOGY

A field investigation was conducted during *summer season* at Crop Research Centre, RAU., Pusa (Samastipur) to study the integrated weed management in summer maize (*Zea mays* L.). The experiment was laid out in randomized block design with 17 treatments of weed management practices *viz.* T_1- Power weeder (one weeding at 30 DAS), T_2- Power weeder (two weeding at 30 and 45 DAS), T_3- Atrazine 1.0 kg/ha (per-emergence) *fb* Power weeder 45 DAS, T_4- Metribuzine 500 ml/ha(per-emergence) *fb* Power weeder 45 DAS, T_5- Grubber (one weeding at 30 DAS), T_6- Grubber (two weeding at 30 and 45 DAS), T_7- Atrazine 1.0 kg/ha *fb* Grubber at 45 DAS, T_8- Metribuzine 500 ml/ha *fb* Grubber at 45 DAS, T_9- Wheel hoe(one weeding at 30 DAS), T_{10}- Wheel hoe (two weeding at 30 and 45 DAS), T_{11}- Atrazine 1.0 kg/ha *fb* wheel hoe at 45 DAS, T_{12}-metribuzine 500 ml/ha *fb* wheel hoe at 45 DAS, T_{13}- weeding by khurpee (two weeding at 30 and 45 DAS), T_{14}- atrazine 1.0 kg/ha, T_{15}- metribuzine 500 ml/ha, T_{16}-weed free (Three weeding at 20, 40, and 60 DAS) and T_{17}- weedy check replicated thrice. Herbicides were applied with the help of knapsack sprayer fitted with flat fan nozzle. Observations on weed population and weed dry matter were recorded from 2 random quadrate of 0.25 m^2 in each plot at 60 DAS.

RESULTS

Among the different weed management treatments, weed free recorded the minimum weed counts and weed dry weight which was significantly superior over rest of the treatments and closely followed by metribuzine 500 ml/ha *fb* power weeder at 45 DAS and atrazine 1.0 kg/ha *fb* power weeder at 45 DAS. The maximum weed control efficiency (79.34%) was recorded by metribuzine 500 ml/ha *fb* power weeder at 45 DAS, followed by (78.31%) by weed free and (72.83%) by atrazine 1.0 kg/ha *fb* power weeder at 45 DAS. The lowest weed index (4.94%) was recorded by metribuzine 500 ml/ha *fb* power weeder at 45 DAS followed by atrazine 1.0 kh/ha *fb* power weeder at 45 DAS. The maximum gross return (Rs. 53171/ha) was recorded by weed free which was closely followed by Metribuzine 500ml/ha *fb* power weeder at 45 DAS. (Rs. 50597/ha) and Atrazine 1.0 kg/ha *fb* power weeder at 45 DAS ₹(49998/ha).

Table 1. Integrated weed management in summer maize

Treatment	Weed count (no./m^2)	Weed dry wt. at 60 DAS (g/m^2)	Grain yield (t/ha)	WCE (%)	Net return (x10^3₹/ha)
Power weeder (one weeding at 30 DAS)	8.68	7.81	3.35	48.86	19.724
Power weeder (two weeding at 30 & 45 DAS)	8.21	7.17	3.71	57.05	23.235
Atrazine 1.0 kg/ha (per-emergence) *fb* Power weeder 45 DAS	7.64	6.91	4.18	60.06	29.325
Metribuzine 500 ml/ha(per-emergence) *fb* Power weeder 45 DAS	7.51	8.86	4.23	60.68	29.724
Grubber (one weeding at 30 DAS)	9.08	8.50	3.22	39.43	17.351
Grubber (two weeding at 30 & 45 DAS)	8.33	7.33	3.65	55.02	20.913
Atrazine 1.0 kg/ha *fb* Grubber at 45 DAS	8.09	7.23	3.82	56.30	24.310
Metribuzine 500 ml/ha *fb* Grubber at 45 DAS	8.03	7.09	3.88	57.94	24.812
Wheel hoe(one weeding at 30 DAS)	8.97	8.24	3.25	43.08	17.919
Wheel hoe (two weeding at 30 and45 DAS)	8.39	7.27	3.65	55.73	21.102
Atrazine 1.0 kg/ha *fb* wheel hoe at 45 DAS	7.90	7.60	3.96	58.37	26.032
Metribuzine 500 ml/ha *fb* wheel hoe at 45 DAS	7.83	6.97	4.05	59.35	26.899
Weeding by khurpee (two weeding at 30 and 45 DAS)	8.80	8.00	3.32	47.17	9.793
Atrazine 1.0 kg/ha	8.63	7.68	3.43	50.64	21.209
Metribuzine 500 ml/ha	8.51	7.48	3.60	53.22	22.942
Weed free (Three weeding at 20, 40 and60 DAS)	4.74	3.62	4.45	89.34	17.926
Weedy check replicated thrice	14.97	10.91	2.60	--	11.461
LSD (P=0.05)	0.45	0.16	0.37	--	10.541

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Performance of barley varieties under weed management

Smita Singh*, A.K. Singh, L.B. Singh, Satish Singh and Mahesh Jerman

College of Agriculture , Rewa, Madhya Pradesh 486 006

**Email:sapnapuat@gmail.com*

Barley (*Hordeum vulgare* L.) is one of the most important winter crops grown for green forage as for feeding animals on its straw beside grains, also as a food by tribes who live in the desert and in dry regions for making bread, either alone or mixed with wheat. Also, it could be used for malting in the brewing industry. Hand labor became scarce and costly; herbicides replaced it as a cheap and easy method of weed control in barley fields. Several herbicides are available to control barley weeds. Weeds are undesirable plants, which infest different crops and inflict negative effect on their yield. Generally weed-crop competition is complicated as weeds compete with the crop plants by occupying a space, which would otherwise be available to the crop plant.

METHEDOLOGY

A field experiment was conducted during *Rabi* seasons of 2010 and 2011 under AICRIP – Barley & Wheat at college of agriculture research Farm, Rewa, JNKVV, Jabalpur to evaluate the barley varieties for restricted irrigation. The experiment was laid out in split plot design with three herbicidal treatment weed free (manual weeding 30 & 60 DAS), isoproturon (750 g) + 2,4 D (500 g) and weedy check in main plot and four varieties K 551,K 508, RD 2552 and jyoti in sub plot. Fertilizers (N, P and K) were applies as per recommendations, 1/3 rd of N and all P and K were applied as basal and rest 2/3 of N was applied after 1st irrigation. Weed population/m² was recorded at 60 DAS under each treatment with the help of 0.25 m² quadrat. Weed population was recorded in weedy check to work out the relative density of weeds.The weed dry matter was also recorded at 60 DAS.Data on weed density and weed biomass were transformed using $\sqrt{x+0.5}$ transformations.

Table 1. Effect of herbicide and varieties on yield attributes and yield of barley

Treatment	Earhead/m^2	Grains/earhead	1000 Grain weight	Yield (t/ha)
Herbicides				
Weed free (30 & 60)	256.00	50.50	41.90	4.153
Isoproturon (750 g) + 2,4 D(500 g)	251.00	49.50	41.60	4.034
Weedy check	232.00	44.50	41.10	3.644
LSD (P = 0.05)	22.05	2.46	1.20	0.63
Varieties				
K 551	238.50	43.50	40.35	3.802
K 508	250.50	46.00	41.55	3.911
RD 2552	266.50	48.00	41.65	3.984
Jyoti	228.00	54.50	42.50	4.084
LSD (P = 0.05)	9.93	2.09	0.79	0.82

RESULT

Manual weeding was superior to herbicide control. More yield reduction in weedy check over manual and herbicide weed control, respectively. The varieties were having almost same trend in all weed control options; however the yield percent reduction was less under Jyoti as compared to other varieties (Table 1). The yield attributing characters (earhead/m^2, 1000 grain wt and grains/ear^2) were less under weedy check compared to weed control method). At 60 DAS, weeds were more under weedy check as compared to manual weeding and herbicide control. Dry weight of weeds was less under manual and herbicide control and similar under different varieties same trend reported by Singh *et.al* (2008).

CONCLUSION

It could be concluded that using Isoproturon (750 g) + 2, 4 D (500 g)resulted in increment of growth and productivity when the barley variety Jyoti was used.

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A Phyto-sociological association of weeds in summer crops of Kashmir Valley under different eco-situations

Purshotam Singh*, Parmeet Singh, Lal Singh, Sameera Qayoom, B A Lone,,Raihana H Kanth, Gurdeep Singh and K N Singh

Division of Agronomy, Sher-e-Kashmir University of Agricultural Sciences & Technology, Kashmir, Shalimar 190 025
**Email: drpurshotam@gmail.com*

Sher-e-Kashmir areas where rice is cultivated two eco-situations exist, first with abundance of soil moisture is infested with weed species like *Potamagetone distinctus, Polygonum hydropiper, Monochoria vaginalis, Ammania baccifera, Gratula japonica,Cyperius defformis, C.irria, Scirpus juncoides etc.* In second eco-situation were farmers have to irrigate rice fiels as per availability of water the fields are infested with weeds like *Echinochloa crusgalli, Gratula japonica,Cyperius defformis, C.irria, Cyperus rotundus* etc.

METHEDOLOGY

The study on the phyto-sociological association of weeds in summer crops viz. rice (*Oryzasativa), maize (Zea mays),* saffron (*Crocus sativus)* and pulses of Kashmir valley was conducted during 2013 at varying altitudes from 1500 to 2500 m above mean sea level (amsl). Areas where rice is cultivated two eco-situations exist, first with abundance of soil moisture is infested with weed species like *Potamagetone distinctus, Polygonum hydropiper, Monochoria vaginalis, Ammania baccifera, Gratula japonica,Cyperius defformis, C.irria, Scirpus juncoides* etc. In second eco-situation were farmers have to irrigate rice fiels as per availability of water the fields are infested with weeds like *Echinochloa crusgalli, Gratula japonica,Cyperius defformis, C.irria, Cyperus rotundus* etc.

RESULT S

Up to 1700 m maximum importance value index (IVI) of *Potamogeton distinctus* (29.28%) among broad leaves, *Echinochloa crusgalli* (27.15%) among grasses and *Cyperus difformis* (18.88%) among sedges was noticed in rice, *Amaranthus viridis* (20.33%) among broad-leaves , *Digitaria sanguinalis (*16.9%) among grasses and *Cyperus rotundus (*20.14%) among sedges in maize and in saffron Star of Bethlehem *(Ornithogalum mbellatum)* (31.85%) among grasses, *Amaranthus virids (18.23%)* among broad leaves and *Cyperus rotundus* (26.18%) among sedges. From 1700 to 2000m amsl maximum IVI of *Potamogeton distinctus* (33.03%) among broad leaves, *Echinochloa crusgalli* (15.48%) among grasses and *Cyperus difformis* (15.89%) among sedges was noticed in rice and *Amaranthus viridis* (22.08%) among broad leaves, *Digitaria sanguinalis*(17.15%) among grasses, *Cyperus rotundus* (14.53%) among sedges and among others *Chenopodium album was* 18.3% in maize + pulses. Above 2000 m amsl *Potamogeton distinctus* (33.59%) and *Marsilea qadrifolia* (28.35%) among broad leaves, *Echinochloa crusgalli* (17.08%) among grasses was, *Cyperus difformis* (17.11%) *and Cyperus iria* (17.12%) among sedges and among others *Polygonum hydropiper* was 17.18% in rice, in maize+pluses maximum IVI of 18.32% was of *Amaranthus viridisamong broad leaves,* 14.37% of *Digitaria Sanguinalis* and 14.93% of *Cynodon dactylon among grasses,* 12.96% of *Cyperus rotundus* among sedges and 13.53% of *Medicago sativa* was observed in maize +pluses.

CONCLUSIONS

Up to 1700 m maximum importance value index (IVI) of *Potamogeton distinctus* (29.28%) among broad leaves, *Echinochloa crusgalli* (27.15%) among grasses and *Cyperus difformis* (18.88%) among sedges was noticed in rice,

Influence of crop establishment methods and different weed management practices on growth, yield and quality of direct seeded rice.

Vinay Kumar, D.K.Roy*, Dharminder and R.K.Pandey
Rajendra Agricultural University, Bihar, Pusa, Samstipur 848 125
**Email: dr_dhirendra_krroy@yahoo.com*

Direct seeded culture has become increasingly important in rice cultivation due to scarcity of farm labour and higher water requirement and higher production cost of transplanted rice. Direct seeded rice needs only 34% of the total labour requirement and saves 27% of the total cost of the transplanted crop (Mishra and Singh, 2011). The direct seeded rice culture is subjected to greater weed competition than transplanted rice because both weed and crop seeds emerge at the same time and compete with each other from its germination resulting in loss in grain yield a weed free period for the first 30-40 days after sowing is required to avoid any loss in yield because the dry weight of weeds increases greatly from 30 DAS in dry direct-seeded rice. Herbicides are more effective in controlling the weeds besides reducing the total energy requirement of rice cultivation. Though, the conventional method of manual weeding is widely practiced, herbicides are more efficient in timely control of weeds in direct seeded rice. Chemical weeding preferably the use of pre-emergence herbicide is vital for effective and cost-efficient weed control in such situation, where weeds compete with the main crop right since the date of germination.

METHEDOLOGY

A field experiment was conducted during *Kharif* season 2012 at Research farm of Rajendra Agricultural University Bihar, Pusa. The soil of the experimental plot was clay loam with pH 8.79 and organic carbon 0.40%. The fertility status of the soil was low in available nitrogen (203.2 kg/ha), phosphorus (17 kg P_2O_5/ha) and potassium (101.7 kg K_2O/ha). The factors under study comprised three establishment methods i.e. E_1- wet seeded (broadcasting of sprouted seeds under puddled condition), E_2 - dry seeded in rows at 20 cm apart, E_3 - drum seeded puddled condition in main plots and 8 herbicidal treatments on direct seeded rice i.e. W_1- butachlor 1.5 kg/ha (pre-emergence), W_2- butachlor 1.5 kg/ha *fb* bispyribac 25 g/ha. W_3- pretilachlor 0.75 kg/ha (pre-emergence), W_4- pretilachlor 0.75 kg/ha *fb* bispyribac 25 g/ha, W_5- pendimethalin 1.0 kg/ha (pre-emergence), W_6- pendimethalin 1.0 kg/ha *fb* bispyribac 25 g/ha, W_7- hand weeding at 20 and 40 DAS, W_8- weedy check in sub- plots in strip plot design replicated thrice. Recommended level of N, P and K 100-60-40 Kg/ha was applied. Nitrogen was applied in three equal splits (sowing time, active tillering stage and panicle initiation stage). Single basal dose of P and K was applied along with N in three equal splits.

RESULTS

Weed population and weed dry matter accumulation were the least under drum seeding of sprouted seed on puddled bed and the maximum under dry seeding. As regards performance of weed management treatment was concerned the minimum number and biomass were noted there under pendimethalin + bispyribac (W_6). Two hand weedings was next in order. Amongst the herbicidal treatment pretilachlor + bispyribac was next in order. It was intresting to make a note here that amongst the pre-emergence applications alone pretilachlor was the best in controlling weeds. But when pre-emergence applications were supplemented with post emergence application of bispyribac, it was pendimethalin + bispyribac. Drum seeding on wet seed bed gave the highest grain yield of rice. The weed management treatments did not show much variation amongst themselves in regard to grain yield where in all the combined applications of pre and post-emergence herbicides (butachlor 1.5 kg/ha *fb* bispyribac 25 g/ha, pretilachlor 0.75 kg /ha *fb* bispyribac 25 g/ha and pendimethalin 1.0 kg/ha *fb* bispyribac 25 g/ha) and two hand weedings (W_7) as well as single pre-emergence application of pretilachlor performed equally well.Weed control efficiency of pendimethalin + bispyribac (71.67%) was superior over two hand weedings (65.67%), pretilachlor + bispyribac (65.06%) and butachlor + bispyribac (57.61%).

CONCLUSION

The wet seeding is superior to dry seeding and drum seeding is better than broadcasting on wet beds. Secondly, high cost involved in manual weeding makes herbicidal treatments more viable proposition. pretilachlor + bispyribac and pendimethalin + bispyribac are the two most effective herbicidal treatments in direct seeded wet or dry rice establishment methods.

Treatment	Weed count (no./m^2)	Weed dry wt. at 60 DAS (g/m^2)	Grain yield (t/ha)	WCE (%)
Wet seeded (broadcasting of sprouted seeds under puddled condition	152.37	106.22	3.27	-
Dry seeded in rows at 20 cm apart	219.00	177.84	2.96	-
Drum seeded in puddled condition	87.50	72.01	3.56	-
LSD (P=0.05)	2.99	2.17	0.36	-
Sub plot: Weed management				
Butachlor 1.5 kg /ha (pre-emergence)	172.33	140.06	3.16	42.27
Butachlor 1.5 kg /ha *fb* bispyribac 25 g/ha	134.66	96.40	3.44	57.61
Pretilachlor 0.75 kg /ha (pre-emergence)	148.00	108.88	3.36	54.08
Pretilachlor 0.75 kg /ha *fb* bispyribac 25 g/ha	116.00	80.07	3.54	65.06
Pendimethalin 1.0 kg/ha (pre-emergence)	180.66	132.67	3.23	46.50
Pendimethalin 1.0 kg/ha *fb* bispyribac 25 g/ha	94.33	64.63	3.56	71.67
Hand weeding at 20 & 40 DAS	107.33	79.11	3.54	65.83
Weedy check	270.33	247.71	2.28	-
LSD (P=0.05)	2.12	2.29	0.29	-

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Effect of herbicides combination for control of complex weed flora in transplanted rice under tarai ecosystem of Uttarakhand

Tej Pratap*, Priyanka Kabdal, V.Pratap Singh, Rohitashav Singh and Abnish Kumar

G.B. Pant University of Agriculture & Technology, Pantnagr, U.SNagar Uttarakhand 263 145

**Email: drtpsingh2010@gamil.com*

Rice (*Oryza sativa L*) is one of the most important food crop in India, contributing about 40% of total food grain production. Rice grain production in our country is reported to suffer a loss of 15 MT annually due to weed competition. The Weed competition bring reduction in yield of transplanted rice by about 50%. The use of herbicide offer selective and economic control of weeds right from the beginning to minimizing crop-weed competition(Singh *et al.* 2004). In India, the widely used herbicides are; butachlor, anilofos, thiobencarb and pretilachlor, which provide effective weed control of annual grasses when applied as pre- emergence (Halder and Patra 2007). Application of post- emergence herbicides may be an alternative for weed management in rice crop. So, there is a necessity that these pre- emergence herbicides should be supplement with post- emergence herbicides alone or as tank mixture to widen the weed control spectrum with respect to non-grassy weeds.

METHODOLOGY

A field experiment was conducted during *Kharif* 2012 and 2013 at N.E. Borlaug, Crop Reasech Centre, G.B. Pant University of Agriculture and Technology Pantnagar (Uttarakhand). The soil of experimental field was clay loam in texture, medium in organic carban (0.64%), available phosphorous (25.6 kg / ha) and potassium (239.5 kg / ha) with P^H 7.3. Experiment consisted of twelve treatments viz; bispyribac-Na 25 g / ha at 25 DAT, Pretilachlor 1000g / ha at 0-3 DAT, penoxsulam 22.5 g / ha at 8- 12 DAT, pyrozosulfuran 20 g / ha at at 0-3 DAT , bispyribac – Na 25g+ethoxysulfuran 18.75 g / ha at 25 DAT, bispyribac – Na 20g / ha + chlorimuran ethyl 10% + metasulfuran methyl 10% 4g / ha at 25 DAT, pretilachlor 750g / ha *fb* ethoxysulfuran 18.75 g / ha at 25 DAT , pretilachlor 750g / ha *fb* CME 10% + MSM 10% 4g / ha at 25 DAT , pyrozosulfuran 20 g / ha at at 3 DAT *fb* manual weeding at 25 DAT, pretilachlor (6%) + bensulf uran (0.69%) at 660 g / ha at 5 DAT and weedy check (Table 1) were laid out in randomized block design with three replications. The 23 days old rice seedlings of variety '*Sarjoo 52*' were transplanted on July 12, 2012.

RESULTS

The experimental field was mainly infested with *Echinocloa colona* (22.3%), *Echinocloa crus-galli*(12.14%), among the grassy weeds, *Alternenthera sessilis* (10.61%), *Ammania baccifera*(11.5%), *Caesulia axillaris*(7.98%) among broad leaved weeds and *Cyperus iria* (10.85%) among the sedges during both the years. All these weeds constituted about 75.38% of total weed population. Besides these, *Leptochloa chinensis* and *Chenopodium difformis* were also observed as major weeds during 2012. The other weeds were appeared in low density (24.62%) such as *Ischaemum rugosu*m , *Eclipta alba* and *Panicum repense* at 60 DAT. The lowest density as well as dry weight of total weeds was recorded with hand weeding twice at 25 and 45 DAT. Among the herbicidal treatments, the lowest weed density as well as dry matter accumulation by total weeds were recorded with pretilachlor 750g / ha *fb* CME 10 %+ MSM 10% at 4g / ha which was at par with bispyribac – Na 25g / ha+ ethoxysulfuran 18.75 g / ha, bispyribac – Na 20g / ha +CME 10%+MSM 10% 4g / ha, pretilachlor 750g / ha fb ethoxysulfuran 18.75 g / ha, pyrozosulfuran 20 g / ha *fb* one manual hand weeding at 25 DAT followed by pretilachlor (6%) + bensulfuran (0.69%) at 660 g / ha and penoxsulam 22.5 g / ha proved most effective herbicides in reducing the density as well dry weight of total weeds as compared to rest of the treatments.

Table 1. Effect of treatments on weed density, weed dry weight (60 DAT) and yield of transplanted rice.

Treatment	Dose (g / ha)	Total weeds density (no / m^2)		Total weed dry weight (g / m^2)		WCE (%)		Grain yield (t / ha)	
		2012	2013	2012	2013	2012	2013	2012	2013
Bispyribac- Na	25	3.6(37.3)	4.1 (15.9)	3.9(51.4)	5.0(24.8)	67.9	70.54	5.22	6.05
Pretilachlor	1000	4.1(58.7)	4.9 (23.4)	4.5(95.4)	7.0(48.6)	40.4	42.28	4.50	5.83
Penoxsulam	22.5	3.6(37.3)	3.8 (13.5)	3.9(49.6)	6.2(37.8)	69.0	55.10	5.25	6.02
Pyrazosulfuran	20	4.4(81.4)	5.8(33.1)	4.6(101.3)	7.4(54.6)	36.7	35.15	3.94	5.55
Bispyribac-Na+etoxysulfuran	25+18.75	3.2(24.0)	2.5 (5.4)	3.4(29.7)	4.0(15.1)	81.4	82.06	5.70	6.51
BispyribacNa+CME 10%+MSM 10 %	20+4	3.3(26.7)	2.6(5.7)	3.4(30.2)	3.9(14.6)	81.1	8266	5.56	6.38
Pretilachlor fbethoxysulfuran	750 / 18.75	3.4(28.1)	3.2 (9.3)	3.6(34.9)	4.5(19.1)	78.2	77.31	5.50	6.22
Pretilachlorfb +CME 10%+MSM 10 %	750 / 4	3.1(22.6)	2.4(4.7)	3.3(27.8)	2.9(16.4)	82.6	80.52	5.65	6.39
Pyrazosulfuran fb annual weeding at 25 DAT	20	3.3(28.0)	3.8(14.3)	3.5(33.5)	4.2(16.7)	79.1	80.16	5.22	6.05
Pretilachlor (6%)+bensulfuran (0.690)	660	3.6(37.8)	3.7(13.9)	4.3(75.9)	5.9(33.9)	52.6	59.73	4.80	5.96
Hand weeding (two) at 25 &45 DAT	-	2.7(13.4)	1.9(2.6)	2.9(18.3)	3.8(13.7)	88.6	83.72	5.91	6.74
Weedy check	-	5.1(159.)	7.1(49.5)	5.9(160)	9.2(84.2)	-	-	2.65	4.38
LSD(P=0.05)		0.26	0.50	0.28	0.33	-	-	0.41	0.59

CONCLUSION

It was concluded that pre–emergence application of pretilachlor 750 g / ha followed by post- emergence application of chlorimuron ethyl +metsulfuron methyl 4g / ha was found most effective in controlling the weeds of transplanted rice.

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Herbicides combinations for control of complex weed flora in transplanted rice

R.A. Yadav, M.Z. Sliddiqui and K.N. Singh

Department of Agronomy, C.S.Azad University of Agriculture and Technology, Kanpur 208 002

**Email: ramashish94@yahoo.in*

Rice (*Oryyza sativa L.)* being a major food crop of Uttar Pradesh is cultivated on 5.93 milion ha with production of 13.96 million tones (Anonymous 2012). Weed competition is one of the major factors responsible for low yield of rice. Rice is infested mainly with *Echinochloa colona* and *Echinochloa crusgalli* and *Cyperus rotundus.* Depending upon intensity of weed infestation and management practices adopted, losses in paddy yield due to weed competition may vary from 25-55% under transplanted conditions (Saikia and Purshotamam, 1996). For better efficacy of these herbicide affect on diverse flora of weeds. For control of diverse weed flora, broad leaf herbicides have been recommended. Hence, there is need for evaluations of combination of different herbicides for control of complex weed flora in transplanted rice.

METHODOLOGY

A field experiment was conducted during, *Kharif* 2013 at Students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur. The soil of the experimental site was sandy loam in texture having pH neutral in reaction low in organic carbon and nitrogen, medium in available phosphorus and potassium. The N P and K was applied 120, 60 and 60 kg/ha through urea, DAP and MOP respectively. Half dose of N full dose of P and K were applied as basal and remaining half dose of N was applied in two split dose. The experiment was laid out in Randomized Block Design with three replications. Twelve treatments viz., T_1 - bisbyribac-Na 25g/ha, T_2-pretilachlor 1000g/ha, T_3 penoxsulam 22.5g/ha, T_4 pyrazosulfuron 20g/ha, T_5 bisbyribac 25g/ha + ethoysulfuron 18.75g/ha, T_6 bispyribac 20g/ha +almix 4g/ha, T_7 pretilachlor 750g/ha fb ethoxysulfuron 18.75g/ha, T_8 pretilachlor 750g/ha fb almix 4g/ha, T_9-T_4 *fb* manual weeding, T_{10} pretilachlor (6%) + bensulfuron (0.6%) 6.6%GR, T_{11} weed free and T_{12} unweeded control variety, '*NDR-118*' of rice transplanted on 26.7.2013.

RESULTS

Among the herbicidal treatment the dry weight of grassy weeds were observed minimum where pyrazosulfuron along with manual weeding was applied. The dry weight of grassy weeds was higher in the treatments where only pretilachlor was applied. The lowest where pyrazosulfuron along with one manual weeding followed by bisbyribac + almix, both were statistically at par. The maximum dry weight of sedges was recorded with the treatment where bisbyribac along with ethxysulfuron was applied. The highest grain yield (4.72 t/ha) was recorded with weed free plot and the lowest (3.72 t/ha) was unweeded control. The yield loss due to uncontrolled growth of weeds as compare to hand weeding was 26.8%. Among the herbicidal treatments the maximum grain yield (4.55 t/ha) was recorded with the treatment where pyrazosulfruon along with one hand weeding was applied followed by application of bisbyribac + almix and minimum yield was recorded where only pyrazosulfuron (3.94t/ha) was applied. Herbicidal treatments resulted in considerably lower cost of cultivation compared with weed free treatment. The B:C ratio was found maximum with bisbyribac-N + almix followed by pretilachlor + almix.

Table 1. Weed dry weight, yield and economics affected by different treatments

Treatment	Weed dry weight (g/m^2)		Straw yield (t/ha)	Grain yield (t/ha)	Gross income (x10³₹/ha)	Net income (x10³₹/ha)	B:C ratio
	Grassy	Sedges					
Bispyribac-Na 25g/ha	5.2 (26.5)	2.3 (4.8)	6.33	4.11	60189	41900	2.14
Pretilachlor 1000g/ha	5.4 (28.6)	2.3 (4.8)	6.16	4.00	58566	37700	2.11
Penoxsulam 22.5g/ha	5.4 (28.6)	2.3 (4.8)	6.22	4.05	59350	37533	2.13
Pyrazosulfuron 20g/ha	5.4 (28.6)	1.6 (2.0)	6.05	3.94	57728	37100	2.15
Bispyribac 25g/ha + Ethoxsulfuron 18.75g/ha	5.1 (25.5)	2.2 (4.3)	6.66	4.27	62706	44922	2.17
Bispyribac 20g/ha + almix 4g/ha	4.8 (22.5)	1.7 (2.4)	6.83	4.44	65055	45588	2.31
Pretilachlor 750g/ha+ ethoxysulfuorn 18.75g/ha	5.2 (26.5)	2.3 (4.8)	6.44	4.11	60300	42850	2.15
Pretilachlor 750g/ha + almix 4g/ha	5.0 (24.5)	1.9 (3.1)	6.72	4.33	63489	44472	2.29
Pyrazosulfuron 20g/ha fb manual weeding	4.5 (19.7)	1.3 (1.2)	6.88	4.55	66567	43461	2.23
Pretilachlor (6%) + bensulfuron (0.6%) 6.6% GR, 660 g/ha	5.1 (25.5)	2.4 (5.2)	6.61	4.16	61195	44639	2.06
weed free	0.7 (0.0)	0.7 (0.0)	6.94	4.72	66805	45927	2.09
Unweeded control	6.3 (39.2)	3.1 (9.1)	5.00	3.72	53761	38378	2.08
LSD (P=0.05)	0.8	0.4	0.4	0.4	5907	7517	0.21

CONCLUSION

It was concluded that post-emergence application of bisbyribac-N 20g/ha + almix 4g/ha was most effective for controlling of weeds and improved grain yield resulted into profitability of transplanting rice.

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Efficacy of Pinoxaden in combination with broad leaf herbicides against complex weed flora in wheat

M.Z. SIiddiqui , R.A.Yadav and K.N.Singh
Department of Agronomy, C.S. Azad University of Agriculture and Technology, Kanpur 208 002
**Email: mzs_csau@yahoo.co.in*

Wheat has commanding position in the Agriculture economy of India, wheat (*Triticum aestivum* L.) being a major food crop of Uttar Pradesh and cultivated on 9.73 million ha with production of 3.13 million tones (Anonymous 2013). Weeds are one of the major constraints in achieving potential yield of wheat. The losses caused by weeds vary depending on the weeds species, their density and environmental factors. Because of higher economic cost of labuour for manual weeding and its lower efficacy, the farmers, are relying heavily on herbicides for effective weed control in different crops including wheat. Several grassy and broad leaf weeds infest wheat (Singh *et at.* 1995) causing severe competition for essential nutrients, moisture and space thus reducing wheat yield and also its quality significantly. Wheat fields are infested with diverse weed flora and for their effective management, combination of herbicides either as ready mixture, if pinoxaden with carfentrazone or as sequential if not compatible are required. However, the sole dependence on herbicide of single mode of action is also not advisable as it has contributed to shift towards difficult to control weeds and the rapid evolution of multiple herbicide resistance, which is a threat T_8 pinoxaden fb 2,4-D 50 and 500g/ha, T_9- carfentrazone 20g/ha, T_{10}- Iodosulfuron + mesosulfuron 12 + 2.4 g/ha, T_{11}- 2,4-D 500 g/ha, T_{12}- weed free, T_{13}- unweeded control in randomized block design with three replications. Wheat variety HUV-234 was sown on 2.12.2011 in 20 cm apart. Data of dry weight yield performance and economics recorded.

RESULTS

Dry weight of grassy weed especially *P. minor* was effectively controlled with the use of iodosulfuron + mesosulfuron followed by pinoxaden along with carfentrazone. Whereas, dry weight of broad leaf weeds were found manimum at 60 DAS and harvest. When pinoxaden fb metsulfuronl applied. The weed free treatment provided maximum grain yield (5.42 t/ha) but due to higher weeding cost incurred in hand weeding reduced the net income (₹ 53,212/ha).The higher net income (₹ 55,050/ha) B:C ratio (2.10) were found with the application of idosulfuron + mesosulfuron (12+2.4 g/ha) *fb* application of pinoxaden (50g/ha) along with carfentrozone (20g/ha) and minimum in unweeded control to wheat production (Malik and Singh 1995).

METHODOLOGY

The investigation was carried out during the *Rabi,* season of 2011-12 at Students' Instructional Farm, C.S. Azad University of Agriculture and Technology, Kanpur. The soil of the experimental site was sandy loam having pH of 7.7, low in available N, medium in available P and K content. The N P and K were applied 120, 60 and 60 kg/ha through urea, DAP and MOP, respectively. Half dose of N full dose of P and K were applied as basal and remaining half dose of N was applied 30 DAS dose. The thirteen treatment comprised of T_1-pinoxaden 50 g/ha,T_2-metsulfuron 4g/ha,T_3- pinoxaden + carfentrazone 50+20 g/ha,T_4-pinoxaden +metsulfuron 50+4 g/ha, T_5- pinoxaden + 2,4-D 50+500 g/ha, T_6- pinoxaden *fb* carfentrazon 50+20 g/ha, T_7-pinoxaden fb metsulfuron 50 and 4g/ha,

Table 1. Weed dry weight Straw, grain yield and economics of treatment influenced by different treatments

Treatment	Weed dry weight (g/m²)		Straw yield (t/ha)	Grain yield (t/ha)	Gross return (x10³₹ /ha)	Net return (x10³ ₹ /ha)	B:C
	Grassy	Broad leaf					
Pinoxaden 50g /ha	2.8 (7.3)	2.0 (3.6)	5.21	4.91	74577	49094	1.95
Metsulfuron 4g /ha	4.1 (16.1)	2.3 (4.8)	5.00	4.72	71664	46094	1.80
Pinoxaden+carfentrazon 50+20 g/ha	1.7 (2.4)	1.5 (1.7)	5.09	4.8	72831	47261	1.84
Pinoxaden+metsulfuron 50+4 g/ha	2.2 (4.2)	2.0 (3.3)	5.00	4.75	72024	46499	1.82
Pinoxaden+2,4-D 50+500g g/ha	1.8 (2.6)	1.7 (2.5)	5.23	4.94	74928	49503	1.94
Pinoxaden fb carfentrazon 50&20 g/ha	0.7 (0.0)	1.7 (2.4)	5.59	5.28	80103	54233	2.09
Pinoxaden fb metsulfuron 50 & 4g /ha	0.9 (0.3)	1.3 (1.2)	5.45	5.14	77994	52244	2.02
Pinoxaden fb 2,4-D 50 and 500 g/ha	0.8 (0.2)	1.6 (2.0)	5.59	5.27	85013	54188	2.09
Carfentrazon 20g g/ha	3.1 (9.0)	2.2 (4.4)	5.43	5.22	77721	52841	2.10
Iodosulfuron + mesosulfuron 12 + 2.4g/ha	0.7 (0.0)	1.8 (2.7)	5.67	5.35	81150	55050	2.12
2,4-D 500 g/ha	3.0 (8.3)	2.2 (4.2)	5.09	4.80	72831	48031	1.93
Weed free	0.7 (0.0)	1.2 (1.0)	4.74	5.42	82212	53212	1.83
Unweeded control	5.3 (27.3)	2.6 (6.8)	4.57	4.32	65493	41493	1.72
LSD (P=0.05)	0.3	NS	0.24	0.44	4621	4494	0.32

CONCLUSION

The minimum dry weight of grassy weeds was recorded with the application of Idosulfuron + mesusulfuron and minimum dry weight of broad leaf weeds were recorded with the application of pinoxaden fb metsulfruon. The maximum yield, net income (₹ 55050/ha) and B:C ratio (2.12) obtained with application of Idosulfuron + mesosulfuon.

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Efficacy of alone and mixed herbicides against weed flora in wheat

Archana Kumari*, Satish Kumar and A. K. Dhaka
Department of Agronomy, College of Agriculture, CCSHAU Hisar, Haryana 125 004
**Email: hemant688@yahoo.com*

Wheat is the world's most widely cultivated food crop. In India, it is second most cultivated staple food crop. Wheat occupies 22% of total area (329 m ha) under food grains in India contributing 36% (85.9 mt) to total food production. Weeds emerge with the emerging seedling and if not controlled in the early stages of crop growth these may cause reduction in yield. Continuous use of a particular herbicide may develop resistance in weeds as continuous use of isoproturon resulted in resistance in controlling *Phalaris minor* in rice-wheat rotation. Herbicide mixture may be one of the options for management or delay of cross resistance development against these herbicides. Considering the above facts, the present investigation was undertaken.

METHODOLOGY

A field experiment was carried out during *Rabi* season of 2011-2012 at research farm of Department of Agronomy, Chaudhary Charan Singh Haryana Agricultural University, Hisar to test the efficacy of different alone and mixed herbicides against weeds. Fourteen treatments consisting of metribuzin at 210 g/ha, clodinafop at 60 g/ha, pinoxaden at 40 g/ha and sulfosulfuron at 25 g/ha, five tank mix herbicide treatments *viz.* clodinafop + metribuzin at 60 + 210 g/ha, pinoxaden + metribuzin at 40 + 210 g/ha, sulfosulfuron + metribuzin at 25 + 210 g/ha, fenoxaprop + metribuzin (Accord plus) at 120 + 210 g/ha and isoproturon + 2,4-D at 1000 + 500 g/ha and three ready mix herbicide treatments Total at 32 g/ha, Atlantis at 14.4 g/ha and Vesta at 60 + 4 g/ha were arranged in a randomised block design with three replications. Wheat variety '*WH 711*' was drilled in the experimental field with recommended package of practices. Data on weed growth, nutrient uptake and economics were recorded.

RESULTS

Grassy weeds were predominant (56%), followed by broad-leaved (45%) and remaining sedges. *Phalaris minor* among the grassy weeds and *Chenopoidium album* among the broad-leaved weeds were more dominant. Herbicidal treatments significantly influenced the population and dry matter production of weeds. Among the herbicidal treatments, dry matter accumulation of weeds was significantly lower in all tank mix or ready mix herbicide treatments as compared to weedy check treatment and alone application of metribuzin at 210 g/ha, clodinafop at 60 g/ha and pinoxaden at 40 g/ha. Among different combinations of metribuzin at 210 g/ha with other herbicides, there was no significant variation in dry matter of weeds, however, numerically lower values of dry matter was recorded in sulfosulfuron + metribuzin at 25 + 210 g/ha at 15 DAS. Maximum weed control efficiency was recorded in weedy free plot. Among the herbicidal treatments, sulfosulfuron + metsulfuron (total) applied at 32 g/ha provided significantly higher weed control efficiency, however, it was at par with sulfosulfuron + metribuzin at 25 + 210 g/ha This clearly indicated that weeds were controlled effectively under sulfosulfuron + metsulfuron (total) at 32 g/ha. Increase in N, P and K uptake was observed with application of metribuzin at 210 g/ha alongwith clodinafop at 60 g/ha or pinoxaden at 40 g/ha or sulfosulfuron at 25 g/ha or fenoxaprop at 120 g/ha as compared to its alone application. Herbicide mixtures failed to produce significant differences in relation to N, P and K uptake of wheat among themselves, however, the lowest values were recorded in clodinafop + metsulfuron at 60 + 4 g/ha. The highest cost of cultivation ₹ 48,119 /ha was recorded in weed free treatment while weedy check recorded lowest cost of cultivation ₹ 45,619 /ha as compared to different herbicide treatments. Among different mixed herbicide application, sulfosulfuron + metsulfuron at 32 g/ha resulted highest B:C ratio (2.09).

Table 1. Weed growth, nutrient uptake and economics of wheat as influenced by different weed control treatments

Treatment	Dose (g/ha)	Weed dry matter (g/m^2)	Weed control efficiency (%)	N uptake (kg/ha)	P uptake (kg/ha)	K uptake (t/ha)	Cost of cultivation (x10^3₹/ha)	B:C ratio
Metribuzin	210	17.8	70.59	116.69	22.73	0.17	46.24	1.78
Clodinafop	60	21.8	59.95	110.61	22.26	0.16	46.56	1.68
Pinoxaden	40	20.9	61.80	113.93	20.86	0.16	46.61	1.71
Sulfosulfuron	25	14.3	76.47	122.38	23.95	0.18	46.49	1.88
Clodinafop+metribuzin	60+210	8.4	82.91	137.99	26.93	0.20	47.19	2.02
Pinoxaden+metribuzin	40+210	7.8	84.25	142.97	27.88	0.20	47.24	2.05
Sulfosulfuron+metribuzin	25+210	6.2	85.91	144.11	29.15	0.20	47.12	2.08
Fenoxaprop+metribuzin	120+210	9.3	84.19	139.07	27.39	0.20	46.86	2.02
Sulfosulfuron+metsulfuron	32	6.0	89.24	143.64	29.13	0.20	46.66	2.09
Mesosulfuron+iodosulfuron	14.4	9.0	84.62	136.97	25.59	0.19	46.81	2.03
Clodinafop+metsulfuron	60+4	9.9	82.24	130.45	25.45	0.19	46.74	1.98
Isoproturon+2,4-D	1000+500	9.6	82.90	130.76	25.25	0.19	46.52	2.00
Weedy check		45.2	0.0	89.27	16.89	0.14	45.61	1.41
Weed free		0.0	100	143.06	27.98	0.20	48.11	2.04
LSD(P=0.05)		5.5	3.79	13.18	3.8	0.02		

CONCLUSION

It was concluded that application of sulfosulfuron + metsulfuron at 32 g/ha was most effective for control- ling weeds, improving grain yield and profitablility of wheat.

Herbicide resistance and its management

M.R. Yogesh*, Sadhana R. Babar and M.S. Dinesha
Department of Agronomy, UAS, GKVK, Bangalore, Karnataka 560 065
**Email: yogeshgowda0279@gmail.com*

Herbicide resistance is an indication of over dependency of herbicides in a particular production system. Herbicide resistant weeds are normally very rare in a weed population. Applying the same herbicide in the same field year after year will select for resistant plants. Compared to insect pest and plant pathogens, weeds have relatively long reproduction cycles and this has contributed to the relatively slow evolution of herbicide resistance.

Prevention of herbicide resistance - Selection pressure is the driving force for resistance evolution, tactics that decrease the selection pressure imposed on the population should be implemented. Herbicide dose, efficacy and frequency of application largely determine selection pressure. Monoculture, intensive herbicide use having the same MOA and reduced cultivation often characterize systems where resistance has evolved (Mortensen *et al.* 2000). Highly effective herbicides, used persistently, impose a high selection pressure that can result in herbicide-resistant populations evolving in just a few generations.

Managing weed populations already resistant to herbicides - The most common situation faced by the farmer is to control weeds that already have become resistant to herbicides. Although the immediate response is to switch to a different herbicide still active on the weed population, long-lasting management of resistance can only be achieved by integration of appropriate tactics based on an adequate knowledge of the biology and ecology of the weed and of the herbicide MOA and resistance mechanism.

Soil preparation and **crop rotation** - Affects weed seed dynamics and seedling densities at planting and thus can contribute to manage herbicide resistant populations. Crops usually have a typical weed flora associated with them. Crop rotations brings about changes in planting patters, tillage practices, life cycles, competitive characteristics. In India, where the rice-wheat sequence was interrupted by the rotation with other crops, the incidence of isoproturon-resistant *P. minor* was substantially lower (Malik and Singh 1995).

Crop competitive advantage - There are additional agronomic practices that can provide competitive advantage to the crop, reducing the impact of the weeds associated with them and decreasing the need for chemical control. Increased attention is being paid to breeding and identifying crop varieties with ability to suppress weeds, especially in grain crops such as wheat and rice (Coleman *et al.* 2001). Crop varieties should be evaluated according to the local cropping systems and their problem weeds.

Alternative chemical control - Once resistance to a herbicide has become evident to the farmer, usually after a re-application of the same product at a maximum dose fails again to control the weed, the typical solution is to switch to another herbicide. Some populations of *A. myosuroides* are resistant to the PS II herbicide chlortoluron because of enhanced mixed function oxydase activity that results in rapid metabolism of both chlortoluron and pendimethalin

Herbicide-resistant crop cultivars (HRC) produced by genetic engineering or by mutation breeding are commercially available. Introduction of these cultivars has allowed farmers to use new chemical alternatives to control herbicide-resistant weeds.

Integration of control practices - As pointed by Mortensen *et al.* (2000) we should go beyond the notion of regarding weeds as a problem that can be solved solely with herbicides to one that can be managed through a better design of cropping systems. Even the most troublesome herbicide-resistance problems could have been prevented by an appropriate integrated weed management strategy.

CONCLUSION

To prevent the development of herbicide resistance it is vital that resistance to herbicides is detected as early as possible so that resistance management strategies can be implemented. No single herbicide or management tactic can solve a particular herbicide-resistance problem and adoption of integrated management practice will be effective in solving this problem.

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Effect of bispyribac sodium on weed management and soil microflora in transplanted rice in inceptisol of West Bengal

Rajib Das*, Ratneswar Poddar and R.K. Ghosh

Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya Mohanpur, Nadia, West Bengal 741 252

**Email: rajibdasagro@gmail.com*

Rice is a major crop in the world, it feeds one third of the world population. In rice, infestation of all types of monocot (grasses, sedges) and dicot weed (broad-leaved) flora was observed. The diverse weed flora under transplanted conditions can cause yield reduction up to 76% (Singh *et al*. 2004). Therefore, farmers need alternate weed management methodology and organic safer herbicides are one of the better substitutions of costly hand weeding. Among popular post emergence selective herbicides, Bispyribac sodium is to be evaluated for their bio-efficacy of controlling wide range of weed flora, better crop growth and yield of rice.

METHODOLOGY

The present investigation was carried out during *Kharif* season 2010-11 and 2011-12 in inceptisol at Kalyani 'C' Block Farm of Bidhan Chandra Krishi Viswavidyalaya. The experiment was laid out in randomized complete block design and replicated thrice with a net plot size of 5 × 4 m. The treatments were bispyribac sodium 10% SC in five doses at 15, 20, 25, 30, g/ha and butachlor (50% EC), hand weeding twice at 25 and 50 DAT and unweeded control. Variety used in this experiment was *Shatabdi (IET 4786)*

RESULTS

In the experimental plots the dominant grasses were *Echinochloa colona* and *Leersia hexandra* while the sedge was *Cyperus rotundus* and among the broadleaf *Ammania baccifera* was dominant. From the table 1, it is very clear that unweeded control treatment (T_7) gave the highest pooled value (55.92) whereas, T_6 recorded the lowest pooled value (0.00) which was closely followed by T_4 (9.08), T_3 (9.37) and T_2 (10.82). Similar results were found by Bera *et al.* 2012. Hand weeding was the best treatment compared to other treatments and recorded highest grain yield (Kathepuri *et al.* 2007). Initially total bacteria, fungi and actinomycetes did not vary significantly in all the doses of the herbicide bispyribac Sodium and butachlor but after herbicide application, they differ for a short period of time. With advancement of time, microorganisms degraded the herbicides and carbon released leads to an increase of the soil microflora population (Bera and Ghosh 2013).

Table 1. Effect of different weed management practices on total weed density/m^2, dry weight (g/m^2), grain yield and soil micro-flora in rice (pooled data)

Treatment	Weed Population		Weed dry weight		Grain yield (t/ ha)	Net production value	Soil microflora (cfu/g of soil)					
	15 DAT	30 DAT	15 DAT	30 DAT			Bacteria x 10^6 cfu		Fungi x 10^4 cfu		Actinomycetes x 10^5 cfu	
							Initial	60 DAA	Initial	60 DAA	Initial	60 DAA
T_1	7.06(49.87)	6.78(45.92)	28.77	27.97	2.82	2.62	36.23	89.15	30.31	73.61	51.55	81.95
T_2	6.55(42.89)	6.18(38.14)	24.76	22.90	3.84	2.76	37.13	113.95	31.43	83.56	53.22	91.49
T_3	6.33(40.06)	5.84(34.13)	22.37	20.20	3.90	2.68	38.52	118.85	32.78	84.29	54.65	95.20
T_4	6.18(38.16)	5.68(32.28)	19.63	18.55	3.91	2.60	39.99	121.55	30.99	85.13	53.28	87.83
T_5	6.36(40.45)	7.24(52.36)	20.94	27.38	3.13	2.48	41.56	119.94	33.68	83.36	54.12	79.22
T_6	4.35(18.93)	8.07(65.14)	14.23	29.03	4.00	2.58	42.86	125.37	34.57	81.42	51.91	84.11
T_7	9.86(97.13)	12.09(146.1)	59.42	77.41	1.90	1.92	41.23	71.15	35.56	55.51	52.95	68.19
LSD(P=0.05)	1.24	2.28	2.07	2.65	2.483	-	1.73	4.39	1.51	3.17	2.38	3.51

T_1- Bispyribac Sodium 10% SC at15 g /ha, T_2- Bispyribac Sodium 10% SC at 20 g /ha, T_3- Bispyribac Sodium 10% SC at 25 g /ha, T_4- Sodium Bispyribac 10% SC at 30 g /ha, T_5- Butachlor 50% EC at 1250 g /ha, T_6- Weed free check (Hand weeding/Farmer's Practice), T_7- Weedy check (zero weed control) *Figures in the parenthesis are original values which are subjected to square root

CONCLUSION

From this experiment, it may be suggested that rice - blackgram crop sequence can be grown in Gangetic medium land of south West Bengal and bispyribac sodium 10 SC at 20 g/ha could be used for an alternative weed management measure in rice as this treatment (NPV= 2.78) is superior over the hand weeding twice is (T_7) (1.98) though T_7 gives slighter higher yield (4.17%). Application of this safer organic chemical also proved higher productivity in follow up crop blackgram by reducing the weed competition and without affecting the soil microflora status.

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Evaluation of weed control efficiency and grain yield in transgenic stacked maize hybrids

K. Sivagamy*[1] and C. Chinnusamy[2]

[1]*Adhiparasakthi Agricultural and Horticultural College, Department of Agronomy, Kalavai, Tamil Nadu 632 506.*
[2]*Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore,TamilNadu 641 003*
**Email: ksivagamy@yahoo.com*

Maize is one of the major world food crop contribute to world food basket just after rice and wheat. The congenial climatic conditions encourage more weed growth in this widely spaced crop and cause yield reduction to the tune of 29 to 70%. Effective control of weeds can help improve maize productivity. Transgenic corn hybrids with stacked event (TC1507 x NK 603) were developed for preventing yield losses of corn and improving productivity (Norsworthy *et al.* 2001). '*TC1507'* maize expresses a Bt insecticidal protein (Cry1F) for control of certain lepidopteron pests and '*NK603'* corn expresses a modified maize 5-enolpyruvylshikimate-3-phosphate synthase enzyme (CP4 EPSPS) that confers tolerance to herbicide products containing glyphosate.

METHODOLOGY

A field experiment was laid out during *Kharif* season of 2011 at Tamil Nadu Agricultural University, Coimbatore to evaluate herbicide resistance in transgenic maize hybrids containing stacked events in maize. The experiment was laid out in randomized block design with treatments replicated thrice. The treatments consisted of two transgenic hybrids '*30V92'* and *'30B11 HR*' resistant to glyphosate, which were treated with two different doses of post-emergence glyphosate at 900 and 1800 g/ha and compared with pre-emergence application of atrazine 0.5 kg/ha followed by hand weeding on 40 DAS in non-transgenic maize hybrids like '*30V92'*, '30B11', 'BIO9681' and '*COHM'5'*.

RESULTS

Among different group of weeds, broadleaved weeds constituted 86 % followed by grasses (9%) and sedges (%) in the experimental area. Lower weed density was recorded with transgenic '*30V92*' maize hybrid applied with post-emergence application of glyphosate at 1800 g/ha (2.15 no./m^2) at 30 days after herbicide application. Weed dry weight conspicuously lowered with different doses of glyphosate with post-emergence application in transgenic hybrid compared to all other weed management methods on conventional hybrids. Higher weed control efficiency was recorded with post emergence application of glyphosate at 1800 g/ha (99.53%) and was followed by '*30B11'* treatment (98.97%). Post-emergence application of glyphosate at 1800 g/ha in transgenic corn hybrid recorded higher grain yield of 12.21 t/ha was 36.64% higher than the unweeded check plot of transgenic '*30V92'.* In support with the present study, early post emergence application of glyphosate provided higher yield in maize hybrids. Single time application of glyphosate as post emergence in transgenic maize hybrids found to have better weed control of weeds upto 75-80 DAS was stated by Ferrell and Witt (2000).

CONCLUSION

Post-emergence spraying of potassium salt of glyphosate at 1800 g /ha in transgenic maize hybrid of '*30V92* ' enhanced complete control of broad spectrum weeds can keep the weed density, dry weight reasonable at lower level and enhance higher productivity and profitability with higher grain yield during the *Kharif* season.

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Effect of potassium salt based glyphosate applied in preceding transgenic stacked corn hybrids on succeeding green gram

K. Sivagamy*[1] and C. Chinnusamy[2]

[1]*Adhiparasakthi Agricultural and Horticultural College, Department of Agronomy, Kalavai, Tamil Nadu 632 506.*

[2]*Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore,TamilNadu 641 003*

**Email: ksivagamy@yahoo.com*

Protecting crop yields and preventing increases in weed populations are the primary reasons for controlling weeds. Glyphosate is a foliar applied, broad spectrum, post emergence herbicide capable of controlling annual, perennial grasses and dicotyledonous weeds. Glyphosate is relatively immobile in most soil environments as a result of its strong adsorption to soil particles (Ghassemi *et al*. 1982). Glyphosate degrades at very low temperatures and does not adversely affect nitrogen fixation, nitrification or denitrification activity. Glyphosate is moderately persistent in soil having half-lives ranging from 3 to 130 days.

METHODOLOGY

A field experiment was laid out during *Kharif* season of 2011 in eastern block farm of Tamil Nadu Agricultural University, Coimbatore. The experiment was laid out in randomized block design with treatments replicated thrice. The treatments consisted of two transgenic hybrids (*'30V92'* and *'30B11 HR'*) resistant to glyphosate were tried with two different doses of post emergence glyphosate at 900 and 1800 g/ha were compared with pre-emergence application of atrazine at 0.5 kg/ ha followed by hand weeding on 40 DAS in non-transgenic maize hybrids like *'30V92',' 30B11',' BIO968'1* and *'COHM5'*. The succeeding crop green gram was sown without disturbing the layout of corn experiment.

RESULTS

Post-emergence application of glyphosate in transgenic maize hybrids did not affect the germination per cent of succeeding green gram. In non-transgenic maize hybrids PE application of atrazine did not exhibit any germination variations in succeeding green gram. Lower weed density was recorded with glyphosate applied plots in preceding maize crop. The different herbicidal treatments did not show variation in yield attributing parameters like number of pods per plant, pod length, number of grains per pod, test weight and yield. Post-emergence application of glyphosate at 1800 g/ ha in transgenic *'30V92'* corn hybrid recorded higher grain yield of green gram and lesser grain yield was recorded PE application of atrazine at 0.5 kg/ha followed by hand weeding in *'COHM 5'* corn hybrid .

Table 1 . Residual effect of herbicides on yield of succeeding green gram

Treatment	Yield (t/ha)	
	Grain	Haulm
30V92 HR Glyphosate 900 g/ha	0.86	1.82
30V92HR Glyphosate 1800 g/ha	0.88	1.79
30V92HR (Weedy check)	0.81	1.75
30B11HR Glyphosate 900 g/ha	0.86	1.79
30B11HR Glyphosate 1800 g/ha	0.87	1.80
30B11HR (Weedy check)	0.79	1.81
30V92 PE atrazine 0.5 kg/ha + HW+ IC	0.86	1.65
30V92 No WC and only IC	0.85	1.74
30V92 No WC and no. IC	0.85	1.80
30B11 PE atrazine 0.5 kg/ha + HW+ IC	0.88	1.66
30B11No WC and only IC	0.84	1.69
30B11 No WC and no. IC	0.83	1.74
BIO9681 PE atrazine 0.5 kg/ha + HW+ IC	0.87	1.77
BIO9681No WC and no. IC	0.82	1.74
CoHM5 PE atrazine 0.5 kg/ha + HW+ IC	0.85	1.64
CoHM5 No WC and no IC	0.79	1.63
LSD(P=0.05)	NS	NS

CONCLUSION

Post-emergence application of glyphosate in transgenic maize hybrids did not affect the germination, growth and yield of succeeding greengram due to different weed management methods imposed in preceeding maize during *Kharif* 2011.

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Resistance of little seed canary grass to isoproturon in Uttarakhand and its management

S.K. Guru*, Nitin Kumar and V.P. Singh

G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 263 145

In India, *Phalaris minor* is a major problematic weed of wheat in the rice – wheat cropping system. Reports of its resistance to isoproturon appeared long back from the states of Haryana and Punjab. In Uttarakhand, monitoring of its resistance was undertaken in the AICRP on weed control. Seeds of *P minor* collected from farmers' fields are tested in pot culture to confirm herbicide resistance. The present study reports the resistance of this weed to isoproturon as well as its management strategies.

METEHDOLOGY

Phalaris minor seeds, collected from farmers' fields from 15 locations in different areas of Udham Singh Nagar and Nainital districts of Uttarakhand and adjoining areas of Uttar Pradesh were sown in pots during the winter season of 2012-2013. Isoproturon was applied at 0.5, 1.0 and 2.0 kg/ha at 39 DAS. In order to manage isoproturon resistant *Phalaris minor,* sulfosulfuron and clodinafop were sprayed at their recommended doses at 39 DAS. All the treatments were replicated thrice. Data on per cent mortality, dry matter production as well as regeneration were recorded in all the treatments.

RESULTS

The isoproturon treatments, the mortality of *P minor* plants ranged from 11.9% at 0.5kg/ha to 57.3% at 2.0kg/ha (Fig.1). In the sulfosulfuron treatment, it was 88.7%. Treatment with clodinafop killed all the plants from all the locations. The survival of plants of different locations in isoproturon treatment ranged from 40.0 to 91.1% at 1.0 kg/ha while at 2.0 kg/ha, it ranged from 11.1 to 91.1%.The recommende d dose,the dry weight of *P.minor* plants ranged from10.3 to 31.2 mg/ plantat 30 day saftersowing. With double dose at 2.0 kg/ha, dryweightperplantrangedfrom0 to 31.5 mg/plant. *P minor* plants from few sources exhibited regeneration in the sulfosulfuron treatment. Sources S7, S9, S13 and S14 showed higher levels of regeneration ranging from 6.67 to 42.22 %(Fig. 2).

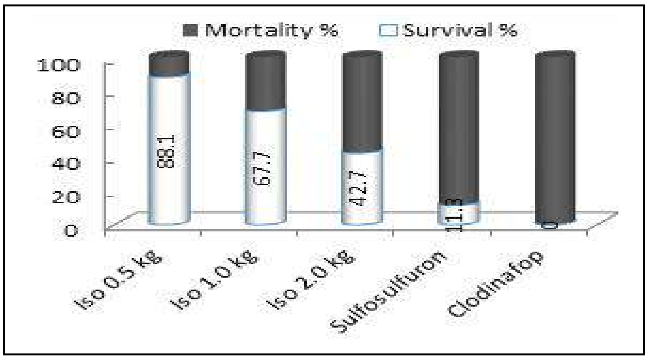

Fig. 1. Mortality and Survival (%) of *P minor* plants in different herbicide treatments

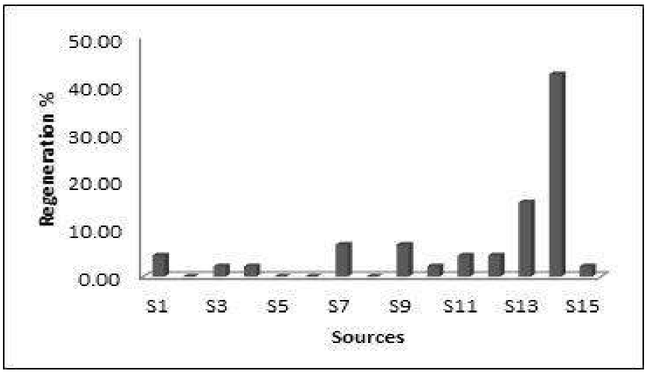

Fig 2. Regeneration of *P minor* in sulfosulfuron treatments.

CONCLUSION

P minor plants from different locations in the state of Uttarakhand have developed resistance to the herbicide isoproturon.These resistant biotypes were effectively controlled by clodinafop. Though sulfosulfuron gave satisfactory control, there was problem of regeneration at later stages.

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Response of wheat cultivars to plant extracts as weed growth inhibitors under field condition

M. Younesabadi*, M. Kalateh, L. Habibian, A. Savari Nejad, H.O. Kashiri.

Plant Protection Research Department, Agricultural Research Centre of Golestan Province, Beheshti Avenue, Gorgan, Golestan, Iran 49156-77555.

**Email: myounesabadi@yahoo.com*

The current trend in agriculture production is to find a biological solution to reduce hazardous impacts from herbicides and insecticides. Natural compounds are excellent alternatives for chemical herbicides to reduce this issue. The object of this project is appraisal of different wheat cultivars response to the spraying of plant extracts as weed growth inhibitors under field condition.

METHODOLOGY

Plant materials were collected from roadsides or agricultural field margins of Golestan province during summer, in 2012 and then were dried in 40 úC oven, for 72 hours, grounded and passed through 2 millimeter sieve. Water extracts prepared from each powder base on Cheema's method (Cheema *et al.* 2005). These extracts were considered as the stock solution (100% concentration) that were diluted with distilled water for preparing 25, 50 and 75% concentrations. In order to evaluation the effect of these water extracts on yield attributes and yield of different wheat cultivars, this experiment was laid out as split-split plot in randomized complete block design with three replications having a plot size of 1.2 × 3 m for each sub sub plot and row to row distance of 20 cm at experimental field of agricultural research center of Golestan province, Gorgan, Iran in 2012. The main factors were water extracts of *A. camelorum*, *S. marianum*, *M. longifolia*, *S. nigra* and *C. murale*, combination of clodinafop-propargil 80 g/ha (one l/ha) + tribenuron-methyl 15 g/ha (20 g/ha) as a standard weed control treatment and weedy check. Sub factors were different doses of these extracts (0, 100,150 and 200 litre/ha from 10% w/v plant extract) and sub-sub factors were different wheat cultivars including: '*Tajan, Arta, N-8019* and *N-8118'*. Wheat cultivars were sown using 120 kg/ ha seed in Jan , 2012. All treatments were applied two month after planting at late tillering stage by knapsack hand sprayer fitted with flat fan nozzle after calibrations using 200 L of water per hectare. Yield attributes and yield were recorded by standard sampling techniques. All data were subjected to analysis of variance using the PROC GLM procedure of SAS to evaluate differences among treatments and least significant difference (LSD) at P= 0.05 were worked out for each parameter for comparing the treatment means.

RESULTS

Field results showed that all plant extracts increased the height of wheat in comparison to control treatment. Among different treatments, *C. murale* followed by *A. camelorum* showed the highest plant height and their effect were significantly different from control treatment (Table 1).There were no significant differences between used plant extracts and herbicide treatment in this regard. The length of spike in all treatments were higher than control treatment, however, there was no significant difference between most of the treatments, but herbicide treatment and *M. longifolia* extract comparable to each other showed the highest spike length. Similar result was observed in case of wheat thousand seed weight.

Increasing yield in this treatment in field condition might be related to inhibitory effect of this plant extract on weeds population (data has not been shown). There was no significant difference between different doses of plant extracts with respect to plant yield attributes and yield (Table 1). But thousand seed weight and seed yield was increased as the plant extracts concentration increased (Table 1).

CONCLUSION

This study showed the stimulatory and inhibitory effects of water extracts of some plant materials, more comprehensive studies are necessary for demonstrating their herbicidal potential on different weed species and their safety on different crop plant.

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Effect of different method of weed management on the yield and economics of scented rice

Pravir Kumar Pandey*, G. S. Tomar, Arati Singh, Rakesh Kumar and Mayurkumar Meshram
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh 492 012
**Email: pravirpandey@gmail.com*

India is second largest producer of rice after China and has an area of over 45.5 m ha with production of 105.31 m t and average productivity is 2393 kg/ha of rice in 2012. Weed infestation is regarded as one of the major causes of low crop yields throughout the world and on an average can causes yield losses to the tune of 10% to as high as 90% which amount to 2.4 mt of grains. Besides yield reduction, weeds deplete nutrients from the soil to an extent of 11.0, 3.0 and 10.0 kg/ha of N, P and K, respectively (Gautham and Mishra 1995). Hence, weed control plays a key role in increasing the productivity of rice and maintain the soil fertility.

METHODOLOGY

The present experiment was conducted at IGKV, Raipur (C.G.) during *Kharif* season of 2011 to find out the most effective weed management method for rice crop cultivation. Treatments (Table 1) were laid out in randomized block design (RBD) with three replications. The recommended dose of nutrient (RDN) 80, 60 and 40 kg was used for N, Pand K kg/ha, respectively. The test crop variety was '*Kasturi*'. The observation on yield attributes, yield, weed density and economics were recorded, computed and were subjected to statistical analysis.

RESULTS

All the weed control treatments expressed their superiority in terms of growth, yield and economics of rice compared to weedy check. In the experimental field was dominated by mainly *Commelina benghalensis, Alternanthera triandra, Echinocloa colona, Cynotis axilaris* throughout the crop season. All the weed management treatments brought down weed densities significantly as compared to that observed in weedy check (23.11 m^2) and later treatment recorded the highest weed population compared to all methods of weed control. Mechanical weeding through cono-weeder (T_2) resulted in significantly highest grain yield (3.56 t/ha) and straw yield (7.38 t/ha) over that recorded with other treatments. This was closely followed by mechanical weeding through ambika paddy weeder and two hand weeding which gave 3.47 and 3.29 t/ha grain yield and 7.13 and 6.99 t/ha straw yield. The highest net return from the scented rice cultivation was realized from treatment T_2 (use of cono-weeder) which was proved to be superior in retaining higher net return (₹ 28544.7/ha). The lowest net return was obtained from T_7 (burn oil spray) due to high treatment cost and lower grain and straw production.

Table 1: Effect of different weed control method on yield attributing, yield, weed density and economics of rice

Treatment	Plant height (cm)	No. of effective Tillers/ m^2	Weed density (No/m^2)	Seed Yield (t/ha)	Net return ($X10^3$/ha)
T_1-Weedy check(20x10 cm)	112	346	23.1	2.63	18.46
T_2-Use of cono weeder (20x20 cm) –25,45 DAT	125	477	7.3	3.56	28.54
T_3-1 H.W (20x10 cm) –25 DAT	120	376	14.1	3.14	23.22
T_4-2 H.W (20x10 cm) –25,45 DAT	124	471	9.1	3.22	23.04
T_5-Acetic acid (20%)(20x10 cm) –25,45 DAT	118	437	15.1	3.04	13.01
T_6-Ambika paddy weeder(20x10 cm) –25,45 DAT	129	470	6.9	3.46	27.70
T_7- Burn oil spray at 15 and 30 DAT + 1 HW at 45 DAT (20x10 cm)	119	423	12.7	3.01	9.52
T_8-Closer row spacing at (15x10 cm)	117	367	13.4	2.99	23.53
SEm+	3.1	1.6	1.2	0.17	-
LSD(P=0.05)	9.6	5.0	3.8	0.54	-

CONCLUSION

Based on the results of the experiment, it can be inferred that it would be better to adopt mechanical weeding by cono-weeder at 25 and 45 DAT as weed control practice for scented rice cultivation as it had positive effect on growth and yield attributes of rice which in turn produced higher yield and economic return.

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Effect of weed management practices and agri-horti system on mungbean yield under dryland agro-ecosystem of eastern Uttar Pradesh

M.K. Singh*and O.P. Shivran

Department of Agronomy, Institute of Agricultural Sciences, BHU, Varanasi, Uttar Pradesh 221 005
Email: manozsingh@rediffmail.com

Mungbean [*Vignaradiata* (L.) Wilczek] is a viable option as an intercrop in the alleys of agri-horticultural plantation. Being a rainy season crop, it is heavily infested with weeds, which reduces the mungbean yield by 28-57%. Greater knowledge of compatible agri-horti species and weed management practices not only facilitates formulation of agroforestry systems with higher yields but also generate a better understanding to improve crop-weed competition. Keeping these facts in view, present investigation was undertaken.

METHODOLOGY

A field experiment was conducted during rainy season of 2011 at Agricultural Research Farm, Rajeev Gandhi South Campus (Banaras Hindu University), Barkachha, Mirzapur, Uttar Pradesh. The soil of experimental field was sandy clay loam, having pH 6.2, low in organic carbon, available N, whereas available P and K were medium. The experiment was laid out in split plot design, keeping three agri-horti systems [guava, custard apple and open field] in main plots and six weed management practices [pendimethalin 1000 g/ha (PE), imazethapyr 125 and 200 g/ha (PoE), 1-hand weeding (HW) (20 DAS), 2-HW (15 and 30 DAS) and weedy check] were assigned to sub plots and replicated thrice. Mungbean variety '*Samrat*' was sown as per standard agronomic package of practices on August 5, 2011 in open field as well as within the alleys of,5 year old, guava and custard apple agri-horti system.

RESULTS

Significantly lowest density (grasses, sedges and broad-leaf weeds) and biomass (total) of weeds recorded under open field followed by guava based agri-horti system. Difference in weed infestation under agri-horti systems might be due to trees selectively inhibits growth of some specific weed species due to allelopathic interactions (Rizvi *et al.* 1999). Similarly, highest plant height recorded under open field, whereas, both the agri-horti systems produced statistically similar plant height. Yield did not differed significantly among agri-horti system. Application of imazethapyr 200 g/ha and 2-HW showed statistically similar lowest density (grasses, sedges and broadleaf) and biomass of weeds. Significantly highest plant height and yield recorded under 2-HW followed by imazethapyr 200 g/ha. Similar findings of lowest weed growth under 2-hand weeding and imazethapyr 200g/ha reported by Kumar *et al.*(2005) and Shete *et al.* (2008), respectively.

Table 1. Effect of agri-horti system and weed management practices on weeds growth, plant height and yield of mungbean

Treatment		Weed[a] density (number/m²) Grasses	Sedges	Broad-leaved	Total biomass (g/m²)	Mungbean[b] Plant height (cm)	Yield (t/ha)
Agri-horti system (S)							
Guava		4.43 (24.67)	4.40 (23.78)	6.95 (56.22)	3.48 (13.68)	40.43	0.71
Custard Apple		5.73 (40.67)	6.22 (44.00)	8.81 (85.33)	4.60 (23.81)	40.40	0.69
Open field		2.96 (10.67)	2.38 (7.56)	4.68 (26.00)	2.62 (7.60)	40.81	0.72
LSD (P=0.05)		1.04	0.50	1.44	0.53	0.24	NS
Weed management practices							
Pendimethalin	1000 g/ha	6.08 (39.11)	6.25 (41.33)	8.55 (75.11)	4.77 (22.43)	37.29	0.63
Imazethapyr	125 g/ha	3.41 (12.89)	3.93 (19.56)	6.64 (49.78)	3.05 (9.52)	39.25	0.75
Imazethapyr	200 g/ha	1.51 (2.22)	2.13 (6.22)	3.93 (20.00)	1.93 (3.33)	43.17	0.78
1-HW	(20 DAS)	4.98 (25.33)	4.23 (20.44)	6.55 (44.44)	3.46 (11.79)	42.16	0.76
2- HW	(15&30 DAS)	2.36 (6.67)	2.03 (5.33)	4.09 (17.33)	1.93 (2.98)	46.03	0.88
Weedy check		7.89 (65.78)	7.42 (57.78)	11.11 (128.44)	6.26 (40.14)	35.39	0.43
LSD (P=0.05)		1.02	1.06	0.98	0.36	0.97	0.09

[a]observation recorded at 60 DAS, [b]observation recorded at harvest. Weeds data are subjected to square root transformation. Original value presented in parenthesis.

CONCLUSION

It was concluded that open field showed lower infestation of weeds followed by guava based agri-horti system. 2-hand weeding effectively reduced weed growth and showed highest yield followed by impazethapyr 200 g/ha.

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Effect of temperature variation on the life cycle stages and reproductive behavior of Mexican beetle

Manoj K. Bangadkar*[1] and Rina S. Saha[2]

[1]P.G.T.D. Zoology, R.T.M. Nagpur University, Nagpur, Maharashtra 440 033

[2]S.M. Mohota College of Science, Nagpur, Maharashtra 440 033

**Email: manoj.rtmnu@gmail.com*

The weed *Parthenium hysterophorus* (Asteraceae: Heliantheae) is an economically important weed in India. Various methods such as chemical, physical, legislative, fire, mycoherbicides, agronomic practices, competitive displacement and classical biological control were used in attempts to control this weed. The exotic insect, *Zygogramma bicolorata* (Coleoptera: Chrysomelidae) is an effective biocontrol agent of *P. hysterophorus* (Sushilkumar 2005). It is a multivoltine species and generations cannot be differentiated under field conditions. The life of insects is influenced by various environmental factors, and temperature is one of the most important and critical of the many abiotic factors and it affect both as a stressor and regulator on the growth, development and survival of insects. So the present study has been made on the effect of temperature variation on the life cycle stages and reproductive behaviour of the Mexican beetle *Z. bicolorata*.

METHEDOLOGY

Adults of *Z. bicolorata* were obtained from *Parthenium* plants during July to August in the laboratory. Beetles were reared in the plastic jars and feed daily on excised leaves of *Parthenium* weed at 27±2^{0}C Temperature, 65±5% RH humidity in B.O.D. incubator. The wilted leaves replaced daily with fresh ones. Newly hatched larvae were reared in Petridishes and when fully grown were transferred to plastic jars filled with moist sand, for pupation. Freshly emerged adults from the stock culture were isolated for use in experiments. Freshly emerged adult beetles were sexed and 10 replicates consisting of a 3 female and 2 male each were placed in plastic Petriplates (9.0 × 2.0 cm) maintained at 20^{0}C, 27^{0}C and 32^{0}C. The beetles were allowed to mate and eggs laid each day were counted and transferred to another petri dish in aseptic condition at the same temperature. Eggs were checked daily for hatching and empty egg shells were counted to assess hatching success. The life cycle, duration of each stages of life history and reproductive behaviour of the beetle were recorded daily at the different temperature.

RESULTS

In *Z. bicolorata*, the developmental period of all the immature are shown in table 1 and all the stages depended significantly on temperature. The duration of first, second, third, and fourth instars were significantly different. The total larval duration decreased with increase in temperature. A statistically significant decrease in total developmental period was recorded with an increase in temperature from 20 to 32^{0}C. First instar larvae suffered the highest mortality, while the pupal stage had the lowest mortality at all constant temperatures. Our results establish that temperature plays a determining role in the development and survival of the life history stages of *Z. bicolorata.* The role of temperature in influencing all levels of biological organization in phytophagous insects has been previously proved The effect of temperature variation on the reproductive attributes of the Mexican beetle *Z. bicolorata* shown (Table 2). The results revealed that all the reproductive attributes *i.e.* Preoviposition period, oviposition period, postoviposition period, fecundity and egg viability are depended significantly on temperature (Table 2). The number of egg lying per female in its complete life span was found highest at 27^{0}C and it falls down with increase or decrease in temperature from 20^{0}C to 32^{0}C and 27^{0}C to 20^{0}C. The percent egg viability was found highest at 27^{0}C and with further increased or decreased temperature from 27^{0}C egg viability was decreased than observed at 27^{0}C.

CONCLUSION

From the above results it is proved that 27-280C is the ideal temperature range for the multiplication of insect in laboratory condition.

Table 1. Effect of temperature variation on the larval developmental period of the Mexican beetle *Z. bicolorata*.

	First larval period (days)	Second larval period (days)	Third larval period (days)	Fourth larval Period (days)	Total larval period (days)
At 20^{o}C	5.25±0.138	4.824±0.247	5.1±0.16	4.28±0.238	19.64±0.679
At 27^{o}C	4.873±0.24	4.32±0.34	4.55±0.16	3.49±0.318	17.86±0.408
At 32^{o}C	4.19±0.209	3.84±0.23	3.89±0.18	3.57±0.268	16.44±0.625

Table 2. Effect of temperature variation on the reproductive attributes of the Mexican beetle *Z. bicolorata.*

	Pre-oviposition period (days)	oviposition period (days)	Post-oviposition period (days)	Fecundity	Egg viability (%)
At 20^{o}C	13.10±0.31	87.80±1.40	21.50±0.78	608.50±18.33	65.40±1.69
At 27^{o}C	7.10±0.38	63.00±1.20	14.40±0.69	987.30±15.56	89.20±1.51
At 32^{o}C	9.60±0.31	31.40±0.99	17.40±0.60	679.90±13.79	60.30±1.67

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Spinach leaf herbicidal to noxious aquatic weed water hyacinth

D.K. Pandey*

Directorate of Weed Science Research, Maharajpur, Jabalpur Madhya Pradesh 482 004

**E.mail: dayapandey@hotmail.com*

Though synthetic herbicides have proved to be magic molecules greatly facilitating weed management in crops and reducing labour, yet their use has potential environmental and toxicological costs raising question about our agricultural dependence on these molecules. Sustained use of herbicides has resulted in development of herbicide resistance in weeds. Development of herbicide resistance in prominent weeds like *Echinochloa* sp. and *Phalaris minor* of major crops rice and wheat, respectively in recent years has been a serious concern. We do not have safer herbicides for aquatic eco-system. Herbicide industry has not had new major herbicide molecules in the past two decades. Thus, quest for new, more efficient and specific, and environment-friendly herbicides has to continue. Synthetic herbicide development is time consuming, expensive, and is limited by availability of facility for testing of new compounds. The natural products and their relatives have been viewed as sources of potential environment-friendly herbicides and offer attractive possibilities for natural molecules derived herbicides. There is rising interest in exploring plant constituents as a source of eco-friendly herbicide formulations [1]. Prompted by these considerations, spinach (*Spinacea oleracea* L.) was evaluated for herbicidal activity on noxious aquatic weed water hyacinth (*Eichhornia crassipes* Mart Solmns.).

METHODOLOGY

The spinach was grown in the field of the Directorate during winter season of 2012-13, leaves were harvested, quickly washed, blot dried and then further dried in the shade, powdered and suspended at different levels in a standardised nutrient medium. Pre-weighed water hyacinth plants were placed with their roots immersed in the medium comprising nutrient medium (controls) or the spinach leaf powder suspended in it at 0.1, 0.25, 0.5, 0.75 and 1% dry w/v in 500 ml volume in plastic containers and kept outdoors during March 2013. Biomass and toxicity symptoms were monitored. Phenolics were estimated in the spinach residue suspensions. Electrical conductivity and pH of the medium were also measured. All the experiments and observations were repeated three times.

RESULTS

The spinach leaf residue showed potential phytotoxicity on water hyacinth at 0.75 -1.0%. At low levels of the residue (0.1-0.5%), water hyacinth growth was not conspicuously affected. However, it inhibited the treated plants at and above 0.75% killing them in 10-15 days after initiation of the treatment. The toxicity symptoms were dull green appearance followed by wilting of older leaves from margins extending to whole structure and to younger leaves, and flaccidity in shoot and roots, depending on treatment duration and the level of the residue in the medium. At lethal levels, the spinach leaf residue caused death and decay of the treated water hyacinth plants in 10-15 days. The spinach leaf residue had high levels (3.7% w/v) of phenolics. In blank series, at 1% residue, they declined slowly with time reaching half the initial levels by 15 days. In the spinach leaf residue suspensions with water hyacinth plants, phenolics declined to one ninth the initial levels by 15 days. The pH of the medium after addition of spinach leaf residue was 6.3-7.4. The electrical conductivity of the spinach leaf residue suspension at 0.1-1.0% ranged between 0.78-2.5 dS/m. Thus, the leaf residue did not act by changing the pH or salinity to inhibitory levels and thus toxicity to the water hyacinth plants was due to inhibitory substances present in the residue. High levels of phenolics present in the leaf residue probably killed the water hyacinth plants. Phenolics dissipated rapidly in the medium containing water hyacinth plants, whereas it was relatively very slow in blank series of the residue suspensions.

CONCLUSION

Spinach leaf had high levels of phenolics (about 3.7%) and potential phytotoxicity to water hyacinth killing them at and above 0.75%. The water hyacinth plants caused rapid dissipation of the phenolics in the residue suspensions. Further work is necessitated to identify the active constituents and elucidation of mechanism of action of the active molecules. Examination of role of the phytotoxic constituents in competitive and or allelopathic interactions of the species under field conditions with reference to weed management would be interesting.

Effects of rice straw on seedling growth and germination of some major weeds in wheat

Kratika Bhandari, Pawanika Chandola and S.K. Guru*

Department of Plant Physiology

G.B. Pant University of Agriculture & Technology Pantnagar, U.S. Nagar, Uttarakhand 244 713

**Email: skguru123@yahhoo.com*

Wheat crop faces severe competition from weeds causing yield losses upto 34.3% which is more than the combined losses caused by insects, pests and disease (Dangwal *et al.* (2010). Chemical weed control, though effective, has other problem such as development of herbicide resistance rice straw due to its allelopathic potential can be used to some extent to manage weeds(Mahmoodzadeh *et al.* 2011). The objective of the present work was to study the effect of rice straw on the germination and seedling growth of four different weeds in wheat crop.

METHEDOLOGY

The laboratory experiment was conducted in the Department of Plant Physiology, G.B. Pant University of Agriculture & Technology, Pantnagar, India. One and two gram powdered straw of rice genotypes 'Pant Dhan 16, UPR 2962-6-2-1 and UPR 2992-17-3-1'was incorporated in the germination medium in Ppetridishes where four weed species viz. *Phalaris minor*, *Vicia sativa*, *Medicago denticulata* and *Lathyrus aphaca* of wheat were kept for germination.. Data on per cent germination, shoot and root length of the weed seedlings were recorded at 21 days after incubation.

RESULTS

Among the weed species, *Phalaris minor* recorded more than 40% reduction in germination when 2g straw all the three rice genotypeswas added to the medium . However, in *Vicia sativa, Medicago denticulata* and *Lathyrus aphaca*, reduction in germination was observed due to the straw of Pant Dhan 16 (1 g). In *Phalaris minor, Vicia sativa* and *Lathyrus aphaca*, reduction in germination was observed due to the straw of UPR 2962 6-2-1 (1 g). The rice genotype '*UPR 2962 6-2-1*' (1 g) had maximum inhibitory effect..

'Pant Dhan 16' (2g) had maximum inhibitory effect on shoot length of *Phalaris minor* while 'Pant Dhan 16 '(2g) followed by '*Pant Dhan 16*' (1 g) had maximum inhibitory effect on shoot and root length of *Vicia sativa*. Straw of 'UPR 2992 17-3-1' (2 g) cultivar had maximum inhibitory effect on root length of *Phalaris minor*. In shoot and root length of *Medicago* *denticulata* and root length of *Lathyrus aphaca*, maximum reduction was recorded in 'UPR 2962 6-2-1' (2 g) while *'UPR 2962 6-2-1'* (1 g) had maximum reduction in shoot length of *Lathyrus aphaca*.

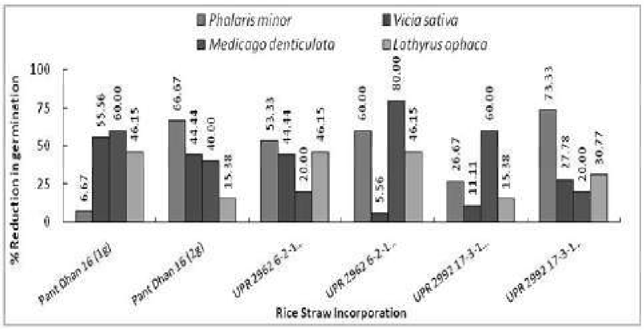

Fig. 1. Effect of rice straw incorporation on per cent reduction in germination of weeds

Table 1. Effect of rice straw on seedling growth of four weed species, 21 days after incubation

Rice straw incorporation	*Phalaris minor* Shoot length (cm)	*Phalaris minor* Root length (cm)	*Vicia sativa* Shoot length (cm)	*Vicia sativa* Root length (cm)	*Medicago sativa* Shoot length (cm)	*Medicago sativa* Root length (cm)	*Lathyrus aphaca* Shoot length (cm)	*Lathyrus aphaca* Root length (cm)
Pant Dhan 16 (1g)	3.96	1.06	0.78	0.40	0	0.002	3.68	1.12
Pant Dhan 16 (2g)	0.83	0.33	0.67	0.51	0.48	0.25	1.95	0.54
UPR 2962 6-2-1 (1g)	1.93	0.51	1.86	1.43	0.76	0.33	1.51	0.68
UPR 2962 6-2-1 (2g)	1.14	0.36	2.14	1.39	0	0.001	1.56	0.44
UPR 2992 17-3-1 (1g)	3.73	1.12	1.86	1.18	0	0.002	3.51	0.87
UPR 2992 17-3-1 (2g)	0.96	0.32	1.14	1.10	0.56	0.22	1.78	0.59
Control	4.23	1.73	2.84	1.66	0.89	0.38	5.34	1.13
LSD(0=0.5)	0.65	0.25	0.16	0.09	0.23	0.01	0.50	0.13

CONCLUSION

The rice genotype '*UPR 2962 6-2-1*' had maximum inhibitory effect on germination of weed seeds. Among the weed species, *Phalaris minor* and *Medicago denticulata* were more sensitive to straw. This shows the potential of rice straw incorporation in soil for weed management.

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Isolation and characterization of fungal biocontrol agents against aquatic weeds in Dharwad

P. Jones Nirmalnath*[1], Netravati Meti[1], H.V. Chaithra[3], R.K. Patil[3] Shamarao Jahagirdar[4], Ramesh Babu[1] D.K. Umesh[3] and Madura A. Sagarkar[2]

[1]AICRP on Weed Control, [2]Institute for Agricultural Research on Climate Change [3]Department of Agril. Microbiology, [4]AICRP on Weed Control, University of Agricultural Sciences, Dharwad ,. Karnataka 580 005

**Email: jones.nirmalnath@gmail.com*

The presence of invasive aquatic plants including both floating as well as submerged have threatened aquatic ecosystem throughout the world. Some of the aquatic species, *viz.* water hyacinth (*Eichhornia crassipes*), alligator weed (*Alternanthera philoxeroides*), giant salvinia, (*Salvinia molesta*) and water lettuce (*Pistia stratiotes*) has been emerged as major invaders of the aquatic habitat. Assimilation of large quantities of nutrients from the water by aquatic weeds may leads to reduced quality and availability of water. Hence, unchecked growth of aquatic weeds most negatively impacted on rural populations whose livelihoods largely depend on access to clean freshwater.

Aquatic weeds can be controlled by several methods including mechanical, chemical and also biological methods. Among all, biological method of aquatic weed control is considered as one of the safe approach keeping in view of the environmental consequences. Microbial weed control represents an innovative means to manage troublesome weeds and aquatic weeds can be controlled by pathogens like Fungi, bacteria and viruses.

METHODOLOGY

A preliminary survey was conducted to document for the incidence of fungal pathogens in the lakesof Dharwad city. Among the different lakes surveyed during our investigations, Kelageri lake which is situated in the art of Dharwad was found to be severely infested with water hyacinth and followed by *Alternenthra* spp. Further observations recorded during the survey work revealed that some of the weedplants exhibited disease symptoms *viz.,* spots, lesions, rots and browning and such diseased weeds were collected in a clean plastic bag and stored at 5^0C. The diseased plant parts were dissected and transferred on to the platecontaining Potato Dextrose Agar (PDA) medium. The plates were incubated at 30^0C for 5-7 days. The tentative identification of the fungal isolates was carried out based on the colony morphology as well as through microscopic observations.

RESULTS

The results of the present investigation based on the morphological characterization have clearly revealed that occurrence of three fungalgenera *viz., Cercospora* spp., *Colletotrichum* spp. and *Curvularia* spp. Out of three genera *Cercospora* spp. and *Colletotrichum* spp. were isolated from Eichhornia crassipes, whereas *Cercospora* spp was isolated from *Alternanthera philoxeroides*. Further, the authenticity of these native fungal pathogens will be carried out byfollowing PCR based molecular techniques before screening them for their disease causing potentialon *Eichhorniacrassipes* and *Alternantheraphiloxeroides*.

CONCLUSION

The *in vitro* studies indicated that the fungal phathogens *viz., Cercospora* spp., *Colletotrichum* spp. and *curvulariaspp* were responsible for the decaying of aquatic weeds and hence the possibility of exploiting these native fungal pathogen sagainst aquatic weeds in an eco-friendly way.

Evaluation of arbuscular mycorrhizal fungi for suppression of *Striga*, a parasitic weed in sorghum

P. Jones Nirmalnath*, A. Madura, Sagarkar Prashant, S. Subbapurmath, Ramesh Babu, K.S. Jagadeesh and A.N. Asha
AICRP on Weed Control, Microbiology,University of Agricultural Sciences, Dharwad, Karnataka 580 005
**Email: jones.nirmalnath@gmail.com*

High input agriculture involves extensive use of chemical herbicides for the effective management of various weeds. Most of these herbicides are toxic xenobiotics and persist in the soil for a considerable period of time and may bring about changes in the soil biological properties, which in turn determines the soil nutrient status. In order to prevent the weed menace as well as to prevent the environmental pollution by herbicides, the biotic interaction is required for effective and sustainable management of weed infestation and which will be a boon to sorghum, maize and sugarcane growing farming community of northern Karnataka wherein devastating losses of yield due to *Striga* infestations are recorded in recent times.

METHODOLOGY

A pot experiment study was undertaken at main Agricultural Research Station, UAS, Dharwad to assess the effectiveness of arbuscular mycorrhiza fungal (AMF) inoculation on the suppression of Striga in sorghum system.

An experiment was laid out in completelyr Randomised design (CRD) during 2012-2013 with four replications and seven treatments, *viz.* T_1 : *Glomus macrocarpum* + *Striga*; T_2: *Glomus fasciculatum* + *Striga*; T_3 : *Glomus mosseae* + *Striga* ; T_4: *Acaulospora laevis* + *Striga* ; T_5: *Sclerocystis dussii* + *Striga*; T_6: *Gigaspora margarita*+ *Striga* and T_7: *Striga* alone. The pots were filled with steam sterilized (121°C for 2h) sand: soil mixture. One gram of *Striga* seeds were mixed with 10ml of sterilized distilled water and poured at the center of the pot and allowed for 10 days conditioning before sowing sorghum. AMF inoculum was mixed in the pot, as per treatment schedule, before sowing and the plants grown under conducive environment for 4 months. The pots were watered twice a weak with distilled water and treated with Hoagland's nutrient solution once a week. The data on the emergence of *Striga,* AM fungal spore count, percent root infection, plant height and dry matter of sorghum, chlorophyll content, dehydrogenase activity and mineral content were recorded and subjected to analysis by CRD analysis. (Table 1). Effects of arbuscular mycorrhizal fungi on *Striga* emergence, AMF root colonization, AMF spore count, plant height, plant dry matter, chlorophyll content, dehydrogenase activity and minerals content of sorghum.

RESULTS

In general, AMF inoculation inhibited *Striga* emergence significantly. The results have clearly revealed that the application of *G. macrocarpum* and *S. dussii* suppressed the *Striga* emergence to a greater extent than other AMF isolates (zero and one, respectively). The highest number of *Striga* emerged was observed in the pots which received *Striga* alone (55.00). With respect to the mycorrhizal parameters, *viz.* root colonization and spore count was highest in the sorghum plants associated with *G. macrocarpum (*92% and 770 spore cont per 50g of soil. Similarly, *G. macrocarpum* treated plants recorded the highest sorghum plant height, total dry matter and chlorophyll content (160 cm, 50 per plant and 46.5, respectively). The inoculation of AM fungal isolates significantly increased the dehydrogenase activity over the uninoculated control (UIC). The highest activity being recorded with *Glomus macrocarpum* (6.86 µg TPF formed / g soil / d), followed by *Sclerocystis dussii* (6.35 µg TPF formed / g soil / d) and the least in UIC (3.65 µg TPF formed / g soil / d). The influence of AMF inoculation on mineral status of sorghum indicated that highest N and P contents were recorded in the plants received *G. macrocarpum* as bio inoculant (0.83 and 1.17 per cent respectively) followed by *Sclerocystis dussii* (0.81 and 1.00 per cent respectively) over uninoculated control (0.29 and 0.49 per cent respectively).

Table 1. Effects of arbuscular mycorrhizal fungi on *Striga* emergence, AMF root colonization,AMF spore count, plant height, plant dry matter, chlorophyll content, dehydrogenase activity and minerals content of sorghum

Treatment	Number of Striga emergence	Per cent Root Colonization	AMF spore count / 50 g soil	Plant height (cm)	Plant dry matter (g)	Chlorophyll content	Dehydrogenase (µg TPF formed / g soil / d)	N (%)	P (%)
Glomus mossae + Striga	12	75	457	98	38	42.8	4.29	0.70	0.75
Glomus fassiculatum + Striga	10	40	378	98	35	42.0	4.17	0.42	0.53
Gigaspora margarita + Striga	8	60	506	103	40	45.0	4.89	68.9	0.87
Acaulospora laevis + Striga	35	60	560	120	40	44.3	5.49	0.79	1.01
Glomus macrocarpmum + Striga	0	92	770	160	50	46.5	6.86	0.83	1.17
Sclerocystis dussii + Striga	1	90	577	150	45	45.7	6.35	0.81	1.10
Striga alone (UIC)	55	12	50	90	30	41.0	3.65	0.29	0.49
LSD (P=0.05)	0.79	4.61	1.85	2.79	0.56	0.28	0.29	0.01	0.01

CONCLUSION

Thus, our preliminary findings are indicative of the effectiveness of AMF in protecting sorghum against *Striga* infestation and hence can be a promising strategy to develop a biological tool for *Striga* control.

Dissipation of anilofos in soil and its harvest residue analysis in rice

Shishir Tandon*

Department of Chemistry, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand 263 145

**Email: shishir_tandon@lycos.com*

Anilofos [S-4-Chloro-N-isopropyl carbaniloylmethyl-O,O-dimethyl phosphorodithioate] is a pre-emergence and early post-emergence selective herbicide used for control of annual grasses, sedges and some broad-leaved weeds in transplanted and direct seeded rice. Anilofos acts on meristematic tissues of weeds severely affecting cell division and cell elongation. Residues studies of anilofos pesticides in rice crop are lacking, hence dissipation studies were taken up in rice crops grown under field conditions.

METHODOLOGY

Field trials on transplanted rice were conducted. Three treatments consisting of control and anilofos applied as pre-emergent herbicide at 400 g/ha and 800 g/ha, respectively. Soil samples were collected from all the plots at different time intervals *i.e.* (0 ,1 hr.), 1, 3, 5, 7, 15, 30, 45, 60, 75 and 90 days after herbicide application and finally on the harvesting day. Rice grain, husk and straw samples were collected at harvest time.

Anilophos was extracted from soil by addition of chloroform: acetone 2:1 (v/v) ratio. The extracts prepared and residue was dissolved in acetonitrile for HPLC analysis. Crushed pulverized grains, rice husk and straw was extracted with chloroform: acetone (2:1 v/v) mixture and concentrated to 1 ml and subjected to cleanup with silica SPE. The eluted sample was dried under steam of nitrogen and residue was dissolved in HPLC grade acetonitrile. The operating chromatographic conditions for anilophos residue were determined on HPLC system, C-18 HPLC column, acetonitrile: water (85:15 v/v) mobile phase, 229 nm wavelength.

RESULTS

Limit of detection for anilofos was 0.003 µg/ml, and limit of quantification for soil, straw, grain and husk was 0.007, 0.010, 0.008 and 0.010 µg/g, respectively. Percent dissipation values at different time intervals were calculated considering the amount of herbicide recovered on 0^{th} day (1 hr after application) as 100%. The values obtained for percent dissipation at 400 and 800 g anilofos/ ha depicted in Table 1. Percent dissipation of herbicide in soil treated at 0.4 kg/ ha decreased from 100 to 86.11% from 0^{th} day (1 hr. after application) to 3^{rd} day; gradually fell up to 47.22% till 7^{th} day on 15^{th} day of application, the persistence decreased to 30.55% and then to 13.89 on 30^{th} day and persisted up till 45^{th} day after application. However, no detectable residue (<0.007 mg/g) was found after 45^{th} day of application. At 0.8 kg anilofos/ha application rate, the persistence of herbicide in soil decreased from 100 to 80.00% from 0^{th} day (1 hr. after application) to 3 day and then it gradually fell up to 42.67% till 7^{th} day on 30^{th} day of application, the persistence decreased to 77.34% and persisted up till 60^{th} day (6.66%) after application. No detectable residue was observed on 75^{th} day of application. Anilofos applied at recommended dose continuously for four seasons in rice, recorded soil residue below toxic level and residues in plant parts lower than MRL (Balasubramanian *et al.* 1999).

Table 1. Dissipation of anilofos in rice soil

Incubation interval	Percent dissipation	
	0.4 kg/ha	0.8 kg/ha
0 day	0.00	0.00
1 day	5.5	8.0
3 day	13.89	20.00
5 day	30.6	33.75
7 day	52.78	42.67
15 day	69.45	58.72
30 day	86.11	77.34
45 day	94.4	85.34
60day	BDL	93.34
75day	BDL	BDL
90 day	BDL	BDL
Harvest day	BDL	BDL

Values in parenthesis show % persistence of the herbicides.
Mean value of 3 replicates BDL= Below detectable Limit, (LOQ < 0.007 mg/g)

CONCLUSION

Anilofos undergoes rapid dissipation in soil and follows first-order degradation kinetics in soil. The half-life value of anilofos in soil was 13.07 days at the lower rate of application (0.4 kg/ha) and 15.59 days at the higher rate (0.8 kg/ha) whereas in husk, grain and straw, at the time of harvesting, no detectable amount of anilofos was observed under sub-humid and subtropical conditions of transplanted rice.

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Evaluation of leaching behavior of oxyfluorfen in FYM amended and un-amended sandy clay loam soil

Asha Arora*
DWSR Center, RVSKVV, College of Agriculture, Gwalior, Madhya Pradesh 474 002
**Email: ashaaroragwl@gmail.com-*

Oxyfluorfen belonging to diphenyl ether group, is a selective pre- and post-emergence herbicide used to control many annual broadleaf and grassy weeds in several crops. Adsorption of pesticides by soils, that influence the movement of herbicides, has frequently been found to be correlated with organic matter and clay contents. The soil of northern Madhya Pradesh is low in organic matter. Therefore the Present study was undertaken to study the mobility of oxyfluorfen in FYM amended and un-amended sandy clay loam soil of Gwalior.

METHODOLOGY

Soil (0-15 cm depth) was collected from surrounding area of Research farm, College of Agriculture, Gwalior. The soil collection site was never treated with any herbicide. The soil was sandy clay loam in texture with sand 55.2%, silt 19.4% and clay 25.4%. The soil was amended with FYM 20 t/ha. The amended soil was moistened with water and kept for 15 days, air dried and passed through a 2 mm sieve. The experiment was done at ambient temperature in a completely randomized design with three replications. Polyvinyl chloride (PVC) columns (10 cm internal diameter and 60 cm long) were cut vertically into two and joined together using adhesive tape. Muslin cloath was tied to one end to hold the soil. Columns were filled with soil by gently tapping the columns. One day before the herbicide application, 500 ml water was added from the top to pre condition soil. Oxyfluorfen was added directly to column after dilution with 10 ml water at doses equivalent to 0.230 and 0.460 kg/ha. Sufficient quantity of water was added to encourage movement of herbicide. A set of columns was used without herbicide for comparison. At the end of the trial (7 days) adhesive tape was cut and the column was split . The presence of herbicides at different soil depths was determined through bioassay by using maize as sensitive crop by following the standard procedure. Plant height, fresh weight and dry weight of maize plant as affected by oxyfluorfen were recorded 21 days after sowing (Table-1).

RESULTS

The pH of the soil was 7.9 and 7.8, electrical conductivity 0.11 and 0.14 dSm^{-1}, and organic carbon 0.20 and 0.33% for non-amended soil and FYM amended soil, respectively. The leaching of oxyfluorfen was affected by the concentration of herbicide as well as amendment of FYM as depicted by the growth of maize plant at different depth. Plant height and fresh weight of maize were reduced up to 30 - 35 cm and 35 - 40 cm at 0.230 kg/ha and 0.460 kg/ha oxyfluorfen, respectively in un-amended soil. In soil amended with FYM the oxyfluorfen leached down to 20 – 25 cm at 0.230 kg/ha and 30-35 cm at 0.460 kg/ha dose as evident by decrease in maize growth (Table 1). Gustafson (1995) revealed that mobility of herbicide in soil is inversely related to its degree of sorption to soil surface. The leaching of oxyfluorfen up to less depth as compared to un-amended soil may be due to higher organic matter in amended soil resulting in higher absorptive capacity of the soil constituents for herbicide. Yen *et al.* (2003) reported that oxyfluorfen was not very mobile in soil and may not contaminate ground water under normal conditions.

Table-1. Effect of Oxyfluorfen on growth of maize at different depths

Soil depth (cm)	0.230 kg/ha						0.460 kg/ha					
	un-amended soil			FYM amended soil			un-amended soil			FYM amended soil		
	Pl. height (cm)	Fresh wt. (g/plant)	Dry wt. (mg/plant)	Pl. height (cm)	Fresh wt. (g/plant)	Dry wt. (mg/plant)	Pl. height (cm)	Fresh wt. (g/plant)	Dry wt. (mg/plant)	Pl. height (cm)	Fresh wt. (g/plant	Dry wt. (mg/plant)
0 - 5	20.78	0.773	89	17.7	0.60	67	18.39	0.710	83	17.2	0.61	82
5 -10	20.77	0.717	78	17.9	0.66	77	18.78	0.611	73	16.2	0.60	76
10-15	22.24	0.823	83	17.3	0.65	68	17.52	0.732	83	18.0	0.64	63
15-20	21.66	0.809	78	18.5	0.79	88	21.22	0.766	83	18.0	0.74	67
20-25	23.72	0.840	86	17.4	0.75	80	21.75	0.707	88	20.2	0.83	68
25-30	24.27	0.961	99	28.1	1.25	13	21.11	0.836	97	25.0	0.75	81
30-35	26.55	1.121	124	27.2	1.28	11	26.00	0.926	104	25.2	0.87	109
35-40	31.44	1.533	160	29.7	1.20	13	26.33	0.903	107	28.0	1.12	131
40-45	30.24	1.474	165	29.0	1.06	13	28.00	1.287	122	30.2	1.06	125
45-50	30.66	1.519	135	30.50	1.21	12	30.22	1.286	111	32.0	1.21	136

CONCLUSION

Oxyfluorfen leaches in soil up to 30 to 40 cm in alluvial soil and the leaching decreases to 20 to 35 cm by amendment of FYM indicating that organic carbon content is an important factor that influences the leaching of oxyfluorfen.

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Effect of herbicides and cultural practices on soil microbial population in chickpea (*Cicer arietinum*).

P.O. Bhutada, P. S. Wakade, R. B. Ikkar

Chickpea (*Cicer arietinum*), an important *Rabi* crop, suffers severely due to competition stress of weeds with yield reduction to the tune of 20 to 49% depending on nature and density of weeds. Timely weed management practices play an important role in the successful cultivation of the crop. The conventional method of weed control by hoeing and hand weeding are very laborious, expensive and time consuming and needs to be often repeated at different intervals. Therefore, the present investigation was planned to find out efficacy of herbicides and cultural management on weed control in chickpea.

METHODOLOGY

An investigation was carried out during 2010-11 at the farm of Agronomy Department, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. The experiment was laid out in randomized block design with 10 treatments and 3 replications for each treatment (Table 1). The Chickpea variety (Jaki 9218) sown in the plot of 4.2 m x 4 m, on 4th November, 2010. Effect on micribial population bacteria, fungi and actinomycetes were workout.

RESULTS

The differences in counts of bacteria, fungus and actinomycetes among the treatments before spraying of herbicides were observed to be non-significant. But after spraying of herbicide, there were considerable differences of their counts among the treatments. After spraying of herbicide microbial count was reduced in herbicidal treatments than cultural method. Treatment weedy check showed maximum microbial count before and after spraying of herbicide.

Table 1. Soil microbial population affected by different treatments in chickpea

Treatments	Bacterial count (x 10^7 cfu/g soil)		Fungal count (x10^4 cfu/g soil)		Actinomycetes count (x 10^6 cfu/g soil)	
	Before spraying	After spraying	Before spraying	After spraying	Before spraying	After spraying
Weedy check	28.25	-	21.46	-	23.99	-
Imazethapyr PE 75 g/ha	25.30	16.12	18.45	12.12	22.52	16.09
Imazethapyr POE 75 g/ha	26.45	17.45	18.88	12.55	21.55	17.43
Pendimethalin PE 1000 g/ha	27.72	21.38	20.38	16.38	22.58	20.92
Quizalofop POE 50 g/ha	25.43	18.76	18.1	13.43	22.33	18.33
Imazethapyr PE 75 g/ha + 1H at 30 DAS	26.02	16.18	19.18	11.52	22.18	15.95
Imazethapyr POE 75 g/ha + 1H at 40 DAS	26.5	16.50	18.83	11.83	21.83	16.17
Pendimethalin PE 1000 g/ha +1H at 40DAS	27.55	22.88	21.22	17.88	22.65	21.68
Quizalofop POE 50 g/ha + 1H at 40DAS	26.63	21.41	20.41	16.07	22.61	19.94
2H at 15 and 40 DAS + 1HW at 30 DAS	27.6	23.50	21.43	18.77	23.10	22.77
SE (m)±	1.05	0.56	2.50	0.90	0.88	0.96
C.D. at 5%	-	1.68	-	2.67	2.62	2.88
G.M.	26.74	17.42	19.83	13.05	22.53	16.93

Before and after spraying of herbicides the samples were drawn for microbial study and it was observed that before spraying of herbicide the bacterial, fungal and actinomycetes count were more or less similar. The bacterial population was ranged between 25.43 to 28.25 x 10^7 cfu/g soil. However, the post emergence spraying quizalofop-ethyl 50 g/ha reduced the bacterial population from 25.43 to 18.76 x 10^7 cfu/g soil. There was least effect on bacterial population when pendimethalin 1.0 g/ha was sprayed. The bacterial population was reduced with post emergence spray of imazethapyr 75 g/ha. Cultural practices have no effect on bacterial population. Fungal population was ranged between 18.10 to 21.43 x 10^4 cfu/g soil, before spraying of herbicides. The fungal growth was reduced (11.52 X 10^4 cfu/g soil) with post emergence spray of imazethapyr 75 g/ha . Pendimethalin has less effect on fungal population. The actinomycetes population was ranged from 21.83 to 23.99 X 10^6 cfu/g soil which was (16.17X10^6 cfu/g soil) reduced due to imazethapyr spray 75 g/ha. Lower effect of pendimethalin (21.68 X 10^6 cfu/g soil) on actinomycetes activity was noticed.

CONCLUSION

The application of herbicides leads to the reduction of microbial counts in soil.

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Sorption of pyrazosulfuron-ethyl in different soils of Tamil Nadu

P. Janaki*, and H. Mohana Sundram
DWSR Centre, Department of Agronomy, TANU, Coimbatore, Tamil Nadu 641 003
**e-mail: janakibalamurugan@rediffmail.com*

Pyrazosulfuron-ethyl, a new herbicides have recently been registered in India for weed control in rice crops. Many field experiments revealed the bioefficacy of this herbicide; however, no or little information is available on the sorption of this herbicide in soil (Naveen *et al.,* 2012), as it decides the efficacy of the applied quantity on controlling the weeds. Further, understanding of the behavior of herbicides in the environment is important otherwise which give rise to contamination of soil, water and food chain (Zheng *et al*., 2000). Therefore, a laboratory experiment was undertaken to investigate sorption behavior of pyrazosulfuron ethyl in different soils.

METHODOLOGY

The surface soil from a depth of 0-15 cm was collected from the TNAU farm, Coimbatore (clayey), Tea garden in Ooty (organic soil) and IARI Regional Research Station, Wellington, Nilgiris (Sandy clay), air dried and processed. Two grams of processed soil samples were placed in a centrifuge tube to which different concentrations (0, 1, 2, 4, 6, 8, 10, 15, 20 ppm) these herbicides were added and the experiment was duplicated. The soil: solution ratio used for this study is 1:5 and were shaken for 12 hrs on an end over end shaker to attain equilibrium. After equilibration, the soil water suspension was centrifuged at 5000 rpm for 10 minutes and the concentration of the heribicdes was measured in the supernatant. The amount of herbicides sorbed was calculated from the difference between the initial and final solution concentrations. Desorption experiment was run immediately after adsorption by dilution of the filtered equilibrium adsorption samples to 1:5 soil: deionised water ratio. The samples were shaken for 12 hrs and supernatant was obtained. Both the herbicides were determined using HPLC-DAD. Statistical analysis was performed by linear regression to calculate the isotherm coefficients. Regression analysis was used to evaluate the influence of the different soil properties on adsorption coefficients.

RESULTS

Results showed that an increase in the concentration of herbicides increased the adsorption of them. Adsorption of pyrazosulfuron ethyl is in the order of clayey>sandy clay>organic soil. The difference in herbicide adsorption with respect to soil type is attributed to the chemical properties of the herbicide molecules studied. While the pyrazosulfuron adsorption is influenced by the clay content; the influence of organic matter was not conspicuous. When the organic carbon increased the quantity adsorbed decreased and vice versa with the clay content of the soils. The shapes of the pyrazosulfuron-ethyl adsorption isotherm in all the soils were of 'S' type. The isotherm expressed an increasing trend in the adsorbed content C_s (mg/kg) with respect to increase in the equilibrium concentration of pyrazosulfuron-ethyl C_e (mg/L) in solution (Fig 1).

A linear fit (straight line) of Freundlich adsorption isotherm was obtained with experimental data in all soils and the coefficient values (K_f) indicate (Table 1) higher adsorption of pyrazosulfuron-ethyl on the clay soil followed by sandy clay and peat soils which confirm the relevance of clay content as the adsorbent for herbicides. It was found from this study that if the clay content is high (Table 1), then the effect of OC on sorption is masked.

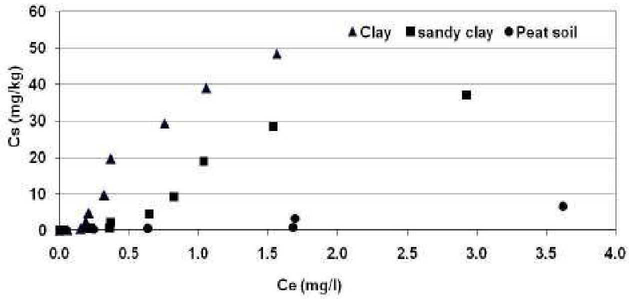

Fig.1. Adsorption isotherm of pyrazosulfuron-ethyl in different types of soils

Amount of adsorbed pyrazosulfuron-ethyl desorbed from soil is in the range of 0.18 – 11.84, 6.2 – 78.42 and 2.86 – 35.82%, respectively for clayey, sandy clay and peat soils. In this study adsorption-desorption coefficient showed extensive hysteric behavior resulting from discrepancies between adsorption-desorption isotherms. Hysteric behavior is extensive for clay soil followed by peat and sandy clay soils and proved that the sorption of pyrazosulfuron-ethyl by the organic carbon is less; hence it is easily subjected to microbial degradation and has low persistence in soil.

Table 1: Freundlich constants, Koc and Kd values for pyrazosulfuron-ethyl adsorption in different soils

Soil types	Clay %	OC %	Adsorption			
			Log K_f	1/n	K_{OC}	Kd ranges
Clayey	44.52	0.53	1.31	1.69	3491	1.21 – 53.81
Sandy clay	37.12	4.56	0.926	1.38	160	2.47 – 18.46
Peat	0.82	13.52	-	-	10.64	0.48 – 2.35

CONCLUSION

It is concluded that the sorption of pyrazosulfuron-ethyl in different soils were significantly influenced by the clay and organic matter content of the soil and in the order of clayey>sandy clay>organic soil.

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Microbial degradation of alachlor using a native fungal strain

Maisnam Jaya[1], Shashi B. Singh[2], Gita Kulshrestha[2] and Satyavir Arya[1]
[1]Department of Chemistry, C.C.R (P.G) College, Muzaffar Nagar, Uttar Pradesh 251 001
[2]Division of Agricultural Chemicals, IARI, New Delhi 110 012

Alachlor, a chloroacetanilide herbicide, is used pre- or early post-emergence to control annual grasses and many broadleaved weeds mainly in maize, but also in cotton, *Brassicas*, oilseed rape, peanuts, radish, soybean and sugarcane. Water solubility (140 mg/L) and log K_{oc} values (2.08-2.28) of alachlor, indicate that it has a high to medium mobility in soil. A review on monitoring data showed that alachlor was present in ground waters in USA at levels ranging from less than 0.1 to 16.6 ìg/L (Ritter, 1900) against the permissible limit of 0.002 mg/L. Detection of metabolites of alachlor was also reported. Hence, remediation of soil is a major concern and need to develop methods for degradation of alachlor residues to minimize pollution in surface and ground water resources. Microbial method of detoxification is an important tool in soil reclamation and has potential to solve such problem.

METHODOLOGY

Isolation of microorganisms from soil (surface alluvial soil collected from the experimental fields of IARI, New Delhi) to study alachlor degradation under laboratory conditions was done by enrichment technique and microbial strains were isolated using different media (fungus, bacteria, actinomycete). The potential fungal strain thus isolated was acclimatised in broth at increasing concentration of alachlor to investigate the degradation ability of the microorganism. Successive transfers were done at alachlor concentrations i.e., 5, 12, 24 and 60 µg/mL to isolate pure acclimatized culture. This was characterized by the microscopic observations. Utilization of alachlor as a sole source of carbon and nitrogen was studied in different mineral salt media. As maximum degradation was observed in nutrient medium supplemented with only 10% N, the microbial degradation kinetics was studied in this medium and analysis was done by Gas Chromatography (GC). Rate of alachlor degradation by the pure isolated fungal strain at 50 µg/g concentration was also studied in sterile and non-sterile soil. Different degradation products of alachlor were identified in broth (using 100 µg/mL of alachlor) by Gas Chromatography- Mass Spectrometry (GC/MS). A degradation pathway was also proposed.

RESULTS

The pure culture obtained by enrichment culture was identified by the microscopic observation of vegetative morphological and cultural characteristics as *Rhizopus oryzea*. The study indicated that the microbe used alachlor as source of nitrogen for energy, although a small amount of nitrogen (10% N) was required to trigger the initial growth of microbes and maximum degradation of higher level of alachlor was achieved. Degradation kinetics of alachlor with *Rhizopus oryzea* showed that initially the degradation was slow in broth (with 10%N). However, rapid degradation was observed during 7 to 20 days. Pothuluri *et al.* (1990) reported biodegradation of alachlor in surface soil (half life 23 day) showing addition of organic nutrient enhance degradation rate. Study in non sterile soil by *Rhizopus oryzea* showed that degradation in both the soil (sterile and non sterile) was almost similar from 7th to 40th day of incubation. On 50th day, residues were below detectable limit in sterile soil whereas 1.7% residues were remaining in non sterile soil. Radosevich *et al.* (1993) reported that alachlor biodegradation in subsurface soil was slow due to the lack of microorganism capable of degrading this compound which is in agreement with the present study. The half life in sterile and non-sterile soil incubated with *Rhizopus oryzea* was found to be 7.2 and 8.6 day respectively (Table 1), indicating almost negligible effect of the native microbial population which are in agreement with the half life values of 23.3 and 10.03 day in sterile and non-sterile soil respectively (Jaya et al. 2009). Therefore, the additional presence of *Rhizopus oryzea* in alachlor contaminated soil could be used as a tool for bioremediation. GC-MS analysis of broth extract after 25 days of incubation of alachlor with *Rhizopus oryzea* showed, eleven different metabolites in comparison to just three in control sample indicating that eight are the purely microbial metabolites.

Table 1. Half life values of alachlor in sterile soil and non-sterile soil after incubation with *Rhizopus oryzea*

Medium	Treatment	Alachlor Concentration	Half life
Sterile soil	*Rhizopus oryzea*	50 µg/mL	7.25 days
Non – sterile soil	*Rhizopus oryzea*	50 µg/mL	8.66 days

CONCLUSION

It can be concluded that *Rhizopus oryzea* is a potential fungal isolate and can be used for the bioremediation of alachlor from soil.

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Optimization of pyrozosulfuron extraction and purification method for residue analysis of sample

S.R. Vikram[1], G.R. Hareesh[2], R. Devendra[2] and M.T. Sanjay[2]

[1]Department of Crop Physiology [2]AICRP on Weed Control,
University of agricultural Sciences, GKVK Bangalore Karnataka 560 065

Apart from food security for growing population use of agricultural product with pesticide lead to toxicology affect on human and animal health. Extraction and cleanup of herbicide from samples, both from plant and soil, takes lot of time and impurities presence reduces the recovery of herbicide. QuEChERS (Quick, Easy, Cheap, Efficient, Rugged and Safe) method employ dispersive solid phase extraction (SPE) in which sample passed through sorbent and retained analytes were eluted with solvent. This method simultaneously removes residual water and matrix interferences (Lehotay et al 2005). Thus conventional partition column method and QuEChERS method were used to extract, cleanup and purified aliquot was injected to HPLC-UV and herbicide residue was estimated. The chromatographs of both the methods were compared to each other for percent recovery, quality and quantity herbicide residue in the treated soil & plant materials.

METHODOLOGY

The rice seedlings were raised in battery pot of size 60 x 30 x 45 cm^3. Pyrozosulfuron ethyl 10 WP herbicide of recommended dosage (250g/ha) was sprayed as pre-emergent one day after sowing. After 10 days of sowing, two sets of soil, root and shoot plant samples were collected. Both the extraction and cleanup procedures were followed one set each. Partition column method involves known quantity of herbicide containing sample was methanol (50ml) extracted by mechanical shaker for 1 hour, later on diluted with deionized water (250ml) having to saturated sodium chloride (50ml) with 6N HCl (1ml) followed by twice extraction with dichloromethane (50ml and 25ml) and evaporated. Precipitated pyrozosulfuron residue was dissolved in n-hexane (5ml) and used in cleanup column filled with silica gel using Hexane:ethyl acetate (1:1). The elute was evaporated to dryness and volume made up with repeated washing with acetonitrile (5ml). This procedure takes 2h per sample of 20gm extract, cleanup with high quantity of too many solvents.

The QuEChERS method 1.5gm sample was added to1.5ml of 1% acetic acid in acetonitrile (v/v) followed by 0.6gm of Magnesium sulphate & 0.15 gm of anhydrous sodium acetate and vertexed for 1 min. then centrifuged for 1 min at 14000 rpm and supernatant was transferred to cleanup tube containing C_{18}, $MgSO_4$ PSA centrifuged at 14000 rpm and supernatant was used for residue analysis. This procedure takes 10 min per sample. Aliquots were fed to the HPLC having V/UV detector and chromatographs were obtained. Chromatographs of both the methods were compared for their herbicide percent recovery, quality of chromatogram and tried to quantify the herbicide in the sample.

HPLC Model Waters 1525 Binary HPLC pump. HPLC Detector Waters 2487 dual lambda absorbance detector. Column 4.6 x 250 mm analytical column. Flow rate 0.6 ml/min. Pressure 4000 psi. UV detector 254 nm Injection volume 20 micro litre. Mobile Phase Acetonitrile and Water (2:1). Retention Time 1.34 min

RESULTS

Based on the OD value the limit of detection is 0.075 ppm and the retention time is 1.52± 0.05 min. The standard curve of different concentration of pyrozosulfuron vs peak height area presented in Fig. 1. Rice seedlings were raised in pot treated with herbicide. Pyrozosulfuron content in soil, root and shoot was estimated using coloum method and kit method. The chromatography shows that extraction and cleanup using QuEChERS kit method was much faster, with less contamination and sharp peak than conventional column method (Fig. 2 and 3). Similar type of chromatograph for soil, and root extract and cleanup were observed.

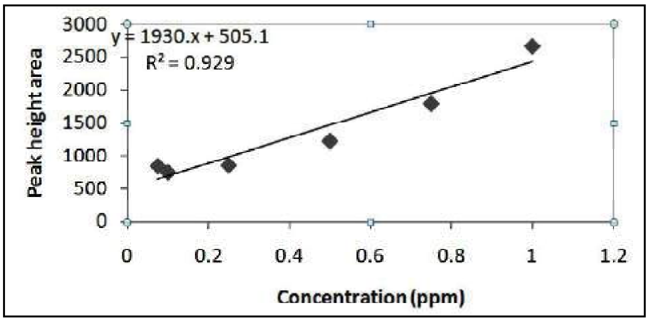

Fig. 1. Standrad curve of Sigma Pyrozosulfuron HPLC–UV detector

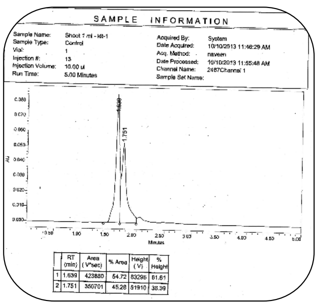

Fig 2. Chromatography of pyrozosulfuron present in rice shoot after extraction and cleanup using QuEChERS kit

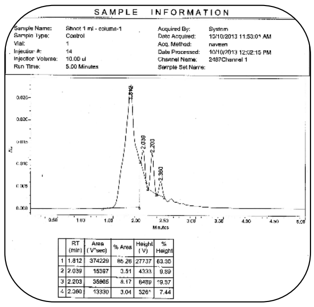

Fig.3 Chromatography of pyrozosulfuron present in rice shoot after extraction and cleanup using conventional column method

CONCLUSION

Apart from drastic reduction in extraction period per sample, QuEChERS method showed superior extraction without impurities and high recovery percent than solvent partition method

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Influence of bispyribac sodium on soil properties and persistence in soil, plant and grain in direct seeded rice (wet)

T. Ramprakash[1]*, M. Madhavi[2] and M. Yakadri[1]

[1]AICRP on Weed Control, [2]Department of Agronomy Rajendranagar, Hyderabad, Andhra Pradesh 500030
**Email: trapkash@gmail.com*

Bispyribac-sodium is a post-emergent herbicide for the control of a wide range of weeds with excellent selectivity on direct-seeded Indica-type rice. Bispyribac sodium is a faintly acidic compound, with a pKa of 3.05, highly soluble in water (73.3 g/L) and inhibits the plant enzyme acetolactate synthase (ALS). Research work on persistence of this herbicide especially in Andhra Pradesh situations where the herbicide is being used on large scale is scanty.

METHODOLOGY

A field experiment was conducted during *Kharif*2011 and 2012 at the College Farm, ANGRAU, Hyderabad. Experiment was laid out in RBD with seven treatments, *viz.* bispyribac sodium 10% SC 10 g/ha, 15 g/ha 20 g/ha 25 g/ha 40 g/ha applied at 20 DAS compared with unweeded control and hand weeding treatment (20 and 40 DAS) and replicated thrice.Soil samples were collected before application of herbicide and at 0, 1, 3, 8, 15, 30, 60 days after herbicide application and at harvest time (80 DAA) from the rice field. Grain and plant samples were collected at harvest.

Soil physical (texture, bulk density, pore space, MWHC), Physico-chemical (pH, EC and CEC) and fertility (Organic carbon, available N, P and K) were analyzed employing standard protocols. Bispyribac residues in the soil samples were analyzed employing the procedures outlined by Zhaeng Li Ying *et al.* (2005) and residues in the grain and plant samples were estimated according to protocol given by Shimin Wu and Jun Mei (2011). Averaged recoveries ranged between 87.12% and 93.22% in soils at the fortified levels of 0.02-1.0 mg/kg. In plant and grain samples the recoveries varied between 92.6 - 98.7% and 90.1 - 94.3%, respectively. Minimum detectable limit was 0.02 mg/kg in grain straw and soil.

RESULTS

There were no significant changes in soil physical (texture, bulk density, particle density, pore space, maximum water holding capacity), physico-chemical (pH, EC, CEC, OC) and fertility properties of the soil (Available N, P_2O_5 and K_2O) due to application of bispyribac sodium. In recommended dose (25 g/ha) treatments, bispyribac sodium residues persistedupto 30 DAA in the soil. At sub-optimal doses (10.0 g/ha and 15.0 g/ha), the soil persistence was recorded only upto3 DAA. At 40 g/ha, residue in soils samples could be detected upto 30 DAA. Residues of herbicide could not be detected in the soil samples at harvest stage of the crop in any of the applied doses. Dissipation behaviour of the bispyribac sodium in soil at different doses of application was as following.

$y = 0.0605e^{-0.04x}$ $R^2 = 0.97$ (40 g/ha)
$y = 0.0484e^{-0.063x}$ $R^2 = 0.96$ (25 g/ha)
$y = 0.0356e^{-0.068x}$ $R^2 = 0.98$ (20 g/ha)

At 40 g/ha, half-life (DT_{50}) was 15.92 days and DT_{90} was 73.49 days. DT_{50} was 10.17 days and DT_{90} was 37.01 days when herbicide was applied at 25 g/ha. At 20 g/ha dose, the half-life (DT_{50}) was 10.87 days and DT_{90} was 34.53 days. Dissipation trends indicated that with increasing doses of bispyribac sodium the half-life and DT_{90} increased significantly. No detectable residues of bispyribac sodium were found in the straw or grain at the time of harvest.

Table 1. Residues of bispyribac sodium (mg/kg) in soil samplescollected at different intervals after application of the herbicide.

Treatments	Residues of bispyribac sodium at different days after application								
	0	1	3	8	15	30	45	60	Harvest
Bispyribac sodium at 10.0 g/ha	0.024	0.022	0.02	BDL	BDL	BDL	BDL	BDL	BDL
Bispyribac sodium at 15.0 g/ha	0.026	0.031	0.027	BDL	BDL	BDL	BDL	BDL	BDL
Bispyribac sodium at 20.0 g/ha	0.034	0.037	0.027	0.021	BDL	BDL	BDL	BDL	BDL
Bispyribac sodium at 25.0 g/ha	0.047	0.051	0.039	0.026	0.020	BDL	BDL	BDL	BDL
Bispyribac sodium at 40.0 g/ha	0.064	0.067	0.053	0.036	0.031	0.021	BDL	BDL	BDL
Control	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Hand weeding	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL

Detection Limit: 0.02 mg/kg

CONCLUSION

Bispyribac sodium when used at recommended rates in direct seeded ricedid not adversely influence the soil properties and residues in soil persisted upto 15 DAA beyond which they residues the BDL (0.02 mg/kg). Residues of bispyribac sodium in grain and straw were BDL at harvest.

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Persistence of pendimethalin, quizalofop-p-ethyl and imazethapyr in soil, grain and plant of soybean

T. Ramprakash[1]*, M. Madhavi[2] and A. Srinivas[2]

[1]AICRP on Weed Control, [2]Department of Agronomy Rajendranagar, Hyderabad, Andhra Pradesh 500030
**Email: trapkash@gmail.com*

Soybean is popular oilseed crop grown in Northern Telangana Region of Andhra Pradesh in morethan 1.2 lakh ha. Farmers use pendimethalin as pre-emregence herbicide and imazethpyror quizalofop-p-ethyl as post-emergence herbicides depending on the composition of weed population. When mixed weed population is observed imazethapyr is used and when grass weed competitionis severequizalofop P ethyl is applied. In Andhra Pradesh conditions, information of persistence of pendimethalin, quizalofop-p-ethyl and imazethapyr in soybean growing soils and plant/grain of soybean are scanty. Hence, the present study was conducted.

METHODOLOGY

A soybean (*JS 335*) field experiment was conducted during *Kharif* 2011 at the College Farm, ANGRAU, Hyderabad. Experiment was laid out in RBD with three replications and seven treatments, *viz*. pendimethalinas PE (1.0 kg/ha), imazethapyras PoE at 20 DAS(100 g /ha), quizalofop P ethyl as PoE at 20 DAS (50 g/ha), pendimethalin as PE (1.0 kg/ha) fbimazethapyras PoE at 20 DAS(100 g/ha), pendimethalinas PE (1.0 kg/ha) fbquizalofop P ethyl as PoE at 20 DAS (50 g / ha) compared with unweeded control and hand weeding treatment (20 and 40 DAT).Soil samples were collected before application of herbicide and at 0, 8, 15, 30, 60, 90 days after herbicide application and at harvest time (105 DAA) from the soybean field. Grain and plant samples were collected at the time of harvest.

Extraction and estimation of Pendimethalin in soil and plant samples was carried out according to Zimdhaland Gwynn(1977) on GC-ECD. Quizalofop-P-ethyl residues in the soil/soybean samples were analyzed employing the procedures outlined by Hu *et al.* (2010)on GC-ECD. Imazethapyr was estimated on GC-NPD.

RESULTS

Retention time of pendimethalin was 10.75 minutes. Soil recovery was 86.8 to 92.4%. In grain and plant recovery was 90.4-94.0% and 88.6 to 92.8% respectively. LOQ was 0.05 mg/kg. Recovery of the quzalofop in soil was 92.6 - 98.5%, whereas in grain and plant recovery was 87.5 - 94.6% and 90.8 to 94.4 %, respectively. LOQ was 0.01 mg/kg. Retention time of Imazethapyr was 5.74 minutes with recovery in soil and plant varied between 81-84% and 86-91%, respectively.

Pendimethalin residues persisted up to 60 DAA at recommended level of application in Alfisols. More than 50% of the Pendimethalin residue dissipated before 30 DAA. At 90 DAA and harvest the residues have reached below detectable limit (0.05 ppm). Dissipation of the Pendimethalin in soil was biphasic, with the initial 50% of the residues dissipating at a faster rate compared to the later half. Pendimethalin residues in soil dissipated by 88.7 of the initial Detected amount (IDA) at 60 DAA.

Quizalofop p ethyl dissipation in soil followed a first-order decay process ($C=C_0 exp^{-kd \cdot t}$). At recommended dose (50 g/ha) half-life of quizalofop P ethyl was 20.38 days and residues reached BDL at 60 DAA. At 15 DAA,quizalofop P ethyl dissipated to 47% of the IDA and 76 % of the residues in the soil were dissipated by 45 DAA.

Imazethapyr residues in soil persisted up to 60 DAA at both the recommended and double doses beyond which they reached BDL (0.005ppm). At 60 DAA, the soil residues dissipated by 87% of the initial detected level in recommended dose (Table 1).

Table 1. Residues ofpendimethalin, quizalofop P ethyl and imazethapyr in soil

Days after application (DAA)	Pendimethalin		Quizalofop P Ethyl		Imazethapyr	
	Residues	% Dissipation	Residues	% Dissipation	Residues	% Dissipation
0	0.461	-	0.042	-	0.064	-
8	0.374	23.2	0.029	31.0	0.057	10.9
15	0.327	29.0	0.022	47.6	0.051	20.3
30	0.167	63.7	0.013	69.0	0.033	48.4
45	0.089	80.6	0.010	76.2	0.017	73.4
60	0.052	88.7	BDL	-	0.008	87.5
90	BDL	-	BDL	-	BDL	-
Harvest (102 days)	BDL	-	BDL	-	BDL	-

CONCLUSION

When applied to *Kharif* groundnut, residues of pendimethalin (PE), quizalofop P ethyl (PoE) and imazethapyr (PoE) persisted in the soil upto 60, 45 and 60 DAA respectively in Alfisols. Residues of all the three herbicides were MRLin soil, grain and plant at the time of harvest.

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Terminal residues of penoxsulam in rice grains, straw and soil

PervinderKaur*, Simerjeet Kaur, M.S. Bhullar
Department of Agronomy, Punjab Agricultural University, Ludhiana, Punjab 141001
Email: pervi_7@yahoo.co.in

Since herbicides are necessary to manage prominent weeds, herbicide residue estimation in soil and edible part is very essential to determine the duration of herbicide activity in soil and its effect on crop, to ensure that the harvest time residue of herbicide on food stuff are below MRL. No studies on the soil residual activity of this herbicide under Indian conditions are available. Hence present study was undertaken to analyze the residue of penoxulam in soil, rice and straw at harvest.

METHODOLOGY

A field experiment was conducted with transplanted rice in the farm of College of Agriculture, Punjab Agricultural University, Ludhiana, Punjab, in a randomized block design with three replications. Penoxulam was applied as early post emergent herbicide 20, 25 and 30 g/ha.

Penoxulam from soil and rice at harvest was extracted by the Matrix solid phase dispersion-MSPD protocol described byTsochatzisetal (2012)[2] with slight modification. Briefly, soil and rice samples (10 g) were homogenized in a pestle and mortar with 2 g of florosil activated at 200°C for 8 hrstransferred to a glass column packed with sodium sulphate and 0.01 mg of charcoal.The sample was allowed to elute drop wise with acetone. The eluatewasevaporated using rotary vacuum evaporator. The sample was reconstituted in 2ml acetonitrile and was analyzed by HPLC. Penoxulam from straw (50 gm) at harvest was extracted with 120 ml acetone for 3-4 hrs. The extract was concentrated to 50 ml and was partitioned with dichloromethane (2X75ml) and then ethyl acetate (2 x 50ml). The combined filtrate was then concentrated on rotary vacuum evaporator. A glass column was packed with florosil between anhydrous sodium sulphate at each end. The concentrated extract was added at the top. The column was eluted with 75 ml of acetone. The eluate was evaporated on rotary vacuum evaporator.The sample was reconstituted in 2ml acetonitrile and was analyzed by HPLCat 230 nm usingSpherisorb 5.0 ?m ODS2 4.6 x 250 mm column. The mobile phase consisted of acetonitrile at the flow rate of 0.5 ml/min. Under these operating conditions, the retention time of penoxsulam was found to be 4.73 min.

RESULTS

The LOD and LOQ were calculated to be 0.003 and 0.01 mg/kg. The recovery of penoxsulam varied from 104-82 % for soil, rice grain and straw samples at fortification level of 0.1 0.5 and 0.01 mg/kg. Below detectable amount of herbicide residue in soil, grain and straw was observed at harvest (Table 1)

Table 1. Residue of penoxsulam in soil, grain and straw at harvest

Dose	Residue(mg/kg)		
	Soil	Rice	
		Grain	straw
20 g/ha	BDL	BDL	BDL
25 g/ha	BDL	BDL	BDL
30 g/ha	BDL	BDL	BDL

BDL Below detection limit>0.01 mg / kg

CONCLUSION

On the basis of above findings it can be concluded that penoxsulam at20-30 g/hacan be safely applied to the rice crop as early post-emergence herbicide as the residue at harvest were below the maximum residue limits set by EPA (0.01 mg/kg).

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Evaluation of three herbicides in green manuring conditions using GCMS triple quadruple

Anil Duhan*, Dharambir Yadav and S.S. Punia
Agrochemicals Residues Testing Laboratory, Department of Agronomy,
Chaudhary Charan Singh Haryana Agricultural University Hisar, Haryana 125004
**Email: a.duhan@rediffmail.com*

Persistence and dissipation behaviour of pretilachlor, butachlor and anilofos were studied under green and non-green manuring conditions using GCMS/MS. Soil samples from permanent experimental field at Regional Research Station Karnal, Haryana since 1999 treated with these herbicides at their recommended doses were collected periodically whereas sampling of grains and straw was done at harvest. The samples were extracted and cleaned-up before analysis. It was observed that under green manuring, the residues of pretilachlor, butachlor and anilofos dissipated faster than under non-green manuring conditions. The residues were found to dissipate near 100% after 30 days under non-green manuring, whereas residues reached below detection level after 15 days under green manuring. The half-life of pretilachlor, butachlor and anilofos was 8.9, 12.5 and 9.4 days, respectively under non-green manuring whereas, under green manuring, the residues of three herbicides attained their half life on 7.3, 4.8 and 4.9 days, respectively. There were no residues in paddy grains and straw.

Factors affecting microbial degradation of herbicides

Sahaja Deva*, Derheen Bai, Bhumika Patel, Pritee Awasthy and Pragya Pandey
Department of Agronomy, Indira Gandhi Krishi vishwavidyalaya, Raipur, Chhattisgarh 492012
**Email: sahajareddy.deva@gmail.com*

Microbial decomposition is one of the major processes of decomposition of herbicides in soil. The rate at which breakdown occurs depends on environmental conditions as well as inherent nature of herbicide. Generally warm and moist conditions favour microbial activity and hence the breakdown of herbicides. Some herbicides lasts only for a short time (eg. glyphosate), while others can persist for longer even more than one cropping season/year. Microorganisms decompose herbicides initially at a slow rate as detected by slow release of CO_2 from soil. It is called "lag phase" and in this phase, they increase their population rapidly and buildup intracellular or extracellular enzyme potential. Lag phase is later followed by rapid increase in the rate of CO2 evolution which indicates rapid microbial activity.

Factors affecting biodegradation

Microbial adaptation

The repeat application of a soil active, biodegradable herbicide is not found to result in its build-up in crop fields, including the paddy fields. It happens so due to the phenomenon of microbial population, bringing about rapid mineralization of the herbicide. Even strongly absorbed and bound residues of herbicides are subjected to this phenomenon of increased bio-mineralization rates. However, the build-up of the adapted microbial population with ability to degrade the applied herbicide at increasing rates occurs chiefly in the surface soil (0-15 cm depth).

Extenders

Extenders are microbial inhibitors employed to extend the persistence of a herbicide (or other pesticide) in soil. Such chemicals prevent the enrichment of enzyme necessary for biodegradation. Boron is a long known extender for linuron. Dietholate (O,O-diethyl-O-phenyl phosphorothioate) is a reported extender for EPTC in soils. Sharon *et al* (1993) found phosphate fertilizers acted as potential inhibitors of terbutryn degradation. The objective in the use of extenders is to increase the weed control period.

Temperature

Extremely sold weather and frosting in the atmosphere as well as in soil reduce the activities of microorganisms. Microbial decomposition is drastically reduced at or below 5°C and temperatures between 24°C and 32°C is most favourable to microorganisms for their growth and activity

Moisture

Soil moisture is very crucial for microbial activity. Excess moisture or water –logging may lead to anaerobic conditions and reduce the growth of aerobic microorganisms. Similarly in deficient moisture or dry soil, microorganisms may die up or remain inactive/dormant and as a result, the persistence of herbicides may be prolonged under moisture stress or dry soils. Microbial decomposition is optimum when soil moisture is at or near field capacity. It however, takes place between 50 to 100% of filed capacity.

Organic matter and adsorption

Organic matter is source of energy for microorganisms. However, if huge amount of organic matte present in soil, it may result in increased herbicide adsorption. Once herbicides are adsorbed, it is likely that they are less prone to decomposition by microorganisms and decomposition would be less. Also equally true is that if organic matter is abundantly available, the microorganisms may use that as source for food and energy and herbicide decomposition will have a second preference and may be subjected to other processes of transfer and decomposition than microbial decomposition.

Soil pH

Microorganisms are highly sensitive to pH and therefore microbial decomposition of herbicides is highly influenced by soil pH. Bacteria and actinomycetes are active at moderate to higher pH and their activities decrease at acidic or lower pH. Soil pH lower than 4.5 drastically reduces their activities. Fungi, on the contrary, are less sensitive to soil pH and work well in almost all pH ranges of normal agricultural soils. They, therefore, predominate in lower pH where bacteria and actinomycetes fall less active or inactive.

Oxygen availability

Aerobic microorganisms require oxygen for their growth and decomposition activity. Therefore, anaerobic conditions (eg. water-logging/poor aeration, poor drainage) of soils will highly reduce their activity towards decomposition of organic residues including herbicides.

Nutrient availability

Mineral nutrients affect the overall growth and population of microorganisms. If there is readily available mineral nutrients (eg N, P and K) in soil or other easily decomposable organic sources for food and energy of microorganisms, herbicides may less preferred by microorganisms and there would be lower decomposition. Decomposition of herbicides is, therefore, dependent on mineral nutrient supply, available organic sources in soil and microorganisms preference for substrates.

Fielddissipation of thofumesate under different methods of application in sugar beet field

P. Janaki*, C. Chinnusamy, D. Radhika, N.K. Prabhakaran and K. Senthil

Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu 641003

**Email: janakiponnusamy2004@gmail.com*

Ethofumesate (2-ethoxy-3, 3-dimethyl-2, 3-dihydrobenzofuran-5-yl methanesulphonate) is a herbicide belonging to the benzofuranyl alkanesulfonate group. It is a selective, systemic herbicide and its persistence in soil is longer than the other herbicides used to control weeds in sugar beet crop (Rahman, 1978). Gardner and Branham, (2001) found that the half-life of ethofumesate in bare soil was 51 days and 3 days in turf grass. Ethofumesate is metabolized in plants to its 2-hydroxy derivative and to carbon dioxide finally (Roberts and Hutson, 1998) and this rapid metabolism is the basis for its selectivity in sugar beet. Though few reports on the degradation and adsorption of ethofumesate in soil under laboratory conditions were published, its dynamics under actual field conditions in tropical Indian conditions is yet to be studied; hence the present study was undertaken.

METHODOLOGY

Field experiment was conducted at the experimental farm of the Tamil Nadu Agricultural University, Coimbatore using sugar beet as a test crop during winter, 2008-09 (Var. Cauvery) in a randomized block design with three replications. Two different doses of ethofumesate 0.99 and 1.98 kg/ha were applied as one time and in three equal splits during 2, 4-6 and 8-10 leaf stage of weeds. Herbicide spraying was done with knap-sack sprayer using flat fan nozzle with the spray volume of 400 L/ha. Another three replicates of plot were sprayed with water alone and maintained as control. Soil samples were collected from all the treatments during 0, 1, 7, 15, 30, 45, 60 days after application of herbicides and subjected to reisdue analysis. Ethofumesate residue from sugar beet was extracted twice using a mixture of methanol and dichloromethane and were cleaned by solid phase extraction. The extracts were evaporated to dryness and the dry residue was re-dissolved in hexane and analyzed by GC-MS. A residue of ethofumesate was extracted from moistened soil with acetone. The extract was concentrated and residue was partitioned from aqueous phase with dichloromethane. Ethofumesate was analyzed by GC-MS of Varian Company, The Netherlands (Model-CP3800) equipped with Mass Spectrometer (Model Saturn 2000).

RESULTS

Rates of dissipation for ethofumesate in soil and plant were calculated and found to be first-order kinetics. There was a steady decrease in residue content and by 30th day the residues were 0.021 and 0.093 µg/g from two levels, respectively and the DT_{50} values calculated are 5.4 and 9.6 days (Table 1). It persists up to 60 days under high dose of application. There was a steady decrease in residue content in sugar beet plant and by 15th day the residues were 0.017 and 0.081 µg/g from two levels, respectively and the DT_{50} values calculated are 4.2 and 7.7 days. A similar pattern of dissipation was also observed in soil. The ethofumesate content went down below detectable limit under low dose of application whereas it persists up to 45 days under high dose of application. The DT_{50} values calculated are 5.1 and 5.4 days (Table 2). Similar to the soil, gradual decrease of residue in sugar beet plant was observed with time and by 15th day the residues were 0.009 and 0.031 µg/g from two levels, respectively. The DT_{50} values calculated are 2.3 and 2.9 days.

Table 1. Half life of ethofumesate in sugar beet plant and field soil under single time application

Dose	Regression equation	r^2	Half life (days)
Sugar beet plant			
T_1 = 0.99 kg/ha	y = 2.379-0.077x	0.987	4.20 days
T_2 = 1.98 kg/ha	y = 2.476-0.033x	0.988	7.70 days
Field soil			
T_1 = 0.99 kg/ha	y = 2.810-0.058x	0.976	5.39 days
T_2 = 1.98 kg/ha	y = 2.932-0.033x	0.997	9.67 days

Table 2. Half life of ethofumesate in sugar beet plant and field soil under split application

Dose	Regression equation	r2	Half life (days)
Sugar beet plant			
T_1 = 0.99 kg/ha	y = 2.358-0.071x	0.975	2.30 days
T_2 = 1.98 kg/ha	y = 2.140-0.141x	0.988	2.90 days
Field soil			
T_1 = 0.99 kg/ha	y = 2.486-0.032x	0.919	5.11 days
T_2 = 1.98 kg/ha	y = 2.353-0.084x	0.931	5.38 days

CONCLUSION

Quantity of application has influence on the persistence and dissipation of ethofumesate in soil and sugar beet plant.

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Leaf-cutin assisted phototransformation of 2,4-D ethyl ester

Partha P. Choudhury
Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004
Email: parthatinku@yahoo.com

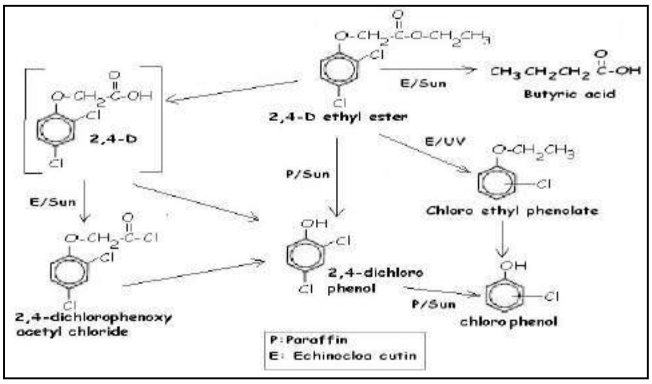
The importance of post emergence foliarly applied herbicides has been increased in the last decade with the availability of a greater number of post emergence herbicides. For these herbicides vegetation plays a key role determining their fates. After application, herbicides deposit on leaf surface. Leaf surface, made up of polymerised esters of higher fatty acids, is the first reaction environment for those herbicides. These fatty substances generate reactive radicals or ions in presence of sunlight. These radicals or ions may interact with herbicide molecules leading towards their degradation. That results in the loss of bioefficacy of herbicides and the formation of metabolites of unknown toxicity. An extensive study on the phototransformation of sulcotrione on maize leaf and on extracted maize cuticular wax revealed that cuticular wax may affect both phototransformation rates and photoproducts nature (Ter *et al.* 2006 2007). In this present study, the role of plant cuticular wax, extracted from rice and *Echinocloa*, in the photolysis of 2,4-D ethyl ester (2,4-D EE) was investigated.

METHODOLOGY

An experiment was conducted to study the rate kinetic and photoproduct formation from the exposure of 2,4-D EE on cutin surfaces under sunlight and UV-light. Epicuticular waxes were extracted from rice, and *Echinocloa colona* leaf surface by using chloroform as solvent. The yields of the purified cuticular wax (cutin) were 44 mg and 45 mg per 100 g of leaf of rice and *Echinocloa*, respectively. Thin cutin surfaces were prepared from extracted cuticular waxes on glass surface. Similarly, thin films of paraffin were also prepared on glass plates. By a standardised process the thin films of cutin and paraffin were coated with 2,4-D EE. These thin films were used for the rate kinetic study. The rate kinetic studies on the photolysis of 2,4-D EE on the thin films were carried out under UV-light and for metabolite formation study these were irradiated under sunlight. The irradiated samples of different time-intervals were extracted in chloroform, cleaned-up by silica gel-based column chromatography, dried, and diluted to required volume in hexane. For rate kinetic study, the samples of 2,4-D EE were analyzed by GLC method and of isoproturon by HPLC method. For structural elucidation, the purified products and products in extract were finally characterized by LC-MS/MS.

RESULTS

The half-life of 2,4-D EE on glass surface was around 26 min. It is generally considered that no influence is offered by glass surface in the photolysis of any organic molecule. Therefore, the transformation of 2,4-D EE on glass surface is due to direct photolysis of the compound. On rice cutin coated surface, the transformation of the herbicide is very slow as it is evident from its higher half-life (106 min) as compared to that on glass surface. It may be due to the quenching effect imparted by the cutin material or simply screening effect of it on the herbicide. But the cutin material extracted from *Echinocloa* does not have such effect. This difference in response imparted by cutins of two sources is probably due to the quantitative and qualitative difference of functional groups present within cutins. Photolysis of the herbicide on all the surfaces followed first-order rate kinetic with significant regression coefficients (R^2). The extracts after irradiation were analysed by LC-MS/MS and the structures of five different photoproducts were characterised by their respective spectra. The analysis of the extract from control sample of 2,4-D EE, which was kept in dark, did not show formation of any degraded product on cutin, paraffin or glass surfaces. But the herbicide exposed on these surfaces under sunlight underwent different types of photoreactions. The formation of the molecule 2,4-dichlophenoxyacetylchloride suggests that the chlorination of 2,4-D acid, an intermediate, took place during irradiation abstracting the chlorine atom released photolytically from another molecule of 2,4-D EE. Finally, chloride derivative was converted to 2,4-dichlorophenol. Photodechlorination was also a predominant reaction through which photoproducts, *viz.* chloroethyl phenolate and chlorophenol were formed. The most unique thing, which was not reported earlier, was the formation of butyric acid on *Echinocloa* cutin surface. This aliphatic acid was formed by a photorearrangement reaction of the radical.



CONCLUSION

Leaf surface has a role in altering the organic xenobiotic photochemically on its surface. The result of the present investigation shows the rate and extent of the degradation vary from plant to plant due to the difference in composition of leaf cutin present on the surfaces. This phenomenon of photolysis of herbicides on leaf surface may some times affect their bioefficacy.

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Evaluation of cyhalofop-butyl leaching in sandy loam soil under field conditions

Shobha Sondhia*
Directorate of Weed Science Research, Adhartal, Jabalpur, Madhya Pradesh 482 004
**Email: shobhasondia@yahoo.com*

High and repeated application may cause pesticide leaching, pose serious environmental problems, and harmful effects on non-target organisms. Cyhalofop-butyl is used as a post-emergence herbicide for control of grassy weeds, especially barnyard grasses (*Echnochloa* spp.) in rice. It acts by inhibition of acetyl CoA carboxylase (ACCase) in susceptible plant cells. High precipitation or irrigation causes pesticide leaching and enhances the risk of groundwater contamination. Therefore, a study was conducted to evaluate cyhalofop-p-butyl (butyl (R)-2-[4-cyano-2-fluorophenoxy) phenoxy]) propanoate is an aryloxyphenoxy propionate) mobility in a sandy loam soil and following distribution of residues at various depths under field conditions.

METHODOLOGY

Study was conducted in sandy laom soil in lysemeters of two meter depths receiving natural rains. Cyhalofop-p-butyl was applied at field rates equivalent to 90 (T_1) and 180 (T_2) g/ha. Soil samples at 3, to 90 days were taken from 0-150 cm depths. Soil samples and leachates were analyzed by HPLC consisting of an LC-10 Atvp pump and a photo diode array (PDA) detector and a Phenomenex C18 (ODS) column of 25 cm length x 4.6 mm id using mobile phase acetonitrile: water (70:30) at flow rate of 1 mL/min. Characterization of transformation products of cyhalofop-p-butyl in soil and leachates was done by LC-MS/MS.

RESULTS

After 3 d of application, 0.049 µg/g cyhalofop-butyl was found in the upper depth (0-25 cm) of lysemeter. Further 0.0043, 0.0019, 0.014 and 0.0013 µg/g cyhalofop-p-butyl leached to 0-25, 25-50, 50-75 and 75-100 cm depths, respectively, after three days. After 10 d of experiment, precipitation resulted in a movement of 0.0071, 0.0017, 0.0010 µg/g of cyhalofop-butyl residues at upper, 0-25, and 25-50, cm depths, respectively. After 20 d cyhalofop-p-butyl residues were found <0.001 µg/g at various depths (Table 1). Sondhia, (2008, 2013) reported that leaching of herbicides in soils was governed largely by the amount of rainfall and soil type. Three metabolites namely 2-[4-(4-fluoro-4-cyanophenoxy) phenol propanoic acid, 2-[4-(2-fluoro-4-cyanophenoxy) phenol, and 2-[4-(2-fluoro-4-cyanophenoxy) phenoxypropanoic acid, were identified at various depths from soil by LC/MS/MS. Precipitation caused substantial mobility of cyhalofop-butyl in the soil and 1.1 to 7.6 µg/L^1 of cyhalofop-butyl was found in leachates.

Table 1. Residue of cyhalofop-butyl at various depths

Treatment	Days after application			
	3	5	10	20
90.0 g/ha	0.0073	0.0024	0.0033	<0.001
180.0 g/ha	0.0124	0.0025	0.0031	<0.001
Control	<0.001	<0.001	<0.001	<0.001
LSD (TxT)	0.0076	0.0005	0.00092	
Depth (cm)				
Upper	0.0049	0.0084	0.0071	<0.001
0-25	0.0043	0.0031	0.0017	<0.001
25-50	0.0020	0.0020	0.0010	<0.001
50-75	0.0014	BDL	BDL	<0.001
75-100	0.0013	<0.001	<0.001	<0.001
100-125	<0.001	<0.001	<0.001	<0.001
125-150	<0.001	<0.001	<0.001	<0.001
LSD (D*D)	0.0013	0.0011	0.0001	
LSD (TxD) at 5%	0.0018	0.0011	0.0015	

CONCLUSION

Precipitation caused leaching of cyhalofop-p-butyl and its major metabolites. Cyhalofop-p-butyl could be considered as a moderate leaching herbicide by comparing results of this study with previous leaching studies of herbicides commonly used in rice.

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Microbiological assessment of degradation of different herbicides applied to *Kharif*- rice field

Tapas Chowdhury[1]*, A.P. Singh[1] and [1]S.B. Gupta

[1]Department of Agricultural Microbiology and [2]Agronomy, College of Agriculture, IGKV, Raipur, Chhattisgarh 492 012
**E-mail: tapas_mb@rediffmail.com*

Herbicides have created two major problems initially by persisting and accumulating in the environment and contaminating numerous plants and animals and secondly they affect human health directly or indirectly. Most herbicides such as simazine, atrazine, glyphosate, thoibencarb, allachlor *etc.* have been extensively used for control of weeds worldwide. Most of the organic pollutants are herbicides (Dorigo *et al*. 2007), which are used not only in agriculture but also for many other purposes. However, the application of several chemicals may lead to synergy and development of toxic effects hazardous for humans, animals and microbes. Microbial action is a major mode of decomposition of herbicides in soils. Many new post and pre emergence herbicides including Oxadiargyl and Bispyribac are recently been introduced in our country but their fate and persistence in soil are almost unknown. These herbicides are used in different combinations for weed control by farmers. In this experiment different herbicidal combinations were compared with respect to their ultimate effect on soil microflora.

METHODOLOGY

A field study was conducted during *Kharif*, 2012 in Instructional cum Research Farm, IGKV, Raipur, to evaluate the degradability of different herbicides in terms of microbial and biochemical characteristics of rhizosphere soil comparing with hand weeded herbicide free condition. Six different herbicides (oxadiargyl as pre-emergence *fb* bispyribac as post-emergence herbicides 80.00 gm and 20.00 gm/ha, respectively; pyrazosulfuron applied at early post-emergence stage (8 DAS) 25 gm/ha and tank mixed combination of fenoxaprop and chlorimuron-ethyl **+** metsulfuron-methyl applied at post-emergence stage 60.00 gm and 25.00 gm/ha, respectively) were tested for their environmental suitability compared with hand weeding practice. The experiment was conducted on *Kharif* rice (O*ryza stativa* L.) with test variety MTU-1010. The soil was Inceptisol (pH : 6.73, EC : 0.13 dS/m, organic carbon : 0.45%, available N: 157 kg/ha, available P: 12.03 kg/ha and available K : 198 kg/ha).The treatments were replicated thrice under randomized block design. Rhizosphere soil was collected at a depth of 7.5-15 cm from six locations at different stages of crop growth from the same plot & pooled together for the purpose of analysis.

RESULTS

The results of the investigation revealed that at the time of sowing (0 DAS) all of the weed management practices were found in-significant to alter the microbial environment but after application of different pre- and post-emergence herbicides in single and combined form the above soil properties were affected at different levels. At 30 DAS all the applied herbicides *i.e.* oxadiargyl *fb* bispyribac, pyrazosulfuron and fenoxaprop + chlorimuron ethyl + metsulfuron methyl significantly reduced basal soil respiration rate (BSR), dehydrogenase enzyme activity (DHA) (Table 1), acid phosphatase activity (AP), microbial biomass carbon content (MBC) and population of nitrogen fixers and phosphate solubilizers in soil. In this stage of crop growth maximum inhibitory effect on soil microflora was visualized due to application of oxadiargyl and bispyribac, which were applied at pre and post emergence stages of crop, respectively. This indicated that pyrazosulfuron degraded before 50 DAS of crop.

Table 1. Effect of long term herbicidal trial in direct seeded rice-chickpea cropping system on basal soil respiration rate (mgCO_2/h/100g soil) and Dehyrogenase activity (µg TPF/h/g soil) in rhizosphere soil of rice.

Treatment	Days after sowing							
	0		30		50		At harvest	
	BSR	DHA	BSR	DHA	BSR	DHA	BSR	DHA
Oxadiargyl 80 g/ha *fb* Bispyribac 25 gha	0.294	27.25	0.192	11.02	0.148	7.57	0.162	20.78
Pyrazosulfuron 25 g/ha	0.298	29.13	0.251	22.79	0.406	75.60	0.201	28.92
Fenoxaprop 60 g/ha + CME+ MSM 4 g/ha	0.291	26.85	0.263	28.61	0.161	18.49	0.150	16.92
Hand weeding twice	0.300	29.84	0.364	56.11	0.435	81.41	0.209	31.36
Un weeded control	0.302	30.02	0.372	58.34	0.450	84.37	0.215	32.86
LDD (P=0.05)	NS	NS	0.024	3.50	0.033	5.90	0.017	2.51

CONCLUSION

Maximum inhibitory effect of fenoxaprop + chlorimuron-ethyl + metsulfuron methyl was found in comparison to other applied herbicides as they continuously reduced the microbial activities in rhizosphere after their application. Pyrazosulfuron was found rather safe to others *wrt* to its effect on soil microbes as it completely degraded before 50DAS. The hand weeding practice and weedy check had positive effect to enhance the microbial population and their activities in soil in the entire growth period of crop.

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Weed management studies in soybean with special reference to dodder

H.H. Dikey*, S.P. Patil, M.S. Dandge and R.S. Wankhade
Regional Research Centre, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Amravati, Maharashtra
**Email: hhdikey@rediffmail.com*

Under the present scenario parasitic weed dodder (*Cuscuta* spp.) is emerging as a major weed in soybean fields. Its presence in soybean field is reported from many places in Amravati district of Maharashtra state. Since it is difficult to control by manual methods, farmers are facing problem to control the *Cuscuta* spp. Chemical method of weed control and particularly integration of such method with cultural practices have assumed greater importance. Recently imazethapyr and quizalofop-ethyl as selective early post-emergence herbicides has been developed for control of grassy and broad leaf weeds in soybean crop. The study is conducted to evaluate the effect of imazethapyr and quizalofop-ethyl to control the newly emerging parasitic weed *Cuscuta* spp. in soybean crop.

METHODOLOGY

The present investigation comprised of nine treatments (Table 1), each of which replicated thrice and applied in randomized block design during *Kharif* 2013 at Regional Research Centre, PDKV, Amravati and observations were recorded on five plants from each replication. The result obtained is presented as under

RESULTS

The experimental results revealed that *Cuscuta* free plot exhibited highest significant plant height and numder of pods per plant *i.e.* 50.70 cm and 30.8, respectively over all other treatment except quizalofop-ethyl 3 ml/l treatment (48.30 cm and 27.8 cm, respectively) which is at par with each other. Minimum *Cuscuta* intensity was observed in imazethapyr 2 ml/l + quizalofop-ethyl 2 ml/l (39.4%) followed by imazethapyr 4 ml/l (41.8%) and imazethapyr 3 ml/lit (44.1%). *Cuscuta* dry weight was significantly reduced in treatment quizalofop-ethyl 3 ml/l as compared to control and other treatments (Table 1). *Cuscuta* free plot treatment recorded highest significant soybean grain yield *i.e.* 1.74 t/ha

Table 1. Yield, yield attributes of Soybean and *Cuscuta* dry matter accumulation as influenced by various treatments

Treatment	Plant Height (cm)	No. of pods /plant	No. of soybean plants / plot	No. of plants affected by *Cuscuta*	*Cuscuta* intensity (%)	Dry wt. of *Cuscuta*/ plot (g/m^2)	Grain yield (t/ha)
Cuscuta free	50.7	30.8	37.0	0.0	0.0	0.0	1.74
Cuscuta infestation as it is (Control)	35.9	14.8	32.3	23.0	71.2	13.7	0.85
Imazethapyr 2 ml/l	36.3	18.2	39.0	20.3	52.2	10.5	1.20
Imazethapyr 3 ml/l	38.8	21.8	37.6	16.6	44.1	10.1	1.13
imazethapyr 4 ml/l	44.8	21.7	37.3	15.6	41.8	10.0	1.11
Quizalofop-ethyl 2 ml/l	44.9	23.5	38.3	17.3	45.1	9.5	1.28
Quizalofop-ethyl 3 ml/l	48.3	27.8	36.0	18.3	50.8	7.6	1.44
Quizalofop-ethyl 4 ml/l	36.0	23.9	38.6	17.6	45.5	9.8	1.20
Imazethapyr 2 ml/l + quizalofop-ethyl 2 ml/l	35.3	21.9	38.0	15.0	39.4	97	1.11
LSD (P=0.05)	5.7	4.4	-	4.3	-	1.3	0.2

Downward movement of atrazine in different soils using bioassay

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B. T. Sheta
DWSR Anand Centre, B. A. College of Agriculture,
Anand Agricultural University, Anand-388110 (Gujarat)
E-mail : btsheta@yahoo.co.in

Downward movement of atrazine was studied in laboratory at DWSR Centre, AAU, Anand during 2010-11 in *Rabi* Season in laboratory. Clayey soil was collected from Vadodara district while Sandy loam soil was collected from the field of DWSR Anand-Centre. Polyvinyl chloride (PVC) columns (100 mm internal diameter and 60cm long) were cut vertically into two pieces and joined together using adhesive tape. Muslin cloth was tide to one end of column to hold the soil. Six columns were filled with different soils from bottom by gently taping the columns. Water was added from the top to pre condition the soil. atrazine was applied at the recommended dose (1.00 kg/ha) and double the recommended dose (2.00 kg/ha). A set of column was used without herbicide (control) for comparison of two types of soils. After 15 days of the treatments, columns were cut and open. Presence of herbicide in the soils at different depth was tested by bioassay technique. Cucumber (*Cucumis sativus*) 10 seeds were sown in each column. Germination of cucumber was recorded periodically. Movement of atrazine applied at 1.0 and 2.0 kg/ha in sandy loam soil restricted germination of cucumber up to 10 cm soil depth. While in clayey soil, it was slightly influenced by residues of atrazine up to 5 cm in both the levels of herbicide application at 7 days after sowing (DAS). From 10 to 60 cm soil depth, movement of atrazine was not observed and germination of cucumber was not restricted in both the soils. It was observed slightly increasing trend up to 15 DAS. Overall it was observed that atrazine movement in sandy loam soil showed more as compared to clayey soil. The clay content is an important factor that influenced downward movement of herbicides in soil.

Invasive weeds of India and their management

M.S. Dinesha*, Sadhana R. Babar and M.R. Yogesh
Department of Agronomy, UAS, Bangalore, Karnataka 560 065
**Email: dineshagron@gmail.com*

Alien species are recognized as the second largest threat to biological diversity the first being habitat destruction. Weeds due to their inherent properties of efficient nutrient uptake and use efficiency easily invade new habitats and adversely affect the ecosystem and pose a serious challenge to sustainable management of forests and agricultural ecosystems and conservation of biodiversity. Some of the most important invasive weeds in India are *Parthenium hysterophorus*, *Chromolaena odorata*, *Lantana camara*, *Eichhornia crassipes*, *Salvinia molesta*, *Ipomoea carnea*, *Phalaris minor*, *Orobanche spp. Cuscuta spp.* and *Striga* spp.

Littleseed canary grass (*Phalaris minor*) is a most serious winter annual grass weed. Management of *Phalaris minor* in wheat can be done by using improved variety and certified seed, close spacing & higher seed rate, proper time of sowing, crop rotation, residue management, zero tillage, furrow irrigated raised beds system (FIRBS), herbicides-alternate herbicides, herbicide mixtures. Bhan and Singh (1993) reported that for reduction of *Phalaris* infestation, the replacement of wheat by some other crops will be more useful than replacing rice from the rice-wheat cropping system.

Broomrape- (*Orobanche* spp.) is commonly known as broomrape, is a flowering plant that parasitizes the root of many economically important crops. The tip of the radicle enlarges as soon as it attaches to the host root and forms a "haustorium" and it penetrates to host root by enzymatic degradation. Management includes application of neem cake 200 kg/ha (rows) in tobacco, spraying of glyphosate 0.1% (directed application) in tobacco – 55 DAP, neem cake 200 kg/ha (rows) + pendimethalin 0.5 kg/ha pre-emergence in Brinjal, soil solarisation for 30 -40 days lower emergence of Orobanche by 50 - 60%.

Striga- (Witch weed) is a annual partial root parasitic herb, propagation through seeds, germination by a stimulus from host root exudates. Striga has ability of to produce a tremendous number of seeds, which can remain viable in the soil for more than 10 years, and their intimate physiological interaction with their host plants, are the main difficulties that limit the development of successful control measures that are acceptable to subsistence farmers.

Parthenium hysterophorus - It is an erect-branched annual that can grow and flower throughout the year in subtropical environments. Control options for Parthenium are limited in non-crop land. One of the best means is biological control. Sushilkumar and Puja Ray (2011) found that augmentation of *Z. bicolorata* caused substantial damage to the parthenium stand at all release sites.

Lantana camara L. is a perennial erect shrub/ straggling shrub, strongly odorous, 2-5 m tall with profuse branches. Reproduction as obligate outcrosser, pollinated by butterflies. Management by removal of adult clumps using cut root stock method, weeding out of seedlings/young plantlets of lantana, ecological restoration of weed-free landscapes are effective.

Chromolaena odorata L. - is a serious weed of pastures, forests, orchards and commercial plantations in south and north-east India. Manual weeding (hand cutting) alone was not effective in controlling growth and re-sprouting of *Chromolaena*. In effect, there was a significant increase in height of the weed and its re-sprouting ability after cutting. However, herbicidal treatment after manual weeding, irrespective of concentration of herbicides, resulted in significant reduction in plant height and basal bud sprouting compared to controls.

Ipomoea Carnea Jacq (Convolvulaceae) is native of South America, grows in dense populations along river beds, banks, canals and other waterlogged (wetland) areas. Chaudhuri *et al.* (1994) mentioned that manual control measures by cutting and digging of stems, though commonly undertaken, are costly and ineffective. Any remaining stems and seeds that are in the soil easily and rapidly re-infest the cleared areas.

CONCLUSION

Invasive weeds can cause serious problem to crops by reducing yield. Effective management practices such as crop rotation, selection of clean certified seeds for sowing, use of herbicide mixtures for praying and use of insects or pathogens in controlling the weeds.

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Effect of Mexican beetle on growth and defoliation of *Parthenium* weed

M.G. Patil, A.S. Jadhav and A.K. Gore

Vasantrao Naik Marathwada krishi Vidyapeeth, Parbhani, Maharashtra 431 401

Email: Minakshipatil013@gmail.com

Parthenium hysterophorus Linneaus is one of the worst species in the world. It is popularly known in India as 'White top' 'Star weed', 'Carrot weed', 'Gajar grass', 'Ranphol', 'fever few'. The origin of *Parthenium* is considered to be in Mexico, America, Trinidad and Argentina. Within last 100 years it has spread to Africa, Australia and Asia. It was first observed in India by the East India Company at Calcutta. Crop production, animal husbandry and biodiversity seriously influenced due to *Parthenium*. Ever since in India efforts are being made to manage the weed by a number of methods such as mechanical, legal, biological and chemical. The Mexican beetle, *Zygogramma biocolorata*, was introduced in 1984 after host specifically tests for controlling *Parthenium* in India (Jayanth and Nagarkatti 1987, Dhileepan 2003, Jayanth and Bali 2004).

METHODOLOGY

Effect on damage by the introduced biocontrol insect *Zygogramma bicolorata* pallister (Coleoptera: Chrysomelidae) on the annual Asteraceae weed *Parthenium hysterophorus* were studied in field of DWSR centre at Vasantrao Naik Marathwada Agricultural University, Parbhani. The biological agent i.e. Mexican beetle was received from the NRC, Jabalpur (M.P). Two separate locations were selected for the release of the insect in *Parthenium* affected sites. The insect were released on the two sites as 10 pairs of beetle in 5 square meter area for each site and the effectiveness of the beetle was ascertained with regard to it's management. The *Parthenium* infested experimental sites were visited regularly. Beetles were released during *Kharif* season on 20 June, 2010and 27 June, 2011and per cent damage was recorded. Observations on number of eggs, larvae and adult beetles per plant were made at monthly intervals.

RESULTS

Above table indicate that the activity of beetles increased at both the sites from July beginning with increase in mating and laying of eggs during July to September. There was better multiplication of beetles during September, October and November months *(Rabi* season.) From mid-November the beetles started evading from the infested blocks and sites. Maximum population of Larvae was seen during August and September. The beetles were not seen during October to the beginning of November. The larval and beetle population per *Parthenium* plant was more during July to September at both the site. After a month of release there were 8-10 Eggs/plant, 1-8 Larvae/plant and 5-15 Adults/plants at both sites. *Parthenium* damage was in the range of 70-85% and 58-80% during observed months with an average damage of 74.8% and 69.2%. However, with higher *Parthenium* damage was recorded during September in both the side during *Kharif 2010*. During *Kharif* 2011, 8 eggs/plant, 1-6 larvae/plant and 10 adults /plants with *Parthenium* damage in the range of 40-75 % was recorded in both the Site which was slightly lower as compared to *Parthenium* damage during *Kharif* 2010 it may be due to receiving less rainfall during *Kharif* 2011.

Table 1. Egg, Larvae and Adult population of Mexican beetles per plant and per cent damage to Parthenium at two sites Year - 2010

	Site – 1				Site – 2			
	Egg	Larvae	Adult	Damage %	Egg	Larvae	Adult	Damage %
July	8	6	5	70	6	7	8	68
August	10	8	10	80	20	8	16	75
September	08	5	15	85	8	4	15	80
October	-	1	8	71	1	2	7	65
November	-	-	5	68	-	-	6	58
Year – 2011								
July	6	4	3	55	4	4	2	48
August	8	6	8	70	8	3	7	60
September	7	3	10	75	6	6	8	65
October	1	1	4	60	2	1	4	60
November	-	-	3	40	-	1	2	45

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Efficacy of halosulfuron-methyl on weed flora and yield of autumn planted sugarcane

Vijay Shankar[1], T.N.Thorat[2]*, Vinod Kumar[2], M.K.Tarwariya[3] and Jai Dev Sharma[3]

[1] *Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh 224 229*

[2] *Jawaharlal Nehru Krishi VIshwavidyalaya, College of Agriculture, Jabalpur, Madhya Pradesh 482 004.*

[3] *Jawaharlal Nehru Krishi VIshwavidyalaya, College of Agriculture, Rewa, Madhya Pradesh 486006*

**Email: tnt161975@gmail.com*

Sugarcane (*Saccharum officinarum* L.) is grown extensively in tropical and sub- tropical regions of India as cash crop and plays a pivotal role in both agricultural and industrial economy of the country. In India, sugar-cane is grown under different agro-climatic conditions and occupies about 2.54% (5.08 m ha) of gross cropped area with an average productivity of 68.4 t/ha. Its productivity in India is lower as compared to many other sugarcane growing countries of the world. Among the factors responsible for low productivity, negligence towards weed management is one of the most important factors as reduction in cane yield. Sugarcane crop faces tough competition with weeds between 60 to 120 days of its planting which causes heavy reduction in cane yield ranging from 40-67% (Chauhan and Srivastava 2002). Among the different factors responsible for low yield of sugarcane, invasion of different type of weeds especially perennial weeds played a very important role. Among the perennial weeds *Cyperus rotundus* posed a very serious problem as its nature of survival and propagation, it is known as worst weed in the world. For solving this problem a new herbicide molecule (halosulfuron-methyl) has been developed and reported to control the *Cyperus rotundus* as applied at 2-3 leaf stage. Considering this fact in view, the present investigation was undertaken.

METHODOLOGY

A field experiment was carried out during autumn season of 2010-11 at Agronomy Research Farm of Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad, Uttar Pradesh to test the efficacy of halosulfuron-methyl (Shempra 75 WG) against weeds. Ten treatments consisting of halosulfuron-methyl at varying doses along with different herbicides (2,4-D, atrazine, metribuzin) and hand hoeing were arranged in a randomised block design with three replications. Sugarcane variety '*Co-92269*' was planted at 75 cm apart in the experimental field with recommended package of practices. Data on weed growth, yield performance and economics were recorded.

Table 1. Weed growth, WCE (%), yield, quality and economics of sugarcane as influenced by different weed control measures

Treatment	Weed dry matter (g/m²)	Weed control efficiency (%) (60 DAS)	Cane yield (t/ha)	Juice extraction (%)	Brix value (%)	Cost of cultivation (x10³₹/ha)	Net returns (x10³₹/ha)	B:C ratio
Halosulfuron 70 g/ha	4.99 (24.4)*	76.0	47.6	51.7	17.3	48.36	102.29	2.11
Halosulfuron 80 g/ha	4.61 (20.8)	77.1	49.0	51.8	17.5	48.53	105.57	2.17
Halosulfuron 90 g/ha	4.52 (20.0)	79.8	56.8	52.9	18.3	48.70	125.87	2.58
Halosulfuron 100 g/ha	3.59 (12.4)	81.8	56.9	53.1	18.6	48.86	125.84	2.57
Halosulfuron 200 g/ha	3.24 (10.3)	86.3	57.6	55.1	19.5	50.53	124.94	2.47
2,4-D 3750 g/ha	2.43 (70.7)	72.0	47.8	52.3	17.4	48.74	102.43	2.10
Atrazine 250 g /ha	6.82 (46.0)	60.3	49.8	52.5	18.0	48.32	107.90	2.23
Metribuzin 750g/ha	5.99 (36.1)	62.5	48.5	53.2	17.8	48.75	104.06	2.13
Hand hoeing (30, 60 and 90 DAP)	2.96 (8.3)	72.3	63.8	55.7	19.9	71.20	121.73	1.70
Weedy check	12.80 (163.4)	-	31.3	49.5	16.4	47.00	60.19	1.28
LSD (P= 0.05)	1.53	-	7.78	NS	1.96	-	-	-

*Values in parentheses are original. Data transformed to square root transformation, DAS- Days after spraying of herbicide, NS- Not significant

RESULTS

The sugarcane crop was infested mainly with 10 weed species during the course of experimentation. Out of which *Chenopodium album, Melilotus alba, Anagallis arvensis, Commelina benghalensis* and *Ageratum conyzoides* among the broad leaf weeds and *Cyperus rotundus* of sedges group while *Cynodon dactylon*, *Phalaris minor* and *Dactyloctenium aegyptium* were the grassy weeds. As far as the total weed density was concerned the weed density was increased from 30 DAP (107.6/m²) to 60 DAP (235.75/m²) afterward a declining trend was observed up to harvest stage of the crop. Herbicidal treatments significantly influenced the population and dry matter production of weeds. Among the herbicidal treatments, the lowest weed density (20.1/m²) was observed at harvest under halosulfuron-methyl 200 g/ha, *fb* 100 (22.8/m²) and 90 (25.9/m²) g/ha (Table 1). The minimum weed dry weight was also recorded in these treatments, which was significantly lower than all other treatments.

CONCLUSION

It was concluded that post-emergence application of halosulfuron-methyl at 90-100 g/ha was most effective for controlling weeds, improving cane yield and profitability of autumn planted sugarcane.

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Utilization of *Parthenium* as vermicompost for integrated nutrient management of potato – sesame cropping system in lateritic soils

B.C. Sarkar, B. Duary* and G.N. Chattopadhyay

Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal

**Email: bduary@yahoo.co.in*

Appreciable quantity of nutrients in *Parthenium* can be utilized to nourish the crops after vermicomposting by which lot of green *Parthenium* can be controlled in one hand and on the other hand huge *Parthenium* biomass can be recycled for the production of vermicompost which can increase the productivity of our crop land as recycling is now being considered as an effective means of controlling this weed. Integrated use of *Parthenium* in soil modifies the physico-chemical, biological and nutritional quality of the soil and the high concentration of elements in composted *Parthenium* increase the yield of different agricultural crops (Kishor *et al.*, 2010). Potato – sesame cropping system requires huge quantity of nutrients. Utilization of *Parthenium (P. hysterophorus L.*) vermicompost as integrated nutrient management may be one of the viable options for efficient and judicious use of plant nutrients in the form of organic manure of *Parthenium* biomass to get maximum benefits. With this perspective the present investigation was conducted to assess the effect of vermicomposted *Parthenium* under integrated nutrient management of potato–sesame cropping system.

METHODOLOGY

The field experiment was conducted in Agricultural Farm of the Institute of Agriculture, Visva-Bharati, Sriniketan during *rabi* and summer seasons of 2007-08 and 2008-09. Vermicompost (VC) was prepared from three stages of *Parthenium, viz.* pre-flowering, flowering and matured with three ratios of 3:1, 1:1 and 1:3 *Parthenium*:cowdung (fresh wt. basis) from each stage thus making 9 combinations. The field experiment was carried out with eleven treatments comprising of integrated use of 75% recommended dose of NPK (RDF) of potato with vermicompost at 5 t /ha prepared from above 9 combinations along with one non-*Parthenium* vermicompost and one RDF only. The experiment was laid out in randomized block design with 10 treatments and 3 replications. Sesame was grown as residual crop after potato without any application of fertilizer.

RESULTS

The experimental results revealed that the highest plant height, leaf area index, leaf area duration, dry matter accumulation, crop growth rate, tuber bulking rate, tuber growth rate, number of tubers per plant and total tuber yield were recorded with the integrated application of 75% RDF + vermicompost prepared from flowering *Parthenium* and cow dung in 1:3 ratio at 5 t/ha during both the years. However, in most of the cases the results were statistically at par with that of 75% RDF + vermicompost prepared from pre-flowering *Parthenium* and cow dung in 1:3 ratio at 5 t/ha. The gross return, net return and return per rupee invested were also higher in these treatments. Vermicomposted *Parthenium* used under integrated nutrient management in potato exerted significant residual effects on improving almost all the growth as well as yield attributes and seed yield (Table 1) of succeeding sesame crop under this study and also gave the highest gross return, net return and return per rupee invested. However, this treatment was comparable with that of 75% recommended dose of NPK + vermicompost prepared from preflowering *Parthenium* and cow dung in 1:3 ratio at 5 t/ha and 75% RDF + vermicompost prepared from flowering *Parthenium* and cow dung in 1:1 ratio at 5 t/ha in most of the cases. No regeneration of *Parthenium* occurred where vermicompost was prepared from pre-flowering and flowering stages. However, little regeneration was observed with vermicompost prepared from matured stage.

Table 1. Number of tubers and tuber yield of potato, seed yield of sesame and system net return and return per rupee invested under different treatments (pooled)

Treatment	No. of tubers/plant	Tuber yield (t/ha)	Sesame seed yield (t/ha)	System net return ($x10^3$₹/ha)	System return/rupee invested
(75% RDF + VC_1 at 5 t/ha)	4.58	24.44	0.85	81.92	2.23
(75% RDF + VC_2 at 5 t/ha)	4.89	24.26	0.97	82.24	2.19
(75% RDF + VC_3 at 5 t/ha)	5.71	26.43	1.10	94.60	2.32
(75% RDF + VC_4 at 5 t/ha)	4.68	25.23	0.96	88.66	2.32
(75% RDF + VC_5 at 5 t/ha)	5.11	26.10	1.04	92.96	2.34
(75% RDF + VC_6 at 5 t/ha)	6.39	27.95	1.18	104.0	2.44
(75% RDF + VC_7 at 5 t/ha)	4.92	23.87	0.96	81.75	2.21
(75% RDF + VC_8 at 5 t/ha)	5.50	25.28	1.06	89.68	2.29
(75% RDF + VC_9 at 5 t/ha)	5.59	24.79	0.97	83.11	2.17
(75% RDF + VC_{10} at 5 t/ha)	4.71	24.38	0.86	78.26	2.11
(100% RDF)	4.72	23.87	0.72	77.66	2.21
LSD (P=0.05)	0.72	1.57	0.11	-	-

CONCLUSION

Vermicompost prepared from pre-flowering *Parthenium* at 1:3 or flowering *Parthenium* 1:1 with cow dung at 5 t/ha along with 75% of recommended NPK may be advocated for higher productivity, profitability and residual soil fertility under potato-sesame cropping system.

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Rapid decomposition of germination stimulants prior to their action- a new concept for management of parasitic weeds

Chinnaswamy Kannan and Binne Zwanenburg[1]

Directorate of Weed Science Research, Jabalpur, Madhya Pradesh 482 004

[1]Prof. Emeritus, Synthetic Organic Chemistry, IMM, Radboud University, Nijmegen, The Netherlands

**Email: agrikannan@gmail.com*

Parasitic weeds especially *Striga* spp. and *Orobanche* spp. are increasingly becoming a threat to agricultural food production in many countries. Seeds of these parasites remain viable in the soil for about twenty years and germinate only in the presence of a host plant. The first germination stimulant was isolated from root exudates of cotton (a non-host plant) by Cook et al. (1966) and later several artificial analogues like GR24, Nijmegen 1 were synthesized (Zwanenburg *et al.* 2009). Application of germination stimulants in the soil before sowing/planting the host crop, results in the germination and death of the parasitic weed seeds, called as "suicidal germination approach". However the limited stability of germination stimulants, attributed to several soil factors, mainly the soil pH, would preclude their use in the suicidal germination approach. This study aims at rapid decomposition of the germination stimulants released by the host roots in soil before they reach the parasitic weed seeds in order to suppress their germination.

METHEDOLOGY

The synthetic germination stimulants were treated with the chemical compounds and the initial screening was done with thin layer chromatography. UV spectra and GLC were used for measuring the kinetics of degradation of the stimulants. The $t_{1/2}$ values of the stimulants at various pH were determined by plotting the concentration vs. time.

RESULTS

The results indicated that the half-life of the stimulants at basic pH (pH-8.0) was less than 5 hours for GR24, Nijmegen 1 and coumarine derivative, while the tetralone derivative was more stable and had at $_{1/2}$ of 20 hours at pH-8.0. Nijmegen 1 was found to be less stable when compared to GR24. The decomposition of stimulants was studied with aqueous alkaline solutions among which borax ($Na_2B_4O_7$) and thiourea ($SC(NH_2)_2$) were found to be more appropriate at various concentrations. The ratio of stimulant and borax/thiourea concentration was varied and the fastest clearance of the stimulant was observed using the ratio of stimulant and borax/thiourea of 1:100. Complete disappearance of the stimulants at various concentrations of different agents as studied by TLC is given in Table 1.

Table 1. Time (in h) required for complete disappearance of SL stimulants (concentration 5 mM) when treated with aqueous alkaline solutions

Stimulants	Borax (mM)				Thiourea (mM)			
	5	25	50	100	5	25	50	100
Nijmegen 1	>24	>24	4.0	0.5	>24	>24	4.0	2.0
GR24	>24	>24	5.5	1.0	>24	>24	6.0	2.5

CONCLUSIONS

In conclusion, we developed a novel concept for the control of parasitic weeds by decomposing the germination stimulant prior to action. For this, we identified two attractive agents, namely aqueous solutions of borax and thiourea in aqueous solution at concentrations of 10^{-3}M, respectively. Currently, in vivo studies of including field applications are under investigation at DWSR, India.

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Effect of native fungi on *Orobanche* in tomato

Aditi Pathak and C Kannan*

*Rani Durgawati University, Jabalpur and *Directorate of Weed Science Research, Jabalpur 482 004*

**Email: agrikannan@gmail.com*

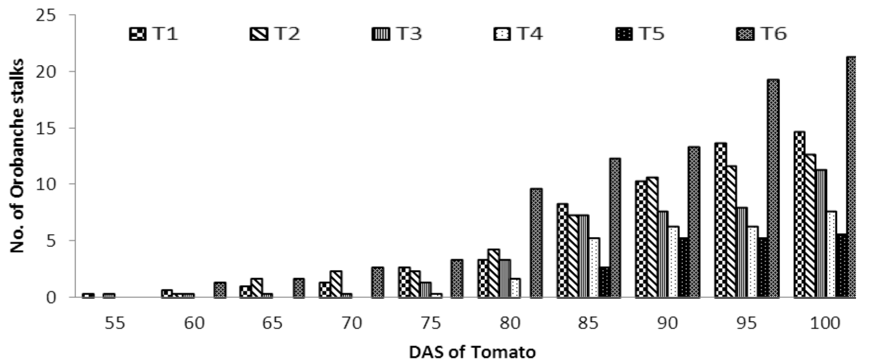
Orobanche, commonly called as broomrape, is a total root parasitic flowering plant, considered a major weedthat causes severe damage to many economic crops worldwide. In India, it is a major production constraint in mustard, tobacco, tomato and brinjal. Depending upon the intensity of infection, stage of the host crop and maintenance of the field, yield loss ranges from 20 to 80% and in some cases a total failure (Shekhawat *et al*. 2012). Therefore appropriate management practices applied in right time would help in reducing the incidence of this dreaded weed and increase the crop yield.

METHODOLOGY

The fungal antagonists were isolated during 2010-11from the native rhizosphere of tomato infested with *O. crenata*from the farmers' fields near Gwalior and Jabalpur. The fungi were grown in potato dextrose (PD) broth for 15 days and spore suspension was prepared using the entire broth solution. Concentration of the spore suspension was maintained at about 25 x 10^3 cfu/ml. Pot experiments were conducted in containment chamber during 2011-12 and the fungi were applied as seed treatmentsfollowed by foliar spray at 30 and 60 DAS on tomato (var. Pusa Ruby) with 3 replications per treatment.Observations on the emergence of *O. crenata* stalks, number of stalk per pots and growth of the plants were recorded (data not shown).

RESULTS

Results indicated that application of *P. Oxalicum* and *Fusarium* sp. as seed treatment followed by foliar application caused a delay of 30 days in the emergence of *O. crenata* stalk in tomato when compared to the control (Fig. 1). First emergence of *O. crenata* was observed in 55DAS of tomato.



T1.-Seed treatment with *T. viride* 4 g/kg fb foliar spray at 30 and 60 DAS, T2- Seed treatment with salicylic acid 0.01M fb foliar spray at 30 and 60 DAS, T3- Seed treatment with *Gliocladium virens* 4g/kg *fb* foliar spray at 30 and 60 DAS, T4 -Seed treatment with *Fusarium* sp. 4 g/kg *fb* foliar spray at 30 and 60 DAS, T5- Seed treatment with *P.oxalicum* 4 g/kg fb foliar spray at 30 and 60 DAS, T6- Tomato and *O. crenata*

Fig.1. Effect of microbial treatments on the emergence of the flowering stalks of *O. crenata* in tomato

The delay in the development of *Orobanche* would be due to the suppression of germination of *O.crenata* seeds in soil. The fungi when applied as seed treatment was able to reduce the produce a film of mycelial growth on the initial roots of tomato which might alter the volatiles being released by the host roots. This change might delay the essential preconditioning period of the dormant seeds of *O. crenata* and thereby delay their germination and development. The foliar application of the fungal bioagents produces an immediate flush of defence enzyme, mainly the reactive oxygen species and other enzymes catalysing the signal transduction processes in the host plants as reported by several workers (Goldwasser *et al.* 1999). This rapid flush of enzymes may alter the development process of the parasitic *O. crenata* which essentially depends on the physiology of the host tomato.

CONCLUSION

The delay in emergence of the flowering stalks would mean that the development of the parasite and thus the host crop may escape the infection during its critical stages. Further, delay in stalk emergence means less seed production and seed bank in the soil.

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Evaluation of bioefficacy of halosulfuron-methyl against sedges in bottle gourd

R. Dash*, M.M. Mishra and M.M. Behera

All India Coordinated Research Project on Weed Control, OUAT, Bhubaneswar, Orissa 751 003

**Email: rabiratnadashouat@gmail.com*

Botttle gourd (*Langenaria siceraria* (Mol.) Standl), a commonly grown vegetable of India, is cultivated in a 0.0.11mha area with a production and productivity of 1.43 million tones and 13.2 t/ha respectively (Anonymous 2011). Besides many reasons for its low productivity, poor management of weeds is one of them. Due to slow early growth and close canopy structure, bottle gourd faces severe competition from weeds, particularly perennial sedges resulting in huge yield loss. Halosulfuron-methyl is known to be very effective against sedges. However, no information is available on testing of the herbicide on the bottle gourd in the state Odisha; hence the present investigation was carried out to evaluate the bioefficacy of halosulfuron-methyl against perennial sedges on the bottle gourd.

METHODOLOGY

Field experiment was conducted at Central Farm OUAT, Bhubaneswar during the *Kharif* season of 2012. Six different treatments consisting of three different doses of halosulfuron-methyl, *i.e* 52.5, 67.5 and 135 g/ha and one conventional herbicide *i.e.* pre-emergence application of metribuzin 490 g/ha along with two hand weeding *i.e.* 25 and 40 DAS and one untreated control were executed in the field in a randomized block design with four replications. The bottle gourd variety "*Devagiri*" was sown in three seeds/pit where the pit size was (20×20×20 cm).All the recommended packages of practices were followed. The herbicide halosulfuron-methyl was applied at 3-4 leaf stage of the *Cyperus* sp. and metribuzin was applied immediate after sowing of the field.

RESULTS

The crop was mainly infested with the sedges (21%) along with grasses (53%) and broad leaved weeds (26%). Application of halosulfuron-methyl completely controlled the sedge (particularly *Cyperus rotundus)* population and dry matter irrespective of doses followed by the metribuzin treated plots where the population and dry matter recorded were 14/m^2 and 6.8 g/m^2 respectively (Table 1). However, owest weed population (23/m^2) was observed in case of metribuzin application followed by halosulfuron-methyl treated plots with 135 g/ha. The significantly lowest weed dry weight (10.84 g/m^2) was also recorded in this treatment.

Table 1. Weed growth, yield and economics of bottle gourd as affected by herbicides

Treatment	*C .rotundus* density (no./m^2) 30 DAS	*C. rotundus* dry matter (g/m^2)	Total weed density(no./m^2) 30 DAS	Total dry matter (g/m^2)	Yield (t/ha)	Cost of cultivation (×10^3? /ha)	B:C ratio
Halosulfuron-methyl 52.5g/ha	0	0	38	19.67	21.25	13.21	2.63
Halosulfuron-methyl 67.5g/ha	0	0	32	18.40	20.30	13.34	2.57
Halosulfuron-methyl 135g/ha	0	0	27	14.32	18.54	13.56	2.41
Metribuzin 490 g/ha	14	6. 8	23	10.84	22.64	13.18	2.60
Two hand weeding (20 and 40 DAS)	16	7.4	42	23.41	22.87	14.52	2.13
Unweeded check	37	13.6	89	42.70	14.32	12.87	1.19
LSD(P=0.05)	2.3	0.3	3.2	4.76	1.88	-	-

Highest fruit yield (22.87 t/ha) was recorded with two hand weedings followed by metribuzin treatments and the lowest (14.32 t/ha) was obtained in unweeded check. Among different doses of halosulfuron-methyl, the application 37.5 g/ha recorded 48% of yield advantage over unweeded control and it was at par with the lower dose of 67.5 g/ha. The higher dose of 135 g/ha significantly reduced the yield in comparison to other two lower doses. The herbicidal treatments brought about lower cost of cultivation as compared to two hand weedings (14.52×10^{31} /ha).The highest B:C ratio of 2.63 was observed in halosulfuron-methyl 52.5 g/ha, followed by metribuzin treated plots 2.60 and lowest with unweeded check (1.19).

CONCLUSION

Post emergence application of halosulfuron-methyl 52.5 g/ha at 3-4 leaf stages of sedges was very effective in controlling the specific weed and thereby increase the yield and profitability of the bottle gourd.

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Management of *Cuscuta* in niger under south eastern hilly regions of Odisha

M.M. Mishra*, R. Dash and M.M. Behera
All India Coordinated Research Project on Weed Control, OUAT, Bhubaneswar, Orissa 7510 03
**Email: mishramm2012@gmail.com*

Cuscuta chinensis, a stem parasitic plant, poses serious problem in oilseeds, pulses and fodder crops in rain fed areas of the country. Depending upon the severity of infestation, *Cuscuta* can reduce the crop yields by 27-100% (Mishra 2009). In Odisha, it is widely seen in the Niger crop (*Guizotia abyssinica*), widely grown in the hilly tracts of southern parts of the state, reducing its yield up to 60%. Considering the above facts, an on-farm testing at the farmer's field was conducted at Semiliguda in the district of Koraput, Odisha to evaluate the best chemical control of these species.

METHODOLOGY

The field experiment was conducted at farmers' field during the *Kharif* 2012 to evaluate the treatments consisting of pre emergence application of pendimethalin 1.0 kg/ha, stale seedbed followed by pendimethalin 1.0 kg/ha, along with imazethapyr 75 g/ha applied one day before sowing (PPI). The crop was sown on 13th August, 2012 and harvested on 2nd December, 2012 adopting all standard practices of cultivation. Data on *Cuscuta* germination, growth, yield and economics were recorded for observation.

RESULTS

Among the different weed control methods, *Cuscuta* appeared as early as 12 DAS in stale seedbed *fb* pendimethalin 1.0 kg/ha applied as pre-emergence and it was delayed up to 18 DAS in the treatment of pendimethalin 1.0 kg/ha PE . The germination of *Cuscuta* was less in stale seedbed *fb* pre-emergence application of pendimethalin 1.0 kg/ha (2/ m^2) (Table 1). Among the herbicidal treatments, the treatment stale seedbed *fb* pendimethalin 1.0 kg/ha, recorded the lowest *Cuscuta* density of 3.2 / m^2 and 12.4/m^2 at 30 and 60 DAS followed by pendimethalin 1.0 kg/ha (4.3 and 13.1/m^2). The treatment of stale seed bed *fb* pendimethalin 1.0 kg/ha PE recorded the highest grain yield of 792.5 kg/ ha followed by pendimethalin 1.0 kg/ha (710 kg/ha). Stale seed bed *fb* pendimethalin 1.0 kg/ha increased the grain yield of niger by 11.5% and 12.8%, respectively over pendimethalin 1.0 kg/ha and imazethapyr 75 g/ha. Similar findings were corroborated by Anonymous (2011).The treatment of pendimethalin 1.0 kg/ha PE produced the highest B: C ratio (1.85) followed by imazethapyr 75 g/ ha (1.81).

CONCLUSION

Adoption of stale seed bed followed by application of pendimethalin 1.0. kg/ha proved very effective in controlling the *Cuscuta* species in niger crop.

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New record of mistletoe as a potential weed: serious threat to sapota cultivation in Chhattisgarh

S.K. Ghritlahre*[1], A.K.Awasthi[1], J.L. Ganguli, A.P.Singh[2], and Y.S. Nirala[2]
[1]Department of Entomology, [2]Department of Agronomy, Indira Gandhi Krishi Viswavidyalaya, Raipur, Chhattisgarh 492 012
**Email: sanjubaba15051990@gmail.com*

Sapota, *Achras sapota* L. is one of the prominent fruits and belongs to family sapotaceae. In Chhattisgarh, it covers about 220 ha under cultivation and yielding 748.5 metric tons of fruits. Various factors affect the yield of Sapota, among them insect pests and parasitic plants are important. Parasitic plant was first reported on sapota in 2014 at Horticultural orchard, T. C. B. College of Agriculture and Research Station, Sarkanda, Bilaspur, (Chhattisgarh).

METHODOLOGY

The present studies on the parasitic plant, *Dendrophthoe falcata* (L.f) Ettingsh was conducted at the Sarkanda Farm of T.C.B. College of Agriculture, Bilaspur during 2013-14. Observations were recorded on the number of parasitic plants/ tree on five trees of sapota (cv kalipatti) at four directions viz. North, South, East and West.

RESULTS

It was observed that on an average plant population of 1.7 plants/trees was recorded and more number of the parasitic plant were recorded on North and East direction, 2.20 and 2.20 respectively.

Table 1. Number of misteltoe/plants of Sapota

S. no.	North	South	East	West	Mean
1	1	0	3	1	1.25
2	4	2	0	0	1.5
3	2	1	3	2	2
4	1	0	4	1	1.5
5	3	0	1	5	2.26
Mean	2.2	0.6	2.2	1.8	1.7

CONCLUSION

Dendrophthoe falcata is the serious problem of sapota in Chhattisgarh,

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Invasive weeds of aquatic ecosystem

M.R. Yogesh*, M. S. Dinesha and Sadhana R. Babar
Department of Agronomy, UAS, GKVK, Bangalore, Karnataka 560 065
**Email: yogeshgowda0279@gmail.com*

Non-native invasive species of aquatic and wetland plants were introduced as a result of human activities and are causing detrimental effects on beneficial uses (irrigation, fishing, swimming, boating, native flora and fauna) including declines of indigenous aquatic species and aquatic habitat. Selective aquatic weed management is critical to sustaining the function of waters. The most important invasive weeds of aquatic ecosystem which infests rivers, dams, lakes and irrigation channels mainly includes water hyacinth and *Ipomoea*.

Eichhornia crassipes **-** It is commonly known as water hyacinth, is the most serious aquatic weed in India, infesting more than 200,000 ha of water surface. The weed was introduced into India before 1900 and has spread throughout the country. Management by physical removal e.g. manually removing plants from small areas of water such as farm dams and drains is an effective form of controlling water hyacinth, but only when the rate of removal is faster than the rate of regrowth. Chemical control, when treating water that is used for irrigation purposes, the withholding period should be followed. Spraying an entire heavy infestation can cause water hyacinth to sink and result in pollution from the rotting weed. Biological control is the most economical and practical way to keep the weed under check and it is environmentally safe and poses no threat to non-target organisms' environment and biodiversity.

Ipomoea carnea **jacq (Convolvulaceae) -** *Ipomoea carnea*, a native of South America, grows in dense populations along river beds, banks, canals and other waterlogged (wetland) areas. It has become a naturalized species that invades the canal and drain banks, road sides and field edges. Chaudhuri *et al.* (1994) mentioned that manual control measures by cutting and digging of stems, though commonly undertaken, are costly and ineffective. Any remaining stems and seeds that are in the soil easily and rapidly re-infest the cleared areas. The herbicide 2,4-D is known to be effective against *Ipomoea* spp. Doses of 1 to 3 kg 2,4-D/ha in 0.05% aqueous solution usually provide over 90% control. It was noted that unless plants are thoroughly sprayed, many escape the spray in dense infestations and regrow rapidly.

The fine spray of the ordinary compression or power sprayers does not reach sufficiently far or high enough to cover the upper leaves of tall Ipomoea carnea plants. Although in general, mechanical cutting of the weed is advocated as a control method, the practice is not effective due to the high plant densities and expense.

CONCLUSION

Water hyacinth and *Ipomoea* were introduced as ornamental plants in India but now they are the worst noxious aquatic weeds with high invading powers. Integration of biological and herbicidal methods is advocated to manage the aquatic weeds, but this can only be achieved when herbicides are non toxic to the bio control agents and safer to aquatic fauna.

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An Improved management strategy for *Striga* control in sugarcane in North Karnataka

Ramesh Babu*, Gourishankar sajjanar, Rajashekar Rajput, Sudhindra Saunshi and Mallikarjun, C
AICRP on Weed Control, MARS, UAS Dharwad, Karnataka 580 005
**Email: rameshbabu.niws@gmail.com*

Sugarcane (*Saccharum officinarum L*) is the principal commercial crop for the farmers in Belgaum, Bagalkot and Bijapur Districts of North Karnataka. Alarming infestation of *Striga*- a root parasite, in these major sugarcane areas is threatening cane cultivation, causing reported yield losses of 20 to 70%. Sometimes total crop failure is also a common feature. *Striga* infestation is a consequence of monocropping which host the parasite, and declining soil fertility which weakens the host plant for *Striga* attack (Khan *et al.* 2003). The traditional sorghum growing areas in this part of the state where striga was prevalent have been transformed into sugarcane fields, because of which the parasitization of cane crop is severe. The farmers are fighting a losing battle against *Striga* scourge and at the same time they are not ready to switch over to other crops. Therefore, reducing the losses caused by *Striga* through any improved strategy could significantly reduce the parasitization of the crop thus increasing yield. Hence, an effort was made in this study to reduce the *Striga* infestation, on farmers' fields on participatory research.

METHODOLOGY

A field trial was conducted on farmers' participatory approach in Rainapur village (Gokak Taluk, Belgaum District). Sugarcane field severely infested with *Striga* was selected for the study. Before conducting this study several cane farms were surveyed and surveys revealed that in majority of cane fields *Striga* emergence was seen after 90 to 110 days of planting (DAP). Hence different herbicide mixtures (tank mix.) where applied at 110 DAP coinciding with emergence of *Striga* and were compared to the treatment No.1 the sprays were repeated after 150 DAP and then mulching was done.

RESULTS

The data on *Striga* emergence indicated that herbicides mixture oxyfluorfen + 2,4-D reduced the *Striga* parasitization after 140 DAP and 180 DAP (3 and 3, respectively). The application of diuron + 2,4-D or metribuzin+ 2,4-D or atrazine + 2,4-D were also effective in reducing the *Striga* infestation, the number of *Striga* weeds emerged were higher after 140 and 180 DAP (29 and 21 respectively) with the treatment *i e.,* atrazine 1kg/ha PE 3 DAP + HW on 45 DAP fb earthing up on 60 DAP *fb* Post–emergence spraying of 2, 4-D Na salt 5g/l + urea 20g/l 90 DAP *fb* trash mulching at 5 t/ha on 120 DAP, compared to the herbicide mixtures

Table1. Effect of different herbicides treatments on *Striga* emergence

Treatment	Striga emergence after 30 days after spraying (/ m^2)		
Atrazine 1kg/ha PE 3 DAP + HW on 45 DAP *fb* earthing up on 60 DAP *fb* Post–emergence spraying of 2, 4-D Na salt 5g/l + urea 20g/l 90 DAP fb trash mulching at 5 t/ha on 120 DAP	27	29*	21**
Atrazine 1.25 kg/ha + 2, 4 –D Na salt 2 kg/ha applied after 110 DAP. Repeated spray after 150 DAP and mulching	6*	5**	
Metribuzin 1.00 kg/ha + 2, 4 –D Na salt 2 kg/ha applied after 110 DAP. Repeated spray after 150 DAP and mulching	4*	4**	
Diuron 1 kg/ha + 2, 4 –D Na salt 2 kg/ha applied after 110 DAP. Repeated spray after 150 DAP and mulching	4*	3**	
Oxyfluorfen 0.25 kg/ha + 2, 4 –D Na salt 2 kg/ha applied after 110 DAP. Repeated spray after 150 DAP and mulching	3*	3**	

* *Striga* emergence after 140 DAP ** *Striga* emergence after 180 DAP

CONCLUSION

It may be concluded that application of herbicide mixtures tried in the study, synchronizing the emergence of *Striga* is effective in reducing *Striga* infestation in cane. Further studies are in progress. The *Striga* inflicts most damage on the crop before it emerges from soil. Attachment may occur after 60 or 70 DAP depending upon the *Striga* seed bank and exudation of the stimulant by cane roots in the vicinity of *Striga* roots. Keeping these aspects in view, studies are underway on farmers' field to address this problem more effectively.

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Management of *Cuscuta* in lucerne using integrated weed management practices

P. Revathi, Dr. K.B. Suneetha Devi, M. Madhavi and M. Padmavathi Devi
Department of Agronomy, College of Agriculture, ANGR Agricultural University, Rajendranagar, Hyderabad 500 030

Lucerne (*Medicago sativa* L.) is an important high yielding multicut, nutritious and palatable fodder crops of India and mostly grown in almost all parts of country. The crop being grown under irrigated conditions, severe weed competition especially *Cuscuta chinensis* one of the major constraints in achieving high fodder productivity. Yield losses as much as 90 per cent was reported due to cuscuta infestation. To overcome this problem, hence, present study was undertaken to find out the most effective and economical integrated weed management method to control cuscuta in Lucerne under semi-arid condition of Hyderabad

METHEDOLOGY

A field experiment was conducted during Rabi season of 2008-09 at Students Farm, College of Agriculture, Rajendranagar, and Hyderabad. The experiment consisting of 12 treatments (Table 1) and laid out in a randomized block design with three replications for each treatment. The Lucerne seed procured from local market of Hyderabad was used for sowing the experiment except in treatment 9 wherein pure seed of lucerne that was procured from ACRIP on forage crops, ARI, Rajendranagar, Hyderabad was used for sowing. The Lucerne was sown in first week of November at a spacing of 30 cm x solid rows with seed rate 15 kg / ha. The herbicides were sprayed using a spray volume of 600 l / ha. *Cuscuta* twines attached to lucerne plants in an area of 0-25 m^2 was removed at each cut and over dried to record dry weight.

RESULT

Dry matter production of *Cuscuta* was higher at I cut and reduced towards increasing the number of cuts (Table 1). Application of pendimethalin 0.5 and 0.75 kg / ha as PE, imazethapyr 75 and 100 g / ha at 12 DAS and in combination with salt (10%) treatment to seeds and pure seed of lucerne + T_{10} treatments eliminated the infestation of cuscuta. It was clearly showed that application of herbicides is an effective measure to control cuscuta in lucerne.

Tabel 1. Effects of treatments on *Cuscuta*

Treatment	Cuscuta dry weight			Avg. CCE (%)	GFY Total	DFY Total
	I cut	II cut	III cut			
T_1 – Salt (10 %) treatment to Lucerne seeds before sowing *fb* farmers practice (T_{10})	71.5	10.25	5.75	52.84(62.64)	18.607	5.847
T_2 – Salt (10 %) treatment to seeds +iImazethapyr 75 g / ha at 12 DAS	0.0	0.0	0.0	90.00(100.00)	29.575	9.108
T_3 – Salt (10 %) treatment to seeds + pendimethalin 0.5 kg / ha at 12 DAS	0.0	0.0	0.0	90.00(100.00)	26.038	8.245
T_4 – Stale seed bed + hand weedinging at 30 DAS	72.45	12.60	6.60	50.67(59.29)	13.984	4.410
T_5 – Pendimethalin 0.5 kg / ha as PE	0.0	0.0	0.0	90.00(100.00)	19.689	6.084
T_6 – Pendimethalin 0.75 kg / ha as PE	0.0	0.0	0.0	90.00(100.00)	23.331	7.155
T_7 – Imazethapyr 75 g / ha at 12 DAS	0.0	0.0	0.0	90.00(100.00)	33.544	10.185
T_8 – Imazethapyr 100 g / ha at 12 DAS	0.0	0.0	0.0	90.00(100.00)	27.671	8.273
T_9 – Pure seed of lucerne *fb* farmers practice (T_{10})	0.0	0.0	0.0	90.00(100.00)	30.388	9.391
T_{10} – Farmers practice (hand weeding) at 30 DAS and after each cut)	78.15	14.44	11.52	45.30(50.68)	12.367	3.842
T_{11} – Weedy check	128.12	36.15	31.65	0.57(0.0)	8.569	2.699
T_{12} – Weed free check	59.62	12.72	7.62	52.19(62.03)	17.081	5.277
LSD (P = 0.05)					5.954	1.791

* Figures in parenthesis are actual values. Presented in Angular transformation.

CONCLUSION

Hence, it was concluded that application of imazethapyr 75 g / ha at 12 DAS and in combination with salt treatment to lucerne seeds before sowing and sowing pure seed of lucerne followed by farmers practice of hand weeding at 30 DAS and after each cut were effective in controlling weed flora in lucerne including cuscuta and achieved higher green and dry fodder yield of lucerne.

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Impact of weed management in mustard with special reference to *Orobanche*

Karan Singh Jadhav, Ajay Chourasiya*, Vinod Kuma, T.N. Thorat, R.L. Rajput
Department of Agronomy, College of Agriculture, RVSKVV, Gwalior, Madhya Pradesh 474 002
**Email: ajaychourasiya09@gmail.com*

The mustard crop is infested with grassy as well as broadleaf weeds. Broomrape (*Orobanche aegyptica* pers.), a holoparasitic weed has been causing heavy losses to the mustard crop in light soils of Grid region. Weed infestation during early stages reflected the crop growth and reduction in yield up to 58 %.

METHODOLOGY

A field experiment was conducted at Research Farm, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during *Rabi* season 2011-12.Twelve weed control treatments administered to mustard consisted of pendimethalin 1.0kg/ha PE, glyphosate 50g/ha alone after emergence of *Orobanche*, trifluralin 1.5kg/ha PPI, glyphosate 25g/ha alone with 1% solution NH_4SO_4 at 40 DAS, neem cake 200 kg/ha in furrow and pendimethalin at 0.5kg/ha (PE) followed by 1 hoeing at 40 DAS, neem cake200kg/ha in furrow followed by imazethapyr 30g/ha at 20DAS, trifluralin 1.5kg/ha +neem oil 1% PPI, soybean oil 2 drops/shoot after emergence of *Orobanche*, application of 25% extra dose of phosphorus and phosphorus solubilizing fungns, *Trichoderma viride*@ 2.5 kg/ha as basal application, Farmers practice-1 hoeing at 40 DAS and weedy check.

RESULTS

The lowest weed density (0.33/m^2) was recorded under pendimethalin 1.0kg/ha at 60DAS, which was at par with trifluralin 1.5 kg/ha +neem oil 1% PPI, neem cake at 200kg/ha in furrow and pendimethalin at 0.5kg/ha (PE). Pendimethalin 1.0 kg/haresulted in significantly lowest weed dry biomass (13.60 g/m^2) and highest weed control efficiency (86.98%) and weed index (26.13%).

CONCLUSION

Pendimethalin 1.0 kg/ha (PE) or trifluralin 1.5kg/ha + neem oil 1% PPI could be adoptedas effective weed control measure against different weeds (prominently *Orobanche*)in mustardfor attaining higher seed yield and net returns.

Table1. Weed density,weed dry biomass, weed control efficiency of *Orobanche* and total weeds as affected by various treatments on seed yield and economics of mustard

Treatment	Weed density/m^2	*Orobanche* density/m^2	Weed control efficiency (%)	*Orobanche* Control efficiency (%)	Weed index (%)	Seed yield (t/ha)	Gross income (x10^3₹/ha)	Net income (x10^3₹/ha)	B:C ratio
Pendimethalin 1.0kg/ha PE	4.4(81.3)*	1.5(1.3)*	86.98	15.56	26.13	2.22	66.66	51.36	4.36
Glyphosate 50g/ha alone after emergence of *Orobanche*	6.2 (496.3)	1.4(1.0)	33.34	23.33	11.35	1.85	55.53	41.56	3.98
Trifluralin 1.5kg/ha PPI	4.6(96.3)	1.27(0.3)	82.97	29.44	19.21	2.03	60.75	45.25	3.92
Glyphosate 25g/ha alone with 1% solution NH_4SO_4 at 40 DAS	5.7(310.0)	1.2(0.7)	44.96	31.11	11.83	1.86	55.89	41.63	3.93
Neem cake 200kg/ha in furrow and pendimethalin 0.5kg/ha (PE) followed by 1 hoeing at 40 DAS	4.5(92.3)	1.3(0.7)	79.93	29.44	22.27	2.11	63.18	46.30	3.75
Neem cake 200kg/ha in furrow followed by imazethapyr 30g/ha at 20DAS	6.00(398.6)	1.5 (1.3)	41.74	15.56	0.00	1.64	49.05	32.61	2.99
Trifluralin 1.5kg/ha +neem oil 1% PPI	4.4(84.0)	1.1(0.3)	82.47	37.22	23.36	2.14	64.23	48.42	4.07
Soybean oil 2 drops / shoot after emergence of orobanche	6.6(753.6)	1.7(2.0)	13.87	5.00	6.29	1.75	52.41	38.32	3.72
Application of 25% extra dose of phosphorus and phosphorus solubilizing bacteria	6.5(667.0)	1.6(1.7)	22.14	10.00	4.09	1.71	51.36	37.04	3.59
*Trichoderma viride*2.5kg/ha as basal application	6.4(583.6)	1.5(1.3)	30.92	15.56	10.87	1.84	55.20	40.76	3.83
Farmers practice-1 hoeing at 40DAS	6.2(490.3)	1.4(1.0)	31.57	21.67	11.35	1.85	55.53	41.43	3.94
Weedy check	6.8(840.6)	1.8(2.3)	0.00	0.00	0.00	1.64	49.29	35.35	3.54
LSD (P=0.05)	0.2	0.4	1.272	0.488	-	0.13	-	-	-

*Values in parantheses are original. Data transformed to square root transformation

Effect of water hyacinth and alligator weed compost on growth and yield of maize

B. Nethravathi[1] and R.C. Gowda[2]

[1]*University of agriculture and horticulture sciences, shimoga, Karnataka*

[2]*University of Agricultural Sciences, GKVK, Bangalore, Karnataka 560 065*

**Email: nethra7shiva@gmail.com*

There are many challenges an Indian farmer has to face in agriculture with an objective of maximizing profit. The most important among them are decreasing production cost, increasing yield and maintaining soil health. There are many ways by which increased production can be achieved. But only way of reducing cost is by using low cost inputs and healthy agricultural practices. One important low cost input for meeting nutrient requirement of crop is compost, which can be produced by a simple technique. Weed infestation lowers 30 per cent yield as a result of competition for space, nutrient, sunlight, water etc. Hence weeds growing on land and water bodies must be controlled and their biomass must be used for composting as it contains nutrients required for growth.

METHODOLOGY

An experiment was conducted to study the effect of water hyacinth and Alligator weed compost on growth and yield of Maize during the *Kharif* season of 2010 at UAS, Bangalore. The raw materials used in the preparation of compost were water hyacinth (*Eichhornia crassipes*), alligator weed *(Alternanthera philoxeroides),* cow dung and microbial culture. The experiment consists of 11 treatments, *viz.* absolute control, 50% RDF, 50% RDF+ FYM 10 t/ha, 50% RDF+ water hyacinth compost10t/ha, 50% RDF+ alligator weed compost 10 t/ha, 50% RDF+ alligator weed compost 5 t/ha+ water hyacinth compost 5 t/ha, 100% RDF, 100% RDF+ FYM10t/ha, 100% RDF+ water hyacinth compost 10 t/ha, 100% RDF + alligator weed compost10 t/ha, 100% RDF+ alligator weed compost 5 t/ha+ water hyacinth compost 5 t/ha and replicated thrice.

RESULT

The highest plant height was observed with 100% RDF + FYM 10 t/ha *i.e.* 110.6 cm at 30 DAS, 221.9 cm at 60 DAS, 229 cm at harvest respectively followed by 100% RDF+ compost of water hyacinth10 t/ha (Savithri *et al.* 2000). There was significant difference in the grain yield of maize in all the treatments. The highest yield (6.20 t/ha) was obtained with 100% RDF+ FYM 10 t/h and was on par with 100% RDF + water hyacinth compost10 t/ha (6.18 t/ha) and 100% RDF + alligator weed compost10t/ha (5.61 t/ha) respectively. The higher yield was due to better nutrient supply as indent from higher nutrients uptake in maize (Bevacqua *et al.* 1994 and Verma 1991).

The treatments which were in combination of organic and inorganic source of fertilizers recorded higher yield as compared to the treatments receiving either organic or inorganic sources alone.

Table 1. Effect aquatic weed compost on growth and yield of maize crop

Treatment	Plant height at 60 DAS	Plant height (cm)	Grain yield (t/ha)
Absolute control	111.1	121.67	19.54
50% RDF	193.2	203.46	38.61
50% RDF+FYM 10 t/ha	194.5	206.3	43.35
50% RDF + compost of water hyacinth 10 t/ha	193.7	203.96	41.70
50% RDF + compost of alligator weed 10 t/ha	196.8	207.36	45.42
50% RDF + compost of alligator weed 5 t/ha+ compost of water hyacinth 5 t/ha	197.1	211.46	48.80
100% RDF	201.5	212.43	49.75
100% RDF + FYM10 t/ha	221.9	229	62.03
100% RDF + compost of water hyacinth 10 t/ha	211.3	218.76	61.88
100% RDF + compost of alligator weed 10 t/ha	210.8	215.56	56.06
100% RDF + compost of alligator weed 5 t/ha + compost of water hyacinth 5 t/ha	202.1	214.3	53.47
FYM10t/ha	191.5	199.73	34.72
compost of water hyacinth10 t/ha	172.2	183.67	25.86
compost of alligator weed10 t/ha	187	198.24	28.76
compost of alligator weed5 t/ha + compost of water hyacinth5 t/ha	187.2	198.96	31.69
LSD (P=0.05)	13.05	13.62	19.40

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Broomrape parasitic weed biology and its management with herbicides in naturally infested tomato field

M.S. Dinesha* and G.N. Dhanapal
AICRP on Weed Control, UAS, GKVK, Bangalore, Karnataka -560 065
**Email: dineshagron@gmail.com*

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important and widely grown solanaceous vegetable both in tropical and sub-tropical regions of the world. The low yield of tomato crop can be attributed to wide range of factors. Weed infestation is one among the severe problem causing yield reduction to the tune of 40-45 per cent. In recent years, in addition to general weeds, it is also being affected by a serious holo-root parasite called broomrape (*Orobanche cernua* L.). *Orobanche*, commonly known as broomrape, is a flowering plant that parasitizes the root of many economically important crops. The genus belongs to the family orobanchaceae and it contains about 150 species (Musselman 1980); most of these are perennials, but few weedy species are annuals with short life cycle. They draw nutrients and water through haustoria that penetrate the root tissue, establish connections with the vascular system of the host plants and disrupt the growth and development of host plants. Broomrape became a serious menace in tomato crop in the farmer's field in Bagepalli taluk of Chikaballapura district in Karnataka. Detailed studies on various fundamental and applied aspects of *Orobanche cernua* L. on tomato in India are scarce. Therefore, field studies were conducted in a naturally infested tomato field to describe above-ground growth and development of the parasite in relation to the host crop and its control by using herbicides at lower doses/concentrations.

METHODOLOGY

The study was conducted in farmer's field at Hosakote village of Bagepalli taluk in Chickballapura district. The site is located in Eastern Dry Zone of Karnataka state (Zone-5). The experiment was laid out in Randomized Complete Block Design and replicated thrice. The treatments comprising four herbicides applied at two levels *viz.* sulfosulfuron (75% WG), glyphosate (41% SL), imazethapyr (10 Wsc) were applied at 50 and 75 g/ha each of the treatment and metribuzin (70% WP) were applied at 150 and 250 g/ha, these were compared with weedy check and weed free check treatments. Herbicides were applied at 30 days after transplanting tomato. Days taken for emergence of the broomrape spike after transplanting of tomato was observed periodically and recorded as number of days. Number of broomrape spikes per square meter area at 60, 75, 90 DAT and at harvest was recorded and average was worked out and all other parameters regarding broomrape were recorded from 15 tagged spikes in each treatment.

RESULTS

Broomrape spikes started emerging above-ground from 43-58 days after transplanting tomato. Till that time different stages of development of the parasite were occurred below-ground. Flowering was completed by 7-13 days after emergence above-ground. Stem drying was completed by 26-38 days after emergence above-ground and it has taken 37-50 days to complete its life cycle after emergence above-ground in tomato transplanted field. The broomrape height ranges from 12.2 cm to 25.7 cm and the mean height was 18.9 cm and the average dry weight of the individual spike was six gram.

Application of sulfosulfuron 75 g/ha recorded significantly lowest broomrape number (T_4: 1.66 to 3.96/m^2), spike height (T_1: 17.12 to 12.18 cm) and dry weight (T_4:7.77/m^2) throughout the crop growth period with higher broomrape control efficiency(85.9%), which resulted in higher plant height, number of branches and leaf area in tomato at harvest. Among all the herbicide treatments, sulfosulfuron 75 g /ha recorded higher fruit weight per plant (T_4: 2.63 kg) and fruit yield of tomato (T_4: 66,82 kg/ha). However, weedy check (T_{10}) recorded 35 per cent reduction in fruit yield over weed free check due to broomrape infestation (44.31 t/ha). The results corroborate with the findings of Eizenberg *et al.* (2007).

CONCLUSION

The results on parasitic biology in relation to tomato have highlighted that the broomrape spikes started emerging above-ground from 43 days after transplanting of tomato and continued up to 58 days and it took 37-50 days to complete it's life cycle after the emergence above-ground. The study on herbicidal control of broomrape in tomato revealed that application of sulfosulfuron 75 g/ha is proved to be highly effective. Apart from higher broomrape control efficiency highest fruit yield were also recorded without causing any phytotoxicity in tomato.

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Chemical control of hardy weeds in *Kharif* maize at farmers fields in Punjab

Amandeep Singh Sidhu*, Jaswinder Singh, Sat Pal Saini and Vinay Kumar
Krishi Vigyan Kendra, Ropar Punjab Agricultural University, Ludhiana, Punjab 141 001
**Email: sidhuas@pau.edu*

In the era of diversification, maize (*Zea mays* L.) is an important crop for the state of Punjab especially for sub-montaneous region. Weeds are a serious problem in *kharif* maize as its sowing coincides with start of monsoon rains and also due to wider row spacing of the crop. The infestation of some weed species like *Commelina bengalensis*, *Acrachne racemosa* and *Brachiaria reptans* was increasing day by day in the Nurpur bedi and Anandpur sahib blocks of district Ropar of Punjab especially where farmers are using atrazine year after year. Farmers were unaware of new herbicidal recommendations of Punjab Agricultural University, Ludhiana for controlling above said and other hardy weeds in *Kharif* Maize. To address this problem, on farm trials were planned to test the efficacy of recommended treatments to control hardy weeds in *kharif* maize.

METHODOLOGY

Field experiments were conducted at University Seed Farm, Nabha and at the farmer's fields at five different locations in district Ropar during *Kharif* 2012 and 2013 each. Locations having enough population of hardy and other weeds were selected during both the years. The experiment was laid out with 4 treatments (Table 1) in randomised complete Block design. Each location was considered as one replication. The herbicides were applied as pre-emergence within two days of sowing using knapsack sprayer fitted with flat fan nozzle by mixing 500 litres of water per ha. Maize variety '*PMH 1*' was sown in first fortnight of June using a seed rate of 20 kg/ha. In third treatment one row of Cowpea variety *'CL 367'* was sown in between two rows of maize by using a seed rate of 20 kg/ha. Both crops were sown simultaneously.

RESULTS

The weed flora of different farmer's fields had enough population of weeds like *Commelina bengalensis*, *Acrachne racemosa* and *Brachiaria reptans,* apart from these some other weeds like *Trianthema portulacastrum*, *Amaranthis viridis*, *Digera arvensis*, *Eleusine* spp. and *Eragrostris* spp. were also present.

Table 1. Weed growth, yield and economics of *Karif* maize in relation to different weed control Practices

Treatments	Dose Kg /ha	Grain Yield (t/ha)		Grains per Cob		Dry Matter of weeds (t/ha)		Weed Control efficiency (%)		Net Returns (10^3x Rs/ha)		B:C ratio	
		2012	2013	2012	2013	2012	2013	2012	2013	2012	2013	2012	2013
Atrazine alone	1.0	4.45	4.28	402.5	398	0.31	0.34	73.5	72.3	39.50	33.40	2.18	1.81
Atrazine + pendimethalin	0.75 + 0.75	5.23	5.19	426	416.5	0.17	0.20	85.5	83.7	48.87	43.83	2.64	2.32
Intercropping of one row of Cowpea CL 367	-	4.05	3.84	392.4	380.6	0.64	0.65	45.3	47.2	34.43	28.18	1.89	1.54
Unweeded Control	-	3.26	3.15	288	273	1.17	1.23	-	-	24.27	20.16	1.35	1.11
LSD (P=0.05)		0.43	0.55	7.8	9.6	0.23	0.27	-	-	-	-	-	-

Dry matter of weeds recorded at harvest was significantly lowest (0.17 and 0.20 t/ha) with pre-emergence tank mix application of atrazine (0.75 kg/ha) + pendimethalin (0.75 kg/ha) as compared to all other treatments during both years. Alone application of atrazine and intercropping of cowpea resulted in poor control of hardy weeds although other weeds were controlled appreciably. These results are in conformity with findings of Walia *et al*. (2007) who also observed lower weed dry matter in *Kharif* maize with tank mix application of atrazine and pendimethalin. The maximum weed control efficiency (85.5 and 83.7%) was recorded with pre-emergence tank mix application of atrazine + pendimethalin during both the years.

Grain yield was significantly more (5.23 and 5.19 t/ha) during 2012 and 2013 with pre-emergence tank mix application of atrazine (0.75 kg/ha) + pendimethalin (0.75 kg/ha) followed by alone application of atrazine at 1.0 kg/ha. Singh *et al*. (2007) also recorded higher grain yield of maize with tank mix application of herbicides. Highest net returns (48.87 and 43.83 x 10^3 ₹/ha) and BC ratio (2.64 and 2.32) were recorded with pre-emergence tank mix application of atrazine + pendimethalin, which makes these herbicides economically feasible and cost effective for controlling weeds.

CONCLUSION

For effective management of hardy & other weeds in *Kharif* maize and for getting profitable grain yields, pre-emergence tank mix application of atrazine (0.75 kg/ha) and pendimethalin (0.75 kg/ha) showed better results.

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Bioefficacy of pinoxaden 5 EC in combination with broad-leaf herbicide against complex weed flora in wheat

Shalu Abraham*, Toshiba Pandagare, Preeti Awasthi, D. Chandrakar, A.P. Singh and D.K. Dewangan
Department of Agronomy,ndira Gandhi Vishwavidyalaya, Raipur, Chhattisgarh 492012
**Email: annsabraham07@yahoo.in*

In order to sustain global agricultural food production, the importance of protecting arable crops against negative yield effects from weeds is well recognized. Wheat (*Triticum* spp.) is one of the most important grain crops which is grown in approximately 225 million ha worldwide. Several broad-leaved weeds are becoming a serious problem along with grassy weeds in wheat. Continuous use of same herbicide for many years resulted in development of resistance against some weeds necessitating the search for new herbicide molecules. Pinoxaden, belonging to phenylpyrazolin group with acetyl-COA-carboxylase (ACCase) has inhibiting action. It is a selective grass killer with foliar action. Since grass killers don't control the broad-leaved weeds, the present study was conducted to evaluate the bioefficacy of pinoxaden in combination with herbicides that were reported to be effective against broad-leaved weeds such as metsulfuron-methyl, carfentrazone and 2,4-D.

METHODOLOGY

An experiment to evaluate the bioefficacy of pinoxaden 5 EC alone and in combination with broad-leaved herbicides against mixed weeds in wheat was conducted during *the Rabi* seasons of 2010-11 and 2011-12, at Instructional cum research farm of I.G.K.V., Raipur. The experimental soil was inceptisols low in organic carbon, low in available nitrogen, medium in phosphorus and high in potassium with neutral soil reaction. The experiment was laid down in randomized block design replicated thrice with thirteen treatments, *viz*. pinoxaden (50 g/ha), metsulfuron-methyl (4 g/ha), pinoxaden (50 g/ha) with and before carfentrazone (20 g/ha), metsulfuron (4 g/ha), 2,4-D (500 g/ha), carfentrazone (20 g/ha), idosulfuron + mesosulfuron (2.4 +12.0%), 2,4-D (500 g/ha), weed free (hand weeding twice) and a weedy check. All herbicides alone and in combination were applied as post emergence between 28-35 DAS as per treatment. Application of the second herbicide was made two days after the first. Wheat variety '*Kanchan'* was sown during first fortnight of December for both the years. The recommended fertilizer dose of 100:50:30 kg/ha N:P:K was applied. A seed rate of 100 kg/ha was sown at a distance of 20 cm row to row spacing. Rest of the recommended package of practices was followed.

RESULTS

The flora was dominated by broad-leaved weeds (*Medicago denticulata, Chenopodium album* and *Alternanthera triandera*) constituting 86.46% and 87.27% of the total weed flora during 2010-11 and 2011-2012 respectively. Other weeds included the meager occurrence of *Echinocloa colona*, *Melilotus indica*, *Rumex dentatus*, *Anagallis arvensis etc*. Weed density at 28 DAS was lowest under hand weeding treatment than rest of the treatments and remained low or comparable in the later part of the crop growth till harvest. At 60 DAS and at harvest, the weed density was low under pinoxaden and carfentrazone at 50 + 20 g/ha and pinoxaden + metsulfuron 50 + 4 g/ha and this was comparable with hand weeding. The mean data on the dry weed biomass at 60 DAS and at harvest revealed lowest weed biomass in pinoxaden + carfentrazone followed by weed free treatment and pinoxaden+ metsulfuron. This is in conformity with the findings of Shoeran *et al*. (2013) and Yadav *et al*. (2009). The same trend was depicted during both the years. The weed control efficiency against broad leaved weeds at harvest was found maximum in weed free (60.58% and 61.05%) followed by pinoxaden + carfentrazone with mean values of 58.83% and 58.95% during both the years, respectively. Maximum number of tillers per meter row length was recorded in weed free followed by pinoxaden + carfentrazone during both the years, respectively. The maximum grain yield was recorded in weed free treatment during both the years with mean values of 2.71 and 2.80 t/ha, respectively. However among the herbicidal treatments, pinoxaden + carfentrazone recorded the maximum grain yield (2.73 and 2.66 t/ha) in both the years followed by pinoxaden +metsulfuron.

CONCLUSION

It was concluded that pinoxaden can safely be used as tank mix with metsulfuron or carfentrazone with no loss of herbicide efficacy.

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Efficacy of Metribuzin in combination with clodinafop, sulfosulfuron and pinoxaden against weeds in wheat

Toshiba Pandagare*, Shalu Abraham, S. Bharti, Anjum Ahmad, A.P. Singh and Harishankar
Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh 492012
******Email: toshiba.igkv@gmail.com*

Weeds reduce wheat yields, if, are not controlled in the critical stages of crop and may cause yield reduction up to 66% (Angiras *et al.*2008). Chemical weed control is a preferred practice due to scarce and costly labour as well as lesser feasibility of mechanical or manual weeding. Metribuzin is an approved herbicide for a wide range of noxious broadleaf weed. Therefore, the present investigation was undertaken to evaluate the efficacy of metribuzin alone and in combination with recommended post-emergence herbicides against mixed weed flora particularly in wheat.

METHODOLOGY

An experiment was conducted to evaluate the bio efficacy of metribuzine in combination with clodinafop, sulfosulfuron and pinoxaden against mixed weeds in wheat during the winter seasons of 2010-11 and 2011-12, at I. G. K. V., Raipur. The experimental soil was inceptisols low in organic carbon, low in available nitrogen, medium in phosphorus and high in potassium with neutral soil reaction. The experiment was laid down in randomized block design replicated thrice with ten treatments comprised of post emergence application of clodinafop 60 g/ha, sulfosulfuron 25 g/ha, metribuzin 175 g/ha, pinoxaden 50 g/ha, clodinafop 60 + metribuzin 105 and 122.5 g/ha, sulfosulfuron 25 g + metribuzin 105 g/ha, sulfosulfuron 25 + pinoxaden 40 g/ha, weed free (two hand weeding at 20 and 40 DAS) and weedy check. Wheat variety '*Kanchan'* was sown during first fortnight of December for both the years. The recommended package of practice was followed.

RESULTS

Weed flora

The important weed species observed in the experiment field were, *Medicago denticulata, Chenopodium album, Anagalis arvensis, Alternanthera triandera* and constituted 90.87% and 89.77% of the total weed flora in 2010-2011 and 2011-2012, respectively. *Medicago denticulata* alone contributed 61.92%.

Effect on weed density and biomass

The results revealed that at 60 DAS, significantly lowest weed biomass was observed in weed free treatment, but, it was at par with all the treatments except weedy check. While, at harvest, the lowest weed biomass was recorded under sulfosulfuron + metribuzin (25+105 g/ha). Kumar *et al*. (2006) also reported lowest weed biomass under sulfosulfuron + metribuzin treatment than weedy check. Application of sulfosulfuron + metribuzin recorded highest weed control efficiency of 56.84% and 60.80% which was followed by the weed free (51.22% and 55.00%) during 2011 and 2012, respectively.

Effect on crops

Application of sulfosulfuron + metribuzin (25+105 g/ha) has resulted in significantly higher grain yield of wheat and it was found comparable with other treatments except weedy check in both years. The increase in grain yield over weedy check was to the tune of 48 and 52% during first and second year, respectively. Higher grain yield of wheat was owing to effective control of weeds and higher growth and yield attributes of wheat. Similar findings were noticed by Kumar *et al*. (2006). Yield attributes mainly number of tillers per meter row length also followed the similar trend as that of grain yield.

CONCLUSION

It may be concluded that combined application of sulfosulfuron + metribuzin (25+105 g/ha) is very effective in controlling mixed weed flora in wheat and resulting in higher wheat yields

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Effect of weed management practices on weed density, weed dry matter production and grain yield in system of rice intensification (SRI)

Sadhana R. Babar*[1] and A. Velayutham[2]

[1]*Department of Agronomy, UAS, Bangalore, Karnataka 560 065*

[2]*Professor, Department of Agronomy, TNAU, Coimbatore, Tamilnadu 641 003.*

**Email: sadhattnau@gmail.com*

Rice (*Oryza sativa* L.) is one of the most important cereal crop. Weeds emerge fastly due to alternate wetting and drying. Competition of weeds brings reduction in yield of transplanted rice by about 50% (Mukherjee and Singh 2005). Weed control in transplanted rice by mechanical and cultural is an expensive method. Especially at the time of peak period of labour crisis, sometimes weeding becomes late causing drastic losses in grain yield. In contrast to this chemical weed control is effective to control weeds. Use of herbicides that provide wide-spectrum weed control would be desirable for effective weed control.

METHODOLOGY

The experiment was conducted in wetland of TNAU, Coimbatore in *Kharif,* 2009. The experiment was laid out in randomized block design with three replications. The treatments comprised of different weed management practices, *viz.* recommended weed management practice, *i.e.* 4 times conoweeding from 10 DAT at 10 days interval and conoweeding 3 times at 20, 30 and 40 DAT. These two treatments in single and in combination with three different herbicides, *viz.* almix at 20 g/ha, butachlor at 1 kg/ha and pretilachlor at 0.75 kg/ha were tested along with unweeded control treatment. The variety used in experiment was CO(R) 49.

RESULTS

The observation made on the common weeds of the experimental field consisted of grasses, sedges and broad leaved weeds (BLW) from unweeded check plot at 30, 45 and 60 DAT. The major weeds were *Echinochloa crus-galli* (L.), *E. colona* (L.), *Cyperus difformis* (L.), *Cyperus iria* (L.), *Cyperus rotundus* (L.) and *Eclipta alba* (L.). Application of pretilachlor as pre-emergence at 0.75 kg/ha + 4 times conoweeding from 10 DAT at 10 days interval was found to be the best treatment in lowering the total weed density of 2.08, 1.90 and 1.67 per m^2 at 30, 45 and 60 DAT respectively. Next best treatment was the application of butachlor as pre-emergence at 1 kg/ha + 4 times conoweeding from 10 DAT at 10 days interval and application of almix as post-emergence at 20 g /ha + 4 times conoweeding from 10 DAT at 10 days interval. The unweeded control has recorded significantly higher weed density. Significant variations were observed on the total weed DMP at 30, 45 and 60 DAT respectively due to the adoption of different weed management practices. Application of pretilachlor as pre-emergence at 0.75 kg/ha + 4 times conoweeding from 10 DAT at 10 days interval has recorded significantly least total weed DMP.

Table 1. Effect of weed management practices on total weed density, total weed DMP and grain yield in SRI rice

Treatments	Total weed density (no. sq.m) at 45 DAT	Total weed DMP (g/sq.m) at 45 DAT	Grain yield (t/ha)
Recommended weed management practice *i.e.* 4 times conoweeding from 10 DAT at 10 days interval	2.43 (9.34)	1.61 (3.00)	5.16
Conoweeding 3 times at 20, 30 and 40 DAT	3.08 (19.67)	2.30 (8.00)	4.15
Almix™ at 20 g/ha as POE + T_1	2.20 (7.00)	1.49 (2.44)	5.41
Butachlor 50 EC at 1 kg/ha as PE + T_1	2.16 (6.67)	1.39 (2.00)	5.61
Pretilachlor 50 EC at 0.75 kg/ha as PE + T_1	1.90 (4.67)	1.21 (1.35)	5.86
Almix™ at 20 g/ha as POE + T_2	2.89 (16.01)	2.07 (5.89)	4.59
Butachlor 50 EC at 1 kg/ha as PE + T_2	2.85 (15.33)	2.02 (5.54)	4.66
Pretilachlor 50 EC at 0.75 kg/ha as PE + T_2	2.69 (12.67)	1.79 (3.98)	4.82
Unweeded control.	4.16 (62.00)	4.99 (145.20)	1.81
LSD (P=0.05)	0.29	0.26	0.64

Figures in parentheses are means of original values.

Application of pretilachlor as pre-emergence at 0.75 kg/ha + 4 times cono weeding from 10 DAT at 10 days interval registered significantly highest grain yield of 5.86 t/ha. Comparable grain yield was observed among the treatments like application of butachlor as pre-emergence at 1 kg/ha + 4 times cono weeding from 10 DAT at 10 days interval and application of Almix as post-emergence at 20 g /ha + 4 times cono weeding from 10 DAT at 10 days interval.

CONCLUSION

Pretilachlor application at 0.75 kg/ha as pre-emergence + 4 times cono weeding from 10 DAT at 10 days interval has registered lowest total weed density, total weed dry matter production (DMP) and registered higher grain yield of 5.86 t/ha.

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Efficacy of herbicides and their combination on nut grass dominated *Rabi* maize

S. Patil*, M. Kumar and D. Singh

Department of Agronomy, Rajendra Agriculture University, Pusa, Samastipur, Bihar

Email:sandeeppatil.pusa@gmail.com

Maize (*Zea mays L.)* is the third most important food crop after rice and wheat. In Bihar, it is cultivated in over 6.45 million ha with a production of 14.39 million tonnes having average productivity of 2.23 t /ha. The research evidences suggest that the weedy environment beyond 30 DAS and up to 59 DAS is detrimental to maize crop and causes considerable yield losses and also increases cost of cultivation because there is no selective post emergence herbicide and their combinations for proper controlling of sedges, grasses and broad leaf weeds. Estimation of losses in yield caused by Grasses-77.7% , Non grassy-44.2% and Sedges -38.4% (Pandey *et al.* 2002). Now, it is need of the day to find out suitable herbicide & their combination for effective weed control in maize.

METHODOLOGY

An experiment on "efficacy of herbicides and their combination on *Cyprus* dominated *Rabi* maize (*Zea mays*)" was conducted at TCA farm Dholi, Muzzffarpur during *Rabi* 2013-14. Thirteen treatment of the post-emergence application of Halosulfuron-methyl in different level along with combinations of atrazine, carfentazone, 2,4-D and Hand weedingwere arranged in a RBD design with three replication. QPM maize cultivar '*Shaktiman-3'* sown in the experimental field with recommended package practices. Fertilizers were applied uniformly in the field through Urea, SSP and MOP at 150:60:40 kg N, P_2O_5 and K_2O /ha, respectively.

RESULTS

Sedges weeds were predominant Followed by broad leaves and grasses. *Cyprus* spp. among sedges, *Cynodon* among the grasses weeds and *Chenopodium* among broad-leaf weeds were more dominant. Herbicidal treatment significantly influenced the population and dry weight of matter production of weeds. Among the herbicidal treatments, the lower weed density and dry weight of weeds were observed under atrazine at 500 g/ha (PE) + halosulfuron-methyl at 67.5 g/ha (Po. E.). Maximum weed index was recorded in unweeded check. Atrazine at 500 g/ha (P.E.) + halosulfuron methyl at 67.5 g/ha (Post. E.) recorded minimum weed index and maximum weed control efficiency which was similar with weed free plots. This clearly indicates that weeds were controlled effectively under both doses of atrazine at 500 g/ha (PE) + halosulfuron-methyl at 67.5 g/ha (Po. E.) and atrazine at 250 g/ha (P.E.) + halosulfuron methyl at 67.5 g/ha (Post. E.) equally higher grain yield and stover yield were recorded under weed free plot, atrazine at 500 g/ha (P.E.) + halosulfuron methyl at 67.5 g/ha (PoE) and atrazine at 250 g/ha (PE) + halosulfuron-methyl at 67.5 g/ha (Po. E.) significantly superior with respect to other treatments and the lowest grain yield and stover yield were recorded under unweeded check. Both treatment atrazine at 500 g/ha (P.E.) + halosulfuron methyl at 67.5 g/ha (PoE) and atrazine at 250 g/ha (P.E.) + halosulfuron-methyl at 67.5 g/ha (Po.E.) were found very effective to minimise weed population and dry weight of weed, and maximized the grain and stover yield per ha significantly superior over check. Both treatments were increased in yield by 139.7% and 124.3%, respectively over the yield obtained in weed y check.

Table1. Weed density, weed dry weight Grain yield, stover yield, and weed index as influenced by different weed control treatments in maize

Treatment	Weed density (no./m^2)	Weed dry weight (g/m^2)	WCE	Weed index (%)	Grain yield (kg /ha)
Halosulfuron-methyl at52.5 g/ha at 25-30 DAS*	8.95(79.25)*	2.93(7.62)*	79.24	27.29	58.4
Halosulfuron-methyl at 67.5 g/ha at 25-30 DAS*	8.80(76.75)	2.91(7.52)	79.14	26.27	59.31
Halosulfuron-methyl at 135 g/ha at 25-30 DAS*	8.39(69.50)	2.79(6.81)	80.99	35.79	51.65
2,4-D ethyl ester at 900 g/ha at 25-30 DAS*	16.38(267.50)	5.88(33.58)	25.96	43.75	45.25
Atrazine at 500 g/ha as pre emergence (immediately after sowing).	16.39(267.75)	5.89(33.75)	25.67	17.79	66.14
Atrazine at 250 g/ha at 25-30 DAS*	16.464(270.25)	5.90(33.85)	25.35	24.84	60.46
Atrazine at 500 g/ha (Pre-emergence) + Halosulfuron methyl at 67.5 g/ha at 25-30 DAS*	6.75(44.75)	2.60(5.79)	86.65	0.46	80.08
Atrazine at 250 g/ha (Pre-emergence) + Halosulfuron methyl at 67.5 g/ha at 25-30 DAS*	6.95(47.50)	2.66(6.11)	85.86	1.44	79.29
Carfentazone at 20 g/ha at 25-30 DAS*	16.33(266.00)	5.87(33.48)	26.29	47.21	42.47
Carfentazone at 20g/ha + Halosulfuron methyl at 67.5g/ha at 25-30 DAS*	6.97(48.00)	2.66(6.10)	85.85	29.60	56.46
Halosulfuron-methyl at 82.5 g/ha at 25-30 DAS*	8.93(79.00)	2.96(7.83)	79.00	32.33	54.43
Weedy check	19.29(371.75)	6.66(43.42)	0.00	58.49	33.39
Weed free (Farmer practice Hand weeding at 30, 60 and 90 DAS)	3.07(8.50)	1.40(0.98)	97.64	0.00	80.45
LSD (P=0.05)	0.66(16.81)	0.21(2.003)			6.85

*values in parenthesis are original. Data transformed to square root transformation

CONCLUSION

The result clearly indicates that the application of atrazine at 500 g/ha (P.E.) + halosulfuron methyl at 67.5 g/ha (Po. E.) and atrazine at 250 g/ha (P.E.) + halosulfuron methyl at 67.5 g/ha (Post. E.) were more effective to minimise *Cyprus* dominated weeds and maximized the grain yield of maize.

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Effect of sequential application of herbicides on weed flora and yield of wet seeded rice

Mallikarjun*, C.S. Shrinivas and U.N. Santhosh
Department of Agronomy, University of Agricultural Sciences, Raichur, Karnataka 584 102
Email: yalagimallikarjun1@gmail.com

Rice (*oryza sativa* L.) is the major staple food of Karnataka cultivated in 1.48 m ha with an annual production of 3.69 million tones and with a productivity of 2482 kg/ha (Anon., 2010). Due to labour scarcity and high labour cost can be overcome by adopting direct seeding method especially of wet seeded rice, the field is puddled and leveled as done for transplanting but instead of transplanting rice seedlings, pre-germinated rice seeds are broadcasted. Conventional pre emergent herbicides like butachlor, anilophos which encounters weed competition from the day of germination followed by post emergent herbicides like 2, 4-D sodium salt and bispyribac-sodium were effective against many annual, dicot and sedge weeds in wet seeded rice.

METHODOLOGY

A field experiment was conducted during *Kharif* season 2011 at Agricultural Research Station, Malnoor, Karnataka, to investigate the effect of weed management practices on growth and yield of wet seeded rice (*Oryza sativa* L.). 15 treatments were laid with randomized block design with three replications (Table 1). Rice variety of BPT-5204 was wet seeded in the experimental field with recommended package of practices. Fertilizers were applied uniformly through dia ammonium phosphate, urea and muriate of potash 150 kg N 75 kg P_2O_5, 75 kg K_2O/ha, respectively. Data on weed growth, yield performance and were recorded.

RESULTS

Among the herbicidal treatments T_7, T_4, T_{10}, T_5 and T_8 recorded significantly the lower weed population and dry weight of grassy, broad leaved and sedges which were on par with each other. Among the herbicidal treatments, lowest weed density (3.67, 3.97, 4.32, 4.63 and 4.86/0.25 m^2), was recorded under T_7, T_4, T_{10}, T_5 and T_8 respectively, over unweeded check. The minimum weed dry weight was recorded in same treatments, which was significantly lower than all other treatments except hand weeding thrice and weed free check. These results are in conformity with the findings of Yadav *et al.* (2009). Maximum weed index was observed in unweeded check. Among the treatments T_7 and T_4 recorded minimum weed index (4.57 and 5.93%, respectively). This clearly indicated that weeds were controlled effectively under sequential application of herbicides. The highest grain yield (5.10 t/ha) was recorded in weed free check followed by hand weeding thrice (5.07 t/ha) and lowest (1.86 t/ha) was under unweeded check. The yield loss due to uncontrolled growth of weeds as compared to hand weeding thrice was 63.3%. Among the herbicidal treatments, T_7, T_4, T_{10}, T_5 and T_{11} recorded highest grain yield (4.87, 4.80, 4.68, 4.55 and 4.48 t/ha respectively) which were on par with each other and significantly highest over the other herbicidal treatments. The maximum straw yield was recorded in weed free check (5.46 t/ha) and lowest (2.27 t/ha) in unweeded check.

Table.1 Weed growth and yield of wet seeded rice as influenced by different weed control treatments

Treatment	Weed density (no. /0.25 m^2)	Weed dry weight (g /0.25 m^2)	Weed index	Grain yield (t/ha)	Straw yield (t/ha)
Butachlor 50 EC 1.25 kg/ha	7.4 (55.1)	2.8 (7.8)	27.21	3.71	4.19
30 EC 600 g/ha	7.6 (57.8)	2.9 (7.9)	28.80	3.64	4.11
Oxyfluorfen 23.5 EC 200 g/ha	7.9 (63.0)	3.34(10.6)	52.90	2.39	2.82
Butachlor *fb* 2,4-D sodium salt	3.9 (15.3)	1.7 (2.6)	5.93	4.80	5.22
Anilophos *fb* 2,4-D sodium salt	4.6 (20.9)	1.8 (2.8)	10.36	4.55	4.99
Oxyfluorfen fb 2,4-D sodium salt	6.5 (41.7)	2.4 (5.6)	42.79	2.82	3.30
Butachlor *fb* bispyribac sodium	3.6 (12.9)	1.7 (2.5)	4.57	4.87	5.26
Anilophos *fb* bispyribac sodium	4.8 (23.1)	1.8 (3.0)	10.97	4.53	4.99
Oxyfluorfen *fb* bispyribac sodium	6.1 (36.9)	2.4 (5.5)	39.02	3.07	3.55
Butachlor *fb* hand weeding at 25 DAS	4.3 (18.2)	1.8 (2.7)	8.31	4.68	5.10
Anilophos *fb* hand weeding at 25 DAS	5.1 (25.8)	1.9 (3.1)	11.91	4.48	4.97
Oxyfluorfen *fb* hand weeding at 25 DAS	6.3 (39.4)	1.9 (3.1)	41.80	2.94	3.31
Hand weeding (thrice) at 20, 40 and 60 DAS	0.7 (0.0)	0.7 (0.0)	0.76	5.07	5.44
Unweeded check	11.3 (129.3)	4.0 (16.4)	63.45	1.86	2.27
Weed free check	0.7 (0.0)	0.7 (0.0)	0.00	5.10	5.46
LSD (P=0.05)	0.7	0.4	-	0.36	0.85

*Values in parantheses are original. Data transformed to squre root transformation

CONCLUSION

It was concluded that sequential application of butachlor fb bispyribac sodium or 2,4-D sodium salt or hand weeding at 25 DAS was more effective for controlling weeds, improved grain yield and profitability of wet seeded rice.

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Effect of pyrazosulfuron-ethyl for weed control in rice in bilaspur district of Chhattisgarh plain

Vinamarta Jain , Namrata Jain and M.P.Thakur
College of Agriculture, Rajnandgaon, Chattisgarh 492 010

Rice is the staple food for the 65% of total world's population. Rice is the major crop of Chhattisgarh and cultivated in around 37 lakh hectare with average productivity of 1751 kg/ha which is far below of its potential yield. Weeds are the major constraints in production of direct seeded rice which reduced the yield upto 50-97 % in rainfed uplands (Singh *et al*. 1996). Direct seeding of rice is possible, provided there is a good crop establishment as well as adequate weed control methods are available to keep the crop free from weeds. Keeping this in view, the present trial was conducted to evaluate the performance of pre emergence herbicide pyrazosulfuron-ethyl in farmer's field.

METHODOLOGY

An on farm trail was conducted to evaluate the performance of pre emergence application of pyrazosulfuron ethyl in farmer's field at village Khargahna (Block – Takhatpur) of Bilaspur district Chhattisgarh plain in upland rainfed condition of rice during 2011-12 in comparison to farmer's practice (Biasi). The crop was sown in the first week of July with recommended dose of fertilizer 100:60:40 Kg N:P:K /ha. Full dose of phosphorus and potash was given as basal and nitrogen was applied in three splits.

RESULTS

It is revealed from the data that application of pre emergence pyrazosulfuron-ethyl followed by one hand weeding at 25 DAS recorded 22.91% higher number of effective tillers as compared to farmer's practice. Application of pyrazosulfuron-ethyl followed by one hand weeding at 25 DAS recorded the higher grain yield (2.65 t/ha) as compared farmer's practice (2.00 t/ha). The average net return was higher in pyrazosulfuron-ethyl followed by one hand weeding at 25 DAS (1.17560/ha) as compared to farmer's practices (1.2000/ha) and the B:C ratio was also superior in Pyrazosulfuron ethyl followed by one hand weeding at 25 DAS (1.52:1) over farmer's practice (1.22:1).

CONCLUSION

It was concluded from the trail that application of pre emergence Pyrazosulfuron ethyl followed by one weeding gave higher yield and net monetary return at farmer's field situation of Khargahna block of Chhattisgarh plain in direct seeded rice.

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Evaluation of sequential application of herbicides on weed control and yield of maize

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Shrinivas C. S.*, Mallikarjun, Shrikant and Rajanand Hiremath
Department of Agronomy, University of Agricultural Sciences, Raichur, Karnataka 584102
**Email: scs4268@gmail.com*

However, Weeds are one of the limiting factors in maize cultivation which are controlled with sequential and tank mix application of herbicides to ensure high profitability with less cost on controlling weeds.

METHODOLOGY

A field experiment was conducted during *Kharif* season of 2012-13 at Agricultural Research Station, Malnoor, Yadagir (Dist.) Karnataka, to evaluate the sequential application of herbicides on weed control, growth and yield of maize (*Zea mays* L.) under irrigated condition. Treatments details given Table 1. Maize variety '*MAI-105*' was dibbled in the experimental field with recommended package of practices. fertilizers were applied uniformly through Urea, DAP, muriate of potash 150 kg N 75 kg P_2O_5, 37.5 kg K_2O/ha, respectively. Data on weed growth, yield performance and were recorded.

RESULTS

Among the fifteen treatments, T_{12}, T_3, T_7, T_8, T_4, T_5 and T_9 recorded significantly lower weed density (0.71, 2.64, 3.31, 3.80, 3.89, 3.90 and 4.12 /0.25m^2) over weedy check and T_7, T_3 and T_2 recorded significantly lower weed dry weight which was at par with each other. However, highest weed population and dry weight was recorded in weedy check over rest of the treatments. These results are in conformity with findings of Ramesh and Nadanassabady (2005). Lower weed population and dry weight, resulting in higher weed control efficiency in T_7, indicates that treatments that received the 2, 4-D sodium salt as post emergent and tank mix of herbicides were effective in controlling weeds. However, weed free check recorded significantly higher grain yield (5.73 t/ha) which were at par with T_3, T_4, T_6, T_{11}, T_7, T_{10} and T_1 and same trend was fallowed in stover yield.

CONCLUSION

It was concluded that tank mix application of atrazine (50%) + pendimethalin (50%) was found to be the best and it controlled all the type of weeds (grasses, sedges and broad leaved weeds) for long time and recorded higher grain yield, net returns and benefit cost ratio.

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Weed management in linseed with herbicides

R.K. Singh[1*], P.N.S. Thakur[1], Aarti Singh[1] and Kanchan Singh[2]

[1]*Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221005*

[2]*Deptt. of Food Science and Technology, SHIATS, Allahabad, Uttar Pradesh*

[*]*Email: profrksinghagronomybhu@gmail.com*

Linseed (*Linum Usitatissimum* L.) is one of the major industrial oilseed crop of India and stands next to rapeseed-mustard in *rabi* oilseeds in area and production. Every part of linseed is utilized for productive purposes, either directly or after processing. Linseed is mainly grown under conserved moisture and limited nutrient conditions with poor management practices. Among the various constraints in linseed production, weeds pose a major threat in depleting these conserved resources. Yield losses due to weed completion in linseed were reported to be to the tune of 40% (Saraswat *et al*. 1991). Crop weed studies competition indicate that the initial 20-45 days after sowing are critical, and if weed free conditions are maintained during this period higher yield could be realized. Therefore, the present study was undertaken to find out the effective herbicide for weed control in linseed.

METHODOLGY

A field experiment was conducted during *Rabi* 2012-13 at the Agricultural Research Farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (U.P.). The soil of the experimental field was sandy clay loam in texture, low in available N (165.5 kg/ha), medium in available P (23.2 kg/ha) and K (254.5 kg/ha) having neutral reaction (pH 7.2). The experiment comprised of nine treatments, *viz*., T1- weedy check, T2- hand weeding, T3- pendimethalin 30 1 kg/ha, T4- pendimethalin 30 EC+ imazethapyr 2 EC 0.75 kg/ha, T5- pendimethalin 30 EC + imazethapyr 2 EC 1 kg/ha, T6- isoproturon 1kg/ha at 2-3 leaf stage of weed, T7-clodinafop 60 g/ha at 2-3 leaf stage of weed, T8- imazethapyr 10 EC 75 g/ha at 2-3 leaf stage of weed, T9- imazethapyr 10 EC 100 g/ha at 2-3 leaf stage of weed was replicated thrice in a randomized block design. Linseed variety '*Shekhar*' was sown in rows 30 cm apart with a seed rate of 30 kg/ha on 11 November 2012. All the recommended packages of practices for the region were followed. Recommended doses of herbicides were applied with a foot operated sprayer fitted with flat fan nozzle. After 30 days of sowing weeds enclosed in quadrate (0.25 m^2) were randomly collected from each plot. Weed control efficiency (%) was calculated on the basis of weed dry weight at 30 days after sowing. Observations on yield attributing characters, yield and economics were also recorded.

RESULTS

The dominant weed flora of the experimental field consisted of *Anagallis arvensis*, *Melilotus* spp., *Solanum nigrum*, *Chenopodium album*, *Cyperus* spp., *Phalaris minor* and *Eleusine indica*. All the herbicidal treatments caused significant reduction in total density and dry weight of weeds as compared to weedy check. Among the various herbicidal treatments application of imazethapyr 10 EC 100 g/ha was significantly superior in reducing the weed density, dry weight and recording higher weed control efficiency. Yield attributes *viz*. no of capsules/plant, no of seeds/capsule, test weight and yield were significantly superior with the application imazethapyr 10 EC 100 g/ha but remained comparable with the application of clodinafop 60 g/ha. These results are in conformity with the findings of Babu *et al*. (2013) in groundnut crop. Higher B:C ratio was observed with the application of imazethapyr 10 EC 100 g/ha.

CONCLUSION

Based on the above findings it could be concluded that imazethapyr 10 EC 100 g/ha and clodinafop 60 g/ha can be used in place of hand weeding twice at Varanasi.

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Impact of OFR trial cum demonstration on weed management technology in maize

P.K. Singh* and K.K. Barman

Directorate of Weed Science Research, Jabalpur Madhya Pradesh 482 004

**Email : drsinghpk@gmail.com*

Maize is one of the important food, green forage and industrial crops of the world. In India it is the third most important food-grain crop and has been considered as a promising option for diversifying agriculture in upland area. The total area for maize in India is 74 lack hectares and 73% of it is cultivated under rain fed conditions (Prajneshu 2008). The state of Madhya Pradesh is one of the traditional maize growing states, and accounts for 13 per cent of the total maize area. However, its productivity when compared to other maize growing states is very low. The low productivity level of maize in Madhya Pradesh is primarily due to inability of the majority of farmers to follow the recommended package of practices either due to high cost or lack of awareness. In recent years, severe weed menace in maize resulted in reduction in productivity, quality produce and income to farmers. Therefore, an attempt was made under on farm research programme of DWSR to address the weed management issue in the farmer's field.

METHODOLOGY

During preliminary survey it was found that the soils of two tribal villages (Khukham, Ranipur) of Kundam tehsil of Jabalpur (MP) are highly unfertile, full of gravels/stones, red coloured with very low content of organic carbon. The land of the area is highly undulated and farmers are fully dependent on rain water. The water holding capacity of soil is also very poor. Farmers are illiterate and very backward in terms of modern agricultural technologies. They used to grow only local varieties of maize without any application of fertilizers and modern weed management practice. They occasionally practice 1HW, that too at later stage of crop growth with the intention of using the weed biomass as fodder. Twenty OFR cum demonstration trial on improved technologies including weed control were laid out at farmer's field in a participatory mode in Maize crop during kharif seasons of 2012 and 2013 at these purposively selected localities. The objective of this OFR trial was to show the performance and profitability of proven weed management technologies, *viz.* atrazine at 1.0 kg/ha (PE), atrazine at 1.0 kg/ha PE + 1 HW at 30 DAS and atrazine at 1.0 kg/ha PE+ mulching, on weed growth and productivity of maize at farmers fields.

RESULTS

The improved technologies including weed management under OFR-cum-demonstration were found effective in increasing grain yield of maize by 63-103% over farmers practice depending upon the intensity and growth of weeds, and gave an additional economic benefit of ' 12500-19000/ha over farmers practices (FP). Weed control efficiency (WCE) and BC ratio of the imposed treatments were 50-72 percent and 1.93-2.15, respectively (Table 1). During the period of OFR-cum-demonstration, it was noted that farmers practice, *i.e.* manual weeding at inappropriate stages of crops, has no relevance over the crop yield and economy. It was also observed that few resourceful farmers were aware of the role of improved weed management technology in enhancing the overall crop productivity but still continuing the conventional practice of HW owing to various social, economical and other constraints prevailing in the rural areas. A general comparison of the costs of cultivation of traditional and hybrid cultivars has revealed that the cost increases on using the improved cultivars due to higher requirements of fertilizers, irrigation, herbicides and plant protection chemicals as compared to that needed for the traditional varieties. However, with the significant increase in yield, the cost of production per unit amount of grain yield has been much lower in case of the improved cultivars. The estimation of technical efficiency of the farmers has revealed that on an average the sample farms operate 35-40 per cent below the frontier output levels. Hence, it has been concluded that the maize yield and farmer's income of these localities can be increased through adoption of proper technologies.

Table 1. On-farm research cum demonstration on weed management technologies in maize.

Treatment	Weed count (no/m²)	Dry weight (g/m²)	Weed control efficiency (%)	Grain yield (t/ha)	% increase in yield over FP	Cost of treatments (x10³₹/ha)	Economic benefit due to treatment over FP (x10³₹/ha)	BC Ratio
Atrazine at 100 g/ha PE	66	41.4	50	1.88	63	0.72	12.66	1.93
Atrazine at 100 g/ha PE + 1 HW at 30 DAS	42	30.4	64	2.19	84	2.72	15.35	1.94
Atrazine at 100 g/ha PE + Mulching	34	23.4	72	2..41	103	2.22	19.08	2.15
Farmers Practice 1 HW	123	82.6	-	1.19	-	3.20	-	1.46

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Farmers participatory assessment of herbicidal weed control in r*abi* groundnut

L.G. Pawar, B.P. Patil and V.N. Shetye

College of Agriculture, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli , Maharashtra 415 712

Groundnut, the non-traditional oil seed crop for *Konkan* has been becoming increasingly popular, especially, in its south zone because of its higher productivity as *Rabi* (winter) irrigated crop due to warmer climate with mean maximum and minimum temperatures ranging between 25^0-35^0 C and 17^0 – 27^0 C respectively which also favours incidence of many weeds and their faster growth. Hand weeding is the common practice of weed control, which many farmers are not able to attend at critical period of 20 to 45 days after sowing (DAS) groundnut because of labour shortage at the peak period of their demand and their higher rates of wages. Yaduraju *et al.* (1980) observed reduction in yield of groundnut by 70 per cent due to weed infestation.

METHODOLOGY

On Farm Trials were conducted at the *Hodawade* village in *Sindhudurg* district of Maharashtra during 1999-2000 and 2000-2001 to assess comparative efficacy of herbicides and hand weeding for weed control in groundnut variety *TG-26* as per treatment details indicated in Table 1 which were replicated on the fields of 15 farmers during both the years of study. While butachlor was applied as pre-emergence (PE), fluchloralin was applied as pre-plant incorporation (PPI). Observations on composition of weed flora, their mean density and growth were recorded in four randomly thrown quadrants of 0.25 m^2 in each of the treatment at 90 DAS and were summed-up to get weed density and growth/m^2 in addition to treatment-wise yield of dry pods.

RESULTS

Weeds *viz. Digetaria ciliaris, Echinocholoa colona, Eleusine indica, Dactyloctenium aegyptium* from grasses and *Physalis minima, Abutilon indicum. Cleome viscosa* and *Mollugo* species from broad leaf weeds were present. In general, grasses were dominant in respect of their density (67.8%) and growth (61.6 %) as compared to BLWs (Table 1). All weed control measures tested, reduced density and growth of both grasses and BLWs significantly as compared to untreated control.

Table 1. Effect of different weed control measures on incidence of weeds, and their growth dry pod yield and economics of treatments

Treatment	Mean density of weeds (no./m^2)		Mean weed growth (g/m^2)		Mean dry pod yield (t/ha)	AR	AC	AR/AC ratio
	Grasses	BLW'S	Grasses	BLWS				
Control weedy check	98.1	46.6	124.0	77.2	1.35	--	--	
Manual weeding twice at 20 and 40 DAS	15.6	8.8	12.6 (89.83)	3.4 (95.60)	2.25	31500	5400	5.83
Butachlor at 1.5 kg/ha (PE)	18.1	22.9	19.6 (84.19)	21.8 (71.76)	2.24	31150	1320	23. 60
Fluchloralin *at 1 kg/ha(PPI)*	14.6	21.4	12.2 (90.16)	20.1 (73.96)	2.33	34300	2036	16.85
Fluchloralin *at 0.75 kg/ha (PPI)*	21.2	23.4	26.4 (78.70)	29.1 (62.31)	2.14	27650	1647	16.79

Figures in parenthesis indicates weed control efficiency, BLWs- Broad leaf weed, WCE - Weed control efficiency per cent, PE - Pre-emergence, PPI - Pre-plant incorporation, AR - Additional returns (₹/ha), AC- Additional cost (₹/ha), Prices - Groundnut dry pods : ₹ 35,000/t, Butachlor: ₹ 280/kg ; Fluchloralin : ₹ 700 /kg, Wages: ₹ 120/ day

Amongst these effective treatments, hand weeding twice at 20 and 45 DAS was the best for control of grasses and BLWs too exhibiting highest mean weed control efficiency of 92.72% followed by the treatments of using fluchloralin at 1.0 kg/ha (82.06%) and butachlor (77.97%). However, differences between latter treatments were not much conspicuous. Use of herbicides showed increase in density of BLWs and their growth also due to their late emergence in herbicide treated plots. Dry pod yield of groundnut was maximum in fluchloralin treated plots at 1.0 kg/ha closely followed by treatments, *viz.*, manual weeding twice and use of butachlor as against control. Loss of dry pod yield due to weeds as compared to best treatment of fluchloralin was found to be 42.06 per cent. On the basis of treatment-wise costs incurred and returns obtained, butachlor use was the best treatment exhibiting highest AR/AC ratio of 23.60 as against 5.83 in case of hand weeding.

CONCLUSION

Pre-emergence application of butachlor at 1.5 kg/ha for weed control in *Rabi* groundnut in South *Konkan* Coastal Zone is the best cost effective option as an alternative to hand weeding which besides being economical, averts problem of labour shortage at the peak demand.

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System of rice intensification : an appropriate and alternative technology for natural resource conservation and yield enhancement

Damini Thawait, Samaptika kar and Amit Kumar Patel
Indira Gandhi Agricultural University,Raipur, Chhattisgarh, 495001
E-mail: daminithawait@gmail.com

Rice is life to a majority of people in Asia. The cultivation of rice represents both a way of life and a means to livelihood. For more than half of humanity, India is second largest producer after china and has an area of over 42.2 million hectares and production of 104.32 million tonnes with productivity of 2372 kg/ha (Anonymous, 2012a). SRI was first developed by Henri de Laulanie in the late 1980's in Madagascar country, hence popularly called as "Madagascar method" of rice cultivation by people of other countries. SRI is a methodology, which increases the productivity of irrigated rice by changing the management of plants, soil, water and nutrients. Due to use of organic manures and optimium use of fertilizers and other components of SRI the quality of grains are enhances and the yield is also increases.

MATERIAL AND METHOD

The present investigation was conducted at IGKV, Raipur Chhattisgarh during the *Kharif* season (July to December) 2012. The experiment was conducted during *Karif* . Raipur is situated in mid-eastern part of Chhattisgarh state and lies at 21^0 16' North Latitude and 81^0 36' East Longitude with an altitude of 298.5 metres above the mean sea level. This region comes under dry moist to sub humid climatic condition. The region receives on an average of 1200-1400 mm rainfall annually, out of which about 87 percent received during the rainy season (June to September) and the rest 13 percent during winter season (October to February). The source of rainfall is south western monsoon. The kernel length and breadth (mm) was calculated by taking ten milled grain and average length and breadth were recorded in mm where as the kernel length: breadth ratio is calculated by dividing the length of milled rice to breadth of milled rice.

RESULTS

Treatments were able to produce significant variation for length, breadth and L: B ratio of kernel. The kernel breadth was recorded highest under treatment 25 x 25 cm +S_{2-3} (T_2) which was significantly superior over all other treatments. Whereas the highest kernel length was recorded under the treatment 25 x 25 cm + S_{2-3} (T_2), 25 x 25 cm + S_{4-5} (T_3) and 25 x 20 cm + S_2 (T_5) which was at par with the treatments 25 x 25 cm + S_1 (T_1), 25 x 20 cm + S_1 (T_4) and 25 x 20 cm + S_3 (T_6). The highest value of L:B ratio was recorded under the treatment 20 x 10 cm + S_{2-3} (T_{14}) which was found to be at par with treatments 25 x 25 cm +S_1 (T_1), 25 x 25 cm+ S_{2-3} (T_2), 25 cm x 25 cm + S4-5 (T3), 25 x 20 cm + S_{2-3} (T_5), 25 x 20 + S_{4-5} (T_6), 25 x 15 + S_1(T_7), 25 x 15 + S_{2-3} (T_8), 25 x 15 cm + S_{4-5} (T_9), 25 x 10 + S_1 (T_{11}) and 20 x 20 cm+ S_2 (2S) (T_{13}). It might be due to difference in spacing and seedling density. So this type of practices works as the appropriate and alternative technology for natural resource conservation and yield enhancement. The similar results are found by Bajpai and Singh (2010) and Babu *et al.*(2006).

Table 1. grain quality as influenced by system of rice intensification practices

Treatment	Kernel Length (mm)	Kernel Breadth (mm)	Kernel L:B ratio
T_1 25x25cm^2+S_1	5.53	1.80	3.08
T_2: 25x25cm^2+S_{2-3}	5.54	1.83	3.07
T_3 25x25cm^2+S_{4-5}	5.54	1.78	3.07
T_4 25x20cm^2+S_1	5.53	1.80	3.05
T_5 25x20cm^2+S_{2-3}	5.54	1.79	3.08
T_6: 25x20cm^2+S_{4-5}	5.51	1.79	3.07
T_7 25x15cm^2+S_1	5.47	1.77	3.08
T_8 25x15cm^2+S_{2-3}	5.47	1.77	3.08
T_9 25x15cm^2+S_{4-5}	5.48	1.77	3.10
T_{10}:25x10cm^2+S_1	5.47	1.76	3.05
T_{11}:25x10cm^2+S_{2-3}	5.47	1.74	3.13
T_{12}:25x10cm^2+S_{4-5}	5.43	1.77	3.06
T_{13}:20x20cm^2+S_2(2S)010	5.39	1.73	3.08
T_{14}:20x10cm^2+S_{2-3}	5.31	1.72	3.11
SEm +	**0.01**	**0.005**	**0.01**
CD(P=0.05)	**0.04**	**0.01**	**0.04**

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Design, development and evaluation of DWSR herbicide wick applicator for weed management in field crops

H.S.Bisen*

Directorate of Weed Science Research, Jabalpur – 482004, Madhya Pradesh

**E-mail: erhsbisen@gmail.com*

Mechanical hand tools and long handle weeders are adopted by farmers for removing weeds when weeds are small but mechanical weeding is time consuming, labour intensive and costly. Weeds grow rapidly and their control by mechanical weeding method is difficult when weeds are grown up at later stages. The DWSR herbicide wick applicator is suitable in these crop situations when weeds are grown up and selective herbicides are not available and recommendations are not there. In those situations, the herbicide wick applicator is a better option for application of non-selective and contact nature of herbicides.

METHEDOLOGY

A DWSR herbicide wick applicator has been designed and developed for applying non-selective herbicides in between crop rows. It consists of cylindrical roller pad, frame, ground wheels, solution tank, cut-off valve and handle. The concentrated herbicide solution stored in chemical tank and flows over to cylindrical roller pad through cut-off valve. The cylindrical roller is covered with fibrous clothed pad which gets wet by herbicide solution. When the unit is operated in wide spaced crop rows, the wet roller pad / cloth comes in contact with the grown up weed plants and herbicide solution gets in contact with weeds. Further improvement has been made to enhance the stability during operation of this applicator by reducing the overall weight of the machine, reducing the size of tank, compact arrangement of fixing herbicide tank at lower height and incorporating bearing in rotor wheels. The DWSR herbicide wick applicator was evaluated in soybean and mustard crops and compared with high volume Knapsack sprayer for application of herbicides.

RERSULTS

The weed control efficiency achieved on weed dry wt. basis with DWSR herbicide wick applicator was 58.0% as compared to 70.9% WCE with knapsack sprayer (HV spraying) for imazethapyr. For application of chlorimuron-ethyl + quizalofop-ethyl by wick applicator and knapsack sprayer, the wed control efficiency were 62.3% and 73.1% respectively in soybean (Table 1)

The field performance of the wick applicator was carried out in mustard during *Rabi* - 2011-12 and compared with HV Knapsack sprayer using nozzle hood for application of imazethapyr and glyphosate. The weed control efficiency on dry wt basis was 67.7 %with herbicide wick applicator as compared to 72.1% under HV Knapsack sprayer. In the case of glyphosate, both the application techniques were found at par in respect to weed control efficiency (Table 2)

Table 1. Weed control efficiency (%) achieved by wick applicator and H.V. knapsack sprayer in Soybean crop.

Treatment	Weed control efficiency (%)		Yield (t/ha)
	Weed count Nos./sq m	Dry wt	
Imazethapyr by wick applicator	62.3	58.0	1.52
Chlorimuron + quizalofop by wick applicator	60.1	62.3	1.55
Imazethapyr by H.V. Knapsack sprayer	60.6	70.9	1.56
Chlorimuron + quizalofop by H.V. Knapsack sprayer	64.1	73.1	1.55
Weed free by mechanical twin wheel hoe weeder	71.07	60.5	1.56
No Control measures	0.00	0.0	1.57

Table 2. Weed control efficiency (%) achieved by wick applicator and H.V. knapsack sprayer with nozzle hood in mustard crop in Rabi 2011-12

Treatment	Weed control efficiency (%)		Yield (t/ha)
	Weed count	Dry wt.	
Imazethapyr by wick applicator	57.6	67.8	1.13
Glyphosate by wick applicator	57.0	74.0	1.17
Imazethapyr by H.V. Knapsack sprayer with nozzle hood.	54.6	72.1	1.17
Glyphosate by H.V. Knapsack sprayer with nozzle hood.	53.9	75.2	1.17
Weed free by mechanical twin wheel hoe weeder	57.7	90.7	1.24
No Control measures	0.00	0.00	1.00

CONCLUSIONS

The DWSR herbicide wick applicator performed satisfactorily and controlled weeds. growing in between crop rows and its weeding efficiency was found at par with HV knapsack spraying having nozzle hood.

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Preliminary evaluation of the biorationals of *Colletotrichum dematium* FGCC#20 for the management of *Parthenium*

Jaya Singh*, Saurabh Gupta, & Deepak Mishra[1]

**Research Institute Biodiversity Conservation and Rural Biotechnology Center, Jabalpur (M.P)*

[1]Dept. of Biotechnology A.K.S.University Satna (M.P)

Parthenium hysterophorus L. popularly known as Congress grass, is a poisonous, aggressive herbaceous annual inhabiting tropical and subtropical environments. It is an ephemeral member of Asteraceae which poses a serious threat to agricultural crops, human beings and livestocks. It has emerged as one of the world's worst weed causing loss to crop productivity, biodiversity and environment. Conventional methods of the control have failed due to one or the other reasons. Exploitation of microbes and their by products as herbicide has generated significant interest worldwide (Pandey *et al.* 2003 Saxena *et al.,* 2001). *Colletrotricheum dematium* is a well known phytopathogen responsible for many diseases in plant. Various species and strains of the fungus synthesize a variety of phytotoxic secondary metabolites and of 21 days old CFCF after 24 hpt. Few of them have also been evaluated for their herbicidal potential against many weeds (Graupner *et al.* 2003).

METHODOLOGY

The strain of *Colletotrichum dematium* FGCC#20 was grow on 250ml Erlenmeyer's flasks containing 200ml Richard's Broth were seeded with 5mm disc of inoculums separated from 7 days old cultures grown on PDA medium. Inoculated flasks were incubated at 28$\pm$2^{o}C in a BOD incubator and the cell free culture filtrate (CFCF) was extracted after 7, 14, 21 and 28 days.The metabolized broth was passed through what man no 1 filter paper under aseptic conditions through a pre-weighed what man filter paper no. 1 and was centrifuged at 400rpm for 15-20 min. The pellet was discarded and the supernatant was again filtered *in vacuo* by microfiltration using sterile micro filters, 0.45 mm pore size, Minisart (Sartorius, Gottingen, Germany) making it cell free. Thus Cell Free Culture Filtrate was obtained. Herbicidal potential of the strain was determined by different bioassay *viz.* Shoot cut, Seedling and Detached leaf bioassay

RESULTS

Herbicidal potential of Cell Free Culture Filtrate (CFCF) of *Colletotrichum dematium* FGCC#20 against *Parthenium hysterophorus* was determined by seedling and Detached Leaf Bioassays. Maximum phytotoxicity was obtained from 21 days old fermented Broth at 100% concentration. Significant reduction in biological contents *i.e.* photosynthetic pigment and protein contents was observed in the host weed on treatment with the CFCF as determined by Detached leaf Bioassay Phytotoxic damage such as severe wilting, chlorosis, necrosis and complete collapse of the entire parts of the weed were also noticed due to CFCF application in the seedlings, while leaf area damage assessed in detached leaves bioassay of the test weed application in 100% concentration of 21 days old CFCF. The above findings clearly indicate that CFCF of the pathogen have significant herbicidal potential against the target weed.

Table 1. Phytotoxic damage of 21 days old CFCF of *C. dematium* FGCC#20.

Concentration (%)	Phytotoxic damage rating		
	12 hrs	24 hrs	48 hrs
Control a	0	0	0
Control b	0	0	0
25	0.22	0.64	0.84
50	1.55	2.35	2.55
75	3.6	4.44	5
100	3.84	4.64	4.88

CONCLUSION

The above finding clearly indicates that CFCF of the pathogen *C. dematium* FGCC#20 have significant herbicidal potential against Parthenium weed requires extensive evaluation regarding maximization, formulation and finally large scale application.

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Automization system effects on productivity, water and weeds of summer rice

Anamika Sonit, Hemlata Nirala and A.L. Rathore
Department of Agronomy, IGKVV, Raipur 492 012 Chhattisgarh
Email-hemlatanirala@gmail.com

Summer rice occupied sizeable area in the state and with increasing availability of water; area of summer rice is increasing gradually. Flood irrigation is only method of irrigation to summer rice. Atomization system delivers the water directly to small area and control the water loss. Summer rice occupied sizeable area in India including Chhattisgarh which is gradually increasing with creation of irrigation facilities. Summer rice is grown in 4.83 million ha with average productivity of 3174 kg / ha (2010-11) in the country. In Chhattisgarh, rice is grown in 3.788 million ha during *Kharif* season with average yield of 1751 kg / ha (2010-11).

METHODOLOGY

The experiment was conducted at Research Farm, IGKV, Raipur (C.G.) during summer season 2013. Treatment consisted of two rice varieties ('*MTU1010*' and '*IR64*' as main plots and five drip irrigations (0.6, 0.8, 1.0, 1.2 and 1.4 IW: CPE ratio), micro sprinkler irrigation once in three day and flooding as sub plots. Data on weed growth, and yield performance were recorded. The data on weed density before and after implementation of weed control treatment are presented in Table 1. Under aerobic condition weed is the major problem therefore to control weeds herbicide was applied at early vegetative stage and subsequently manual weedings were done. The maximum seed yield was recorded in drip irrigation at 1.4 IW: CPE ratio which was at par with traditional flooding. Water use efficiency in all the drip irrigation treatments (1.0, 1.2 and 1.4 IW:CPE ratio) was in the range of 2.5-2.9 kg / ha mm whereas it was 0.11 kg / ha mm in flooding. Net return and B:C ratio were significantly higher in drip irrigation at 1.2 and 1.4 IW:CPE ratio than other treatments. The crop was highly infested with weeds in all stages of crop.

RESULT

Highest weed density was recorded at 80 days after emergence in IW / CPE 0.6 ratio which was statistically similar with drip irrigation at 0.8, 1.0, 1.2 and 1.4 IW:CPE ratio and micro sprinkler but were significantly superior over the traditional flooding method of irrigation treatment. Seed yield of summer rice (Table 1). The maximum seed yield was recorded in drip irrigation at 1.4 IW: CPE ratio which was at par to traditional flooding and drip irrigation at 1.2 IW: CPE ratio but these treatments were significantly superior over rest of the treatments. The seed yield of micro sprinkler irrigation was at par to drip irrigation at 1.0 and 0.8 IW: CPE ratio. Better yield may be due to sufficient availability of water whereas stress condition might has reduced the seed yield. Seed yield does follow the pattern of yield attributing characteristics; both the varieties did produce statistically similar yields. The straw yield followed the trend of seed yield. Harvest index was statistically similar in all the treatments and showed numerical difference among them. Similar results were also reported by Zimmerman, (2011) and Govindan and Grace, (2012).

Table 1. Effect of irrigation schedule and varieties on weed count (no./m²) seed and straw yield and harvest index of summer rice

Treatment	Weed count (no. / m²) at harvest	Seed yield (t/ha	Straw yield (t / ha)	Harvest index (%)
Irrigation schedule				
Drip 0.6 IW:CPE	44.00	2.43	3.69	39.68
Drip 0.8 IW:CPE	45.33	2.71	3.84	41.37
Drip 1.0 IW:CPE	45.33	2.94	3.97	42.74
Drip 1.2 IW:CPE	40.67	3.24	4.46	42.34
Drip 1.4 IW:CPE	39.33	3.30	4.94	40.19
Sprinkler-3D	44.67	2.94	4.25	41.05
Sub-Trad	44.67	3.28	4.87	40.27
LSD (P = 0.05)	11.11	2.97	0.52	NS
Variety				
'MTU1010 '	45.24	28.68	41.34	41.08
'IR64'	41.62	30.94	44.38	41.11
LSD (P = 0.05)	10.071	NS	NS	NS

CONCLUSION

It was concluded that drip irrigation however using by the farmers in plantation crops but in this study it was used in rice. Findings of the present study is however preliminary but quite encouraging. It can be concluded that drip irrigation (1.2 and 1.4 IW:CPE ratio) is superior to flooding for summer rice in relation to (i) water and energy saving, (ii) water use efficiency, (iii) minimize methane production and (iv) harvest attractive seed yield.

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Management of weeds under organic farming through conservation agriculture

Sunita Verma*, Lokesh Dubey and Arvind Verma
Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur, Madhya Pradesh 482 004
**Email: sunitavermajnkvv11@gmail.com*

Weeds are often a major threat in organic farming and it seems as a key bottleneck for a promotion of sustainable organic plant production (Bàrberi 2002). In India, near about 25-50% of potential crop yield is reduced by weeds and yield reduction is more severe under organic farming systems because of banned in agrochemicals use. Before introduction of agro-chemicals, almost all agricultural areas were organic by default. Interestingly, commercial organic farming was only started since early 1990s after realizing the hazards of agro-chemicals in human and environment (Pokhrel and Pant 2009). Willingness to pay for organic product is increasing whereas the production and productivity of organic products are low in India. The primary reasons could be unavailability of organic inputs, lower crop yields, higher weed problems (Mader and Berner 2012), lack of structured markets, improper counseling and lack of training on OF. Organic farming and conservation agriculture (CA) have two contradictory philosophies for a weed control. OF focuses in no-use of agro-chemicals and promotes intensive tillage for weed control CA is focused on three principles; i) less disturbance of soil by minimum tillage or zero-tillage and use of herbicides for suppression of weeds, ii) retention of sufficient residues on the soil surface, and iii) cover crops and crop rotations to control the weeds, pests and diseases, and protect the soil from erosions. In this context, this paper explores the possibility of integration of the principles of CA under OF to minimize the weed problems. Furthermore, it also explores the possibility of soil quality improvement, pest and diseases control through adoption of CA principles on organic farming.

METHODOLOGY

The methods used for weed control under organic farming in conservation agriculture are traditionally done through ploughing, harrowing, stubble grazing; hand weeding and recommended cultural means of weed control are crop rotation, high planting densities.

RESULT

One reason for tillage is to control the weeds, i.e. to produce a clean seed bed. Ploughing and harrowing kills growing weeds mainly by burying them. This gives the planted crop an advantage in emerging before most weeds come out. With conservation tillage the weed control by ploughing is eliminated. Reduced or zero-tillage tillage decreases the weed population through creating unsuitable conditions for weed seed germination. Deep and frequent tillage foster for a higher weed population through exposing old and dormant weed seeds to suitable climate. Thus, by reducing the intensity of tillage to minimum, weed populations can be suppressed under organic farming.

Appropriate crop rotations and growing of cover crops during fallow period helps to suppress the weed population by smothering and allopathic effect. Physical effects of cover crops are the most important to reduce weed population. A permanent residue covers or cover crops reduces the sunlight exposure of weed seeds and compete with the weeds for space and nutrient.

Continuous cultivation without addition of substantial amount of soil organic matter causes the sharp decrease in soil organic carbon and nitrogen. Depletion of soil organic matter ultimately decreases soil fertility and productivity. Conservation tillage in organic farming systems improves the soil fertility by sequestering the soil organic carbon .Maximum amount of soil organic matter is deposited on the top layer of soil in conservation tillage practices resulting high infiltration rate, reduced run off, increased microbial communities and increased binding capacity of soil particles.

CONCLUSIONS

The review study shows the integration of CA techniques and principles under OF seems reasonable for sustainable organic plant production in India. Organic farms/ farmers are mainly facing weed and organic matter depletion problems. Depletion of soil organic matter from the field and increased weed pressure limits to further OF promotion. Although a number of approaches have been used for weed control, adoption of CA principles could be an option for weed management under OF. Adoption of reduced or zero tillage makes an inappropriate environment for weed seed germinations. It also stores a higher amount of organic matter by reducing the mineralization rates and subsequently decreases energy consumption and carbon oxide emissions. Crop residues on the soil surface lower the possibility of weed seed germinations by creating obstruction for proper contact to the soil. Similarly, it invites the diversity of beneficial insects, birds and wide range of invertebrates by providing the habitats for weed seeds and pest predators. Maintaining appropriate crop rotation with legume and non-legume crops, and growing of cover crops during fallow period helps to suppress the weed population by smothering.

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Efficacy of chlorimuron ethyl against Weeds in Soybean

Shraddha Bhagat, S.K. Vishwakarma, Asha Singh* and M.L. Kewat
Department of Agronomy,College of Agriculture,JNKVV,Jabalpur,M.P.482004
**Email: ashasinghrajpoot@gmail.com*

Soybean is an important oilseed crop of India and playing a vital role in sustaining the oilseed production and changing the economical position of the farmers in India particularly in Madhya Pradesh. Being a rainy season crop, it is mainly infested by annual grassy weeds *viz. Echinochloa colonum, Cyperus rotundus,* and dicot weeds *viz. Eclipta alba, Phyllanthus niruri,* is one of the major constraints in soybean cultivation (Sharma and Shrivastava 2002). Chlorimuron ethyl is applied asearly post-emergence to get rid of weed notoriety in soybean. Very meager information is available about the activity of chlorimuron against weeds in soybean especially for Kymore Plateau and Satpura Hills Zone of M.P., hence the present investigation was undertaken.

METHODOLOGY

Field experiment was conducted at livestock farm unit of JNKVV, Jabalpur during *Kharif* season of 2011, to study the efficacy of chloromuron ethyl against weed flora in soybean. Seven treatments consisted of four doses of chlorimuron-ethyl 12, 24, 36 and 48 g/ha, weed free treatment (two Hand weeding at 20 and 40 DAS), mechanical weeding at 20 DAS and weedy check, were laid out in randomized block design with three replications. Soybean variety JS 97-52 was grown in the experimental field with recommended package of practices. Full dose of major plant nutrients (20 kg N+60 kg P_2O_5+20 kg K_2O/ha) was applied as basal through urea, single super phophate and muriate of potash.

RESULTS

The *Echinochloa colona* (44.00%) was the most dominant weed followed by *Cyperus rotundus* (40.66%) and *Cyperus iria* (25.33%). The activity of chlorimuron ethyl was poor when it was applied at the lowest rate (12 g/ha) but it was improved five times with corresponding increase in application rate to 24 g/ha as early post emergence. However, further increase in application rates (36 to 48 g/ha) there was marginal increase in the activity of chlorimuron ethyl. The reduction in the yield of soybean was more when chlorimuron ethyl was applied at the lowest rate (12 /ha). However, the hand weeding twice (20 and 40 DAS) registered almost zero reduction in seed yield of soybean due to timely and effective control of weeds during critical period of crop-weed competition and proved superior over chlorimuron ethyl applied at all the rates (12-48 g/ha) and mechanically weeding once (20 DAS). The seed and stover yields were poor when weeds are not controlled throughout the crop season but both the parameters and benefit per rupee of investment was increased when weeds were controlled chemically or mechanically. The hand weeding twice excelled chlorimuron ethyl at all the rates (12 to 48 g/ha) and mechanically weeding once (20 DAS) by recording the maximum values of seed (1.49 t/ha) and stover (2.80 t/ha) yields and benefit-cost ratio (1.73) and proved significantly superior over all the treatment even with the highest cost of production (₹ 18,590/ha).

Table 1. Influence of weed control treatments on weed control efficiency, weed index, yield and economics of soybean

Treatment	Weed control efficiency (%)	Weed index	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (x10³₹/ha)	B:C Ratio
Chlorimuron ethyl 12 g/ha	41.06	54.42	0.68	1.40	15.01	1.05
Chlorimuron ethyl 24 g/ha	54.64	49.66	0.75	1.53	15.04	1.16
Chlorimuron ethyl 36 g/ha	61.97	47.18	0.79	1.56	15.06	1.21
Chlorimuron ethyl 48 g/ha	68.37	39.86	0.90	1.71	15.09	1.37
Hand weeding (20 and 40 DAS)	98.02	0.00	1.49	2.80	18.59	1.73
Mechanical weeding (20 DAS)	25.47	55.43	0.66	1.62	15.69	1.00
Weedy check (Control)	0.00	64.42	0.53	1.32	14.69	0.85
LSD (P=0.05)	-	-	0.01	0.03	-	-

CONCLUSION

It could be concluded that hand weeding twice controlled the weed growth effective and proved more remunerative than chlorimuron ethyl at all the rates and mechanically weeding once (20 DAS).

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Weed management technology application in rice - a KVK approach

S.R.K. Singh, A.P. Dwivedi, Anupam Mishra, Prem Chand

Zonal Project Directorate, Zone VII, ICAR, Jabalpur Madhya Pradesh 482 004

Technology dissemination in agriculture is the process under which proven agricultural technologies are demonstrated to increase crop productivity and thereby enhancing farmer's income level. Weeds are relatively more problematic to crop production compared to insects and diseases. Empirical evidence shows that rice yield is affected significantly by weed infestation 50-60 percent (upland condition) and 15-20 (transplanted). In fact, it is a widespread biotic constraint and is responsible for reduction in crop yield as well as quality of produce. The promising technologies were evaluated under various farming situations through several OFTs and FLDs conducted by KVKs of Zone VII situated in Madhya Pradesh. The promising technologies were evaluated under various farming situations through several OFTs and FLDs conducted by KVKs of Zone VII situated in Madhya Pradesh. In India, area under rice is 43.97 million ha with production of 110.56 million tonnes with national productivity of 2.23 t/h. It ranks second in rice production in the world after China and sharing 17.90% in the global rice basket. Therefore, controlling the weeds have greater economic importance for the nation.

METHEDOLOGY

Thirty trials were conducted for assessment of improved weed management technology using Fenoxaprop-p-ethyl *fb* chlorimuron + metsulfuron-methyl (fenoxaprop-p-ethyl 60 g/ha (25 DAS) *fb* chlorimuron + metsulfuron methyl 4 g/ha) for the control of wide varieties of weed flora in paddy crop including *Echinochloa colona*.

RESULTS

The improved technology reduced weed population by 70.9% and increased yield by 9.8% over farmers practice of two hand weeding. Compared to the farmers practice, the increase in the net return recorded due to chemical weed control was ₹ 2,281/ha. The BC ratio also increased from 1.70 under farmers practice to 2.10 under improved management of weeds (Table 1). Fifteen trials were conducted by KVKs to assess the pre-emergence application of Butachlor for the control of annual grasses and some broad leaved weeds in paddy field. The improved technology reduced weed population by 86.5% and increased yield by 14.5% over farmers practice of two hand weeding. Compared to the farmers practice, the increase in the net return recorded due to chemical weed control was ₹ 1,648/ha (Table 2). The BC ratio also increased from 1.32 under farmers practice to 1.88 under improved practice of weed management (Table 3). Hence, improved weed management techniques must be an important component of crop production strategies to cut down production cost.

Table 1. Performance of Fenoxaprop-p-ethyl *fb* chlorimuron + metsulfuron-methyl in paddy

Details	No. of trials	Weed count (no/m^2)	Yield (t/ha)	Net returns (x10^3₹/ha)	BC Ratio
Improved Practice fenoxaprop-p-ethyl 60 g/ha (25 DAS) *fb* chlorimuron + metsulfuron-methyl 4 g/ha	30	3.9	5.15	15.42	2.10
Farmers Practice 2 hand weeding		13.5	4.69	13.15	1.70

Table 2. Performance of butachlor in paddy

Details	No. of trials	Weed count (no./m^2)	Yield (t/ha)	Net returns (x10^3₹/ha)	BC Ratio
Improved Practice Butachlor 1250 g/ha (PE)	15	2.4	3.15	6.27	1.88
Farmers Practice 2 Hand weeding		18.2	2.75	4.63	1.32

Studies on herbicide combinations for control of complex weed flora in direct – seeded rain fed rice under mid hill conditions of Himachal Pradesh

Dinesh Badiyala, Suresh Kumar and Neelam Sharma

Department of Agronomy, Forage and Grassland Management, CSKHPV, Palampur (HP)176062

Rice production systems are undergoing several changes and one of such change is shift from transplanted rice to direct seeding. Direct seeded rice system has several advanges, weeds however, are considered one of the major biological constraints in this system. Weeds causes yield losses upto 80%. in direct seeded rice culture. Direct seeding of rice will only be successful provided there is good crop establishment as well as adequate weed management methods are available to keep the rice fields/ crop free from weeds. Manual removal of weeds is labour intensive, less cost effective, troublesome, back breaking and does not ensure weed removal at critical stage of crop-weed competition. In rice herbicides presently used are mainly pre emergence and weeds flushes coming at later stages of crop growth are not controlled effectively. Moreover, direct seeded rice crop suffers from complex weed flora and several hervicides like butachlor, pendimethalin, oxidiazon, oxyfluorfene have been used and reported to provide fair degree of weed control in this system of rice cultivation. Keeping in view fact the present study was carried out at CSKHPKV, Palampur with the following objectives :

a. To study the bio-efficiency of combination of herbicides against weed complex; their effect on growth and yield of rice,

b .to study the phytotoxic effects on the crop, if any in direct seeded upland rice

METHEDOLOGY

A field experiment was conducted at the Experimental Farm of Department of Agronomy, Forage & Grassland Management , CSKHPKV, Palampur (HP) during *Kharif*- 2013 in randomized block design with 10 treatments(Table 1) replicated thrice. The soil of the experimental site was silty clay loam in texture, acidic in reaction (pH 5.6) medium in available nitrogen (320kg/ha), phosphorus(9.5 kg/ha) and high (285 kg/ha) in available potassium. Rice variety HPR 1156 was sown on 01.06.2013 with recommended package of practices except the treatments. Herbicides were applied with power sprayer using 600 L water per hectare. Data on on total weed density and dry weight of weeds was recorded at 60 DAS (days after sowing) and at harvest of crop. The crop was harvested on 22.10.13.

RESULTS

The major weeds of the experimental field were *Echinochloa colona, Digitaria sanguinalis, Panicum dichotomiflorum, Commelina benghalensis, Aeschynomene indica*, *Ageratum conyzoides* and *Cyperus iria.* Total weed count and total weed dry weight at both the stages of observations were significantly influenced by different weed control treatments (Table 1). All the weed control treatments except three mechanical weeding with cono/rotary weeder behaving statistically similar resulted in significantly lower total weed count and total weed dry weight at both the stages of observations. In respect of total weed count and total weed dry weight. The weedy check treatment recorded the maximum weed count and accumulation of dry matter at both stages of observations

Different treatments influenced the plant height, panicle length, number of effective tillers and spikelets/panicle significantly. All the weed control treatments except pendimethalin *fb* manual weedy 1000g/ha (0-2 *fb* 25-30 DAS) behaving statistically similar resulted in taller rice plants, length of panicle and more number of spikelets/panicle. Whereas, in case of panicle length, all the weed control treatments except three mechanical weedings with cono/rotary weeder and pendimethalin *fb* manual weedy 1000 g/ha (0-2 *fb* 25-30 DAS), behaving statistically similar resulted in significantly higher panicle length. Weeds in unweeded check reduced the grain yield of paddy by 54.9% over pendimethalin fb bispyribac *fb* manual weed 1000 *fb* 25g/ha (0-2 *fb* 20 DAS fb 45 DAS). However, pendimethalin fb bispyribac *fb* manual weed 1000 *fb* 25g/ha (0-2 *fb* 20 DAS fb 45 DAS) behaved statistically alike with all the weed control treatments except three mechanical weedings with cono/rotary weeder and pendimethalin *fb* manual weedy 1000 g/ha (0-2 *fb* 25-30 DAS) and resulted in significantly higher grain yield. It was followed by pyrazosulfum *fb* bispyribac 20 *fb* 25 g/ha (0-3 fb 25 DAS).The lowest grain yield was recorded in weedy check treatment.

Table 1. Effect of different treatments on total weed count (no/m^2) and total weed dry weight (g/m^2) in direct seeded rice.

Treatment	Total weed count (no./m^2)		Total weed dry weight (g/m^2)		Grain yield (t/ha)
Rice	60 DAS	At harvest	60 DAS	At harvest	
Bispyribac 25g/ha (20 DAS)	4.17(16.4)	4.82(22.3)	3.35(10.2)	6.54(41.9)	2.79
Pendimethalin *fb* bispyribac 1000 *fb* 25g/ha (0-2 fb 25 DAS)	2.40(5.0)	4.77(21.8)	2.77(6.7)	5.45(28.8)	3.02
Oxadiargyl *fb* bispyribac 100 *fb* 25g(0-2 fb25 DAS)	3.16(9.0)	4.2(16.6)	2.44(5.0)	5.85(33.3)	3.08
Pyrazosulfum *fb* bispyribac 20 *fb* 25g/ha (0-3 fb 25 DAS)	2.70(6.4)	4.4(18.8)	2.48(5.2)	5.54(29.7)	2.79
Pendimethalin *fb* bispyribac *fb* manual weeding 1000 *fb* 25g/ha (0-2 *fb* 20 DAS *fb* 45 DAS)	3.00(8.7)	3.9(13.9)	2.48(7.12)	5.64(30.8)	3.14
Pendimethalin *fb* manual weeding1000g/ha (0-2 *fb* 25-30 DAS)	3.47(11.9)	5.71(31.7)	3.35(10.26)	6.70(43.9)	1.96
Bispyribac + (chlorimuron + metsulfuron methyl) 20+ 4g/ha (20 DAS)	3.61(12.1)	3.83(13.7)	3.83(13.72)	5.81(32.8)	2.65
Three mechanical weedings(cono/rotary weeder)	5.35(27.7)	5.31(27.3)	2.20(3.88)	7.63(57.3)	2.23
Weed free	2.51(5.35)	4.8(22.4)	3.60(12.0)	6.0(35.0)	2.79
Weedy check	4.33(17.8)	7.14(50.0)	5.76(32.2)	9.76(94.4)	1.11
LSD (P=0.05)	0.62	1.96	1.18	2.33	0.37

Weed management options for sustaining productivity under conservation agriculture.

A.K. Vishwakarma*, R.S. Chaudhary and A. Subba Rao
Indian Institute of Soil Science, Bhopal

Conservation agriculture is a crop management system being promoted due to its potential to conserve, improve and make efficient use of water and nutrients besides energy savings and environmental benefits. It is a modern concept and an advanced agronomic tool of growing crops from year to year without disturbing the soil through tillage primarily for seed bed preparation and weed control. Ploughing helps in weed management effectively by uprooting and burial, but at the same time it is considered to be most energy-consuming, among all field operations. Compared to conventional agriculture, farmers can save up to 40% of time, labour and fuels in conservation agriculture. The other benefits of conservation agriculture include reduction in soil erosion, increased soil moisture conservation, lower surface run-off of herbicides and fertilizers, and improved profits. However, weeds are the major biological constraints towards the large scale adoption, and are considered to be one of the most important aspects in crop production under conservation agriculture. Conservation agriculture does not allow using the traditional means of weed management by ploughing to prepare the field for cropping and may result in weed shifts towards perennial weeds besides increasing the herbicide use. The changes in farming system practices under conservation agriculture may lead to weed flora shift in the crop field, and thus necessitate the requirement of new weed management strategy.

Keeping above facts in view literature has been reviewed to find weed management options for sustaining productivity under conservation agriculture and the possible options for an integrated weed management. A number of weed management options are available to control weeds in conservation agriculture, but any single approach may not be able to provide season long effective weed control. To maintain weed population and sustainability of production levels under conservation agriculture, there is a need to integrate different weed-management options to develop a strategy for effective weed management. These may include use of preventive measures, stale seedbed technique, adjusting crop sowing time, use of crop residue as mulch, narrow row spacing, high seeding rates, weed-competitive cultivars, adopting crop rotation, intercropping, fertilizer management, manual weeding, and judicious use of herbicides. Therefore, to increase the sustainability of conservation agriculture, there is a need to manage weeds by using integrated weed-management strategies. Integrated strategies will also ensure that herbicide use remains profitable and environmentally sound over a long period of time.

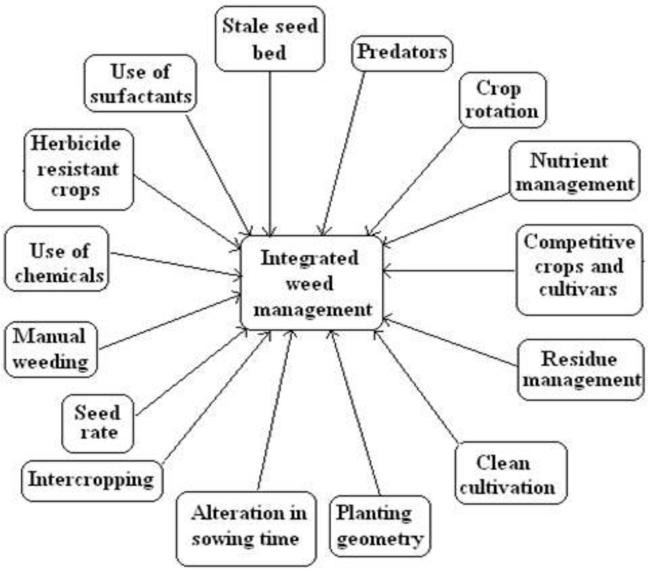

Figure-1. Integrated weed management options under conservation agriculture.

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Effect of rice establishment method and integrated weed management in direct seeded rice

R.I. Yadav, M.K. Singh* and Ram Kumar Singh

Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh 221 005

**Email: mksingh194.m@gmail.com*

In recent years, there has been a shift from transplanted rice to direct seeded rice cultivation in several countries of Southeast Asia. (Pandey and Velasco 2002). Heavy weed infestation is one of the major constraints in DSR causing severe yield losses which is the major bottleneck in DSR cultivation especially in dry field conditions. Yield losses due to weeds varied from 40-100% in direct seeded rice (Choubey *et al*. 2001).Rice establishment methods plays an important role in influencing weed and crop growth and productivity. Most of the herbicides recommended for aerobic rice are applied as pre-emergence to control weeds during initial period; however, a combination of herbicides may be more effective to control various flushes of weed in DSR. Keeping above facts in view to study the effect of rice establishment and integrated weed management practices on weed crop growth in direct seeded rice.

METHEDOLOGY

A field experiment was conducted at Agricultural Research Farm, Institute of Agricultural sciences, Banaras Hindu University, Varanasi, Uttar Pradesh (India) during *Kharif* season of 2012. The experiment were laid out in split plot design with 20 treatment combinations replicate thrice, the main plot treatment consisted of five rice establishment methods, *viz.* T_1 (Conventional Tillage(R × R -18 cm), T_2 (Conventional Tillage (R × R -20 cm, P × P-20 cm),T_3(Conventional Tillage Paired Row (9-27-9 cm),T_4 (Reduced Tillage Paired Row (9-27-9 cm), T_5(Reduced Tillage square planting (R × R -20cm, P × P-20 cm) and subplot consisted of four weed management treatments, *viz.* W_1(weedy), W_2 (Two hand weeding), W_3-Pendimethalin1kg/ha(PE) *fb* azimsulfuron17.5 g/ ha + bispyribac25g/ha (Tank mixed) 15 DAS + 1 HW), W_4-Oxadiagryl 50 g/ha (PE) *fb* metsulfuron methyl 2g/ha + chlorimuron ethyl 2g/ha 20 DAS + 1HW).All the standard practice was adopted to raise the crop . Biometric observations on crop and weeds were recorded at various growth stages.

RESULTS

Amongst weed management practices weed population and weed dry matter at 60 DAS, the mimimum value was recorded in two hand weeding *fb* azimsulfuron17.5 g/ ha + bispyribac 25 g/ha 15 DAS + 1HW and metsulfuron-methyl 2 g/ha + chlorimuron ethyl 2 g/ha 20 DAS + 1HW. The maximum number of tillers/m^2 was recorded under conventional till paired row planting followed by reduced till paired row but both these treatments were found significantly better than remaining rice establishment methods where as the maximum dry matter accumulation was obtained under conventional till normal spacing which was followed by CT paired row and both these treatments were found significantly better than remaining rice establishment methods. In case of weed management practices, plant height in weed management treatments was significantly higher than weedy.

Treatment	Yield attributes					
	Panicle length (cm)	No. of panicle/ m^2	No of grains /panicle	Test weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)
Rice						
CT Normal spacing	24.9	413.7	115.0	23.5	5841.1	8401.5
CT Square planting	25.2	427.7	116.9	23.3	5724.2	7767.9
CT Paired row	24.7	481.0	115.8	24.2	5909.3	9073.2
RT Paired Row	24.9	382.3	109.8	22.2	5724.3	8430.7
RT Square planting	25.0	350.3	119.0	22.4	5109.1	6517.9
LSD (P=0.05)	NS	17.81	3.90	0.61	469.45	1598.71
Weedy		315.2	89.5	22.3	2802.1	6920.6
Two hand weeding	25.2	474.4	131.9	25.0	7203.7	8736.1
Pendimethalin1 kg /ha *fb* azimsulfuron 17.5 g /ha + bispyribac25 g /ha 15 DAS + 1HW	25.1	446.7	125.1	23.2	6590.9	8371.0
Oxadiagryl 50 g /ha fb Metsulfuron methyl 2g/ha + Chlorimuron ethyl 2g/ha 20 DAS + 1HW	24.5	407.7	114.7	22.0	6049.8	8125.2
LSD (P=0.05)	0.44	13.54	3.60	0.55	379.54	1129.31

*CT- conventional tillage, **RT- reduced tillage *values given in parentheses are original means

CT paired row recorded the maximum number of panicle/m^2 and straw yield and it was found significantly better than remaining rice establishment methods. The maximum test weight and grain yield were recorded under CT paired row and it was found significantly better than remaining rice establishment methods. The maximum number of grains/panicle was obtained under RT square planting followed by CT Square planting and it was also found significantly better than RT paired row and CT normal spacing. In case of weed management practices all the weed management treatments recorded higher values of yield attributing characters *viz.* number of panicles/m^2, test weight and grain yield as compared to weedy. Two hand weeding recorded significantly higher than other weed management treatments.

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Effect of tillage system and weed control practices on soil health and yield of wheat under rice-wheat cropping system

R.S. Singh, Raj Kumar, Jaidev and S.S. Singh

Department of Agronomy, N.D. University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh 224 229

Email: rkpnduat@gmail.com

The issue of sustainability of rice-wheat cropping system is based on second generation problems after green revolution in India. System sustainability is positively correlated with soil health. In silt loam soil the tillage operation for sowing of wheat tend to form clods, which affect the germination and growth of crop. Adaptation of zero tillage along with stubbles improves the physical condition of soil by improving organic matter content in soil. The weed management practices could hardly affect the soil health but may brought changes in soil properties when combined with tillage practices. The information on the effect of all these factors on soil health is rather meager. Thus an attempt was made to find out the effect of tillage system and weed control practices on soil health and yield of wheat.

METHODOLOGY

A field experiment was conducted during rabi season 2012 at Agronomy Research Farm of N.D. University of Agriculture & Technology, Faizabad. The soil was silt loam, pH 8.1, organic carbon 0.28%, electrical conductivity 0.21/dSm, bulk density 1.45 g/cc, available N 182.5 mg/kg, olsen P 8.5 mg/kg, available K 210 mg/kg, population of bacteria 35.35 cfu/g, population of fungi 13.67 cfu/g, soil biomass carbon 100.20µg, acid-phosphate-activity 85.23 µg NP/h/g, alkaline- phosphate-activity 158.25 µgNP/h/g dehydrogenase activity 18.25 by TPF/h/g of soil. The experiment was laid out in split plot design. Keeping in rice only conventional methods (CT), where as in wheat it consisted conventional tillage (CT) and zero tillage (ZT) in the main plot. However in the sub plot three weed management practices were taken for rice and wheat (Two hand weeding (W_1), butachlor 1.5 kg/ha (W_2) and weedy check (W_3)) and in wheat [two hand weeding (W_1), isoproturon 1.0 kg/ha + 2, 44-D Na salt 0.5 kg/ha + HW (W_2), Weedy check (W_3)]. After application of recommended doses of NPK and Zn fertilizer wheat was grown in CT and ZT treatments. All the herbicides were applied as per treatments in wheat crop.

The rhizospheric soil sample were collected randomly from the top layer of the soil depth (0-15cm) from each plot at 50 DAS for physic-chemical and microbial determination of experimental field during rabi season by standard laboratory methods.

RESULTS

The data (Table 1) revealed that tillage system had no significant effect on physic-chemical and biochemical properties of soil (pH, EC, OC, bacteria fungi, soil microbial biomass carbon dehydrogenase activity, alkaline-P and acid-P). Among various tillage system in wheat at 50 DAS slightly improvement in soil health were observed under zero tillage as compared to wheat sown through conventional tillage. This may be ascribe due to more retention of organic residue into zero tillage.

Further Table 1 indicate that at 50 DAS maximum organic carbon, free living bacteria, phosphate solublizing bacteria, soil biomass carbon, soil respiration, percent root, colonization, acid-P, alkaline-P and dehydrogenase activity were recorded in zero tillage (0.36%, 11.52% cfu/g, 10.9 cfu/g, 112.0 µg, 0.54 mg CO_2/g/day, 11.50 µg, 92.72 µgp-NP/h/g, 157.0µgp-NP/h/G and 15-10 µg TPF/h/g, respectively.

Among various weed control practices maximum improvement in soil health were observed in hand weeding treatment. This was mainly due to interculture operations, sunlight and aeration effect. Hand weeding allow to facilitate the growth of micro organism. Lowest soil health parameters were observed under herbicidal treatment. This was mainly due to herbicide effect.

The crop sown under zero tillage system gave significant by higher grain and straw yield (35.80 and 47.54g/ha) over conventional tillage (32.70 and 44.15g/ha). The interaction effect between tillage system and weed control practices were found non significant on soil health and yield of wheat.

Table 1. Effect of tillage system and weed control practices on soil health and yield of wheat

Treatment	Soil health at 50 DAS											Yield (q/ha)	
	pH	EC	OC	FLNFB	PSM	SBC	SR	PRC	Acid P	Alkaline P	DHA	Grain	straw
Tillage practices													
ZT	8.13	0.22	0.36	11.52	10.9	112.0	0.54	11.50	92.72	157.0	15.10	35.80	47.54
CT	8.10	0.24	0.35	10.40	10.0	111.50	0.52	11.35	92.25	162.0	15.0	32.70	44.15
LSD (P=0.5)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.7	2.2
Weed management													
W_1	8.10	0.22	0.34	12.50	11.55	113.11	0.60	14.0	94.11	164.2	18.52	38.2	49.7
W_2	8.14	0.23	0.34	10.15	9.20	103.25	0.57	10.50	87.25	152.55	12.10	36.8	47.9
W_3	8.13	0.23	0.33	10.25	10.0	105.0	0.53	10.15	89.50	155.15	13.0	27.8	36.14
LSD (P=0.05)	NS	NS	NS	1.20	1.25	6.50	0.14	2.20	3.50	6.50	1.27	3.6	2.5

CONCLUSIONS

On the basis of results obtained it is concluded that among various tillage system in wheat at 50 DAS slightly improvement in soil health were observed under zero tillage as compared to wheat sown through conventional tillage. Among various weed control practices maximum improvement in soil health were observed in hand weeding treatment. Crop sown under zero tillage system gave significant by higher grain and straw yield over conventional tillage.

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Effect of weed control measures on soil enzymes and beneficial soil micro organism under rice wheat-cropping system

Raj Kumar, Jaidev, R.S. Singh, S.S. Singh and S.K. Tripathi

Department of Agronomy, N.D. University of Agriculture & Technology, Kumarganj, Faizabad, Uttar Pradesh 224 229

The effect of herbicide application on soil microbial environment is always of great concern. Depression in the microbial growth due to application of different herbicides was reported by various workers Solomon 1999. However, the information in respect to the impact of herbicides on the specific group of soil micro organism involved with the agriculturally important soil biochemical processes, *viz.* biological nitrogen fixation, P-solubilization its are very scanty. Weed management practices could hardly affect the microbial properties of soil. The information on the effect of herbicides on soil enzymes and beneficial microorganism is rather merge. Keeping this in view a study was undertaken to find out the effect of weed control measures on soil enzymes and beneficial soil microorganism on under rice-wheat cropping system.

METHODOLOGY

Field experiment was conducted at Agronomy Research Farm during rabi and *Kharif* season of 2012 in a split plot design with three replications. Keeping Kharif season treatments in main plots (*Viz.* K_0 (Weedy), K_1 (Two hand weeding) and K_2 (butachlor 1.5 kg/ha) and rabi season treatments (*viz.* R_0- Weedy, R_1- two hand weeding and R_3 –Isolroturon 1.0 kg /ha + 2,4-D Na salt 0.5 kg/ha) in a sub plot. The soil of the experiment field was silt loam in texture pH 8.2 organic carbon 0.27%, EC 0.21/dSm, available N 187.2 mg/kg, olsen P-10.7 mg kg/ha, available K 210 mg/kg, bacterial population 33.30 cfu/g, fungal population 13.5 cfu/g, soil biomass carbon 99.5 µg, acid-P 84.25 µg-NP/h/g, alkaline –P 155.20 µg p- NP/h/g and dehydrogenase activity 18.00 µg TPF/h/g of soil. After application of recommended dose of N, P and k fertilizers rice and wheat crop was grown in the respective treatments. All the herbicides were applied as per treatments in rice and wheat crop.

The rhizospheric soil sample were collected randomly from the top layer of the soil depth (0-15 cm) from each plot at. 50 DAS and at harvest stage for soil enzymes and beneficial microbial determination of experimental field during rabi and *Kharif* season 2012 by standard laboratory methods.

RESULTS

The data (Table 1) revealed that weed control treatment applied during rabi and *Kharif* season show significant effect on microbial parameters (N-fixing bacteria, phosphate solubilizing bacteria, soil respiration, alkaline-P, acid-P and dehydrogenase activity) were observed in between hand weeding (K_1R_1) and herbicides treatment (K_2 R_2) during rabi and *Kharif* season at 50 DAS while at harvest stage non significant variation were observed. Maximum microbial parameters were found in hand weeding plot at various growth stage (50 DAS and at harvest). This was mainly due to interculture operation, sunlight and aeration effect. Hand weeding allow to facilitate the growth of micro-organism. However minimum microbial parameters were observed under herbicidal treatment. This was mainly due to herbicide effect. Mishra *et al.* (2007) also reported similar results. Further results revealed that butachlor and isoproturon + 2,4-D applied in rice-wheat cropping field did not observed any harmful effect on microbial properties of the soil.

Table 1. Effect of different treatments on soil enzymes and microbial properties of rhizospheric soil of rice and wheat during 2012.

Treatment	Soil enzymes and microbial properties														
	At 50 DAS								At harvest						
	FLNFB	PSM	PRC	SBC	Acid P	Alkaline P	DHA	SR	FLNFB	PSM	SBC	Acid P	Alkaline P	DHA	SR
Kharif															
K_0	12.10	10.2	15.6	132	100	225	20.5	0.62	14.15	12.15	129.2	85.50	222.50	18.50	0.35
K_1	13.70	12.1	20.0	138	112	242	25.0	0.65	14.35	13.00	132.0	100.70	240.05	20.00	0.42
K_2	11.20	10.1	13.7	129	95.7	209	18.7	0.60	13.00	12.30	127.2	87.20	205.21	17.50	0.31
LSD (P=0.05)	2.24	2.2	4.9	6.2	4.7	5.90	4.9	NS	NS	NS	NS	2.50	5.70	NS	NS
Rabi															
R_0	11.25	11.8	15.0	135	98.1	215	18.0	0.61	13.50	12.00	134.5	83.20	212.50	17.50	0.37
R_1	13.11	14.4	22.5	140	107	237	25.0	0.70	14.70	12.50	134.9	95.50	230.00	20.00	0.43
R_2	11.25	11.1	10.5	132	85.0	204	14.5	0.64	13.35	12.00	130.0	80.00	198.00	17.70	0.33
LSD (P=0.05)	2.24	2.21	4.6	6.3	5.28	6.59	4.81	NS	NS	NS	NS	3.20	6.25	NS	NS

CONCLUSIONS

On the basis of results obtained it is concluded that among various weed control measures two hand weeding recorded positive effect on soil health a (soil enzyme and beneficial soil microorganism) while isoproturon and 2-4,D applied 1 kg and 0.5 kg/ha did not leave any harmful effect in soil under rice-wheat cropping system.

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Weed management studies in chickpea

Jaidev, S.K. Dubey, S.K. Singh, R.K. Pathak* and D.K. Maurya

Department of Agronomy, N.D. University of Agriculture & Technology, Kumarganj, Faizabad Uttar Pradesh 224 229

Email: rkpnduat@gmail.com

Chickpea seems to be more sensitive to weed competition than many other crops and competition is more severe during early stages of crop growth because of its slow growth rate and less leaf area development. In India losses caused by weeds have been reported in the range of 40-90%. Thus, there is a tremendous scope to improve the yield of chickpea only by adopting a suitable weed management practices. In the present time some of the very effective high potency herbicide molecules have been developed which may be useful to control the wide spectrum weeds in chickpea.

METHODOLOGY

A field experiment was conducted at Agronomy research farm of N.D.U.A.T. Kumarganj, Faizabad (UP) during *Rabi* season of 2011-12 with an objective to find out bioefficacy of weed control treatments to control the weeds in chickpea. Field experiment was laid out in RBD with three replications having 14 numbers of treatments *viz.* pendimethalin 1000 g (PE), pendimethalin 1000 g (PE) *fb* quizalofop 60 g (PoE), pendimethalin 1000 g (PE) *fb* clodinafop 60 g (PoE), pendimethalin 750 g (PE) fb quizalofop 60 g + oxyfluorfen 200 g (PoE), oxyfluorfen 200 g (PE), oxyfluorfen 200 g (PE) *fb* quizalofop 60 g (PoE), oxyfluorfen 200 g (PE) fb clodinafop 60 g (PoE), oxyfluorfen 200 g + quizalofop 60 g (PoE), oxyfluorfen 200 g (PE) + clodinafop 60 g (PoE), imazethapyr 75 g (PoE), pendimethalin 1000 g (PE) *fb* imazethapyr 75 g (PoE), pendimethalin 1000 g (PE) *fb* imazethapyr 75 g + quizalofop 60 g (PoE), along with weed free and weedy check. The herbicidal treatments were applied on next day of sowing and at 35 DAS as pre and post emergence to weeds and crop, respectively.

RESULTS

At 60^{th} days stage, pendi. 1000 g/ha as well as oxy. 200 g/ha both applied as PE along with their quizal. or clodi. 60 g/ha, each applied as PoE being at par, recorded significantly lower density and dry weight of weeds over the alone treatment of either pendi. 1000 g or oxy. 200 g/ha, while pendi. 750 g/ha along with oxy. 200 g + quizal. 60 g (PoE) and pendi. 1000 g along with imaze. 75g + quizal. 60 g/ha (tank mixed) being at par recorded significantly lower dry weight as compare to other treatments. WCE was recorded highest with pendi. 1000g and oxy. 200g ha^{-1} as PE when supplemented with sequential application of quizal. or clodi. 60 g/ha as PoE each in both of the PE herbicides over single application of either pendi. 1000 g or oxy. 200 g/ha as PE. Regarding phyto-toxicity oxy. 200g + either quizal. or clodi. 60 g/ha each (tank mixed) applied as PoE as follow up application in pendi. 1000g or oxy. 200 g/ha (PE) treatments or tank mixed application proved highly toxic to crop plants as well as weeds. In the context of crop dry matter and grain yield, either quizal. or clodi. 60 g/ha each as PoE in the pendi. 1000 g or oxy. 200 g/ha (PE) being at par recorded significantly higher over rest of treatments including single application of pendi. 1000 g or oxy. 200 g/ha (PE). PE application of pendi. 1000 g/ha along with PoE of either clodi. or quizal. 60 g/ha recorded substantially higher values of net return (Rs 53,588 and Rs. 50,448 ha) and BCR (Rs 2.24 and Rs. 2.05) *fb* oxy. 200g/ha (PE) along with clodi. or quizal. 60 g/ha each as PE and weed free treatments.

Table 1. Effect of weed control treatments on total weed density, dry weight at 60 DAS, WCE and phyto-toxicity

Treatment	Total weed density (m^2)	Weed dry weight (g/m^2)	WCE (%)	Phyto-toxicity at 15 DAHA	
				Stunting	Wilting
Pendi.1000g/ha (PE)	6.9 (46.7)	6.8 (45.9)	75.6	0	0
Pendi.1000g ha^{-1} (PE) fb quizal. 60 g ha^{-1} (PoE)	5.5 (29.7)	5.5 (30.1)	83.1	0	0
Pendi.1000g ha^{-1} (PE) fb clodi. 60 g ha^{-1}(PoE)	5.1 (25.4)	5.1 (25.3)	86.8	0	0
Pendi.750g (PE) fb quizal. 60 g + oxy. 200 g ha^{-1} (PoE)	3.9 (14.9)	3.4 (11.4)	92.2	8	8
Oxy. 200 g ha^{-1} (PE)	7.3(52.9)	7.1 (49.4)	73.5	0	0
Oxy. 200 g (PE) fb quizal. 60 g ha^{-1} (PoE)	5.9 (35.5)	6.0 (35.9)	81.1	0	0
Oxy. 200 g (PE) fb clodi. 60 g ha^{-1} (PoE)	5.7 (29.9)	5.7 (31.4)	84.8	0	0
Oxy. 200 g+quizal. 60 g ha^{-1} (PoE)	5.3 (28.2)	4.5 (20.2)	89.7	8	8
Oxy. 200 g+ clodi. 60 g ha^{-1} (PoE)	5.8 (33.6)	5.0(24.6)	88.6	7	7
Imaze.75gha^{-1} (POE)	7.9 (62.9)	6.7 (44.7)	74.7	9	0
Pendi.1000g ha^{-1} (PE) fb Imaze. 75gha^{-1} (POE)	4.7 (21.9)	4.4 (16.3)	90.5	3	0
Pendi.1000g (PE) fb Imaze. 75g+ quizal. 60 g ha^{-1} (PoE)	3.4 (10.3)	2.9 (8.2)	95.0	4	4
Weed free	0.7 (0.0)	0.7 (0.0)	100.0	0	0
Weedy check	13.4 (180.6)	13.6 (184.1)	0.0	0	0
LSD (P=0.05)	0.95	0.3	-	-	-

CONCLUSION

It may be concluded that PE application of pendi. 1000 g ha^{-1} along with PoE application of either clodi. or quizal. 60 g/ha proved superior over rest of treatments with respect to WCE, grain yield and economics of chickpea fb oxy. 200 g/ha as PE along with clodi. or quizal. 60 g/ha (PoE).

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