FIRST BIENNIAL CONFERENCE IN THE NEW MILLENNIUM ON ECO-FRIENDLY WEED MANAGEMENT OPTIONS FOR SUSTAINABLE AGRICULTURE

LEAD PAPERS AND ABSTRACTS

MAY 23-24, 2001
BANGALORE

INDIAN SOCIETY OF WEED SCIENCE
and
UNIVERSITY OF AGRICULTURAL SCIENCES, BANGALORE

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Secretary, DARE and Director General
ICAR, Krishi Bhawan, New Delhi

MESSAGE

April 27, 2001

It is a matter of great pleasure to know that the University of Agricultural Sciences, Bangalore and Indian Society of Weed Science are jointly organising IX Biennial Conference on "Eco-Friendly Weed Management Options for Sustainable Agriculture " on 23rd and 24th May, 2001 at University of Agricultural Sciences, Hebbal Campus, Bangalore.

In view of my visit abroad during that period, I regret that it would not be possible for me to participate in the above conference. However, I take this opportunity to convey my best wishes for the success of the Conference.

(R.S. Paroda)

GOVERNMENT OF KARNATAKA

Dr. R. Dwarakinath
Chairman - Agriculture Commission

Richmond Road
Bangalore

MESSAGE

May 18, 2001

It is a matter of great pleasure that the University of Agricultural Sciences, Bangalore in collaboration with Indian Society of Weed Science, is organising Weed Science Conference at Hebbal Campus, Bangalore on May 23-24, 2001. As we all know weeds retard crop production and result in marked losses in both quality and yield. I do hope that the two days' deliberations will take into consideration of the various problematic issues and come out with valuable recommendations. I am sure that these recommendations will go a long way in solving the weed problems faced by the farmers. I wish the Conference a grand success.

Chairman
Agriculture Commission

CHIEF GUEST'S ADDRESS

WEED MANAGEMENT OPTIONS FOR SUSTAINABLE AGRICULTURE

M. MAHADEVAPPA
Chairman

Agricultural Scientists' Recruitment Board, Indian Council of Agricultural Research, Government of India, New Delhi 110 012

I am indeed very happy to be amongst you this morning to inaugurate the first Biennial Conference of Weed Science, being held in the new millennium at Bangalore, after a lapse of 20 years. It may be recalled here that, in 1981, the first International Conference – Eighth Asian Pacific Weed Science Society was held in August at Bangalore, under the leadership of Dr. K. Krishnamurthy and late Dr. H.R. Arakeri.

The main theme of "Eco-Friendly Weed Management options for Sustainable Agriculture" chosen for this Conference is quite apt under the present context of Eco-safety and clean Environment, Environmental awareness and the movement of Organic agriculture. The contents of the Conference emphasise on the eco-friendly approaches like Weed Ecology including Biology, Weed Dynamics and Physiology, Integrated Weed Management in Specific Crops/ Cropping systems, Integrated Weed Management in High Value crops, Management of Aquatic/ Parasitic/ Wasteland weeds, Herbicides – New molecules, Formulations, Application Technology, Herbicides' Resistance, Herbicides – Environment – Socio- Economic changes – Transfer of Technology, Alternate Weed Management Approaches – Biological/ Allelopathy/ Solarization, Weed Utilitarian aspects, and Information Technology in Weed Management.

Weeds are considered to be a potential pest causing 33% loss in yield of field crops, when compared to 26% due to diseases, 20% due to insects, 15% due to storage and miscellaneous pests and 6% due to rodents, based on the estimate made during 1992-95. The total losses due to these pests is estimated to be around Rs. 6000 crores annually. This loss is quite tremendous. The agricultural scientists have a challenging task of increasing the agricultural production to an amazing requirement of 260 M.T. by 2030 AD. As the weeds cause nearly 33% of the total losses, every attempt has to be made to contain the weed menace and uphold the production. Thus, sufficient emphasis has to be given for the overall development of Weed Science in India.

Weed management takes away nearly one third of total cost of production of field crops. In India, the manual method of weed control is quite popular and effective. Of late, labour has become non- available and costly, due to intensification/ diversification of agriculture and urbanisation. The alternative for this, is the use of herbicides particularly under irrigated agriculture and that too for high value crops. The usage of herbicides is only 14% of the total agro-chemicals used in agriculture in India, as against 48% used at the global level, and 55% used in the USA, as per the estimate made during 1998. There is a tremendous scope for the various Pesticide Industries to work in hand with State Agricultural Universities and ICAR Institutes to bring in to the market new molecules which are safe, eco-friendly and comparatively less expensive.

With the establishment of National Research Centre for Weed Science at Jabalpur by the ICAR, weed science research has gained momentum with 22 co-ordinated centres distributed all over India covering all agro-climatic zones. In addition, SAU' s, ICAR Institutes, and Crop Improvement Projects are also involved in the Weed Science Research, Teaching and Extension activities. Thus, there is vast scope for the development of eco-safety weed management options for sustainable agriculture, keeping in mind the animal, soil, environmental and human health.

I hope the Weed Scientists coming from all over Country will deliberate on various methods of weed control in all spheres like weed management in agriculture, waste land, aquatic situation, forest, parasitic weeds, specific weed management in different agro-climatic zones, and monitoring of herbicide residues in soil/plant/under ground water bodies. In addition, I suggest that the eminent Weed Scientists assembled here to give enough thought and ponder over the development of alternate methods of weed control – use of bio-herbicide, herbicide resistant crops, use of allelo-chemicals of plants/ weeds, use of naturally occurring herbicides and use of genetically engineered micro- organisms for faster degradation of toxic herbicides, development of microbial herbicide safeners and for production of synthetic herbicides.

Analytical methods to estimate herbicide residues in soil, plant and water bodies are to be standardised in atleast identified lead centres to start with. This will help in generating information on herbicide contamination in the environment, which is of prime importance in the present World. Another front, which requires larger attention, is the transfer of technology to the users. Large- scale demonstrations on farmers' fields is required to elucidate confidence among farmers on the utility of modern weed management options. The farmers have less knowledge on the choice of herbicides, crop selectivity, usage of herbicides in the field, time and method of application, conditions for increasing the efficiency of herbicides in weed control, the adverse effect, if any, on the succeeding crops, and to mitigate harmful effect in the event of wrong usage of herbicides.

There is always a danger of alien weeds' introduction through food commodities to our territory. To cite an example, *Parthenium hysterophorus* was introduced to our country through imported wheat seeds. Hence, it becomes a prime objective for the scientists and the policy makers to chalk out urgently the ways and means to contain such introduction.

Weeds' utilitarian aspect is an another sphere to be considered by the Weed Scientists. Succulent weeds like *Celosia argentea, Amaranthus viridis, Portulaca oleracea, Commelina benghalensis* serve as good leafy vegetable, particularly when used during younger stages. By this practice, we can successfully contain the menace of these weeds. Weeds can also serve as a composting material. Certain other weeds can be used for medicinal purposes. For example, *Phyllanthus niruri* for curing Jaundice, Datura *stramonium, Lantana camera, Euphorbia hirta* for their antiseptic properties.

Added attraction of this Conference is the encouragement for young scientists by having a separate session and recognising best presentation. I appreciate this novel idea, which goes a long way in building the confidence of the Young Scientists and stimulate their zeal to work sincerely for the future building of the Weed Science activities in India.

I wish this first Biennial Conference of the new millennium, a great success in bringing out useful eco-friendly weed control recommendations for the benefit of the mankind.

PRESIDENTIAL ADDRESS

ECO- FRIENDLY WEED MANAGEMENT OPTIONS FOR FUTURE SUSTAINABLE AGRICULTURE

A. M. KRISHNAPPA
Vice- Chancellor
University of Agricultural Sciences, Bangalore 560 065

I am honoured to be amongst you this morning to chair the first Biennial Conference in the new millennium on "Eco-Friendly Weed management options for sustainable agriculture" , being held at Bangalore, as a sequence of the first International Conference – Eighth Asian Pacific Weed Science Society, held in August 1981, under the stewardship of Dr. K. Krishnamurthy, former Vice - Chancellor of the University of Agricultural Sciences, Bangalore and late Dr. H.R. Arakeri, former Chairman, Agricultural Scientists' Recruitment Board, New Delhi. The theme chosen for this conference is quite apt and relevant to the present scenario of greater awareness of people on eco – safety, clean and less polluted environment for the future generations. I hope that the deliberations on all spheres of Weed Science will be focus on eco-safety and come out with weed management strategies, which will preserve soil – plant – environment for the future use on a sustainable basis.

As per the estimate of 1992, when compared to losses of 26 and 20% caused by diseases and insects respectively in field crops, weed is an important pest causing 33% of total loss. The total annual losses caused by weeds is estimated to be Rs. 1980 crores in India alone. Thus it becomes imperative to give enough emphasis for weed management in future, as the Agricultural Scientists have a Herculean task of meeting the food requirement of the ever-increasing population.

I am happy to see that this conference is covering all aspects of weed management, from the point of Eco-safety, clean environment and sustainable agriculture. To this conference, Weed Scientists from all over India representing different agro-climatic conditions have assembled.

Parasitic weeds occurring on high value forest timbers, horticultural and other commercial/ field crops are posing severe problems. These need to be contained on a war footing.

In other fronts like wastelands, high ways, railway lines, air strips/ runaways, industrial areas, buildings, golf/ turf/ other sport fields, water bodies, weed menace is noticed. I wish the scientists to look into this aspect of weed management.

Following suitable crop combinations since times immemorial is an important source of weed management practice. To cite an example, Coriander is grown along sorghum crop to check the weeds menace. Growing of garlic is reported to reduce the menace of nut grass (*Cyprus rotundus*).

At the same time, it is also necessary that we, the Scientists to focus on the utilitarian aspects of weeds like medicinal value, as leafy vegetables, for compost purposes, for bio-gas generation, nutritional value as forage, etc. Weeds *like Centella asiatica, Tridax procumbens, Leucas aspera, Calotropis gigantea, Solanum nigrum* can be exploited by Pharmaceutical Industries, for medicinal value and for manufacture of plant based dyes. Even as a young boy, I remember that *Celosia argentia, Amaranthus viridis, Digera arvensis, Portulaca oleracea* are used as leafy vegetables and preparations made out of this are very palatable. I think, the Scientists will kindly ponder over this issue, as exploitation in this way will help to control the weeds.

Usage of combinations of herbicides having synergistic effect is catching up in many crops particularly in developed countries, from the point of increased spectrum of weed control, to avoid building up resistance by weeds in the long run, and lower the dosage of herbicides impounded on the soil and environment. It is note worthy at this juncture that the usage of surfactants having co-penetrating effects with the herbicides will help in containing the problematic weeds propagated through under ground propagules. In addition, this method will effectively lowers the residue build up in soil, plant, water bodies, etc.

- Herbicides' usage is increasing in recent years in view of scarcity and prohibitive wage of labourers. Yet the herbicides' usage is only 14% in our situation as against 48% of the total pesticides used in the world. Under this context, monitoring herbicides' residue in Soil/ Plant/ Water Bodies/ Environment, is another front needing greater attention, from the point of Eco-Safety. I, being the Soil Scientist, strongly recommend that Residue Chemists/ concerned Weed Scientists to develop the protocol to standardise the estimations of various herbicides in soil/ plant/ water bodies. Thus, quantification of residues should indicate whether the herbicide is eco-safety or accumulate in negligible proportion over a period of time.

In addition, usage of modern herbicides needing high dose of accumulation for causing mammalian toxicity and lesser dose requirement for weed management, requires attention. The alternate methods of weed management viz., use of allelo-chemicals/allelopathy, bio-herbicides, natural herbicides, etc. assumes importance in modern agriculture, where enough emphasis is given for maintenance of clean environment.

I hope by virtue of vast experience of the Weed Scientists assembled here, the conference will bring out the useful recommendations, which will have far reaching consequences in solving the weeds' menace faced by the farmers. I wish the Conference a grand success.

ADDRESS BY GUEST OF HONOUR

WEED MANAGEMENT OPTIONS FOR ECO-SAFETY AND SUSTAINABLE AGRICULTURE

K. Krishnamurthy
Former Vice- Chancellor, University of Agricultural Sciences, Bangalore
and Past President of ISWS

I am indeed happy and honoured to meet you all and be one amongst you at Bangalore after a lapse of 20 years, after the first International Conference on Weed Science i.e. Eight Asian – Pacific Weed Science Society Conference, held in 1981 at Bangalore. I convey my heart felt feelings and best wishes to you all. The main theme chosen for this Conference on "Eco-Friendly Weed management options for future sustainable agriculture" is very appropriate under the present need and thinking on Natural farming, Organic farming, Eco-safety, clean Environment, and Environmental awareness, etc. Above all, weed management is more appropriate than weed control.

To recollect the near past about the inception and growth of the Indian Society of Weed Science, I am happy to tell you that in 1977 at Hyderabad, I, Dr S.R. Obien, Dr. S.V.R. Shetty thought of rejuvenating the ISWS. This ultimately took birth with the conduction of the first conference of ISWS in 1977 at APAU, Rajendranagar, Hyderabad with the help of Dr. Krishna Rao, then Vice- Chancellor, APAU. This stimulated the growth of Weed science. Here at this conference, I brought out my invitational paper, the need to establish National Institute of Weed Science. Later, I happy to convey that the Eight Asian – Pacific Weed Science Society Conference, was conducted by me as Conference Secretary under the leadership of late Dr. H.R. Arakeri, then chairman of ASRB, New Delhi, at Bangalore in 1981. This paved way for establishment of National Research Centre for Weed Science at Jabalpur. In addition, the Co-ordinated Research Programme on Weed Control under the financial assistance of PL – 480 was started in 1978 with six centres initially. This was further expanded into AICRP on Weed Control under ICAR funds. Now it has grown in to 22 centres representing various agro-climatic zones of the country. Several renowned Weed Scientists joined hands for fostering the weed Science activities in India. To name a few are Dr. H.S. Gill, Dr. S.K. Mukhopadhyay, Dr. U.C. Upadhyay, Dr. H.K. Pandey, then Director, CRRI, Cuttuck. From 1981 conference onwards, the Industries extended full support in expanding the activities of the Weed Science in general and the Society in particular. Here the role of Dr. K.C. Nag, Dr. Unni, Dr. Negi, Dr. Bibhas Ray, Dr Majumdar, needs to be acknowledged.

To foster the growth of Indian Society of Weed Science, the efforts made by Dr. S.R. Obien from Philippines, Prof. V.S. Mani, Dr. H.S. Gill, Dr. S.V.R. Shetty, Dr. U.C. Upadhyay, Dr. S.K. Mukhopadhyay, Dr. V.S. Rao, Dr. S. Sankaran, Dr. Bibhas Ray, Dr. K.C. Nag, Dr. H.K. Pandey, Dr. Unni, Dr. Negi, Dr. Anderson from USA, others and myself during this initial phase of revival needs to be remembered now.

The Society should make a dent in advising the government on several policy issues of Weed Science activities in India. The conference should give more emphasis on alternate methods of weed management namely allelopathy, bio- herbicides, soil solarisation, biological control of weeds, weed seed stimulation, herbicide resistance, genetic engineering, development of herbicide resistant crops, new molecules with low mammalian toxicity and high environmental safety. I wish that weed science should progress in such a way that natural balance is maintained in the environment by achieving cost- effective management of weeds.

I also wish that the National Centre for Weed Science located at Jabalpur should be recognised as a national Post- Graduate Centre, as like National Plant Protection Centre, Oregon, USA, and Weed Research Organisation at Oxford in England. This will help in providing basic and advanced Weed Science research in India and provide support as centre of excellence. This should attract students from Asia and Asia Pacific regions.

I wish that the young Weed Scientists assembled here to take more responsibility in leading the Society to a greater height and glory in the years to come. I wish the conference great success and let it come out with good eco- friendly recommendations, which will have adoptable solutions so as to help the farming community, which is our atmost responsibility.

KEY NOTE ADDRESS

ECO - FRIENDLY WEED MANAGMENT OPTIONS FOR SUSTAINABLE AGRICULTURE

S. Sankaran
Former Vice Chancellor,
Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu

India with 2.4% of the total area of the world is sustaining more than 16% global population (5.7 billion). With a potential development of irrigation in 80 M.ha, the second largest in the world, India can boost present food production (2000 M.T) to more than 260 M.T. by the year 2030 to keep pace with the bourgeoning population. New crop production technology must cope up with this challenge, in relation to inputs of farm productivity. Weed management is one of the significantly inputs in this situation.

i) Low Productivity: According to Economic survey of India 1999, the farm productivity of most of the important crops is very low in their world ranking. In terms of world acreage, the country occupies first in rice, sorghum, pulses and cotton, second in sugarcane, and the third in wheat and potato. However, the productivity per unit area of these crops ranges from 34 (for sugarcane) to 118 (for pulses) ranks of the world. How to step up the productivity is the greatest challenge posing the country today? With modern technology productivity per unit of land can be built up as we witness the yields of wheat in Punjab and Haryana. Integrated weed management, Including herbicides, is an important production tool in achieving the target.

ii) Low herbicide use : Out of 40 M.ha of rice and 24.0 M.ha of wheat area of the country only 5 and 8 percents of the respective crop areas are treated with herbicides (Sabharwal and Rathi, 1993). In recent years, the usage of herbicides in field crops has steadily increased to 12 per cent of the total pesticides used in the country. This is a very low figure as compared to USA where herbicide accounts for 55 per cent of the total pesticides used (Bhowmik, 1999). Among the herbicide applied in India, Isoproturan application in wheat ranks the top position (1900 T.). While butachlor (1600 T.) ranks second place in its coverage in rice. Other herbicides account for 2500 T. making a total of 6000 T.

The figures published on annual losses due to pests in field crops (Kulshreshta and Parmar, 1992) have shown that weeds account for 33 per cent of the total losses as compared to 26 and 20 per cent by pathogens and insects respectively. The data on yield losses due to weeds in major crops account for about 16 per cent in wheat and 40 per cent in rice. In India, weed management takes 30 to 50 per cent share of the total cost of plant production (Bhan, 1997). This illustrates the importance of Weed control in minimizing the yield losses and stepping up the crop productivity.

Weed Research Organizations in India

Weed management research in India is carried out by a number of organizations. Under ICAR, the Crop Directorates of rice, wheat, oilseeds, pulses, cotton and vegetables conduct

coordinated weed control trials in the selected centers. The National Research Center for Weed Science, Jabalpur with its 22 coordinating centers situated in different states also conducts weed management research (since 1978) in all the field crops including horticultural crops. A small group of scientists also conduct weed research in plantation crops in Tea Research Institute, Tocklai, UPASI in South India and in Jute crop at Barakkpore. In addition, a few of the private herbicide industries conduct need based and applied research on weed management. A conservative estimate indicates that about 400 scientists in different disciplines work on basic and applied aspects of weed management problems in the country. This is fairly a large group of scientists for tacking different regional weed problems provided their researches are properly coordinated in planning and execution.

In this Biennial conference of Weed Scientists, papers will be presented on the advancement made in weed management in different crops including parasitic and aquatic weeds of the country. Therefore, my presentation will be largely confined to the thrust areas in weed research and eco-friendly weed management options for future sustainable agriculture.

Documentation of biology and Ecology of Weeds :

For the past one-decade the researchers in All India Coordinated Project of weed control are systematically conducting weed survey in the agro climatic zones of each state on the weed flora present in important crops. The weed species met with in kharif, rabi and summer seasons have been grouped into grasses, broad leaved wheats and sedges. The scientists were able to identify, using weed index values, the major weed spectrum in each area that cause yield reduction in the economic crops. Several states have already surveyed most of the agro-clinmatic zones and ready for the preparation of Weed Atlas. The atlas when prepared is expected to give information on the major weed species, occurring in important crops of the state in each season. This publication will be useful for the planners, researchers, extension workers and the industry people to formulate the area specific weed management strategies.

This basic document may be updated once a decade by systematic weed surveillance network jointly conducted by research and field level extension scientists to record the changes in weed flora over time.

Modeling crop-weed interactions :

Competition between crop and weed for resources of growth (light, water and nutrients) is a critical process in agricultural ecosystems. The mechanisms of competition are not simple. Models of weed invasion, population growth and control will be usefull for organizing biological informations on weeds and for developing weed control strategies. Conventional field trials cannot answer several of the key questions in weed control because of the constraints of cost, time or complexity. Hence models are essential and are integral part of weed management research and advice.

The estimate of impact of weed level on crop yield is necessary to decide, whether weed control will be economical. The reasons for the variability in weed-crop competition are, crop yields tends to change according to changes in weed densities over the growing season and variation in competition for resources. Similarly, crop spacing, cropping practices and the relative emergence time of weed and crop also modifies the yield reduction associated with weed density. In spite of these problems, wide range of models have been proposed to predict the

reduction in crop yield as the function of weed density. The future of weed modeling seems to lie on long-tern population dynamics study based on physiological principles.

Permanent Herbicde Trial

The application of herbicides has become an integral part of the Integrated Weed Management System in major cropping systems. Continuous application of the same herbicide over season in the same crop has given use to new problems in the field. The build up of residue in soil, water and ecosystem had become detrimental to microflora and fauna of the treated area. There is need for periodical estimation of herbicide residues in soil, plant and water ecosystems. A continuous monitoring study on the rate and extent of persistence of applied herbicides need to be undertaken. Similar to Long Term Fertilizer Trial in the country, the Long Term Herbicide Trial plots are to be laid down to monitor the residual effects on crop and weed flora. A few states / centers are ahead in this area of research but there is no uniformity in layout, observations recorded and the sampling techniques and analyses. These aspects need to be addressed soon to strengthen the research coordination in the country.

Impact of herbicide use

The usage of herbicides in India and elsewhere in the world is increasing due to possible benefits to farmers. Due to inherent selectivity of herbicides used in various crops, a shift in weed flora from annuals to perennials, which are often difficult to control, has occurred in a few situations in all countries.

i) Weed shifts due to herbicides: In India, repeated application of anilofos in rice to control *E. crusgalli* and *E. colonum* gave rise to *Cyperus* iria from the third rice season. Similarly, repeated application of butachlor in rice caused the build up of *Ischaemum rugosum* in three seasons. In Korea, repeated applications of butachlor, thiobencarb and 2,4-D to rice have resulted in the predominance of perennial sedge, *Cyperus serotinus*. In International Rice Research Institute, Philippines, long-term annual herbicides applications have resulted in *E. crusgalli* and *Monochoria vaginalis* besoming minor weeds and *Scirpus maritimus*, a perennial sedge becoming increasingly dominant (De Datta, 1977). A detailed account of shift in weed flora due to weed control methods in upland rice was given by Sankaran and De Datta (1985).

ii) Herbicide resistance in weeds: The weeds may be develop partial resistance, cross resistance (a weed population resistant to two or more herbicides due to single resistance mechahism) and multiple resisitance (resistant plant possess two or more distinct resistance mechnism) to applied herbicides. Le Baron (1992) has reported 113 herbicide- resistant weed biotypes evolved worldwide. Of which 58 species resistant to triazines and 58 species resistant to 14 other classes of herbicides. In India, out of 45 samples of Phalaris minor collected all over Punjab, 20 biotypes showed resistance to isoproturon at 1.0 kg. And 14 numbers at 2.0 kg per ha. Moss and Rubin (1993) recommended alternate herbicide use, herbicide mixtures / sequence, herbicide managment, synergists and safeners, thresholds and other cultural techniques for the prevention and control of resistant development.

As the herbicides applications are on the increase, similar problems will crop up in different regions of the country sooner or later as witnessed already in Punjab.

Recent trends in herbicide technoloy

Judicious use of herbicides may laed to reduced contamination of ground water.

i) Low environmental risk herbicides: Following strict regulations to protect the environment, the herbicides recently introduced in the market are known to pose very low health hazards than ever before.

ii) Reduced rate technology: During 1970s, the rate of herbicides recommended for specific weed control in crops was in the order of 2 to 4 kg./ha. This rate has come down by more than 50 per cent in the past 30 years. Of late same of the newly introduced herbicides are recommended at the rate of 3-4 gm. per ha.

iii) Herbicides of low toxicity: Unlike many of the highly toxic triazine commpounds, which were widely used for weed control in field crops, the recent introductions such as glyphosate and the sulfonylureas are applied at very low rates and degrade from the environment in a few weeks. Their toxicity ratings are almost equal to table salt (Bhawmik, 1999).

Biotechnological approaches:

In agriculture, weed control is an area where biotechnology could be of immediate practical use.

i) Molecular markers in weed identification: One of the first principles of weed management is to correctly identify the weed, if correct weed control strategies are to be used. Protein Isozyme Polymorphisms (PIP), starch gel electrophoretic seperation of polymeric forms of protein serve as a "finger print" to identify genotypes and populations independent of environmental influences, Restriction-Fragment Length-Polymorphisms (RFLP) is based on either total genomic DNA or chloroplast DNA. Though, this method is more expensive and time consuming, it can provide more information than PIP (Nissen et al 1991).

ii) Herbicide resistant crops: The selective herbicide can control only a section of weeds, whereas non-selective herbhicides kill all the plants including the crop. This problme of crop susceptibility can be solved by screeing tolerant avilable cultivars and developing resistance in crops against broad spectrum herbicides, which provide effective weed control. The methods used for tolerant breeding are: classic breeding method - selection of whole plant for resistance; tissue culture method-culture plant cells are manipulated in herbicide medium; protoplast fusion technique-transfer of protoplast or DNA controlled resistant traits into plants and gene transfer method-direct transfer of cloned genes into cells of sensitive plants. The potential application of tissue-cultured techniques related to weed management were reviewed by Sankaran and Ilangovan (1993).

iii) Bioherbide approach: In the bioherbide approach, microbial plant pathogens (bacteria, virus, fungi) are applied to target weeds in a manner similar to herbicides. Fungi are most useful and hence the trem 'mychoherbicide' is also used to refer bioherbiceds. 'De vine' containing a formation of soil borne fungus *Phytophthora palmivira* and '*Collego*' containing spores of *Colletotrichum gloeosporides* as endemic *Anthracnose* fungus are commericalized herbicides. Other fungal bioherbicides have been developed including 'Velgo' based on *Fusarium lateritium* and 'casst', which is based on *Alternaria cassiae.*

iv) Naturally occurring herbicides: Many chemicals have been found to possess good herbicidal activity.'Bialophos' is the first herbicide developed by this method and commerically marketed in Japan under the trade name 'Herbiace' isolated from the fermentation froths of *Streptomyces hygroscopcus* and *S. viridochromogens* exhibits activity against wide spectrum of grasses and broad leaved weeds on foliar application.

Another approach is the biorational synthesis of synthetic analogues. Methoxy phenone, marketed in Japan (Nihorn, Japan) as a selective herbicide for *E. crusgalli* in rice is a synthetic analogue of the microbial toxin anisomycin.

v) Genetically engineered micro organisms: Genetically engineered micro organisms may be useful for solving a number of difficulties involved in modern weed management and herbicide technology, such as microbial degradation of soil applied herbicides; development and use of microbial herbicide safeners and use of micro organisms as biocatalysts in the production of synthetic herbicides.

vi) Allelopathy in weed management: Chemical herbicides pose health hazards and environmental problems. Besides this, the increasing incidence of herbicide resistant weeds throws new challenges in weed management. To overcome these problems, allelopathic phenomenon for biological weed management could be exploited. Although the allelopathic suppression of crops by weeds has been well documented, the research on allelopathic effect of crops on weeds has been very limited.

Beta vulgaris seeds release an inhibitor that suppressed *Agrosteimma* sp. The toxicity of *Lupinus albus* and *Zea myas* to weed growth has been reported. Studies on soybean showed that out of 141 lines. some lines stimulated, while others inhibited the growth of weeds *Helminthia echinoids* and *Alopercurus myoscuroides.*

Another approach for weed suppression through allelopathy is to examine role of crop residues and mulches. Release of phytotoxic ferulic acid from wheat crop residues suppressed *Ipomoea purpurea* and *Sida spinosa* populations in the field. Knowledge of allelopathic interactions between plant species of an eco-climatic region could be used for weed control.

The practical approaches in this direction could be, mulching of allelopathic fresh residues; spraying of extract from plant parts; planting strips of species toxic to weeds but not the crops; integration of allelopathic strategies with other methods of weed control; hormonal stimulation of inhibitor production in crops or specific weeds and genetic incroporation of allelopathic properties into cultivars.

Evolving Herbicide Tolerant Crops

More than 20,000 trials were conducted in USA in crops like corn, soybean, tobacco, tomato etc. to develop transgenic crops with significant tolerance to specific herbicides.Corn is by far the most frequently (44 percent) tested followed by 10 to 15 percent each of tomato, soybean and potato, and cotton at 8 percent. In the USA, IMI-corn (tolerant to imidazolinona herbicides) was introduced in 1991 as the first major transgenic crop. About 8 M.ha. of herbicide tolerant crops were planted in 1997. Other herbicide tolerant crops are SR-corn (tolerant to sethoxydium), Liberty Link corn (resistant to glufusinate), STS tolerant soybeans (tolerant to glyphosate), Roundup Ready soybean (tolerant to glyphosate).

In 1996, herbicide tolerant soybean in USA resulted in 10 to 40 percent less herbicide requirements, improved yields, no carry-over herbicide residues. It also led to more flexibility in agronomic management and better control of weeds and soil moisture conservation.

Tackling problem weeds in the country

The weed researches in India have mostly concentrated their resources in developing viable weed management strategies in field crops such as cereals, pulses, oilseeds, fiber crops, sugarcane and to a certain extent in plantation crops like tea, coffee and rubber. Sporadic attempts have been made by a few scientists to control some of the widespread national weeds such as Parthenium, Eupatorium, Oxalis, Mikania, Lantana, Chromolena. in terrestrial areas; water hyacinth, Salvinia and Typha in aquatic bodies; Cuscuta, Loranthus, Orabanche and Striga spp. under parasitic weeds. These weeds are prevalent all over the country under varied agro ecological zones posing serious challenges to crop production and environmental hygiene. Specific target oriented coordinated research efforts are necessary to tackle these problem weeds.

The management of aquatic weeds in both static and running water is long neglected area of research in our country. A systematic survey of aquatic vegetations in the different water bodies need to be undertaken as in the case on terrestrial weeds. The biology and ecology of aquatic weeds, development of integrated weed management practices, monitoring herbicide residues in water bodies and commercial utilization of the aquatic weeds collected are some of the specific aeras of research to be taken up.

Center of Excellence in Herbicide Residue Analyses

One of the major lacunae in the country in weed science research is the dearth of well equipped Residue analytical laboratories to precisely estimate the MRL of the herbicide in the eco-system nearly two dozzen herbicides are commonly available for weed management in various crops and to control specific weeds. Some of these are highly persistent while a few lose its toxicity in a few days time. More and more new herbicide molecules are being tested in the country for use as herbicide in specific situations. Simulataneous analysis of its qualities with reference to its persistence in soil, water and crop residues are essential to safeguard the environment on its application. Special efforts need to be taken up to establish the state of the art residue laboratories in the country with fully competent scientists in charge on such facilities.

Efficient Transfer of Weed management technology

In our country, farmers practices both commercial and subsistence agriculture side by side. Commercial farming is concerned with operational efficiency to maximize net income. The major problem facing these farmers is to adjust to the effects of changing technology while subsistence farming, on the other hand, is characterized by relatively simple and stable technologies and the major problem for these farmers is to obtain new information and resources in order to achieve a break through in poor production system and improve their economic position. Subsistence farmers commonly use about 40- 60 percent of their labour on weed control before or after planting (Singh, 1993). The adoption of labour saving methods may have a negative impact on the labour force and also may be resisted, as farmers are reluctant

to adpot a technology that carries added risk. As weed contorl systems may be highly site specific, the direct transfer of technology is rarely successful.

The selection of an acceptable weed control system requires a through understanding of the technical, economic and social realtities of the area. In developing eco-friendly weed management options for sustainable agriculture the major steps to be considered are: identification of the target farmer group and the present cultural practices, study of socio economic conditions, testing of promising methods on the farmers fields using local practices, promoting mrthods to target farmers and monitoring their acceptability. Such a wholistic approach alone is likely to yield fruitful results in the field.

Conclusion

India faces tremendous challenges in food front to enhance its grain production from 200 M.T. to 260 M.T. in the next 30 years. Modern weed management is one of the efficient tools available in achieving the target of increased farm productivity. The weed scientists working in different organizations in the country need coordination to avoid duplicaiton and overlapping of research efforts. The biology and ecology of weeds in all agro climatic regions are to be documented and mapped. There is need for countinuous monitoring of weeds for its shifts and developing resistance ot certain herbicides. The residue analysis of all commercially available herbicides in the country are to be monitored for their persistence in soil, water and ecosystemes. Since modern weed management technologies are area specific, socio-economic studies of the farmers of the region should precede before recommending the technology for adoption.

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LEAD PAPERS

USE OF BIOLOGICAL CONTROL METHODS IN WEED MANAGEMENT FROM THE POINT OF ECO-SAFETY

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Introduction

Weeds are unwanted plants playing a very important role in different ecosystems and many of them cause enormous direct or indirect losses. The losses include interference with cultivation of crops, loss of biodiversity (native plant species are displaced), loss of potentially productive land, loss of grazing areas and livestock production, poisoning of humans and livestock, erosion following fires in heavily invaded areas, choking of navigational and irrigation canals and reduction of available water in water bodies.

Several methods including mechanical, chemical and biological control have been adopted from time to time for the management of weeds. Most of the weeds have occupied such niches, forest areas, tea, rubber and other plantation crops, vacant or grazing areas and water bodies where chemical or mechanical control measures are neither feasible nor economical. Several of these weeds are introduced from other parts of the world. Biological control offers highly effective and environmentally friendly solutions to the problem of invading alien weeds. However, proper planning in the introduction of host-specific exotic bioagents to combat the alien invasive weeds is essential. The maximum degree of success (55.5%) in classical biological control in India has been achieved in aquatic weeds followed by terrestrial weeds (23.8%) (Singh, 1995). Once successful, the natural vegetation returns to the site and all other associated problems are solved.

The efforts made in the management of some important noxious weeds through biological means are briefly enumerated in this paper.

Water hyacinth, *Eichhornia crassipes* (Martius) Solms – Laubach (Pontederiaceae)

Water hyacinth, *E. crassipes* is of Brazilian origin and perhaps the most serious aquatic weed in India, infesting more than 200,000 ha of water surface. Introduced into India before 1900 as an ornamental plant it has spread throughout the country. The seeds sink to the bottom mud where they can remain viable for about 20 years. Aided by the absence of regulatory mechanisms like insects, which keep it under check in its native South America, the weed has multiplied at such an alarming rate (it is capable of doubling its biomass in 10 days) that manual, mechanical and chemical methods of control have failed to keep it under check.

Biological control efforts were initiated in 1982, when two curculionid weevils *Neochetina eichhorniae* Warner and *N. bruchi* Hustache and a galumnid mite *Orthogalumna terebrantis* Wallwork of Argentinean origin, were imported from USA. The results as reported by Singh (1989) and Jayanth and Singh (1993) are briefed. Adults of the weevils feed on leaves and deposit their eggs below the epidermis of the petioles and leaf lamina. *N. eichhorniae* deposits

only one egg while *N. bruchi* deposits several in each hole. Eggs hatch in a week. Larvae are white with a yellow orange head and tunnel in the petioles and crown where they form pockets and do extensive damage. Fully-grown larvae come out and pupate on live roots by making a cocoon. Larval and pupal periods are completed in about 2 months. The adults live for about 140 days and lay 680 - 890 eggs. The typical damage is in the form of symmetrical scrapings/ scars. *O. terebrantis* lays eggs in the lower surface of young central leaves. The larvae mine the leaf lamina and adults emerge from there. Host-specificity tests conducted for the weevils on 76 species of plants and on 88 species of plants for the mite revealed that they either did not feed or complete development on these plants proving the safety for field liberation in India.

In Bangalore, upto 1986 more than 25,000 laboratory bred weevils were released in 8 infested tanks. About 95% control of the weed has already been achieved in the tanks located at Bellandur, Agaram, Varthur, Byramangala, Hebbal and Nagavara with a total area of about 950 ha. In the Bellandur tank 3.5 lakh rupees were spent between August 1982 and March 1983 by deploying 200 daily wage and 419 regular gangmen for cleaning the weed. After the release of weevils, this type of recurring expenditure is no more required.

Several lakh weevils have already been released in to 15 states, viz., Andhra Pradesh, Assam, Gujarat, Haryana, Kerala, Madhya Pradesh, Maharashtra, Manipur, Orissa, Punjab, Tamil Nadu, Uttar Pradesh and West Bengal. Among these, the most spectacular result has been achieved within four years by releasing 12,000 adults of *N. eichhorniae* and 5,500 adults of *N. bruchi* in the 286 sq. km. Loktak Lake in Manipur. During 1999, Project Directorate of Biological Control, Bangalore released over three lakh weevils and eight lakh mites in Bhindawas lake (Haryana) for the management of water hyacinth.

In 1987, *N. eichhorniae* and *N. bruchi* were released over a period of 3 years in a 20 acre tank at Nacharam in Hyderabad. Ninety eight per cent reduction in the density of water hyacinth was recorded (Gupta *et al.*, 1993).

N. eichhorniae and *N. bruchi* were released through 28,545 weevil-infested plants at Ramgarh lake near Gorakhpur (UP) in 1988. In May 1989, the weevils had spread throughout the 1,700 acre Ramgarh lake (44.92 individuals/plant) and complete defoliation was achieved (Misra *et al.*, 1989).

In 1990, 2,16,000 *N. eichhorniae* and *N. bruchi* were released in 43 kms peripheral Surha tal, Balia (UP) on heavy thickets of water hyacinth. Within 4 years the weevils have given significant control of water hyacinth restoring the lake for tourism (Misra, M.P., Personal communication).

Release of *O. terebrantis* in tanks already having *N. eichhorniae* and *N. bruchi* or release along with these two species of weevils is recommended as it is likely to increase the stress load on the weed and improve the overall control of water hyacinth.

Nine species of fungal pathogens have been recorded from water hyacinth. *Alternaria eichhorniae* Nag Raj & Ponnappa has been considered as a potential biocontrol agent for water hyacinth (Nag Raj & Ponnappa, 1970; Ponnappa, 1974). Subsequently it was reported that damage to water hyacinth due to *Alternaria* sp. was more extensive than other pathogens, *Fusarium* and *Cercospora* (Jamil *et al.*, 1983).

In addition to *A. eichhorniae, A. alternata* (Fr.) Keissler is found to be infecting water hyacinth in India (Aneja, 1998). Both species are present in the lakes in and around Bangalore and during the monsoon months were found to be highly damaging to the weed. The apparently narrow host-range and production of a phytotoxin that has a very narrow host spectrum strongly favour the use of *A. eichhorniae* as a biological agent for water hyacinth.

Other than *Alternaria*, two species of *Cercospora*, namely, *C. rodmanii* Conway and *C. piaropi* Tharp have been reported to infect water hyacinth in different parts of the world, including India. *C. rodmanii* occurs in some northern states and has been proved to be host-specific. Integration of *C. rodmanii* with insects such as *Neochetina* spp. is an ideal option to check the growth of water hyacinth. *Acremonium zonatum* (Saw.) Gams. a fungal pathogen, is found usually associated with the weed where there is high presence of the mite, *O. terebrantis*. Its occurrence in India is still not known, but with more research, there is a possibility of identifying the fungus locally for exploitation in combination with the mite.

Diquat, 2,4-D, paraquat, Temephos and phenthoate are relatively safe to the curculionids *N. eichhorniae* and *N. bruchi* and could be used in integrated management of water hyacinth (Patnaik *et al.*, 1987; Gupta *et al.*, 1989; Ganga Visalakshy, 1993).

Water fern, *Salvinia molesta* D. S. Mitchell (Salviniaceae)

S. molesta is a free floating weed of Brazilian origin. The weed was first observed in 1955 in Vole lake, Kerala, assumed pest status 1964 and is known to affect the lives of 5 million people there. In Kuttanad area alone, which is considered the rice bowl of Kerala, some 75,000 acres of canals and another 75,000 acres of paddy fields are affected by this weed. It choked rivers, canals, lagoons, covered Kakki and Idukki reservoirs affecting navigation, irrigation, fishing, shell collection and other operations were hindered. In some areas cultivation of paddy had to be abandoned on account of *Salvinia* infestation (Joy *et al.*, 1985).

The results of biological suppression of *S. molesta* as reported by Joy *et al.*, 1985; Singh, 1989 and Jayanth and Singh, 1993 are briefly enumerated. Biological control efforts initiated in 1976, by introducing a grasshopper *Paulinia acuminata* De Geer, were not successful. In 1982, a culture of the weevil *Cyrtobagous salviniae* Calder and Sands was obtained from Australia, where it had demonstrated its potential as an effective control agent. Females are slightly larger than males and mating takes place between 5 and 26 days after emergence and females start egg laying within 6 to 14 days. Eggs are laid singly in stem cavities created by adult feeding on unopened leaf buds. The eggs hatch in about 10 days. Newly emerged larvae are white, crescent shaped. The larvae feed on the terminal tender leaf buds and roots. After feeding for 3 to 14 days larvae enter the base of leaf bud, tunnel inside the rhizome to complete three instars. The attacked leaves start darkening, turn brown and finally drop off. The larval period is usually completed in 22-25 days. The larva spins a cocoon beneath the water surface in close contact with the live plant tissue. Pupal period lasts 8-10 days. The adults live for 100 to 235 days. The adults are good colonisers and establish easily. Quarantine studies in Bangalore involved 75 plants and the results confirmed the safety of this insect to economically important plants in the country. Initial field trials in a 200 sq. m. lily pond at Bangalore gave successful control within 14 months.

Since 1983, field releases were carried out throughout the state by Kerala Agricultural University, Thrissur. The insect established in most of the release areas and brought about control of the weed within 12 to 14 months. In most of these places *Salvinia* choked canals are not seen any more. Population of the weed is thin and scanty in most of the paddy fields in the release areas. Already about 2,000 sq. km. area of the weed has been cleared by *C. salviniae*.

In paddy fields the labourers were engaged to physically remove the *Salvinia* growth before transplanting. The establishment of the weevil has resulted in a saving of about Rs.6.8 million annually.

Among fungal pathogens *Myrothecium roridum* Tade ex Fries from *S. molesta* on the Kakki reservoir, Kerala and *Verticillium nigrescens* Pethybridge from the same species near Bangalore have been reported (Anon., 1974). The release of specific fungal pathogens following release of *C. salviniae* will result in hastening the collapse of *S. molesta*.

Lantana, *Lantana camara* Linnaeus (Verbenaceae)

L. camara, a central and South American weed was introduced into India in 1809 as an ornamental plant. It spread soon into wasteland and pastures forming dense thickets. Apart from several drawbacks of this plant such as competitive displacement, it has been reported to be a symptom less carrier of sandal spike disease (Nayar and Srimathi, 1968). It is an important weed and is very difficult to manage with herbicides. In India it has by now spread everywhere. A survey of its natural enemies yielded 148 species of insects but only the pterophorid *Lantanophaga (Platyptilia) pusillidactyla* (Walker) was of some importance (Rao, 1920). However, *L. pusillidactyla* has a number of natural enemies which impaired its effectiveness. A polyphagous scale insect *Orthezia insignis* Browne has been recorded suppressing the lantana population in many parts, including Kodagu and Bangalore Districts of Karnataka, but it cannot be used because it attacks a number of economic hosts.

The seed fly *Ophiomyia lantanae* (Froggatt) was introduced from Hawaii in 1921 and evaluated in south India (Sankaran, 1973; Singh, 1994). It did establish but failed to give any visible weed suppression. The lace bug *Teleonemia scrupulosa* Stal was imported from Australia in 1941, however due to apprehensions about its possible attack on teak in the field, releases were not attempted (Roonwal, 1952). But the insect escaped quarantine and by now it has been recorded on Lantana in all parts of the country. As far as its impact is concerned it was reported to kill the plants in Bhimtal, Nainital, U.P. (Joshi, 1969). Subsequent observations, however, have shown that inspite of defoliation by this insect, the plants were not killed (Singh, 1976; Bisht and Bhatnagar, 1978). The lace bug therefore does not kill the plant outright but restricts its growth to a small bush which can be neglected if growing over cultivable barren land because it cannot propagate or hamper agricultural operations. The effectiveness of *T. scrupulosa* is impaired by a mymarid egg parasitoid *Erythmelus teleonemiae* Subba Rao. *E. teleonemiae* accounted for significant variation in the population build up of *T. scrupulosa* (Ganga Visalakshy, 1998). The female lace bugs start laying eggs 24 hrs after emergence, eggs are inserted on the underside of tender leaves, 48-60 eggs are laid during the life span of 15-35 days, eggs hatch in 4-6 days and 4-5 nymphal instars are completed in 12-22 days (Varma and Sadatullah, 1973). The lace bug is reported to feed on teak flowers and also attack *Sesamum indicum* L. in the absence of lantana. But in India no such damage has been reported. For

biological suppression of lantana, *Diastema tigris* Guenee, *Salbia* (Syngamia) *haemorrhoidalis* Guenee and *Uroplata girardi* Pic. (Origin: Mexico) have also been introduced (Sankaran, 1973). *U. girardi* and *Octotoma scabripennis* Guerin-Meneville have established in India (Julien and Griffiths, 1999). Similarly *Epinotia lantanae* (Busck) has established in certain pockets of south India (Muniappan and Viraktamath, 1986) although evidence of introduction is not available. *E. lantanae* in combination with *O. lantanae* effects 95% of the fruits of lantana in Bangalore.

Siam weed, *Chromolaena odorata* (Linnaeus) R.M. King and H. Robinson (Asteraceae)

C. odorata, a native of West Indies and continental America, is a serious weed of pastures, forests, orchards and commercial plantations in south and north-east India (Singh, 1998).

It has migrated to Assam during the first world war (1914-18) where it is locally known as Assam-lata or Assam-lota. It is also known as German ban, because of its introduction during the German war. After it spread to entire north eastern region in 1924-25 it further spread to West Bengal. From West Bengal it also spread to Orissa. From eastern region it spread to Kerala in 1942 through the seeds stuck to the belongings of workers returning from the Assam front. From Kerala the weed has spread rapidly to all the southern states. It is now well distributed in north eastern and southern states, particularly in Assam, West Bengal, Orissa, Karnataka, Maharashtra, Tamil Nadu and Kerala. The distribution of the weed is limited to areas receiving rainfall of 150 cm and above.

C. odorata has occupied pastures, marginal lands and open areas. It has become a menace in coconut, rubber, oil palm, tea, teak, coffee, cardamom, citrus and other plantation, orchards and forests. It impedes the access to crop and wild life management programmes. In forest ecosystem, it decreases the value of timber, forest seed, orchards, increases the cost of seedling production in nurseries, hampers the harvesting operations in the forest and affects the overall productivity of the forest ecosystem. During the dry season, it can be a serious fire risk in the forests.

In 1970, a nucleopolyhedrovirus infected Trinidad strain of *Pareuchaetes pseudoinsulata* Rego Barros was sent to Bangalore Station of CIBC primarily for selecting virus free stocks and supplying to Malaysia and Nigeria. The culture was successfully multiplied in the laboratory. In host specificity tests, out of 13 plants tested, nibbling on *Eucalyptus citriodora* Hk. and slight feeding on *Sesamum indicum* Linnaeus were observed but larvae failed to develop normally (Giriraj & Bhat, 1970). Subsequent tests conducted on 5 plants revealed slight feeding on nine species (Sankaran and Sugathan, 1974), but was later found safe.

Field releases were commenced in Kodagu where eggs (6,700), larvae (33,000) and adult moths (600) were released but the insect failed to establish probably due to detrimental activities of predatory ants (Sankaran & Sugathan, 1974). Renewed efforts were made under All India Co-ordinated Research Project on Biological Control of Crop Pests and Weeds but with the same stock. Between September 1978 and April 1979, some 20,750 larvae of different stages and 600 gravid females were released in three different forests and recoveries could be made only up to 10 days of release of young larvae. The failure and non-establishment is attributed to a granulovirus later detected in the laboratory and predacious ants in the field

(Singh, 1980). The life stages lasted-egg 5 to 9 (average 7), larval 30 to 51 (39.6) pupal 8 to 22 (15.4) and adult 2 to 20 (8.3) days (Singh, 1980). Attempts made later to evaluate again the strains from Venezuela and Trinidad failed due to various reasons (Anon., 1983). In 1984, a Sri Lankan strain was introduced, which proved superior (Anon., 1984). In 1985, some 40,000 larvae and 400 moths of this strain were released at Trichur in a rubber plantation. The insect became established and partial defoliation was observed (Anon., 1985a,b). Further releases have resulted in defoliation of *Chromolaena* stands in about two hectares (Anon., 1986). The insect was also released in 1986 in Chickmagalur, Kodagu and Bangalore but establishment has not been observed (Anon., 1986). Following recent releases, the insect has established at Mallesara near Teerthahalli in Shimoga District and Sullia, Dakshina Kannada District, Karnataka. *P. pseudoinsulata* has also been recovered from Tamil Nadu (Singh, 1996).

Most of the fungicides and herbicides were found to be relatively safe, but all the insecticides used in plantation areas were toxic to all the stages.

Other exotic agents viz., *Apion brunneonigrum* B.B. and *Mescinia parvula* (Zeller) have failed to establish, but perhaps their re-evaluation is necessary. *Acalitus odoratus* Keifer has to be compared with the indigenous eriophyid mite *Calacarus* sp. recorded by Muniappan and Viraktamath (1986). Frequently fungal pathogens *Cercospora eupatore* Peck. and others have been recorded but fungal pathogens have never been evaluated seriously especially in combination with arthropods.

Carrot weed, *Parthenium hysterophorus* Linnaeus (Asteraceae)

P. hysterophorus, also known as white top and congress grass, is native to the area around Gulf of Mexico including the West Indies, and central South America. The plant is now widely distributed in India, Africa, China, Vietnam, Pacific Islands and Australia. In India, it was first recorded in 1810 in Arunachal Pradesh and Nagaland and in Pune in 1955. Due to the absence of effective natural enemies that keep it under check in its native home, combined with allelopathic properties of the weed, *Parthenium* grows in pure stands in almost all the states, where climatic conditions are congenial for its growth, suppressing local vegetation and threatening natural diversity. It has occupied fallow land along roadside and railway tracks, pastures and is a serious health hazard to susceptible individuals and cattle. A number of native natural enemies have been recorded on this weed in India but they do not suppress its population but rather utilise it as alternate host (Kumar *et al.*, 1979). Considering the failure of indigenous natural enemies, in 1983, a chrysomelid beetle *Zygogramma bicolorata* Pallister was imported from Mexico. In host specificity tests on 37 of 40 plant species tested, no adult feeding, oviposition or larval feeding were observed. Slight adult feeding was observed on jasmine (*Jasminum grandiflorum* Linn.) and niger (*Guizotia abyssinica* Cass.) but in multiple choice tests, oviposition and larval feeding occurred only on *P. hysterophorus*. It was declared to be safe to economic plants after testing (Jayanth and Nagarkatti, 1987).

Adults and larvae of *Z. bicolorata* feed only on *Parthenium* leaves (Jayanth and Nagarkatti, 1987). The eggs are laid singly or in small groups up to 5, mostly on the under surface of leaves and hatch in 4-6 days. The early stage larvae feed on the terminal and auxiliary buds and on the leaf blades as they grow. The full grown larvae enter the soil and pupate. The larval and pupil periods under laboratory conditions lasted 14-16 days and 8-10 days, respectively, at 26°C and 40-60% RH. Females are capable of laying on an average 800 eggs.

Z. bicolorata was released in 1984 and it has established in the field (Jayanth, 1987). Extensive defoliation of parthenium was observed in 1988. Z. *bicolorata* has spread over more than 2,00,000 sq.km. in and around Bangalore, causing defoliation of *P. hysterophorus* and encouraging the growth of vegetation formerly suppressed by this weed. The adults sent from Bangalore were released in 1991 at Vindhyanagar, Madhya Pradesh. Three years after the initial release, *Z. bicolorata* has spread up to 28 kms from the released site (Kumar *et al.*, 1998). Recently it has also established in Punjab, Haryana, Gujarat and Himachal Pradesh. The beetle has already spread naturally in entire Karnataka, Tamil Nadu, Andhra Pradesh, Maharashtra and Kerala (Singh, 1993; 1997). By 1991, its adults started feeding on sunflower leaves. The feeding on sunflower appears to be exploratory. It is attributed to the massive population build up on *Parthenium* and its migration to adjoining sunflower fields when *Parthenium* dries up. The female resorts to suicidal oviposition on sunflower as most of the hatching grubs fail to feed or develop on sunflower. Moreover, the incidence of feeding on sunflower leaves has been recorded in kharif season which is not the main sunflower growing season in Karnataka.

Field activity of *Z. bicolorata* coincides with receipt of 1.5 mm rainfall. It may therefore, perform better in well distributed heavy rainfall areas. It is apparent that *Z. bicolorata* undergoes diapause within the soil during the dry months (October-May) of the year and emerges with the onset of rains. Out of herbicides 2,4-D was relatively less toxic to *Z. bicolorata* (Patnaik *et al.*, 1988).

Other efforts in classical biological control include, a consignment of *Smicronyx lutulentus* Dietz, a seed feeding weevil from Mexico which reached dead. A culture of *Epiblema strenuana* (Walker) introduced from Australia had to be terminated in quarantine because it was found capable of completing its development on niger, an important oilseed crop in India (Jayanth, 1987b).

India has never imported a fungus for the classical control of any weed. However, under a collaborative project between CABI (UK) and ICAR, the rusts, *Puccinia melampodii* Diet. & Holw. and *P. abrupta* Diet. & Holw. var. *partheniicola* (Jackson) Parmelee were evaluated against Indian biotypes of parthenium. Both the pathogens have been performing very well in Australia and based on the experiences in that country, suitable studies were made on the feasibility of using the two rusts, especially *P. melampodii*. Work on mycoherbicides under the same project resulted in the identification of many new pathogens on parthenium in India. *Cryptosporiopsis* sp., *Alternaria zinniae* M.B.Ellis, *Phoma sorghina* (Sacc.) Boerema, Dorenb. & Kesteren and *Lasiodiplodia theobromae* (Pat.) Griffon & Maubl. were some of the hitherto unrecorded pathogens on the weed (Kumar, 2000; Kumar and Kumar, 2000a; Kumar and Kumar, 2000b; Kumar and Singh, 2000). *P. abrupta* var. *partheniicola* has also been reported from India near Bangalore in the late 1980s. Its occurrence in Andhra Pradesh has also been documented (Kumar, 1998). The most pathogenic isolate [WF(Ph)3; IMI 378270] of *Cryptosporiopsis* sp., was evaluated further and found to be an ideal candidate for mycoherbicide development (Evans *et al.*, 2000).

Similarly, based on the investigations carried out during 1996-1999 at PDBC, Bangalore, isolate [WF(Ph)30] of *Fusarium pallidoroseum* (Cooke) Sacc. (=F. *semitectum* Auct.), a leaf-spotting pathogen, was also found to be an alternative candidate for the development of a mycoherbicide. All the parthenium populations from all over Karnataka were found susceptible

to the isolate WF(Ph)30. Total susceptibility (100%) was observed in the case of samples brought from Bangalore Urban (Hebbal, Bangalore City), Mandya, Mysore, Hassan, Tumkur and Bellary districts. The overall mean susceptibility was 91.10%, indicating that there are not many resistant populations of parthenium. All the parthenium biotypes from six different states were found to be susceptible to *F. pallidoroseum*. A specialized host range screening was undertaken especially to give more emphasis to the internationally accepted centrifugal phylogenetic system. The plant species taken up for intensive investigation was sunflower (*Helianthus annuus* L.) because of its close taxonomic relationship with parthenium. A total of 21 cultivars/accessions, including the already evaluated $KBSH_1$ and Morden, were taken up for the screening. This special host-range testing concentrating only on sunflower indicated that the results obtained in the preliminary assessment of a few sunflower cultivars were enough to show the immunity of sunflower to *F. pallidoroseum*. The specificity of the isolate WF(Ph)30 has been proved to be sufficient for its use as a mycoherbicide for parthenium under varied field conditions.

Crofton weed, *Ageratina adenophora* (Sprengel) R. M. King & H. Robinson (Asteraceae)

A. adenophora, a native of Mexico has spread to the hilly areas of south and north India forming dense thickets up to some 3 m on valuable grazing land. The weed has also occupied the vacant places in tea, teak, rubber and other forest plantations. For the biological suppression of this weed the tephritid gall fly *Procecidochares utilis* Stone (origin: Mexico) was introduced in 1963 and released in the Nilgiris (Tamil Nadu), Darjeeling and Kalimpong areas (West Bengal). Although *P. utilis* has established in all the areas it failed to create any substantial impact on the weed, probably due to heavy rainfall and parasitism (Sankaran, 1973).

Prickly pear, *Opuntia* spp. (Cactaceae)

Prickly pear cacti, *Opuntia* spp. (origin: New World) are vacant or wasteland and grazing-land weeds. The first outstanding success in biological control of weeds in India was achieved when *O. vulgaris* Miller was controlled in central and north India by introduction of the mealybug *Dactylopius ceylonicus* (Green) from Brazil in 1795. This, of course, was not a deliberate attempt as *D. ceylonicus* was mistaken for the true cochineal insect *D. coccus* Costa and was introduced for commercial production of cochineal dye. But the potentiality of classical biological suppression was established for the first time in use of an insect to control a weed. The area became fit for cultivation within 5-6 years (Pruthi, 1969). *D. ceylonicus* being restricted to *O. vulgaris* proved a failure when introduced and distributed in south India to suppress *O. stricta* (Haworth) (=*O. dillenii* (Ker-Gawler) Haworth). In 1926, *D. opuntiae* (Cockerell) a north American species was imported from Sri Lanka and its colonisation resulted in spectacular suppression of *O. stricta* and related *O. elatior* Miller (KunhiKannan, 1928; Ayyar, 1931). More than 40,000 ha area was cleared (Narayanan, 1954).

***Orobanche* spp. (Orobanchaceae)**

Parasitic weed in tobacco, brinjal, tomato, sunflower and other crop lands. An agromyzid, *Phytomyza orobanchia* Kaltenbach was imported and tried. The maggots feed on the seed buds but the insect did not establish. *Fusarium oxysporum* var. *orthoceras* Schlechtendahl ex Fries has also been recorded as a potential fungal parasite.

***Cyperus rotundus* Linnaeus (Cyperaceae)**

The nut grass, *C. rotundus* is a cosmopolitan weed and many natural enemies have been reported but all are mostly polyphagous. Tortricid borers, *Bactra minima* Meyrick and *B. venosana* (Zeller) are very specific and of some promise.

***Mikania micrantha* Kunth (Asteraceae)**

Mikania micrantha (mile-a-minute weed) is another target under a collaborative project between several institutes, especially the Kerala Forest Research Institute (KFRI), Peechi, and CABI Bioscience (UK). The weed is a gregarious climber which covers up a vast area within a very short time, cuts off sunlight and suppresses the host plant eventually causing death of the host. Evaluation of many strains of the microcyclic rust, *Puccinia spegazzinii* Toni from different countries like Mexico, Brazil and Trinidad against mikania collections from India has resulted in the identification of a few strains of the rust suitable for introduction into India. *Cercospora mikaniacola* F.L.Stevens, a leaf-spotting pathogen that causes brown sunken lesions, is one of the fungi identified in India.

The above account on biological control attempts on weeds emphasizes the need for further efforts to fine tune the technology evolved for the weeds already discussed in this paper. The biological suppression possibility of the following weeds may be investigated, i.e., *Pistia stratiotes* Linnaeus, *Alternanthera philoxeroides* (Martius) Grisebach , *Potamogeton* spp., *Hydrilla* sp., *Typha* sp., and *Imperata cylindrica* (Linnaeus) among aquatic, *Acacia melanoxylon* R.Brown, *Cyperus rotundus* Linnaeus, *Mikania micrantha* Kunth, *Oxalis latifolia* Kunth, *Solanum elaegnifolium* Cavanilles, *Phalaris minor* Retz., *Prosopis juliflora* (Swartz) de Candolle and *Xanthium strumarium* Linnaeus, among terrestrial and *Orobanche* spp., *Striga* spp., *Cuscuta* spp. and *Loranthus* spp. among parasitic weeds.

Future needs

- Prioritization of taxonomic survey, identification of species and biotypes and preparation of distribution maps of weeds.
- Creation of electronic databases on all aspects of weeds and their management.
- Development of information system for early warning of alien species threat.
- Determination of the suitability of weed problem for biological suppression.
- Survey of natural enemies of the weeds.
- Study of the biology of natural enemy and the weed-natural enemy relationships to determine how best they could be used to solve the problem.
- Determination of weed host specificity of the natural enemy.
- Implementation of weed suppression and introducing new natural enemies to the problem area.
- Increasing the effectiveness of the indigenous host specific natural enemies through different types of manipulations.
- Evaluation of the effectiveness of the natural enemy/enemies.
- Development of code of conduct for import, export, release and documentation of natural enemies.
- Development of expertise through training.
- Development of interaction between different scientists and laboratories for effective management of alien invasive weeds.

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SOLARIZATION – A NEW CONCEPT IN CROP PRODUCTION

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Introduction

The intensive agricultural being practiced widely, weeds have become one of the major deterrents in the development of sustainable agricultural systems. Chemical toxicants are being developed since 1950s to combat weeds and are presently extensively used in developed nations. Herbicides form nearly 43.5 per cent of world pesticide trade. Chemicals are, though time-efficient, the associated residue hazard, evolution of resistant biotypes and species replacement problems have necessitated development of alternate non-hazardous means of weed management. Consequently, researchers in their search for new methods also took interest some of the traditional practices with a hope of evolving a much efficient tool of vegetation management.

In India, traditionally it is a practice to deeply plough the land after crop harvest and expose it to direct sun during summer to disinfest and regenerate fertility of soil. In 1939, Groshevoy used solar energy and controlled *Thielaviopsis brassicola* by heating soil using direct sunlight. Later on, in Israel extension workers and growers suggested that intensive heating that occurred under mulched soil might be used for soil disinfection. This led to the development of a non-hazardous method of soil disinfection what is now known as 'soil solarization'

The term 'soil solarization' denotes intensive heating of moistened soil by mulching with transparent polyethylene sheet during hottest months of the year to increase soil temperature to lethal or near lethal levels for weeds and other soil borne pests. These days the term also includes post-plant solarization for enhanced productivity through soil disinfection, alteration of rhizosphere dynamics, moisture conservation and improved microclimate near ground surface in perennials and commercial crops.

India with many locations experiencing daily summer mean maximum air temperature of over 38-40°C provides ample opportunity for solarization. In organic farming also pre-planting solarization has been suggested for soil disinfection. Besides its effect on soil fauna and flora, solarization is reported to affect plant growth through physical, chemical and biological changes. Initial studies carried out at ICRSAT, Hyderabad, University of Agricultural Sciences, Dharwad (Karnataka) and elsewhere in the country were encouraging. In view of these beneficial effects of soil solarization is discussed in the following text.

Effect of Solarization on Weeds

Soil solarization or soil tarping was initiated for control of soil pathogens. Though control of weeds was one of the most visible effects, in the seventies not much attention was given to weed control and was considered only as a beneficial side effect. Later on investigations by Sando *et al.* (1977), Uzard (1977) and Grinstein *et al.* (1979) threw light on weed control through solarization. This led to concentrated efforts on major difficult to control species such as *Orobanche* (Jacobsohn *et al.*, 1980 and Abdel-Rahim *et al.*, 1988) or *Cyperus* (Abdel Rahim

et al., 1987; Sauerborn *et al.*, 1989 and Kumar *et al.*, 1993) or for general weed control in high value crops (Bell and Elmore, 1983 and Materazzi *et al.*, 1987) or as a method of broad spectrum weed control.

Winter Annuals

Solarization in onion fields of Israel found to decrease weed population, except *Melilotus* (Katan *et al.*, 1980). They observed effective control of many winter annuals including *Anagallis*, *Avena*, *Lactuca*, *Sisymbrium* and *Stellaria*. Elmore and Van Hausen (1981) found that one week of solarization with 2 mil UV stabilized polyethylene in June and July in Davis, California controlled *Poa annua, Montia perfoliata* and *Senecio vulgaris*. In Mississippi, Egley (1983) observed significant control of many unspecified winter annuals with four weeks of solarization. Silveira *et al.*,(1986) in their two year study noticed *Poa annua* and *Conyza bonariensis*, the wind distributed species as the major invaders of solarized fields. Horowitz *et al.* (1983) reported the control of *Lamium amplexicaule* in Israel. In Portugal, *Sonchus oleraceus* cover was found to be reduced by 87.5 per cent in late summer experiments (Silveira and Borges, 1984). Thus, species of weeds that germinate under cool temperature are effectively controlled as temperature regime required for germination made these species very susceptible to elevated soil temperatures.

Summer Annuals

Unlike winter annuals, weed species growing in the summer months require high temperatures and longer days to germinate hence are more difficult to control. Inconsistent results have been reported in respect of *Malva niceansis* (Jacobsohn *et al.*, 1980; Horowitz *et al.*, 1983 and Rubin and Benjamin, 1983), *Fumaria judaica* (Jacobsohn *et al.*, 1980 and Horowitz *et al.*, 1983), *Portalaca oleracea* (Grinstein *et al.*, 1979; Katan, 1980, Egley, 1983 and Chttapur, 1998), *Solanam luteum* (Katan, 1980 and Rubin and Benjamin, 1983) *etc.* Some sensitive species viz., *Sida spinosa, Xanthium pensylvanicum* and *Anoda cristata* are however killed with one week of solarization during mid summer (Egley, 1983).

In cotton fields of Israel, solarization caused reduction in population of *Avena* sp. and *Chenopodium* sp. by 60 to 100 per cent (Katan *et al.*, 1983). Standifer *et al.* (1984) observed that some summer annuals are very sensitive to solarization. Clear and black films controlled annual sedge in the 0 to 2 cm depth during a two-week treatment. With clear film, however, the control was increased upto 3 to 4 cm depth after more than 4 weeks of solarization. In the same study *Commelina communis* was controlled to a depth of 10 to 11 cm with clear film. In India, *Commelina benghalensis* L. though responded to solarization it was not completely killed (Chttapur, 1998).

Cartia (1985) while reviewing the work at USA, Israel and Italy noticed control of *Ditylenchus dipsaci, Amaranthus retroflexus, Avena fatua, Chenopodium album, Orobanche, Portulaca, Rhaphanus raphanistrum, Sinapis arvensis, Solanum nigrum, Sonchus oleraceus* and *Tribulus terrestris*. Further, in Sicily he noticed decreased total weed seeds in the field by approximately 80 per cent (Cartia, 1987). Population of *Malva neglecta* and *Amaranthus* sp., was noticed to be reduced by 92 and 100 per cent, respectively.

In Germany, Braun *et al.*,(1988) reported, *Digitaria sanguinalis* to be very tolerant. *Digitaria sanguinalis* and *Denebra retroflexa,* in India required longer duration of solarization

(Chttapur, 1998). In Northern Italy, solarization reduced total number of moncot weeds per m^2 from 226 to 9 and that of dicot weeds from 216 to 3 (Garibaldi and Tamietti, 1989). In fruit orchards of Davis, reduction in weed cover by 82 per cent was noticed (Stapleton *et al.*, 1989). At ICRISAT, Hyderabad decreased growth of annuals was obtained due to solarization (Chauhan, *et al.*, 1988). Similar was the observation by Philips (1990).

In the USA, solarization before planting of tomato crop caused lower population of weeds upto crop harvest (McSorley and Parrado, 1986). On the contrary, at Naples, Italy, solarization before cultivating seed onion inhibited weed growth in the period immediately after its application (Duranti and Cuocolo, 1988). Del Busto *et al.*, (1989) reported complete weed control for at least one month. Solarizations of short duration (1 to 2 weeks) have indicated the sensitivity of many weed species; however common length of film coverage of 4 to 6 weeks or more has given the most consistent control of summer annual species (Chittapur, 1998). Factors that could affect the sensitivity of the species include soil moisture, care in placing film, duration of solarization, depth of seed in soil and weather conditions (Elmore 1991; Habeeburrahaman, 1992 and Chittapur, 1998).

Perennials

Differential responses have been achieved with solarization for perennial weed control. The difficult to control weeds, *Cyperus esculentus* and *C. rotundus* have both been evaluated. Hejazi *et al.* (1980) reported that tarping the soil with clear polyethylene reduced the tuber viability of *Cyperus esculentus* by 26 per cent after six weeks. Further, they observed tuber mortality by 100 per cent at 60°C for six days and a temperature of 50°C only reduced viability by 60 per cent after 32 days of treatment.

Cyperus rotundus has been generally resistant to control (Katan *et al.*, 1976; Grinstein *et al.*, 1979; Rubin and Benjamin, 1984, Kumar *et al.*, 1993 and Chittapur, 1998). Reduction of tubers has been less than 40 per cent compared to an untreated area. Egley(1983) and Rubin and Benjamin(1984) reported enhanced germination of *C. rotundus*. Rubin and Benjamin (1984) found that temperatures of 70°C for 30 minutes were required to significantly reduce tuber germination in soil. Kumar *et al.*,(1993) from IARI, Delhi, reported reduction in germination by seed by 90 per cent, however the population emerging from tubers increased in mulched plots compared to unmulched plots.

Seeds of the perennial weed *Cynodon dactylon*, were found to be sensitive to solarization (Grinstein *et al.*, 1979 and Rubin and Benjamin, 1981). Rubin and Benjamin (1984) found that when buried rhizomes of *C. dactylon* or *S. halepense* were subjected to 0.5 h of 40°C temperature, there was reduction of 90 to 95 per cent emergence with no emergence after 0.5 h of 50°C. Since emergence of weed occurs from various depths depending on cultural management, they suggested that if the burial of rhizomes was controlled, control of *Cynodon, S. halepense* could be achieved.

The control of established *Convolvulus arvensis* varied. Horowitz (1980) reported that many shoots of *C. arvensis* appeared after the removal of black plastic; none emerged after the removal of transparent plastic. Silveira and Borges (1984) found a five per cent cover of *C. arvensis* with 40 days solarization as against 20 per cent cover in untreated areas. Chauhan

et al. (1988) indicated an initial decrease with a gradual recovery. Similar report was also made at California where recovery occurred after two to three weeks of film removal. Elmore (1991) suggested that since *C. arvensis* is found on heavy, deep soils and the root stocks are deep in the soil, control of established populations with solarization alone would probably not be satisfactory.

Orobanche

The efficiency of solarization in controlling Egyptian Broom rape (*Orobanche* sp.) is widely reported. At Hebrew University, Jerusalem, Israel, no carrot plant was parasitised with *Orobanche* upto 110 days after planting in solarized plots while 90 per cent plants were parasitized at 75 Days after planting in non-solarized plots (Jacobsohn *et al.*, 1980). Seventy two to 100 per cent control of *Orobanche* was obtained in Sudan (Braun *et al.*, 1988). In Egypt, control of *Orobanche* in faba bean and tomato fields was noticed for two years after solarization (Satour *et al.*, 1991). *Orobanche aegyptica* failed to appear in solarized tomato fields of Jordan (Abu-Irmaileh, 1991), Meti (1993) at Agricultural Research Station, Nipani (India) reported that 40 days soil solarization was effective in controlling *Orobanche.* Transparent polyethylene for 10 and 20 days and black polyethylene for 40 days were, however, not effective. Interestingly, *Orobanche* emergence was stimulated with 10 days of solarization.

Effect of Solarization on Microbial Population

Due to solarization changes are reported to occur in the population of soil microorganisms. Solarization causes increase in temperature and at higher temperature only a few species are able to survive close to the upper limit of temperature for that group. No eucaryotes are known to grow at temperatures above 60-61.5°C (Brock, 1978).

Fungi

At Sicily, Italy, it was observed that the total fungal population was decreased by 50 to 53 per cent due to solarization (Cartia, 1987). At Varanasi, India, there was reduction in total fungi in the zero to 10-centimetre depth of solarized soil, it was found to increase when solarized plots were under shade (Dwivedi and Dubey, 1987). Similarly in Cameroon, soil solarization for two months drastically reduced the number of potentially deleterious fungi (Gamliel *et al.*, 1989). In Western Australia, significant reductions in the fungi population in zero to 10 cm soil by 2.2 fold but increase by 1.3 fold in 10 to 30 cm soil were reported (Kaewruang *et al.*, 1989). Meron *et al.* (1989) reported 50 to 100-fold decrease in number of fungi.

Thus, many soil brone fungi are quite sensitive to solarization, their population being reduced by 90 per cent (Gamliel and Katan, 1991, Stapleton and DeVay, 1982). In addition to many major pathogens, species of *Pythium, Penicillium* and *Aspergillus* were controlled by solarization (Gamliel *et al.*, 1989a and 1989b). On the other hand, antogonistic fungi, especially *Trichoderma, Talaromyces* and *Aspergillus* spp., were reported to survive or even increase in number in solarized soil (Kaewruang *et al.*, 1989, Stapleton *et al.*, 1987, Tjamos and Paplomatas, 1988). A number of thermotolerant fungi, some of which were reported to have antogonistic activity were not significantly affected by solarization (Stapleton and DeVay, 1982 and Gamliel and Katan, 1991).

Bacteria

Bacterial counts were generally unaffected by soil solarization, but number in bare soil were usually lower for all bacterial types (Hankin *et al.*, 1982). Stapleton and DeVay(1984) found upto six fold increase in colonization of roots with *Pseudomonas fluoroscens* when used for seed treatment, compared to non-solarised soil. The bacteria *Pseudomonas* was increased to 50 to 100 fold in the rhizosphere of tomato and cotton in Israel (Meron *et al.*, 1989). Gamliel and Katan (1991) found upto 130 fold increase in colonization of roots of tomato plants growing in solarised soil of different type. On the contrary at Colima, Mexico along with fungi, a reduction in bacterial population by 62 to 100 per cent was noticed (Stapleton, 1991).

Rhizobium

Solarization had no effect on the association between *Rhizobium* and groundnut roots (Grinstein *et al.*, 1979). In Israel, Katan (1981) suggested that population of *Rhizobium* spp., sufficient to effect heavy nodulation of bean roots, survived solarization. Reduction of *Rhizobium* spp. and consequently of nodulation of broadbean, chickpea and cowpea was recorded in early stages of plant growth in solarized soils (Chauhan *et al.*, 1988 and Abdel- Rahim *et al.*, 1988). Later in the growing season, however, nodulation was improved and plant gorwth had recovered to normal levels. In the absence of inoculation, reduction in nodule number in soybean was observed (Chittapur, 1998). Chauhan *et al.* (1988) at Hyderabad did not notice much change in the rhizobial population or nodulation of either chickpea or pigeonpea. In other studies, nodulation by *Rhizobium* was increased after solarization (Arora and Pandey, 1989 and Nair *et al.*, 1990). This suggests variation in response differing with crops and cropping situations. Probably in deep rooted crops viz. chickpea, pigeonpea,etc.,there may not be much reduction in nodule number. However, seed inoculation favours colonization and nodulation due to absence of competition from native inefficient rhizobia.

Nitryfing bacteria

The soil borne populations of nitrifying bacteria decreased after solarization (Hassan *et al.*, 1989). Accumulation of NH_4^+ after solarization has been frequently observed in many experiments (Chen and Katan, 1980; Stapleton *et al.*, 1985; Kaewruang *et al.*, 1989 and Meron *et al.*, 1989).

Actinomycetes

Population levels of actinomycetes were not greatly affected by solarization (Stapleton and DeVay, 1982 and Kaewruang *et al.*, 1989). Many members of this group are known to be antagonistic and produce antibiotics. It is possible that their ability to survive solarization compared to many other microorganisms improves their chances to colonize important niches in the soil and rhizosphere, thus protecting roots from deleterious microorganisms and minor pathogens more efficiently.

Effect of Solarization on Soil Nutrients and Other Chemical Properties

Soil solarization was found to result in increases in EC of most treated soil (Chen and Katan, 1980; Stapleton *et al.*, 1985 and Chittapur, 1998) and to have little or no effect on some soils (Stapleton and DeVay, 1984 and Chauhan *et al.*, 1988). Chen and Katan (1980) attributed

the increase in EC to enhanced decomposition and mineralization of soil organic matter and to the transport of ions toward the heated surface where water evaporates and recondenses on the polyethylene sheets. The increases in EC attributed to this mechanism did not exceed 0.5 to 1.0 dS m^{-1}.

Plastic mulched and steamed soils usually contain higher levels of soluble mineral nutrients than unmulched soils (Cook and Babu, 1983 and Jones *et al.*, 1977). This phenomenon was also noticed on solarization treated soils of Israel (Chen and Katan, 1980), California (Stapleton *et al.*, 1985) and Morocco (Besri, 1991). Significant increases in NH_4^+-N, NO_3-N, Ca^{2+}, Mg^{2+} and EC were found. Chauhan *et al.* (1988) and Kaewruang *et al.* (1989) also found increase in NH_4^+-N and NO_3-N. Phosphorus, K^+ and Cl^- increased in some soils. Water-soluble Mn^{2+}, Fe^{3+} and Cu^{2+} increased in most of the solarised soil in Israel (Solovitch, 1982). This was attributed to release of soluble mineral nutrients from soil organic matter and heat killed soil biota (Chen and Katan, 1980).

A number of investigators have suggested that the increased growth responcese on solarization is related to the increase in available N (Waksman and Starkey, 1923). Others claim that the change in available N is only one of the factors involved in increased crop growth (Chen and Katan, 1980 and Solovitch, 1982).

Soil solarization, which is a moderate heating treatment, did not result in significant change in total organic matter (Chen and Katan, 1980; Stapleton *et al.*, 1985; Kaewruang *et al.*, 1989 and Hassan *et al.*, 1989). Water-soluble organic matter (or low molecular weight fulvic acid), however increased significantly (Chen and Katan, 1980, Solovitch, 1982). Fulvic acid and humic acids are well known to enhance plant growth when their concentration in nutrient or soil solution reaches an optimum of 50 to 150 mg l^{-1} (Chen and Aviad, 1990). Chen and Katan (1980) and Solovitch (1982) observed that concentrations of fulvic acid in solarised soils might increase from below 50 mg l^{-1} in unsolarized plots to over 100 mg l^{-1} in solarized plots.

Chen *et al.* (1991) suggested following mechanisms for increased growth under solarization (1) increase in NH_4-N and NO_3-N, (2) changes in the NH_4^+/NO_3^- ratio, (3) increase in organic matter, mostly fulvic acid, resulting in improved micronutrient nutrition and in direct positive effects of humic substances on plant growth and (4) increase in available micronutrients and other mineral elements.

Residue Recycling and Soil Solarization

Solarization can be combined with other management systems either during or after solarization. Adding suitable organic residues to the soil enhance the benefits of solarization (Katan, 1981). Katan *et al.*(1983) has suggested that pest suppressiveness in solarized soils which may result from shift in microbial population in favour of heat resistant antagonists could be enhanced when solarization is combined with residue management wherein chemical break down products from green manure residues may provide even wider variety of additional interactions, leading, ultimately, to the better soil disinfestation and improved crop growth.

Phytophthora spp. were found very sensitive to nitrate and other nitrogeneous compounds in soil amended with various materials (Tsao and Oster, 1981). Elad *et al.*(1980) and Chet *et al.*(1982) reported that combining the antagonist *Trichoderma harzianum* with

solarization in *Rhizoctonia* infested soils improved disease and pathogen control. Combining soil amendments such as cabbage residues with solar heating of soil found to provide complete control of cabbage yellows caused by *Fusarium oxysporum* sp. *conglutinans* (Ramirez-Villapudua and Munnecke, 1987).

Not much information on solarization on nutrient release through residue management is available. However, Chittapur (1998) reported favourable changes in soil fertility. Residues under transparent polyethylene mineralized rapidly and released available form of nutrients. The EC, organic carbon, available P_2O_5 and available K_2O were higher with residues particularly with glyricidia and pigeonpea stalks. Wheat straw + cattle dung + *Phanerochaete chrysosporium* inoculation recorded higher soybean yield (3479 kg/ha) compared to residue-free solarized (2589 kg/ha) and non-solarized (2004 kg/ha) checks.Wheat straw + cattle dung (3621 kg/ha) and cotton stalks + dung + decomposer (3058 kg/ha) were next in order.Higher with inoculated residues were understood to be due toenhanced mineralization of residues.

Effect of Solarization on Crop Performance

Various researchers have reported yield increase and improvement in growth to various degrees due to control of weeds and disease pests, increase in antagonistic microflora, improvement in nutrient availability and other factors influencing growth from soil solarization. Solarization found to increase groundnut pod yield by 52 per cent through its effect on weeds (Grinstein *et al.*, 1979). Similarly, Katan *et al.*(1980) reported increased yields of onion due to solarization through its effects on weeds, *Rhizoctonia* and *Fusarium*. In broomrape infested carrot fields, solarization caused drastic reduction of parasitization of carrot plants and thereby increased carrot yields (Jacobsohn *et al.*, 1980).

Increase in the yield in the absence of known pathogen was also due to improved growth. Katan(1980) observed 56 per cent yield increase over control due to improvement in crop growth.

At Torino, Italy, due to the complete eradication of *Rhizoctonia solani* and 94 to 99 per cent control of dicot and monocot weeds by solarization, the fresh weight of beans in the first and second crop after solarization was increased by 41 and 37 per cent, respectively. Quite recently, in Jordan, six weeks solarization found to decrease weed growth and increase tomato yield by more than 300 per cent over non-solarized control (Abu Irmaileh, 1981).

At California, USA, weed control achieved through solarization for four to six weeks resulted in increased crop vigour in brocoli, carrots, onion and melons and there was significant yield increase in bracoli (Elmore, 1983). According to Stapleton and DeVay (1986) the process of soil solarization comprising of several modes of action including thermal inactivation of weed seeds and weakening of propagules which will alter plant root environment and result in increased growth response.

Katan *et al.*,(1987) observed increase in yield of cotton from 2.46 to 4.17 t per ha due to reduction in weeds and *Fusarium* on account of solarization.

At Colima, Mexico, sesame crop growth one week after solarization for 45 days showed 72 per cent increase in seed yield over non-solarized plots due to 97 to 100 per cent reduction in weed population and 92 to 100 per cent reduction in *Macrophomina*. Number of pods per plant in groundnut increased from 25 to 49, seed yield from 867 to 1491 kg per ha and fresh weight of plants from 60 to 124 g per plant (Stapleton and Garza - Lopez, 1988). At Giza, Egypt, Fahim *et al.* (1987) reported increased yields of *Phoseolus vulgaris* due to effect of solarization on damping of, root rot and weeds.

At ICRISAT, Hyderabad, Chauhan *et al.*(1988) noticed a yield increase in a disease resistant genotype from 0.4 to 1.1 t per ha and total dry matter accumulation from 1.4 to 3.5 t per ha. They attributed this improvement mainly to weed control and benefits other than disease control by solarization. Chickpea recorded a yield increase of about 23 per cent.

Habeeburrahaman (1992) in sorghum reported maximum yield (4228 kg/ha) with transparent polyethylene (0.05) for 40 days which was on par with weed free check (4226 kg/ha) and the increase in yield of the former over unweeded control was by 92.4 per cent. In a separate experiment in groundnut he observed higher yield of groundnut pods (3207 kg/ha) with transparent polyethylene for 40 days, which was on par with weed-free check (3550 kg/ha).

Working on solarization in tobacco, Meti (1993) reported increase in cured leaf yield (1386 kg/ha) of tobacco with transparent polyethylene mulched for 40 days compared to non-mulched treatment. He attributed the improvement in yield to increased vigour of tobacco resulting from weed reductions particularly the obligate root parasite *Orobanche*

CONCLUSION

Summer solarization with transparent polyethylene with thinner film (0.05mm) for a period equal to or more than 50 days is advantageous for crops succeeding solarization for one more seasons primarily due to control of weeds and pests apart from many other reasons of improved growth responses. Enhanced mineralization of treated pre-plant incorporated residue is also possible under solarization. Soil solarization is also an approved method for farmers wishing to produce and sell foods as organic. Some organic farmers, however, have voiced concern regarding adverse effects of solarization on micro-environment. These concerns include decreasing organic matter content through enhanced degradation, killing of beneficial microorganisms, and leaving plastic in soil. Strip tarping, because it does not treat as much area as complete coverage, helps ameliorate some of the concerns of organic farmers. Hence, solarization offers opportunity for greater benefits. In view of growing concerns for environment safety and sustainability of agricultural production integration of solarization and other crop management practices would provide an eco-friendly and sustainable system.

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Impact assessment and socio-economic audit of zero tillage technology in Haryana

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During first two years (1996 and 1997) almost everyone was too scary about zero tillage, but the joint efforts by scientists of Haryana Agricultural University, ACIAR, Australia and Rice-Wheat Consortium, made the mood to swing in another direction. Some myths about *more you cultivate and more you produce* were required to be removed from the minds of farmers and extension agencies. The farmers' participatory approach, especially when farmers wanted to come out of herbicide resistance crisis, became the source of rapid growth of zero tillage from only 10 acres in 1996 to approximately 100000 acres in 2000. From now on if the Government and international agencies grasp this opportunity to make the long-needed 'ever green revolution' a success, the sustainability of rice-wheat cropping system could even end up stronger than before. Herbicide resistance therefore combined the case for danger and opportunity .The dangers in thick of herbicide resistance were evident by large-scale wheat yield losses during 1993- 94 and 19994-1995 and it forced scientists to pursue the tillage reforms, which in happier times would have been unthinkable. The success in Haryana, has offered excellent opportunity to accelerate the rapid adoption of zero tillage technology not only in India but also in South Asia. What the scientists need now is to change the way they conduct their research.

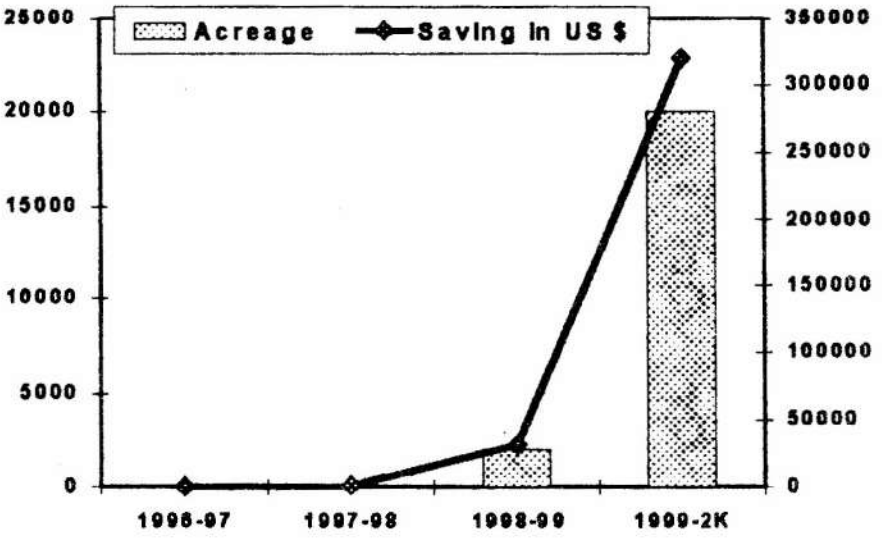
Inter-departmental or inter-institutional linkages have been seldom seen as a locus of activity. Some of the important factors that have contributed to faster acceptance of zero tillage in Haryana are:

- Role of CIMMYT through their help in designing zero tillage machine some time in mid 1980s, training of scientists, early acceptance of the fact that the herbicide resistance is a sustainability issue, and participatory support in this venture.
- Role of ACIAR-Australia in supporting farmers participatory research model for herbicide resistance management.
- Corporate sector and the state department of Agriculture for participating with scientists after seeing the benefits in 1997-98.

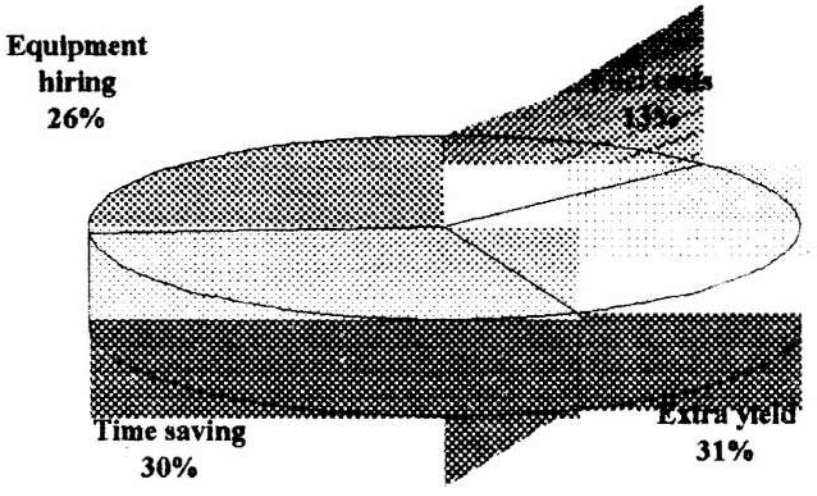
In the years ahead, the researchers have the potential advantage because **they can understand** cause and effect of any new technology and also have the potential to smoothen the rough edges of new technologies. Furthermore, scientists working in tandem with extension media particularly on farmers' fields minimize chances of mistakes and can produce more innovative research.

There is every chance that other states will also have the same approach. Since most states do large proportion of their research and extension on land grant pattern, each state can magnify their focus area that can lead to the acceptance of conservation tillage technologies.

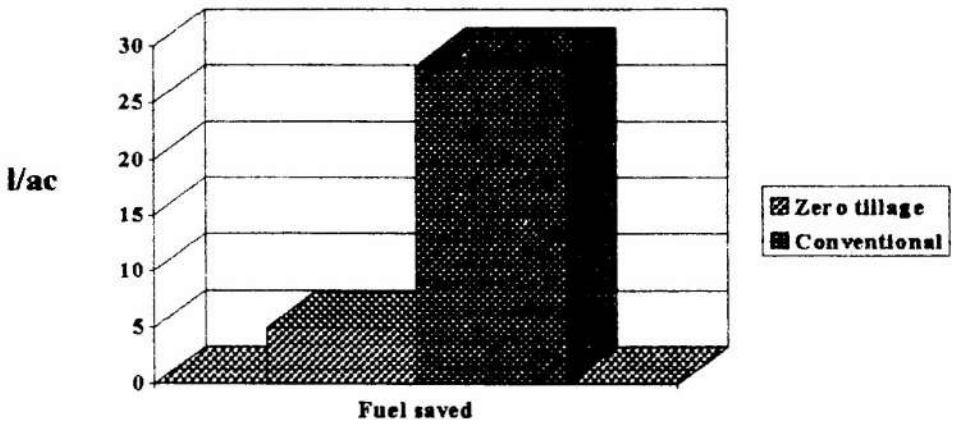
Impact of zero tillage – A case of Haryaná state



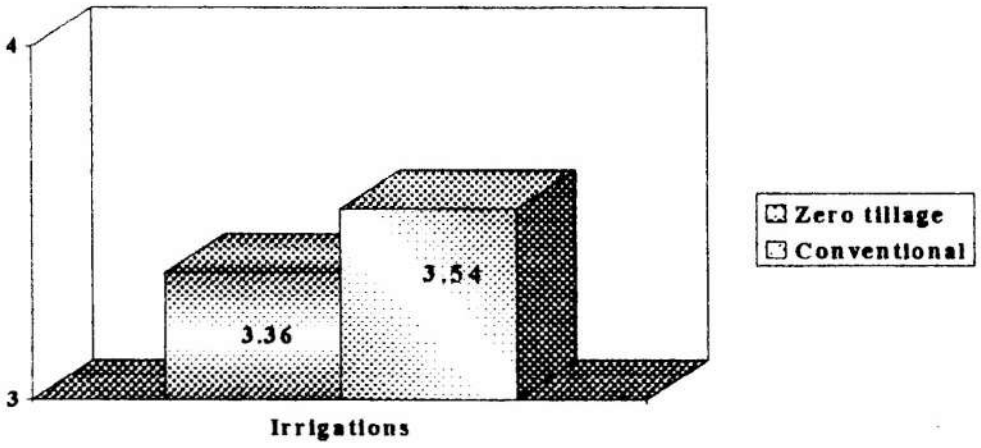
Tangible Benefits



Fuel saving



Number of irrigations



was successful, the international agency will have much higher level of participation than few years ago. Adoption of a new practice is an individual decision but diffusion takes place in the society as a process almost automatic, provided the adoption is at a proper place and with an appropriate focused approach through a well-identified human resource.

The underlying causes and effects including socio-economic issues need to be characterized using survey and eco-system audit. This can be followed by education and training programme based upon monitoring and survey and then the researchers can implement the technologies with the help of extension agencies and master trainers of farmers. Universities and extension agencies will benefit by participating in the multidisciplinary research through this approach to gain knowledge in data handling and statistical analysis. The tangible benefits are always visible either through improved productivity or through cost minimization (see boxes on page 3 and 4), but intangible benefits like environmental pay offs are not visible and may not help immediately in the acceptance of a technology.

The farmer always visualizes the current benefit and the long-term benefits accrued through conservation technologies are not considered by the farmers. The economic and non-economic costs and benefits of resource conservation technologies need to be quantified with appropriate tools such as CVM or Conjoint analysis. Contingent Valuation Method where users give a perceived value to the benefits in monetary terms and in conjoint analysis the weighted preferences are considered. The Multiagent System of developing simulation models using Cormas may be used for examining the long-term macro effect of these technologies. These models may also serve as a tool for participatory appraisal of technology impact assessment and also a media for extension workers. Gender issues also need to be examined as the resource conservation technologies like zero tillage saves the time of farm women and it will be interesting to quantify trade off between farm and household activities as a result of this technology.

WEED RISK ASSESSMENT (WRA) SYSTEM FOR INDIA

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The implementation of New Policy on Seed Development (NPSD) by Govt. of India has provided stimulus for import of plant/plant materials from around the world 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. A weed risk assessment system is described that used information on a plant's current weed status in other parts of the world, climate and environmental preferences, and biological attributes. The system is designed to be operated by the Plant Quarantine personnel.

The basis of the WRA is the answer to 49 questions based on the main attributes and impacts of weeds. These are combined into a scoring system which in the absence of any evidence to the contrary, gives an equal weight to nearly all questions. Thsi covers a range of weedy attributes in order to screen for plants that are likely to become weeds of the environment and/or agriculture. The questions are divided into three sections producing identifiable scores that contribute to the total score.

Answers to the questions provide a potential total score ranging from - 14 (benign plant) to 29 (maximum weediness) for each plant. The total score is partitioned between answers to questions considered to relate primarily to agriculture, to the environment, or common to both. The total scores are converted to one of the three possible recommendations by two critical score settings. The lower critical score, 0, separates acceptable plants from those that should be rejected. Evaluation means either obtaining more data and re-running the system or undertaking further inverstigation.

It is concluded that the weed risk assessment sytem with explicit scoring of biological, ecological and geograpical attributes is useful tool for detcting potentially invasive weeds in world and should be used in Indian Plant quaratine to assess the plants befor issue of the Import Permit.

The implementation of New Policy on Seed development by Govt. 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 worls wide 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 form new plants, regulatory authorities have a statutory responsibiltiy to ensure that all plants proposed to be imported, which are not already established, be evaluated for their potential to damage theproductive capacity or environment of the country.

Quaratine in India officially came into operation with the passing of the Destructive Insects and Pests Act(DIP Act) in 1 914. Thsi act rovides a legislative framework for the aplication 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 and losses in production, but also to restrict access to export markets, if the pest has the potential to contaminate the marketable product.

Effective plant quaratine 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 and 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 befor they can be excluded by quarantine regulations (Walton and Parnell, 1996), the system must be based on explicit assumptionand scientific principles so that country cannnot be accused of applying unustified non-traiff trade barriers. Idealy the sytem should be capable of identifying which land use system the plant islikely to invade, to assist in an economic evaluation of its potentioal impacts. Finally, the system must be cost effective.

The Weed Risk Assessment (WRA) system for india is designed in consultation with the weed scientists of Australia and New Zealand during the first author's advanced training at the University of Queensland, Australia in August - September, 2000.

METHODS

The basis of the WRA is the answers to 49 questions (Annexure-I) based on the main attributes & impacts of weeds. These are combined into a scoring system which in the absence of any evidence to the contrary, gives an equal weight to nearly all questions (Annexure-II). These cover a range of weedy attributes in order to screen for plants that are likely to become weeds of the environment and / or agriculture. The questions are divided into three sections producing identifiable scores that contribute to the total score (Annexure-II). Most questions are answered, as yes, no or don't know.

Biogeography consists the documented distribution, climate preferences, history of cultivation, and weediness of a plant elsewhere in the world, i.e. apart from the proposed recipient country. Weediness elsewhere is a good predictor of a plant becoming a weed in new areas with similar environmental conditions (Forcella and Wood, 1984). The question concerning the history of cultivation recognises the important human component of propagule pressure (Williamson and Fitter, 1996), but such data are obviously never available for the proposed new country.The global distribution and climate preferences, where these are available, are used to predict a potential distribution in the recipient country.

Undesirable attributes are characteristics such as toxic fruits and unpalatibility, or invasive behaviour, such as a climbing or smothering growth habit, or the ability to survive in dense shade.

Biology / ecology are the attributes that enable a plant to reproduce, spread, and persist (Noble, 1989) such as whether the plant is wind dispersed or animal dispersed, and whether the seeds would survive through passage of an animal's gut.

Availability of information is often very limited for new species which can restrain the utility of screening systems. To ensure that atleast some questions were answered for each section, the WRA system requires the answer to two questions in section A, two in section B and six in section C before it will give an evaluation and recommendation. The recommendation can be compared with the number of questions answered as an indication of its reliability which obviously improves as more questions are answered.

Answers to the questions provide a potential total score ranging from-14 (benign plant) to 29 (maximum weediness) for each plant. The total score is partitioned between answers to questions considered to relate primarily to agriculture, to the environment, or common to both (Annexure-I). The total scores are converted to one of the three possible recommendations by two critical score settings. The lower critical scores 0, separates *acceptable* plants from those requiring *evaluation,* and the higher critical score, 6, separates plants requiring *evaluation* from those that should be *rejected.* Evaluation could mean either obtaining more data and re-running the system, or undertaking further investigations such as field trails (Mack, 1996).

RESULTS

The answer to most of the questions in the WRA is yes (y), no (n) or don't know (leave blank or ?) The system translates these responses into a numerical score.

A typical score for a question is : Yes = 1 point, No.=-1 or 0 and don't know / ? = 0.

The questions in section's 2 and 3 (climate & weed elsewhere) of the questionnaire differ from the typical scoring system in that they generate a score by a weighting system. The score given for question 2.01 and 2.02 is used to weight the scores for 'yes' answers in the weed elsewhere questions (3.01 to 3.05). The quality of climate data greatly affects the climate match. A good climate match increases the probability that a weedy species will behave the same way in India as it does overseas. The weediness score also increases if the information used to produce the climate match is not comprehensive, due to the greater uncetrtainty introduced by this data.

Two other questions do not fit into the standard scoring system :

1) A score of 'no' for question 3.01, whether a plant has naturalized overseas, is modified by the score to question 2.05, its history of repeated export species with repeated introductions outside of their native range that have not established are a lower risk.

2) Question 6.07, the manimum generative time, requires the input of a numbercial score. This generative time is standardized by the use of a correlation factor (reproduction in less

Annexure - I

Form – A : Weed Risk Assessment System question sheet : Answer yes (y) or no (n), or don't know (leave blank) unless otherwise indicated

		Botanical name :	Outcome:	
		Common name :	Score :	
		Family name :	Your name :-	
			History / Biogeography	
A	1	**Domestication/ cultivation**	1.01 Is the species highly domesticated? If answer is 'no' got to question 2.01	
C			1.02 Has the species become naturalised where grown?	
C			1.03 Does the species have weedy races?	
	2	**Climate and Distribution**	2.01 Species suited to Indian climates (O-low; 1-intermediate; 2-high)	2
			2.02 Quality of climate match data (O-low; 1 intermediate; 2-high)	2
C			2.03 Broad climate suitability	
C			2.04 Native or naturalised in regions with extended dry periods	
			2.05 Does the species have a history of repeated introductions outside its natural range?	
C	3	**Weed elsewhere**	3.01 Naturalised beyond native range	
E			3.02 Garden / amenity / disturbance weed	
A			3.03 Weed of agriculture / horticulture / forestry	
E			3.04 Environmental weed	
			3.05 Congeneric weed Undesirable	
			Biology / Ecology	
A	4	**Undesirable traits**	4.01 Produces spines, thorns or burrs	
C			4.02 Allelopathic	
C			4.03 Parasitic	
A			4.04 Unpalatable to grazing animals	
C			4.05 Toxic to animals	
C			4.06 Host for recognised pests and pathogens	
C			4.07 Causes allergies or is otherwise toxic to humans	
E			4.08 Creates a fire hazard in natural ecosystems	

E			4.09 Is a shade tolerant plant at some stage of its life cycle	
E			4.10 Grows on infertile soils	
E			4.11 Climbing or smothering growth habit	
E			4.12 Forms dense thickets Plant type	
E	5	**Plant Type**	5.01 Aquatic	
C			5.02 Grass	
E			5.03 Nitrogen fixing woody plant	
C			5.04 Geophyte	
C	6	**Reproduction**	6.01 Evidence of substantial reproductive failure in native habitat	
C			6.02 Produces viable seed.	
C			6.03 Hybridises naturally	
C			6.04 Self-fertilisation	
C			6.05 Requires specialist pollinators	
C			6.06 Reproduction by vegetative propagation	
C			6.07 Minimum generative time (years)	
A	7	**Dispersal**	7.01 Propagules likely to be dispersed unintentionally	
C		**mechanisms**	7.02 Propagules dispersed intentionally by people	
A			7.03 Propagules likely to disperse as a produce contaminant	
C			7.04 Propagules adapted to wind dispersal	
E			7.05 Propagules buoyant	
E			7.06 Propagules bird dispersed	
C			7.07 Propagules dispersed by other animals (externally)	
C			7.08 Propagules dispersed by other animals (internally)	
C	8	**Persistence**	8.01 Prolific seed production	
A		**attributes**	8.02 Evidence that a persistent propagule bank is formed (>1 yr)	
A			8.03 Well controlled by herbicides	
C			8.04 Tolerates or benefits from mutilation, cultivation or fire	
E			8.05 Effective natural enemies present in India	

A = agricultural, E = environmental, C = combined.

Form – B : Weed risk assessment scoring sheet.

	a	b	c	d	e
Section	Question	Response[1]	Score[2]	*N* score	*Y* score
A C	1.01			0	3
C	1.02			-1	-1
C	1.03			-1	-1
	2.01		These response for these questions is 2 unless a climate analysis is done.		
	2.02				
C	2.03				
C	2.04				
	2.05				
C	3.01			Refer to lookup table	
N	3.02				
A	3.03				
E	3.04				
C	3.05				
B C	4.01			0	1
C	4.02			0	1
C	4.03			0	1
A	4.04			-1	1
C	4.05			0	1
C	4.06			0	1
N	4.07			0	1
E	4.08			0	1
E	4.09			0	1
E	4.10			0	1
E	4.11			0	1
C	4.12			0	1
C E	5.01			0	5
C	5.02			0	1
E	5.03			0	1
C	5.04			0	1
C	6.01			0	1
C	6.02			-1	1
A	6.03			-1	1
C	6.04			-1	1
C	6.05			0	-1
A	6.06			-1	1
C	6.07				
A	7.01			-1	1
C	7.02			-1	1
A	7.03			-1	1
C	7.04			-1	1
E	7.05			-1	1
E	7.06			-1	1
C	7.07			-1	1
C	7.08			-1	1
C	8.01			-1	1
C	8.02			-1	1
A	8.03			1	-1
A	8.04			-1	1
C	8.05			1	-1

Total score [3]	
Outcome [4]	
Agriculture [5]	
Environment [6]	

Lookup table for section 3.
Locate value of inputs and lookup output for each question

Yes to question 3.01 - 3.05										**default**
Inupts	2.01	0	0	0	1	1	1	2	2	2
	2.02	0	1	2	0	1	2	0	1	2
Results	3.01	2	1	1	2	2	1	2	2	2
	3.02	2	1	1	2	2	1	2	2	2
	3.03	3	2	1	4	3	2	4	4	4
	3.04	3	2	1	4	3	2	4	4	4
	3.05	2	1	1	2	2	1	2	2	2
No to questions 3.01 - 3.05										
Input	2.05	?	N	Y						
Results	3.01	-1	0	-2						
	3.02-3.05	0	0	0						

Procedure

1. Record appropriate responses in column b.
2. Look up score in columns d & e and record result in column c.
3. Calculate total score.
4. Lookup and record recommendation.
5. Verify that minimum number of questions from each section are answered.
6. Compute Agricultural (A&C) and Environmental (E&C) scores: if either score is less than 1, the outcome pertains to the other sector.

Lookup table for 6.07

years	1	2	4
score	1	0	-1

Score	Outcome
<1	Accept
1-6	Evaluate
>6	Reject

Section	Minimum # questions[5]
A	2
B	2
C	6
Total	10

than 1 year to 2 years scores 1, between 2 and 4 years scores 0, greater than or equal to 4 years scores 01).

The WRA compares the total score for a species to the critical values to determine the recommendation for the species. The threshold values for the system are, if the plant scores :

less than 1, accept the plant
greater than 6, reject the plant and
from 1 to 6, the plant requires further evaluation

The threshold values are the product of the assessment of over 20 species. The species used for the calibration of the system ranged from severe agricultural and environmental weeds to benign and beneficial plants.

The WRA tallies the number o questions answered in each section. The WRA allows for a minimum number of question in each of its three different categories. The minimum number of questions for each section is : 2 for section A, 2 for section B, and 6 for section C. when using the Excel spreadsheet if the minimum number of questions is not completed, a message that more information is required is posted by the system.

The WRA has some capacity to suggest the type of ecosystems likely to be affected by plant assessed. The WRA indicates if the plant is more likely to be a specific weed of agriculture or the general environment, once it has assessed the plants potential to become a weed in India. A species may be assessed to be a weed of both categories. The partitioning helps to identify areas most at risk from the characters assessed for the species.

DISCUSSION & CONCLUSION

The system identifies a wide range of weeds, and does not accept plants known to be major weeds in India. The few minor weeds accepted lie very close to the critical scores, and as these scores are not inviolate they may be adjusted in time as experience is gained. Indeed, allowing the critical scores to be moved under different circumstances including the general attitudes towards weeds in different countries represents a strengyth of the system. By splitting the total score the model also allows an estimate of whether the weed is more likely to impact on agricultural or natural environment systems, which may assist regulatory authorities in making a recommendation. These features suggest that the system could be altered and still be expected to produce satisfactory results in other bio-climatic regions of the globe where protocols are lacking (Ruesink *et al.*, 1995). As the system is simple and spread sheet based it can be used by lay people who wish to import plants and it has an educational role because it shows the effect of individual questions on the total score.

The system distinguishes between many useful plants, but some useful plants can be rejected. This is to be expected, because planned introductions are chosen for their ability to survive (Ruesink *et al.*, 1995), and the questions asked by the system are based primarily on biological & ecological criteria which identify attributes common to both useful agricultural plants and weeds (Lonsdale, 1994). These may differ only in a small number of characteristics within any single life form (Perrins et. al., 1992). Where a plant may have significant economic benefits, a further evaluation of its weediness potential may include experimental studies (Williamson,

1993 ; Scott and Panetta, 1993). Economic value should be scored in a transparently separate exercise and balanced against weediness in appropriate risk assessment evaluations (Walton and Parnell, 1996).

We conclude that 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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WEEDS OF PLANT QUARANTINE SIGNIFICANCE FOR INDIA

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India is an overwhelming agrarian country. Hence, there is a paramount need to save the agricultural and horticultural economy of the country from the ravages caused by the pests including weeds. In order to ensure effective implementation of Plant Quarantine regulations, it is essential that the imported plants and plant materials are free from exotic weeds. Preclusion of the introduction of exotic weed seeds into our country would certainly go a long way in the best interest of the agrarian economy of the country. An estimated 8000 species of plants are beleived to behave as weeds in agriculture, out of which about 250 species are considered to be potentially dangerous. As per Holm, there are 975 "Serious" and "Principal" weeds in different parts of the world which have not been recorded or reported in India (Table 1). Australia and New Zealand top the list with 195 weed species followed by African countries (191), South East Asia and Japan (150), Middle East (118), South America (102), Europe (80), Central America (30), USSR (20) etc.

Table 1 : World's major weeds which are not recorded in India yet

Country	No. of weed species
Australia, New Zealand	195
African countries	181
SE Asia, Far East	150
Middle East	118
South America	102
Europe	90
Central America	86
North America	33
Former Soviet Union	20
Total	975

BIOLOGY AND CONTROL OF *ASPHODELUS TENUIFOLIUS CAV.*

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A field experiment on biology and control of *Asphodelus tenuifolius* Cav. was conducted in micro plots during *Rabi* season of 1999-2000 at AICRP on Weed Control, Anand. It is an annual and slender herb belongs to family liliaceae. Germination of *Asphodelus tenuifolius* was more observed during the month of October and November. Seedlings of *Asphodelus tenuifolius* made vegetative growth up to first week of December only. Pendimethalin, fluchloralin, trifluralin, oxadiazon, metribuzin and atrazine were tested as pre-emergence in the field for controlling *Asphodelus tenuifolius.* Results revealed that the *Asphodelus tenuifolius* weed was controlled 80 to 90 per cent by application of metribuzin (0.70 kg/ha) or pendimethalin (1.50 kg/ha) or oxadiazon (0.75 kg/ha), while more than 90 per cent control was achieved with the application of atrazine (0.50 kg/ha).

STUDIES ON THE COMPETITIVE BEHAVIOUR OF WINTER SEASON WEEDS IN WHEAT (TRITICUM AESTIVUM L.)

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The competitve behaviour of different winter season weeds in wheat was studied under field conditions in micro plots (I m2) during 1999-2000 and 2000-2001. Treatments consisting of nine important weed species of wheat viz., *Phalaris minor, Avena sterilis* var. ludoviciana, *Chenopodium album, Lathyrus aphaca, Vicia sativa, Medicago hispida, Cichorium intybus, Asphodelus tenuifolius Melilotus alba*, along with weed free check were replicated thrice in randomized block design. Hundred plants of each weed species and wheat were maintained per square meter. Results revealed that *Cichorium intybus* produced the maximum dry matter at harvest fb *Avena sterilis* var. ludoviciana and Chenopodium album. The lowest weed dry matter was accumulated with Asphodelus tenuifolius. The highest seed yield was recorded under weed free conditions. Among different weed species *Ciochorium intybus* being more competitive significantly reduced the seed yield of wheat by 42% as compared to weed free check.

WEED BIOLOGY – PERIODICITY OF GERMINATION OF *TRIANTHEMA PORTULACASTRUM*

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Field experiments were conducted at Annamalai University Experimental Farm, Annamalai nagar during 1997 – 98 to assess the periodicity of germination in *Trianthema portulacastrum.* For the experiment on periodicity of germination of *T. portulacastrum* a field wherein no weed control measure was takenup in the previous season was selected. The field was laidout into 36 strips of dimenson of 8 m x 5 m at the start of the experiment. Three strips at random were prepared by ploughing at the beginning of every calendar month and irrigated. These strips were

later observed for the germination of *T. portulacastrum* at 15 and 30 days after. The fields prepared during August showed highest germination pattern of *T. portulacastrum* with the highest germination count of 126.8 m^{-2} on 15th day. The germination was observed to be comparable during the months of July (102.4 m^{-2}) and June (85.6 m^{-2}). The plots prepared during January, February and March showed lesser germination pattern with January recording the least of 8.5 m^{-2}. The weed showed absolutely nil germination during October, November and December. The higher germination pattern was observed during the month of August followed by July and June. This could be due to the exposure of the weed seeds to favourable microclimate, with optimum soil temperature ranging from 34 to 36°C and also the possible breaking time of dormancy (after the completion of previous summer). The months of October, November and December were seen to be safe in respect of *T. portulacastrum,* as they showed least or negligible germination of the weed. This might be due to the seeds entering into dormancy during this period and also due to unfavourable environment especially the temperature, heavy rainfall and water stagnation.

STUDIES ON THE GERMINATION, GROWTH AND DEVELOPMENT OF MEDICAGA DENTICULATA UNDER POT CULTURE CONDITION

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Biology of *Medicago denticulata* was studied during winter season of 1996-97 and 1997-98 in pot culture under glass house condition at G.B. Pant University of Agriculture and Technology, Pantnagar, Distt. Udham Singh Nagar (Uttaranchal). *Medicago denticulata* emergence continued upto 15 days after sowing, but most of the seedling (40.0 per cent) emergd within 6 days after sowing. Thereafter, a steep decline in the seedling emergence from 6 to 15 days after sowing was observed and no more seedling emerged beyond 15 days.

Plants took about 8 to 9 days to complete their first leaf formation. The second leaf was formed at 15th day of sowing. Branch initiation took place at 38 to 40 days after sowing. The flower initiation was recorded from 70 to 73 days, after sowing, whereas the pod formation took place at 82-84 days after sowing. Plants took about 118 to 122 days to complete maturity of the seeds in the pod.

The relative increase in root and shoot length, plant spread, number of green leaves and branches per plant was slow upto 30th day of sowing - than during the later stages of growth. The root length, shoot length, plant spread and plant dry weight increased with the increase in the plant age upto maturity. Number of leaves and branched per plant also increased with the advancement of growth upto 90th day of sowing. A reduction in the number of green leaves was recorded at maturity. More than 10 per cent reduction in leaf number was noted at maturity stage. The rate of increase of plant dry weight was slow upto 30 days, owing to slow leaves production. Dry matter accumulation of plant was linear upto maturity. The production of branches reached highest by 90 days of sowing and no further production was observed subsequently. More than 70 pods per plant were recorded at matruity with on an average 4 seeds per pod.

ECOLOGICAL DISTRIBUTIION OF WEEDS IN DIFFERENT AGRO ECOSYSTEMS OF TAMIL NADU

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An attempt has been made to survey the weed flora in the different districts of Tamil Nadu under various cropping systems. The ecological distribution of weeds in various crops and cropping systems of lowlands, irrigated uplands and unlands of different ecological zones of Tamil Nadu. Weed maps were developed based on the order of dominance of weed species in each cropping situation.

In lowland situation the major weeds species accounted in the order of dominance were, *Echinochloa colonum*, *Echinochloa crus-galli* and *Brachiaria sp.* in grasses, *Cyperus iria*, *Cyperus difformis*, *Cyperus rotundus* and *Bulbostylis barbata* in sedges and *Eclipta alba*, *Marsilea quadrifoliata*, *Ammania baccifera*, *Rotala densiflora*, *Ludwigia parviflora*, *Aristolochia bracteata* and *Spheranthus indicus* in broad leaved weeds. Among these weed species, *E.colonum*, *E. crus-galli*, *C.iria* and *C.difformis* are the predominant monocot weeds infesting rice culture in more than 20 districts of the State, while, *E.alba* and *M.quadrifoliata* are the major dicot weeds distributed in 14 and 11 districts, respectively.

The weed species documented in the order of dominance in irrigated uplands were *Dactyploctenium aegyptium*, *Cynodon dactylon*, *Panicum repends* and *Chloris barbata in grasses*, *Cyperus rotundus*, *Bulbostylis barbata*, *Fimbristyylis miliaceae in sedges and Trianthema portulacastrum*, *Amaranthus viridis*, *Celosia argentea*, *Digera arvensis*, *Euphorbia hirta*, *Acalypha indica* and *Boerhaavia* in broad leaved weeds. Out of more than two dozen weed species accounted in various crops and cropping systems of irrigated lands of the state, *C.rotundus* is regarded as the most widely distributed (24 districts) and difficult weed to control. The major grass weeds were *D.aegyptium*, *C.dactylon* and *P. repens* accounted in 16.11 and 10 districts respectively, while, more than 10 broad leaf weed species are widely recorded in most of the districts across different cropping situations.

Under upland condition, *Cynodon dactylon*, *Dactyloctenium aegyptium*, *Panicum repens and Echinochloa colonum* in grasses, *Cyperus rotundus* and *Bulbostylis barbata* in sedges and *Trianthema portulacastrum*, *Boerhaavia diffusa*, *Celosia argentea*, *Euphorbia hirta*, *Amaranthus viridis*, *Corchorus ditorius* and *Eclipta alba* in broad leaved weeds were the dominant weed species. Similar to irrgated situation *C.rotundus* was accounted in 25 districts followed by *C.dactylan* (19) and *D.aegyptium* (12). Though *T.portulacastrum* and *B.disffusa* are the dominant broad leaf weeds, a wide range of dicot weeds are associated with rainfed cropping situation of the state.

SOIL SEED BANK, DYNAMICS OF *PHALARIS MINOR* UNDER DIFFERENT HERBICIDES IN WHEAT++++

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A field experiment was conducted to see the effect of variable seed bank of P.minor on its control and seed production under different herbicides in wheat. Variable seed bank was created by charging soil with *P.minor* seed at 200 g, 400 g, 600 g and 800 g 100 m^{-2} in the month of May. The population of 88, 121, 135 and 155 seedlings m^{-2} was obtained respectively with the charged seeds of P.minor after sowing of wheat. The recommended herbicides, namely, isoproturon 0.94 kg/ha, clodinafop - methy 0.06 kg/ha, phenoxaprop-p-ethyl 0.10 kg/ha, sulfosulfuron 0.025 kg /ha and tralkoxydim 0.35 kg/ha were applied. The differences in *P. minor* population and seed produced at the time of maturity were non-significant due to variable seed charged. All herbicides significantly reduced the *P.minor* population over control. The preformance of clodinafop-methyl was best as it reduced the amount of *P.minor* seed produced (1.19 g m^{-2}) over the seed charged into the soil and this was followed by sulfosulfuron (4.16 g m^{-2}), phenoxaprop-p-ethyl (6.08 g m^{-2}), tralkoxydim (8.30 g m^{-2}) and isoproturon (22.77 g m^{-2}) as compared to control (40.53 g m^{-2}).

REGENERATION POTENTIAL OF *CYPERUS ROTUNDUS* AS INFLUENCED BY APPLICATION OF GLYPHOSATE AND GLUFOCINATE AMMONIUM

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A filed and pot experiment was conducted for two years in 1999 and 2000 to see the effect of glyphosate (1.0 and 1.5 kg/ha) and glufocinate ammonium (0.90 kg/ha) on regeneration potential of *Cyperus rotundus* when these herbicides were applied in May- June and August. The results revealed that two or three split applications of glyphosate (0.5 + 0.5 kg /ha and 0.5 kg + 0.5 kg + 0.5 kg/ha) and glufocinate ammonium (0.45 kg + 0.45 kg/ha) reduced shoot and tuber population. Resprouting from bulbs of killed shoots was observed in all treatments. The maximum reduction in regeneration potential was obtained with glyphosate (0.5 kg + 0.5 kg + 0.5 kg/ha) treatment. The effect was better when herbicides were applied in August than when applied in May-June.

COMPETITIVE ABILITY OF WILD OATS (*AVENA LUDOVICIANA* DUR) WITH WHEAT IN RELATION TO CROP DENSITY AND NITROGEN LEVELS.

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Field experiments were conducted at the experiment area of Punjab Agricultural University, Ludhiana during *Rabi* season of 1998-99 and 1999-99 in order to study the competitive behaviour of wild oats and broad leaf weeds with wheat raised on loamy sand soil. Two seed rates (100 & 150 kg/ha) and three nitrogen levels (120, 150 & 180 kg/ha) were kept in main plots and four weed competition treatments i.e. competition with wild oats alone, with broad leaf weeds alone, with both and no competition (weed free) in sub plots. The differences in grain yield of wheat with seed

rates were non-significant during both the years. Application of 150 kg/ha of N significantly improved grain yield over 120 kg N/ha (recommended). The differences in grain yield among 150 and 180 kg N/ha were non-significant during both years. Among weed competition treatments, association of wild oats alone or both types of weeds with wheat resulted in singificnatly more reduction in grain yield than alone leaf weeds. On an average of years, 17.0, 35.0 and 45.1 perecent reduction in grain yield of wheat was observed with competition of only broad leaf weeds, only wild oats and both respectively. Dry matter accumulation by all types of weeds tended to decrease with increase in seed rate and nitrogen levels although these differenoes were statistically non-significant.

INFLUENCE OF ISOPROTURON NITRATE REDUCTASE ACTIVITY IN WHEAT LEAVES AND ITS RALATIONSHIP WITH GRAIN PROTEIN CONTENT

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A field experiment was conducted on silty clay loam soil during rabi 1999 at Department of Agronomy, CSKHPKV, Palampur to study the effect of isoproturon on nitrate reductase activity at different stages of wheat and its relationship with grain protein content using a randomized block design with three replications. Leaf samples for NRA analysis were collected at monthly intervlas after herbicide application and grain samples for protein at threshing of the crop. A significant decrease in nitrate reductase activity in wheat leaves at 30 days after application was obtained with isoproturon 1.5 kg/ha (35 DAS) and twice Handweeding (30 DAS & 60 DAS). A decreasing trend was observed from 60 to 120 days after spray in all the treatments. However, isoproturon 1.5 kg/ha(35DAS) maintained its superiority over all other treatements at all the sampling stages. A significantly positive correlation was obtainde with laef nitrate reductase activity and grain proten conent.

UPTAKE, TRANSLOCATION AND METABOLISM OF ISOPROTURON IN *PHALARIS MINOR* - A PHYTOTRON STUDY

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A study was conducted in phytotron chambers of the National facility on phytotron, LBS Building, IARI. *Phalaris minor* is a problematic weed in wheat crop. To compat this, isoproturon - a urea nerbicide is applied in wheat crop. Over the period some biotypes of phalaris minor have developed resistance against isoproturon. The metabolic behaviour of isoproturon resistance has been studied under contolled conditions in the phytotrin chambers. The results showed that resistant biotypes tolerated upto five times dosage of isoproturon phytotoxic to susceptible P. minor. It was observed that uptake and translocation of isoproturon was faster in resistant in comparison to the susceptible biotypes and pattern was comparable to that of wheat showing the similar types of metabolites.

EFFECT OF LEVELS AND TIMES OF ISOPROTURON APPLICATION ON WEED GROWTH, PROTEIN CONTENT AND YIELD OF LATE SOWN WHEAT

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A field experiment was conducted during winter seasons of 1997-98 and 1998-99 at Agricultural Research Farm of Banaras Hindu University to study the effect of levels and times of isoproturon application on weed growth, protein content in grain and yield of late sown wheat. The three levels of isoproturon 0.75, 1.0 and 1.25 kg ha-1 were applied as pre-emergence and as post-emergence one week before first irrigation and one week after first irrigation. The dominant weed flora were *Rumex* spp., *Phalaris minor, Cyperus rotundus, Anagallis arvesis* and *Chenopodium album*. Application of isoproturon 1.0 kg ha-1 after first irrigation was most effective in arresting weed growth and enhancing grain yield. Application of isoproturon 1.25 kg ha-1 after first irrigation had more protein content in wheat grain as compared to other treaments. However, all the herbicidal treatments were significantly effective in reducing weed growth, either applied as pre-or post-emergence over weed check. Application of isoproturon 1.0 and 1.25 kg ha-1 before first irrigation showed phytotoxic effect on crop and recorded significanly low grain and straw yield as compared to all other herbicidal treatments. However, all the herbicidal treatments were significantly superior to weedy check except isoproturon 1.0 and 1.25 kg ha-1 applied before first irrigation which were at par among themselves.

WEED SEED DYNAMICS UNDER CULTIVATED FIELD AS INFLUENCED BY PREPARATORY TILLAGE AND WEED MANAGEMENT METHODS IN MAIZE

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Soil management by means of preparatory tillage is an intensive activity in resource poor small farming and energy intensive activity in large scale mechanised farming. Tillage helps in weed management by destroying germinating weed seeds, killing emerging seedlings, exposing weed seeds and delaying the growth of pernicious weeds. The optimum preparatory tillage practice combined with effective weed management method is to be identified for efficient weed control in irrigated maize under different soil types. Two field experiments, one in black clay loam soil at Eastern Block, Tamil Nadu Agricultural University, Coimbatore and another in red sandy loam soil at Agricultural Research Station, Bhavanisagar, were carried out during *rabi* 1999-2000 with CO.1 maize as test crop, to study the weed seed dynamics as influenced by the tillage and weed management methods. The interaction effect of five preparatory tillage methods Country plough, Cultivator, Stale seed bed with cultivator, Mould board fb cultivator and Disc plough fb cultivator) were compared in combination with manual weeding and an unweeded control in both the soils. Results on weed density, weed drymatter and crop growth and yield attributes along with yield and economics were studied.

The results indicated that preparatory tillage with country plough resulted in lower densities of grasses and sedges, whereas, broad leaf weed population was reduced by tractor drawn disc or mould board plough followed by cultivator tillage. Efficiency of tillage practice on weed control could be further increased by integration of weed management with pre-emergence application of atrazine at 0.25 kg/ha fb one HW on 35 DAS in maize both under black clay loam and red sandy loam soils. Higher grain yield and better economic returns could be achieved by land preparation with tractor drawn disc plough followed by cultivator tillage combined with pre-emergence application of atrazine at 0.25 kg/ha fb one hand weeding on 35 DAS in maize cultivated in both black clay loam and red sandy loam soils.

PHYSIOLOGICAL STUDIES ON WEED CONTROL EFFICIENCY OF DIFFERENT HERBICIDES IN DIRECT SOWN ONION

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AICRP on Weed Control, UAS, Dharwad

Field experiment was conducted during 1998 and 1999 in *kharif* season medium black soils at Main Research Station, University of Agricultural Sciences, Dharwad to study the effects of different herbicides for control of weeds in direct sown onion. All the horbicides significantly reduced the weed biomass and increased the yield of onion in both the years over weedy check. The lowest mean weed dry weight (40.1 g/m^2), maximum weed control efficiency (78.6%), least weed index (-3.7) and higher photosynthetic rate (11.5 m mol/m^2/sec) were observed with application of oxadiazon @ 0.5 kg a.i./ha. Highest chlorophyll content (0.55 mg/g fresh weight) was noticed weed free check which was on par with application of oxadiazon @ 0.5 kg a.i./ha (0.53 mg/g fresh weight). The highest average bulb yield of 170.9 q/ha was obtained in oxadiazon @ 0.5 kg a.i./ha and recorded higher net returns (Rs. 59874) and benefit cost ratio (7.06).

PHYSIOLOGICAL STUDIES ON WEED CONTROL EFFICIENCY OF DIFFERENT HERBICIDES IN SUNFLOWER

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AICRP on Weed Control, UAS, Dharwad

A field experiment was conducted during *kharif* 1998 in medium black soils at Main Research Station, University of Agricultural Sciences, Dharwad to study the efficiency of different herbicides in controlling the weeds and their effect on physiological parameters in sunflower. All the herbicides significantly reduced the weed biomass, weed index and increased the sunflower yield. Application of oxadiazon @ 1.0 kg ai/ha recorded the lowest weed dry weight (4.1 g/m^2) followed by butachlor (15.0 g/m^2) maximum weed control efficiency (95.0%), least weed index (4.0), higher chlorophyll content and photosynthetic rate (18.5 m mol/m^2/sec) was recorded i oxadiozen treatment. The maximum sunflower yield (1205 kg/ha) was recorded in oxadizon treatment followed by butachlor (1095.0 kg/ha). The lowest yield was recorded under unweeded control due to poor growth and yield components and reduced photosynthetic rate. The maximum benefit : cost ratio was observed under application of butachor 1.5 kg a.i./ha followed by oxadiazon @ 1.0 kg a.i./ha.

WEED DYNAMICS IN POPULAR CROP ROTATION OF CHHATISGARH, INDIA: A STUDY

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To know the weed dynamics of cereal legume, cereal-cereal and legume-cereal crop rotation in rabi season, a study was conducted at Department of Agronomy, Indira Gandhi Agricultural University, Raipur (C.G.), Indira during 2000-2001. Under cereal - legume rotation, rice-gram, cereal-cereal rotation, rice-wheat and legume cereal, soybean-wheat were taken respectively. In these rotations 30 and 50 day after sowing weed control was taken adopting stardard recommended techniques. On the basis of these observations, absolute density (A.D.), absolute frequency (A.F.), relative frequency (R.F.) and relative density (R.D.) were calculated. The study revealed that more than 15 weeds infest these rotations in rabi season. Out of these weeds, *Chenopodium album, Medicago indica, Anagallis arvensis, Melilotus alba and Echinochloa colomum* were identyfied as dominant weeds in these rotations. In rice-gram rotation, maximum infestation of *Chenopodium, Medicago, Anagalis and Melilotus* was observed. Whereas, in this rotation lowest ifestation of *Echinochloa* was observed as compared to rest of the crop rotations. Maximum *Echnochloa resulted* in lowest infestation of *Chenopodium and Anagallis*. Lowest infestation of *Medicago and Melilotus* was observed under rice-wheat crop rotation.

METHODS AND TIME OF APPLICATION OF TRIFLURALIN FOR CONTROL OF *PHALARIS MINOR* IN WHEAT

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Integrated weed management involving hoeing followed by trifluralin (0.75 and 1.0 kg/ha) applied before first irrigation or hoeing done before first irrigation and trifluralin applied after first irrigation gave good control of P.minor and yielded higher. However, herbicide application as pre-plant incorporation or pre-emergence incorporation proved toxic to the crop, more so at the higher dose (0.1 kg/ha). The study indicated that trifluralin could be used for control of isoproturon resistant population of P.minor in wheat and besides, it also gave good control of broad leaf weeds.

EFFECT OF WEED MANAGEMENT PRACTICES AND CULTIVARS ON BORO RICE

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An investigation was carried out at Research Form, Institute of Agricultural Sciences, BHU, during dry season on 1997 and 1998 to assess the effect of cultivars and weed management practices in boro rice situation. The experiment was conducted in split plot design with three replications. Six cultivars viz., Gautam, Prabhat CN-88 C-1-271, RAU 504-48-4, Pusa-2-21 and Rasi were kept in main plots and three weed management practice i.e. control, two hand weedings (30 & 50 DAT) and bulachlor PE +2, 4-D POE (1.5+05 kg/ha) were adjusted in sub plots. Seeds were shown in nursery in first week of November and transplanting was done in deepwater field with residual water stagnation in 2nd fortnight of February. Predominant weeds were *Marsilea minuta, Sirpus erctus* L., *Cyperus rotundus* L. *Ipomee aqustiea Forsk, Nymphen nouchale* Burm, *Cynodon daclylon*(L)Pers, *Lchinochloe colonum* (L) link, *Paspalum distichum* L., *Eclipta alba* (L) Hassk and prstea Strafloles L. Results indicated that application of butachlor 1.5 kg + 2 4-D 0.5 kg was most effective in minmizing the yield of boro rice. This treatment was on par with hand weeding twice 30 & 50 DAT in respect to weed management and grain yield which had highest production Amongst cultivars, prabhat proved to be better competitor gainst weeds and had minimum weed growth on accounts of its more vigarous growth and droopy lower leaves. However, the maximum grain yield was recorded under cultivar Gautam and minimum under RAU 504-48-4.

EVALUATION OF DICAMBA AGAINST WEEDS IN WHEAT.

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Dicamba is a versatile herbicide & has been tested to find out the effective doese of dicamba on the yield of wheat and associated weeds in wheat at NRC for Weed Science, Jabalpur for control annual broad leaved weeds.

WH - 147, a dwarf variety was dirlled @ 120 kg/ ha in 1998-99 and 1999-2000. The fertility level of the fields were maintained at N 120 kg/ha, P_2O_5&K_2O @ 60-80 kg & 40 kg respectively. Half of the N and full dose of $P_2O_5K_2O$ were applied at the time of sowing. The soil of the experimental field was rich in clay content. Eight treatments were replicated 3 times in randomized block design. The dicamba was applied at 4 does i.e. 125,250,500 and 1000 g /ha compared with isoproturon 1250 g/ha and 2,4-D 500 g /ha at 35 DAS.

The major weed population of experimental plot conisted of *phalaris minor, Chenopodium album & Medicago* sp. Other weed species of minor infestation were *Rumex dentata Convovulus arvensis* and *Vicia sativa.*

The application of dicamba at 35 DAS was found to decrease weed population & weed biomass @ 500 - 1000 g /ha However, the dicamba in combination with isoproturon application @ 125g/ha plus 1250g/ha was the best treatment as regards to control of both grassy as well as broad leaved weeds are concerned. The grain yield was the highest under dicamba in combination with isoproturon and comparable with dicamba @ 1.0 kg/ha.

The aforesaid study revealed that dicamba can be a substitute of 2,4-D for the control of broad leaved weeds to a greater extent. For the controll of broad spectrum weed control dicamba may be applied with isoproturon in wheat. There was no phytotoxic effect of dicamba in wheat. It was observed that dicamba acts fast & reveals the results within 2-3 days after application of treatment. The weeds stop growing & necrosis was observed at the base of tillers this was accompanied by chlorosis to the leaf ultimately leading to necrosis the plants die generally within 20-25 days after treatment application.

WEED MANAGEMENT OPTIONS IN RICE CULTURE

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Experiments were conducted in farmers fields of scarce rainfall zone in Andhra Pradesh during *kharif*-2000. Hand weeding once at 30 days after transplanting or twice at 30 and 45 days after transplanting was compared with chemical approach by the pre-emergence application of 5G butachlor @ 1.5 kg a.i ha^{-1}, 5G butachlor @ 1.0 kg a.i ha^{-1} + 4.5G 2,4 D- EE @ 0.5 kg ha^{-1} and integrated approach i.e, pre- emergence application of 5G butachlor @ 1.5 kg a.i ha^{-1} followed by weeding at 30 DAT. The results showed that the herbicide 5G butchlor @ 1.5 kg a.i ha^{-1} applied as pre emergence reduced the weed density by 44% at 30 days after transplanting. At harvest the density of monocots was 32% and that of dicots was 48% of those in hand weeding treatment. The effect was more pronounced on weed dry weight. The monocots lost 61% and dicots 62% of the dry weight of those in hand weeding .The combined application of 5G butchlor @ 1.0 kg and 4.5G 2,4 D- EE @ 0.5 kg a.i ha^{-1} was most effective. The density of weeds was only 30% at 30DAT. The density of monocots and dicots was 54 and 25 % of the corresponding species at harvest compared to hand weeding treatment. The dry weight was only 21 and 16%. The maximum rice yield of 6329 kg ha^{-1} was obtained by this treatment compared to 5038 kg ha^{-1} due to hand weeding once. The additional expenditure of Rs 125 on these herbicides fetched additional net returns of Rs 7639 ha^{-1}.

CHEMICAL CONTROL OF *PARTHENIUM HYSTEROPHORUS* L. IN UPLAND RICE

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In an investigation on chemical control of *Parthenium hysterophorus* L. in upland rice at crop research farm of the Department of Agronomy, during rainy seasons of 1996 and 1997, the maximum dry weight of weeds was recorded in the unweeded plots. Minimum dry weight of the weeds was in the hand weeded plots. In the year 1997, 2,4-D at 1.0 kg/ha applied as pre-emergence resulted in second best minimum weed dry weight in the treated plots. When averaged over both the years of investigation, the dry weight of weeds was comparatively lower in this treatment than other herbicidal treatments. The minimum dry weight of *P. hysterophorus* was in the hand weeded plots followed by the plots treated with the combination of pre-emergence application of butachlor at 1.0 kg/ha and post-emergence application of 2,4-D at 1.0 kg/ha. Highest plant dry weight of rice plants was obtained in the hand weeded plots and higher grain yield was also recorded in these plots. This was followed by the plots treated with combination of pre-emergence application of butachlor at 2.0 kg/ha and post-emergence application of 2,4-D at 1.0 kg/ha, which can be attributed due to highest number of effective tillers and more number of filled grains per plant in these plots.

COMPATABILITY STUDIES OF CYHALOFOPBUTYL WITH 2,4-DEE AND BUTACHLOR TO CONTROL WEEDS IN DIRECT SEEDED PUDDLED RICE

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To find out the compatability of cyhalofopbutyl with 2,4-DEE and butachlor as tank mix and sequential applications to tonrol mixed weed flora in direct seeded puddled rice a field experiment was conducted during kharif 1997 and 1998 in randomized block design with 16 treatments combinations and three replications. Treatments included cyhalofopbutyl 90 g/ha (20 DAS), butachlor 1.5 kg/ha (7 DAS), 2,4-DEE 1.0 kg/ha (30 DAS) alone, tank mixture combinations of butachlor and 2,4-DEE with cyhalofopbutyl 75 and 90 g/ha and their sequential applications alongwith farmer practice and unweeded as checks. Results of the study revealed that tank mixing of 2,4-DEE 1.0 kg/ha with cyhalofopbutyl 75 or 90 g/ha resulted in antagonistic effect over alone application of cyhalofopbutyl 90 g/ha in controlling grass weeds and increasing grain yield of puddled rice. However, cyhalofopbutyl did not antagonise the effect of 2,4-DEE to control broadleaved weeds and sedges. Sequential application of cyhalofopbutyl 75 g/ha (20 DAS) followed by butachlor + 2,4-DEE was as effective as farmer practice in increasing grain yield of rice by controlling grasses, sedges and broadleaved weeds.

INTEGRATED WEED MANAGEMENT IN KODO MILLET (*PASPALUM SCROBICULATUM*)

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A field experiments were conducted during *Kharif* 1998-99 and 1999-2000 at Tribal Agriculture Research Station, JNKVV Research Farm, Dindori (M.P.) in mixed-red sandy soil. The main

objectives of the research was to find out an effective and economical method of weed control in Kodo millet and bioefficacy of herbicides on grassy and broadleaved weeds in Kodo millet. The treatments comprised of 2,4-D Na salt @ 0.40 and 0.75 kg a.i./ha alone as post emergence spray (P_0Es) and integration with one hand weeding at 20 DAS and two intercultivation at 20 & 40 DAS, Isoproturon @ 0.25 and 0.50 kg a.i./ha applied alone as Pre emergence spray (P_r Es) and integration with one hand weeding (20 DAS) and two inter cultivation (at 20 and 40 DAS), hand weeding once (20 DAS), hand weeding twice (20 and 40 DAS), intercultivation twice (20 & 40 DAS) and weedy check (absolute control). Kodo millet variety 'JK-41' was sown 26th June 1998 and 1999, respectively with 10 kg seed/ha at a row distance of 25 cm and fertilized with 40 kg N+20 kg P_2O_5 + 10 Kg K_2O/ha. The weed flora comprised of *Digiteria adscendens, Setaria glauca, Cynodon dactylon* as the major grassy weeds while *Ageratum conyzoides, Phyllanthus niruri, Tricogyna spp* were the dominant broadleaved weeds. The grass herbicide isoproturon proved potential against *Digiteria adscendens,* while Na Salt of 2,4-D reduced the intensity and biomass of broadleaved weeds, the former being more effective than the later.

On an average basis of 2 years data, the seed yield varied from 825-1119 Kg/ha. due to various chemical weed control, whereas it was varied from 1065-1325 kg/ha under chemical with hand weeding or chemical with interculture weed control methods. Among all the treatments, the maximum yield was (1818 kg/ha.) found under hand weeding twice (20 and 40 DAS), but it was not feasible and practical in economics point of view. Therefore isoproturon @ 0.25 kg a.i./ha as pre emergence with one hand weeding (20 DAS) gave highest economic return under present investigation on kodo millet.

INTEGRATED WEED MANAGEMENT IN DIRECT SEEDED LOW LAND RICE UNDER SPLIT APPLICATIONS OF NITROGEN

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Experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during k*harif* and *rabi* seasons of 1998-99 to study the effect of integrated weed control methods and split application of nitrogen on weeds, yield and yield attributes and economics of direct seeded low land rice. Soil type of the experimental field was clay loam with low available N, medium available P and high available K. Experiments were laid out in split plot design with 3 replications. Main plot treatments consisted of two N management practices: (i) application of N in four splits as 1/6 of recommended dose (*kharif* @ 120 kg/ha; *rabi* @ 150 kg/ha) at 10 days after sowing (DAS), 1/3 at active tillering, 1/3 at panicle initiation and 1/6 at heading stage and (ii) five equal splits at basal, 10 DAS, active tillering, panicle initiation and at heading stage. Sub-plot treatments consisted of seven weed control methods *viz.*, manual, mechanical + manual, cultural + manual, cultural + mechanical, cultural + chemical + mechanical, chemical + manual and unweeded control. *Echinochloa crus-galli* (L) P. Beauv, *Cyperus difformis* (L), *Eclipta alba* (L) Hassk were the three predominant weeds out of 15 species prevalent in the experimental field. Application of N in four splits without basal application showed better performance over five splits of N (with basal application) in enhancing yield attributes and yield of rice through reduced weed growth. The lowest weed population and dry matter and the highest weed control efficiency were observed under cultural + manual method of weed control in both the seasons. Yield was maximum under cultural + manual

method (6846 and 6332 kg/ha). Uncontrolled weed growth resulted in 40.1 and 37.8 per cent yield loss for *kharif* and *rabi* seasons, respectively compared to cultural + manual method. Maximum benefit-cost ratio (3.06 and 3.23) was achieved with cultural + manual method of weed control.

EVALUATION OF DICAMBA IN WHEAT

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A field trial was conducted during winter seasons of 1998 and 1999 to study the effect of dicamba on weeds and its resultant effect on grain yield of wheat. The treatments consisted of post-emergence application of Dicamba at 125, 250, 500, and1000 g ha^{-1}, isoproturon 1250 g ha^{-1}, 2, 4-D1250 g $ha^{-1}$and tank mix application of isoproturon 1250 g ha^{-1} with dicamba at 100, 150, 200 and 250 g ha^{-1} and 2. 4-D 1250 g ha^{-1} with dicamba 125 g ha^{-1}. These were compared with weed free and weedy check treatments. The design of experiment was Randomized Block Design with three replication. Crop under weedy check condition was infested with *Rumex spp, Anagallis arvensis, Melilotus alba, Chenopodium album, Phalaris minor, Cynodon dactylon Cyperus rotundus* in order of dominance. Application of dicamba had significant effect on broad leaved weeds and its increasing dose to 100 g completely eradicated the broad leaved weeds. Dicamba at all the doses also reduced the *Phalaris minor* growth but had no effect on *Cynodon dactylon* and *Cyperus rotundus.* Mixed application of isoproturon 1250 g + dicamba, 250 g proved to be most effective and provided complete control of all the weeds species present in the treated crop field. Alone application of dicamba 500 and 1000 g ha^{-1} recorded maximum grain yield which were comparable to yield recorded under mixed application of isoproturon with dicamba at 200 & 250 g ha^{-1}.

SUSTAINABILITY OF WEED MANAGEMENT PRACTICES IN RICE-BLACKGRAM CROPPING SYSTEM

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Field experiments and laboratory studies were conducted at Department of Agronomy, Annamalai University, Annamalainagar over a three year cropping sequence involving rice-blackgram-rice-blackgram-rice, to study the impact of independent and integrated weed management practices of component crops on weed dynamics and shift, crop biometrics, carry-over effect, residual toxicity, economics and soil microflora. Eight treatments comprising an unweeded control, twice hand weeded, butachlor 1.0, 1.5 and 2.0 kg ha^{-1} with and without a hand weeding suppliment were compared in a Randomized Block Design in rice with plots of size 40 m^2. In blackgram, these plots were sub divided in to two equal halves, wherein one was left undisturbed to study the carry over effect of rice weed control and the other halves were used to compare similar treatments again with alalchlor replacing butachlor, at respective doses. Results revealed that butachlor 2.0 kg ha^{-1} or 1.5 kg ha^{-1} with a hand weeding suppliment performed significantly superior in respect of weed control and crop biometrics, than the rest of the treatments. However, in rice fallow blackgram, twice hand weeding excelled the other treatments in respect of weed control and crop biometrics.

As regards the weed dynamics, both the indices worked out viz., IVI and SDR evidently brought out the shift in weed flora towards more persistent perennials like *Cyperus rotundus* and

Marsilea quadrifolia, with sole dependence on herbicides. Shift in the weed flora occurred with exclusive manual weeding also and the shift was towards grassy weeds viz., *Echinochloa* sp. and *Leptochloa chinensis*. No significant carryover effects of rice weed control measures were observed in the subsequent blackgram crops. Regarding the soil persistence of butachlor, the herbicide under all the three doses was observed to persist in the soil for less than 45 days and the half life periods were deciphered to be 3.4, 3.4 and 3.3 days under 1.0, 1.5 and 2.0 kg ha^{-1} of doses, respectively. Alachlor persisted in the soil even after 45 days of application under all the three doses and the half life periods were determined to be 17.2, 19.5 and 21.4 days, respectively. No detectable butachlor residue was revealed by HPLC analysis as well as cucumber bioassay in the soil and by HPLC analysis in rice grain and straw. Alachlor at 1.0 kg ha^{-1} did not leave any detectable residue in the soil and seeds of blackgram. However, at 1.5 kg and 2.0 kg ha^{-1} doses, significant residues were traced in the soil as well as seeds of blackgram. Regarding the impact on soil microflora, the fungal and actinomycetes population in rice soil were not significantly altered by butachlor but the bacterial population was significantly suppressed by it's higher doses during MT stage. In blackgram, there was an initial depression in the nodule number and nodule biomass but the same were found increased at later stages.

INTEGRATED WEED MANAGMENT IN DIRECT SEEDED RICE UNDER RAINFED LOW VALLYE SITUATION OF UTTARANCHAL

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An experiment was condutcted during spring season of 1997 and 1998 at Majhera, Research Station of G.B. Pant University of Agriculture and Technology, Pantnagar, to evaluate the efficacy of weed control methods involving mulching and use of herbicides for achieving most practical, effective and economical weed control in spring sown rice (mid Feb. to mid March) under upland rainfed situation. The treatments included combinations pendimethalin as pre, post-emergence, 2,4-D Na salt post-emergence, pine needless and farm wastes as mulch materials, farmers practice, weed-free and weedy check. Experiment was laid out is randomized block design with three replications. Results indicated that pendimethalin at 1.0 kg/ha + fram wastes as mulch supplemented with one hand weeding at 45 days after sowing decreased weed density, dry matter and gave highest weed control efficency (91.3%) which was comparable to the farmers practice of thrice hand weeding at 30, 60 and 90 DAS. This treatment also produced the highest grain and straw yields at par with weed-free and farmer's practice of hand weeding thrice. Pre-emergence application of pendimethalin at 1.0 kg/ha supplemented with post-emergence application of 2,4-D at 0.6 kg/ha also yield similar to these treatments and economic analysis showed that this treatment was most beneficial for controlling the weeds as it gave the highest net return and benefit: cost ratio (1.9).

INTEGRATED WEED MANAGEMENT IN FINGER MILLET.

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A field experiment was conducted during mansoon season of 1998-99 to 2000-2001 at NARP, Kolhapur to evaluate the relative efficacy of different chemical herbicides alone and in

combination with mechanical methods for weed management in drilled finger millet. The grain and straw yields of finger millet were significantly higher in weed free check, however it was on par with Pre emergence application of isoproturon @ 0.375 Kg. ai/ha + one hand weeding (30 DAS) and oxyfluorfen @ 0.100 Kg. ai/ha as a pre sowing + one hand weeding (30 DAS). The reduction in grain yield of finger millet due to weeds was to the extent of 12.66 to 70.74 per cent. The highest weed control efficiency was recorded in weed free check (88.19 %) followed by Pre-em. application of isoproturon @ 0.375 Kg. ai/ha. and pre- sowing application oxyfluorfen @ 0.100 Kg. ai/ha. coupled with one hand weeding (30 DAS) 81.43 and 78.41 per cent respectively. Among the weed control treatments significantly maximum net returns were obtained from Pre- em. application of isoproturon @ 0.375 Kg ai./ha. + 1 H.W. (30 DAS) Rs.4623/- followed by Pre-sowing application of oxyfluorfen @ 0.100 Kg. ai/ha. + 1 H. W.(30 DAS) Rs. 4027 and Weed free check (Rs. 3337) over rest of the treatments.

INTEGRATED WEED MANAGEMENT IN DIRECT WET SEEDED RICE

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Area under wet seeding of rice in lowland condition is expanding as this practice permits raising of crop and save about and inpu needed for raising nursery. Integration of appropriate production technologies could result in a yield equivalent to that of transplanted rice. However, herbicidal weed management, as it is a time bound activity, delayed application of pre-emergence herbicide results in poor weed management as well as possible crop phytotoxicity. Hence, a field experiment was conducted in direct wet seeded rice during *kharif* 2000 to develop an integrated weed management package for drum seeded direct sown rice (ADT 43). Four seeding methods, drum seeding rice alone (M1), drum seeding rice + daincha intercropping (M2), and broad casting rice at 100(M3), and 200 kg seeds ha $^{-1}$ (M4), were tried with four weed management methods, including butachlor at 1.0 kg/ha (S1) and pretilachlor+safner at 0.45 kg/ha fb.one HW on 35 DAS (S2), HW twice (S3) and an unweeded control (S4) in a split plot design replicated thrice. Observations were made on weed flora, weed density, weed drymatter and crop growth and yield attributes along with yield and economics.

Major weed flora of the experimental field compased of *Ecinochloa colonum*, *Echinocloa crusghalli* and *Panicum repens* among grasses, *Eclipta alba*, *Marsilea quadrifoliata*, *Monochoria vaginalis* and *Ludwigia parviflora* among borad leaf weeds and *Cyperus spp.* and *Fimbristylis mileaceae* among sedges. Results on weeds and yield indicated that drum seeding of rice + daincha intercropping resulted in higher productivity of rice (5395kg/ha) with lesser weed density and dry matter (214.8g/m^2). Per-emergence application of pretilachlor + safner at 0.45 kg/ha followed by one manual weeding on 35 DAS registered lesser weed density and weed dry weight (62.8g/m^2) with higher grain yield of 5617 kg/ha in direct wet seeded rice. As a result of better crop growth and panicle production, higher productivity of wet direct seeded rice was achieved with drum seeding of rice + daincha intercropping and integrating pre-emergence application of pretilachlor + safner at 0.45 kg/ha on 8 DAS followed by one hand weeding on 35 DAS, with better economic returns.

MANAGEMENT OF *ISACHNE MILIACEA* ROTH. IN SEMI-DRY RICE

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Semi-dry system of rice cultivation is popular in kerala during the first crop season where irrigation facilities are inadequate. *Isachne miliacea* (locally called Naṟinga), a hairy perenntial to control this weed once it spreads into the field and the menace is more serious than *Echinochloa colona.* An experiment was undertaken with 14 treatments involving common rice herbicides-butachlor, thiobencarb, anilophos, pretilachlor and oxyflourfen - at two doses each replicated thrice in RBD to find out appropriate herbicides for the management of this problem grass. The number and dry matter production of *Isachne miliacea* observed at 60 days after sowing showed that the plots treated with oxyflourfen 0.2 kg/ha, oxyflourfen 0.1 kg/ha and thiobencarb 2.0 kg/ha had significant control of the weed. The herbicdes, butachlor (1.0 kg/ha & 2.0 kg/ha), thiobencarb (1.0 kg/ha) and propnail (1.75 kg/ha) did not have much effect on Isachne. Nevertheless, the highest grain yield of 5956 kg/ha was from hand weeded plots, which was in trun on par with oxyflourfen 0.1 kg/ha (4667 kg/ha) and thiobencarb 2.0 kg/ha (4889kg). Taking into consideration the grain yield, weed control efficiency and the cost involved, thiobencarb 2.0 kg/ha and oxyflourfen 0.1 kg/ha are the most effective herbicides for the management of *Isachne miliacea* in semi-dry rice.

COMBINED APPLICATION OF BUTACHLOR AND PROPANIL FOR WEED CONTROL IN WET-SOWN RICE

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Severe weed competition is usually encountered in wet-sown (puddle sown) rice. Butachlor is usually recommended for pre-emergence weed control, whereas propanil is recommended for post-emergence application. Complete control of all the weeds may be obtained by one time application of these two herbicides, by suitable adjustments in the time of application so that the expenditure on applying the herbicides twice can be reduced. Hence a trial was conducted to find out the ideal time and dose of for the combined application of butachlor and propanil in wet sown rice. In the trial, laid out in RBD with three replications, efficacy of four doses of the herbicide combination sprayed at 10 and 15 DAS was compared with pre-emergence application of butachlor, pretilachlor and anilofos and two controls (hand-weeded and unweeded). Results showed that combined application of butachlor and propanil resulted in better weed control and higher yields than the presently recommended herbicides. Though there was slight phytotoxicity to rice seedlings from the application of the combination at the higher doses (6&8 l/ha), the crop recovered soon. Mean grain yield for the two seasons showed that application of butanil @ 6 l/ha on 10 or 15 DAS gave higher yields than all other treatments, including hand weeded control.

EFFECT OF WEED MANAGEMENT PRACTICES AND BIOFERTILIZERS ON THE GROWTH AND YIELD OF FINGER MILLET

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Field experiment were conducted at Annamalai University Experiment Farm, Annamalai Nagar to study the influence of weed management practices and biofertilizers on the growth and yield of finger millet cv. CO 13 during June-Sept 1998 and Feb-May 1999. The experiments were laid out in split plot design. Four main treatments (weed management practices) Viz,. conventional weeding (15 and 30 DAT), alachlor @ 2 kg ha^{-1}alone, alachlor @ 2kg ha^{-1} with one hand weeding at 30 DAT, unweeded control and five sub-plot treatments (biofertilizer inoculation) *viz.*, recommended NPK alone, recommended NPK with Azospirillum, 75% recommended N and full PK with Azospirillun, recommended NPK with Azospirillum adn Phosphobacteria, 75% recommended NP and recommended K with Azospirillum and phosphobacteria. Among the weed management practices, pre-emergence application of alachlor @ 2kg ha^{-1} with one hand weeding at 30 DAT recorded the least weed count, weed DMP, higher WCE and WCI followed by conventional hand weeding. The growth and yield components as well as grain and straw yield were found to be significantly highest with alachlor @ 2kg ha-1 with one hand weeding at 30 DAT. Among the sub-plot treatments, dual inoculation of Azospirillum + phosphobacteria with recommended NPK favourable influenced the growth and yield components. It amy be conluded that pre-emergence application of alachlor @ 2kg ha^{-1} and one hand weeding at 30 DAT combinde with dual inoculation of Azospirillum and phosphobacteria with recommended NPK hold promise as an appropriate technology for achieveing efficient and economic weed control and also higher yield in finger millet.

WEED MANAGEMENT IN RICE (*ORYZA SATIVA* L.) NURSERY

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A field experiment was conducted during summer-kharif season to study the different weed management practices on the control of weeds in rice nursery at B.A. College of Agriculture, Gujarat Agricultural University, Anand, Nine treatments consists four soil solarization (SS) (combination of moist and dry soil conditions and two type of polyethylene (PE) films (treatment and black), rabbing with bajara husk at 6.0 t/ha, butachlor 1 kg a.i/ha as emergence at 5 DAS, pre-sowing irrigation 15 days prior to sowing (stale cultivation), hand weeding and unweeded control. Hnad weeding showed higher weed control efficiency (91.4%), closely followed by SS on moist soil with transparent PE (76.7%). SS with transparent PE on moist soil condition recorded significantly higher soil temperature than other treatments. SS with dry as well as moist soil conditons along with transparent PE produced significantly more number of healthy and lower number of yellow rice seedlings per unit area and controlled weeds effectively, it was at par with hand weeding. Similar trend was recorded in case of fresh and dry weight of total and healthy rice seedlings. SS on moist soil with transparent PE yielded maximum content of chlorophyll (a, b and total) in leaves of rice seedlings.

INTEGRATED WEED MANAGEMENT IN DIRECT SEEDED PUDDLED RICE

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Field experiments were conducted at Annamalai University Experimental Farm, Department of Agronomy, Annamalainagar, Tamilnadu to device suitable weed control measures for direct seeded puddled low land rice. The treatments comprised of application of butachlor @ 1.5 kg a. i. ha^{-1} with and without safener (fenclorim) 4 days after sowing (DAS), 8 DAS alone and also in conjunction with hand weeding at 30 DAS. Hand weeding twice and a weedy check were also maintained. A seed rate of 100 kg ha^{-1} was followed. The seeds were soaked in Bio-digested slurry 50 % solution+ KH_2PO_4 1% + Penshibao 50 ml ha^{-1} and the pre germinated seeds were directly broadcast in well puddled mainfield. Pressmud @ 6.25 t ha^{-1} was uniformly incorporated in the plots.

Incorporation of Pressmud @ 6.25 t ha^{-1} and application of butachlor with safener (fenclorim) in direct seeded rice at 4 DAS followed by hand weeding on 30 DAS resulted in effective weed control without any phytotoxicity on rice seedlings, and also enhanced the rice grain yield.

SYSTEMS ON WEED GROWTH IN WHEAT(*TRITICUM AESTIVUM* L.)

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A field experiment was conducted during winter season of 2000-2001 to study the effect of weed control methods viz., weed check, sulfosulfuron 25 glha and isoproturon +2, 4-D (1.0 kg/ ha +0.5 kg/ha) under different tillage systems viz., conventional (two ploughing followed by planking) and zero tillage on weed growth in wheat. The common weed flora in the experimental field were *Rumex cripus* L; *Phalaris minor* L; *Parthenium hysterophorous* L; *Melilotus alba* L; *Chenopodium album* L; and *tnagallis arvensis* L.

The weed density at 50th days stage of crop growth in weedy cheeck plot was lower (320 M^{-2}) in zero tillage system as compared to conventional tillage system (420 m^{-2}). Herbicidal treatments were more effective in zero tillage as compared to conventional tillage in minimizing weed growth. Plot treated with sulfosulfuron and isoproturon +2, 4-1) under zero tillage system had 42 and 22 weed population m^{-2} where as in conventional tillage system the weed density was same treatments has weed population 60 and 42 m^{-2}, respectively. Treatment differed markedly in arresting the dry weight of weeds. The weed dry weight under zero tillage were 140, 16, 12 gm^{-2} and under conventional tillage were 150, 28, 22 gm^{-2} in the weedy check, sulfosulfuron and isoproturon +2, 4-D effectively controlled the weeds under zero tillage system as compared to conventional tillage system. Application of sulphosulfuron (Postem) was found less efficive as compared to isoproturon +2, 4-D in respect to weed management in both the tillage system but effective against P. minor as compared to isoproturon +2, 4-D in both system. Plant height (cm), number of shoots per meter row length, dry matter per meter row length and leaf area index (LAI) were significantly affected and were more in isoproturon +2, 4-D under zero tillage than conventionla tillage system.

INTEGRATED WEED CONTROL IN DRILL SOWN RAINFED FINGER MILLET (*ELEUSINE CORACANA* GAERTN.)

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Series of field experiments, On-station and On-farm demonstrations were conducted during 1994-99 on red sandy loam soils of *Gandhi Krishi Vignana Kendra*, Bangalore and on the farmers fields of Bangalore, Kolar and Tumkur Districts to evaluate the effects of herbicides and cultural and mechanical measures of weed control on yield of drilled rainfed finger millet. Out of eight herbicides tested pre-emergence application of Isoproturon @ 0.5 kg a.i./ha (2907 kg/ha) gave comparable yields to that of farmer's practice of two intercultivations and one hand weeding (3078 kg/ha) and weed free check – one intercultivation and two hand weedings (3177 kg/ha) besides accounting for lower weed biomass (444, 125 and 59 kg/ha, respectively) and higher weed control efficiency (86.7, 96.2 and 98.2 per cent, respectively). Combinations of Isoproturon and cultural plus mechanical measures of weed control have further enhanced the yield by 12.6 to 28.9 % over no chemical. 2, 4-D sodium salt @ 0.75 kg a.i./ha as post emergence spray 15-20 days after sowing is next alternative herbicide. On farm trials confirmed the superiority of Isoproturon over farmer's practice of weed control to an extent of 6.4 % yield increase besides being less labour intensive providing effective weed control.

ECONOMICS OF CHEMICAL WEED CONTROL IN FINGER MILLET

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A field experiment involving five herbicides in comparison with hand weeding treatment was conducted at College of Agriculture, Shimoga during *Kharif* 1999 to findout their efficacy on the growth and yield of finger millet and also the effective control of weeds. The economic use of herbicides in finger millet was worked out. Among the weed control treatments, the highest gross returns were obtained in hand weeding (Rs.18430/- ha^{-1}) followed by isoproturon (Rs. 18143/- ha^{-1}). However, the B:C ratio was higher in isoproturon (1.84), chlorimuron ethyl at 5 g a.i. ha^{-1} (1.83) and at 10 g a.i. ha^{-1} (1.68) as comapred to hand weeding (1.54). The lower B:C ratio in hand weeding was due to higher cost of cultivation (Rs. 11936/- ha^{-1}) and this was followed by press mud (Rs. 10536/- ha^{-1}) and lowest cost of cultivation was recorded was recorded by unweeded check (Rs. 9536/- ha^{-1}). Thus, use of isoproturon or chlorimuron ethyl was economical in control of weeds in finger millet than hand weeding.

ECONOMIC EVALUATION OF HERBICIDES FOR DRUM SEEDED RICE UNDER PUDDLED CONDITION

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Drum seeded rice is becoming popular in most of the Southern India and yields are comparable to that transplanted rice during last few years (DRR, Annual Report 1998 and 1999),

there is a need to evolve and study the effect of new herbicides in Drum seeded rice to control weeds effectively. Hence, the present study was conducted during wet season of 1999 to evaluate the effectiveness of single and mixed herbicides in control of weeds in direct seeded rice. Field experiment was conducted during Kharif 1999 (June-October) season at Directorate of Rice Research farm, RajendraNagar, Hyderabad with 12 herbicides and their combinations compared with hand weeding twice and unweeded control. The per cent grain yield reduction of 32.40 due to the weeds where, hand weeding twice and unweeded control recorded grain yields of 4.67 and 3.15 t/ha respectively. Among the herbicides butachlor + safener recorded significantly maximum grain yield of 4.78 t/ha which was comparable with hand weeding twice and mixture herbicide butachlor +2, 4-D EE @ 1.0 kg a.i./ha. The yield attributes such panicle/m^2, effective tillers panicle weight and test weight were higher with butachlor + safener @ 1 kg a.i./ha). Similarly, the higher weed management index values were recorded with butachlor + safener followed by two hand weedings. Economic evaluation of the data clearly indicates the superiority of the butachlor + safener as compare to other herbicides (2.64). The B:C ratio was lower with hand weeding twice due to higher cost of cultivation as compared to herbicides tested in the study. The significant negative correlation (-0.73) was obtained between weed dry weight Vs. grain yield. The regression equation based on the weed dry weight and grain yield clearly indicated that for every increase of one kg weed dry weight decreased the grain yield by 4.9 kg/ha.

Based on the study, it can be concluded that butachlor safener @ 1.0 kg a.i/ha (2.64) and butachlor +2, 4 D EE @ 1.0 kg a.i./ha (2.44) -a herbicide mixture found superior and effective in controlling weeds with higher B:C ratio compared to hand weeding twice (2.01) with medium duration variety Krishnahamsa under clay loam soil.

INTEGRATED WEED MANAGEMENT IN UPLAND DIRECT SEEDED RICE (*ORYZA SATIVA* L) CV NAGALAND LOCAL

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A field experiment was carried out during summer season of 1998 at the Research farm of School of Agricultural Sciences and Rural Development Nagaland University, Medziphema, Nagaland having eleven treatment combinations viz, weedy check, weed free check, one hand weeding at 20 DAS, one hand weeding at 40 DAS, 2 hand weeding at 20 DAS and 40 DAS, 2, 4 - D@ 1 kg /ha - 20 DAS, 2, 4 - D @ 1 kg/ha - 20 DAS + one hand weeding - 40 DAS, Butachlor @ 1.5 kg /ha pre- emergence (PE), Butachlor @ 1.5 kg/ha PE + one hand weeding - 20 DAS , Butachlor @ 1.5 kg / ha. PE + one hand weeding - 40 DAS and Butachlor @ 1.5 kg/ha - PE + 2,4 -D @ 1.0 kg/ha - 20 DAS. The treatments were replicated three times in randomised block design. The dominant weed species of the experimental field comprised of *Borreria hispida, Ageratum conyzoides, Digetaria sangunalsis, Setaria glauca and Elusine indica*, and *Cyperus rotundus.*

The data reveled that pre-emergence application of Butachlor @ 1.5 kg/ha in combination with one hand weeding either at 20 to 40 days after sowing recorded lesser values for weed population and dry matter of weeds. All the weed control treatments recorded significantly better and superior values of growth characters viz - plant height, tillering and effectives tillers per hill over weedy check. The yield attributes viz- number of pannicles length of pannicle, number of fertile grain/pannicles, test weight of grains recorded significantly higher values in all the weed

control treatments over weedy check. Weed free treatment produced the highest grain yield and straw yield. This has followed by two hand weeding at 20 DAS and 40 DAS; pre emergence application of Butachlor @ 1.5 kg/ha + one hand weeding either at 20 or 40 DAS. Pre-emergence application of Butachlor @ 1.5 kg / ha + one hand weeding at 40 DAS (T_{10}) was found to be the most profitable treatment with net income of Rs 4,461/ha with cast: benefit ratio of 1.4.44.

INTEGRATED WEED MANAGEMENT METHODS UNDER SPLIT APPLICATION OF NITROGEN IN WET SEEDED LOWLAND RICE-RICE CROPPING SYSTEM

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To develop an integrated weed management practice for wet seeded (drum seeded) lowland rice under 4 and 5 times of split application of N, a study was made at wetland, Department of Agronomy, Coimbatore, for two years (4 crops) in a rice-rice cropping system using ADT 36 in kharif season and ADT 39 in rabi season. Four splits of N were made as 1/6 at 10 DAS + 1/3 each at active tillering and panicle initiation + 1/6 at heading stages; the five split application of N was given as 1/5 each at sowing + 10 DAS +active tillering +panicle initiation +heading stages. The recommended fertilizer dose of fertilizer for Kharif (120:38:38 kg NPK/ha) and rabi (150:50:50 kg NPK/ha) was adopted.

The six integrated weed management methods included manual method (hand weeding once/twice as per treatment), mechanical + manual method (working of Cono-weeder at 20 DAS +manual weeding 35 DAS), cultural +manual method (intercropping of *Sesbania rostrata* as smother crop + manual incorporation cono-weeding 35 DAS),, cultural + mechanical method (intercropping of *Sesbania rostrata* as smother crop and incorporation by working Con-weeder at 35 DAS), cultural + chemical + mechanical method (intercropping of *Sesbania rostrata* as smother crop + pre-emergence application of pretilachlor (S) 0.45 Kg/ha on 7 DAS +working Cono-weeder on 25 DAS for weeding and incorporation of intercrop) and chemical + manual method (pre-emergence application of pretilachlor (S) 0.45 kg/ha on 7 DAS + hand weeding on 35 DAS). Unweeded control was maintained for comparison.

Application of N in 4 splits(1/6 at 10 DAS + 1/3 each at tillering and panicle initation + 1/6 at heading stages) skipping basal dose did not favour weed growth, while, promoted the crop growth, yield and economics of wet weeded rice as against 5 spoits (1/5 each at sowing + 10 DAS + tillering + panicle initiation + heading stages). The weeds which are the major problem in wet seeded rice could be effectively controlled by integrated method of growing Sesbania rostrata as a weed smother intercrop and incorporating manually *insitu* with simultaneous manual weeding at 35 DAS (cultural + manual method) to maximise yield and economics of wet seeded lowland rice. Alternatively, pre-emergence application application of pretilachlor (S) 0.45 kg/ha at 7 DAS, growing Sesbania as intercrop and mechanical incorporation by Cono-weeder along with manual weeding on 35 DAS (chemical + cultural + mechanical) could be integrated to reduce the labout requirement, yet to maintain the yield and economics. Combining cultural (growing of weed smother intercrop) + mechanical (their incorporation by Cono-weeder) without manual incorporation and/or

weeding resulted in partial incorporation of green manure and poor weed control resulting in substantial yield losses in wet seeded rice. Thus, combination of N application in four splits and control of weeds with cultural + manual method or chemical + cultural + mechanical method could be judged as the best integrated approach for weed management in wet seeded lowland rice on the basis WCE, grain yield and economics.

EVALUATION OF DOSES AND FORMULATIONS OF ACETOCHLOR FOR WEED MANAGEMENT IN TRANSPLANTED RICE FOLLOWED BY GREEN GRAM, KARNATAKA

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Field experiment was conducted during Kharif 1997- summer 1998 at Kathalagere, Agricultural Research Station, University of Agricultural Sciences, Bangalore. Different doses (75 to 150 g ai/ha) and formulations (90 EC, 1% and 5% granules) of acetochlor were compared to work out optimum doses and bio efficacy in controlling weeds in relation to hand weeding and other standard herbicides- butachlor and pretilachlor. The major weed flora observed in the experimental fields were *Cyperus difformis, Scirpus* sp (from initial stages), *C. iria* (Ci) (from middle stage of the crop growth), *Panicum tripheron, Echinochloa colona, Paspalum dilatatum,* (among grasses) *Ludwigia parviflora, Rotala verticillaris, Dopatrium junceum, Eclipta alba, Cyanotis axillaris* (among broad leaf weeds. In transplanted rice on sandy clay loam soil, use of acetochlor at 100 g ai/ha (3 DAP) in the form of 90 EC or 5% G or 1 % G formulations gave good control of weeds and grain yields comparable to hand weeding, pretilachlor and butachlor treated plots. Acetochlor caused no phytotoxicity to rice even at 150 g ai/ha in all formulations. Acetochlor lowered grasses particularly *E. colona* considerably and had moderate effect on *L. parviflora, R. verticillaris, E. alba.* Thus acetochlor at 100 g ai/ha when applied at 3 DAP was found good in transplanted rice.

After the harvest of rice crop during summer 1998, the residual effects of herbicides if any was studied by raising a follow-up crop of green. There was no residual adverse effect of acetochlor applied in rice at the rates of 75 to 150 g ai/ha in the formulations of 90 EC or 5% G or 1% G, on the growth and seed yield of succeeding green gram. Here, succeeding green gram was sown 174 days after application of herbicides to rice.

INTEGRATED WEED MANAGEMENT IN WHEAT

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A field experiment was conducted during two consecutive years (1997-98) to study the effect of cultural, manual and herbicidal treatments on the weeds and grain yield of wheat crop. Two methods of sowing (Pre - sowing and post-sowing irrigation) and five weed control treatments (Weedy check, two hand weedings, pendimethalin 0.50 kg/ha + one hand weeding at 30 DAS , 2,4-D @ 1.0 KG/HA AT 30 DAS and pendimethalin 0.50 kg/ha + 2,4-D at 0.50 kg/ha + 2,4-D at 0.50 kg/ha) were evaluated in factorial randomized block design with 3 replications.

Intensity of Chenopodium album and C. murale were recorded 82% of total weed flora. Other weed species like Melilotus indica. Asphodelus tenuifolius, Anagalis arvensis, G linus lotoides, Convolvulus arvensis and cynodon dactylon dactylon exhibited their little infestation individually.

Pre-sowing irrigation had sown significantly lower weed population as well as dry matter production as compared to post-sowing irrigation. The weed population and dry weight of weeds were recorded 36 and 32 per cent lower over post-sowing irrigation respectively. Among the weed control treatments, pre-emergence application of pendimethalin either supplemented with one hand weeding or 2,4-D at 30 DAS resulted maximum reduction in the weed population and dry matter production and recorded statistically at par with that of two hand weedings. Post-emergence application of 2,4-D at 1.0 kg/ha was observed next best treatment for reducing weed population and dry weight. However, all the weed control treatments were significantly superior to weedy. Pre-sowing irrigation resulted significant increase in the yield attributes and as a result grain yield was recorded 13% higher over post-sowing irrigation. Maximum grain yield was obtained under two weedings given at 30 and 50 days after sowing. Integration of reduced rate of pendimethalin at 0.50 kg/ha with either one hand weeding or 2,4-D at 0.0 kg/ha at 30 DAS provided grain yield statistically equivalent to two hand weedings. Post=emergence application of 2,4-D at 1.0 kg/ha alone also proved its superiority and gave significant superior grain yield over the pre-emergence application of pendimethalin at 1.00 kg/ha and weedy check. However, among the weed control treatments combination of pre-emergence application of pendimethalin at 0.50 kg/ha + 2,4-D at 0.50 kg/ha at 30 DAS provided maximum net returns.

EFFECT OF WEED CONTROL METHODS UNDER DIFFERENT TILLAGE SYSTEMS ON WEED GROWTH IN WHEAT(*TRITICUM AESTIVUM* L.)

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A field experiment was conducted during winter season of 2000-2001 to study the effect of weed control methods viz., weed check, sulfosulfuron 25 glha and isoproturon +2, 4-D (1.0 kg/ha +0.5 kg/ha) under different tillage systems viz., conventional (two ploughing followed by planking) and zero tillage on weed growth in wheat. The common weed flora in the experimental field were *Rumex cripus* L; *Phalaris minor* L; *Parthenium hysterophorous* L; *Melilotus alba* L; *Chenopodium album* L; and *tnagallis arvensis* L.

The weed density at 50th days stage of crop growth in weedy cheeck plot was lower (320 M^{-2}) in zero tillage system as compared to conventional tillage system (420 m^{-2}). Herbicidal treatments were more effective in zero tillage as compared to conventional tillage in minimizing weed growth. Plot treated with sulfosulfuron and isoproturon +2, 4-1) under zero tillage system had 42 and 22 weed population m^{-2} where as in conventional tillage system the weed density was same treatments has weed population 60 and 42 m^{-2}, respectively. Treatment differed markedly in arresting the dry weight of weeds. The weed dry weight under zero tillage were 140, 16, 12 gm^{-2} and under conventional tillage were 150, 28, 22 gm^{-2} in the weedy check, sulfosulfuron and isoproturon +2, 4-D effectively controlled the weeds under zero tillage system as compared to conventional tillage system. Application of sulphosulfuron (Postem) was found less efficive as compared to isoproturon +2, 4-D in respect to weed management in both the tillage system but

effective against P. minor as compared to isoproturon +2, 4-D in both system. Plant height (cm), number of shoots per meter row length, dry matter per meter row length and leaf area index (LAI) were significantly affected and were more in isoproturon +2, 4-D under zero tillage than conventionla tillage system.

EFFECT OF TIME OF APPLICATION ON THE EFFICACY OF TRIFLURALIN IN WHEAT

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To find out the influence of time of application on the efficiency of trifluralin against mixed weed flora, an experiment was conducted at the Research Farm of CCS Haryana Agricultural University, Hisar (India) during *rabi* seasons of 1997-98 and 1998-99. The soil of the experimental field was sandy loam in texture, low in available nitrogen (182.5 kg ha^{-1}), medium in available P_2O_5 (13.8 kg ha^{-1}) and high in K_2O (352.8 kg ha^{-1}) with slightly alkaline in reaction (pH 8.3). The wheat variety WH-542 was sown with tractor drawn seed-cum-fertilizer drill on 4.12.97 and 11.12.98 using seed rate of 125 kg ha^{-1}, keeping row-to-row spacing of 20 cm. The experiment consisted of 13 herbicidal treatments viz.; trifluralin at 0.50, 0.75 and 1.0 kg ha^{-1} each applied as pre-plant incorporation (PPI), pre-emergence (PE) and just before first post sowing irrigation at 20 days after sowing (BI), trifluralin + isoproturon (1:1) at 0.50, 0.75 and 1.0 kg ha^{-1} and isoproturon 1.0 kg ha^{-1} at 30 DAS along with weedy and weed free check was laid out in randomized block design with three replications. The experimental field was infested with mixed weed flora comprising mainly *Rumex* spp. (60%), *Chenopodium album* (10%), *Avena ludoviciana* (15%) and *Phalaris minor* (15%).

Trifluralin applied as PPI at 0.50 – 1.0 kg ha^{-1} resulted into 30 – 65% control of mixed weed flora, however, it also inhibited the germination of wheat crop to the extent of 10-50% at various doses. Trifluralin at 0.50 – 1.0 kg ha^{-1} applied as PE provided around 40% control of grassy weeds only. Delayed application of trifluralin i.e. at 20 DAS (BI) further reduced its efficacy and plots under these treatments yielded similar to weedy check which was minimum among all treatments. Tank mixture of trifluralin + isoproturon (1:1) at 0.5 – 1.0 kg ha^{-1} provided better control of weeds and higher grain yield of wheat as compared to alone application of trifluralin at various times. Isoproturon 1.0 kg/ha at 30 DAS proved best among all herbicidal treatments which gave satisfactory control (80%) of mixed weed flora accept *Rumex* sp. Maximum grain yield of wheat was recorded in the plot kept weed free throughout the season and it was followed by the treatment of isoproturon at 1.0 kg/ha applied at 30 DAS.

DENSITY AND DRY WEIGHT WEEDS AS AFFECTED BY AFFECTED BY SULFOSULFURON AND IRRIGATION IN WHEAT

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The field trial to test three irrigation frequencies (2, 4 and 60 and four levels of sulfosulfuron (20, 40 and 60 g ai/ha and weedy check) against weeds in wheat was laid out in split plot design during rabi season of 1996-1998 on sandy loam soils of CCS Haryana Agricultural University,

Hisar. Frequency of irrigation was alloted to main plots and levels of sulfosulfuron to sub plots with six replications. The crop was sown on 30th November and 18 December in 1996 and 1997, respectively. The herbicide was sprayed after 35 DAS with a manually operated Knapsack sprayer with a spray volume equivalent to 500 litres/ha.

The weed flora present in the field was P. minor Retz; Chenopodium album. L, Melilotus indica L, Anagallis arvensis. L, Rumex maritimus L; Polygonum plebejum R. Br. and Coronopus dedymus L. which constituted 5.3, 35.9, 12.0, 12.4, 21.8, 10.8 and 39.5 per cent to the total infestation, respectively. Results revealed that frequency of irrigation failed to influence the density and dry weight of weeds except Rumex maritimus which gained 21.2 and 6.5 per cent more dry weight under highest number of irrigations as compared to 2 and 4 irrigations, respectively, applied to wheat. Sulfosulfuron significantly reduced the density of weeds except Rumex maritimus and their dry weight. However, reduction in density beyond 20 g ai/ha remained non-significant amongst doses of herbicide, used. The WCE was highest (93.9%) with 60 g/ha as compared to 90.8 and 92.9 % with 20 and 40 g/ha, respectively.

It is concluded that sulfosulfuron @ 20 g/ha is an effective alternate to control grassy as well as broad leaved weeds in wheat and only four number of irrigations are sufficient under shallow water table conditions in Haryana.

EFFECT OF METHOD OF FERTILIZER PLACEMENT AND WEED MANAGEMENT ON WEED GROWTH AND YIELD OF RAINFED MUSTARD [*BRASSICA JUNCEA* (L.) CZERN. & COSS.]

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A field experiment was conducted during winter season of 1998-1999 and 1999-2000 at Varanasi, to find out an effective method of fertilizer placement and weed management to minimize weed interference for higher yield of rainfed mustard. *Anagallis arvensis L., Asphodelus tenuifolius* Cavan, *Chenopodium album L., Cynodon dactylon* (L.) Pers. and *Vicia sativa* were the dominant weeds. Dicot weed population was affected significantly by fertilizer placements. However, population of monocot weeds was not altered by fertilizer placement methods tried. Deep and side placement of fertilizer significantly reduced the population and dry matter of weeds as compared to broadcasting method. Similarly, deep fertilizer placement significantly enhanced the average seed yield up to 25.32 ± 0.12% and 37.87 ± 0.12% over side placement and broadcasting method of fertilizer application, respectively. Pre-emergence application of isoproturon 1.0 kg coupled with one intercultural operation at 30 days after sowing brought significant reduction in population and dry matter of weeds and resulted in highest seed yield (14.08 qha^{-1} ± 0.20 at $CD_{0.05}$ = 0.58) and weed control efficiency (90.18%) as compared to weedy check. Pre-plant incorporation of isoproturon 1.0 kg integrated with one intercultural operation having WCE of 89.50% and the grain yield of 13.42 qha^{-1} was the second best. Interaction effect fertilizers placement and weed management practices was found to be significant on seed yield during both the years. The maximum crop yield (17.59 qha^{-1} ± 0.35 at $CD_{0.05}$ = 0.99) and net return per rupee invested (2.16) was noted in deep placement of fertilizer with isoproturon 1.0 kg as pre-emergence coupled with one intercultural operation at 30 days after sowing.

INTEGRATED WEED MANAGEMENT IN SOYBEAN [G*LYCINE MAX* (L.) MERRILL] GROWN IN VERTISOLS UNDER RAINFED AGRO ECOSYSTEM

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A Field experimentwasconducted at A.R.S., Kota during kharif 1998 and 1999 to develop suitable weed management practice in soybean. The experiment was carried out in randomised block design replicated thrice with these treatments viz; Alachlor @ 2.0 kg/ha Pre-emergence; Trifluralin @ 1.0 kg/ha pre plant incorporation; Anilophos @ 1.5 kg/ha pre emergence ; Lectofen@90 g/ha post emergence; Farmers practice; Two hand weeding at 30 & 45 days after sowing; Alachlor @ 2.0 kg/ha followed by single running of bullock cultivator (locally called 'Dora' practice) in between rows of soybean at 5 weeks Trifluralin @ 1.0 kg/ha followed by 'Dora'/cultivator; Anilophos @ 1.5 kg/ha followed by 'Dora'/cultivator and weedy check. The field was dominated by weeds viz; Echinochloa crusgalli, *Echinochloa colonum, Trianthema protulacastrum, Celosia argentia, Digera arvensis and Aclypha indica.* Among the weed control treaments lower weed population 00 and 26.3/m^2 at 30 & 60 days after sowing and higher weed control efficiency were observed in hand weedings twicely closely followed by the application of Alachlor @ 2.0 kg/ha (PE) or Trifluralin @ 1.0 kg/ha followed by 'Dora'/cultivator. Weed density under weedy check was 168 and 174 /

m^2 during 1998 and 1999, respectively and being minimum in the Alachlor @ 2.0 kg/ha or Trifluralin @ 1.0 kg/ha followed by 'Dora'/cultivator at 35 DAS (57, 76 and 40,45 at 30 & 60 DAS) having lower weed biomass also during both the years. During both the years minimum yield under weedy check was 1075 & 873 kg/ha. An integration of one herbicide (Alachlor or Trifluraline) followed by single running of Bullock drawn Dora / cultivator provides better control of weeds resulted in better growth, yield attributes and consequently higher soybean yield (2066, 1810 and 1966, 1763 kg/ha) during 1998 & 1999 , respectively and was higher than either of the single treatment.

EVALUATION AND EFFICACY OF CHLORIMURON -ETHYL AS INFLUENCED BY DOSE AND TIME OF APPLICATION AGAINST WEEDS IN SOYBEAN (*GLYCINE MAX* (L.) MERRILL)

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A field experiment was carried out to evaluate the efficacy of new post emergence herbicide, chlorimuron-ethyl at different doses and time for weeds control in soybean grown in vertisols at Agricultural Research Station, Kota, during rainy seasons of 1999 and 2000. The experiment was laid out in randomised block design with three replications. The tretaments comprised of viz; chlorimuron- ethyl @ 6.25 and 9.25 g ha^{-1} at 5, 10, 15, 20 and 25 days after sowing (post emergence), alachlor @ 2.0 kg ha^{-1} pre emergence, two hand weeding at 30 and 45 days, one hand weeding and weedy check. The post-emergence Chlorimuron- ethyl was sprayed by dissolving it in water @ 500 l/ha using surfactant as spreading and sticking agent. The predominant weeds were *Celosia argentia, Commelina benghalesis, Eclipta alba, Cirsium arvensis, Trianthema portulacastrum, Euphorbia hitra, Aclypha indica, Corchonis spp., Digera arvensis,Xanthium spp. Digertaria sanguinalis* , among the broad leaf weeds Echinochloa spp., Cyperus rotundus and Cyanadon dactylon were among the grasses and sedges. The experiental plots were mainly colonised by the Celocia argentia(60%) and other broad leaf weeds. The results revealed that Chlorimuron -ethyl brought down significant reduction in broad leaved population as well as weed dry matter as compared to alachlor, one hand weeding and weedy check. Chlorimuron -ethyl @ 9.25g ha^{-1} at 5-15 days after sowing controlled broad leaf weeds very effectively but either of the doses i.e. 5.25 or 9.25 g ha^{-1} couldn't control *Echinochloa spp.*, and Cyperus rotundus. All the doses of test chemical resulted in higher weed control efficiency and seed yield as compared to one hand weeding and weedy check. Chlorimuron-ethyl applied @ 9.25 g ha^{-1} at 10 and 15 days after sowing were found most effective and were significantly superior to 6.25 g ha^{-1} and has recorded higher yield (1673, 1707 and 1836, 1816 Kg ha^{-1}) with an increase of 48.5, 51.5 and 93.9, 97.8 and 37.73, 36.23, and 75.52, 73.61 per cent over one hand weeding and weedy check during 1999 and 2000, respectively. Unweeded control had recorded significantly lower seed yield (863 and 1046 Kg ha^{-1}) and reduction in yield was 109 and 97 per cent compared to two hand weeding and Chlorimuron-ethyl @ 9.25 g ha^{-1} , respectively.

The growth and yield components of soybean were imporved with the application of Chlorimuron -ethyl and significantly higher weed control efficiency of 76,82,93 and 78,83,92 at 30 and 45 days after sowing, were observed with the Chlorimuron applied at 5,10 and 15 days after sowing during 1999 and 2000, respectively but efficiency decreases after 15 days application . The test herbicide (Chlorimuron-ethyl) was very effective to control predominate broad leaf weeds in the region, (*Celosia argentia, Commelina benghaslensis and Digetaria arvensis).* The

Chlorimuron-ethyl remarkably had higher weed control efficiency and selective of the soybean crop. Higher seed yield and effective control of weeds particularly broad leaved in soybean could be achieved with the application of chlorimuron ethyl @ 9.25 gha^{-1} at 4-6 leaf stage of the weeds.

INTEGRATED WEED MANAGEMENT IN RAINFED SUNFLOWER

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Experiments were carried out at RARS, Nandyal for four consecutive years (1997 - 2000) to find out the Effective weed control method (Culfural and / or pre-emergnece application of herbicides) in rain-fed Sunflower crop. The experiment was conducted in a randomised block design with 12 treatments and replicated thrice. Results indicated that the yield differences varied significnatly due to different treatments depending on the seasonal rainfall fluctuations. Pooled analysis (1997, 99, 2000), revealed that the highest seed yield (907 kg /ha) was obtained with two inter-cultivations (2 I.C) + two hand weedings (2 H.W.) at 25 and 45 days after sowings, (DAS) followed by Pendimethalin + one hand weeding (838 kg/ha), Pendimethalin alone (835 kg/ha) and Butachlor + one hand weeding (838 kg/ha) all of which were on par with each other. The yield decreased by 32.5% due to un-weeded check over two IC + 2 HW. On the other hand, the yield increase recorded with or with out one hand weeding in case of Pendimethalin was 28.4 and 27.9% while with Butachlor, it was 27.6 and 26.6% respectively over un-weeded check.

EVALUATION OF HERBICIEDS FOR WEED MANAGEMENT IN SEED CROP OF PEA (*PISUM SATIVAUM* L.)

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A field trial to evaluate the effects of clomazon, pendimethalin, imazithapyr, linuron ans chlorimuronethyl at different rates of application along with weedy and weed free treatments was conducted for weed managment in seed crop of pea variety Arkel grown on sandy loam soil at G.B. Plant University of Agriculture and Technology, Pantnagar during winter season of 2000-2001. The major weeds infesting experimental field were *Melilotus indica, Chenopodium album, Fumaria parviflora* and *Cyperus rotundus* constituting more than 70 per cent of the total weed density at 60 days after sowing the crop. Presence of weeds throughout growing season resulted in maximum dry matter production by the weeds. Herbicieds with increasing rates either alone or in combination, reduced weed dry matter accumulation significantly over weedy check. Pendimethalin and prometryn both at lower doses and imazithapyr at 625 g/ha did not contorl major weeds resulting in comparatively higher dry matter production, which was almost similar to that obtained under weedy plots.

Unchecked weed growth on an average recorded 64.8 per cent reduction in seed yield of pea as compared with weed free treatment. Chlorimuronethyl at 6 g/ha being on par with pendimethalin at 1000 g and mixture of clomazon at 250 g with pendimethalin at 500 g/ha produced significantly higher grain yield as compared to rest of the herbicides and their combinations. Increaseing rate of clomazon either alone or combined with pendimethalin did not increase seed yield significantly when compared with their increasing rates and their combinations, whereas

chlorimuronethyl, pendimethalin and prometryn gave significantly higher grains as compared to their lower doses. Application of prometryn at lower dose did not influence seed yield and was almost similar to that of weedy plots due to poor weed control and higher dry matter accumulation by the weeds.

EFFECT OF WEED MANAGEMENT AND FERTILITY LEVELS ON RAJMASH (*PHASEOLUS VULGARIS*) & ASSOCIATED WEEDS UNDER DRY-TEMPERATE HIGH HILLS IN HIMACHAL PRADESH

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Field experiments were conducted at the Research farm of RRS, Kukumseri (2672 m above m s l) during summer 1999 & 2000 to study effect of weed control methods & fertility level on weeds & yield of Rajmash. Twelve treatment combination of four weed control methods (Pendimethalin 1.2 kg/ha(Pre), Alachlor 1.5 kg/ha (Pre), Pendimethalin 0.9 kg + Alachlor 0.75 kg/ ha and weedy check) and three fertility levels (50%, 100% and 150% of recommended NPK levels) were laid out in RBD design with three replicates. In both years of experimentations Rajmash variety 'Triloki' was sown . The soil of the experimental field was sandy loam in texture, having pH 6.7 , available N 375, available P 32 & available K 298 kg/ha .

The dominant weed flora observed in the experimental field were *Amaranthus viridis, A. spinosus, Chenopodium album, Althaea ludwigii, Gallinsoga parviflora and Digitaria sanguinalis.*

All the herbicide treatments being statistically at par among themselves produced significantly lower weed dry matter than weedy check thus resulting in significantly higher seed yield of rajmash over weedy check.

Hundred per cent and 150% of recommended fertility levels being statistically to each other produced significantly higher seed yield than 50 % of the reommended fetility level. Whereas, with reference dry matter production of weeds, 50 and 100% of the recommended fertility levels being statistically at par to each other produce significantly lower weed dry mater than 150% of the recommended fertility level. However, 100 and 150% levels of fertility were also statistically at par to each other in production of weed dry matter.

WEED CONTROL IN GROUNDNUT-RICE CROPPING SYSTEM

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The investigations were carried out in groundnut-rice cropping system to study the efficacy of herbicides in groundnut and their residual effect of succeeding rice at Agronomy farm, College of Agriculture, Dapoli during rabi season of 1997, 1998 and 1999. Weed control measures for rabi groundnut comprised of weedy check, two hand weeding (20 and 40 DAS), fluchloralin @ 1.5 kg ai/ha, oxadiazon @ 0.5 kg ai/ha and butachlor @ 0.5 kg ai/ha as pre-emergence application.

Data showed that weed control merasures increased the dry pod yield of groundnut over weedy check. Among the herbicides, fluchloralin @ 1.0 kg ai/ha and oxadiazon @ 0.5 kg ai/ha as pre-emergence application recorded significanly higher dry pod yield (14.30 and 13.61 q/ha) as compared between farmer two herbicides was of similar magnitude. Hand weeding twice proved

significanfly superior than the remaining weed control measure fluchloralin @ 1.5 kg ai/ha showed its superiority over all other herbicides and registered higher weed control efficiency (46.40%) next to two hand weeding of 52.61%.

Residual effect of herbicides applied to groundnut did not show significantly influence on weeds in rice. Economics analysis of data showed that groundnut B:C ratio 2.77 and that of butachlor @ 1.5 kg/ha(2.68) as pre sowing to rice was more economical.

INTEGRATED WEED MANAGEMENT IN CASTOR

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An investigation was carried out in red sandy loam soil to evaluate the impact of integrated weed management practices on weed growth, yield attributes and seed yield in castor, at the Main Research Station, University of Agricultural Sciences, Bangalore, during the year 1995. The study involved three herbicides viz., butachlor (1.0kg a.i./ha), each at without and with hoeing at 30 DAS or post emergence application of glyphosate (1.0 kg a.i./ha). One or two hand weedings with or without hoeing was also considered along with weed free treatment. Including the unweeded check, the total of 16 treatments were laid out in randomised complete block design with three replications.

The evaluated results indicated that, the lowest weed population (35.04/m^2 area) and weed dry matter (31.81/0.25m^2) and highest weed control efficiency (87.6%) were obtained with the application of butachlor @ 1.0 kg a.i./ha + hoeing at 30 DAS. Therefore the weed free environment with this treatment caused for the highest plant height (141.74cm), maximum dry matter production (150.46g/plant), early initial flowering (30 days) in castor and hence significant improvement was noticed in yield attributing characters. Consequently, the seed yield (2279 kg ha-1) and stals yields (3049 kgha-1) were improved to a significant extent. The next best treatment was pre-emergence application of butachlor @ 1.0 kg a.i./ha + hoeing at 30 DAS. However, the moderate weed control and castor performance was noticed with rest of the treatments.

INTEGRATED WEED MANAGEMENT IN GROUNDNUT (*ARACHIS HYPOGEA,* (L.)

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A field experiment was conducted during kharif 1987-88 at the Main Research Station under rainfed conditions to sudy the level of weed management practices required by planting groundnut (JL-24) at 20-, 30-, 40-cm row spacing (main plots). Nine weed management practices (sub plots) with or without pre-emergent application of 1.0 kg ai / ha of Alachlor [2-Chloro-N-(2-6-diethyl-phenyl)-N-C (methoxy methyl) acetamidel] were tried. Weed management practices were unweeded check, handweeding (HW) at 20 and 40 DAS, hoeing at 20 and 40 DAS, Alachlor 100%, Alachlor 50%, Alachlor 50 + HW at 40 DAS and Alachlor 50% + hoeing at 40 DAS. All the recommended package of practices were followed and the crop was harvested 102 days after planting.

Broad leaf weeds, such as, *Acanthospermum hispidium, Ageratum conyzoides, Amaranthus viridis, Commelina bengelensis, Euphorbia hirta, Galingsoga parviflora* car, *Heliotropium hispidium,*

Nicandra physalodes Gaertner, *Ocimum adscendens* willd, *Phyllanthus fraternus* webstr, *Richardia scaber.* and *Spilanthes calva*, , grass weeds, namely, *Brachiaria erussiformis* Griseb, *Cynodon dactylon, Digitaria adscendens* (H.B & K) henr. and *Eragrostic pilosa* and the sedge *Cyperus rotundus*. were noticed.

Experiment results indicated that weed growth increased wiht the increase in row spacing. Early period of 20 days was the critical period for weed competetion in groundnut. Hand weeding at 20 DAS recorded the highest pod yield (1746 kg/ha). Weed management practices, such as application of Alachlor 50% + HW at 40 DAS, Alachlor 100% and Alachlor 50% + hoeing at 40 DAS were the next effective weed management practices as the pod yields were 1660, 1639 and 1592 kg/ha, respectively.

STUDIES ON THE EFFECT OF WEED MANAGEMENT PRACTICES AND FOLIAR NUTRITION ON THE GROWTH AND YIELD OF BLACKGRAM CV. ADT 3

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Field experiment were conducted at Annamalai University Experimental Farm, Annamalai Nagar to study the effect of weed management and foliar nutrition on the growth and yield of blackgram cv. ADT 3, during February to April 1999 and January to April 2000. The experiments were laid out in split plot design. Four main treatments (weed management) viz., unweeded check, hand weeding twice (15 and 30 DAS), pre-mergence application of pendimethalin @ 1.5 kg ha^{-1} and fluchloralin @ 2.0 kg ah^{-1} and six sub-plot treatments (foliar spray) viz., no foliar spray, DAP 2% spray, Penshiobao 0.01% spray, NAA 30 ppm apray, DAP 2% and NAA 30 ppm spray and Penshibao 0.01% and NAA 30 ppm spray.

Among the main plot treatments, hand weeding twice on 15 and 30 DAS recorded the least weed count, weed DMP, higher WCE and WCI following by fluchloraliln @ 2.0 kg ha^{-1}. The growth and yield components as well as grain and haulm yield were found to be significantly highest with twice hand weeding (15 and 30 DAS) . Among the sub treatments, foliar application of Penshibao 0.01% and NAA 30 ppm favourably increased the growth, yield and yield components of blackgram as compared to the other treatmenst. Hand weeding twice on 15 and 30 DAS along with foliar application of penshibao 0.01% + NAA 30 ppm recorded the highest grain yield of 1381.00 and 1253.00 kg ha^{-1} during the year 1999 and 2000 respectively.

INTEGRATED WEED MANAGEMENT IN CASTOR (*RICINUS COMMUNIS* L.) AND THEIR RESIDUAL EFFECT ON GERMINATION OF GREENGRAM UNDER IRRIGATED CONDITION

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A field experiment was conducted on sandy loam soli during 1991-92 to 1993-94 at Agronomy Instructional Fram, C.P. College of Agriculture, Gujarat Agricultural University, Sardarkrushinagar to identify the economial weed control measures for castor (GCH 4) under irrigated condition. On the basis of pooled data over three years, the castor seed yield obtained from two interculturing + two hand weedings at 30 and 60 DAS + broadcasting of lucerne in October for forage crop was the

highest, but it was at par with the yield obtained from weed free treatment, two interculturing + two hand weedings at 30 and 60 DAS + spraying of fluchloralin @ 1.0 kg a.i/ha in October/November, two interculturing + two hand weedings at 30 and 60 DAS + one hand weeding in October/ November as well as two interculturings + two hand weedings at 30 and 60 DAS. Singificantly the lowest seed yield was obtained from the treatment of weedy check becuase of higher number of monocot and dicot weeds with higher weight of dry weeds/ha. Presowing application of fluchloralin 0.5 and 1.0 gk a.i/ha were affected adversely on the growth and yield attributing characters this has resulted in lower were yield in these treatments. Two interculturings + two hand weedings at 30 and 60 DAS + broadcasting of lucern in October for forage recorded the highest net realization. There was no residual effect of weed management treatments on the germination of succeeding crop of greengram.

BIOEFFICACY OF DINITROANILINE HERBICIDES FOR WEED CONTROL IN SESAME. (*SESAMUM INDICUM* L.)

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To evaluate the effect of different dinitroaniline herbicides on weed control in sesame, field studies were conducted for two consecutive years i.e. kharif, 1999 and 2000 at Oilseeds Research Area of Haryana Agricultural University, Hisar. The soil was sandy loam in texture, low in available N, medium in available P and high in available K. During both the years, experimental field was dominated with *Echinochloa Crusgalli* L., *Cyperus rotundus* L., *Dactyloctenium aegyptium* L. and *Trianthema portulacastrum* L. All the weed control treatments significantly reduced the population and dry weight of different grassy and broad leaf weeds over weedy check which resulted into significant increase in number of branches/plant, number of leaves/plant, crop dry weight and leaf area index over weedy check. Season long weed competition caused 55 and 66 percent reduction in seed yield during 1999 and 2000, respectively. None of herbicides was effective against *Cyperus rotundus* L. Among weed control treatments, two hoeings at 3 & 6 WAS, integration of either fluchloralin, pendimethalin or trifluralin each @ 1.0 kg a.i./ha with one hoeing at 4 WAS were significantly better in terms of weed control efficiency and seed yield as compared to one hoeing at 4 WAS or herbicide used alone. Oil and straw yield followed the same trend.

INTEGRATED WEED MANAGEMENT IN RAJMA

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An experiment was conducted on sandy loam soil during rabi season from 1995-96 to 1997-98 to study the bioefficacy of weed management treatments in control of weeds in rajma (DPR 87 -43) at Main Pulse Research Station, Gujarat Agricultural University Sardarkrushinagar. Among cultural practices, keeping the plot weed free condition found the most effective than one hand weeding either at 45 DAS or 60 DAS. In case of herbicide, application of Pendimethalin @ 0.75 kg a.i/ha as pre-emergence registered higher yield as well as net realization.

EFFECT OF TRIFLURALIN, ACETACHLOR AND LINURON ON WEED MANAGEMENT IN MUNGBEAN

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Two years field studies were conducted for the control of weeds in mungbean (*Vigna radiata* L.Wilczek). During both years the field was dominated by carpet weed (*Trianthema portulacastrum*) and barnyard grass (*Echinochloa crus-galli*). Three herbicides including trifluralin and linuron at 0.75 and 1.0 kg/ha and acetachlor at 1.0 & 1.5 kg/ha each applied alone or with one supplementary hoeing given 30 days after sowing (DAS) with their lower doses or the sequential treatment of fenoxaprop-P-ethyl along with lower doses of these herbicides. In general dry weight of weeds 40 DAS reduced significantly following the treatments of trifluralin, linuron or acetachlor along with one hoeing 30 DAS. The grain yield of mungbean during both years was more in plots treated with trifluralin 0.75 kg/ha followed by one hoeing 30 DAS or acetachlor 1.0 kg/ha followed by one hoeing 30 DAS. Linuron applied pre-emergence at both doses and also with follow up treatments of hoeing or fenoxaprop provided significantly lower yield compared to trifluralin or acetachlor or acetachlor supplemented with one hoeing 30 DAS.

STUDIES ON INTEGRATED WEED MANAGEMENT IN RABI GROUNDNUT *(ARACHIS HYPOGEA)*

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Field investigation was carried out during rabi season of 1998-99 at Reddipalli. The weed flora of the experimental field consisted of *Cynodon dactylon, Cyperus rotundus, Dactylactenium aegyptium, Digitaria sanguinalis, Parthenium hysterophorus, Amaranthus viridis, Commelina benghalensis, Blainvillea echnella, Cleom viscosa and Trichodesma indicum.* Lowest weed density and highest weed control efficiency was obtained with metolachlor @ 0.75 kg a.i./ha integrated with hand weeding at 30 DAS in comparison to other treatments. Higher net returns and returns per rupee invested was realised with this treatment. The reduction in pod yield due to weed competition ranged between 40-70%. Based on the results obtained and economics of weed management practices, it could be concluded that pre-emergence application of metolachlor @ 0.75 kg a.i/ha followed by hand weeding at 30 DAS was found the effective weed management practice in groundnut.

WEED MANAGEMENT STUDIES IN BLACKGRAM-MUSTARD CROPPING SEQUENCE

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Field Studies were carried out during rainy season (*kharif*) on black gram and in *rabi* season on mustard of 2000-2001 to evolve appropriate chemical weed management practices in black gram – mustard cropping sequence under agro- climatic conditions of northern M.P. Six herbicides

(Alachlor, Metolachlor, Pendimethalin, Fluzifop P- Butyl pre-emergence Fluchloralin and trifluralin as pre plant in two rates were compared with one hand weeding, two hand weeding, weed free any weed check in black gram

The major weed flora of experiment was *cyperus rotundus* and *echinocloa crusgalli* among grasses while broad leaves weeds were *Trianthema monogyna, Degera arvensis, commenlina benghalensis* and *Celosia argentea.* The mean weed density and their dry matter production of weeds was reduced markedly by different weed control treatments.

The maximum seed yield of black gram and minimum dry matter production of weed was obtained in weed free plot. Herbicide Alachlor @2.0 Kg/ha, Fluzifop P. Butyl @ 0.25 kg/ha and Metolachlor @0.75 kg/ha were next in order. After harvest of black gram, mustard experiment was laid out at the same layout, site and randomization of black gram. Four herbicides viz. Isoproturon, oxidiargyl, oxyfluorfen and Pendimethalin in three doses each were evaluated to Fluchloralin, one hand weeding, weed free and weedy check (Total 16 treatments).

Both monocot and dicot weed species were found in the experimental field. Among monocot, *cyperus rotundus, cynodon dactylon* and *phalaris minor* and among dicots *Chinopodium spp.* and *convolvulus arvensis* were major weeds found infesting the field.

The highest and lowest dry matter of weeds were recorded in weedy check and weed free plot respectively. All the weed control treatments gave higher seed yield and lower dry matter production of weeds as compared to weedy check.

The maximum seed yield (2516 kg/ha) weed control efficiency (88.8%) and minimum dry matter production weeds (13.7 kg/ha) was obtained in weed free plot. Herbicide oxydiargyl @ 0.120 kg/ha was next in order.

WEED MANAGEMENT IN SOYBEAN-WHEAT CROPPING SYSTEM

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Sixteen treatments (five herbicides; Alachlor, Metolachlor, Clomazone, Imazathapur, Lactofen in two rates, Fluchloralin, Chlorymuron hand weeding, one hand hoeing, weed free and weedy checks) were tested on soybean. After the harvest of soybean wheat experiment was laid out at same site and lay out as per kharif randomization. 16 treatments (2,4-D 0.5 kg/ha Isoproturon at 0.75, 1.0 and 1.25 kg/ha, 2,4-D @ 0.5 kg/ha + IPU 0.75, 1.0 and 1.25 kg/ha, Metsulfuron 4 gm/ ha, Metsulfuron 4.0 gm + IPU 0.75 kg/1.0 and 1.25 kg/ha, farmers practice, one hand weeding, one hoeing, weed free and weedy check) were tested maximum seed yield of soybean was obtained in weed free plot, herbicide lactofen @ 0.12 kg/ha and clamazon 0.75 kg/ha were next in order. In wheat crop also maximum grain yield was found in weed free plot (5958 kg/ha) the next best treatment was 2,4-D @ 0.5 kg/ha + IPU 1.25 kg/ha and both were significantly superior to rest of treatments under study. It was also tested that in general combined application of herbicides was better as compared to independent application of herbicide for effective control of weeds.

CHEMICAL CONTROL OF *ASHPHODELUS TENUIFOLIUS* IN CHICKPEA GROWN UNDER RAINFED CONDITION

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Field experiment was conducted for two consequtive winter (1997-99) in sandy loam soil of central Uttar Pradesh at Kanpur to findout effective herbicides for controlling *A. tenuifolius*- a troblesome weed in rainfed chickpea. Weedy conditions caused 81% reduction in grain yield. Oxadiazon (0.5 kg/ha) and pendimethalin (1.0 kg/ha) applied as pre-emergence were found effective in reducing the emergence of *A. tenuifolius* to the extent of 77 per cent and 73 per cent resulting in, on an average, 1096 kg/ha and 1081 kg/ha grain yield, respectively, against 272 kg/ha obtained under untreated. The highest grain yield was recorded (1428 kg/ha) in manual weeded twice (20 and 40 days after sowing. The net monetory return of Rs. 10746 ha and Rs. 10377 ha were obtained due to application of oxadiazon (0.5 kg/ha) and pendimethalin (1.0 kg/ha) application, respectively.

DIRECT AND RESIDUAL EFFECTS OF HERBICIDES FOR WEED CONTROL IN SOYBEAN (*GLYCINE MAX* L.) - MUSTARD (*BRASSICA JUNCEA* L) CROPPING SYSTEM

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Fiels experimentsconducted during 1995-96 and 1996-97 on a fixed site in medium black soil under soybean -mustard cropping system revealed that pre-emergence application of alachlor at 2.0 kg/ha and clomazon at 1.0 kg/ha in soybean effectively controlled the most dominant weed viz., Echonochloa crusgalli. However, clomazon was not effective against *Commelina communis* and *Phyllanthus fraternus*. The weed control efficiency of alachlor and clomazon was 77.6 and 63.0 percent, respectively as against 90.3 per cent under hand weeding. In mustard isoproturon at 1.0 kg/ha reduced the population of major weeds viz., Phalaris minor Retz. Medicago hispida, *Melilotus alba* and *Chenopodium album* but not *Anagalis arvensis*.

The highest seed yield of soybean was obtained with alachlor (1210 kg/ha) followed byclomazon (1172 kg/ha) in comparison to 503 kg/ha under weedy check. In mustard isoproturon 91246 kg/ha) yielded on par to hand weeding (1373 kg/ha) and both produced significantly higher seed yeild than weedy check (1054 kg/ha). The residual effect of herbicides applied to soybean exhibited significantly higher yield of mustard during 1996-97. However, the residual effeect of isoproturon applied to mustard was not evidenced on yield of soybean.

CHEMICAL WEED CONTROL IN BERSEEM (*TRIFOLIUM ALEXANDRINUM* L.) WITH SPECIAL REFERENCE TO *CICHORIUM INTYBUS*

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A field experiment was carried out during winter season of 1998-99 at Experimental Farm of J.N. Krishi Vishwa Vidyalaya, Jabalpur on medium black soils, to evaluate the efficiency of herbicides

INTERACTION EFFECT OF MULCHING, IRRIGATION AND FERTILIZER LEVELS ON WEED CHARACTERISTICS AND SEED YIELD OF INDIAN MUSTARD (*BRASSICA JUNCEA*) GROWN IN ALFISOLS OF EASTERN DRY ZONE OF KARNATAKA

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Bineet Mishra and Mirza Karim Baig

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A field experiment was conducted during *Rabi* season of 2000-2001 at Main Research Station, Hebbal, Bangalore. The experiment consisted of 16 treatment combinations involivng two irrigation levels with and without mulching and 4 fertilizer levels. The result revealed that different levels of irrigation and fertilizers with or without mulching differed significantly among themselves in controlling the weeds species. Lowest weed biomass (28.28 kg ha^{-1}) was recorded in 0.8 IW/CPE without much + 125% RDF which was on par with 0.8 IW/CPE with much + 125%RDF. Both 0.8IW/CPE without much + 50% RDF and 0.5IW/CPE without much + 100%RDF recorded significantly higher weed biomass (213.2 kg ha^{-1}). The observation on weed population indicated a 100 per cent control of *Lagasca molis* with 0.8 IW/CPE with much + 125% RDF and a significant reduced population of *Digitaria marginata* (1.33 /0.25m^2) with 0.5IW/CPE with much +125%RDF treatment combination. Seed yield of mustard was significantly higher (1328 kg ha^{-1}) in 0.8IW/CPE with much +125%RDF on account of better yield attributes and lesser weed biomass (26.72 kg ha^{-1}).

BIO-POTENTIAL OF ALLELOPATHIC PLANT MATERIALS, SMOTHER CROP ON WEED SUPPRESSION IN AMERICAN COTTON (G. HIRSUTUM L.)

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A field experiment was conducted at the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during Rabi 1997-98 to study the bio-potential of certain allelopathic crop/tree residue materials, plant leachate and smothering intercrop-pearlmillet for weed suppression in irrigated cotton eco-system. The treatments were soil incorporation of sunflower stalk residues, *Eucalyptus globulus* fresh leaves, *Prosopis juliflora* leaf litter each @ 2 t/ha before sowing, mulching of sunflower stalk residues @ 5 t/ha, spraying of *Eucalyptus* fresh leaf leachate at 10% (w/v) concentration as pre-emergence and intercropping of pearlmillet cv. Co.7 with cotton cv. MCV 5 at 1:1 etc. weed flora of the experimental field consisted of four species of grass, one sedge and ten broad leaved weed species in which *Trianthema portulacastrum* L. is a major weed. In unweed control plot broad leaved weeds accounted for 55% and 70% at 20 DAS and 40 DAS respectively.

The results revealed that the highest weed control efficiency (based on DMP of weeds) is achieved by smother intercrop pearlmillet with cotton i.e. 47.5% and 70.2% at 20 DAS and 40 DAS respectively. It was followed by a WCE of 36.8% and 28.1% at 20 DAS and 40 DAS in soil incorporation of sunflower residues and a WCE of 30.3% and 45% in mulching of sunflower residues. As a result of better weed suppression in these treatments, the growth and yield parameters of cotton was higher.

INTEGRATED WEED MANAGEMENT IN COTTON

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The field experiment was conducted during kharif season 1996 and 1997 at Research Station. Bulandshahr. Ten treatments Pendimethalin 1kg /ha Pendimethalin 1 kg/ha + Hand Weeding 30 DAS Pendimethalin 1 kg/ha + Paraquat 0.5 kg/ha Alachalor 2 kg/ha Alachalor 2 kg/ha + Hand weeding 30 DAS Alachalor 2 kg/ha + Paraquat 0.5 kg/ha Isoproturam 1 kg/ha Isoproturam 1.5 kg/ha hand weeding 30 & 60 DAS Control . The experiment were laid out in randomized block design with four replication. Results reveal that the cotton yield weed density and weed dry weight was significantly affected by different treatments during both the years. Maximum yield of Cotton 11.48 q/ha was recorded with two hand weeding 30 + 60 days after sowing and minimum yield 7.81 q/ha was recorded with control. Premergence application of Pendimethalin at 1.5 kg/ha + hand weeding 30 days after sowing Alachalor 2 kg/ha + hand weeding 30 days after sowing and Alachalor 2 kg/ha + Paraquat 0.5 kg/ha were found significantly at par and as effective as two hand weeding at 30 & 60 days after sowing which controlled large number of weeds in the field by reducing the population and dry weight of weeds by increasing cotton yield during both the years as compared to control. The major weed species were Cyprus rotundus. cynodon dactylon cyperus irriial, panicum sp. trianthema monogyma with total weed density 256 weeds/m^2 and dry weight of 202 gm/m^2 recorede at harvest.

WEED COTNROL IN COTTON (GOSSYPIUM HIRSUTUM L.)

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Krishi Vigyan Kendra, Rohtak, Haryan

Field experiment were conducted during the kharif seasons of 1998 and 1999 at CCS,Haryana Agricultural University, Hisar, Haryana. The climate is sub-tropical with hot and desiccating winds in May and June and with an average rainfall of about 400 mm which falls between the end of July and middle of September. In both the years, the experiment was located on a sandy loan soil with pH of 8.1 and an organic matter content of 0.4 per cent. Cotton cv.HS-6 was sown at spacing of 60 x 30 cm. Fertilizer, irrigation and insecticides were applied in accordance with the standard local practices. Sowing was done with the help of seed cotton drill on 12 and 11 May during the years 1998 and 1999, respectively.

Pre-emergence applications of Thiazopyr at 240 g ha-1 significantly reduced the density and dry weight of weeds, overweedy check. Whereas pre-plant incorporation of trifluralin at 1000 g ha-1 followed by Glyphosate at 0.5% or Glufosinate 500 g ha-1 or paraquat 0.3% proved next best treatments and at par with each other. Significantly less per cent control of barnyard grass and carpet weed was noticed where trifluralin at 1000 g ha-1 was applied alone. Maximum seed cotton yield was recorded in season long weed free situation. Pre-emergence application of Thiazopyr 240 g ha-1 or pre-plant incorporation of trifluralin at 1000 g ha-1 and followed by other post emergence herbicides increased the seed cotton yield significantly over weedy check. Single application of Glyphostate at 0.5% or Glufosinate at 500 g ha-1 at 40 and 60 DAS increased the seed cotton yield satisfactory both the years.

INTEGRATED WEED MANAGMENT IN GROUNDNUT + CHILLI (4:2) INTERCROPPING SYSTEM

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A field experiment was carried out during kharif 1998 and 1999 at Main Research Station. University of Agricultural Sciences. Dharwad to study the cultural and chemical method of weed control in groundnut + Chilli intercropping system. All the herbicides and cultural treatments significantly reduced the weed biomass and increased the yields of both the crop over weedy check. The lowest mean weed biomass (0.69 q/ha) and maximum weed control efficiency (90%) were noticed with application of metalachlor (1.0 kg a.i/ha) + one intercultivation at 30 DAS + one hand weeding at 40 DAS. The highest pod yield of groundnut (1916 kg/ha) was obtained in Alachlor (1.25 kg a.i/ha) + one intercultivation at 30 DAS + one hand weeding at 40 DAS while. application of oxadiazon (@ 0.5 kg a.i/ha) + one intercultivation at 30 DAS + one hand weeding at 40 DAS recorded the higher fruit yield of green chilli (3442 kg /ha). Alachlor (1.25 kg a.i /ha) intergrated with one intercultivation + one handweeding recorded maximum net returns (Rs.21, 533) and benefit cost ratio (2.44)

WEED MANAGEMENT IN SPRING PLANTED SUGARCANE UNDER *TARAI* CONDITIONS OF UTTARANCHAL

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A field experiment was conducted, to study the effect of weed management practices on sugarcane and associated weeds during 1997-1999, at Crop Research Centre of G. B. Pant University of Agriculture &Technology, Pantnagar. The experimental soil was *silty loam* in texture, rich in organic carbon, medium in available phosphorus and potassium with pH 7.8. The area enjoys shallow water table and encounters intense weed problem owing to fertile lands and easy access to moisture. *Cyperus rotundus, Cynodon dactylon* and *Sorghum halepense* were the dominating weeds associated with the crop and constituted 55.8, 12.1 and 13.2 per cent of total weed population, respectively. One hoeing at 30 days after planting followed by application of atrazine @2.0 kg/ha (just after hoeing) led to lowest weed population with WCE of 57.2 per cent at 120 days after planting. This also resulted in highest cane yield being higher by 51.4 % than weedy and by 2.9 % than 3 hoeings at 30,60and 90 days after planting. Commercial cane sugar yield was recorded to be 7.1, 10.7 and 11.0 t/ha under weedy, 3 hoeings at 30,60 and 90 days after planting, and one hoeing followed by atrazine @2.0 kg /ha. Metribuzin applied @1.5 kg/ha as pre-emergence also proved effective, as compared to weedy, in controlling weeds but could not reach to the level of one hoeing + atrazine @ 2.0 kg/ha, possibly due to rapid loss of moisture from the soil.

INTEGRATED WEED MANAGEMENT IN CULTIVATION OF FCV TOBACCO IN SOUTHERN TRANSITION ZONE OF KARNATAKA

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A field experiment was conducted for three years during kharif seasons of 1998-2000 on red sandy soils of Regional Research Station, Navile, Shimoga under rainfed situations to study the effect of two levels of metolochlor (0.5 and 0.75 kg a.i./ha) integrated with one hand weeding at 30 DAP on weeds as well as yield and quality of FCV Tobacco. The results indicated that weeding as and when essential along with intercultivation recorded significantly lowest weed dry weight (0.08 t/ha) as compared to weedy check (8.67 t/ha) but found on par with metolochlor (0.75 kg a.i./ha) + one hand weeding at 30 DAP (1.64 t/ha). Similarly green leaf (81.48 q/ha) and cured leaf (11.18 q/ha) yields and top grade equivalent (7.09 q/ha) were also higher due to hand weeding as and when required being on par with metolochlor (0.75 kg a.i./ha) + one hand weeding (75.80, 10.24 and 6.60 q/ha, respectively) as compared to control (32.15,4.47 and 2.24 q/ha, respectively).

INTEGRATED WEED MANAGEMENT IN MULBERRY (*MORUS INDICA* L.)

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The investigation was carriedout in red loamy soil of Sericulture college, Chintamani, during the year 1998-99, to evaluate the combined influence of crop residue and weed control treatments on growth, leaf yield and quality mulberry. The experiment consisted of 12 treatments with crop residues (control, ragi straw burnt at 10 t/ha, and ragi straw incorporation at 10 t/ha) as main plot treatments and weed control treatments (weed free throughout, diuron at 1.5kg/ha, metolachlor at 1.5 kg/ha and fluchloralin at 1.5kg/ha) as sub plot treatments, were laidout in split-plot design with three replications.

The evaluated results indicated that, weed control treatments in combination with the ragi straw either burnt or incorporation at 10 t/ha resulted in increased leaf yields (1425 to 4221.5 kg/ha/crop) with the reduction in weed density (16.5 to 76.5 /m^2) and dry weight (11.8 to 31.25 g/m^2) as compared to control (1165.5 to 3450.6 kg/ha/crop, 39.2 to 99.5/m^2 and 17.8 to 42.6g/m^2, respectively). Among the herbicides diuron at 1.5 kg a.i./ha performs better as compared to other herbicides. The conclusion is that, the straw incorporation or burnt at 10 t/ha increases the efficiency of weed control treatments with the additional benefits in leaf yields.

STUDIES ON HERBICIDAL CONTROL OF *PORTULACA SPP.* IN YOUNG PLANTATION OF BANANA

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A field experiment was under taken during 1997-98 to 1998-99 on sandy loam soil at AICRP on Weed Control, Anand to assess the efficacy of diuron (0.50-2.00 kg/ha) for controlling *Portulaca Spp.* (*P. quadrifida* and *P. oleracea*) and other weeds in the young plantation of banana (cv. Basarai). Two years study showed that application of diuron @ 2.00 kg/ha 150 days after planting integrated with one hand weeding at 60 days after diuron application in young plantation of banana proved effective to control the *Portulaca Spp.* to the tune of 83 per cent. Among chemical and integrated treatments, minimum weed biomass was recorded under higher dose of diuron integrated with one hand weeding at 60 days after herbicidal application. Maximum banana fruit yield (675 q/ha) was recorded under the treatment of five hand weedings done at 30, 60, 90, 120 and 150 days after earthingup. Application of diuron @ 1.50 to 2.00 kg/ha supplemented with one hand weeding at 60 days after its application is best practices for controlling *Portulaca Spp.* without any phytotoxicity to banana crop.

EFFICACY OF DINITROANILINE HERBICIDES IN TRANSPLANTED ONION (*ALLIUM CEPA* L.)

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The experiment was conducted on weed management studies in onion at Gujarat Agricultural University, Anand during *Rabi* seasons of 1997-98 to 1998-99. Dinitroaniline herbicides viz., trifluralin (0.70, 0.80, 0.90, 1.00 and 2.00 kg/ha), pendimethalin (1.00 kg/ha) and fluchloralin (1.00 kg/ha) were applied one day before transplanting of onion seedlings. The major weed species observed in the experimental field were *Eragrostis major* Host, *Cyperus rotundus* L., *Elusine indica* Gaerth, *Digitaria sanguinalis* L., *Chenopodium album* L. *Phyllanthus niruri* L., *Euphorbia hitra* and *Asphodelus tenuifolius*. Application of pendimethalin or trifluralin or fluchloralin @ 1.00 kg/ha before transplanting of onion seedlings gave effective weed control (97.3 to 98.8 % WCE) and higher onion bulb yield (376.2 to 421.3 q/ha). Hand weeding twice (30 and 60 days after transplanting) was also effective practices for controlling weeds in onion crop. Higher dose of trifluralin did not show any phytotoxicity effect on onion seedlings.

EFFICACY AND PHYTOTOXICITY OF PENDIMETHALIN, FLUCHLORALIN AND METRIBUZIN IN TRUE POTATO SEED NURSERY

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AICRP on Weed Control, B. A. College of Agriculture, Gujarat Agricultural University, Anand – 388 110

An experiment was conducted during *rabi* season of 1999 to evaluate the efficacy and application techniques of three herbicides viz., pendimethalin @ 0.30 and 0.60 kg/ha as pre-emergence, fluchloralin

@ 0.45 and 0.90 kg/ha as pre-emergence and metribuzin @ 0.18 and 0.35 kg/ha as pre-plant, pre-emergence and 10 days after sowing (DAS) in TPS nursery. The field trial was arranged in randomized block design with four replications. The experimental field was infested with *Chenopodium album* L., *Cyperus rotundus* L., *Eragrostis major* Host, *Digera arvensis* and *Portulaca oleraceae*. Higher dose of pendimethalin and fluchloralin proved phytotoxicity on crop and resulted in poor plant stand as well as poor yield of potato tubers. Significantly higher potato tuber yield was recorded under two hand weedings (15 & 30 DAS) treatment, which was at par with application of metribuzin @ 0.35 kg/ha as pre-plant, pendimethalin @ 0.30 kg/ha as pre-emergence, fluchloralin (0.45 kg/ha) as pre-emergence and metribuzin applied @ 0.18 and 0.35 kg/ha at 10 DAS. More than 85 per cent weed control efficacy was achieved in all the herbicidal treatments.

INTEGRATED WEED MANAGEMENT IN OKRA (*ABELMOSCHUS ESCULENTUS* L.)

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A field experiment was conducted during 1999-2000 at AICRP on Weed Control, Anand to find out best integrated weed management practices in okra crop. Six herbicides viz., alachlor, fluchloralin, trifluralin, pendimethalin, metolachlor and butachlor were tried at different concentrations and compared with two hand weedings (3 and 6 WAS), three hand weedings (3, 6 and 9 WAS) and weedy check. The field trial was arranged in randomized block design with four replications. Common hand weeding was done in all the herbicidal treatments at 9 weeks after sowing (WAS). Significantly lowest plant height of okra was recorded at 45 DAS in metolachlor applied @ 1.00 kg/ha as pre-emergence which indicates phytotoxicity on okra crop. Significantly higher fruit yield of okra was obtained with three hand weedings (3, 6 and 9 WAS) and it was at par with two hand weedings, pendimethalin 1.00 kg/ha as pre-emergence and fluchloralin 1.00 kg/ha as pre-emergence. Among herbicidal treatments, pendimethalin showed superiority in weed control efficiency (85 % WCE) compared to other treatments.

IMPACT OF IRRIGATION LEVELS AND METRIBUZIN ON WEED GROWTH AND TUBER YIELD IN POTATO (SOLANUM TUBEROSUM L.) UNDER VERTISOLS

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Field experiment were conducted during winter seasons of 1998-99 and 1999-2000 to study the influence of irrigation levels and metribuzin on intensity and dry matter producation of weeds and tuber yield of potato Treatments comprised of four levels of irrigation (rainfed, one irrigation at 30 DAP, two irrigation at 30 and 45 DAP and three irrigation at 30, 45 and 60 DAP) in the main plots and three levels of metribuzin (0.30, 0.50 and 0.75 kg/ha) along with two hand weedings at 20 and 40 DAS and weedy check as sub-plots in split plot desgin with three replications. The experimental field was infested mainly with *Chenopodium album, Medicago hispida, Rumex dentatus, Lathyrus aphaca and Cichorium intybus* among broadleaf weeds and *Phalaris minor* and *Avena sterilis* var. Ludoviciana among grassy weeds. Presence of weeds throughout growing season caused 41 per cent reduction in tuber yield of potato. Weed dry matter accmulation increased with increasing levels of irrigation. The lowest weed growth and maximum tuber yield of

potato were recorded with weeding twice at 20 & 40 DAP. The higher tuber yield of potato was recorded under three levels of irrigation. The response of metribuzin increased with metribuzin 0.5 kg/ha under three levels of irrigation given at 30, 45 & 60 DAP. Even metribuzin 0.3 kg/ha. under three levles of irrigation gave the higher yield compared to metribuzin 0.75 kg/ha with one irrigation.

EFFICACY OF PRE AND POST EMERGENCE APPLICATION OF HERBICIDES ON WEED GROWTH IN POTATO (SOLANUM TUBEROSUM L.).

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Field experiment were carried out during winter season of 1998-99 and 1999-2000 to find out the performance of some pre and early post emergence herbicides for the control of weeds in potato. The treatments comprised of metribuzin at 0.50 kg/ha, oxyfluorfen at 0.2 kg/ha, atrazine at 1.0 kg and prometryn at 0.75 kg/ha as a pre-emergence and metribuzin 0.50 kg/ha, glyphosate at 0.5%, paraquat at 1.0 kg/ha and 2,4-D 0.5 kg/ha as early post emergence. All the post emergence herbicides were applied at 8 days after planting (DAP) at 10-15 % emergence of potato. The experiment was laid out in randomised block desgin with 3 replications. The experimental field was infested mainly with *Cichorium intybus, Chenopodium sp., Medicago hispida, Vicia, Rumex sp. and Lathyrus aphaca* among grassy weeds. Uncontrolled weeds caused 48.15 & 53.73 per cent loss in tuber yield of potato during both the years, respectively. Pre-emergence application of metribuzin 0.50 kg/ha and atrazine 1.0 kg/ha were found most effective in controlling all weed speices except *Lathyrus aphaca*. Among early post-emergence herbicides, application of metribuzin 0.50 kg/ha and 2,4-D 0.5 kg/ha at 8 DAP were effective for controlling the weeds. Significantly maximum tuber yield (26.75 and 22.37 t/ha) of potato was recorded with metribuzin 0.5 kg/ha PE fb metribuzin 0.5 kg/ha as early as post emergence (23.47 and 18.71 t/ha), oxyfluorfen 0.2 kg/ha (19.87 & 17.76 t/ha) and atrazine 1.0 kg/ha (19.69 & 18.16 t/ha).

EFFECT OF METHODS OF PLANTING AND METRIBUZIN ON WEED GROWTH AND YIELD IN POTATO (SOLANUM TUBEROSUM L.) UNDER VETISOLS.

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Field experiment were conducted during season of 1999-2000 and 2000-2001 to find out the effect of methods of planting and time of metribuzin application on weed growth and yield of potato. the experiment was laid out in split plot design with the combination of 4 methods of planting (flat sowing, flat sowing fb earthing at 40 DAP, sowing in furrows + earthing and sowing in ridges) in the main plots and 2 times of metribuzin application (pre-emergence adn early post emergence) along with weedy check in sub plots with 3 replications. The experimental field was infested mainly with *Chenopodium album, Lathyrus aphaca, Vicia sativa, Nedicago hispida, Cichorium intybus, Avena sterilis* var. ludoviciana and *phalaris minor*. Presence of weeds throguh out the growth period caused 63.56 and 28.4% reduction in tuber yield. Different methods of planting did not influence the tuber yield of potato but flat sowing + earthing at 40 DAP significantly reduced the weed biomass as compared to other methods. Metribuzin 0.50 kg/ha as pre-

emergence produced the lowest weed bio-mass and highest tuber yield (25.8 and 24.5 t/ha).

HERBICIDAL EFFECT ON GROWTH, YIELD AND YIELD ATTRIBUTES OF GARLIC (*ALLIUM SATIVUM* L.)

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An investigation on weed management studies in Garlic, consisted of thirteen treatments, namely, Fluchloralin, Pendimethalin @ 1.00 and 1.50 kg a.i./ha), lower does of each combined with hand weeding (HW) at 40 days after sowing (DAS), HW 40 DAS,HW 40 & 70 DAS, weed free and weedy check; was conducted at Regional Research Station, Dhaulakuan of Chaudhary Sarwan Kumar Krishi Vishvavidyalaya, Palampur (H.P). The results revealed that Oxadiazone applied @ 1.50 kg a.i. per hectare showed its supremacy for most of the growth, yield and yield attributes of garlic and was followed by Oxadiazone @ 1.00 kg a.i./ha + HW 40 DAS as well as Pendimethalin @ 1.50 kg a.i. /ha.

COMPARATIVE EFFICACY OF HERBICIDES TO CONTROL WEEDS IN POTATO (*SOLANUM TUBEROSUM L.*)

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A field experiment was conducted to test the efficacy of different herbicides for controlling weeds in potota variety Kufri Badshan on sandy loam soil at G.B. Pant University of Agriculture and Technology, Pantnagar during winter season of 2000 - 2001. Treatments consisting pre-emergence application of clomazon at 250 and 500 g; pendimethalin at 500 and 1000 g; prometryn at 500 and 750 g; mixture of clomazon at 125 and 250 g each with pendimethalin at 500 g and post-emergence application of chlorimuronethyl at 4 and 6 g/ha along with weedy and weed free checks were replicated thrice in a randomized block design.

The experiment field was infested with *Anagallis arvensis, Chenopodium album, Medicago denticulata, Rumex acetosella, Melilotus indica, Coronopus dedymus, Vicia sativa, Cyperus rotundus* and *Sonchus arvensis, A. arvensis* and *C. album*, constituting 33 and 23 per cent of the total weed population at 60 days after planting, dominated over all the other weeds. Post-emergence application of chlorimuronethyl and spraying the mixture of clomazon and pendimethalin (250 + 500 g/ha) just after planting reduced weed density and their dry matter accumulation significantly over all the other treatments. Maximum tuber production was recorded under weed free treatment. Among different herbicides, post-emergence spray of chlorimuronethyl at 4 or 6 g/ha and pre-emergence application of the mixture of clomazon and pendimethalin at 250 + 500 g/ha were most effective and yielded at par with that of weed free treatment. Presence of weeds throughout the growing season caused 46.2 per cent reduction in tuber yield. All the herbicides provided significantly higher tuber yield as compared to weedy check. Increasing dose of clomazon either alone or combined with pendimethalin at 500 g/ha did not influence tuber yield significantly,

however, the higher rate of clomazon mixed with same rate of pendimethalin recorded significantly higher tuber production as compared to clomazon at 250 g/ha. Prometryn or pendimethalin each at lower rates of application gave almost similar tuber yield, whereas pendimethalin at higher rate of application was more effective as compared to prometryn applied at higher dose.

MANAGEMENT OF COMPLEX WEED FLORA IN SEED POTATO WITH HERBICIDAL MIXTURE UNDER DRY-TEMPERATE HIGH- HILLS OF HIMACHAL PRADESH

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Field experiments were conducted during summer 1999 & 2000 at Regional Research Station, Kukumseri(2672 m above m s l) of CSKKV., Palampur. The soil of the experimental field was sandy loam in texture, rich in organic matter (2.5) with pH 6.2. The soil had 592,19.8 & 192 kg available N, P_2O_5 & K_2O/ ha, respectively. Fourteen treatments of herbicide mixture of atrazine with its two doses(0.75 & 0.5 kg/ha) in combination with two doses of isoproturon (1.0& .75 kg / ha) & pendimethalin (0.9 & 0.6 kg /ha) alongwith checks were tested in RBD with 3 replications. In both the years experimentation, potato variety "Chandermukhi" was sown.

The weed flora of the experimental field consisted of *Amaranthus viridis, Amaranthus spinosus, Chenopodium album, C. sachraderanum, C. bunus-henricus, Althaea ludwigii, Gallinsoga parviflora, Euphorbia sp, & Digitaria sanguinalis.* The *Amaranthus sp., Chenopodium album* and *Digitaria sanguinalis* were predominant weeds during both the years of investigation. All the herbicide treatment combinations of atrazine 0.75 &0.5 kg/ha with isoproturon 1.0 & 0.75 kg/ha and pendimethalin 0.9 & 0.6 kg/ha alongwith check treatments of atrazine 1.0, isoprotorun 1.25 and pendimethalin 1.2 kg/ha , hand weeding twice and farmers practice except herbicide mixture treatment of atrazine 0.5 kg + isoproturon 0.75 kg/ha, atrazine 0.5kg + pendimethalin 0.6kg /ha being statistically similar each other produce significantly higher tuber yield than weedy check.

However, with reference to dry matter of weeds, only three herbicide treatment combinations of atrazine 0.75 kg/ha with isoproturon 1.0kg and pendimethalin 0.9 & 0.6 kg/ha alongwith check treatments of atrazine 1.0 kg/ha, pendimethalin 1.2 kg/ha, handweeding twice and farmers practice being statistically at par to each other resulted in significantly lower dry weight than other herbicide mixture and check treatments.

SCREENING OF HERBICIDES IN ROSE EFFICACY AND SELECTIVITY.

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Field experiment to know the bioefficacy of Herbicides in control of weeds in rose. Herbicides torted were pendimethalin @ 1.0 kg a.i./ha oxyflourfen @ 0.1 k.g. a.i./ha. atrazine @ 1.0 kg a.i./ ha. All pre-emergent herbicides applied three days after pruning (DAP) and glyphosate @ @ 1.0 k.g.a.i./ha. a post emergent herbicides applied @ 20 days in relation to hand weeding and

unweeded control. Among four herbicides glyphosate @ 1.0 k.g. a.i./ha. gave excellent control of weeds and in trun influenced greatly on flower yield and it was on per with oxyflourfen @ 0.1 kg a.i./ha. while atrazine and pendimethalin gave moderate weed control. However hand weeding superior to herbicides unweeded control lowered the flower yield by sixty percent.

WEED MANAGEMENT IN TRANSPLANTED ONION UNDER PROTECTIVE IRRIGATIED SITUATION

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A field experiment was conducted during Kharif seasons form 1996 to 1998 to study the efficacy of pre-emergence herbicides in controlling weeds and on the crop growth and bulk yeild of onion. Results indicated that application of oxyfluorfen 250 ml/ha followed by hand weeded once 30 days after planting and oxyfluorfen 500 ml/ha without hand weeded reduced weed population (26 and 15 per 0.25 mt^2 area respectively] and weed dry weight efficiently (18.80 gm and 6.85 gm 0.25 mt^2 area respectively) recorded at 30 days after planting and weed dry weight at harvest, (1095 kg and 3117 kg/ha respectively) resulted better bulk yield (13703 kg to 14395 kg/ha) compared to unweeded check (4830 kg/ha) nearly 209.2% increased bulk yield. Maximum weed control efficiency (53.53% to 86.67%) was recorded with lower quantity of chemical used resulted in getting more profit per rupee invested (Rs. 28.55 to Rs. 36.55) compared to weed free treatment (Rs. 13.48) and other herbicides (Rs. 16.94 to Rs. 31.22). The effect of oxyfluorfen was comparable with that of metolachlor (1.5 and 2.0 lt/ha.). Pendimethalin (2.25 and 3.0 litre/ha) and also weed free check (stand weeded twice at 30 to 60 days after planting) with respect to bulk yield (12907 kg to 15451 kg/ha.).

INTEGRATED WEED MANAGEMENT IN SELECTED VEGETABLE CROPS

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Integrated weed management (IWM) is an important component of a total integrated production management program of vegetable culture. IWM of vegetable crops combines a variety of approaches to suppress weeds and reduce herbicide use. IWM is important for vegetable crops because of their high value, intensive culture, and lack of competitiveness. Combining different weed management approaches reduces the dependence on chemical control and increases the likelihood that control will be successful. Among different components of IWM suppressing weeds through cultural practices is an important approach. Cultural weed control is the management of the crop to make it more competitive against weeds. Cultural control involves optimizing planting date, seeding rate, row spacing, fertility, irrigation, and the use of adapted varieties so that the crop will be vigorously growing and more competitive with weeds. Generally, the plant that emerges first, establishes rapidly, and closes canopy first, is the most competitive. This plant captures the majority of the environmental resources (i.e. light, water, nutrients) necessary for growth. The aim

should be to make vegetable crop varieties that are adapted or developed for your specific location. These varieties will have growth that is more rapid and will tolerate pests better than non-adapted varieties. The trails conducted at IIHR farm, Bangalore have clearly proven this as evidenced by better performance of improved cultivars like Arka Meghali (tomato), Arka Anamika (okra) and Arka Kalyan (onion) during *Kharif* season. Plant stress such as a water deficit or infestation with a disease or virus will reduce a crop's growth and competitiveness. So adoption of improved production technology like micro-irrigation, fertigation, foliar feeding of specialty fertilizers and use of mulches can effectively reduce weed infestation or weed competition with the commercial crop. The trials conducted on use of mulches, organic or black poly (10 micron) for rainfed chilli, okra and tomato and agrimulch in drip irrigated melons, bell pepper and hybrid tomato reduced weed population substantially leading to better use of water and applied nutrients resulting in higher qualitative and quantitative yield.

Planting schemes can also be adapted to make a crop more competitive. Plant at a uniform depth for even emergence and as straight as possible to allow for close cultivation. Using higher plant densities (tomato and capsicums around 50,000 plants/ha) or narrower row spacings can ensure rapid canopy closure in some vegetable crops. Appropriate planting times are also important. Plant crops when soil temperatures favour their rapid germination and emergence. Planting warm season crops in cold soils will slow initial growth and reduce competitiveness and this has been observed in okra planted during *rabi* season under Bangalore conditions. Transplanted crops usually have a competitive advantage over weeds germinating from seed. This method can be particularly important when other weed control practics such as herbicides, are limited.

POST-EMERGENCE HERBICIDAL MANAGEMENT OF PROBLEM WEEDS IN BANANA GARDENS

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Cyperus rotundus is one of the most noxious perennial weeds infesting the cultivated fields impairing the regular operations. As the propagation is by vegetative underground stolons and rhizomes it is very difficult to control with manual or by contact selective herbicides. *Portulaca quadrifida*, is noxious weed persisting in large numbers in garden lands with black clay loam soils. It is well adopted to soils with adequate moisture and in shady conditions. It multiplies with seeds as well as vegetative fragments with inter-nodes. It is a common weed in garden land crops like banana, grapes, tapioca, cotton and chillies and other vegetable crops. An On-farm trial was conducted to study the efficiency of post-emergence herbicides for the control of *Cyperus rotundus* and *Portulaca quadrifida* in established banana gardens by directed spray.

Observations on weed count at 25 days after spraying revealed that there was considerable reduction in all the weeds with herbicide application. There was 95.6% control of *Cyperus rotundus* with glyphosate 1.0 kg/ha+2,4-D Na salt 0.50 kg/ha. Similarly, the *Cyperus rotundus* population was reduced by 88.1 percent with paraquat 0.3 kg/ha+2,4-D Na salt 0.5 kg/ha. The contact herbicide paraquat 0.60 kg/ha applied alone could control only 68.7% of *Cyperus rotundus*, as against 81.5% control with the translocated herbicide glyphosate 2.0 kg/ha. Considerable reduction in other weed population was observed with glyphosate 2.0kg/ha or glyphosate 1.0 kg or paraquat 0.3 kg/ha each with 2,4-D 0.5 kg/ha.

There was general reduction of *Portulaca quadrifida* in all the herbicide sprayed plots. Maximum coverage reduction of *Portulaca quadrifida* was observed with the herbicide mixture of glyphosate 1.0 kg/ha +2,4-D Na salt 0.5 kg/ha. The *Portulaca quadrifida* coverage was reduced by 56.9 to 57.8 percent with paraquat 0.6 kg/ha or glyphosate 2.0kg/ha as well as paraquat 0.03 kg/ha +2,4-D, Na salt 0.5 kg a.i./ha. However, the reduction in *Portulaca quadrifida* coverage was lower either by 2,4-D Na salt kg/ha or by atrazine 1.0 kg/ha post emergence spraying. There was considerable reduction in the population other broad leaved weeds and grasses and sedges population in paraquat or glyphosate alone or in combination with 2,4-D Na salt sprayed plots. Hence, post-emergence directed spraying of tank-mix of glyphosate 1.0 kg/ha +2,4-D Na salt 0.50 kg/ha is recommended to control *Cyperus rotundus* and *Portulaca quadrifida* in established banana fields.

WEED MANAGEMENT IN BER (*ZIZYPHUS MAURITIANA*) NURSERY

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An experiment in ber (*Zizyphus mauritiana*) nursery was conducted during *kharif* seasons of 1999 and 2000 to study the weed management strategies at CCS Haryana Agricultural University, Hisar. The experiment included thirteen treatments comprising three treatments of mulching i.e. white and black polyethylene mulch and straw mulch, protected as well as directed spray of glyphosate (Round up/Glycel, 41% SL) @ 0.5, 1.0, 1.5 and 2.0% (Product basis) were compared with the treatments of four hand weedings (at an interval of 30 days) and untreated check. The treatments of mulching were accomplished between and within paired rows of ber plants only after removing pre-germinated weeds at 45 days after planting. The edges of each mulch were carefully covered with sand to stop the free passage of air from beneath the mulch material. The major weed flora infesting the field comprised of mainly *Cyperus rotundus* (70%), *Cynodon dactylon* (20%) and other annual broad leaf and grassy weeds (10%). Protected (covering ber plants with polyethylene while spraying) as well as directed (knocking directly the weeds near ground) spray of glyphosate were done with knapsack sprayer boom fitted with single flat fan nozzle using 650 L water/ha. The ber cuttings were transplanted in the first week of May and various weed management treatments were given at 45 days after transplanting. The experiment was laid out in randomized block design replicated thrice. The data recorded on visual phytotoxicity on ber plants at 15 and 30 DAT and on weeds at 60, 90 and 240 DAT revealed that there was no phytotoxicity on ber plants due to any herbicidal treatments and the treatments of each mulching and glyphosate at 1.5 and 2.0% caused around 80-95% mortality of all the weeds up to 90 DAT. White and black polythelene mulching being at par with each other were partially superior to straw mulching. Glyphosate sprayed as protected or directed caused similar level of toxicity against all the weeds. The treatment of four hand weeding (at 30 days interval) also proved effective but regeneration of weeds particularly *Cyperus rotundus* was faster between two hand weedings in hand weeded plots compare to the plots receiving herbicidal or mulch treatments. It was observed that glyphosate at 1.5% followed by either of the mulching treatment could be more cost effective and less tedious compared to hand weeding. The treatment of mulching were maintained only up to 60 DAT. The effect of mulching and glyphosate against weeds were prolonged even up to 240 DAT compared to unweeded check. However, there was fresh germination or regeneration ranging from 40-50% in

these plots which might required repeat spray of glyphosate or additional one or two hand weedings. There was profuse growth of weeds in hand weeded plots after 3rd week of October to 240 DAT which warrants for 8-10 hand weedings to maintain the nursery weed free for a period of around one year which is generally practices to attain required plant growth.

TUBER YIELD AND YIELD ATTRIBUTE OF POTATO AS INFLUENCED BY HERBICIDAL WEED CONTROL

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A field experiment to study the effect of post emergence herbicides on yield attributes and tuber yield of potato was conducted at Research Farm of CCS Haryana Agricultural University, Hisar during *rabi* season of 1996 – 97. The soil of the experimental field was sandy loam in texture, slightly alkaline in reaction (pH 8.01), low in available nitrogen (201 kg ha^{-1}), medium in available phosphorus (16.09 kg ha^{-1}) and high in available potassium (401 kg ha^{-1}). Medium sized potato tuber, variety Kufri chandramukhi was planted manually on ridges at a spacing of 60x15 cm using seed rate of 12.5 q ha^{-1}. Fifteen treatments including linuron 0.75 and 1.0 kg ha^{-1}, Linuron + atrazine (5:1) 0.75 and 1.0 kg ha^{-1}, glyphosate 0.3 and 0.5 %, atrazine 0.15 and 0.20 kg ha^{-1}+, linuron + metribuzin (2:1) 0.75 and 1.0 kg ha^{-1}, metribuzine 0.44 and 0.55 kg ha^{-1}, two hand weeding (20 and 45 DAP), weedy check and weed free were laid out in randomizing block design keeping three replications. All herbicides were sprayed 15 days after planting of potato. The field was infested mainly with *Chenopodium album, Avena ludoviciana, Melilotus alba* and *Rumex maritimus*.

Maximum number of tubers $plant^{-1}$ were recorded in glufosinate and minimum number, with lowest tuber weight $plant^{-1}$ was recorded in plots where weeds were allowed to grow through out the growing season and it was significantly lower than all other treatments. Highest weight of tubers $plant^{-1}$ was recorded in plots kept weed free and it was at par with linuron + metribuzin 1.0 kg and metribuzin 0.55 kg ha^{-1}. With regard to the size of tuber, in general the highest tuber yield was recorded in grade A (>5.0 cm), followed by grade B (4-5 cm), C (3-4 cm) and D (<3.0 cm). Grade maximum tuber yield was recorded in weed free and it was at par with linuron + metribuzin 1.0 kg and metribuzin 0.55 kg ha^{-1}. Not even a single A grade tuber was found in weedy plot. Among weed control treatments lowest grade A tubers were observed in glufosinate. Similar trend was noticed in case of B and C grade tubers as that of A grade. Maximum unmarketable (D grade) yield was observed in glufosinate and minimum in metribuzin 0.55 kg ha^{-1}. Highest tuber yield was recorded in weed free and lowest yield in weedy check. Among herbicidal treatments, maximum tuber yield was obtained in linuron + metribuzin 1.0 kg and metribuzin 0.55 kg ha^{-1} which were statistically at par with weed free.

WEED CONTROL IN ISABGOL *(PLANTAGO OVATA FORSK)*

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A field experiment for controlling weeds in isabgol was carried out on sandy loam soil at the Student Farm of Department of Agronomy, CCS Haryana Agricultural University, Hisar during *rabi* season of 2000-2001. The experiment consisted of sixteen treatments *viz.*, imazythapyr at 50, 75

and 100 ml ha^{-1} pre-emergence (2 DAS) alone and alongwith one hand weeding (30 DAS), imazythapyr at 50, 75, 100 and 150 ml ha^{-1} alongwith 0.1% surfactant at post-emergence stage (28 DAS), trifluralin at 500 and 1000 ml ha^{-1} as pre-sowing soil incorportation alone and alongwith one hand weeding (30 DAS), weed free and weedy check. The trail was laid out in randomized block design with three replications. Uniform herbicidal applications were made with a knap-sack-sprayer by using 600 1 of water ha^{-1}. HI-5 variety of isabgol was sown on 14-12-2000 by using a seed rate of 7.5 kg ha^{-1} at a row spacing of 30 cm. Weed flora recorded in the field were: *Chenopodium album, Melilotus spp., Anagallis arvensis, Circium arvense, Cynodon dactylon, Cyperus rotundus, Convolvulus arvensis* and some other seasonal weeds.

Trifluralin both at 500 and 1000 ml ha^{-1} completely inhibited germination of isabgol seeds. It initially controlled the weeds upto 35 DAS but at later stages, weeds reinfested and dry matter of weeds was 43.7% less than the weedy check at harvest. Weed population (40 m^{-2}) and dry weight (90 g m^{-2}) was the highest in the weedy check treatment and the lowest (21 m^{-2}) and (45 g m^{-2}) in the treatment imazythapyr at 100 ml ha^{-1} as pre-emergence alongwith one hand weeding which significantly increased the seed yield (88.8%) of isabgol (204 kg ha^{-1}) over weedy check (108 kg ha^{-1}). Weed free treatment maintained its superiority for seed yield of isabgol (540 kg ha^{-1}) over rest of the treatments.

WEED MANAGEMENT STUDIES IN TUBEROSE (*POLIANTHES TUBDROSA* LINN) CV. SINGLE

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Experiment on weed management and vase life studies in tuberose (*Polianthes tuberosa* Linn.) Cv. Single was conducted during 1999-2000 in the Floriculture Unit, Division of Horticulture, University of Agricultural Sciences, Dharwad. The treatments included were six herbicides and organic mulch for weed management studies and for vase life studies four chemicals were included. The experiment was laid all in randomized complete block design.

Oxyfluorfen 0.15 kg a.i. ha^{-1}, alachor 2.50 a.i. ha^{-1} caused slight toxicity at early stages of tuberose crop. Unweeded control had significantly higher weed count and higher dry matter of weeds at all the crop growth stages. In general the weed population and weed dry weight were reduced with the application of herbicides. Atrazine 1.00 kg a.i. ha^{-1} was very effective against dicot weeds. Oxyfluorfen 0.15 kg a.i. ha^{-1} and pendimenthalin 1.00 kg a.i. ha^{-1} were very effective against controlling of weeds and recorded plant growth parameters like number of leaves, plant height and higher cut flower yield. The quality of flower spikes was not effected by different herbicide treatments. Water uptake, water loss and vase life was not affected by these treatments. Different chemicals solutions tested on vase life studies, the highest vase life was obtained from sugar 4 per cent + citric acid 100 ppm + aluminium sulphate 50 ppm treatment.

Economics of weed control, among herbicide treatments application of pendimethalin at 1.00 a.i. ha^{-1} and oxyfluorfen 0.15 kg a.i. ha^{-1} resulted in higher marginal and net returns, lowest net returns and marginal returns were obtained in metolachlor 1.00 kg a.i. ha^{-1}. Highest profit per rupee spent as we control was obtained in atrazine 1.00 kg a.i. ha^{-1}, whereas less profit per rupee invested was obtained in hand weeding treatment.

ECONOMICS OF INTEGRATED WEED CONTROL METHOD IN OKRA (ALBELMOSCHUS EXCULENTUS (L.) MOENCH)

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A field experiment was conducted during 1994 at farmers field Chintamani taluk, Kolar district to test the effect of herbicides on Okra yield and economics. The experimental results revealed that pre emergence application of alachlor at 1.5 kg a.i. ha^{-1} super imposed with one hand weeding at 45 days after sowing (DAS) and alachlor at 1.5 kg a.i. ha^{-1} alone gave highest pod yield (9277-9078 kg ha^{-1}) respectively and there by recorded maximum net return (Rs. 8695-8029 ha^{-1}), marginal return (Rs. 14130-13712 ha^{-1}) and cost benefit ratio (1:12-1:10) respectively, followed by alachlor and fluchloralin both at 1.5 and 0.75 kg a.i ha^{-1} supplemented with one hand weeding at 45 DAS, among the herbicidal weed control treatments.

WEED MANAGEMENT - A MUCH NEEDED APPROACH FOR HORTICULTURAL CROPS UNDER SURGUJA CONDITION

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Surguja comes under North Eastern Hill Region of Chhatisgarh state which is mainly inhabitated by tribal population (60 per cent). Owing to its diversification in soil and climatic condition, there is an ample scope of production of Horticultural crops in the region. This region received 1400 to 1600 mm annual rainfall. The weeds are problematic here during Rabi and especially Kharif season where rainy season occurs during June to september. The tribal farmers are usually confined to badi situation where they cultivate fruits and vegetables in smaller areas for home consumption. Potato, onion, tomato, brinjal, chillies, cauliflower, cabbage and pea are the important vegetable crops being cultivated during Rabi season. The Kharif season includes french bean, okara, gingar, turmeric, clocassia, elephant foot, cabbage, tomato, brinjal, chillies, other beans and wine crops. The productivity of potato and onion (150 qtl/ha), ginger (90 qtl/ha) and other horticultural crops is quite low due to pool fertility of soils which is further adversely affected by the recurring complex weed flora in the standing crops particularly during Kharif season. The survey conducted at Silphili, Khajuri, Dwarikanagar. Latori and Bhagwanpur villages revealed that majority of farmers (more than 98 per cent) are reuctant about the importance of weed management and use of different weed control methods. It was observed that farmers practise manual weedings at inappropriate stages of crop which is of no relevance in yield and economy. During the surveys, it was realised that despite technological development in the fields of weed science, the rationale behind tribal dominated agricultural system is to derive the crop yields only through basic weed management strategy owing to various social economical and other constraints prevailing in the region. This may include preentive measures, eradication, use of well decomposed FYM, crop rotation proper sowing and transplanting time, tillage operations, field preparations etc. However, adoption of chemical weed control by tribal farmers may have certain importance such as illiteracy, lack of technical skill and guidance lack of knowledge of weedicides and time and method of ther application, non availability of chemical in time, scarcity of irrigation water at the time of weedicide application and continuous rains not allowing the weedicide application at the time when it is needed.

HERBICIDAL PROPERTY OF P-HYDROXYBENZOIC ACID ON AQUATIC WEEDS

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Floating species Eichhornia arassipes Mart Solmns., Salvinia molesta Mitchell., Pistia L., Azolla nilotica Decne., Lemna pausicostata Hegelm., Spirodela polyrhiza L. Schleid. and submerged ones Hydrilla verticillata L.f. Royle, Ceratophylum demersum L. and Najas graminea Del., occurring commonly singly or in all possible combinations, are problem weeds of most fresh water bodies and paddy fields across the country except in cold waters. Management of weeds throguh application of allelochemicals and by an alleopathic species are attractive environment friendly possibilities. p-Hydroxybenzoic acid, a phenolic constituent allelochemical of many plant species, but non-toxic to human and animals, was evaluated for herbicidal activity on the commonly occurring nine aquatic weeds. Aquatic weeds were placed in p-hydroxybenzoic acid solution concentrations in nutrient medium in one-liter glass beakers with their side walls covered with black paper. The treatments were set in triplicate in each case and the beakers were incubated outdoors. Evapotranspiratory loss of water was replenished daily. Biomass of - and toxicity to the - test plants were monitored, and mode of action of the allelochemical was investigated using standard and established methodologies. The allelochemical was inhibitory to Salvinia, Azolla, Ceratophylum, Najas and Hydrilla at 5-25 ppm, and to Spirodela, Lemna, Eichhornia and Pistia at 50 ppm. It was lethal to Salvinia, Spirodela, Lemna, Ceratophylum and Hydrilla at 50 ppm; and to Eichhornia and Pistia at 75-100 ppm. At lethal dose, p-hydroxybenzoic acid caused desiccation, loss of chlorophyll and carotenoids, and there was concurrent root dysfunction resulting in death and decay of the floating weeds in 5-10 days. Submerged weeds showed massive fragmentation, loss of chlorophyll and carotenoids, massive damage to cellular membranes followed by death and decay in 5-10 days. Though effective at relatively higher concentration than common herbicides, p-hydroxybenzoic acid appears as a potential herbicide.

INTERNATIONAL PARTHENIUM RESEARCH NEWS CROUP(IPRNG) : WORLD'S FIRST NEWS GROUPS ON OBNOXIOUS WEED *PARTHENIUM HYSTEROPHORUS* L.

P. Oudhia

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Parthenium hyterophorus L., commonly known as Gajarghas, Congress weed, White top, Ramphool etc, is one of ten worst weeds of the world. It is harmful to human beings, crops and animals. It is a curse for the bio-diversity. Many scientists and organisations in national and international level are working on Parthenium management. To provide an international forum for people worldwide, who are associated with Parthenium as scientists, researchers, farmers, as well as those with health problems caused due to this obnoxious weed, international parthenium Research News Group (IPRNG) was formed on 9th May 2000. Its internet address is http:/www. IPRNG. org This is the first website with complete information on various aspects of Parthenium. This website is divided in many sections viz. Articles and works (Articles on different aspects), Bare facts, Picture gallery (having coloured pictures about parthenium, its bio-agents, Parthenium

scientists etc.), Directory of Parthenium scientists (including their postal, phone, fax adn e-mail addresses), Parthenium references (Lastest reference titles on Parthenium, daily updated), Contributions (discussion board for scientists, researchers adn farmers) etc. Anyone from any part of the world can download the informations given in the website without paying any cost. Its membership is a lso free.

CHEMICAL CONTROL OF *SORGHUM HALEPENSE*

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A field experiment was carried out at crop Research Centre of G.B. Pant University of Agricultural & Technology, Pantnagar, Udham Singh Nagar during kharif, 1997. Treatment consisted of glyphosate at 1.50 and 2.25 kg ai/ha applied at two stages (June, 15 and July 15, 1997) with surfactant and without surfactant and untreated (Control) were studied in randomized block design with three replications. Rhizomes of S.halepanse were planted during 1993 and treatments were executed during 1994 to 1997. Surfactant triton was used at 0.2 per cent.

Number of shoots and rhizomes/m^2 and fresh weight of rhizomes were reduced at 30 and 60 days after treatment, due to application of glyphosate, on june 15 but there was no Significant variation in these parameters when applied on July, 15. Application of glyphosate at higher rate, using surfactant also caused reducation in number of shoots, rhizomes and fresh weight of rhizomes.

MANAGEMENT OF *PARTHENIUM HYSTEROPHORUS* L. IN PASTURE LANDS UNDER MID-HILL CONDITIONS OF HIMACHAL PRADESH

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Parthenium hysterophorus L. Wild carrot grass an obnoxius weed belonging to the family Asteraceae has invaded the pasture lands, grasslands, forest lands and waste lands under low and mid-hill condition of Himachal Pradesh. Invasion by this weed has reduced the productivity of pastures, grassland and is posing a serious threat to the health of animals and human beings. To manage this weed a field experiment was conducted during kharif 1999 and 2000 in a randomized block design in a pasture land at Bairghatta with 12 treatment combinations each replicated thrice. Twolve treatments comprised of atrazine and 2,4-D(Na) each at 1.5 and 2.0 kg/ha, 2,4-DEE and glyphosate each at 1.0 and 1.5 kg/ha, paraquat 0.6 kg/ha, sowing of *Cassia tora* and Marigold seeds and unweeded check. Results of the study revealed that Parthenium infestation in unweeded check, reduced the population and dry matter of grasses by 90 per cent and 80 per cent over the best treatment. Application of 2,4-D(Na), atrazine, glyphosate at both the doses, 2,4-DEE at 1.5 kg/ha being statistically at par were effective to control this weed and increase the population and dry matter of grasses. The poor establishment of *Cassia tora* during both the years and marigold during second year did not control this weed effectively.

EVALUATION OF GLYPHOSATE + 2, 4 -D COMBINATION PRODUCT ON WEED CONTROL IN NON-CROP AREAS

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A field experiment was conducted at Viswavidyalaya Farm, Kalyani during 2000 to evaluate the efficiency of Glyphosate + 2, 4 -D combination product on types and spectrum of weed control in non-crop areas. The treatments consisting of 9 ready mixture of Glyphosate IPA salt (13.5%, 9% and 18%) and 2, 4 -D IPA salt (13.5%, 18% and 9%), a tank mixture of Glyphosate + 2, 4 -D – local recommendation along with a control and sole application of Glyphosate and 2, 4 -D @ 10 ml and 4 ml / litre of water respectively applied on 15th July, 2000. The predominant weed flora infesting the experimental field consisted of *Cynodon dactylon, Digitaria sanguinalis, Eleusine indica, Paspalum conjugatum, Cyperus rotundus, Ageratum conyzoides, Mimosa pudica, Parthenium hysterophorus, Vernonia cinera* and *Vitis trilobus.* The ready mixture treatments of Glyphosate + 2, 4 -D showed good control of all types of weed flora within two weeks after spraying. The treatments of ready mixture – Glyphosate 13.5% + 2, 4 -D 13.5% applied @ 1.5 % and Glyphosate 18% + 2 ,4 -D 9% applied @ 2% showed better results in controlling different types of weed flora.

EVALUTION OF BIOEFFICACY OF ROUNDUP 41% SL FOR WATER HYACINTH (*EICHHORNIA CRASSIPES* (MART) SOLMS)

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Experiments were conducted at the water pond of the experimental farm, Department of Agronomy, Annamalai University, Annamalainagar to assess the bioefficacy of Roundup 41% SL for water hyacinth. Nine treatments viz., 2.5, 3.75, 5.0, 6.0, 7.5, 10.0 l/ha of Roundup 41% SL, Gramaxone @ 2.5 l/ha, 2,4-D (Fernoxone) @ 2.5 kg/ha and control (no herbicide) were tested adopting RBD with three replications. Application of Roundup 41% SL at a dosage of 10.0 l/ha was found to control water hyacinth effectively, which, however, was on par with the dosage of 7.5 and 6.0 l/ha. Water quality and fauna of the pond was not affected by Roundup 41% SL even at the highest dosage (10.0 l/ha).

EFFECT OF GLYPHOSATE ON THE CONTROL OF HARIYALI (*CYNODON DACTYLON* L. PERS.)

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A field experiment was conducted on red sandy loam soil of agronomy field unit, Main Research Station, University of Agricultural Sciences, Bangalore, during the year 1995-96, to evaluate the efficacy of glyphosate on the control of cynodon. The experiment consisted of 14

treatments including glyphosate at 2.0, 2.5 and 3.0 kg. a.e./ha alone and each in combination with either ammonium sulphate or urea or sulphuric acid along with sucrose besides which, unweeded check and hand weeding by clipping were included for comparison purpose. The treatments were laid out in Randomised Complete Block Design with three replications.

The mortality per cent of cynodon worked out at 75 days after spraying was recorded to be highest with glyposate applied at 3.0 kg a.e./ha in combination with 2% sucrose and 2% ammonium sulphate and hence which recorded minimum shoot length, number of shoots/m^2 area, fresh weight and dry weight of cynodon. Consequent to the better control of above ground portion, the same combination also performed well in reducing the below ground portions like number of rhizomes, fresh weight and dry weight of rhizomes, which finally lead to the lowest accumulation of total dry matter (21.3 g/m^2 area) and highest weed control efficiency (83.7%). The next best treatments were glyphosate at 3.0 kg a.e/ha + 2% urea and glyphosate at 2.5 kg a.e./ha + 2% ammonium sulphate. However, the moderate control was registered with rest of the treatments (24.1 to 68.5 g/m^2 total dry matter and 47.6 to 83.0% weed control efficiency) and least was registered with unweeded check (130.7 g/m^2 total dry matter and 0.0% weed control efficiency). Hand clipping can be followed to have a moderate control of cynodon with the added advantages of preventing the soil pollution.

APPLICATION OF GLYPHOSATE TO CONTROL OF HARIYALI (CYNODON DACTYLON L. PERS.) AND SUBSEQUENT PERFORMANCE OF MAIZE (*ZEA MAYS* 1.)

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Field study was carried out red sand loam soil of Main Research Station, University of Agricultural Sciences, Bangalore during the years 1995-96, to evaluate the efficacy of weed control treatments on the control of cynodon and subsequent effect on the growth and yield performance of maize. The experiment consisted of 14 treatments including glyphosate at 2.0, 2.5 and 3.0 kg a.e./ha alone and each in combination with either ammonium sulphate or urea or sulphuric acid along with sucrose. Unweeded check and hand weeding by hand clipping were also included and laid out in randomized complete block design with three replications.

The evaluated results indicated that, the mortality per cent of cynodon worked out at 75 days after spraying was observed to be highest with glyphosate applied at 3.0 kg a.e./ha in combination with 2.0% sucrose and 2.0% ammonium sulphate 99.5%) and hence recorded least dry weight cynodon foliage (10 g/0.5m^2 area) and rhizomes (11.3 g/0.5m^2 area), which inturn lead to the highest weed control efficiency (83.72%), Consequent to the better weed control with this treatment germination percentage (91.66%) number of green leaves (8.45 / plant), dry matter accumulation (305.3 g/plant), leaf area index (2.01%), grain yield (60.5 g/ha) and stover yields (38.11 g/ha) of maize were improved to the greater extent and therefore recorded least weed index. The next best treatments were glyphosate at 3.0 kg a.e./ha + 2% sucrose + 2% ammonium sulphate. However, the moderate control was noticed with unweeded control. Hand clipping can be followed to have a moderate control of cynodon and moderate performance of maize. Ultimately to conclude, application of glyphosate at 3.0 kg a.e./ha + 2% sucrose + 2% ammonium sulphate performed well in controlling cynodon and thus paved the way for betterment of maize growth and yield.

INFLUENCE OF CROP ROTATION ON CONTROL OF *OROBANCHE* IN TOBACCO

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Effect of crop rotation on control of *orobanche* in tobacco was studied under field conditions during *kharif* 1991 and 1992. In the experiment a set of *kharif* crops followed by *rabi* crops along with tobacco was grown on one plot and in another plot exclusively tobacco was grown on one plot. In the succeeding year crops were inter changed on the plots and the effect of crop rotation on orobanche incidence was studied. Results have showed that maximum cured leaf yield of tobacco was obtained in tobacco rotated with groundnut + redgram P(1548 kg ha^{-1}) followed by tobacco rotated with maize-bengal gram (1498 kg ha^{-1}), groundnut-bengal gram (1405 kg ha^{-1}) and chilli (1390 kg ha^{-1}). Lowest yield was recorded in the treatment of tobacco rotated with tobacco (998 kg ha^{-1}). Highest tobacco yield due to crop rotation with groundnut + redgram was attributed to reduced *orobanche* infestation and increased soil fertility due to biological nitrogen fixation by leguminous crops. Root exudates of crops used in crop rotation caused suicidal germination of *orobanche* seeds.

SCREENING TRAP CROPS FOR THE CONTROL OF *OROBANCHE* ON TOBACCO

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Effect of five short duration trap crops viz., sunhemp. greengram, sesamum, soybean and sunflower in controlling *orobanche* on succeeding tobacco crop was tested consecutively for 2 years under field condition during *kharif* 1990-91 and 1991-92 on vertisols of north Karnataka. Maximum cured leaf yield of tobacco was obtained in plots earlier grown with sunhemp and was on par with control tobacco plants free from *orobanche* infestation. The factors responsible for difference in tobacco yield grown after different trap crops was attributed to killing *orobanche* seeds by suicidal germination due to root exudates of trap crops, which made a less or non competitive environment for tobacco crop growth.

Growing sunhemp as a preceding crop to tobacco has dual advantage of over coming the problem of *orobanche* besides becoming itself a green manure for succeeding tobacco crop.

RELATIVE UTILITY OF ADJUVANTS IN INCREASING THE EFFICACY OF GLYPHOSATE FOR CONTROLLING *CYPERUS ROTUNDUS*

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Cyperus rotundus commonly known as nutsedge is a serious menace despite the use of improved management practices. Experiments conducted in a fallow cultivated land fully infested with *Cyperus rotundus*. Glyphosate at 2.0 and 1.5 kg a.i./ha was used with adjuvants like ammonium sulphate, potassium nitrate, kaolin and 2, 4-D by spraying on 15 and 21 days after

emergence (DAE) of *Cyperus rotundus*. Glyphosate at 1.5 kg a.i./ha with 2, 4-D or ammonium sulphate as adjuvants is effective and economical as compated to glyphosate at 2.0 kg a.i./ha without adjuvants by reducing DMP, increasing *Cyperus* control efficiency (CCE) and mortality of *Cyperus rotundus*. Spraying of glyphosate at 21 DAE of *Cyperus rotundus* effectively controlled nutsedge compated to spraying at 15 DAE.

PILANTHES ACMELLA MURR. (ASTERACEAE) - A POTENTIAL THREAT TO AGRICULTURE

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Spilanthes acmella is a new weed belonging to Asteraceae family, which recently invades the crop fields of West Bengal where they never existed except sporadically in non-cropped areas. Since it is an appearance of new weed in this locality it is thought to be important to study on its autecology and phyto-sociology in different habitats in the Institute of Agriculture Farm, Visva-Bharati under the lateritic tract of West Bengal providing a strong base to take up efficient control measures. The present study reveals that the genus *Spilanthes* comprises about 20 tropical American species with four varieties. This exotic weed is closely allied and often mistaken as *Tridax procumbens* L. in vegetative condition differing in lower nodal roots, lateral branches and achenes with modified pappus in the form of two bristles. This multi seasonal weed has been found to be of plastic morphological make up and wide degree of adaptation in different habitats. Habit and reproductive out put changed with shifting of habitat and seasons. Studies on life-cycle, perennation, dispersion of propagules, germination and effect of agronomic operations revealed that the possible factors responsible for its extensive spread was perhaps due to its huge seed producing and disperisng ability, regenerating ability through vegetative parts, capability of producing more than one generations annually and adaptability to environmental extremes. Its biomass production, leaf area index and heavy nutrient mining proved to be potential threat to agriculture, Efforts of controlling this weed is therefore, immediately needed to check its rapid spread as experienced in cases of exotic weeds like *Parthenium, Lantana, Eichhornia*, etc. in India.

BIOEFFICACY OF MIX FORMULATION OF CLOMAZONE WITH PROPANIL IN TRANSPLANTED PADDY.

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A field experiment was conducted at Viswavidyalaya Farm, Kalyani to study the weed control efficiency of the herbicide mixture Clomazone with Propanil and its effect on grain straw yield of transplanted paddy during kharif season, 2000. In addition to hand weeding twice at 20 and 40 DAT and butachlor 50 EC @ 1.25 a.i. /ha, there were two different combinations of Clomazone and Propanil (Clomazone 15 EC @ 200 g + Propanil 30 EC @ 400 g a.i. /ha and Clomazone 15 EC @ 150 g + Propanil 30 EC @ 300 g a.i./ ha) applied on there different dates - 10, 15 and 20 DAT. Application of Clomazone with Propanil at lower doses as early post-emergence and at higher doses as late post emergence showed better weed control and higher grain yield of paddy (29.7 and 31.2% over unweeded control respectively). The reduction in yield from the normal yield was due to the occurence of flood from flowering to maturity stage of the crop.

BIO-EFFICACY OF PROMISING HERBICIDAL MOLECULES IN DIRECT SEEDED SPROUTED PUDDLED RICE UNDER MID-HILL CONDITIONS OF HIMACHAL PRADESH

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(Nagrota Bagwan) H.P.

A field experiment was conducted at CSKHPKV, Rice Research Station, Malan consecutively for five years from 1996 to 2000 to evaluate different herbicides for their bio-efficacy in puddled sprouted rice. Herbicides use as a component of an integrated weed management strategy in rice is becoming popular, especially in areas where labour is becoming more & more scarce & costly during peak periods of farm operations Major concerns in herbicides research are increasing the bio-efficacy of promising herbicides through combined use of safeners to reduce phyto-toxicity of sprouted seeds.

In the present study the weed infestation reduced the grain yield of rice from 24.1% to 43.3% during different years. The mean reduction over five years duration from 1996 to 2000 was worked out to be 35.5% with hand weeded and unweeded plots . Among herbicides application of butachlor + safener 50 EC @ 1.0 kg ai/ha within three days of sowing reduced the accumulation of dry matter by weeds significantly over non weeded control resulting in higher grain yield of rice (45.3q/ha). This was followed by aniloguard plus 24+32 EC @ 0.40+0.53 kg ai/ha applied at 10 days after sowing and was comparable to two hand weedings. Similarly other herbicides in study viz. Ethoxysulfuron, Rice guard (Anilophos + Ethoxysulfuron), Rice star (Fenoxaprop-P-ethyl) were also effective in controlling weeds compared to non weeded control plot. At Malan station the weed problem was moderate to severe with unweeded plots recording 106.6 g/m2 on average basis. Butachlor + safener recorded lower weed dry weight (51.3 g/m2) weed population indicated that the grassy weeds predominated followed by sedges and broad leaved weeds.

STANDARDIZATION OF DOSE OF SULFOSULFURON (MON 37503) TO CONTROL WEEDS IN WHEAT

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Field experiments were conducted during *rabi* seasons of 1998-99 and 1999-2000 at the experimental farm of Department of Agronomy, CSKKV, Palampur to find out the optimum dose of sulfosulfuron for controlling weeds in wheat. The area represents the mid-hill wet temperate zone of Himachal Pradesh. The soil of the experimental site was silty clay loam in texture, acidic in reaction, medium in available nitrogen, phosphorus and organic carbon and high in available potassium. The experiment was laid out in a randomized block design with three replications and 12 treatments. The treatments include 4 doses of sulfosulfuron (20, 30, 40 and 50 g/ha) with and without surfactant, isoproturon 1.0 kg/ha + surfactant, diclofop-methyl 0.75 kg/ha, 2 handweedings (40 and 70 DAS) and weedy check. The major weeds of the experimental fields were *Avena fatua*, *Phalaris minor* and *Lolium temulentum* among grasses and *Coronopus didymus, Vicia sp.* and *Anagallis arvensis* among broad leaved weeds. Results of the experiments showed that sulfosulfuron 40 g/ha being at par with sulfosulfuron 40 g/ha + surfactant and sulfosulfuron 50 g/ha with and without surfactant resulted in significantly lower weed dry weight and higher yield attributes and yield of wheat when compared with the lower doses during both the years of study. However, during first year diclofopmethyl 0.75 kg/ha being at par with isoproturon 1.0 kg/ha + surfactant resulted in significantly higher grain yield over other treatments whereas, during the second year diclofopmethyl performed comparatively poor probably because of poor control of *Phalaris minor* which was the dominating weed this year. Isoproturon 1.0 kg + surfactant was as effective as sulfosulfuron 50 g/ha + surfactant and handweeding twice during both the years and also with sulfosulfuron 50 g/ha without surfactant and sulfosulfuron 40 g/ha with and without surfactant during second year of study.

MON 8435 - A NEW HERBICIDE FOR TRANSPLANTED RICE

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Weed control is one of the expensive operation in irrigated farming and more so in rice field where frequent irrigation brings a fresh set of weed seeds. It has been estimated that 16 to 86 per cent of yield reduction is due to uncontrolled weed growth. Hence, use of herbicide is becoming a widely followed agronomic practice to control the weed population timely. However repeated use of same herbicide may lead to development of resistance in weeds. Therefore, rotation of herbicides is important. In this context, a new low voluminous herbicide (MON 8435, Monsanto, Mumbai, India) was evaluated for its efficiency to control weeds in transplanted rice. The field experiment was conducted during 1999 and 2000 at Agricultural Research Station, Siruguppa. The experiment was laid out in RBD with three replications. The experiment consisted of 15 treatments, viz., five levels of MON 8435 (75, 100,125,150 and 300 g a.i/ha.) applied at 0-3 and 6-8 days after transplanting (DAT). Butachlor, topstar - 80 and pretilachlor at 1.25, 0.07 and 0.625 kg a.i. /ha, respectively were also included. Untreated control and hand weeding (once) was also maintained for comparison.

The results indicated that significantly lower seed yield with was recorded untreated control and the reduction was to a tune of 33.2 per cent over hand weeding. Hand weeding recorded the

highest seed yield followed by MON 8435, 75 g or 150 g a.i/ha applied at 6-8 DAT. These treatments were on par each other. Increase in the levels of herbicide (MON 8435) form 75 to 300 g a.i/ha had no benefical effect. Application of butachlor produced on par yield with MON 8435 at 75 g a.i/ha, but significantly superior over topstar - 80 and pretilachlor. The higher rice yields may be attributed to lower number and dry weight of monocot and dicot weeds.

WEED MANAGEMENT WITH FERTILIZER - ADDITIVE MIXED HERBICIDES IN TRANSPLANTED RICE

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Investigations were under taken in Navarai season (December - January - April - May) for three years to study the effect of fertilizer additive mixed herbicides on weed, yield and yield attributes in transplanted rice. The treatment comprised of additives viz., ammonium sulphate, urea and DAP at 1 per cent concentrations along with not additive formed the main treatments, the weed management measures consisted of butachlor at two doses viz., 1.5 kg and 0.75 kg ha^{-1} and anilofos at two doses viz., 0.60 and 0.30 kg ha^{-1} and farmer's practice of two hand weeding compared with unweeded control.

The result of the investigations revealed that the use of additive especially ammonium sulphate 1 per cent with higher dose of anilofos could effectively control the weeds as evident from weed dry matter production WCI and register higher values for panicles $hill^{-1}$, filled grain number $panicles^{-1}$ and grain yield. The effect of lower dose of anilofos was comparable to that of twice hand weeding indicating that it may be substituted for hand weeding and establishing that herbicide dosages could be economically and effectively reduced by combining with fertilizer additives which paves way for pollution management.

EFFECT OF IMAZETHAPYR ON SWINE CRESS (*COROMOPUS SPP.*) IN BERSEEM

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Swine cress weed species which cause economical loss in berseem, consequently their control techniques must be effective. Therefore, the present study is an attempt to find out suitable dose and method of herbicide for controlling the major weed swine cress in berseem.

The field experiment was conducted during rabi season of 1997-98 and 1998-1999 at Live Stock Research centre of G.B. Pant University of Agriculture and Technology, Pantnaga. Eighteen treatements consist imazethapyr at 50, 100, 150 and 200 g ai/ha as pre-plant incorporation (PPI), Pre-emergence (PE) and Post-emergence (POE) at 20 days after sowing, atrazine at 200 g ai/ha before sowing, Pendimethalin at 250 ml ai/ha as PE, oxadiaxone at 250 adn 500 ml ai/ha as POE at 20 days after sowing with weedy and weed-free conditions. The experiment was laid out in randomized block design with three replications. The crop variety vardan was sown on Nov. 12, 1997 and Nov. 6, 1998 in rows at 20 cm apart.\

The major weeds in experimental field were *coronopus didymus and medicago denticulata* which were more than 50 percent. Other weeds were *cyperus rotundus, chemopodium album, vicia sativa, melilotus spp and chicorium intybus.*

Total green fodder yield obtained with application of imazethapyr @ 50, 100 g ai/ha as PPI and @ 50, 100 & 150 g ai/ha as POE at 20 days stage was significantly more than weedy condition and at par to that of yield obtained with weed-free condition. Dry weight of coronopus spp recorded at 60 days stage was significantly low due to imazethapyr at all doses and methods of application as compared to weedy condition.

BIO-EFFICACY OF GLYPHOSATE FORMULATIONS FOR GENERAL WEED CONTROL UNDER NON CROP SITUATION

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Weeds on non crop lands viz., wasteland, public utility places, canal and ditch banks cause shrinkage of area for animal grazing, human and animal health hazards and reduce the aesthetic value of the land. Weeds of non-crop lands are more vigorous than the cultivated land weeds. Therefore a non-selective translocated herbicide may be useful in effectively controlling these weeds. Hence, field experiments were carried out at Tamil Nadu Agricultural University. Coimbatore to evaluate the efficiency of post emergence total herbicides in controlling the weeds in non-crop situation.

The present study was conducted to evaluate the bio efficacy of three non-selective translocated Glyphosate formulation viz., Roundup 41% SL, Roundup dry (MON 14420) and NON 77569 of M/s. Monsanto Ltd., as a sponsored project, in separate trails at different doses and was compared against the presently used herbicides viz., non-selective contact herbicide paraquat formulation (Gramoxone) and non-selective translocated herbicide glyphosate formulation (Glycel).

Better control of diverse weed species in non-crop situation could be achieved with Roundup 41% SL a systemic herbicide formulation of glyphosate form 0.72 to 2.88 kg a.e. /ha compared to contact herbicide (Gramoxone-a paraquat formulation). The Roundup dry formulation of glyphosate had WCE of more than 80% from 0.82, to 5.44-kg a.e. /ha compared to a WCE 32% with paraquat (Gramozone 24 SL). The WCE of both MON 77569 and Roundup formulations of glyphosate gave better WCE of different weeds under non - crop situation (78 to 93% at 0.72 kg a.e. /ha compared to Glycel at 0.72 kg a.e./ha with a WCE of 53.5%.

HERBICIDES - APPLICATION TECHNOLOGY COMPARATIVE EFFICACY OF GLYPHOSATE FOR WEED CONTROL IN TRANSPLANTED RICE

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A field trail was conducted at Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal during 2000-2001 to study the role of Glyphosate as translocated total weed killer for controlling the weeds in transplanted rice Cv. White Ponni.

The treatments include conservative tillage alone, T_1, conservative tillage + glyphosate @ 3 1ha^{-1} T_2,conservative tillage + glyphosate @ 3 1 ha^{-1} followed butachlor @ 2.5 1 ha^{-1} T_3, Local conventional tillage followed butachlor @ 2.5 1 ha^{-1} T_4, Local conventional tillage + two hand weedings at 20 and 40 DAT T_5 and Local conventional tillage alone T_6. The trial was conducted in RBD with three replications.

The weed flora of the experimental field were *Echinochloa colonum*, *Marsilea quadrifoliata*, *Cyperus rotundus*, *Ludwigia parviflora* and *Spharenthus indicus*. The results indicated that the application of glyphosate as pre-plant herbicide has produced significant increase in yield. The highest yield was recorded by T_2(6.13 t ha^{-1}), followed by T_3 (5.18 t ha^{-1}). The yield increase over the control (T_6) ranged from 18 to 99 per cent by various treatments. The DMP of weeds of all the treatments were lesser than the control. Among the treatments, the lowest DMP was observed in T_2 (43.2 g m^{-1}).

From the study it is concluded that glyphosate @ 31 ha^{-1} as pre-plant herbicide along with conservative tillage system produced significant results in weed management of transplanted rice.

EFFECT OF SOME NEW PROMISING HERBICIDES TO CONTROL WEEDS IN TRANSPLANTED RICE (*ORYZA SATIYA* L.)

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Sixteen treatments consisting of butachlor 1.5 kg ai/ha, Flufenancet 0.05 and 0.12 kg ai/ha, Rice guard 0.25 + 0.10 and 0.375 + 0.015 kg ai/ha, Rice star 0.056 and 0.075 kg ai/ha, Acetachlor 0.075 and 0.010 kg ai/ha, Pyrazosufuon ethyl 0.005 and 0.010 kg ai/ha, aniolophos + trichlopyr 1.25 and 1.50 kg ai/ha, two hand weeding (30 to 60 days stage), high plant population (15 x 15 cm) + 1 hw (30 days stage) alone with weedy check were evaluated for weed control efficiency, their effects on Crop growth and grain yield in a randomized block design with four replications. The experiment was conducted at Crop Research Centre of Goving Ballabh Pant University of Agriculture and Technology, Pantnagar, Distt U.S. Nagar (Uttranchal).

Echinochloa colonum (25.0%), *Echinochloa crusgalli* (18.8%) in grasses and ceasulia axillaries (28.1%) among non-grasses were predominant in total weed density at 60 days stage of Crop growth. Excellent control of there weeds was achieved by Anilofos + Trichlopyr (1.5 kg ai/ha) Followed by Rice guard (0.375 + 0.015 kg ai/ha). Highest grain yield (7.05 t/ha) was recorded in the treatment of two hand weeding (30 + 60 days after planting of rice) followed by anilophos + hrichlopyr (1.50 kg ai/ha) and produced 6.25 t/ha. Lowest yield was recorded in weedy check (3.08 t/ha) and thus weeds decreased the grain yield of transplanted rice 56.3%.

EFFECT OF WEED-MANAGEMENT METHODS IN TRANSPLANTED RICE GROWN IN ALLUVIAL SOILS OF WEST BENGAL

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A field trail was conducted during *Kharif* season of 2000 at Jaguli Instructional Farm (Nadia) of Bidhan Chandra Krishi Viswavidyala to study the weed controlling ability of 'Basagran' (Bentazone; chemical name: 3-isopropyl-l H-2,1,3-benzo thiadiazin-4-(3H)-one 2,2-dioxide benzamido-oxyacetic acid) and 'Basagran M 60' (Bentazone + MCPA) in association with 'Facet' (Quinclorac) and 'Tetris' (Clefoxydim) in transplanted *Kharif* rice (IET-4786). This study showed that tank mix (TM) of Basagran and Facet @ 960 + 250 g ai / ha applied at 15 days after transplanting (DAT) and Facet followed by (fb) Basagran @ 250 fb 900 g ai / ha applied at 15 DAT fb 25 DAT controlled the weeds effectively recording the minimum dry weight of weeds / m^2 (1.51 and 1.17 g at 30 DAT; 1.48 and 1.71 g at 60 DAT; 1.57 and 2.39 g at 90 DAT). Both the treatments showed the highest weed control efficiency (WCE) of 88.16% and 92.22% at 90 DAT. Among the chemicals tried, Clefoxydim (75-100 g ai / ha applied at 15 DAT) showed the least WCE (41.07% and 47.27%). Regarding yield, Facet fb Basagran @ 250 fb 900 g ai / ha (applied at 15 DAT fb 25 DAT) produced the highest rice grain yield (4.73 t/ha) which was statistically at par with the yield (4.59 t/ha) obtained from Basagran + Facet (TM) treated plots. These 2 treatments increased the grain yield by 79.85% and 66.36% respectively as compared to the yield of un-weeded plots (2.63 t / ha).

EFFICACY OF SOME ADDITIVES TO INCREASE THE BIO-EFFICIENCY OF GLYPHOSATE

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Glyphosate is a translocated herbicide proved effective for the post-emergence control of many troublesome perennial grasses as well as broadleaf weeds. Experiments were conducted to test the efficacy of some additives to increase the bio-efficency of glyphosate and thus economize its use, taking *Pennisetum pendicellatum*, a perennial grass usually seen in young plantations, as the traget weed. Additives included in the study were ammonium sulphate (0.5%), urea (3%), Kaolin (2.5kg/ha), Triton AE (450 ml/ha) and Sandowit (300ml/ha). Glyphosate was applied at 0.4, 0.6 and 0.8 kg/ha with these additives and without them at 0.4, 0.8 and 1.2 kg/ha along with an unsprayed control. The observations on the number of surviving plants per plot made one month after spraying the herbicides indicated that the treatments, glyphosate 0.4 kg/ha or above plus ammonium sulphate 0.5%, glyphosate 0.6 kg/ha or above plus 3% urea, and glyphosate 1.2 kg/ha without additives were almost similar in effect for the control of P. pendicellatum. Even though kaolin, Triton AE and Sandowit were also effective in increasing the bio-efficency of glyphosate, they were not effective as that of ammonium sulphate or urea. The results suggests that addition of 0.5% ammonium sulphate reduces theeffective rate of glyphosate to one-third and addition of 3% urea reduces the rate by half to get the same level of weed control as that of glyphosate 1.2kg/ha without additives. Glyphosate being a costly herbicide, any reduction in its application rate can significantly reduce the cost of weed control and overall cost of production.

EVALUATION OF GLYPHOSATE AND IMAZAMOX MIXTURES ON PURPLE NUTSEDGD (CYPERUS ROTUNDUS) CONTROL

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Green house experiments were conducted during spring and summer of 1998 at Southern Weed Sciences Laboratory, Stoneville, Mississippl (U.S.A.) to evaluate ptoential interactions between glyphosate and imazamox for control of three months old purple nutesedge. Herbicides were tested alone and in combination at 0.5 and 1.0x rates (1x being suggeated use rate for these herbicides). Results indicated that glyphosate alone at 1120 g/ha gave 87% control of three months old purple nutsedge. All the four berbicides combinations were found to be antagonistion, Thus, mixing of ALS inhibiting herbicide imazamox with glyphosate did not increase the glyphosate efficacy on purple nutsedge.

EFFECT OF SURFACTANTS ON THE EFFICACY OF SULFOSULFURON AGAINST SOME GRASS AND BROADLEAF WEEDS

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Surfactants play a vital role in increasing the efficacy and spectrum of weed kill by selective herbicides. Controlled experiments were conducted to evaluate the potency of two surfactants tank mixed with sulfosulfuron for their differential response, if any, against broadleaf and grass weed species. Ethoxylted tallow amine (MON 0818) and etox tallow amine (Frigate) surfactants were applied (0.2%) with sulfosulfuron (Mon 37500, 20 g ai/ha). Plants of seven weed species (*Bromus, Galium, Stellaria* and *Matricaria*) were sprayed at the 2-4 and 4-6 leaf stages using a motorized track sprayer fitted with a flat fan even nozzle at 300 kPA pressure delivering 200 L water/ha. There were 4 replicate pots (8 plants/pot) for each species and treatment. After spraying, the plants were transferred to growth room with 16 h photoperiod (fluorescence lamps, 83 mEm^{-2} s^{-1} PFD) with day/night temperatures of 26 ± 1/19±2 and relative humidity of 89±0/51±4 were maintained. Observations were periodically recorded for visual mortality and fresh/dry weight were recorded 4 weeks after treatment.

Mon 37500 was more effective against grasses (*Bromus* species) than broad leaf weeds (*Galium*, *Stellaria* and *Matricaria*). The effect was more at the 2-3 leaf stage than the 4-6 leaf stage particularly on broad leaf weeds. Both the surfactants (Frigate and Mon 0818) increased the herbicidal activity of MON 37500, the effect was conspicuous in the case of broad leaf weeds, no significant difference was found between the two surfactants. Among the broad leaf weeds effect of MON 37500 was lower on *Galium* and *Matricaria*; similarly, relative effect of herbicide was less on *Bromus secalinus* than with other *Bromus* species.

EVALUATION OF TANK MIXTURE OF ACETACHLOR AND ATRAZINE OR 2,4-D AGAINST WEEDS IN PEARLMILLET

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To evaluate the performance of acetachlor, atrazine and 2, 4-D Na alone or as tank mixture, an experiment was conducted in *kharif* seasons of 1999 and 2000 at Research Farm of CCS Haryana Agricultural University, Hisar (India). The experiment consisting of seventeen treatment including atrazine 0.5 kg ha^{-1} and acetachlor 1.0 kg ha^{-1} each applied as pre-emergence(PE) and at 10 days after sowing (DAS), acetachlor 1.0 kg ha^{-1} at 15 DAS, 2, 4-D Na at 0.5 kg^{-ha} at 10 and 15 DAS, tank mixtue of acetachlor + atrazine 0.750 + 0.375 kg as PE, 10, 15 and 20 DAS, acetachlor + 2, 4-D Na at 0.750 + 0.50 kg^{-ha} at 10, 15 and 20 DAS were compared with mechanical weeded (20 and 35 DAS), weed free and weedy check. The treatments were distributed in randomized block design replicated thrice. The experimental field was infested with predominantly *Trianthema portulacastrum* and *Echinochloa colonum.* Pearl-millet variety HHB-67 was sown with tractor drawn seed-cum-fertilizer drill on 18th and Ist July, during 1999 and 2000, respectively. The soil of the experimental field was sandy loam in texture, low in available nitrogen, medium in available P_2O_5 and high in K_2O with slightly alkaline in reaction (pH 8.2).

Among herbicidal treatments atrazine at 0.5 kg ha^{-1} applied as PE or 10 DAS, acetachlor + atrazine at 0.750 + 0.375 kg ha^{-1} applied at 10 DAS proved highly effective (>90%) against mixed weed flora in pearl-millet and consequently yielded similar to mechanical weeded and weed free plot. It was critically noticed that acetachlor applied either alone or combination with atrazine or 2, 4-D as PE proved highly phytotoxic (95% in 1999 and 52% in 2000) to pearl millet and weeds (80 – 98%). Acetachlor applied as post-emergence (10 and 15 DAS was ineffective against *T. portulacastrum* and *E. colonum.* However, when acetachlor was used as tank mixed with atrazine found most effective at 10 DAS and also controlled the weeds to some extent even upto 20 DAS indicating the reflection of atrazine only. Post-emergence application of 2, 4-D Na at 0.50 kg ha^{-1} resulted into marginal suppression of only broad leaf weeds.

EVALUATION OF FLUZOLATE (MON 48549) FOR WEED CONTROL IN IRRIGATED WHEAT (*TRITICUM AESTIVUM* L.)

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Fiels experiment was conducted to evaluate the bio-efficacy o fluazolate at 75,100,125 and 150 g/ha applied at zero and seven days of sowong, for weed control in wheat and was compared, with sulfosulfuron (Mon 37500) at 25 g/ha applied either befor first irrigation (BFI) or after first irrigation (AFI), sulfosulfuron at 20 g/ha (BFI). fenoxaprop at 100 g/ha and a weedy check at tha Research farm during winter season of 1980 in randomised blcok design with three replications. The study revealed that fluazolate at all the rates and time of application was effective against grassy wees *viz. Polypogon monplensis* and *Phalaris minor* and increased efficacy was noted with increasing doses of herbicide. The broad leaf weeds viz., *Trifolium flafiferum, Anagalis*

arvesis and *chenopodium album* were also conrolled. Sulfosulfuron also controlled these weeds but the efficacy was relatively low. The weed control efficiency of fluazolate varied from 56.7 to 71.7 percent and that of sulfosulfuron from 13.4 to 67.4 per cent in comparison to 27.0 under fenoxaprop.

The grain yield wassignificantly higher under fluazolate (3944 to 4632 kg/ha) and sulfosulfuron treatments at 25 or 20 g/ha except AFI (4097 -4129 kg/ha)compared to weedy check (3205 kg/ ha) Fluazolate applied either zero or seven daysBFI was equally effective but sulfosulfuron BFI (4129 kg/ha) wa significantly better than AFI(3247 kg/ha)/ Fluazolate at 75 to 100 g/ha at 7 - day stage was found effective from weed control and grain yield point view.

WEED CONTROL IN PUDDLED SEEDED RICE WITH BUTACHLOR AND ANILOFOS ALONE AND AS MIXTURE

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With an object to find out the effect of application of butachlor and anilofos alone and as their mixture on puddled seeded rice and associated weeds, a field trial was conducted during rainy season 1999. The results revealed that hand weeding twice (20 and 40 DAS) and application of anilofos @ 0.4 kg/ha 8 DAS were found equally effective to reduce the weed dry weight per unit area. The highest grain yield (44.58 q/ha) was associated with weed free treatment. Grain yields recorded by the application of butachlor @ 1.5 kg/ha, anilofos @ 0.4 kg/ha and butachlor 1.0 to 1.5 kg/ha + anilofos 0.2 to 0.3 kg/ha each at 8 DAS were found comparable with the grain yield recorded by weed free treatment. Among herbicide treatments, both butachlor and anilofos used either alone or as mixture were found equally effective to produce grain yield.

EVALUATION OF DOSES AND TIME OF APPLICATION OF MON 8435 (ACETOCHLOR) FOR WEED MANAGEMENT IN TRANSPLANTED RICE

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A field experiment conducted for three seasons during 1999 to 2000 on clay loam soils of Agricultural Research Station, Kathalagere, University of Agricultural Sciences, Bangalore to workout optimum dose and time of application of MON 8435 (Acetochlor 90% EC) for controlling weeds, crop safety and yield of transplanted rice. MON 8435 EC formulation at 75, 100, 125, 150 and 300 g ai / ha (all applied at 3 and 6 days after planting) were compared with oxadiargyl (50 EC) 1.25 kg ai/ha, butachlor (50 EC) 1.25 kg ai/ha and pretilachlor (50 EC) 0.625 kg ai/ha (all applied at 3 days after planting) in relation with hand weeding and unweeded control. The major weed flora were *Cyperus difformis, C. procerus, Scirpus sp, Fimbristylis miliacea* (among sedges) *Echinochloa glabrascens, Panicum tripheron, E. colona* (among grasses), *Lindernia veronicaefolia, Ludwigia parviflora, Rotala verticillaris, Eclipta alba, , Cynotis axillaris , Spilanthus acmella* and *Dopatrium junceum* (among broad leaved weeds).

The study revealed that application of acetochlor 75 to 300 g ai / ha at 3 DAT can be used safely with effective weed control and highest grain yield (3660 to 4889 kg / ha) as compared to 6 DAT (3308 to 4575 kg / ha). Grain yields obtained by application of MON 8435 (125 g to 300 g ai /ha) at 3 DAT (4430 to 4889 kg / ha) were comparable to butachlor 1.25 kg ai/ha (4727 kg / ha), pretilachlor 0.625 kg ai/ ha (4684 kg / ha) and hand weeding (4770 kg / ha). The yield improvement and weed control efficiency by advancing the time of application of MON 8435 from 3 DAT to 6 DAT were not noticed. However application of MON 8435 at 300 g ai/ha applied both at 3 and 6 days of planting lowered the grain yield to some extent because of phytotoxic effects exhibited by the crop.

TECHNIQUE OF IMPOSING SELECTION PRESSURE ON GAMETOPHYTES FOR THE DEVELOPMENT OF GLYPHOSATE RESISTANT TOMATO (*LYCOPERSICON ESCULENTUM*)

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Nature imposes selection pressure at two phases of the life cycle of plant (sporophyte & gamatophyte). Ability of Pollen (haploid) resistant to selection modifies the sporophyte (diploid) portion of plant life. This overlap of gene expression between gamatophyte and sporophyte has profound significant in development of resistant progeny for imposed selection pressure. Experiments were conducted to validate this technique in developing glyphosate resistant tomato lines. Using standardized pollen germination media for tomato with varied doses of glyphosate and pollen germination percent, 20 & 50 ppm of glyphosate were identified for selection pressure. Progenies were obtained by applying selection pressure on pollen (P_{20} & P_{50}) or stigmatic surface (S_{20} & S_{50}) or on both (P_{20} XS_{20}). These progenies were tested for glyphosate resistance by assessing dose-response regression and estimating ED_{50} of root and shoot length at seed germination stage and fresh weight at seedling stage (25 DAS). Amongst progenies S_{50} had highest ED_{50} with 7 fold more dose requirement than control progency (without selection pressure).

DO TOMATO (*LYCOPERSICON ESCULENTUM*) GENOTYPES VARY IN THEIR RESPONSE TO GLYPHOSATE

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Seven agronomically superior tomato genotypes were grown to assess the effect of glyphosate on their growth. Glyphosate at the rate of 250 ppm was sprayed on 50 to 60 days old plants, for the purpose of selecting a relatively resistant genotype to be used for building up the resistance. The effect of glyphosate on certain parameters like loss of membrane integrity was assessed through membrane leakage studies. Germination of pollen grains in the presence of glyphosate was also recorded to serve as a screening tool to identify resistant genotypes was done.

Amongst the genotypes tested Arka Ashich was least affected by glyphosate followed by Arka Vikas and Arka Surabh in terms of lesser membrane damage. Measurement of root and shoot growth also indicated a genotypic variation. Extent of reduction in total chlorophyll was also measured. There was good variation in this parameter, Genotype Arka Meghaly showed maximum reduction in total chlorophyll in response to glyphosate. Root growth was comparatively less affected in Arka Vikas. Further studies on incorporating glyphosate resistance are underway.

CROSS-RESISTANCE IN *PHALARIS MINOR* AGAINST FENOXAPROP – RED SIGNAL APPEARS IN INDIA

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Little seed canary grass (*Phalaris minor* Retz.) is a major annual weed of wheat in the rice-wheat sequence of North-West India. Isoproturon was largely used by farmers against this weed since 1980s but intensive use of isoproturon coupled with mono-cropping resulted into the evolution of resistance in *P. minor* in 1992. Pot culture experiments conducted during last 4-5 years indicated that resistant biotypes of *P. minor* required 6.3 to 11.2 times more of isoproturon compared to susceptible biotypes. Consequently, recommendation of isoproturon was withdrawn from resistance affected areas in 1997 and four alternate herbicides (clodinafop 60 g/ha, fenoxaprop 120 g/ha, sulfosulfuron 25 g/ha and tralkoxydim 350 g/ha) were recommended. Pot-culture experiments, at CCS Haryana Agricultural University, Hisar and farmers field trials in resistance prone areas conducted in 1995-96 and 1996-97 clearly indicated that these alternate herbicides including *fenoxaprop-p-butyl* (Puma super, 10 EC, Agro Evo) were equally effective against susceptible as well as resistant biotypes of *P. minor.* The GR 50 values in case of fenoxaprop ranged from 19.3 to 22.9 g/ha against two isoproturon-resistant (H3 and KR1) and two susceptible (R1 and H2) biotypes. Then complaints were received from few farmers regarding poor performance of fenoxaprop after 2-3 years of its continuous use in the same field. The seeds of progenies of such six biotypes which were already treated with fenoxaprop for 2-3 years were collected from affected fields in 1999-2000 and were further subjected to pot culture experiments. It was confirmed that GR50 values of fenoxaprop in these six biotypes collected from resistance affected areas now varied from 62.7 to 90.6 g/ha clearly indicating red signal of cross-resistance in *P. minor* against fenoxaprop has started appearing in India. Similarly large scale failure of fenoxaprop was reported in Mexico and based on diagnostic survey by CIMMYT, Mexico. It has been found that performance of fenoxaprop which was excellent at initial stages was now poor against *P. minor* particularly in the fields where fenoxaprop alone was continuously used in wheat. Seeds of the progenies of fenoxaprop treated biotypes (two of *P. minor* and one of *P. paradoxa*) were collected and further subjected to bioassay studies at Obregaon, CIMMYT, Mexico in 1999. The GR50 values of fenoxaprop based on probit analysis for *P. minor* biotypes were 87.4 and 133.1 g/ha, and for *P. paradoxa,* it was 195.3 g/ha. Now situation in India may also be similar to Mexico if proper attention is not given regarding herbicide rotation, optimum doses, herbicide mixtures, proper method of application and other resistance management strategies.

EVALUATION OF JV 485 AND SULFOSULFURON AGAINST RESISTANT BIOTYPES OF *PHALARIS MINOR*

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Isoproturon resistant biotypes of *P. minor* have spread to over 1 m ha of N-W India causing a threat to the option of chemical weed control. The resistant biotypes have been found to degrade isoproturon by enhanced detoxification mediated by cyto P450 monooxygenase enzymes.

Herbicides of different mode of action are required to combat the evolution of cross-resistance. Experiments were conducted to evaluate the efficacy of JV 48500 (isopropazol) and Mon 37500 (sulfosulfuron) against the resistant and susceptible biotypes of *P. minor* and selectivity against wheat. Plants of resistant/susceptible biotypes and wheat were raised in a glasshouse (198.6 $mEm^{-2} s^{-1}$ PFD, 14 h photoperiod with max/min temp of 30/14°C with 10 plants/pot arranged in a completely randomized block design. JV 485 was applied 2 DAS (PRE); isoproturon and sulfosulfuron (± 0.2% surfactant) were applied 21 DAS (POE at the 2-3 leaf of *P. minor* and 3-5 of wheat) and 35 DAS (4-6 leaf stage) with 3 & 4 replicate pots for each treatment. Plants were sprayed using a motorized track sprayer fitted with a flat fan even nozzle at 300 kPA pressure delivering 200 L water/ha. Observations were periodically recorded for visual mortality and fresh/ dry weight were recorded 4-6 weeks after treatment.

Wheat was relatively safe to the treatments of JV485 up to 100 g which being >16 time the GR_{50} values for the *P. minor* biotypes; Mon 37500 was equally safe to wheat and there was no growth inhibition at 20 g ai/ha (± surfactant); both the herbicides were highly effective against isoproturon resistant biotypes of *P. minor*. Mon 37500 was effective even up to 4-6 leaf stage of *P. minor*, some variations though were observed among the biotypes and need further confirmation under the field conditions. Surfactant (0.2% Mon 0818) enhanced the efficacy of Mon 37500 and is desired to use under field conditions.

ISOPROTURON-RESISTANCE IN *PHALARIS MINOR* – AN IRREVERSIBLE PHENOMENON

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Resistance in *Phalaris minor* against isoproturon is now well established fact in rice-wheat cropping areas of North-West India. It has spread more intensively even in new areas of rice-wheat cropping zones adjoining already resistance affected areas. Since 1997 recommendation of four alternate herbicides (*clodinafop* 60 g/ha, *fenoxaprop* 120 g/ha, *sulfosulfuron* 25 g/ha and *tralkoxydim* 350 g/ha) has replaced the already existing recommendation of isoproturon against resistant *Phalaris minor* in rice-wheat cropping sequence. Undoubtedly, the higher cost of new alternate herbicides is continuously an headache for farmers inspite of their improved efficacy compared to isoproturon. And that is why it has been a question of great concern amongst farmers and scientists that once resistance has appeared, it can be reversed or not ? The basic idea behind these queries might be to explore possibilities of reuse of isoproturon after some definite time interval against resistance affected *Phalaris minor* biotypes once subjected to alternate herbicides just to replace these costly herbicides. Keeping these points in view, survey was conducted in resistance affected areas and seeds of progenies (four in case of clodinafop, six in case of fenoxaprop, five in case of sulfosulfuron and one in case of tralkoxydim) already treated continuously for 2-3 years with each of alternate herbicides at recommended doses were collected and subjected to pot-culture experiments at CCS Haryana Agricultural University, Hisar during 1999-2000. The progeny of *Phalaris minor* previously treated with particular herbicide was subjected to graded doses of that herbicide in addition to x and 2x doses of each of other three alternate herbicides and isoproturon at 3 leaf stages. Herbicides were applied with knapsack sprayer fitted with flat fan nozzle using 650 L water/hectare. The pots were arranged in completely randomized design keeping three replications. The dry weight of *Phalaris minor* was recorded 50 days after spraying. Visual phytotoxicity using 0-100 scale (0 = no mortality and 100 = complete

mortality) recorded 45 days after spraying was subjected to probit analysis to find out GR 50 (dose required for 50% growth reduction) levels of various herbicides against each respective biotypes. Based on these studies, it was found that X and 2X doses of each alternate herbicides except lower doses (60 g/ha) of fenoxaprop were quite effective against each of *Phalaris minor* biotypes but isoproturon still at X and 2X doses was effective against none of these biotypes. The data on visual phytotoxicity and dry weight reduction clearly indicated that reuse of isoproturon after three years use of alternate herbicides is not possible to effectively manage resistant *Phalaris minor* and based on these studies, it appears that the phenomenon of isoproturon resistance once evolved in *Phalaris minor* infesting wheat is irreversible.

STUDY ON THE PERSISTENCE OF SULFOSULFURON IN SOIL

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Presistence of sulfosulfuron N [4,6-dimethoxy-2 primidnl amino-carbosyl-2-(ethyl sulfonyl) imidazo (1,2,9) Pyridine-3-sulfonamide] in loamy sand was studied using wild oats as indicator plant. The herbicide concentration tested were control, 0, 0.01, 0.10, 1.0. 5.0 and 10.0 ppm and field dose (0.025 kg/ha). Sulfosulfuron concentration 5 and 10.0 ppm affected the emergence of oats seedling. The oat shoot height and dry weight decreased in treated pots as compared to control. The data indicate that oat seedlings suffered adversely even when planted after 80 days at higher doses (5.0 and 10.0 ppm). The application of Sulfosulfuron (0.025 kg/ha) in wheat did not show its residual effect on succeeding crops.

BIOASSAY STUDIES ON THE PERSISTENCE OF METSULFURON IN SOIL

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The residual activity of metsulfuron in loamy sand was studied using maize as indicator plant. Germination of maize was affected at 0.01 to 10.0 ppm of metsulfuron but after 20 days it germinated in 0.01 and 0.1 ppm and did not germinate at 1.0 to 10.0 ppm upto 60 days. Dry weight of plant decreased with increase in conecentration of herbicide as compared with control. The data indicated that metsulfuron was still persisting up to 60 days and had phytotoxic effect on maize seedlings.

RESIDUAL EFFECT OF HERBICIDE APPLIED FOR WEED CONTROL IN COTTON

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Residual carry over in soil of Visor (Imidazolines thiazopyr) 100, 120, 140 g/ha applied pre-emergence to cotton crop was studied using cucumber as an indicator plant. The data revealed that herbicide applied had no marked effect on emergence count of cucumber. Similarly, plant height and dry weight per plant of cucumber seedling at all doses of herbicide were at par with control. The herbicide applied to cotton left no effect in soil to adversely affect the cucumber seedlings and had no soil carry over effect on the succeeding crops.

DEGRADATION AND MOVEMENT OF HERBICIDES IN SOYBEAN RICE AND GROUNDNUT

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Field studies were conducted on degradation of pendimethalin and metolachlor in soybean, butachlor in rice and oxyflurofen in groundnut and their effects on soil microflora. The degradationn pattern was studied by collecting soil samples at different time intervals and residues were estimated by Gas Liquid Chromatography with E.C.D. detector.

In soybean,pendimethalin @ 1.0 and 1.5 kg a.i. /ha applied as pre emergence degraded by 40 and 60 days after sowing (DAS) graded within 20 and 40 DAS and the residues were not found in post harvest soils. The half life was 7.75 and 9.2 days for pendimethalin and 8.00 and 9.52 days for metolachlor @ 1.0 & 1.5 kg a.i. /ha respectively.

Studies on effectof herbicides appiled to soybean on soil microflora indicated that the bacterial and fungal population (dilution plate method) were lower in all the herbicide treated plots at 30 DAS as compared to untreated plots. Greater decline in bacterial population was observed with application of pendimethalin @ 1.5 kg a.i. /ha. However, the bacterial population increased by harvest as the toxic effect of herbicides was minimized due to degradation.

In rice, butachlor degraded by 30 - 40 DAT. The half life butachlor applied @ 1.0, 1.5 and 2.0 kg a.i. /ha,12.3, 14.97 and 16.2days, Residues of butachlor were not found in soil. Grain and straw at the time of hasves of rice crop. Butachlor degraded safely within the crop period.

In groundnut, 85-90% of oxyfluorfen was lost within 40 DAE the initial deposits of oxyfluorfen in soil declined sharplyboth in 0.10 and 0.15 kg a.i. /ha representing a l oss of about 66 % and 50 % respectively of the toxicant within a period of 20 days. the half-life was found to be 19.43 and 28.87 days respectively in 0.10 and 0.15 kg a.i. /ha.

All the herbicides remained in the soil upto 15 cm in alfisol and upto 10 cm in vertisol with major qunatity of the herbicide remaining in the top 0- 10 cm depth.

HERBICIDE RESIDUES IN CUMIN SEEDS

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Cumin (*Cuminum cyminum* L.) is one of the most important seed spices crop and consumed in daily diets with vegetables. Gujarat and Rajasthan are leading states in production of cumin in India. Among different herbicides, pendimethalin, fluchloralin and trifluralin are effective to control the weeds without phytotoxicity on cumin crop. Therefore, a field study was conducted to know whether the dinitroaniline herbicides applied as pre-plant are absorbed by cumin crop and

translocated in seeds or not. The cumin seed samples were collected at the time of harvest and herbicide residues estimated by GC. Fluchloralin residues (0.040 ppm) were detected in cumin seeds but it was below MRL, while residues of pendimethalin and fluchloralin were not detected in cumin seeds. Therefore, use of these herbicides at recommended dose (1.00 kg/ha) for weed management in sandy loam soil in cumin crop is safe.

EFFECT OF SOIL AND WATER MANAGEMENT ON BUTACHLOR RESIDUES IN LOWLAND RICE

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An experiment was conducted to study the effect of three soil and water management practices (Intensive puddling shallow submergence, Intensive puddling phasic submergence and normal puddling phasic submergence) and three weed managements practices (Weedy check, hand weeding once and butchlor @ 1.5 kg a.i.ha-1) on butachlor residues in factorial design with three replications at Tirupati campus of Acharya N.G. Ranga Agricultural University during kharif 1996. Soil samples collected in butachlor applied plots immediately after harvest of rice were processed and analysed for butachlor residues using gas chromatography equipped with electorn capture detector. Intensive puddling and shallow submergence recorded 0.04 ppm butachlor residue. This was far below the toxic level of 1.0 ppm. Phasic submergence with intensive and normal puddling had below detectable residue limits.

PERSISTENCE OF METRIBUZIN IN SOIL AND SOYBEAN CROP

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Metribuzin [4-amino-6(1,1-dimethyl ethyl)-3(methylthio)-1,2,4-triazin-5[4H]-one), is an asymetric triazinone herbicide used as a selective pre-and post-emergence herbicide. It has shown effective control of a large number of grassy and broadleaf weeds infesting agricultural crops such as soybean, sugracane, corn, wheat and vegetables including tomato, potato and carrot. Integrated pest management (IPM) programmes have reduced the dosage schedule of pesticides in various crop. Efficacy and persistence of metribuzin was studied at a much lower rate to use this herbicide under IPM progamme. Persistence of metribuzin was investigated in soil in soybean crop under IARI tropical conditions following pre-emergence application @ 150 g a.i/ha. The herbicide got leached down to 30 cm depth within 24 hrs perhaps because of rain that followed herbicide application. About 58% dissipation was observed in 26 days. The half life in soil was 21 days. There was almost complete dissipathion of metribuzin in soil at soybean harvest (110 days of the application) along with effective weed control. Soybean grains and oil were found free of any residue of the herbicide and were considered safe for consumption.

GROUND WATER CONTAMINATION OF ATRAZINE RESIDUES IN CONTINUOUSLY APPLIED PLOTS OF SUGARCANE IN KARNATAKA

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A field study was undertaken to determine the residues of atrazine in ground water, where in atrazine was applied continuously over twenty years in sugarcane at Regional Research Station, University of Agricultural Sciences, V.C.Farm, Mandya. Piezometers were installed to a depth of 1.80 m at the center of the sugarcane plot applied with atrazine and water samples were collected. Besides water samples were also collected from the top layer of the open wells/pond at different locations close to the sugarcane plot. The results demonstrated that only the water samples collected from both the piezometers showed atrazine residues of 0.0046 and 0.0020 mg L^{-1} on 45th day after atrazine application @ 1.00kg ai ha^{-1}. Water samples collected from adjacent wells and pond did not show any residue. Thus, in spite of regular applications of atrazine at @ 1.00 kg a.i. ha^{-1} each year. The residues of atrazine were with in the safe limit (< 0.003 mg L^{-1}) and do not get accumulated in ground water.

BIO-EFFICACY AND PERSISTENCE OF HERBICIDES IN SOIL UNDER FINGER MILLET–GROUNDNUT CROPPING SYSTEM

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Field experiments were conducted at Main Research Station, Hebbal Bangalore to know the bio-efficacy and persistence of herbicides in cropping system of finger millet in kharif and groundnut in summer during 1996-97 and 1997-98. Herbicides like 2,4-D ethyl ester @ 0.50 and butachlor @ 0.75 kg a.i. ha^{-1} in finger millet and pendimethalin and metolachlor @ 1.00 kg a.i. ha^{-1} and fluazifop-p-butyl @ 0.125 kg ai ha^{-1} in groundnut were evaluated for bio- efficacy. Persistence in soil was studied only for butachlor and pendimethalin by gas chromatograph. The study revealed that butachlor controlled grass and broad leaf weeds effectively, where as 2,4-D ethyl ester controlled only broad- leaved weeds. The grain yield in butachlor treatment was on par with hand weeding. Persistence studies for butachlor for two years in soil under finger millet indicated that, butachlor residues in soil were below detectable level beyond 20 days after application . Further persistence showed a close correspondence to first order degradation kinetics. Movement of butachlor to sub soil (15-30cm soil layer) was negligible and half-lives were 15.5 and 11.1 days during I and II year respectively. In groundnut crop pendimethalin controlled grasses effectively followed by metolachlor. None of the herbicide treatments showed significant differences in yield compared to hand weeding. When pendimethalin was used for groundnut, the residues were below detectable level beyond 50 and 60 days in the II and I year respectively. The half-lives were 31.3 and 32.3 days during I and II year respectively. The degradation pattern was almost similar during both the years. There was absolutely no movement of pendimetahlin into 15-30 cm soil layer. It can be concluded that use of butachlor @ 0.75 kg a.i. ha^{-1} and pendimethalin @ 1.00 kg a.i. ha^{-1} continuously for two years are safe in finger millet –groundnut cropping system with out deleterious effect on the yield and leaving no residual problem to the succeeding crops.

HERBICIDAL CONTROL OF *EICHHORNIA CRASSIPES* (MART.) SOLMS AND ITS IMPACT ON WATER QUALITY AND FISH GROWTH

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Experiments were conducted during 1996 to compare the efficacy of different herbicides for the control of water hyacinth and to study their impact on quality of water and fish growth in the water system. The performance of paraquat 0.90 kg ha^{-1}, 2,4-D 1.00 kg ha^{-1}, glyphosate 2.20 kg ha^{-1} and imazapyr 0.50 kg ha^{-1} were compared. Regarding the bio-efficacy, imazapyr 0.50 kg ha^{-1} recorded the highest reduction in chlorophyll content (100 per cent), least fresh weight (10.00 g $plant^{-1}$), least plant height (1.00 cm) and 100 per cent plant mortality, during the last observation. However, the dissolved oxygen content of water was reduced to the least of 0.35 ppm by imazapyr and all the herbicides resulted in a reduced dissolved oxygen content compared to the control where fishes were grown in water, free from the weed as well as herbicides. Presence of the weed itself reduced the same to 2.59 ppm. All the herbicides reduced the pH of water and increased fish mortality, with imazapyr recording the highest of 71.42 per cent, unsprayed check (with the weed) recording 28.56 per cent and glyphosate recording 14.28 per cent.

BRIDGING YIELD OF WHEAT THROUGH DEMONSTRATIONS ON WEED CONTROL TECHNOLOGY AT FARMER'S FIELDS

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Seven field demonstrations were conducted during winter season of 2000 - 01 on wheat at three villages of Jabalpur District to see the performance and profitability of proven herbicides viz., isoproturon at 1.0 kg/ha on weed growth and yield of wheat at farmers' field. Fields were found infested mainly with *Phalaris minor, Medicago hispida, Chenopodium album. Rumex dentatus, Lathyrus aphaca* and *Vicia sativa*. Out of seven demonstration sites, two were found heavily infested with *Phalaris minor* where isoproturon and metribuzin were applied separatelu. In rest of the demonstrations, fields were infested with mixed weed flora where isoproturon and 2,4-D were applied alone and in combination. Results revealed that isoproturon failed to control the *Phalaris minor* suspecting the problem of resistance of this weed against isoproturon as the weed seed was brought from Punjab where the problem of resistance already exists. However, metribuzin controlled broadleaved weeds and mixture of 2,4-D with isoproturon gave broadspecturm weed control. All the herbicides undertaken for demonstration resulted an increase of 12 to 25 per cent in yield over farmer's practices except in demonstration-1 where isoproturon failed to control *Phalaris minor*. The application of metribuzin at 0.30 kg/ha contributed the highest rate of increase in the yield of wheat (25.48 per cent) as well as net return (Rs.4755/-) over farmer's method.

EFFECT OF SESBANIA ACULEATA INTERCROPPING ON WEED CONTROL EFFICIENCY AND YIELD OF SUGARCANE

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Rice and sugarcane are the main crops in Papanasam command area of Southern District of Tamil Nadu. In recent years, yields in these are shows in declining trend due to lesser application of required quantity of organic manure. Hence to supply the much required organics with low cost and with out any extra cropping period, a field experiment was conducted at Agriculture college & Research Institute, TNAU Killikulam, with the intercropping of daincha (*S. aculeata*) as greenmanure in ridge planting during 2000 - 2001 including the treatments of Farm Yard Manure, Pressmud and Biocompost.

The weed flora of the experimental plot consisted of broad-leaved weeds like *Trianthema portulacastrum, Amaranthus viridis, Datura sp.* grasses like *Echinochloa crusgalli and Cynodon dactylon* and sedges like *Cyperus rotundus*. The two principal weeds were *Trianthema portulacastrum* and *Cyperus rotundus*.

The *Sesbania aculeata* raised as inter crop with 100% recommended NPK in sugarcane and subsequent incorporation at 45th DAP and recorded a weed controlling efficiency of 69.7% and followed by 75% NPK + *S. aculeata* recorded 66.6% weed control efficiency.

From this study, the maximum cane yield was obtained in bio-compost application @ 6.25 t ha^{-1} (135.35 t ha^{-1}) as compared to the control (85.18 t ha^{-1}) and highest weed control efficiency was observed in *Sesbania aculeata* (69.7%).

Hence intercropping of daincha not only increase the cane and sugar yield but also helps to sustain the soil health for further efficient cropping.

EFFECT OF PLANTING METHODS AND IRRIGATION REGIMES ON WEED GROWTH AND YIELD OF LOWLAND RICE

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Field experiments were conducted at Agricultural College and Research Institute, Killikulam, to study the effect of irrigation and stand establishment techniques on lowland rice during June 2000 - February 2001. The experiment was laid out in split plot design and replicated thrice. The treatment combination comprised of irrigation to a depth of 5 cm on disappearance of previously ponded water, Rotational Water Supply (RWS) 4 days on - 3 days off, and farmers practice of continuously submergence to 5 cm depth in main plots and establishment techniques viz., broadcasting of seeds, drum seeding, broadcasting of seedlings, random transplanting, and line transplanting in sub plots.

The analysis on weed vegetation indicated that *Echinochloa colona* was dominant among grasses, followed by *Cynodon dactylon*. Among the sedges, *Cyperus iria* and *Cyperus rotandus*

were the dominant weeds. Under broad leaved weeds, *Ammania baccifera, Eclipta alba, Ludwigia parviflora, Marsilea quadrifoliata* and *Monochoria vaginalis* were observed.

Irrigation and method of establishment had a significant influence on weed density and weed dry matter production. Among the irrigation, adoption of rotational water supply registered higher weed density at 20 and 40 DAS / DAT during both the seasons (68 and 54; 63 and 43 m^{-2}). Lower weed density at all stages was associated with farmer's practice of continuous submergence in both the seasons (47 and 40; 45 and 29 m^{-2}).

Among the different methods of establishment, weed density and weed dry matter was maximum with direct seeding (86 and 81 m^{-2}; 87 and 80 kg ha^{-1}) as compared to transplanting (35 and 37 m^{-2} and 35 and 36 kg ha^{-1}) in both the seasons. Among the method of planting, line planting significantly lowered the weed density on 20 and 40 DAT duting *Kar* season which was followed by random planting. In the second season crop, line planting recorded lower weed density which was on par with random planting at 20 DAT.

With regard to yield, line transplanting with irrigation to a depth of 5 cm on disappearance of previously ponded water registered significantly higher rice grain yield of 5650 and 5392 kg ha^{-1} respectively in *kar* and *Pishanam* seasons which was on par with line transplanting with continuous submergence (5627 and 5358 kg ha^{-1}) during both the seasons.

IMPACT OF WEED CONTROL METHODS AND SOURCES OF N ON THE SOIL FERTILITY STATUS

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Long-term field experiments were conducted to assess the impact of various weed control methods and N sources on the soil fertility status with a rice-rice cropping sequence. There were about six treatments comprising of three weed control methods viz., hand weeding, herbicide mixture (butachlor + 2,4 DEE) and herbicide rotation (butachlor/pretilachlor) and two sources of N [100% as inorganic fertilizer (urea) and 75% as inorganic + 25% N as organic (Sesbania sp.)].

The test crop ADT 36 was raised after imposing the treatments and harvested. The post-harvest soil samples collected from each treatment were used for estimating the physico-chemical properties. The results revealed that, substitution of 25% N through organic (greenmanure) slightly improved the organic carbon content (0.47 to 0.58%) and P availability (16.8 to 20.4 kgha^{-1}) in the soil. The improved soil environment by the addition of organic might have enhanced the organic carbon and P availability. Weed control methods had no significant influence on these parameters.

The application of herbicides and weed control methods did not show any significant variation in the N and K availability of the soil and the values ranged from 182 to 203 kg ha^{-1} for N and 573 to 629 kgha^{-1} for K.

LONGTERM EFFECT OF TILLAGE AND WEED MANAGEMENT PRACTICES ON NUTRIENT DEPLETION BY CROP AND WEEDS IN RICE-RICE CROPPING SYSTEM

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Manipulation of soil physical environment could not only result in altered resource availability for crop growth such as nutrient, moisture and better aeration. In addition, optimum crop management factors would also influence crop growth and its associated activity. Growth and productivity of rice as well as removal of nutrients by rice and weeds in a manipulated evironment need to be studied for better crop cultivation. Hence, field experiment was conducted to study the impact of various tillage and weed management practices on the nutrient depletion by crop and weeds in a rice-rice cropping system. There were about six treatments comprising of conventional, conservation and minimum tillage practices with a without Machete application at 2.5 1 ha^{-1}.

Results on nutrient uptake by rice indicated that minimum tillage + pre-plant glyphosate spraying with pre-emergence butachlor at 1.25 kg/ha recorded higher N uptake. Whereas higher P uptake was recorded with conventional tillage with butachlor application. Conservation tillage with glyphosate and butachlor application resulted in higher K uptake by rice during kharif. During *rabi*, the N & K uptake were higher with minimum tillage with glyphosate and butachlor resulted in higher P uptake by rice. N, P and K nutrient depletion was higher with conventional tillage without any weed management techniques as against the lowest depletion in minimum tillage without any weed management techniques as against the lowest depletion in minimum tillage with glyphosate and butachlor application during kharif season. Whereas, during rabi, conventional tillage with pre-emergence butachlor application recorded lower N and P depletion as compared to minimum tillage recording lower K depletion by weeds. Conventional tillage without weed management resulted in higher depletion of N,P and K by weeds during both the seasons.

QUANTIFICATION OF HERBICIDES PERSISTENCE IN INCEPTISOL THROUGH BIOASSAY STUDIES

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The continuous use of herbicides in the weed management practices may enter the soil and plant system directly or indirectly thus posing persistence problems due to their residual effect even beyond harvest of the crops. Further the crop injury potential from various herbicides applied prior to crop establishment is a function of herbicide persistnece and susceptibility of the crop to herbicide residue. Hence, monitoring the herbicide residue in soil not only helps us in deciding the rate of application for safe use but also to assess the impact of herbicide residue in soil and crop produce.

Bioassay studies were conducted with soil samples collected at 30 days after herbicide application from the field cropped with cotton using the sensitive crop viz., greengram (Co.6). The collected soil samples were air dried, processed, and two and a half-killogram of soil was taken in the clean plastic pots and sown with seeds of greengram. The plants were thinned to five plants

to avoid competition effect. The crop was grown upto 30 days and the growth paramenters such as plant height, root length and fresh biomass were recorded.

The data on bioassay parameters revealed a significant influence of various herbicides on seedling growth of greengram. The reduction in plant height and root length was more in plots treated with 0.50-percent palmarosa oil. The fresh biomass of greengram was highly affected by the application of oxyflourfen at 0.2 kg ha^{-1} which could be attributed to the inherent high persistence of the herbicide in soil. The results on residue content of these herbicides showed that, the highest persistence was associated with oxyflourfen (0.770 ppm) followed by metolachlor (0.644 ppm) irrespective of plant growth parameters studied. The minimum herbicide residue content was observed with pendimethalin, which could be attributed to its faster degradation and lesser half-life period in soil.

EFFECT OF TILLAGE AND WEED MANAGEMENT PRACTICES ON THE CHANGES IN SOIL PHYSICAL PROPERTIES

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Various methods of land preparations were followed to control the weeds and to improve the soil physical environment for sustaining the productivity of soils and crops. Many researchers reported the positive and significant influence of tillage practices on the changes in soil physical and chemical properties besides the contrary results too. But their effect on a long run is not studies widely. Hence, field experiments were conducted to know more about the conditions, under which herbicides perform perform better and the influence of zero and minimal tillage on the transplanted rice productivity.

The tillage practices significantly influenced the puddling index (PI). Conventional practice of one dry ploughing followed by two puddlings improved the puddling condition (PI=76.0%) of the soil by disturbing the tortuacity / pore arrangement of the soil. The bulk density increased with soil depth and the values ranged from 1.309 to 1.524 Mgm-3. Among the tillage methods, the conventional tillage reduced the bulk density of the soil, which could be ascribed to the destruction of soil structure by puddling. Where as the effect of other two tillage proctices were found to be comparable with each other. The porosity of the soil decreased with depth and showed significant variation with tillage practices (39.9 to 62.1%). The minimum tillage increased the total porosity (57%) , while the other two tillage practices showed no significant impact on porosity. The capillary and non-capillary porosity of the soil also showed a decresing trend with depth of soil and showed a non-significant interaction with tillage practices. The values ranged from 36.1 to 56.2% for capillary porosity and 3.0 to 5.8% for non-capillary porosity.

In general, though this is a variation in the physical properties eith tillage treatments, but the effect was non-significant over the initial soil physical properties.

RESIDUAL PERSISTENCE AND WEED CONTROL EFFICIENCY OF METSULFURON-METHYL

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Pot-culture and field studies were conducted at CCS Haryana Agricultural University, Hisar and at farmers' fields, to study the residual persistence and weed control efficiency of metsulfuron-methyl. Pot culture studies indicated that the dissipation of herbicide after 120 days was 44, 53 and 62 % at 15, 25 and 35 °C temperature, respectively. The half-life of metsulfuron-methyl at 15, 25 and 35 °C was observed to be 147, 108 and 70 days, respectively.

The field studies indicated that the persistence of metsulfuron-methyl was more at 25% available soil moisture (ASM) than at 75% ASM. Under 25 and 75% ASM, the significant reduction in dry weight of test plant was discernible at 4 and 8 g/ha dose, respectively, indicating the safe use of herbicide at 4 g/ha under moist conditions without any residual effect. The efficacy of metsulfuron-methul against broadleaf weeds in wheat was evaluated in field experiments at the research farm as well at the farmers fields. It has been observed that metsulfuron-methyl has been quite effective in controlling most of the broadleaf weeds particularly *Rumex* sp which is not controlled effectively by traditional herbicides like 2,4-D. The control of weeds has been found to be more than 80%. Metsulfuron-methyl does not have any adverse effect on any of the wheat cultivars which are sensitive to 2,4-D.

NUTRIENT UPTAKE BY SESAME (*SESAMUM INDICUM* L.) AND ASSOCIATED WEEDS AS INFLUENCED BY HERBICIDES AND CULTURAL METHODS OF WEED CONTROL

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A field experiment was conducted during Kharif, 1999 to find out the nutrient uptake by sesame and associated weeds as influenced by herbicides and cultural methods of weed management. All the weed control treatments significantly lowered the quantum of NPK depletion by weeds and enhanced the nutrient uptake by crop as compared to weedy check. Maximum NPK uptake by sesame was recorded in weed free situation. Different weed control treatments increased the NPK uptake by 50.2 to 173.3%, 47.2 to 155.7% and 5.31 to 117.8% respectively as compared to weedy check. In case of herbicides, fluchloralin @ 1.0 kg a.i. ha + one hoeing at 4 WAS resulted in highest uptake of N (144.62 Kg/ha), P (13.37 Kg) and K (73.5 Kg/ha) which was at par with other two herbicide viz. pendimethalin and fluchloralin at 1.00 kg/ha when integrated with one hoeing at 4 WAS. Minimum uptake of NPK by weeds was recorded in treatments of two hand hoeings at 3 & 6 WAS and integration of one hoeing at 4 WAS with either fluchloralin/ trifluralin/pendimethalin each at 1.00 kg a.i./ha. Variation in doses of herbicides did not bring out any significant effect on N and P uptake by weeds.

EFFECT OF BUTACHLOR ON THE MICROBIAL POPULATION OF DIRECT SOWN RICE

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Field experiments were conducted at Annamalai University Experimental Farm, Department of Agronomy, Annamalainagar to device suitable weed control measures for direct seeded puddled low land rice and to study the effect of the weed control measures on the soil microbial population. The treatments comprised of application of rice herbicide butachlor @1.5 kg a. i. ha^{-1} with and without safener (fenclorim) 4 days after sowing (DAS), 8 DAS alone and also in conjunction with hand weeding at 30 DAS. Hand weeding twice and a weedy check were also maintained.. Pressmud @ 6.25 t ha^{-1} was uniformly incorporated in the plots

The predominant microorganisms were bacteria - *Bacillus cereus* and *Azospirillum* sp., fungi - *Aspergillus niger, Aspergillus flavus, Penicilium crysogenum, Pythium* spp.; actinomycetes - *Streptomyces* sp., *Micromonospora* sp., *Nocardia* sp. and *Actinomyces* sp. The bacterial population at maximum tillering stage was significantly influenced by weed control treatments. At maximum tillering stage, the population of bacteria was significantly reduced by butachlor application when compared with that of unweeded control and twice hand weeding. The injury to microbes caused by herbicide disappeared with the advancement of crop's age and at flowering stage of crop, there was no significant difference among the treatments. The fungal and actinomycetes population remained unaltered by weed control treatments at both the stages.

EFFECT OF DIFFERENT RATES OF ALACHLOR AND METOLACHLOR ON WEED CONTROL, CROP TOLERANCE AND HERBICIDE RESIDUE IN SOYBEAN (*GLYCINE MAX* (L.) MERRIL)

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Field study conducted during 1997 on medium black soil containing 27 % sand, 25.5 % silt and 46.9% clay at the Reseach Farm revealed that application of alachlor at2.0, 3.0 and 4.0 kg/ha and metolachlor at 1.0. 1.5 and 2.0 kg/ha reduced the population of all the dominant weed spices and efficacy of alachlor increased with increasing levels compared to weedy check. However, metolachlor was effective upto 1.5 kg/ha. The efficacy of metolachlor was better than alachlor, particularly against *Echinochloa crusgalli* and *commelina communiss.* The weed control efficiency of alachlor varied from 72.2 - 89.5%, while under metolachlor treatments it was 90.0 - 93.2% as against i 79.1% in hand weeded plots.

Both the herbicides at increasing levels did not cause adverse effect on germination. The crop tolerated almost double the recommended dose of the herbicides without showing any phyto toxic symptoms in terms of crop growht and vigor. The herbicidal treatments (1458 1664 kg/ha) produced significantly higher seed yield than weedy check (1032 kg/ha) and onpar to hand weeding 91429 kg/ ha). The herbicide residue analysis revealed that in most of the samples the herbicide residue could not be detected. Application of metolachlor at 3.0 kg/ha showed residue concentration of 0.008 mg/kg of seed which was much lower than maximum residue limit (MRL). The residue of alachlor was detected in straw at 4.0 kg /ha (0.0007 mg/ha). The soil samples taken from 15-30 cm and 30 - 45 cm depth were found contaminated with metolachlor reesidue to the extent of 0.008 and 0.0012 mg/kg soil, respectively and this concentration was much below the MRL. The study revealed that both the herbicide did not leave the residue and neither contaminated the soil nor the plant system.

PERSISTENCE OF PENDIMETHALIN IN SANDY LOAM SOIL OF DELHI FOLLOWINGPRE-EMERGENCE APPLICATION TO SOYBEAN

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Experiment were condùcted at Indian Agricultural Research Institute, New Delhi, during *kharif* season of 1995 and 1996, to determine the persistence of pendimethalin in sandy loam soil and grains following its pre-emergence application to soybean. The semi-logarithmic plots of data showed that the rate of dissipation of pendimethalin did not follow first order kinetics at any rate of application in both the years. The rate of dissipation of pendimethalin (at 1.0 and 1.5 kg/ha) was more acute during the first 30 days in which more than 55 per cent of the original value of pendimethalin was lost and by 45 days more than 75 per cent of pendimethalin was dissipated and reached to a non-detectable limit at harvest (110 days) of soybean. The half-life values of pendimethalin at 1.0 and 1.5 kg/ha in *kharif* season varied between 24-25 days respectively. The soybean grains were safe for consumption as pendimethalin residues in grains were not detected even at 1.5 kg/ha application rate to soybean.

EFFECT OF HERBICIDES IN A TRANSPLANTED FINGER MILLET-GROUNDNUT CROPPING SEQUENCE ON NATIVE VA MYCORRHIZAL FUNGI AND SOIL MICROBIAL BIOMASS

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The experiment was conducted continuously for four years with ragi in kharif and groundnut in summer, two crops a year in a Randomized Block Design. The herbicides used for finger millet were 2,4-D and butachlor and that for groundnut were fluazifop-p-butyl, metalachlor and pendimethalin with unweeded and hand weeded control treatments. The weed control treatments of the previous crop were superimposed with the weed control treatments of the succeeding crop every year. Soil samples were collected after fourth year of study in the root zone soil of each crop after harvest and analysed for VAM spores, infective propagules and microbial biomass.

Application of herbicides did not significantly influence spore numbers in the root zone soil of finger millet grown in kharif whereas the number of infective propagules were considerably increased due to application of 2,4-D compared to hand weeded and unweeded control treatments. Hand weeding markedly reduced infective propagule numbers compared to unweeded control. Soil microbial biomass did not significantly differ in any of the treatments. Application of butachlor did not affect VAM colonization whereas 2,4-D application significantly reduced VAM colonization. There was a highly significant negative correlation between soil microbial biomass and VAM colonization ($r = 0.883^{**}$) and a positive correlation of finger millet grain yield to soil microbial biomass and a negative correlation with VAM colonization, however it was not statistically significant.

Application of metalachlor enhanced spore numbers in root zone soil of groundnut grown in summer compared to unweeded control. Fluazifop - p - butyl and pendimethalin significantly reduced spore numbers compared to hand weeding.The number of infective propagules was highly stimulated by fluazifop-p-butyl compared to hand weeding or unweeded control. Least number of

infective propagules, considerably lower than control was observed in pendimethalin treated plots. All the herbicides used for groundnut significantly stimulated soil microbial biomass compared to hand weeded treatment. VAM colonization significantly decreased in all the treatments except fluazifop-p-butyl compared to hand weeding. A significant negative correlation between soil microbial biomass and VAM colonization ($r = 0.729^{**}$) was noticed. There was a positive correlation between pod yield and microbial biomass but negatively correlated with VAM colonization; however they were not significant.

EFFECT OF HERBICIDES ON NATIVE VA MYCORRHIZAL FUNGI AND MICROBIAL BIOMASS IN SOIL UNDER MANAGEMENT OF WEEDS IN SPECIFIC CROPPING SYSTEMS

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An experiment was conducted wherein seven herbicides *viz.* 2,4-D , isoproturon, butachlor, anilofos, oxadizon, chloimuron ethyl, metsulfuron methyl and two weed control treatments were compared in a Randomized Block Design replicated thrice in a red sandy loam soil using ragi cultivar GPU-28. The results indicated that application of anilofos at recommended dose resulted in a significantly higher number of spores compared to the unweeded control plots, plots in which hand weeding was done as well as all other herbicidal treatments. The number of Infective propagules was highest with 2,4- D at 0.75 kg ha^{-1} followed by isoproturon. Compared to unweeded plots application of metsulfuron methyl decreased the number of infective propagules.

Soil microbial biomass was not affected due to application of anilofos, chlorimuron ethyl and metsulfuron methyl compared to hand weeding as they were all statistically on par with each other but they were all significantly stimulated more compared to unweeded control. Application of 2,4-D and isoproturon and butachlor significantly reduced the microbial biomass compared to hand weeding; however they were on par with unweeded control.

Application of all the herbicides increased mycorrhizal colonization compared to plots where hand weeding was done. Maximum mycorrhizal colonization of 55.2% occurred when oxadiazon was applied at the recommended level. The grain yield was least in unweeded plots. Hand weeding and application of herbicides significantly increased grain yield.

There was a negative correlation between soil microbial biomass and VAM colonization but was not statistically significant. The number of infective propagules had a significant negative correlation with soil microbial biomass ($r = -0.461^{*}$). There was a significantly negative ccrrelation between soil microbial biomass and grain yield ($r = -0.305^{*}$) but a positive correlation was noticed between VAM colonization and grain yield however, it was not statistically significant.

STUDIES ON RESIDUAL EFFECTS OF 2, 4-D NA SALT APPLIED IN RICE ON SUBSEQUENT WHEAT CROP IN RICE - WHEAT CROPPING SYSTEM

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Field trials with 6 treatments were laid out in a four replicated randomized block design during rabi 1992-93 and 1993-94 at Agronomy Research Farm of N. D. University of Agric. & Tech., Kumarganj Faizabad, to find out the residual effects of 2, 4-D Na Salt applied in rice on succeeding wheat crop in rice-wheat cropping system. The soil of the experimental field was found silt loam in texture and medium in fertility with a pH 8.4. 2, 4-D Na Salt was applied in transplanted rice at 10 DAT to control the weeds @ 0.25, 0.50, 0.75, 1.0 and 1.25 kg/ha. After the harvest of rice the layout was left undisturbed for sowing of wheat crop in succeeding winter season. Wheat CV. HUW 234 was sown and all the agronoimic practices recommended for wheat were adopted during the course of investigation. Density and dry weight of weeds and wheat yield were recorded and data were analysed statistically.

The results revealed that application of 2, 4-D Na salt at varying rates i.e. 0.25, 0.50, 0.75 1.0 and 1.25 kg/ha in transplanted rice at 10 DAT did not bring out significant effect on the yield of succeeding wheat crop and density as well as dry weight of associated weeds. Finally it is concluded that 2,4-D Na Salt applied at different doses (0.25, 0.50, 0.75, 1.0 and 1.25 kg/ha) in rice 8 days after transplanted did not show its any harmful toxic residual affects on succeeding wheat crop as well as associated weeds.

A STUDY OF NON-ADOPTION OF HERBICIDES IN KHARIF CROPS IN SURGUJA (CHHATTISGARH)

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Surguja is a Tribal dominating district of newly born stete Chhattisgarh. Use of herbicides in the district is negligible. Therefore, a study was conducted to find out the reasons of non-adoption of herbicides in Kharif Crops in Surguja. Out of 19 blocks of the district four blocks were selected for the purpose and out of these blocks eight villages were selected. Thus, twenty farmers from each village i.e.; 160 farmers were randomly selected for the study and were interviewed as per interview schedule.

The study revealed that major constraints for non-adoption of herbicides in Kharif crops were non-availability of herbicides, lack of technical knowledge, lack of demonstration, lack of skill, illiteracy of the farmers and lack of communication media were recorded in high range with mean score of 4.90, 4.85, 4.70, 4.65, 4.50 and 4.30, respectively. In medium range constraints fodder to animals, poor socio-economic status, cost of herbicides, lack of money, continuous rainfall, timely unavailability were recorded with mean value of 3.75, 3.70, 3.60, 3.55 3.40 and 3.10, respectively. In low range constraints harmful effects of herbicides on crop plants, un-necessity of herbicides, duplicacy in herbicides, harmful effects on soil were recorded with mean score of 2.25, 2.15, 2.10, and 2.05, respectively. Therefore spacial and skill training,demonstration and farmers day should be organised at village level to increase the knowledge, skill and adoption of herbicides use in the district.

CROP STAND MANIPULATIONS FOR REDUCING HERBICIDE USE IN TRANSPLANTED RICE (*ORYZA SATIVA* L.)

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Field studies were carried out during *kharif* season of 1999 and 2000 to explore the possibility of reducing herbicide use in transplanted rice by increasing competitiveness of the crop through variable plant populations. Treatments included combinations of 3 crop stands (25, 33 and 44 hills m^{-2} under 20 x 20 cm, 20 x1 15 cm and 15 x 15 cm spacings, respectively) and 3 weed control treatments (pre-em. butachlor 1.5 kg/ha, butachlor 1.125 kg /ha and unweeded control).

Increase in crop stand from 25 hills m^{-2} to 44 hiils m^{-2} caused substantial decrease in population, dry matter and nutrient depletion by weeds and a significant increase in number of tillers, panicle length, grain yield and nutrient uptake by the crop. Crop stand of 44 hills m^{-2} produced 27.5 and 11.8 per cent increase in grain yield of rice over that under 25 and 33 hills m^{-2}. Combinations of crop stand and weed control treatments caused pronounced effect on crop growth and grain yield. Butachlor 1.125 kg/ha under 44 hills m^{-2} produced significantly higher paddy yield than that under butachlor 1.5 kg/ha with 25 hills m^{-2}, indicating there by possibility of reducing herbicide use in transplanted rice under thicker plant population.

INFLUENCE OF NITROGEN LEVELS AND PLANT DENSITIES ON THE GROWTH AND DEVELOPMENT OF WEEDS IN TRANSPLANTED RICE (*ORYZA SATIVA*)

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A field experiment was carried out at the experimental area of Punjab Agricultural University, Ludhiana during 1998-99, to study the competitive behaviour of transplanted rice with variable plant densities (22, 33 and 44 hills/m^{-2}) receiving different nitrogen levels (120, 150 and 180 kg/ ha) having the infestation of *Echinochloa crusgalli*. The field under the experiment was sandy loam in texture and was under continuous rice wheat rotation since from last eight years.

During 1998, seed yield of rice increased significantly with each increment in N level, however, during 1999, aplication of 180 kg N/ha significantly increased seed yield of rice than 120 and 150 kg N/ha and the differences in the latter treatments were found to be non-significant. Similarly seed yield of rice increased significantly with increase in plant population from 22 to 44 plants (hills) per sq. meter during both years. Higher plant density increased seed yield by 19.1 and 9.3 percent than the recommended (33 plants/m^2) and 47.3 and 12.0 than 3/4th of recommended (22 platns/m^2) during 1998 and 1999, respectively. Higher dose of nitrogen (180 kg/ha) and higher plant density of 44 plants/m^2 resulted in a significant reduction in dry matter accumulation by weeds as compared to recommended N (120 kg/ha) and plant density of 33 plants/m^2 during both the years.

CROP WEED COMPETITION AS INFLUENCED BY SOWING DATES OF CHICKPEA CULTIVARS

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An experiment was conducted during 1999-2000 and 2000-2001 at Varanasi to study the effect of sowing dates on weed and yield of chickpea cultivars under weed free and weedy conditions. Treatments comprised of combinations of three dates of sowing (20th October, 5th November and 20th November) as main plots, three genotypes (Avarodhi, Pusa 256 and KPG 59) as sub plots and two weeded controls (Weedy and Weedy free check) as sub-sub-plots in a split-split design. The major weed flora were *Anagallis arvensis L.*, *Chenopodium album* L., *Cyperus rotundus L.* and *Melilotus spp. L.* 5th November sown crop showed maximum population and dry weight of weeds as compared to other sowing dates. Date of sowing significantly influenced weed dry weight in only *Chenopodium album* L. No significant variation in weed species and weed dry weight was noted among chickpea genotypes. Weedy check had significantly higher weed dry weight than weed free treatment. Maximum grain yield (25.95 qha^{-1} ± 1.82 at $CD_{0.05}$ = 5.04) was recorded in 5th November sown crop and minimum (20.27qha^{-1} ± 1.82 at $CD_{0.05}$ = 5.04) with 20th November sown crop. Pusa 256 recorded maximum grain yield (24.19 qha^{-1}). An average increase of 24.81 per cent was noted in weed free crop compared to weedy check. Interaction effect of varieties and dates of sowing showed significant variations on grain yields during both the years. Avarodhi was less affected in respect of yield due to delayed sowing as compared to other varieties. The highest benefit cost ratio (2.83) was found in weed free conditions sown at 5th November in Pusa 256 genotype.

EFFECT OF SOLARIZATION ON THE PERSISTENCE OF HERBICIDES

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Herbicides are used to reduce the competitive ability of weeds and realize the potential yield of a crop. The extensive use of herbicides often leads to the persistence of their residues in soil. These residues often affect the germination of the next crop or even leach down in ground water. The methods for decontamination of herbicides are not universal in nature as the chemical structures of herbicides vary. This paper examines soil solarization as a technique for the decontamination of soil from the residues of five herbicides and indicates where it can be of use. It was found that solarization could enhance the persistence of alachlor and metolachlor from 13 to 15 and 9 to 12 days, respectively as is evident from their half lives but pendimethalin degraded faster after intervention by solarization.

STUDIES ON GRADED LEVELS OF MAJOR NUTRIENTS AND CROP - WEED COMPETITION ON THE GROWTH AND YIELD OF HYBRID MAIZE

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Two field Experiments were conducted at Annamalai University Experimental Farm, Annamalainagar during kharif (June-October) 1998 and Summer (February to May) 1999 to study the effect of graded levels of major nutrients and crop-weed competition period on the growth and yield of hybrid maize. The experiments were laid out in split plot design replicated thrice with three main treatments viz., 25 per cent less than the recommended level of major nutrients, recommend level of major nutrients and 25 per cent more than the recommended level of major nutrients and eight sub-treatments viz., weedy check, weedy upto 15 DAS, weedy upto 30 DAS, weedy upto 45 DAS, weed free upto 15 DAS, weed free upto 30 DAS, weed free upto 45 DAS, and weed free upto harvest. Among the main treatments, 25 per cent more than the recommended level of major nutrients favourably influenced the growth and yield of maize. In the sub-plot treatments weed free upto harvest recorded less weed population, weed biomass, least weed index, the higher crop growth and yield. However, it was comparable with weed free upto initial 15-45 DAS. The treatment combination of 25 per cent more than the recommended level of major nutrients and weed free upto initial 15-45 DAS recorded the highest crop growth and yield.

SOIL SOLARIZATION – A NON PESTICIDAL METHOD FOR WEED MANAGEMENT

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Soil solarization is a non pesticidal method of controlling soil borne pests by placing plastic sheets on moist soil during periods of high ambient temperature. The plastic sheets allow the sun's radiant energy to be trapped in the soil, heating the upper levels and increased soil temperature kills many disease- causing organisms (pathogens),nematodes,and weed seed and seedlings. Field experiments were conducted at Annamalai University Experimental Farm, Annamalainagar during 1995-'96 to assess the performance of soil solarization on the weed management and growth and yield of sorghum .

The experiments were laid out in split plot design replicated thrice with four main treatments viz., off season soil solarization for 20,30 & 40 days and no soil solarization and five sub treatments viz., unweeded control, twice hand weeding, metolachlor (0.75 kg ha^{-1}), metolachlor + 1 HW and metolachlor + intercropping with black gram. The predominant weed flora of the region include *Trianthema portulacastrum Cleome viscosa, Cyperus rotundus* & *Cyanodon dactylon.* Results revealed that the treatment viz., off season soil solarization for 40 days along with metolachlor + intercropping resulted in greater reduction of weed population, biomass, nutrient depletion by weeds and higher weed control index (78.5%). Off season soil solarization for 40 days along with metolachlor + intercropping with blackgram out yielded all other treatments in respect of grain yield.

EVALUATION OF LONG TERM BENEFITS OF CONSERVATION TILLAGE BY USING ROUND UP-CT IN TRANSPLANTED RICE FOLLOWED PULSES IN CAUVERY DELTA

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A field experiment was conducted during late kharif of 2000-2001 at the Experimental Farm, Department of Agronomy, Faculty of Agriculture, Annamalai University, Tamil Nadu to evaluate the long term benefits of conservation tillage by using Roundup/CT in transplanted rice (fb. pulses) in Cauvery delta. The experiment was laid out in RBD with seven treatments viz., T1-Conservation tillage/CT (1 ploughing) +Roundup/CT @ 2.5 l/ha prior to rice planting + Machete application @ 2.5 l/ha at 3 DAT, T2-Conservation tillage as in T1 without Machete application, T3- Conservation tillage (2 ploughings)+ Roundup/CT +Machete application as in T1, T4 – Conservation tillage as in T3 without Machete application, T5- Conventional tillage (farmers' practice) with Machete application @ 2.5 l/ha at 3 DAT, T6-Conventional tillage (farmers' practice) without weeding and T7-Conventional tillage (farmers' practice) with twice hand weeding. The conservation tillage (2 ploughings) followed by pre-planting application of Roundup/CT @ 2.5 l/ha + pre-emergence application of Machete @ 2.5 l/ha was significantly superior to the conventional tillage + twice hand weeding by recording an additional yield of 0.63 t/ha. An increased return per rupee invested of 46 paise was obtained over the latter. This treatment reduced the total weed number and weed biomass with a WCI of 97.94 per cent. In respect of residual crop-black gram, the same treatment combination resulted in increased yield of 72 kg/ha over the conventional tillage practised in first crop-rice. Increased return per rupee invested of 57 paise was obtained over the latter.

In general, the treatment T3 registered the highest net return (Rs.29,394) as well as benefit cost ratio (2.80) in the rice-black gram cropping system as a whole and this was followed by T7 (conventional tillage (farmers' practice) with twice hand weeding in rice.

ALLELOPATHIC EFFECTS OF VARIOUS WEED SPECIES BIOMASS INCORPORATION ON GROWTH AND YIELD OF SOYBEAN (GLYCINE MAX L.)

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In order to explore the possibility of allelopathic effects of *Phalaris minor, Avena ludoviciana, Ageratum conyzoides, Chenopodium album* and *melilotus alba* biomass incorporation on growth and yield of soybean, an experiment under field condition was carried out during kharif season of 1995 and 1996. Biomass of all the weed species at 250 and 500 g/m^2 on dry weight basis was incorporated into the soil 30 days before seed sowing.

Significantly lower number of plants/m^2 was recorded in those treatments where incorporation of weed biomass of *A. conyzoides* at 250 and 500 g/m^2, *C. album* at 500 g/m^2 and *M. indica* at

500 g/m² at 12 days stage of the crop and *A. conyzoides* at 500 g/m² at 24 days after sowing of the crop as compared to that where no incorporation of weed biomass was made. Similar trend was noted in case of shoot length at 12 days after sowing. Root length at 12 and 24 days after sowing and seedling dry weight/plant at 12 days after sowing were significantly less in plots where biomass of *A. conyzoides, C. album* and *M. indica* was applied at 500 g/m² than that of no weed biomass incorporation. Grain yield of soybean was reduced significantly due to incorporation of biomass of *A. conyzoides, C. album* and *M. indica* each at 500 g/m².

EFFECT OF SOURCES OF NITROGEN ON YIELD AND N-UPTAKE BY WEEDS IN RICE-WHEAT CROPPING SEQUENCE

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An experiment was laid out to find the effect of sources of nitrogen on growth, development and nitrogen uptake by weeds in rice-wheat cropping sequence when a uniform dose of N @ 120 kg/ha applied in rice but through different sources viz., FYM dhaincha green manuring (GM) and urea and their combinations under different weed control treatments of weedy, herbicide (butachlor @ 1.5 kg/ha and weed free situations.

The dominant weed flora in rice was *Echinochloa colonum, Corchorus acutangulus and alternantera sessilis* while in wheat Phalaris minor and Chenopodium album were the dominant weeds. The nitrogen application @ 120 kg/ha through dhaincha (GM) alone or in combination with urea reduced the weed population and weed dry matter significantly in rice. Amongst weed control treatments butachlor @ 1.5 kg/ha caused significantly reduction in weed dry matter. The treatment of Urea 60 + Dhaincha 60 kg N/ha proved better in producing higher yield and N uptake by the rice. Dhaincha applied in rice had significantly residual effect on weed dry matter in wheat recorded at 45 DAS in comparison to other treatments. Application of N through two different sources in rice proved beneficial in terms of wheat grain yield as compared to application of N through single source.

EFFECT OF WEED CONTROL AND INTEGRATED NUTRIENT MANAGEMENT IN SUSTAINING PRODUCTIVITY OF RICE

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A field experiment was conducted during kharif seasons of 1998, 1999 and 2000 in an acid inceptisol to evaluate an effective weed control and nutrient management practice for kharif rice. Results revealed that butachlor 1.0 kg/ha or pretilachlor 0.75 kg/ha applied at 3 days after transplanting were equally effective in reduceing weed density and weed dry matter accumulation at 25 and 45 days after transplanting over weedy check and increased the yield of rice. The different nutrient management practices tried could not show any significant variation in weed density and dry matter accumulation. Combined use of vermicompost @ 2.5 t/ha or fresh biomass of either *Ipomoea* or *Crotolaria* @ 5 t/ha along with 75 per cent recommended fertilizer resulted in

similar and significantly higher grain yield of rice over recommended fertilizer applied alone. Significant improvement in soil organic carbon and available N, P and K status was recorded due to combined use of organic and inorganic sources of nutrients over recommended fertilizer applied alone. Results clearly indicated the possibility of saving atleast 25 per cent inorganic fertilizer through the utilization of weed biomass.

WEED SMOOTHERING EFFICIENCY AS INFLUENCED BY INTERCROPPING IN CHILLI

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A field experiment was conducted for two seasons during kharif 1997 and 1998 to study the relative efficiency of intercrops in smoothering weeds in chilli intercropping grown on red sandy soils of College of Agriculture and Regional Research Station, Navile, Shimoga, Karnataka under rainfed situations. The treatments included chilli (Byadagi) as base crop (planted under normal and paired row system) and Cotton, French bean and Groundnut as intercrops. The results indicated that intercropping of normal Chilli + Hy. Cotton + Groundnut showed significantly lower weed density (3.4/m^2) as compared to sole chilli (38.1/m^2) both the seasons. Similarly, weed dry weight was also significantly lowe in normal chilli + cotton + french bean (3.2 g/m^2) system than sole chilli (41.8 g/m^2). Among the various intercropping systems, higher weed smothering effciency was observed due to chilli + cotton + french bean (92.3%) at 45 DAP which was attributed to cannopy coverage by groundnut/french bean as evidenced by higher light interception by these intercrops.

INFLUENCE OF PLANT POPULATION, GEOMETRY AND WEED CONTROL METHODS ON WEEDS AND YIELD OF IRRIGATED MAIZE

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Weeds interface with maize growth at all stages and reduce the crop yield considerably. Higher population of the crop suppressed the weed growth by competition. Application of nitrogen at higher doses favour the crop in terms of competition over weeds. Integrating the herbicide application along with higher population over the recommended level suppresses the weed growth and fetches more crop yield. Hence, field experiment was carried out at the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore, during 1999-2000, to identify a suitable integrated weed management package with appropriate level of plant population in irrigated maize. Treatments comprised of four levels of plant population and crop geometry (60 x 20 cm - 83335 plants/ha, 45 x 20 cm -1,11,111 plants/ha, 40 x 30 cm -83335 plants/ha and 30 x 30 cm -1,11,111 plants/ha), two levels of N (135:63:50 kg N: P: K/ha and 30% extra N) and three weed management methods (Unweeded control, Hand Weeding (20 and 35 DAS) and IWM with atrazine 0.25 kg/ha fb. HW at 35 DAS. Observations on weed flora, weed density and weed drymatter and grain and straw yields were made along with net-return and B: C ratio.

Results indicated that, among the three groups of weed, broad-levels weeds dominated with 58.5% followed by grasses (29.5%) and sedges (12%). Lower weed density as well as weed biomass were recorded with higher plant population of 1.11 lakh plants/ha with both the geometry of 45 x 20 cm and 30 x 30 cm. Smothering effect on weeds by well grown maize with 30% additional dose of nitrogen along with recommended dose of 135:65:50 kg NPK/ha, was observed with lesser weed density and weed biomass. Higher weed density and biomass was evident with unweeded plots as against integrated weed management with atrazine (0.25-kg a.i./ha) combined with hand weeding. Higher grain yield of maize was registered with1.11 lakh plants/ha. However, the geometry has no interaction effect with plant population in increasing the grain yield of maize. Similarly, application of additional dose of 30% N over the recommended level of NPK fertilizer resulted in higher grain yield of maize. HIgher grain yield of maize. Higher grain yield of 5152 kg/ ha registered with integrated weed management, which was comparable with that of hand weeding twice. Application of 30% additional dose of N along with recommended NPK with a plant population of 1.11 lakh plants/ha accommodated either in 45 x 20 cm or 30 x 30 cm spacing combined with IWM (attrazine 0.25 a.i./ha + hand weeding) resulted in higher grain yield and better net returns and B: C ratio in maize.

EVALUATION OF LONG TERM EFFECTS OF CONSERVATION TILLAGE AND WEED MANAGEMENT PRACTICES ON WEED GROWTH AND YIELD OF TRANSPLANTED RICE

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In rice production conventional tillage method control weeds and improves soil physical and chemical properties. But other tillage methods like minimum and zero tillage reduce the labour and time requirement for land preparation compared conventional tillage. In the absence of perennial weeds and excessive accumulation of plant materials, chemicals in wetland rice may replace mechanical land preparation.

The present study was, therefore undertaken to evaluate long term effects of conservation tillage with pre-plant and / or pre emergence herbicidal weed management on weed growth and yield of transplanted rice-rice cropping system during *Kharif* and *rabi* seasons. The experiment included three tillage methods viz., conservation tillage, minimum tillage and conventional tillage combined with pre-plant control of germinated weeds using Roundup CT (glyphosate) and followed by with or without butachlor 1.25 a.i/ha for pre-emergence control of weeds. Preplant glyphosate (1.025 kg/ha) was sprayed in conservation and minimum tillage methods. Observations were made on weed growth in terms of density and drymatter accumulation and crop growth and yield attributes along with grain and straw yields.

Conservation tillage with pre-plant and pre-emergence chemical weed control enhanced the yield and economics over conventional tillage and pre-emergence weed control. The data on pre-emergence weed control with butachlor have convincingly indicated the need for application of butachlor to contain weed population and weed dry weight and to improve rice yields. Combination of pre-plant weed control with glyphosate under minimum tillage practice followed by pre-emergence

application of butachlor to control germinating weeds has maximized the yield (6025 and 6517 kg/ha during *Kharif* and *rabi*, respectively) and better economics of Rs. 17494 and 19812 net returns/ha with B:C ratio of 2.40 and 2.59 in *Kharif* and *rabi* seasons.

EFFECT TILLAGE OPERATIONS ON WEEDS, GRAIN YIELD OF RICE AND PHALARIS MINOR POPULATION IN WHEET GROWN IN SEUENCE OF RICE-WHEAT UNDER TARAI REGION OF UTTRANCHAL.

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To optimize the tillage operation in rice and wheat for their optimum production and to see the effect of tillage on weeds, an experiment was conducted in rice-wheat sequence at Crop Research Centre of Goving Ballabh Pant University of Agriculture and Technology Pantnagar district Udham Singh Nagar (Uttranchal). Four tillage treatments (PR-puddling by rotaotyr puddler : 4 passes; reduced puddling (REP)- 2 passes of puddler; CP - conventional puddling, 4 passes by puddler and direct sowing with out puddling (DSWP) were replicated four times in Kharif season of 1999-2000. In rabi season with out puddling (DSWP) were replicated four times in Kharif season of 1999-2000. In rabi season of 2000 two tillage treatment i.e. Zerotillage (ZT) and conventional tillage (CT)- one way plough + 2 harrow + patella) were superiomposed on the same layout and run the experiment in split plot. Twenty five days old seedlings of var. PD-11 were transplanted on July 11, 1999 at 20 x 15 cm and seed 100 kg of the same variety were sown on june 16, 1999 at distance of 20 cm row to row. Soil was silty clay loam and rich in organic matter. Both the crops were nourished with 150 kg N + 60 kg p_2O_5 + 60 kg k_2o/ha. Wheat variety UP 2338 was planted in the experiment using 100 kg seed/ha. A common irrigation (60 mm) was given in all the plots a week before wheat sowing.

Grain yield of rice was significantly influenced by puddling than non-puddled direct sowing. Highest grain yield (5503 kg/ha) was recorded in the plot puddled by rotavotor (PR) and lowest (5044 kg/ha) in direct sown unpuddled soil (DSWP). Grain yield of rice was not influenced significantly under conventional puddling or reduced puddling. Weed species were also influenced by tillage treatments and it was observed that *Fimbristylis dichotoma* in puddled plots and *Cyperus rotundus* in non-puddled soil were found as major sedges. *Echinochloa colonum* population was higher in unpuddled soil where as *Ceasulia axillaris* was highest in puddle soil. *Phalaris minor* population in wheat was highest in conventional tillage (CT) as compared to Zero-tillage (ZT). Though the grain yield was significantly higher (4416 kg/ha) in conventional tillage (CT) as compared to zero tillage (ZT) 3397 kg/ha.

IDENTIFICATION OF COMPETETIVE CROP PLANT TO MANAGE PARTHENIUM (*PARTHENIUM HYSTEROPHORUS* L.)

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An experiment was conducted during kharif 1987-88 at the Main Research Station, Hebbal under rainfed conditions to identify the promising competitive and useful crop plant to manage parthenium weed in abandoned land. Parthenium was allowed to grow naturally (control) or with crop plants, such as, blackgram (*Phaseolus mungo*), cassia (*Cassia uniflora*), cowpea (*Vigna sinensis*), greengram (*Phaseolus mungo*), finger millet (*Eleusive coracona*), groundnut (Arachis hypogea) maize (*Zea mays*) and soybean (*Glycine* max). Corp plants were planted at 30 cm spacing on 22-8-1987 as per the recommended seed rate but no other inputs or intercultivations were attended to.

Greengram, blackgram and cassia plant species maintained significantly higher plant population per unit area compared to other crop plants. Cowpea and maize possessed grater vigour and suppressed parthenium by shading effect. Yield of crop plants was less since these were grown in abandoned land.

Experimental results indicated the possibility of obtaining economical crop plants and at the same time capable of suppressing parthenium as a result of higher plant population, vigour or shading ability.

ALLELOPATHIC EFFECTS OF *PARTHENIUM HYSTEROPHORUS* ON WEEDS

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Pot culture experiments were conducted during *kharif* 1999 and 2000 at CCS Haryana Agricultural University, Hisar to study the allelopathic effects of *Parthenium hysterophorus* on *Cyperus rotundus* and three species of *Echinochloa* i.e. *E. colonum, E. crusgalli* and *E. glaberscence*. Extract of fully grown plants of *Parthenium* comprising all plant parts except roots was prepared during both years. During 1999, extract of 5, 10 and 15% (w/v) and during 2000 extract of 15, 30 and 45% (*w/v*) was prepared by drying, grinding and then dissolving the powdered form in distilled water over night. The solution was pass through sieve and stored in freeze before use. During first year and second year 10 rhizomes/pot of *Cyperus rotundus* were transplanted and 15 seeds of each of three *Echnichloa* spp. were sown on 20.7.99 and 5.8.2000, respectively. After one month, 5 plants of *Cyperus* and each of three species of *Echinochloa* were maintained after thinning. *Parthenium* extract @ 0, 5, 10 and 15% (w/v) was spayed as post-emergence at 30 DAS during first year and as pre-emergence during second year with small kitchen sprayer. During second year in one set of four treatments even the soil was drenched with 0, 15, 30 and 45% solution of *Parthenium* extract just before sowing. Also another additional treatment of mixing dry powder of *Parthenium* in the upper soil surface before sowing was given during second year. The pots were arranged in completely randomized design replicated thrice. The data on visual toxicity and dry weight accumulation recorded at 30 and 60 DAT revealed that there was no adverse allelopathic effect of *Parthenium* extract on the growth of any of the weeds in question during both the years.

EFFECT OF METHODS OF SOWING AND WEED CONTROL MEASURES ON GROWTH AND YIELD OF RAINFED DIRECT SEEDED UPLAND RICE UNDER FOOTHILL CONDITIONS OF NAGALAND

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A field experiment was conducted at Research Farm of School of Agricultural Sciences and Rural Development, Medziphema during 1999 to evaluate the effect of method of sowing and weed control measures on growth and yield of rainfed direct seeded upland rice. The treatments consisted of all possible combination of two method of sowing viz; broadcasting and dibbling in lines; and five weed control measures viz; weedy check, hand weeding at 20 and 40 DAS, Butachlor @ 1.5Kg/ha + one hand weeding at 40 DAS, 2,4-D @. 1 Kg/ha at 20 DAS + one hand weeding at 40 DAS, Butachlor @ 1.5 kg/ha+post-emergence application of 2,4-D @ 1kg/ha. The treatments were arranged in Randomised Block Design.

The major weed flora of the experimental field were *Digitaria sangunalsis, Paspalum conjugatum, Cyperus rotundus, Cyperus iria, Borreria hispida, Amaranthus viridis, Ageratum conyzoides, Mikania micrantha, Mimosa pudica, Euphoribia hirta,*. The findings revealed that dibbling method of sowing and pre-emergence application of Butachlor @ 1.5 kg/ha supplemented with one handweeding at 40 days after sowing was found remunerative as compared to other treatments under study.

EVALUATION OF GLYPHOSATE, MON 77569 FORMULATION, IN GENERAL WEED CONTROL

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Field studies were conducted for two seasons during Kharif 1999-2000 and 2000-2001 at Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore to compare the performance of MON 77569 (Glyphosate 480 g/l) formulation. Weed control efficiency was assessed by visual scoring and biomass production (g/0.25 m^2) of existed weed flora. Glyphosate as Mon 77569 (liquid formulation) at 360 to 3600 g ae/ha was compared with glyphosate as Roundup 360 to 3600 g ae/ha, glyphosate as Glycil 720 g ae/ha, paraquat 600 g ai/ha, hand removal of weeds by spade and unsprayed control. The above treatments were tried in RCBD with three replications. The major weeds observed in the experimental area were *Cyperus rotundus* (a sedge), *Cynodon dactylon, Chloris barbata, Dactyloctenium aegyptium, Digitaria marginata, Eragrostis pilosa, (amongst Grass)* and *Borreria articularis, Ageratum conyzoides, Mimosa pudica, Lagasca mollis, Conyza ambigua, Syndrila nodiflora* etc (among broad leaves). The study revealed that application of Mon 77569 at 720 to 3600 g ae/ha at 30 days enhanced the early symptom development (viz. chlorosis, yellowing, arrest of terminal growth followed by drying of plant foliage), controlled the number of shoots (0 to 3.5 per 0.25 m^2) and plant dry weight (4 to 15 g / 0.25 m^2) as compared to glyphosate as Roundup 720 to 3600 g ae/ha (number of shoot and plant dry wt. 0.2 to 4.3 / 0.25 m^2 and 5 to 20 g /0.25m^2 respectively) and hand removal by spade. High doses of MON 77569 and Roundup (1080 to 3600 g ae/ha) did not permit the re-sprouting after rains compared to paraquat and hand removal.

WEEDS OF MEDICINAL VALUE IN SAVANDURGA RESERVE FOREST

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Weeds in croplands and adjacent forest areas were studied. Forty-two species of weeds were encountered during the study. They encompass herbs, shrubs and climbers competing with crop species and also occupy the shady places adjoining the crop lands The species were checked for their utility as medicinal plants both from secondary sources as well as personal interaction with the local community. Majority of the weeds recorded belonged to herbaceous habit, few were shrubs and climbers. The present communication provides details of the vegetative and reproductive phenology for the benefit of management and utilization of these weedy species. Among the species recorded most of them are found near degraded areas and waste places. Common weeds of medicinal value are Sida cordifolia , *Sida rhombifolia var retusa, Sida rhombifolia var rhomboidea, Sida acuta, Boerrhaevia diffusa , Evolvulus alsinoides, Waltheria indica, Acalypha indica, Centella asiatica, Aerva lanata, Solanum nigrum, Achyranthea aspera, Dodanea vesicosa, Cassai auriculata,*and *Tribullus terrestris.*

DATE BASE ON WEEDS : A TOOL FOR INFORMATION TECHNOLOGY

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Weeds are an integral component of all ecosystems. However information on weeds with respect to floral distribution in different crops and cropping systems, soil types, climatic conditions is either not available or insufficient. Such a data base will be of tremendous use as it would aim at effective and economical weed management Practies. Besides enhancing crop production, identification of major weeds in different crops/cropping systems and agroclimatic regions will also help in world trade. In WTO agreement, it has become essential or mandatory to make all possible information on pest status (including weeds) available before exporting or importing agricultural commodities.

Our ecosystem is threatened by Invasive Alien Species (IAS), Convention on Biodiversity (CBD) has stipulated all signatories to give utmost priority to prevent, control and eradicate IAS to protect natural biodiversity. This calls for data base on native and exotic plant species. Development of national data base would act as a bench mark survey for surveys to be made in future and which will enable identifying major weed flora shifts. This data base will contribute significantly in monitoring for invasive weeds thus helping in protecting biodiversity.

EFFECT OF INIDAZOLINONE AND OTHER HERBICIDES ON NODULATION, SEED YIELD GROWTH AND SOYBEAN AND THEIR RESIDUAL EFFECT ON SUCCEEDING CROP

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A field experiment was conducted to study the effect of imidazolinone herbicides on nodulation, seed yield, yield components of soybean and their resideual effect on succeeding crops at the Main Research Station, Bangalore, during Kharif 1999, Use of Ima zethapyr + pendimethalin (50g + 750g/ha) and imazethapyr (100g/ha) gave significantly higher the nodule count and dry weight as compared to unweeded control, but, was on par with manual weed control. The seed yield was the highest in imazethapyr + pendimethal in (50g + 750g/ha) (2636 kg/ha) followed by hand weeding twice (2404 kg/ha) and imazethapyr (100g/ha) (2396 kg/ha). The residual effect of these herbicides after -100-112 days of application revelaed no significant adverse effect in lowering germination and seedling growth of finger millet and cucumber. However these crops in plots treated previously with metolachlor 1.0 kg/ha and imazamax + imazethapyr (20g + 20g/ha) had higher germination, shoot growth, root growth and dry weight of seelings indicating no residual adverse effect. Bio-assay studies revealed that successful cultivation of crops after soybean, as there was no residual effect.

EVALUATION OF IMIDAZOLINONE HERBICIDES FOR WEED MANAGEMENT IN IRRIGATED SOYBEAN (GLYCINE MAX L.)

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A field experiment was conducted during kharif 1999 on red sandy loam soil at the Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore to know the bioefficacy of imidazolinone herbicides for weed management in irrigated soybean. The major weed flora observed were *Cyperus rotundus L. Digitaria marginata, Dactyloctenium aegyptium, Ageratum conyzoides L. and Commelina benghalensis L.*

Imidazolinones tested were imazethapyr alone or with pendimethalin, imazaquin (as pre-emergence) and imazamax alone or with pendimethalin (as post-emergence) in relation to metolachlor, alachlor, fomesafen, hand weeding and unweeded control. The results of the experiment indicated that application of imazethapyr + pendimethalin (50 +750 g/ha) (2636 kg/ha), imazethapyr 100 g/ha (2396 kg/ha), metolachlor 1.0 kg /ha (2285 kg/ha) and imazamax + imazethapyr 20 + 20 g/ha (2214 kg/ha) have seed yield comparable to or more than cultural practice (2404 kg/ha). Effective weed control with imzethapyr + pendimethalin 50 +750 g/ha and imazethapyr 100g ha^{-1} had improved seed yield by 199 and 172 per cent, respectively as compared to control.

EFFECT OF SEASONAL FLUCTUATION OF AMBIENT WEATHER CONDITIONS & RH AT THE TIME OF FOLIAR SPRAY OF GLYPHOSATE ON GROWTH AND CONTROL OF *CYPERUS ROTUNDUS*

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Experiments were conducted by planting *Cyperus rotundus* in different seasons to know the growth pattern.Relating various weather parameters also assessed the effect of glyphosate spray at different growth seasons on the control. Single tuber was planted per pot and irrigated daily. Thirty days after establishment, glyphosate was sprayed (20,40,80,160,320,640,1200 and 2400 g ai/ha) with or without non-ionic surfactant (triton x 100, 0.1 %). After 45 Days after spray, fresh weight was recoded. Dose-response was regressed and ED_{50} was computed. Significantly higher fresh weight (g/pot) was recorded during December-February planting as compared to November-january planting period. Significant variation in ED_{50} was observed. Season having higher growth rate had higher ED_{50} requirement as compared to low growth rate season. Addition of surfactant significantly reduced Ed_{50} only during November -January growth season probably due to high RH at the time of spray.

COMPARATIVE ECONOMICS AND PHYSICAL OPTIMUM OF NITROGEN UNDER DIFFERENT WEED MANAGEMENT PRACTICES IN SUNFLOWER

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The economics of weed control due to four nitrogen levels (0, 30, 60 and 90 kg N ha^{-1}) and three weed management practices (Metolachlor at 1 kg a.i. ha^{-1} pre. em, hand weeding at 22 and 42 DAS and unweeded control) were studied on red sandy loam soil at GKVK campus, University of Agricultural Sciences, Bangalore during kharif 1999 in sunflower. The physical optimum of nitrogen was relatively less under metholachlor treated plot (80.4 kg N ha^{-1}) as compared to hand weeded plot (99.6 kg N ha^{-1}), while it was as high as 216.6 kg N ha^{-1} under unweeded control. The higher benefit : cost ratio was recorded with application of 60 kg N ha^{-1} in metolachlor @ 1 kg a.i. ha^{-1} (2.0), followed by application of 90 kg ha^{-1} with metolachlor at 1 kg a.i. ha^{-1} (1.93) and the lowest was in no nitrogen coupled with weedy cheek (0.64).The marginal cost of weed management in herbicide treated plot was Rs.1050 ha^{-1} at all N levels as against Rs.1625 ha^{-1} at no nitrogen application. This suggests that the nutrient requirement increase under severe weed competition in sunflower.

STUDIES ON NITROGEN AND WEED MANAGEMENT IN SUNFLOWER (KBSH- 42)

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The nitrogen weed management interaction on yield of sunflower was studied in a field experiment on red sandy loam soil during kharif 1999 at GKVK, University of Agricultural Sciences, Bangalore. The treatment consisted of four nitrogen levels namely 0, 30 60 and 90 kg ha-1 and three weed management practice viz., metolachlor at 1kg a.i. ha-1 pre.em., hand weeding twice (22 and 42 DAS) and unweeded control.

Application of N increased the seed yield 1660 to 2534 kg ha^{-1} significantly from 0 kg to 60 kg N ha^{-1} and further increase to 90 kg N ha^{-1} improved the yield marginally (2634 kg ha^{-1}).Weed management through metolachlor at 1 kg a.i. ha^{-1} as pre-emergent gave yield (2460 kg ha^{-1}) comparable to hand weeding (2483 kg ha^{-1}). Unweed control lowered the yield by 28.4 per cent owing to competition offered by weeds of all categories. High yield in herbicide treated plot was due to lower weed count and weed dry and consequently had higher weed control efficiency (49-48.2%) and lower weed index (1.3%).

LONG TERM MANAGEMENT OF WEEDS WITH NEW MOLECULE OF XL-71AG UNDER NON CROP SITUATION

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A field experiment was conducted at the Bidhan Chandra Krishi Viswavidyalaya. Kalyani, West Bengal during 2000 - 01 to find out a suitable measure for eradicating the obnoxious and troublesome weeds for a long time on non-crop lane. The predominant weed flora infesting the experimental field consisted of *Cynodon dactylon. Eleusine indica. Imperata cylindrica, Cyperus rotundus, Blainvila latifolia, Heliotropium indicum and parthenium hysterophorus.* The chemical XL - 71 AG (monoammonium salt of glyphosate) either at 9 ml or 12 ml l^{-1} of water could manage almost all categories of weeds effectively upto two months after herbicide spraying and ahowed results comparable to glyphosate 41. SI. applied @ 7.5 or 10.0 ml l^{-1} of water.

BIO-EFFICACY OF DIFFERENT HERBICIDES ON WEED CONTROL IN TRANSPLANTED RICE

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A field experiment was carried out at Annamalai University Experimental Farm, during Navarai 1999, to study the bio-efficacy of different herbicides on weed management in transplanted rice. The treatment consisted of unweeded control, anilophos at 0.40 kg ha^{-1}, anilophos + 2,4-D at 0.40

+ 0.40 kg ha^{-1}, butachlor at 1.00 kg ha^{-1}, butachlor +2,4-D at 1.00 + 0.40 kg ha^{-1}, pretilachlor at 1.25 kg ha^{-1}, pretilachlor + 2,4-D at 1.25 + 0.40 kg ha^{-1} and hand weeding twice at 20 & 40 DAT. Among the weed control treatments, hand weeding twice registered the lowest weed dry weight and highest WCI and produced higher yield and yield attributing characters which was observed to be on par with pretilachlor + 2,4-D at 1.25 + 0.40 kg ha^{-1}.

WEED CONTROL IN SOYBEAN [*GLYCINE MAX* (L.) MERRILL]

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An experiment was conducted during rainy (*kharif*) season 1996 at Main Research Station, University of Agricultural Sciences, Dharwad, to study the effect of herbicides on soybean. Response of soybean to different methods of weed control revealed that, the least weed population (3.16/m^2) and lowest dry weight (2.53g/m^2) were recorded in two intercultivations + two hand weedings (at 30 and 45 days after sowing) which was on par with pre-emergence application of alachlor @ 2.0 kg a.i/ha. Maximum leaf area (17.45 dm^2/plant) and leaf area index (5.81) were observed in cultural method of weed control consisting of two intercultivations + two hand weedings. Among the herbicide treatments, pre-emergence application of alachlor @ 2.0 kg a. i/ha recorded the maximum leaf area (14.60 dm^2/plant) and leaf area index (4.86). The higher seed yield (2026 kg/ha) and yield components were recorded with cultural method of weed control. Among the herbicide treatments, the maximum seed yield (1810 kg/ha) was recorded with pre-emergence application of alachlor @ 2.0 kg a. i/ha (1720 kg/ha) which was on par with pendimethalin (pre-emergence) @ 1.5 kg a. i/ha (1720 kg/ha).

COST EFFECTIVE CHEMICAL WEED CONTROL IN LOWLAND TRANSPLANTED RICE

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Field trials were carried out at Annamalai University Experimental Farm, during Navarai seasons of 1999 and 2000, to study the effect of weed control methods on grain yield and economic returns of transplanted rice variety ADT 36. The treatment consisted of pretilachlor +2,4-D (ready mix) at 0.18 + 0.18, 0.24 + 0.24, 0.30 +0.30 kg ha^{-1}, anilophos + 2,4-D at 0.25 kg ha^{-1} pretilachlor at 0.187, 0.25, 0.375 kg ha^{-1} and butachlor at 1.25 kg ha^{-1} and these treatments were compared with hand weeding twice and unweeded control. The maximum grain yield (5.81 t ha^{-1}) was recorded under hand weeding twice treatment followed by pretilachlor +2, 4-D (ready mix) at 0.30+0.30 kg ha^{-1} (5.5 t ha^{-1}) which was on par with pretilachlor + 2, 4-D (ready mix) (0.24 + 0.24 kg ha^{-1}) (5.47 t ha^{-1}). Lowest grain yield of 3.42 t ha^{-1} was observed in unweeded control. The maximum weed dry weight was recorded in unweeded control which was significantly higher over rest of the weed control treatments. The maximum net return of Rs. 17,777 was recorded under pretilachlor + 2,4-D (ready mix) at 0.30+0.30 kg ha^{-1} and it was observed to be on par with pretilachlor +2,4-D (ready mix) at 0.24 + 0.24 kg ha^{-1}.

EFFECT OF SOIL SOLARIZATION ON WEED GROWTH AND YIELD OF SUNFLOWER.

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A Field experiment was conducted during 1999 - 2000 at the Agronomy field unit, main research station, Hebbal, University of Agricultural Sciences, Bangalore to study the effect of soil solarization in controlling weeds and it's influence on growth and yield of sunflower. Two thickness of transparent polyethylene sheets (TPE) were tried with three durations of soil solarization (20, 40 and 60 days) and were compared with recommended dose of herbicide (Pendimethalain @ 1.0 kg a.i. per ha),weed free and weedy check. Soil solarized with thinner transparent polyethylene (0.05mm) sheets for longer period (60 days) recorded higher mean maximum soil temperature (48.22°c) and frequency of temperature exceeding 48°c (66%) compared to control (39.81°c and 0.0% respectively). Further, lower weed density (8.02/m^2) and weed dry weight (3.05g/0.25m^2) of weeds were observed with 0.005mm TPE solarized for 60 days. This resulted in better growth of sunflower and higher plant height (168.8cm) and dry matter (139.37g/plant) were recorded with TPE 0.05mm for 60 days as against 137.3cm and 86.16 g/plant in non- solarized control. Maximum seed yield (30.5q/ha) and yield parameters such as head diameter,(25.13cm) seed weight per head (64.37g) and number of filled seeds per head (1021.62) were obtained with TPE 0.05mm for 60 days and in general, solarized plots performed better compared to non-solarized plots.

HERBICIDE RESISTANCE – PROBLEMS AND STRATEGIES : A REVIEW

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Agriculture cannot remain as a viable enterprise without effective weed control. But, of late, herbicide resistant weeds threaten the continuing success of herbicide technology to contribute to world crop production. The evolution of herbicide resistance in populations of initially susceptible weedy plant species is a dramatic example of evolution in action.

The occurance of multiple herbicide resistance and cross-resistance resulted in loss of useful herbicides available to grower. We should be ever mindful that exclusive reliance on any single, highly efficient control method, chemical or non-chemical can fail as a result of evolutionary forces finding a way to circumvent the control method. Hence, crop rotation, herbicide mixtures, herbicide rotation by using different group of chemicals with varied mode of action, use of genetically engineered plants i.e., transgenic herbicide resistant crops (HRC's) and their integration with other agronomic practices can be undertaken for efficient management of herbicide resistance.

CORRELATION AND REGRESSION STUDY ON WEED PARAMETERS AND YIELD ATTRIBUTES WITH SEED YIELD OF SOYBEAN [*GLYCINE MAX* (L.) MERRILL]

Namrata Jain and S. P. Kurchania

Correlation and regression study on soybean yield with yield attributes and weed parameters carried out at Livestock Research Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur,

Madhya Pradesh during kharif 2000 revealed that the seed yield was positively correlated with leaf area index (0.6995), number of branches plant^{-1} (0.5741), nodules plant^{-1} (0.5406), filled pods plant^{-1} (0.6528), seeds pod^{-1} (0.6394), seed yield plant^{-1} (0.8041) and test weight (0.4132), while plant height was negatively correlated (-0.3918). Weed parameters viz; weed biomass (-0.8972), total weed intensity (-0.6770) and intensity of *Echinocloa crusgalli* (-0.8596) had significant negative correlation with seed yield. The regression analysis revealed that with an unit increase in leaf area index, number of branches plant^{-1}, nodules plant^{-1}, filled pods plant^{-1}, seeds pod^{-1}, seed yield plant^{-1} and test weight, the seed yield increased by 193.1555, 298.8696, 6.8077, 51.5624, 490.7008, 395.4106 and 118.5301 kg/ha, respectively. The yield was reduced by 0.1683 and 1.6043 kg/ha with the increase of one kg weed biomass/ha and one weed plant m^{-2} while yield reduction was 2.9774 kg/ha with an unit increase in the number of *Echinocloa crusgalli* population.

SEASONAL CHANGES IN ARABLE SOIL WEED SEED BANK AND THEIR GERMINABILITY DYNAMICS IN HYBRID MAIZE-COW PEA SEQUENCE

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Two different field experiment were conducted during 1999-2000 kharif season and 2000-2001 summer season at the Main Research Station, University of Agricultural Sciences. Hebbal, Bangalore. In the present study, the total weed seeds from first year of cultivation was increased from 8,205 /0.25m2 to 10,125/0.25m2 because of fresh germination of different weed species in the experimental field and introduction of weed seeds from orgainc manures. The difference in size of different weed species composition were largely a reflection of abundant species Lagasca molis (2250/0.25m2 and 2109/0.25m2) in both the year of cultivation, respectively. In kharif season Commelina benghalensis (1417/0.25m2) and Cyperus rotundus (1041/0.25m2) and in summer season Digitaria marginata (1734/0.25m2) Commelina benghalensis (1171/0.25m2) was distributed next in the order of abundance. There was a greater fluctuation in the number of weed seedling of different species. The reduction in number of seedling emergence of Lagasca molis (11.06%), Commelina benghalensis (45%), Cyperus rotundus (14%) and Acanthospermum hispidum (96.9%) during summer season with increased in their number of weed to seed ratio. The increased germination of Digitaria marginata(81.07%) and Euphorbia geniculata (55%) was noticed in summer season with increase in thier weed to seed ratio. During 1999-2000 kharif season the correlation co-efficient(r) between weed seed and weed count in Lagasca molis was 0.78, where as in summer season it was decreased to 0.76 though there was slight increased in weed to seed ratio from 40.62% to 4.65%. The weed to seed ratio was less or equal in Parthenium hysterophorus and Euphorbia geniculata in two different season but co-efficient of determination (R^2) for both the weed was recorded 75% and 89% respectively. Hence, the study of weed ecology in the crop field plays an important role for adoption of an eco-friendly weed management practices.

NATURAL PRODUCTS AS A SOURCE OF HERBICIDES-AN ECO - FRIENDLY WEED MANAGEMENT PERSPECTIVE

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Achieving the sustainability in crop production along with maintenance of environmental quality and looking to the rapidly evolving resistance to current chemical herbicieds by different weed species have now made inevitable for the scientists and researches for discovering, developing and use of natural products as a source of herbicides for weed management practices. Their environmental short lives, water solubility, easily biodegradability makes sure of their use for attaining the soil health and environmental safety ans security. Various plant products like alleopathic chemicals / secondary products showed profound effects on adoption of alternate weed management pratices. Different plant parts such as roots, stems, leaves, flowers and fruits produces the allelopathic chemicals for controlling the germination, growth and finally reduction in infestation of weeds in the crop fields which showed strong potential in the selection, development and use of landscape without use of herbicides. Plant residue mulch may be a physical barrier to weed seedling growth but secretion of allelopathic chemicals from the residues also plays a prominent role for weed control. The effects of some cover crops for weed control is less physical but more chemical. Someof the plant derived compounds like cinmethylin, Triketone, Artimisinin and Chaparrinone showed significnat effect on weed control practices for both monocots and dicot weeds. Use of herbiceds from natural sources seems to be the need of the time for an eco-friendly weed management approach for sustainable agricultural development.

CORRELATION AND REGRESSION STUDY IN SOYBEAN-WEED ECOSYSTEM

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A study on correlation and regression analysis of soybean-weed ecosystem during *Kharif* 1999 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur indicated that the seed yield had positive association with number of pods/plant (0.67456), number of seeds/plant (0.68165), 100-seed weight (0.53957) and number of branches/plant (0.66714) but leaf area index had non significant association (0.03632) whereas the plant height exhibited negative association with seed yield. All the weed parameters showed negative correlation with seed yield and yield attributes. Total weed population, total weed biomass at harvest, population of *Echinochloa crusgalli* and population of *Phyllanthus niruri* were significantly negative associated (-0.49139, -0.64919, -0.78306 and –0.38658, respectively) with seed yield.

The predication equation Y=a+ bx revealed that in seed yield increased by 216.78 kg/ha with an unit increase in number of branches/plant followed by test weight (165.67 kg/ha), number of pods/plant (47.14 kg/ha) and number of seeds/plant (19.36 kg/ha). However, seed yield decreased by 11.69 kg/ha with an unit increase in plant height. The seed yield decreased by 0.4023 kg/ha with an increase in weed biomass by 1.0 kg/ha. It was further revealed that with an increase of one plant m^{-2} in the intensity of total weeds, the seed yield declined by 5.93 kg/ha. Similar trend was observed when intensity of major weeds was accounted.

Thus, variation in seed yield upto 45% can be predicted by knowing the information on number of pods/plant, number of seeds/plant 100-seed weight and number of branches/plant.

ALTERNATE WEED MANAGEMENT (ALLELOPATHY) IN WET SEEDED RICE

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Non herbicidal innovation to manage weed population are increasingly felt now-a-days because of concern about the environment. The application of allelopathy is an alternate weed management strategy that could be incorporated into an integrated weed management package to reduce the dependence on chemical herbicides. Evidence of allelopathy has accumulated in the literature over many years and many kinds of allelochemicals have been isolated and characterized from various plants.

Lantana camara is a woody perennial shrub wiedely distributed throughout the tropics, subtropics and warm temperate zones. *Parthenium hysterophorus* (L.) is a poisonous weed which occurs throughout the country as one of the most trouble some weed causing serious concern. The alleopathic potential of both have been reported.

Considering the above in view, a field experiment was conducted at Tamil Nadu Agricultural University during north east monsoon season of 2000-2001 to find out the potential of *Lantana camara* and *Parthenium hysterophorus* as plant herbicides in wet seeded rice (IR 20) under puddled condition. The results revealed that Lantana camara @ 10 t ha^{-1} and *Parthenium hysterophorus* @ 10 t ha^{-1} incorporated 7 days before sowing of rice produced comparable rice yield with that of chemical herbicide Pretilachlor + safener @ 0.45 kg a.i ha^{-1} at 7 days after sowing. Weed control was superior in *Lantana camara* @ 10 t ha^{-1} than *Parthenium hysterophorus* @ 5 (or) 10 t ha^{-1} at 35 days after sowing. This preliminary research suggest the possibility of using these weeds in a integrated weed management package in rice crop.

EFFICACY OF PREMIX FORMULATIONS OF CLOMAZONE AND PENDIMETHALIN HERBICIDE IN POTATO (*SOLANUM TUBEROSUM* L.)

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Field experiment on chemical control of weeds in potato variety 'Kufri Jyoti' was conducted at Block Seed Farm, Hooghly, West Bengal during winter season of 2000-01. Eight treatments comprising pre-emergence application of pendimethalin 30EC @ 750g a.i./ha; premix formulations of clomazone + pendimethalin 15+20EC @ 187+250g a.i./ha & 225+300g a.i./ha; clomazone + pendimethalin 15+30EC @ 187+375g a.i./ha, 225+450g a.i./ha & 262+525g a.i./ha along with hand weeding + earthing up and weedy check (control) were evaluated in randomised block design with three replications. The major weed flora in the experimental field consisted of *Cyperus rotundus, Chenopodium album, Croton sparciflora, Fumaria parviflora, Lathyrus aphaca, Medicago sativa* and *Physalis minima*. Presence of weeds throughout the growing season caused a reduction in tuber yield to the tune of 33.83% when compared with hand weeding + earthing up treatment. All the premix herbicide formulations reduced the population and dry matter production of weeds

and produced significantly higher tuber yield as compared to weedy check (control). Among the herbicides, premix formulation of clomazone + pendimethalin 15+30EC @ 262+525g a.i./ha was found to be most effective and comparable with hand weeding + earthing up treatment in reducing the weed density and weed biomass, and increasing the weed-control efficiency as well as number of tubers/hill. Maximum tuber yield was recorded under hand weeding + earthing up treatment. However, the effect was at par with other herbicides (premix formulations) except pre-emergence application of pendimethalin 30EC @ 750g a.i./ha which was found to be least effective.

BIOEFFICACY OF MIX FORMULATION OF CLOMAZONE WITH PROPANIL IN TRANSPLANTED PADDY

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A field experiment was conducted at Viswavidyalaya Farm, Kalyani to study the weed control efficiency of the herbicide mixture Clomazone with Propanil and its effect on grain and straw yield of transplanted paddy during kharif season, 2000. In addition to hand weeding twice at 20 and 40 DAT and Butachlor 50 EC @ 1.25kg a.i./ha, there were two different combinations of Clomazone and Propanil (Clomazone 15 EC @ 200g + Propanil 30 EC @ 400 g a.i./ha and Clomazone 15 EC @ 150g + Propanil 30 EC @ 300g a.i./ha) applied on three different dates – 10, 15 and 20 DAT. Application of Clomazone with Propanil at lower doses as early post-emergence and at higher doses at late post-emergence showed better weed control and grain yield of paddy (29.7 and 31.2 % over unweeded control respectively). The reduction in yield from the normal yield was due to the occurrence of flood from flowering to maturity stage of the crop.

STUDIES ON CROP-WEED COMPETITION ON GROWTH AND YIELD OF HYBRID MAIZE

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Field Experiments were conducted at Annamalai University Experimental Farm, Annamalainagar to study the effect of crop-weed competition on the growth and yield of hybrid maize –Cargill, during kharif 1998 and summer 1999. The experiments were laid out in Randomised Block Design replicated four times with eight treatments, viz., Weedy check, Weedy upto 15 DAS, Weedy upto 30DAS, Weedy upto 45 DAS, Weed free upto 15 DAS, Weed free upto 30 DAS, Weed free upto 45 DAS, Weed free upto harvest.Among the treatments tried, weed free upto harvest, weedy upto 15 DAS, weed free upto 30 DAS, weed free upto 45 DAS, recorded the higher growth and yield components and lesser weed population, total weed biomass and lesser weed index. With regard to crop-weed competition, the critical period for competition in maize is from 15 to 45 DAS, At that time of labour demand is more for weeding operation weed free upto 30 DAS for which hand hoeing twice between 15 days interval is enough.

STUDIES ON THE EFFECT OF HERBICIDES UNDER DIFFERENT TILLAGE PRACTICES IN LATE SOWN WHEAT

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A field experiment was conducted to study the effect of herbicides, isoproturon (1.0 kg), sulphosulphuron (25 g), glyphosate (0.5 kg) and 2, 4 – D (0.5 kg) under different tillage practices, zero, reduced (Chinese rotovator) and conventional (one ploughing followed by two harrowing with disc) on weed growth, germination, growth and yield of late sown wheat cultivar HUW-234, during winter seasons of 2000 & 2001. The tillage practices were kept in main plots and herbicides in sub-plots in split plot design and replicated thrice. Glyphosate was applied as pre-planting (10DBS) and remaining herbicides were applied as post emergence (30 DAS). The weed flora under weedy check recorded at 60 DAS were *chenopodium album, Anagallis arvensis, Melilotus alba, Synedrella noduflora, Rumex spinosus, Phalaris minor, Cyperus rotundus* and *Cynodon dactylon.* Zero tilled plots were dominated by grassy weeds, but reduced and conventional tilled plots were dominated by broad leaved weeds specially *Rumex spinosus* which suppressed all other weeds at later stages of crop growth. Results revealed that application of isoproturon + 2, 4 – D (1.0 + 0.5 kg) at thirty days after sowing (DAS) was most effective and had minimum weed dry weight as compared to other herbicieds. This treatment had maximum grain and straw yields. Application of isoproturon + 2, 4 – D (30 DAS) controlled the weeds more effectively in all the tillage practices as compared to other herbicidal treatments (isoproturon 1.0 kg, sulphosulphuron 25 g and glyphosate (0.5 kg as pre-plant 10DBS) + isoproturon 1.0 kg). Sulphosulphuron (25 g) was effective only against *Phalaris minor* and left rest of other grassy and broad leaved weeds uncontrolled. On an average, application of tank mixed Isoproturon + 2, 4 – D (1.0 + 0.5 kg) increased grain yield by 43.5, 36.8 and 33.4% over unweeded control in zero, reduced and conventional tillage practices respectively.

EFFECT OF WEED CONTROL TREATMENTS IN ZERO TILLED LATE SOWN WHEAT

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A field experiment was conducted to study the effect of twelve weed control treatments viz., weedy check, manual weeding twice at 30 & 45 DAS, mechanical weeding (30 DAS), mechanical weeding (20 DAS) + isoproturon (1.0 kg), isoproturon (1.0 kg), isoproturon (1.5 kg), isoproturon + 2.4 – D (1.0 kg + 0.5 kg), isoproturon (2.0 kg) in two sprays at 20 & 30 DAS, clodinofop (60 g), clodinofop + 2, 4 – D (60 g + 0.5 kg), sulphosulphuron (25 g), and glyphosate. -Isoproturon (0.5 + 1.0 kg) under zero tilled late sown wheat cultivar HUW – 234 during winter season of 2000-2001. Glyphosate was applied as pre-planting (10 days before sowing) and remaining herbicides were applied as post emergence (at 30 DAS). The experiment was conducted in randomized block design with thrice replication. Application of isoproturon + 2, 4 – D (1.0 kg + 0.5 kg) resulted maximum grain yield of wheat and minimum weed dry weight, but this was on par with Isoproturon (1.5 kg), clodinofop + 2, 4 – D (60 g + 0.5 kg), glyphosate + isoproturon (0.5 kg + 1.0 kg), mechanical weeding + isoproturon (1.0 kg) and manual weeding twice at 30 & 45 DAS, and significantly superior to mechanical weeding, isoproturon (1.0 kg), clodinofop (60 g) and sulphosulphuron (25 g). Herbicide sulphosulphuron (25 g) was most effective against *Phalaris*

minor but unable to control other grassy and broad leaved weeds. Application of isoproturon (2.0 kg) in two sprays at 20 & 30 DAS had a severe phyto toxic effect on wheat seedlings and there after this plot remained without plant throughout the growing season. On an average isoproturon + 2, 4 – D (1.0 + 0.5 kg) increased wheat grain yield by 42.3%, glyphosate + isoproturon (0.5 + 1.0 kg) by 38.6%, isoproturon (1.5 kg) by 38%, isoproturon (1.0 kg) by 36.9% and clodinofop + 2, 4 – D (60 g + 0.5 kg) by 32.3% over unweeded control which had grain yield 21.20 q ha^{-1}.

RESIDUAL EFFECT OF PRE-EMERGENCE HERBICIDES APPLIED TO GARLIC ON SUCCEEDING CROP OF CUCUMBER

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A field experiment was conducted at Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore, during the kharif season, residual effect of pre-emergence herbicides applied to garlic crop was tested through bioassay studies using cucumber as indicator plant during 1999 on red sandy loam soils. The results revealed that application of pendimethalin @ 1.5 kg a.i. ha^{-1} gave lowest germination compared to other herbicidal treatments, showing a little persistence in soil, even after the harvest of crop, but did not show their residual effect on root and shoot lenght of cucumber.

COMPARATIVE EFFICACY OF HERBICIDES ON WEEDS IN GARLIC (*ALLIUM SATIVUM* L.)

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A field experiment was carried at Main Research Station, Hebbal, University of Agricultural Sciences, Bangalore during the year 1999 on red sandy loam soils to study the efficacy of different herbicides the results revealed that, the intergrated method of controlling weeds with pre-emergence application of pendimethalin @ 1.0 kg a.i. ha^{-1} or oxyfluorfen @ 0.10 kg a.i. ha^{-1} super imposed with one hand weeding at 30 days after sowing (DAS), have provided excellent control of weed growth in garlic crop and thereby, increased the growth and yield parameters of garlic, which helps in obtaining higher garlic yield. Wherever hand weeding was not possible due to expensive labour and other reasons, pre-emergence application of pendimethalin @ 1.5 kg a.i. ha^{-1} was found most effective in controlling the weeds of garlic crop.

CULTURAL PRACTICES FOR SUSTAINABLE WEED MANAGEMENT IN RICE-RICE CROPPING SYSTEM AND THEIR CARRY OVER EFFECT

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Experiments were carried out at Annamalai University Experimental Farm, Annamalainagar, during Late Samba and Navarai seasons of 1999-2000 to study the effect of certain cultural

practices in combination with off-season land management on weed control and yield performance in rice-rice sequence. The off-season land management practices like fallow, ploughing twice at an interval of 45 days and raising a green manure crop of *Sesbania aculeata* and ploughing in situ during land preparation were compared as main treatments of a split plot design. The sub-treatments comprised various cultural measures that were superimposed during the cropping periods viz., azolla inoculation @ 1 t ha^{-1}, pressmud incorporation @ 10 t ha^{-1}, pressmud incorporation @ 10 t ha^{-1} + azolla inoculation @ 1 t ha^{-1}, twice hand weeding, a standard herbicide treatment butachlor @ 1.25 kg ha^{-1} and an unweeeded check. The off-season land management practices as well as the cultural measures during cropping significantly influenced the weed flora and yield of rice, in both the seasons. They were also found to interact significantly, with off-season ploughing and twice hand weeding in the crop, recording the highest weed control indices of 78.82 and 81.59 per cent and grain yield of 5.91 and 5.54 t ha^{-1} during first and second seasons, respectively. Regarding the different off-season land management practices, green manure raising was also observed to reduce weed competition in succeeding rice. But the weed control effect of the same was significantly lesser than that of off-season ploughing. Comparison of different cultural practices in rice showed that incorporation of pressmud + azolla inoculation was comparable with twice hand weeding and better than butachlor, regarding weed control and yield performance in rice.

Studies on carry over effect of these off-season and crop weed control measures in the second rice crop showed that, though the effect of both of them were carried over to the second season rice crop in sequence, the impact was higher with off-season land management.

BIO-SAFETY OF CHLORIMURON ETHYL, A PROMISING HERBICIDE IN SOYBEAN

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A field study was conducted at Main Research Station, University of Agricultural Sciences, Dharwad during *kharif* 1999 to assess the effect of different herbicides applied to soybean on nodulation and soil urease and dehydrogenase activities. The experiment was laid out in randomized complete block design with three replications and sixteen treatments comprising chlorimuron @6, 9 and 12 g ai ha^{-1} applied as pre-emergence and post-emergence at 4, 8 and at 12 days after sowing and alachlor@1250 g ai ha^{-1}, which were compared with farmers practice (one hand weeding + two intercultivations), weed free check and weedy check. The results showed that chlorimuron @6 to 12 g ai ha^{-1} irrespective of time of application and alachlor@1250 g ai ha^{-1} did not affect the soil urease and dehydrogenase activity. Chlorimuron @9 to 12 g ai ha^{-1} at all the application timings recorded significantly higher nodule number and dry weight of nodules per plant at 45 days after sowing. Chlorimuron @ 12 g ai ha^{-1} irrespective of time of application and chlorimuron @9 g ai ha^{-1} applied as pre-emergence and post-emergence at 4 and 8 days after sowing significantly reduced the weed dry weight and consequently recorded higher seed yield of soybean.

CHLORIMURON ETHYL - A NEW GENERATION PROMISING HERBICIDE IN SOYBEAN

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A field experiment was conducted at Main Research Station, University of Agricultural Sciences, Dharwad during *kharif* 1999 with the objective to evaluate the new generation micro herbicide, chlorimuron-ethyl for weed control and its effect on growth and yield of soybean. The experiment was laid out in randomized complete block design with three replications and sixteen treatments comprising chlorimuron @6, 9 and 12 g ai ha^{-1} applied as pre-emergence and post-emergence at 4, 8, and at 12 days after sowing which were compared with alachlor@1250 g ai ha^{-1}, farmers practice (one hand weeding + two intercultivations), weed free check and weedy check. The results indicated that chlorimuron @6 to 12 g ai ha^{-1} irrespective of time of application did not cause any phytotoxicity on soybean. Chlorimuron @ 12 g ai ha^{-1} at all the application timings and chlorimuron @9 g ai ha^{-1} applied as pre-emergence and post-emergence at 4 and 8 days after sowing were found effective in reducing weed dry weight upto harvest. These treatments also recorded significantly higher seed and haulm yield. The improvement in yield components such as number of pods, number of seeds and seed weight per plant and growth components *viz.*, number of branches, leaf area index and total dry matter production per plant were also observed with chlorimuron @ 12 g ai ha^{-1} at all the application timings and chlorimuron @9 g ai ha^{-1} applied as pre-emergence and post-emergence at 4 and 8 days after sowing.

EFFICACY OF COMBINATIONS OF IMAZETHAPYR AND PENDIMETHALIN ON WEEDS, YIELD AND YIELD ATTRIBUTES OF SOYBEAN (*GLYCINE MAX* MERRILL)

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A field experiment was conducted at the University of Agricultural Sciences, Hebbal Campus, Bangalore, during kharif 1998 on red sandy loam soil to know the bio-efficacy of imazethapyr alone at 100 g ai/ha, and combinations of imazethapyr 50 - 60 g and pendimethalin 750 - 900 g ai/ha at two times of application viz., one day before sowing (DBS) and pre-emergence -3 days after sowing (DAS), in relation to standard herbicides - pendimethalin, alachlor and metolachlor all at 1.0 kg ai/ha (pre-em). These herbicides were compared with hand weeding (twice, 20 and 40 DAS) and unweeded control in a RCBD experiment with three replications. Major weed flora was *Cyperus rotundus, Digitaria marginata, Dactyloctenium aegyptium, Ageratum conyzoides, Commelina benghalensis*, grasses and broad leaf weeds dominated followed by sedges throughout the crop growth period.

Unweeded weed growth lowered the soybean seed yield (KHSB-2) by 60%. Between time of application, pre-emergence was better than pre-plant incorporation. Usage of imazethapyr 50-60 g + pendimethalin 750-900g ai/ha gave seed yield comparable to pendimethalin 1.0 kg ai/ha, alachlor 1.0 kg ai/ha (all pre-em.) and hand weeding twice. The weed index, nutrients uptake through weeds were lower in these herbicides. These herbicides did not affect the nodule number, leaf area and dry matter of soybean, besides showing no herbicidal residual effect on finger millet and cucumber.

INFLUENCE OF VARIED DENSITY OF *DIGITARIA MARGINATA* ON GROWTH AND YIELD OF SOYBEAN (*GLYCINE MAX* MERRILL)

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A field experiment was conducted during kharif 1998 on red sandy loam soil to know the competitive ability of seventeen densities of *Digitaria marginata* L. (0 to 153 weed plants/m2) on the growth and yield of soybean (KHSB -2). The adverse effect of the weed on crop attributes-leaf area, total dry matter production, number of nodules, pods/plant and seed yield was assessed by fitting three polynomial functions viz., linear, quadratic and cubic.

The growth, yield and seed yield loss of soybean under varied weed densities were better-simulated using linear, quadratic functions by more than 97-99%. Competitive threshold levels of *D. marginata* to lower the seed yield by 10 and 20% were 23 and 45/m^2 respectively. Further, to lower the seed yield of soybean by 10%, the number or quantity of *D. marginata* required were 23 number/m^2, 6.9 cm of weed height and 0.88 kg/ha of weed biomass.

GROWTH PATTERN OF GROUNDNUT AND FUNCTIONAL MODELS UNDER VARIED WEED CONTROL TREATMENTS

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A field experiment on red sandy loam soil was conducted during *Kharif* 1999 at the University of Agricultural Sciences, Hebbal, Bangalore, to know the growth pattern of Groundnut under six weed management treatments viz., pendimethalin (pre-em) 1.0 kg ai ha^{-1} (to simulate fairly weed free situation), fluazifop-p-butyl (post-em) 0.25 kg air. ha^{-1} (to simulate competition from broad leaf weeds), imazethapyr (pre-em) 100 g ai ha^{-1} (to simulate weed free situation), chlorimuron ethyl (post-em) 4 g ai ha^{-1} (to simulate competition from grasses), hand weeding (fairly weed free situation) and unweeded control (competition from all weed types). Pre-emergence application of imazethapyr 100 g a.i. ha^{-1} recorded higher total dry matter production, followed by hand weeding twice and pendimethalin (pre-em) 1.0 kg a.i. ha^{-1}. Usage of fluazifop-p-butyl (post-em) 0.25kg a.i. ha^{-1} and chlorimuron ethyl (post-em) 4g a.i. ha^{-1} lowerd the total dry matter production in groundnut at all the stages owing to competition offered by broad leaf weeds and grasses, respectively.

Four functional models (Gompertz, Richards, logistic, and quadratic) were fitted to simulate weed competition effect on growth of groundnut. The functional models like Gompertz, Richards, logistic and quadratic simulated the total dry matter production of groundnut more than 94-99% under various weed management practices. The models did not appear to affect the course of dry matter production under weed management practices.

YIELD LOSS RELATIONSHIP IN GROUNDNUT DUE TO DENSITIES OF *DIGITARIA MARGINATA* AND *DACTYLOCTENIUM AEGYPTIUM*

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A field experiment was conducted at the field unit of AICRP on Weed Control, University of Agricultural Sciences, Hebbal, Bangalore to know the effect of varied densities of *Dactyloctenium aegyptium* and *Digitaria marginata* on growth and yield of groundnut in *Kharif* 1999 on red sandy loam soil. The three polynomial functional models namely, linear, quadratic and cubic were used to simulate the relationship of leaf area, number of leaves and total dry matter per plant (all at 60 days). These models simulated the relationship of number of filled pods and pod yield (kg/ha) of groundnut under varied densities of *D. aegyptium* and *D. marginata* by more than 84-99%.

The yield loss was simulated by linear, quadratic and cubic polynomial by more than 86-96 %. The number of weeds required to cause critical yield loss of 10% in groundnut were 28 and 26/m^2 in case of *D. aegyptium* and *D. marginata* respectively by using linear function. Between two grasses, *D. marginata* was more aggressive than *D. aegyptium* in causing more yield loss in groundnut.

EFFECT OF SOIL SOLARIZATION ON SOIL MICROFLORA DISEASE INCIDENCE AND YIELD OF TOMATO

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A field experiment was conducted during 1998-99 at MRS, Hebbal, UAS, Bangalore to study the effect of soil solarization on soil microflora, disease incidence and yield of tomato. The treatments included two thicknesses (0.05 and 0.10 mm) and three duration's (15, 30 and 45 days) of treatment polyethylene mulching and it was compared with non-solarized control. The results revealed that the microbial population (Bacterial, fungal and Actenomycetes and nematodes were reduced in solarized plots compared to non-solarized control. However the lower total disease incidence of fusarium wilt (2.65%), pseudomonas wilt (3.31%) and rhizactonia wilt (1.33) were observed with TPE 0.05 mm for 45 days compared to control which recorded 32.66%, 40.64% and 16% incidenterespectively. Further significantly higher fruit yield of tomato (34.69 qha^{-1}) was obtained with TPE 0.05 mm for 45 days which was 29.68% hgiher over control (26.76 qha^{-1}).

INTEGRATED NUTRIENT MANAGEMENT WITH DAINCHA INTERCROPPING ON WEED DYNAMICS AND PRODUCTIVITY OF SUGARCANE

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Sugarcane being wide spaced crop with slow rate of germination, provides congenial condition for the weeds to grow luxuriantly. In addition integrated management of inputs like

copious irrigation with adequate fertilizer application adds to the unfavourable growing environment by means of severe competition from associated weeds to cane productivity. Intercropping with green manure crops in sugarcane, besides improving the soili fertility and yield, suppresses the weed population during early growth stages of cane. Hence a field study was carried out at Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during main season (2000), to study the effect of integrated nitrogen and phosphorus managment with daincha intercropping on weeds and yield of early planted sugarcan (cv.Co. 86032).). The experiment was laid out in randomised blocks design with three replication with the treatment combination of two levels of (100% & 75%) nitrogen and phosphorus (SSP&RP) with or without daincha insitu incorporation and phosphobacteria application with recommended NPK as well as control without N or P. Observations on predominant weed flora, total weed population and their drymatter production at 30 days after sowing and yields of cane and sugar were recorded.

The results indicated that *Trianthema portulacastrum, Parthenium hysterophorus in* the broad-leaved weeds, *Cynodon dactylon* and *Chloris barbata* in grasses and *Cyperus rotundus* in sedges were the predominant weed species observed in the experimental plot. Among the total weed population, grasses (70.8%) were the dominant groups followed by broad-leaved weeds (25.1%) and sedges (4.1%) in the cane field. Intercropping of daincha in two rows between the sugarcane crop significantly reduced the weed population and weed drymatter production as compared to without intercropping at both levels of nitrogen and phosphorus. Daincha intercropping in sugarcane favoured more number of broad-leaved weeds while grasses were higher in sugarcane without intercropping. Higher can yield (122.96t/ha) and sugar yield were recorded with 100% Rock phosphate + Daincha intercropping + phosphobacteria application. The lowest cane and sugar yields were recorded at control-without nitrogen but with full P&K application.

SEED DORMANCY AND GERMINATION IN *PENNISETUM POLYSTACHYON* (L.) SHULT. AND *P. PEDICELLATUM* TRIN.

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Pennisetum polystachyon and *P. pedicellatum* are two tropical grass weeds that are widespread in Kerala in young plantation crops such as rubber, coconut and cashew. Under natural conditions, the plants are self-propagated by air borne seeds from mature plants. To understand the germination ability of the freshly harvested seeds and their dormancy behaviour, laboratory experiments were done at monthly intervals using freshly harvested seeds during the month of December 1999. *P. polystachyon* recorded 42 per cent germination in December end and 85 per cent germination in March end. *P. pedicellatum* seeds remain dormant for a longer period than *P. polystachyon.* Seeds of *P. polystachyon* kept for germination in December did not germinate at all. However, those kept for germination in February beginning had 55.2 per cent germination. However, both species showed above 80 percent germination in late March. Since the germination percentage is less in *P. polystachyon* in subsequent months, it could be assumed that its viability is getting lost after March-April. The maximum germination in these two species almost coincide with the receipt of pre-monsoon showers in April-May. The results suggest that seed dormancy in *P. polystachyon* and *P. pedicellatum* is season oriented.

CORRELATION COEFFICIENT ANALYSIS OF SOME WEED PARAMETERS AND YIELD ATTRIBUTES OF TRANSPLANTED RICE (*ORYZA SATIVA* L.)

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A field experiment was conducted to evaluate the bio-efficiency of acetochlor in transplanted rice grown on silty loam soils of JNKVV, Jabalpur during *kharif* 1999. Among the different growth parameters straw yield and effective tillers hill-1 had highly significant and positive correlation with final grain yield, whereas, all the three weed parameters under study namely weed population / m^2, weed biomass and intensity of *Echinochloa crus-galli* had negative relationship with grain yield.

EFFECT OF WEED CONTROL METHODS ON NUTRIENT UPTAKE BY PEARL MILLET CULTIVARS AND ASSOCIATED WEEDS

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A field experiment was conducted at the research farm of the Indian Agricultural Research Institute, New Delhi during *kharif,* 1998. The soil was sandy loam, analysing low in organic carbon, available N and P and medium in K with slightly alkaline reaction. The experiment was laid out in a split plot design with three replications. Main plot treatments comprised three pearl millet cultivars (ICMH 451, Pusa 23 and Pusa Bajri 266) where as six weed control measures [atrazine at 0.5 kg ha^{-1} as pre-em., atrazine at 0.5 kg ha^{-1} as post-em. (15 DAS), atrazine at 0.5 kg ha^{-1} as pre-em. + one HW (40 DAS), one HW (20 DAS) + atrazine at 0.5 kg ha^{-1} as post-em. (25 DAS), two HW (20 and 40 DAS) and weedy check] were accommodated in sub plots.

Among the pearl millet cultivars, Pusa 23 performed better than ICMH 451 and Pusa Bajri 266 in respect of grain and stover yields and nutrient uptake. All the weed control treatments significantly reduced the N, P and K removal by weeds compared to weedy check. If the weeds were allowed to grow uninterrupted in pearl millet, they removed 25.4, 6.7 and 70.0 kg ha^{-1} of N, P and K, respectively. Significantly lower weed population, weed dry weight and N, P, K removal by weeds was recorded with a combination of atrazine application at 0.5 kg ha^{-1} as pre-em. alone. The treatments which permitted lower amount of N, P, and K removal by weeds, recorded higher uptake of these nutrients by crop. Nutrient uptake by the crop was maximum (100.5, 13.8 and 176.5 kg ha^{-1} of N, P and K, respectively) with atrazine application followed by one hand weeding at 40 DAS and minimum (48.4, 6.2 and 92.4 kg ha^{-1} of N, P and K, respectively) in weedy check.

EFFECT OF SOIL SOLARIZATION ON WEED DYNAMICS AND YIELD IN TOMATO

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A field experiment was conducted during summer and *kharif* of 1998 at the Agronomy Field Unit, Hebbal, University of Agricultural Aciences. The experiment was laid out in a randomized complete block design with three replications. There were nine treatments comprising of two

thicknesses of transparent polyethylene sheets (0.05 and 0.1 mm TPE), three months of solarization (March, April and May) and control for all the three months.

TPE 0.05 mm during April recorded significantly higher maximum soil temperature of 54.84°C and 51.42°C at 5 cm and 10 cm depth respectively followed by March month of same thickness. The frequency of observations exceeding 40°C and 50°C was 20 per cent and 80 per cent with TPE 0.05mm during March and all the observations exceeding 50°C was 100 per cent with TPE 0.05 mm during April. In general, the extent of increase in temperature was in the order of TPE 0.05mm>TPE 0.1mm and April>March>May. At all the stages of crop growth, consistent results were obtained with respect to weed count and weed dry weight. The TPE 0.05mm during April recorded the highest reduction in the monocot, dicot and sedges weed count and dry weight and was on par with TPE 0.05mm during March followed by thinner gauge. The total weed count and weed dry weight reduction at harvest was 73.52 and 80.22 per cent respectively over control with TPE 0.05 mm during April followed by March (72.47 and 79.49 t ha^{-1}) with TPE 0.05mm during April and March followed by thinner gauge treatments. The least yield was obtained with the control treatment.

EFFICACY OF SOIL SOLARIZATION FOR WEED CONTROL IN GROUNDNUT

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A field experiment was conducted during *kharif* 1998-99 and 1999-2000 to study the effect of soil solarization on weed control and growth and yield of groundnut on red sandy loam soils of the Main Research Station, UAS, Hebbal, Bangalore. The experiment consists of three thickness of polyethylene sheet (0.05,0.10 and 0.15 mm) and three duration of soil solarization (15,30 and 45 days) along with a control laid out in RCBD with three replications. Soil solarization with 0.05 mm TPE for 45 days registered higher soil temperature of 54.33 and 52.67°C during 1998-99 and 1999-2000 at 5 and 10 cm soil depth, respectively with 13,13.4,10.33 and 12°C rise in temperature compared to control during respective soil solarization period. Higher weed control efficiency (WCE) of 81.95% was registered during 1998-99 due to solarization with 0.05 mm TPE for 45 days while in 1999-2000, solarization for 30 days with 0.05 mm TPE thickness which recorded higher WCE of 82.57%. Soil solarization with 0.05 mm TPE for 45 days gave significantly higher pod yield (28.89 and 25.00 q/ha) due to better yield parameters viz., pod weight (13 and 26 g), number of filled pods/plant (22.10 and 22.66), test weight (26.51 and 51 g/100 seeds) and haulm yield (20.74 and 19 q/ha) during 1998-99 and 1999-2000 compared to control which registered significantly lower yield and yield attributes.

INTERACTION EFFECT OF MULCHING, IRRIGATION AND FERTILIZER LEVELS ON WEED CHARACTERISTICS AND SEED YIELD OF INDIAN MUSTARD (*BRASSICA JUNCEA*) GROWN IN ALFISOLS OF EASTERN DRY ZONE OF KARNATAKA

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Bineet Mishra and Mirza Karim Baig

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A field experiment was conducted during *Rabi* season of 2000-2001 at Main Research Station, Hebbal, Bangalore. The experiment consisted of 16 treatment combinations involivng two irrigation levels with and without mulching and 4 fertilizer levels. The result revealed that different levels of irrigation and fertilizers with or without mulching differed significantly among themselves in controlling the weeds species. Lowest weed biomass (28.28 kg ha^{-1}) was recorded in 0.8 IW/CPE without much + 125% RDF which was on par with 0.8 IW/CPE with much + 125%RDF. Both 0.8IW/CPE without much + 50% RDF and 0.5IW/CPE without much + 100%RDF recorded significantly higher weed biomass (213.2 kg ha^{-1}). The observation on weed population indicated a 100 per cent control of *Lagasca molis* with 0.8 IW/CPE with much + 125% RDF and a significant reduced population of *Digitaria marginata* (1.33 /0.25m^2) with 0.5IW/CPE with much +125%RDF treatment combination. Seed yield of mustard was significantly higher (1328 kg ha^{-1}) in 0.8IW/CPE with much +125%RDF on account of better yield attributes and lesser weed biomass (26.72 kg ha^{-1}).

BIO-POTENTIAL OF ALLELOPATHIC PLANT MATERIALS, SMOTHER CROP ON WEED SUPPRESSION IN AMERICAN COTTON (G. HIRSUTUM L.)

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A field experiment was conducted at the Department of Agronomy, Tamil Nadu Agricultural University, Coimbatore during Rabi 1997-98 to study the bio-potential of certain allelopathic crop/tree residue materials, plant leachate and smothering intercrop-pearlmillet for weed suppression in irrigated cotton eco-system. The treatments were soil incorporation of sunflower stalk residues, *Eucalyptus globulus* fresh leaves, *Prosopis juliflora* leaf litter each @ 2 t/ha before sowing, mulching of sunflower stalk residues @ 5 t/ha, spraying of *Eucalyptus* fresh leaf leachate at 10% (w/v) concentration as pre-emergence and intercropping of pearlmillet cv. Co.7 with cotton cv. MCV 5 at 1:1 etc. weed flora of the experimental field consisted of four species of grass, one sedge and ten broad leaved weed species in which *Trianthema portulacastrum* L. is a major weed. In unweed control plot broad leaved weeds accounted for 55% and 70% at 20 DAS and 40 DAS respectively.

The results revealed that the highest weed control efficiency (based on DMP of weeds) is achieved by smother intercrop pearlmillet with cotton i.e. 47.5% and 70.2% at 20 DAS and 40 DAS respectively. It was followed by a WCE of 36.8% and 28.1% at 20 DAS and 40 DAS in soil incorporation of sunflower residues and a WCE of 30.3% and 45% in mulching of sunflower residues. As a result of better weed suppression in these treatments, the growth and yield parameters of cotton was higher.

WEED DYNAMICS AS INFLUENCED BY CHEMICAL WEED CONTROL IN FIELD BEAN

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A field experiment was conducted during summer at Main Research Station, University of Agricultural Sciences, Hebbal, Bangalore to study the weed dynamics as influenced by various herbicides as compared to control. Significantly lower total weed population (3.95 /0.25m^2) and weed dry weight (3.15 g /0.25m^2) was observed in hand weeded twice. Among the herbicides, fluchloralin @ 1.0 and 1.25 kg ha^{-1} and metalochlor 0.75 kg ha^{-1} produced lower total weed population and weed dry weight. Further they also reduced the number of monocots, sedges and dicot weeds and dry weight. However, *Cynodon dactylon*, *Cyperus rotundus* and *Acanthospermum hispidum* were not controlled effectively by any of these herbicides. Infact, their population was incresed by 58-61%, 42-62% and 60-85%, respectively. Weed control efficiency was higher in hand weeded twice (84.1%) followed by fluchloralin 1.0 and 1.25 kg ha^{-1} (58 and 53.9%) and metalachlor 0.75 kg ha^{-1} (52%) which ultimately resulted in higher seed yield.

BIOEFFICACY AND PHYTOTOXICITY STUDIES OF TWO NEW HERBICIDES (*FACER* SC AND *TETRIS*) FOR CONTROL OF WEEDS IN *KHARIF* RICE NURSERY

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Field experiment was conducted during the kharif season of 2000 at Kalyani Seed Farm (23.5^{0}N, 89^0 E, 9.75 m AMSL) of Bidhan Chandra Krishi Viswavidyalaya to study the bioefficacy and phytotoxicity of two new herbicides, 'Facet SC' {Quinclorac 25 % suspension concentrate (SC); Chemical name : 3,7- dichloroquinoline-8- carboxylic acid} and 'Tetris' {Clefoxydim 7.5% EC; Chemical name: 2-[1-2-(2-(4-chlorophenoxy) propoxyimino)-butyl] 3-oxo-5-thian-3-ylcyclohex-l-enol} for weed management in rice (IET-4786) nursery. It was observed that Facet SC @ 125-250 g ai / ha when applied at 2-6 leaves stage (of weeds) controlled most of the weeds in rice nursery effectively. Facet SC @ 250 g ai / ha gave the highest weed control efficiency (WCE) of 86.65% with lowest weed dry matter (1.94 g / m^2) at 28 days after sowing (DAS). Facet SC at nay dose applied in this experiment showed no phytotoxicity (to rice) and the germination percentage of rice was also not affected (97-98%). From this study Facet SC can be considered as eco-friendly because even at higher rates (upto 2.5 kg ai / ha) it had no negative effect on soil respiration, carbon mineralization and nitrogen fixation. In case of Tetris, lowest weed dry matter (2.12 g /m^2) was recorded at 100 g ai / ha and it was statistically at par with 50 and 75 g ai / ha recording 2.14 and 2.52 g / m^2 of weed dry matter respectively. The highest WCE (85.41% at 28 DAS) with the treatment Tetris was observed at 100 g ai / ha; although lower doses (50-75 g ai / ha) of this herbicide were also equally effective (statistically as par with the dose of 100 g ai / ha) in controlling weeds in rice nursery. Tetris (even in higher doses) had no negative effect on germination percentage (96-99%) and was not phytotoxic as evidenced from the record of no yellowing or scorching of rice seedlings.

EFFECT OF SOIL SOLARIZATION ON YIELD AND WEED CONTORL EFFICENCY IN GROUNDNUT (*ARACHIS HYPOGAEA* L.)

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A field experiment was conducted at Agronomy Field Unit, Main Research Station, University of Agricultural Sciences, Bangalore during kharif 2000, to study the effect of soil solarization as a tool for weed control in groundnut. The results revealed the superiority of soil solarization in increasing soil temperature (51.13 to 55.07°C) compared to non-solarized plot (47.17°C) irrespective of transparent polythylene sheet thinckness. Throughout the period of soil solarization higher soil temperature ws recorded in top 5 cm soil depth as compared to 10 cm soil depth. Soil solarization with TPE 0.05 mm for 45 days + one hand weeding resulted in high weed control efficency (80.07%) followed by TPE 0.10 mm for 45 days + one hand weeding (78.76%) at 60 days after sowing as a result of significant reduction in weed dry weight (3.70 and 3.79 g / 0.25 m^2 respectively). Further, the maximum pod yield of groundnut(24.44 and 24.03 q/ha) was recorded with TPE 0.10 and TPE 0.05 mm for 45 days in integration with one hand weeding.

INFLUENCE OF INTEGRATED WEED MANAGEMENT IN CHILLI (*CAPSICUM ANNUUM* L.) ON NUTRIENT UPTAKE BY CROP AND WEED

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A field experiment was conducted on black soils at the Main Research Station, University of Agricultural Sciences, Dharwad (Karnataka) during *Kharif* season of 1996 on soils having a pH 7.70, organic carbon 0.56 per cent, available N 284.60 kg ha^{-1}, available p_2O_5 40.30 kg ha^{-1} and available K_2O 382.20 kg ha^{-1}.

The experiment consisted of twelve treatments replicated thrice in the randomized block design. These includes pre-emergent herbicide alachlor @ 2.00 kg ha^{-1} + Inter-cultivation at 40 and 60 days after transplanting (DAT) + one hand weeding (HW) at 50 DAT, post emergent herbicide glufosinate ammonium @ 0.30, 0.60, 0.90 and 1.20 kg ha^{-1} applied alone and in combination with cultural methods viz., IC at 40 and 60 DAT + HW at 45 and 75 DAT were used in the experiment in comparison with un-weeded check and weed free check.

The data revealed that the nutrient uptake by weeds greatly reduced with post-emergence application of glufosinate ammonium @ 1.20 and 0.90 kg ha^{-1} both in combination with IC at 40 and 60 DAT of HW at 45 and 75 DAT (4.49, 0.83, 3.43 and 5.35, 0.97, 4.23 kg N, P and K ha^{-1} respectively) followed by alachlor @ 2.00 kg ha^{-1} + IC at 45 and 75 DAT (6.24,1.23 and 4.52 kg N, P and K ha^{-1}). In general, all the weed control treatments recorded higher nitrogen, phosphorus and potassium uptake by the crop over on weeded check.

The treatment glufosinate ammonium @ 0.90 kg ha^{-1} + IC at 40 and 60 DAT + HW at 45 and 75 DAT has proved higher number of fruits per plant and total dry chilli yield.

EFFECT OF DIFFERENT INTER CROPPED COVER CROPS ON WEED DYNAMICS IN HYBRID COTTON

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A field experiment was conducted at main Research Station, UAS, Dharwad-5 during the year 1996-97 and 1997-98. To study the effect of Inter cropped cover crops on weed dynamics and it's influence on hybrid cotton yield. Four cover crops were used for the study viz., centrocema pubescence *stylosanthes hamata, stylosanthes scabra* and *Lucerne*. Among these four cover crops *Lucerene* cover crop recorded significantly lower weed count and weed dry weight over other cover crops. Sole cotton recorded significantly higher weed count over all other cover cropped treatments. Cover crop with row proportion of 1:2 recorded significantly lower weed count over 1:1 row proportion.

A cutting interval of 45 days recorded significantly lower weed count over 30 days cutting intervals. *Lucerne* at 1:2 row proportion with 45 days cutting interval recorded significantly lower weed count and weed dry weight over all other treatment combinations. All the cover cropped treatments recorded significantly higher seed cotton yield lower weed count and weed dry weight over sole cotton.

DYANAMICS OF WEEDS AS INFLUENCED BY ALLELOPATHIC CROP RESIDUES IN GREEN GRAM

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Field experiments were conducted at Tamil Nadu Agricultural University during summer and *kharif* seasons of 1998 to study the Allelopathic effect of crop residues on weeds in green gram. The treatments include mulching of *Eucalyptus* leaf litter, pigeonpea leaf litter, sweet potato fresh vines residues, maize and sorghum stover residues, sunflower stalk residues each 2 t/ha etc., with one unweeded control. The experiments were laidout in randomized block design with 3 replications. *Trianthema portulacastrum*, *Parthenium hysterophorus* in broad leaved weeds, Cynodan *dactylon* in grasses and *Cyperus rotundus* in sedges were the predominant weed species observed in the experimental plot. In summer season, among the total weed population *Trianthema portulacastrum* accounted for 38.86 and 46.26% at 20 DAS & 40 DAS respectively, *Cyperus rotundus* (6.13 and 10.48%), *Parthenium hystorophorus* (14.63 and 13.57%) and *Cynodan dactylon* (24.53 and 15.59%). During kharif season *Trianthema portulacastrum* constitutes 40 and 48% at 20 &40 DAS respectively, *Cyperus rotundus* (18 and 16%), *Parthenium hysterophorus* (12 and 10%) and *Cynodan dactylon* (17 & 16%). Soil mulching of *Eucalyptus* leaf litter at 2 t/ha significantly reduced the total weed dry matter production as compared to other crop residues and it was followed by sweet potato vines residues. Mulching of *Eucalyptus* leaf litter and sweet potato fresh vines residues gave comparable growth suppression of *Cyperus rotundus* during kharif 1998.

ALLELOPATHIC EFFECT OF CROP RESIDUES ON PHYSIOLOGICAL AND MICROBIAL STATUS IN GREEN GRAM UNDER SOIL ECO-SYSTEM

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An investigation was taken up at TNAU to study the use of crop residues with allelopathic potential, pure allelo chemicals and alleopathic intercrop on weed management in green gram. These allelopathic treatments were *eucalyptus* leaf litter, mulching of sweet potato fresh vines residues, mango seed nut pulp, soybean stalk, sunflower stalk, red gram leaf litter, maize stover and cowpea stalk residues at 2 t/ha^{-1} each, were tested and were compared with chemical + one hand weeding on 20 DAS and 40 DAS and unweeded control.

Higher chlorophyll 'a' content of leaf (1.03 mg g^{-1} and 1.05 mg g^{-1}) was recorded under pre-emergence application of fluchlorolin + one hand weeding in the respective stages. This was closely followed by mulching of *eucalyptus* leaf litter (1.01 mg g^{-1} and mg g^{-1}) and mulching of sweet potato fresh vine residues (1.02 mg g^{-1} and 0.93 mg g^{-1}). The lowest chlorophyll 'a' content (0.51 mg g^{-1} and 0.26 mg g^{-1}) was recorded with unweeded control as compared to all other treatments. At 25 and 50 DAS, chlorophyll 'b' and total chlorophyll content of leaf have followed the trend of chlorophyll 'a' with reference to different treatments. The maximum growth of bacteria was obtained under the soil incorportion of wattle tannin (51.33 x 10^5 CFU/g) which was on par with Eucalyptus leaf litter (47 x 10^5 CFU/g). Fungi and actinomyces population were at higher magnitude under neem cake treatments. The yield of green gram was higher under chemical weed control (871.66 kg ha^{-1}). This was followed by mulching of Eucalyptus leaf litter (707.67 kg ha^{-1}).

IMPACT OF WEED INVASION ON FLORAL DIVERSITY IN NATURAL HABITATS

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One of the most important causes for decrease in the biological diversity is the habitat fragmentation. The breaking up of the continuous vegetation regime brings in the phenomena of edge effect. The opening of the canopy and the creation of new forest edges allow for the establishment of the weedy or exotic species particularly herbaceous weeds. These invader species due to their positive dispersal mechanisms and adaptations form the pioneer community of any disturbed area. The invasion of weeds has profound effect on the diversity of the ground vegetation especially the evergreen forests. To check the effect of weeds on the diversity of the ground flora, eight evergreen plots were studied. Keeping in view, the definition of weed as "any plant in an unwanted place", all invader species irrespective of their habit were recorded as weeds. The enumerated data of each plot was analyzed for species richness using Simpson's index and the weed to native species (W/N) ratios were calculated. The analysis showed that two plots were devoid of weedy species and had lower richness indices than the others. Among the other plots, an increase in W/N ratio generally resulted in increased richness values. Thus from the results obtained, we can infer that disturbance results in higher diversity. But the validity of these disturbed areas of higher values for conservation is questionable. The present study indicates that when deriving conservation priorities, areas of biological integrity are more important than those, which put forth higher richness values.

WEEDS AS MEDICINE

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A very large percentage of our soil binding weeds are, in one form or the other, edible. Most of them are very nourishing and medicinal. Our traditional system of medicine and folk medicine emphasizes on most commonly occuring plants and their use in medicine. The very common plants considered as weeds such as *Acalypha indica, Boerhavia diffusa, Achyranthes aspera, Bacopa monnieri, Centella asiatica , Andrographis paniculata, Abutilon indicum and Aristolochia indica* possess a number of medicinal properties. Among these plants, three of them viz., *Acalypha indica, Centella asiatica* and *Bacopa monneiri* have been taken up for further studies since they possess useful alkaloids and saponins. The medhya drug *Bacopa monnieri* and *Centella asiatica* is an important drug in Ayurveda for the improvement of memory and revitaiization of sense organs. *Acalypha indica* , another weed with medicinal property has an alkaloid, acalyphine which can be substituted for senega. These plant species show associations with VA mycorrhizae which helps in phosphorous uptake and thus enhances the yield and biomass of the plant and also enriches the soil fertility. Associations of these plants with *Glomus fasciculatum, Glomus mosseae, Acaulospora laevis* and *Scutellospora calospora* showed better performance in field with respect to plant height, total biomass and yield. This can be further exploited in pharmaceutical and pharmacological industries.

CHEMICAL WEED CONTROL IN BEET ROOT (*BETA VULGARIS* L.)

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A field experiment was conducted in the irrigated land at the Division of Horticulture, UAS, GKVK, Bangalore during Rabi 1998 in which the pre-emergence application of alachlor at 0.5, 0.75 and 1.0 kg a.i /ha, butachlor at 0.5, 0.75 and 1.0kg a.i/ha, pendimethalin at 0.5, 0.75 and 1.0kg a.i/ha, organic mulching, hand weeding at 15, 30 and 45 DAS and weedy check were evaluated. Minimum weed population and dry weight of weeds (g/0.5m2) were recorded under butachlor at 1.0 kg a.i/ha. However, maximum plant height, number of leaves per plant as well as maximum root yield (ton per ha) were obtained under butachlor at 1.0 kg a.i/ha followed by pendimethalin at 1.0 kg a.i./ha and hand weeding at 15, 30 and 45 DAS.

RESIDUAL EFFECT OF HERBICIDES APPLIED TO BEET ROOT (*Beta vulgaris* L.) ON SUCCEEDING CROP

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A field experiment was conducted at the Division of Horticulture, UAS, GKVK, Bangalore during 1998-99 to study the residual effect of certain herbicides viz; alachlor, butachlor and pendimethalin applied to beetroot on finger millet, which was grown as succeeding crop. The results revealed that the maximum germination percentage, root and shoot length in finger millet were recorded in unweeded control and organic mulching. Among herbicides except alachlor at 1kg a.i. per ha all other herbicides recorded the maximum germination percent, root and shoot length of finger millet. Besides they are no phytotoxic to beet root crop indicating their sage use. Where as alachlor at higher concentration (1 kg a.i per ha) had residual effect on germination and shoot and root length of finger millet indicating its unsafe use for controlling weeds in beet root.

INFLUENCE OF CHEMICAL AND NON-CHEMICAL WEED MANAGEMENT METHODS ON NUTRIENT UPTAKE OF COTTON (*GOSSYPIUM HIRSUTUM* L.) AND ASSOCIATED WEEDS

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Field experiments were conducted at Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during winter season of 1998-1999 and 1999-2000 to find out the nutrient uptake of cotton and associated weeds and seed cotton yield as influenced by different chemical and non-chemical weed management methods. The experiments laid out in randomized block design with three replications. The treatments were two doses of cinmethylin at 0.5 and 0.6 kg ha^{-1} with and without hand weeding at 40 days after sowing (DAS). The different doses of cinmethylin were compared with the recommended herbicide, pendimethalin at 1.0 kg ha^{-1} + HW at 40 DAS, allelopathic treatments such as parthenium incorporation at 2 t ha^{-1} and whole plant extract spray (10%) with and without hand weeding at 40 DAS, growing weed smother crops such as cowpea, pearl millet and green gram upto 40 DAS, hand weeding twice at 20 and 40 DAS and unweeded control. The soil was sandy loam with low in nitrogen, medium in phosphorus and high in potassium. The pH of the soil was 7.9 with organic carbon content of 0.42%. The results revealed that application of cinmethylin at 0.5 kg ha^{-1} followed by hand weeding at 40 DAS effectively controlled weeds and increased the crop NPK uptake on 120 DAS with higher seed cotton yield of 1878 and 1781 kg ha^{-1} in first and second crop, respectively. Regarding non-chemical weed management practices, growing of smother crops (esp. green gram and cowpea) reduced the weed growth thereby increased the NPK uptake of cotton crop.

WEED MANAGEMENT USING *LANTANA CAMARA* L. IN RICE-RICE-GREEN GRAM CROPPING SYSTEM

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Field experiments were carried out from June 1996 to April 1998 at Tamil Nadu Agricultural University to study the non-chemical methods using *Lantana camara* L, azolla and hand weeding and also it was compared with new low rate herbicide acetochlor and with recommended herbicide butachlor. These treatments were combined with two land preparation methods namely, spraying paraquat @ 1.0 kg ha^{-1} + tractor ploughing with cage wheel by one pass and tractor ploughing with cage wheel by two passes. Spraying paraquat @ 1.0 kg ha^{-1} (7 days prior to tractor ploughing) + tractor ploughing with cage wheel by one pass destroyed all the weeds and facilitated puddling operation by tractor, which is also reduced the germinated weeds and controlled the further growth of weed biomass considerably. Compared to the tractor ploughing with cage wheel by two pass. Among the non-chemical methods, being a weed, lantana biomass incorporation @ 5 t ha^{-1} + HW effectively controlled the weeds in rice through the allelopathic effect. Lantana incorporation also checked the weeds particularly the problematic sedges throughout the crop growth and the grasses and broad leaved weeds in early stages. Azolla inoculation as dual culture controlled the weeds with less efficiently compared to lantana incorporation. Azolla did not control the *Paspalum distichum* L. and sedges population. Application of acetochlor during 8 DAT has recorded higher yield than application at transplanting and also compared to non-chemical methods and the recommended dose of butachlor + HW and hand weeding twice. Among the non-chemical methods lantana biomass incorporation + HW is the economical weed management method but next only to acetochlor.

EFFECT OF SEQUENTIAL APPLICATION OF HERBICIDES ON POPULATION AND DRY WEIGHT OF *CYPERUS ROTUNDUS* L. AND *CYNODON DACTYLON* L. *PERS* IN HYBRID COTTON

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A field experiment was conducted during 1999-2000 at Main Research Station, Dharwad (Karnataka) on black clayey soil to study the efficacy and dosage of herbicides on population and dry weight of *Cyperus rotundus* and *Cynodon dactylon* in hybrid cotton. Field predominantly infested with these weeds was selected for the experiment, which was laidout in a randomised block design with three replications. There were fifteen treatments comprising of pre-plant application of glyphosate at four levels (1 to 4 kg ha^{-1}), each level was followed by inter-cultivation (IC) at 45 and 60 days after sowing and directed spray of glyphosate 1 kg ha-1 or glufosinate of ammonium 1 kg ha^{-1} at 45 days after first spray. Standard checks viz., weed-free checks, farmers practice and weedy-check were also included for comparison. Results indicated that the lowest total density of Cyperus rotundus and Cynodon dactylon was recorded in weed free check (2.53 m^{-2}) and glyphosate 4 kg ha^{-1} followed by eigher glufosinate ammonium 1 kg ha^{-1} (3.35 m^{-2}) or IC (4.01 m^{-2}) or glyphosate 1 kg ha-1 (4.17 m^{-2}). Dry weight of weeds also followed the same trend. These treatments recorded higher kapas yield of cotton due their effective weed control. Weedy check recorded the highest density of weeds and recorded significantly the lowest kappas yield.

PERFORMANCE OF ISOPROTURON WITH SURFACTANTS FOR WEED CONTROL IN WHEAT (*TRITICUM AESTIVUM* L.)

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Field experiments were conducted during the winter season of 1996-97 and 1997-98 at Krishi Nagar Farm, JNKVV, Jabalpur, with the objectives to ameliorate the efficacy of isoproturon of adding surfactants and to economise the herbicide dose, on sandy loam soil, in randomized block design with three replications. The treatments comprised of two rates of isoproturon applied as pre-emergence (1.0 & 1.25 kg/ha) and post emergence (0.75 & 1.0 kg/ha) either alone or in combination with surfactants, viz. Urea, jaggery, teepol and wetwel. The results revealed that application of isoproturon either pre or post emergence was significantly effective in reducing the density of *Phalaris minor* and other broad leaved weeds compared to weedy check (18.36/m^2). The efficacy of isoproturon @ 1.0 kg/ha was considerably improved when urea was added as surfactant and recorded the lowest weed density (6.68/m^2) closely followed by isoproturon 1.0 kg + jaggary (6.69/m^2), isoproturon 1.0 kg + teepol (6.88/m^2), one hand weeding (6.99/m^2) and other isoproturon treatments. Isoproturon as post emergence at both the rates proved significanlty superior to pre-emergence application. The lowest weed biomass (256 kg/ha) was recorded under isoproturon 1.0 kg/ha + jaggery (2.0%) as surfactant, with weed control efficiency of 82.09% as against 8.03% under isoproturon 1.0 kg/ha + wetwel (0.2%). The highest grain yield was recorded under hand weeding (4223 kg/ha) closely followed by isoproturon @ 1.25 kg/ha (4186 kg/ha) pre emergence and isoproturon @ 1.0 kg/ha + urea (4006 kg/ha) and isoproturon @ 0.75 kg/ha +urea (3973 kg/ha) as post emergence. The lowest grain yield was obtained under weedy check (2756 kg/ha). The yield reduction in weedy check was 34.77% when compared with hand weeded plots. Both the rates of isoproturon either 0.75 or 1.0 kg /ha with surfactant produced grain yield on par to each other. Thus the study concluded that urea @ 2% can be added to isoproturon @ 0.75 or 1.0 kg/ha from increased weed control efficiency and grain yield.

BIO-EFFICACY OF PENDIMETHALIN AGAINST WEEDS IN SOYBEAN (*GLYCINE MAX*.L)

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A field experiment was conducted art Research Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur(M.P), during *kharif* 2000, to evaluate the bio-efficacy of *pendimethalin* against weeds in soybean crop. The seven treatments comprised of pre-emergence application of *pendimethalin* (0.5, 1.0, 1.5, 2.0 and 2.5 kg/ha), hand weeding twice, 20 and 40 days after sowing and weedy check were replicated three times in randomized block design. Pre-emergence application of *pendimethalin* at all the rates controlled the growth of all the dominant weeds except *Cynotis axillaris* and *Commelina communis*. Weed Control Efficiency (W.C.E) of *pendimethalin* was increased in ascending order with increase in the rates of application. The lowest weed biomass (78 kg/ha) was recorded when *pendimethalin* was applied at 2.5 kg/ha, followed by 2.0, 1.5, and 1.0 kg/ha. Weed Control Efficiency of *pendimethalin* was lowest when applied at 0.5 kg/ha in *Vertisol* as compared to other dosage. Hand weeding twice (20 and 40 days after sowing) had checked all the dominant weeds . *Pendimethalin* @ 2.5 kg/ha *had phyto-toxic* effect on soybean seedlings and also reduced the leaf area / plant while other rates did not cause any adverse effect on seedling mortality and plant growth. Maximum grain yield of soybean (14.5 qt/ha) was recorded under hand weeding twice and proved significantly superior to all other treatments. Pre-emergence application of pendimethalin at 1.0. 1.5 and 2.0 kg/ha was also found promising and registered 6.53,7.2 and 8.0 qt/ha more grain yield respectively over weedy check. Grain yield was reduced by 12.7%, when pendimethalin was applied at 2.5 kg/ha to soybean.

EFFICACY OF BUTANIL (BUTACHLOR 27.5% + PROPANIL 27.5% EC) FOR WEED MANAGEMENT IN SPROUTED RICE

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Field study was conducted for two season during Kharif 1997-98 on clay loam soil of Agricultural Research Station, Kathalagere, University of Agricultural Sciences, Bangalore to know the comparative performance of Butanil (a ready mix formulation, combination of butachlor 0.275 kg + propanil 0.275 kg/litre) in controlling weeds as well as crop safety and grain yield. Butanil, a ready mix of butachlor at 0.55 to 1.10 kg + propanil 0.55 to 1.10 kg ai/ha was compared with butachlor alone at 1.25 kg ai/ha, pretilachlor 0.625 kg ai/ha, anilofos 0.375 kg ai/ha (all applied at 10 days after sowing) in relation to hand weeding and unweeded control. The major weeds observed in the experimental fields were *Cyperus iria, C. difformis, Scirpus* sp, *Fimbristylis miliacea* (among sedges), *Echinochloa glabrascens, Panicum tripheron, Ludwigia parviflora, Lindernia veronicaefolia, Rotala verticillaris, Eclipta alba, Cynotis axillaris, Dopatrium junceum, Spilanthus acmella* (among broad leaf weeds). The two seasons study revealed that butachlor 0.825 to 1.10 kg + propanil 0.825 to 1.10 kg ai/ha (Butanil 3.0 to 4.0 lit/ha) at 10 to 15 DAS can be used safely for weed control in sprouted rice. Butanil application at 10 DAS was appeared to be relatively more effective than at 15 DAS, from the point of initial weed control. The average grain yields obtained in plots with Butanil at 3.0 to 4.0 lit/ha (3301 to 3621 kg/ha) were comparable with plots treated with anilofos 0.375 kg ai/ha (3140 kg/ha), pretilachlor 0.625 kg ai/ha (3258 kg/ha) and butachlor 1.25 kg ai/ha (3194 kg/ha) at 10 DAS. The yield improvement for advancing the time of application of Butanil from 10 DAS to 15 DAS was slight (0.15 to 3.5 % only).

EVALUATION OF GLYPHOSATE (ROUNDUP CT) FOR CONSERVATION TILLAGE IN TRANSPLANTED RICE- RICE SYSTEM,UNDER BHADRA COMMAND AREA OF KARNATAKA

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Field studies were conducted during 1997-99 for season at Kathalagere and Honnaville, Agricultural Research Stations, University of Agricultural Sciences, Bangalore to study the use of glyphosate in lowering the tillage as against the conventional farmers' practice. The three treatments tested were farmers' practice of 2-3 plowings followed by puddling, levelling and planting of rice, conservation tillage - one plowing after harvest of previous crop followed by two irrigations for emergence of weeds, spraying of glyphosate (Roundup CT 41 SL) 0.9 kg ae/ha followed by flooding, land softening , levelling and planting of rice, zero tillage- after the harvest of previous crop, two irrigations to facilitate weeds emergence, spraying of glyphosate 0.9 kg ae/ha followed by flooding, land softening, levelling and planting of rice. These trials were tried without and with butachlor 1.25 kg ai /ha, conducted on sandy clay loam soils coming under Bhadra command area during kharif 1997, summer 1998,kharif 1998 and summer 1999.

The major weed flora observed in these fields were *Cyperus iria*, *Scirpus* sp., *Cyperus difformis*, *Fimbristylis miliacea*, *Echinochloa colona, Panicum tripheron, Paspalum dilatatum, Ludwigia parviflora, Lobelia olecinoides, Dopatrium junceum, Rotala verticillaris*. Application of butachlor 1.25 kg ai/ha (pre-em.) lowered the weeds' menace considerably and consequentially improved the rice yield in all the four seasons. The grain yields obtained in the conservation tillage and farmers' practice plots were not many variations based on the four season's average results. However, zero tillage-adopted plots recorded significantly lesser grain yield over farmer's and conservation tillage practices. With regard to cumulative excess water infiltrated over farmer's practice during cropping period (1 to 90 days after planting), it was comparatively less in conservation tillage (4.5 cm and 4.92 cm than zero tillage practice (35.68 cm and 12.64 cm) at Kathalagere and Honnaville respectively., for three seasons (1998 summer to 1999 summer). However, conservation tillage practices minimised the tillage and reduced the water requirement (8.0 to 9.5 cm) for the land preparation by avoiding the puddling. Weed emergence due to tillage practices was almost similar in all the four seasons.

IMPACT OF INTEGRATED WEED MANAGEMENT IN MULBERRY AND ITS RELATIVE EFFICACY ON QUALITY OF MULBERRY LEAF AND SILK QUALITY

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Field experiments conducted at field unit, GKVK, University of Agricultural Sciences, Bangalore for two years (1994-95 & 1995-96) in mulberry revealed that the moisture percent and crude fiber percent did not differ significantly. However, the quality parameters like chlorophyll content (mg/g), crude protein carbohydrates, total sugars, starch, ash content (%) were significantly superior in plots created with Metolachlor 1.0 kg (pre-em) followed by glyphosate at 1.5 kg a.e./ ha. (post-em). Whereas unweeded control and hand digging + weeding at 30 and 60 days after pruning recorded the lowest quality parameters.

The silkworm larval weight, cocoon and silk quality parameters viz., cocoon weight, shell weight, shell percentage, mean filament length and weight, 100 cocoon weight and raw silk weight were higher in repeated hand weeding and Metolachlor 1.0 kg a.e./ ha and Oxyflurofen 0.10 kg a.e./ha, each in combination with glyphosate 1.5 kg a.e. / ha as compared to unweeded control and other herbicidal treatments.

COMPARATIVE EFFICACY OF INTEGRATED WEED MANAGEMENT ON MULBERRY (*MORUS INDICA* L.) PRODUCTION

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Field experiments conducted at Agronomy field unit, GKVK, University of Agricultural Sciences, Bangalore, during 1994-95 and 1995-96 revealed that application of Metolachlor 1.0 kg in combination with glyphosate at 1.5 kg a.e. / ha gave better control of weeds followed by oxyflurofen 0.10 kg in combination with glyphosate at 1.5 kg a.e. / ha and glyphosate alone at 2.0 kg a.e. / ha gave highest leaf yield compared to other treatments.

Growth performance of mulberry was better with metolachlor 1.0 kg in combination with glyphosate at 1.5 kg a.e. / ha recorded significantly higher plant height, number of leaves number of branches, leaf area and leaf dry weight as compared to other herbicidal treatment. The next best treatments were oxyflurofen 0.10 kg in combination with glyphosate at 1.5 kg a.e. / ha and glyphosate alone at 2.0 kg a.e / ha. The dry matter accumulation of crop was inversely proportional to the dry matter production of weeds. Metolachlor 1.0 kg in combination with glyphosate at 1.5 kg a.e. / ha registered 253.2 and 266.8 per cent increase in leaf yield over unweeded control during 1994-95 and 1995-96, respectively.

SURVEY OF RABI WEEDS IN BHAL AND COASTAL AREA OF GUJARAT

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The weed flora associated with Wheat, Cotton, Gram and Cumin crops were investigated by surveying in Bhal and Coastal area of Gujarat. Based on relative frequency (%), dominant weeds viz., *Suaeda maritime*, *Convolvulus arvensis* and *Alhagi psudalhagi* in wheat and gram fields, *Suaeda maritime*, *Eragrostis major* and *Convolvulus arvensis* in cotton fields and *Asphodelus tenuifolius* in cumin fields were noticed. Cumin crop was newly introduced in Dhanduka and Arnej area of Ahmedabad districts under problematic soils. Weed flora of cumin crop was almost similar to gram and wheat crop.

STUDIES ON RESIDUAL EFFECT OF DINITROANILINE HERBICIDES APPLIED TO TRANSPLANTED ONION ON SUCCEEDING PEARLMILLET

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An experiment was conducted in sandy loam soil having 0.34 per cent organic carbon at Gujarat Agricultural University, Anand to study the residual effect of dinitroaniline herbicides applied to transplanted onion under different methods on the succeeding sensitive *Kharif* pearlmillet crop. All the three herbicides viz., pendimethalin, fluchloralin and trifluralin were applied @ 1.00 kg/ha as pre-transplant, post-transplant and herbigation at the time of transplanting. The investigation revealed that germination recorded at 10 days after sowing (DAS) and plant height as well as no. of leaves per plant recorded at 30 DAS of succeeding sensitive pearlmillet crop were not significantly affected by residual effect of herbicides applied to onion in *Rabi* season. Among various herbicides, pendimethalin showed slightly higher residual effect on plant growth of pearlmillet as compared to fluchloralin and trifluralin. Among different methods of herbicide application, herbigation had slightly higher residual effect on growth of succeeding sensitive pearlmillet crop as compared to pre-transplant and post-transplantation.

STUDIES ON COMPARISON OF DIFFERENT HERBICIDES WITH CULTURAL METHOD OF WEED CONTROL IN SOYBEAN *[GLYCINE MAX* (L.) MERRILL]

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A field experiment was conducted on black soils at the Main Research Station, University of Agricultural Sciences, Dharwad, during *kharif* 1996, to study the weed management practices in soybean under rainfed conditions. Maximum weed control efficiency (91.26%), lowest weed dry weight (8.18 kg/ha) and lowest weed index (8.69) was recorded with cultural method of weed control consisting of two intercultivations + two hand weedings at 30 and 45 days after sowing.

Among the herbicides, alachlor (pre-emergence) @ 2.0 kg a. i./ha recorded significantly lower weed dry weight (10.18 kg/ha) and maximum weed control efficiency (86.45%). The higher seed yield of soybean was obtained in the treatment of two intercultivations + two hand weedings (2026 kg/ha). Among the herbicides, pre-emergence application of alachlor @ 2.0 kg a. i /ha exhibited the maximum seed yield of 1810 kg/ha. Two intercultivations + two hand weedings recorded significantly highest nodule dry weight per plant (351 mg/plant). Among the herbicide treatments, pre-emergence application of pendimethalin @ 1.0 kg a. i./ha recorded the maximum nodule dry weight (256 mg/plant) which was on par with alachlor (pre-emergence) @ 2.0 kg a. i./ ha (255 mg/plant).

ECOLOGICAL STUDIES ON WEED FLORA ASSOCIATED WITH COTTON

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A field study was done during kharif, 2000 to enlist the spectrum of weeds associated with American cotton in vertisols of scarce rainfall zone of Andhra Pradesh. The predominant weeds detected at 30 days after sowing were Blumea virens,DC., *Trichodesma indicum, Euphorbia hirta*, Linn. *Corchorus olitorius*,linn., *Achyranthes aspera*,linn., *Phyllanthus maderaspatensis*,linn., *Echinocloa colonum*,linn. The relative density of *Blumena virens* was 56.9% while **Echinocloa colonum** constituted 30.2% of the total weed species. The abundance, density, frequency, importance value, relative frequency, relative dominance and importance value index were also maximum in the same order as *Blumea virens* and *Echinocloa colonum* compared to all others. Despite large variations in the relative occurrence the frequency of each of the ten species was inadvertently recognized in every quadrat as revealed by the frequency percent.

A SURVEY OF WEED SPECTRUM IN SUNFLOWER

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A field survey was done during *rabi* 2000-01 to enlist the spectrum of weeds associated with irrigated sunflower in vertisols of scarce rainfall zone of Andhra Pradesh. The predominant weeds detected at 30 days after sowing were *Phyllanthus maderaspatensis Linn.,Digera arvensis,Forsk.,Grangea maderaspatana,Poir.,Chrozophora rottleri,Klotzsch.,Portulaca oleracea,Linn., Cyperus rotundus,Linn., Cynodon dactylon,pers.,Panicum isachne,Roth.,. Cyperus rotundus* was the most abundant species contributing 37.1% of the total weed flora.The density of *Phyllanthus maderaspatensis* and *Grangea maderaspatana* was 19.3 and 18.3 % respectively. The density of *Digera arvensis* formed 11.7% of the total weed species. Thus these four weed species infested the sunflower crop to the extent of 86.4% while the rest were in relatively low proportions. The abundance of *Cyperus rotundus* was 37.1, importance value 15.1, relative dominance 27.3 , relative frequency 14.7 and importance value index 26.4%. It was traced in every sampled quadrat recording 100% frequency. *Digera arvensis* and *Phyllanthus maderaspatensis* recorded maximum importance values of 17.9 and 16.7% respectively.Despite the fact that their cumulative relative density of 31% was less than the single weed species – *Cyperus rotundus* their frequency was also 100%.

CHEMICAL CONTROL OF *CYPERUS ROTUNDUS*

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A field experiment was conducted at crop Research Centre of G.B. Pant Univ. of Agric. & Technology, Pantnagar,, Udham Singh Nagar during Kharif, 1994. Treatments consisting of glyphosate at 1.5 and 2.25 kg ai/ha, applied on 15 June, 1994 and 15 July, 1994 with and without surfactant and control (untreated) were laid out in randomized block design with three replications. Nuts of *C.rotundus* were uniformly planted during 1993 and the treatments were applied during 1994. Surfactant triton was applied at 0.2%,

Glyphosate applied at 2.25 kg ai/ha, on 15th July, 1994 reduced number of nuts of C.rotundus. There was nom effect of surfactant.

EFFECT OF HERBICIDES AND THERI METHODS OF APPLICATION IN CONTROLLING WEEDS IN SOYBEAN

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An investigation was carried out to find out suitable herbicide and its methods of application for weed control in soybean at Agronomy Department, College of Agriculture, Dapoli in rabi season during 1996-1997 to 1998-1999. Four herbicides viz., fluchloralin @ 1.5 kg ai/ha, oxadiazon @ 0.5 kg a.i/ha, butachlor @ 1.5 kg ai/ha and pendimethalin @ 1.5 kg ai/ha as pre-em application were assigned in main plot and two methods of application as spray and application through sand mixing were tested in sub plot.

Data indicated that grain yield of soybean was not significantly influenced due to different treatments; while application of oxadiazon @ 0.5 kg ai/ha resulted in higher grain yield (13.91 q/ ha) of soybean. The dry weight of weeds remained unaffected due to different herbicides, as well as methods of application. Economic analysis of the data indicated that the butachlor @ 1.5 kg ai/ha through spray followed by the hgihest net return of Rs. 2415/ha, followed by oxadiazon spray @ 0.5 kg ai/ha (Rs. 1558/ha). Pendimethalin spray @ 1.5 kg ai/ha and through sand mixing (Rs.800/ha and Rs.603/ha). Application of flunchlorlin through spray or sand mixing proved to be ineffective and hence was not profitable.

WEED CONTROL IN MANGO ORCHARD

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Investigation were undertaken in mango orchard consecutively for three seasons (1997 to 1999) at Agronomy farm, College of Agricultural, Dapoli with the objectives to find out suitable herbicide and its time of application. The treatments comprised of two herbicides i.e. glyposate @ 1.0 kg ai/ha and paraquat @ 1.0 kg ai/ha and applied three times after on set of monsoon i.e. 1, 2 and 3 month.

Data indicated that application of paraquat @ 1.0 kg ai/ha after 2 and 3 months after onset of monsoon colud control most of the weeds and recorded the lowest number of weds (9.31/ 0.25m2) resulting in the highest weed control efficiency (91%) as compared to other treatments. The economics analysis indicated that application of paraquat and glyphosate @ 1.0 kg ai/ha two months after monsoon were more economical (Rs.1541 and 1561/ha). The prominent weeds in the mango orchards were *Celocia arengia, Euphurbies hirta, Digitaria sanguinalis, Ageratum conyzoides, Ocimum grtissimum and Cynadon doctylan*

WEED COMPETITION IN DOLICHOUS BEAN

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Investigation were undertaken during rabi season of 1996, 1997 and 1998 at Agronomy farm, College of Agriculture, Dapoli, to study the crop weed competition period in Dolichos bean. The weed control measures comprised of keeping crop weed free for 30, 45, 60 and 75 DAS and one weedy check. Data indicated that the differences in green pod yield of Dolichos bean free of weeds from 30-75 DAS did not differ significantly amongest them but were significantly superiors than weedy check. Similar trend was noticed on dry weight of weeds. Dolichos bean under weed free control for 75 days resulted in the lowest dry weight of weeds (6.06 q/ha) with 52% weed control efficiency as compared to the rest of the treatment under the investigation. It can be conducted from this studies that Dolichos bean crop needs to be kept weed free for first 30 DAS which helps this crop to suppress weed in later period of its life cycle.

INTEGRATED WEED MANAGEMENT IN ROSE.

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Herbicide when used in combination with the cultural practices gave good control of weeds in Rose. Herbicides keep the crop weed free right from the early stages of crop grown in glyphosate at 1.0 k.g. a.i./ha. gave excellent control of weeds and influenced greatly on flower yield and it was on par with oxyflourfen @ 1.0 k.g. a.i./ha, pendimethalin and atrazine gave Moderate weed control and higher flower yield.

INFLUENCE OF INTEGRATED NUTRIENT MANAGEMENT WITH DAINCHA INTERCROPPING ON NUTRIENT DEPLETION BY WEEDS IN SUGARCANE

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Competition for nutrients constitutes as important aspect of crop-weed competition. Weeds absorb fertilizer nutrients at faster rates and relatively in higher amounts than crops, therefore

crop yields are reduced even at higher levels of fertilization. Management of weeds in vitally important not only to check the losses caused by weeds, but also to increase the fertilizer use efficiency. Growing of green manure crops in the inter rows of cane, used to add the nutrients to the soil and indirectly suppresses the weeds at early growth stages of cane. Hence, the present investigation was undertaken to find out the weed drymatter production, nutrient, remove by weeds and the yield of sugarcane (cv.Co.86032) at Tamil Nadu Agricultural University, Coimbatore during main season (2000). The experiment was laid out in randomised blocks design with three replication. The treatments consisted of two levels of (100% & 75%) nitrogen and phosphorus (SSP&RP) with or without daincha insitu incorporation and phosphobacteria application with recommended NPK as well as control without N or P. Observations on weed dry matter accumulation and nutrient removal by weeds was made in addition to cane and sugar yields of sugarcane.

The results of the study revealed that daincha intercropping in sugarcane resulted in significantly lower weed dry matter and lesser nutrient removal by the weeds compared to sole sugarcane. The highest (28.06:5.84:32.55 kg NPK/ha) nutrient removed by weeds in control without N but full P & K against lesser nutrients removal (18.7:3.88:21.69 kg NPK/ha) at 75% N + 100% RP+daincha intercropping +phosphobacteria application. Daincha intercropping in cane recorded higher yields of cane compared to without intercropping. The highest cane yield of (122.96 t/ha) was recorded at 100% RP+daincha intercropping + phosphobacteria application plots where as the lowest yield of 111.4 t/ha was recorded in control plots without N but with full P & K application. Therefore, it could be inferred from the study that the daincha intercropping and incorporation in sugarcane reduced the weed drymatter production and nutrient removed by weeds and resulting in higher cane and sugar yields of early-planted sugarcane.

ALLELOPATHIC EFFECTS OF MISSION GRASS (*PENNISETUM POLYSTACHYAN* (L.) SHULT.) AND DHEENANATH GRASS (*P. PEDICELLATUM* TRIN.), TWO MAJOR TROPICAL GRASS WEEDS

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Pennisetum polystachyon and *P. pedicellatum* are two major perennial grass weeds of the tropics seen as weeds in young plantation crops and waste places. Experiments were conducted to study the allelopathic effects of roots, leaves and seeds of these grass weeds using cowpea, bhindi and cucumber as test crops. The leachates (both cold and boiled water extracts) of leaf and roots were prepared at 1:3 ratio (one part of sample and three parts of water) and that of seeds at 1:5 ratio. The results indicated that both cold and boiled leaf extracts of both species do not have any influence on the germination of bhindi, cucumber and cowpea. However, both cold and boiled water extracts inhibited root and shoot growth of all the test crops. In the case of root extracts, cold extracts of both *Pennisetum* spp. reduced the germination percentage of bhindi; while others were unaffected. The shoot and root length of bhindi was completely inhibited by the boiled root extract of *P. pedicellatum*. Root lenght was considerably reduced in cucumber also. However, in cowpea some promotery effects on shoot length was noticed in the cold root extract of both *Pennisetum* spp. Seed extracts showed inhibitory effect on cowpea germination, others were unaffected. However, shoot and root length was considerably reduced in all the test crops by both cold and boiled seed extracts. The responses observed in these experiments can be ascribed to the presence of allelopathic substances in *Pennisetum polysachyon* and *P. pedicellatum*.

EFFICACY OF WEED CONTROL METHODS ON YIELD AND ECONOMICS OF PEARL MILLET

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A field experiment was conducted at the research farm of the Indian Agricultural Research Institute, New Delhi during *kharif*, 1998. The soil was sandy loam, analysing low in organic carbon, available N and P and medium in K with slightly alkaline reaction. The experiment was laid out in a split plot design with three replications. Main plot treatments comprised three pearl millet cultivars (ICMH 451, Pusa 23 and Pusa Bajri 266) where as six weed control measures [atrazine at 0.5 kg ha^{-1} as pre-em., atrazine at 0.5 kg ha^{-1} as post-em. (15 DAS), atrazine at 0.5 kg ha^{-1} as pre-em. + one HW (40 DAS), one HW (20 DAS) + atrazine at 0.5 kg ha^{-1} as post-em. (25 DAS), two HW (20 and 40 DAS) and weedy check] were accommodated in sub plots.

The results revealed that cultivar Pusa 23 performed better than ICMH 451 and Pusa Bajri 266 in respect of weed suppressing ability, grain and stover yields. All the weed control treatments caused significant reduction in population and dry weight of weeds compared to weedy check. Application of atrazine at 0.5 kg ha^{-1} as pre-em. coupled with one hand weeding at 40 DAS proved most effective in reducing weed infestation and improving pearl millet yield (27.92 q ha^{-1}) resulting in maximum net return (Rs. 7735 ha^{-1}). Next best treatment was application of atrazine at 0.5 kg ha^{-1} as pre-em. which recorded 25.90 q ha^{-1} of grain yield and a net return of Rs. 7104 ha^{-1}. Atrazine application as pre-em. was found to be better than its application as post-em. (15 DAS) in controlling weeds as well as in obtaining higher pearl millet yields and net returns.

RELATIVE EFFICACY AND ECONOMICS OF POST EMERGENT HERBICIDES ON CONTROL OF COMMUNIST WEED (*CHROMOLAENA ODORATA*)

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A field experiment was conducted at the botanical garden of GKVK, University of Agricultural Sciences during 1998-99. The experiment was laid out in a randomized complete block design with three replications. There were nine treatments comprising of post emergent herbicides i.e., 2, 4-D ethyl ester (1.5 and 3.0 kg ai ha^{-1}), Glyphosate (1.7 and 3.4 kg ai ha^{-1}), Paraquat (1.3 and 2.0 kg ai ha^{-1}), 2, 4-D ethyl ester + Paraquat (1.5 + 0.65 kg ai ha^{-1}), Glyphosate + Chlorimuron ethyl (1.7 + 0.0015 kg ai ha^{-1}) apart from repeated cuttings six times at 15 days interval and unweeded control.

The results revealed that Glyphosate (1.7 and 3.4 kg ai ha^{-1}) gave moderate to excellent control compared to the rest of the herbicides used alone as per the weed control ratings. Among the herbicide combinations, 2, 4-D ethyl ester + Glyphosate (1.5 + 1.7 kg ai ha^{-1}) and Glyphosate + Chlorimuron ethyl (1.7 + 0.0015 kg ai ha^{-1}) gave moderate to excellent control. Similarly, the highest mortality rates and lower stem and weed dry weight of the communist weed were obtained with the same treatments. The highest cost of weed control was recorded with repeated cuttings

(Rs. 7026) whereas Glyphosate at 3.4 kg ai ha^{-1} and 2, 4-D ethyl ester + Glyphosate (1.5 + 1.7 kg ai ha^{-1}) recorded higher cost of weed control (Rs 4416 and 3156 ha^{-1} respectively). Though the treatment Chlorimuron ethyl (0.0015 and 0.003 kg ai ha^{-1}) recorded savings of Rs 6760 and 6690 ha^{-1} respectively over repeated cuttings but taking the efficacy of weed control, Glyphosate + Chlorimuron ethyl (1.7 kg ai ha^{-1} + 0.0015 kg ai ha^{-1}) would be the best (Rs 5130 /ha).

ECO-FRIENDLY WEED MANAGEMENT THROUGH SOIL SOLARIZATION IN GROUNDNUT-TOMATO CROP SEQUENCE

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A field experiment was conducted during 1997-98 and 1998-99 at Agronomy Filed Unit, Main Research Station, Hebbal, Bangalore to investigate influence of soil solarization as a tool for weed control in groundnut-tomato crop sequence. The performance of transparent polyethylene sheets with varying thickness and duration was compared with recommended dose of herbicide (alaclor 1.5 kg a.i/ha), one hand and two hand weedings and weedy check. The results of the study revealed that superiority of thinner (TPE 0.05 mm) transparent polyethylene in increasing soil temperature compared to thicker once (0.10 mm). The maximum soil temperature was recorded by TPE 0.05 mm for 45 days (51.3°C) and least was in control (36.1°C). Consequently lower dry weight of monocots, dicots and sedges (2.29 & 1.31, 3.3 & 1.09, 1.93 & 1.07 / 0.25 m^2) was recorded with TPS 0.05 mm for 45 days during 1997-98 and 1998-99 respectively. Further, higher groundnut and tomato fruit yield were observed with the same treatment.

EFFICIENCY OF SOIL SOLARIZATION ON WEED CONTROL AND YIELD OF GROUNDNUT

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Field experiment was conducted during 1997-98 to study the influence of soil solarization on weed control and yield of groundnut in sandy loam soil at Agronomy Field Unit, Main Research Station, University of Agricultural Sciences, Bangalore in irrigated conditions. The experiment involved two thickness of polyethylene mulch (0.05 mm and 0.10 mm), three durations's of polyethylene much (15,30 and 45 days), chemical (alachlor 1.5 kg a.i/ha) and cultural (one and two hand weedings) methods of weeds control. Significantly higher soil temperature was recorded in soil solarization for 45 days with TPE 0.05 mm (50.5 and 46.90C at 5 and 10 cm soil depth respectively) compared to non-solarized soil (39.3 and 35.0C at 5 and 10 cm soil depths respectively). Soil solarization with TPE 0.05 mm for 45 days resulted in the higher weed control efficiency (90%) next to two hand weedings (93%) as a result of significant reduction in total weed count (5.56/m^2)and weed dry weight 2.40 g/ 0.25m^2). Further, high groundnut pod yield (19.11 q/ ha) was recorded with TPE 0.05 mm for 45 days of soil solarization compared to control (8.5 q/ha) and other treatments.

BIO-HERBICIDES FOR ECO-FRIENDLY WEED MANAGEMENT

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Plants produce several of compounds with the ability to effectively inhibit the growth and development of weed plants and they are called as 'secondary products'. An example for such plant product is 'Juglone' from black walnut tree, which is effective against the weeds, red root pigweed (*Amaranthus retroflexus* L.), velvet (*Abutilon indicum* L. Sweet) and barnyard grass (*Echinochloa crus-galli* L. Beauv.). Allelopathy is the mechanism involved in the weed suppressing ability of such plant products. Later, synthetic herbicides were produced based on chemistry of plant products and one is 'cinmethylin' which is based on chemical nature of 'cineole' - a plant product from *Eucalyptus* spp.

Toxins produced by microbes are also have promising herbicidal activity. The first commercial bio-herbicide, anisomycin is produced from *Streptomyces* sp. and is strongly phytotoxic to barnyard grass with little or no detrimental effect on several horticultural crops. This provide the chemical basis for the development of new synthetic herbicide 'methoxyphenone'. 'Bialophos' is another bio-herbicide from *Streptomycetes hygroscopicus* and *S. viridochromogenes*, which is marketed as 'Herbiace' in Japan. It exhibits strong selective herbicidal activity against a wide spectrum of grass and broadleaved weeds. 'Phosalacine' is a microbial compound (available as herbicide - 'glufosinate') produced by *Kitasatosporia phosalacinea* containing active principle phosphinothricin and its herbicidal behaviour is similar to bialophos. The ammonium salt of glufosinate, a synthetic mixture based on the chemistry of 'phosphinothricin', marketed as 'Basta'. Fusaric acid is produced by *Fusarium* spp. and a chlorinated analogue of fusaric acid namely 'Picloram' is under use in various field crops elsewhere in the world. Use of natural products or synthetic bio-herbicides offer several advantages which leads to reduction in environmental pollution.

INFLUENCE OF WEED MANAGEMENT METHODS ON WEED GROWTH IN CASTOR

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A field experiment entitled Influence of weed management methods on growth of weeds in castor, was conducted on sandy loam soil during the kharif season of 1995 at Main Research Station - University of Agricultural Sciences, Bangalore. The experiment consisted of three emergence herbicides viz., butachlor @ 1.0 kg a.i./ha, matolachlor @ 1.0 kg a.i./ha each at without and with hoeing at 30 DAS or post emergence application of glyphosate @ 1.0 kg a.i./ha. One or two hand weedings with or without hoeing was also considered along with weed free treatment. Including unweeded check, the total of 16 treatments were laid out in randomised complete block design with three replications.

The most predominent weed species observed in the experimental field were *cynodon dactylon, Digitaria marginata, Commeline benghalensis, Acanthospermum hispidum, Tridex procumbense, Mimosa pudica, Parthenium histerophorus and Cyperus rotandus.*

Among the different weed control treatments, pre-emergence application of butachlor @ 1.0 kg a.i./ha + hoeing at 30 DAS recorded lower weed population (35.04/1.0 m^2 area) and weed dry weight (31.81g/0.25m^2) which helps in arriving the highest weed control efficiency (87.60%) and lowest weed index value (3.23%). Besides which, the save treatment also registered the highest weed management system index and therefore passed the way for obtaining highest seed yields (2279 kg ha-1). The next best treatment was metolachlor @ 1.0 kg a.i./ha & hoeing at 30 DAS. Rest of the treatments were recorded the moderate values. Herbicide efficiency was highest with pre-emergence application of butachlor @ 1.0 kg a.i./ha in combination with hoeing at 30 DAS performs better with excellent control of weeds in castor.

EFFECT OF FERTIGATION AND CONVENTIONAL METHOD OF IRRIGATION ON WEED GROWTH IN MULBERRY GARDEN

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A field experiment was conducted at the Main Research Station, University of Agricultural Sciences, Bangalore, during the years 1993-94 on weed growth in mulberry garden. The experiment consisted of furrow irrigation at 0.8 IW/CPE and drip irrigation at 0.6 and 0.8 IW/CPE and in conjuction with normal fertilisers under furrow irrigation and water soluble fertilisers under drip irrigation each at four levels (100,85,70 and 55% recommended fertilisers). Total of twelve treatments were laidout in split-plot design. The weed dry weight was recorded in 0.5m^2 area in all the three seasons of two years.

During the initial period of the experiment i.e. in rabi season of 1993-94, fertigation treatments registered the highest weed dry weight (29.6 to 50.2g/0.5m^2 area) as compared to treaditionally irrigated and fertilised treatments (28.2 to 39.2g/0.5m^2 area) whereas in the later season the weed dry weight was found to be greater with traditionally irrigated and fertilised treatments (23.0 to 42.0g/0.5m^2 area) as compared to fertigation treatments (10.2 to 31.2g/0.5m^2 area). Similarly during the rabi and Kharif season of 1994-95, fertigation treatments caused for lesser weed dry weight (19.2 to 26.2 and 12.3 to 24.2 g/0.5m^2 area, respectively) in comparision to traditionally irrigated and fertilised treatments (30.0 to 52.2tg and 36 to 50.2 g/0.5m^2 area, respectively). The individual levels of irrigation and fertiliser also influenced the weed dry weight in mulberry garden. Furrow irrigation as compared to drip irrigation and recommended fertiliser as compared to other reduced levels caused for the increased dry weight of weeds in mulberry garden.

DISTRIBUTION OF WEEDS IN MULBERRY GERM PLASM

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A field study was carried out at Sericulture College, Chintamani during the Kharif season of 2000, to evaluate the distribution pattern of weeds in mulberry germ plasm. Germplasm consisted of 18 mulberry varities viz., V_1, MR-2, RFS-175, S-41, S-36, S-34, S-13, M-5, Local, S-54, DD-1, BC-259, S-146, S-1708, C-763, S-1635 and S-1. Under each variety, the prominent weeds were identified and quantitative parameters like weed density, frequency, relative density, relative frequency and relative dominance were calculated. The weed count and dry weight were recorded in 1.0 sq.m area of each variety.

The predominent weeds of mulberry germplasm were *Cyperus rotundus, Cynodon dactylon, Ageratum conizoides, Parthenium histerophorus, Tridex procumbense, Emelila sanchifolla and Digitaria marginata.*

Distribution of sedges was found to be highest with all the varieties of mulberry except in the variety S-1708, followed by grasses and broad leaved weeds. Total weed population was registered to the be highest with S-1 (425/m^2 area) followed by V_1 (374/m^2) and BC-259 (345/m^2), whereas the least was noticed with S-1708 (85/m^2). However, the fresh weight of broad leaved weeds was found to highest with most of the varities followed by sedges and grasses. The highest fresh weight was noticed with S-13(251.2g/m^2) and least was with S-41(55.9/m^2).

The quantitative parameters of dominant weeds indicated that, the weed density, frequency, relative density and relative frequency was found to be highest with *Cyperus rotundus,* followed by *Cynodon dactylon, Ageratum conizoides, Parthenium histerophorus, Tridex procumbense, Digitaria marginata and Emelila sanchifolla,* in all the gerplasm varities.

WEED CONTROL EFFICENCY AND NUTRIENT REMOVAL BY WEEDS AS INFLUENCED BY DRIP FERTIGATION IN HYBRID COTTON

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Weeds can be contorlled by advanced irrigation and fertilizer application methods. Drip irrigation and fertigation offers potential to reduce the weed menace as water and nutrients are applied preciously at the root zone of the crop. In this background field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during winter (August to February, 1999) and summer (March to August, 1999) seasons to study the weed control Efficency (WCE), Dry Matter Production (DMP) and removal of nutrients by weeds and yield of hybrid cotton (TCHB 213) under drip irrigation and drip fertigation as compared to furrow irrigation with band application of nitrogen. The experiments were laid out in a split plot design with three replications. The treatments consisted of three drip irrigation regimes (100, 75 and 50% of furrow irrigation) in main plots and four levels of nitrogen application (drip fertigation as 120, 90 and 60 kg N ha^{-1} and drip band application of 120 kg N ha^{-1}) in sub plots and an absolute control (furrow irrigation with band application of 120 kg N ha^{-1}) for comparison. Results revealed that WCE was decreased with increasing levels of drip irrigation regimes and fertigation. Weed control efficiency was significantly improved by drip irrigation and fertigation as against furrow irrigation with band application of nitrogen. At both stages and seasons of study, weed DMP and uptake of nutrients by weeds were higher in higher levels of drip irrigation and fertigation. However drip irrigation and drip fertigation significantly reduced the weed DMP and weed nutrients uptake than furrow band N application. Drip irrigation significantly improved the seed cotton yield by 9.3 and 13.6 per cent during winter and summer seasons over furrow irrigation. Nitrogen application by drip fertigation increased the seed cotton yield by 10.8 per cent in winter and 15.0 per cent in summer seasons respectively than furrow band N application.

ECONOMICS OF INTEGRATED WEED MANAGEMENT IN CHILLI (*CAPSICUM ANNUUM* L.)

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A field experiment was conducted at Main Research Station, University of Agricultural Sciences, Dharwad (Karnataka) during *Kharif* season of 1996 to study the integrated weed management in chilli under rainfed condition on black soils. The experiment consisted of twelve treatments replicated thrice in the randomized block design. These includes pre-emergent herbicide alachlor @ 2.00 kg ha^{-1} + Inter-cultivation (IC) at 40 and 60 days after transplanting (DAT) + one hand weeding at 50 DAT, post emergent herbicide glufosinate ammonium @ 0.30, 0.60, 0.90 and 1.20 kg ha^{-1} applied alone and in combination with cultural methods viz., IC at 40 and 60 DAT + HW at 45 and 75 DAT were used in the experiment in comparison with un-weeded check and weed-free check.

Weed-free check recorded the highest gross income (Rs.32060 ha^{-1}) followed by glufosinate ammonium @ 0.90 kg ha^{-1} (Rs.29945 ha^{-1}) and alachlor @ 2.00 kg ha^{-1} (Rs.27770 ha^{-1}), both in combination with IC at 40 and 60 DAT + HW at 45 and 75 DAT, whereas, lowest gross income was recorded in unweeded check (Rs.6100 ha^{-1}). But, the highest net income (Rs.18611 ha^{-1}), net gain over unweeded check (Rs.17775 ha^{-1}) and highest B:C ratio (Rs.2.64) was recorded by glufosinate ammonium @ 0.90 kg ha^{-1} + IC at 40 and 60 DAT + HW at 45 and 75 DAT followed by alachlor @ 2.00 kg ha^{-1} and glufosinate ammonium @ 0.60 kg ha^{-1}, both in combination with IC at 40 and 60 DAT + HW at 45 and 75 DAT. On the contrary, lowest net income was obtained with weedy check (Rs.636 ha^{-1}) and glufosinate ammonium @ 0.30 kg ha^{-1} (Rs.1281 ha^{-1}). This was due to considerably lower chilli fruit 45 and 75 DAT. On the contrary, lowest net income was obtained with weedy check (Rs.636 ha^{-1}) and glufosinate ammonium @ 0.30 kg ha^{-1} (Rs.1281 ha^{-1}). This was due to considerably lower chilli fruit yield.

EFFECT OF INTER CORPPED LUCERNE COVER CROP ON WEED DYNAMICS IN HYBRID COTTON

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A field experiment was conducted at main Research Station, UAS, Dharwad during 19998-1999 and 1999-2001. To study the effect of Inter cropped *lucerne* cover crop and its influence as hybrid cotton yield and weed dynamics. In this experiment 4 plant geometry's and 4 fertility levels were tryed. Inter cropped *lucerne* cover crop in cotton with all the plant geometry and fertility levels recorded significantly lower weed count and weed dry weight over sole cotton (without cover crop).

A plant geometry at 90 x 60 cm and 90 x 45 cm recorded significantly lower weed count and weed dry weight over all other treatments *lucerne* cover cropped with cotton reduced the weed count and weed dry weight over sole cotton (without cover crop).

A plant geometry of 90 x 45 cm with 50% RDF+ *lucerne* cover crop recorded significantly lower weed count and weed dry weight over all other treatment combinations.

WEEDS OF BANANA PLANTATION

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Weeds occupy an important place in agriculture and horticulture. Being ubiquitous in nature, they are well adopted to the conditions of the soil and environment. They are not easily destroyed. Therefore, it is necessary to study them in various aspects so that different means may be adopted to manifest them and utilize them if possible. Banana is one of the ancient, commercially important crop. Similar to other plantations, banana plantation due to its favourable conditions of high nutrient and water content, offers a congenial environment for the persistance and propagation of weedy species. About forty weed species were enumerated as associates in the plantation. Among these twelve species were found to be more dominant like *Synedrella nudiflora, Cyperus cyperoides, Cyperus rotundus, Cyanodon dactylon, Cassia cerasia, Alternanthera pungens, Cleome monophylla* etc. The less dominant species were *Commelina benghalensis, Eragrostis tenella, Boerhaavia diffusa, Chromolaena odorata*, etc.*Solanum nigrum, Mimosa pudica, Cardiospermum helicacabum, Oxalis spp., Phyllanthus neruri, P.virgatus,* were the least dominant species. Among these weeds few are medicinally important like *Phyllanthus neruri, Cyanodon dactylon, Psitaria palludipusca*, etc. Some like *Oxalis spp., Boerhaavia diffusa*, are edible. Many of the weeds are used as geeen manure, for fodder and for mulching. These species though are useful, are detrimental to the banana crop as they compete for water, nutrients, space etc. Some play host to many of the pests like aphids. Therefore these should be removed periodically. Nevertheless these weeds can be utilized to exploit their usefulness through inter-cropping.

STUDIES ON STANDARDIZATION OF BIOASSAY TECHNIQUE FOR FLUCHLORALIN

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Pot and laboratory experiments were conducted for detecting sensitive plants for fluchloralin. The various crop plants viz. Wheat, pearl millet, cucumber, sunflower, soybean and moong were tested under laboratory condition using root and shoot length after 48 hours of pre-germinated seeds at different conditions. Wheat, cucumber and pearl millet were found sensitive against fluchloralin. Soil bioassay in pots was conducted with these sensitive crops using 0-6.4 ppm concentration of fluchloralin in soil. On response of different parameters like root length, shoot length, fresh weight and dry matter production, root length of cucumber and pearl millet was found the best parameter for detecting fluchloralin residue in soil.

SURVEY OF RABI WEEDS IN NORTHERN MADHYA PRADESH

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Three districts viz. Gwalior, Morena and Bhind of northern Madhya Pradesh were surveyed for weeds during Rabi season 2000-2001. Six crops viz. wheat, pea and Berseem under irrigated

condition while gram, lentil and mustard in rainfed condition were observed. In all fifteen weed species were recorded, out of those, weed species *Asphodelus Tenuifolius, Chinopodium* spp., *Anagallis arvensis, Metolotus* spp. and *convolvalus arvensis* were found most dominant.

In Gwalior district under irrigated condition, weed species *Anagallis arvensis* (38.5%) and *Chinopodium* spp. (Bathua/khartua 26.5%) in wheat, *Cichorium intybus* (28.8%) and *Mililotus* spp (23.5%) in Berseem and Vicia sative (28.8%) and *Cyperus rotendus* (17.6%) in peas were found in higher degree of infestation.

Under rainfed condition, *Asphodelus Tenuifolius* (30.5%) *and Anagallis arvensis* in mustard, *Vica sativa* (22.7) and *Convolvulus arvensis* (18.8%) in gram and *Cyperus rotendus* (26.4%) and *Cynodon dactylon* (28.3%) in lentil were observed most dominant weeds.

In Morena district the wheat crop was mostly infested by *Chenopodium* spp (26.3%) and *Cyperus rotendus* (24.8%) while in peas, weeds *Anagallis arvensis* (24.6%) and *Cyperus rotandus* (17.4%) were dominant. whereas in Berseem, the most dominant weed species were *Cichorium intybus* (45.1%) and *Melilotus* spp. (18.0%)). Under rainfed condition it was noted that mustard and gram crop were infested by *Asphodelus lenuifolic* to the level of 45 and 22 % respectively *Cyperus rotendus* (27.5%) was found major weeds of lentil.

In Bhind district, under irrigated condition weed species *Anagallis arvensis* (22.9%) and *Chinopodium* spp. (21.6%) were identified as major weeds in wheat, while in Berseem and pea crop, the most dominant weed species were *Cichorium intybus* (26.3%) and *convolvalus arvensis* (22.7 %) respectively.

It was also noted that under rainfed condition, the weed spectrum in mustard fields consisted chiefly of *Asphodelus Tenuifolius* (37.6%) and *Chinopodium* spp (23.4 %) whereas, the gram and lentil crops were infested chiefly by the weed spp. *Asphodelus Tenuifolius* (38.8%) and *convolvalus arvensis* (29.3%) respectively.

RESPONSE OF SOYBEAN (*GLYCINE MAX*) AND WEEDS TO FORMS AND LEVELS OF ALACHLOR

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Field trail was conducted during kharif season for two consecutive years of 1996 and 1997 at JNKVV, RARS, Sagar (M.P) in RBD, replicated thrice having ten treatments in order to test the bioefficacy and phytotoxicity of alachlor in soybean. Results revealed that the experimental site was infested with 33 different weed species consisted of 26 broad, 6 narrow leaved and 1 sedge weeds. At 7 days after sowing (DAS), different treatments did not vary significantly in controlling sedges. At this stage, not a single count on narrow leaved weeds was noted while all treatments were found at par in controlling broad leaved as well as total weeds /m^2. Oxyfluorfen @ 0.235 kg/ha as pre-emergence (PRE) was found the best treatment in this regard. At 14 DAS, various streatments did not differ statistically among themselves in reducing sedges but all the

treatments were found superior over weedy check in controlling narrow weeds. Again, various treatments did not influence for controlling broad leaved weeds while oxyfluorfen reduced total weeds significantly over all others. At 28 DAS, all the levels (i.e. 1500, 2000 & 3000 g/ha through granules & ED as PRE) of alachlor reduced sedge infestation significantly over fluchloralin @ 1000 g/ha as PPI and weedy control plot. Both weedy control and alachlor with lower rate of 1500 g /ha PRI through granules were found statistically inferior to all treatments in reducing narrow leaved weeds. Similarly, broad leaved weeds were controlled significantly by all treatments except weedy plot. Oxyfluorfen was found the best treatment among all. Total weeds were also controlled efficiently by the same herbicid followed by others except weedy check, alachlor granules @ 1500 g/ha PRE and fluchloralin PPI. However, liquid form of alachlor @ 3000 g/ha produced the lowest dry weed biomass of 3.97 q/ha but, maximum crop biomass (38.43 q/ha) was produced under granules of alachlor applied @ 2000 g/ha over others while significantly highest grain yield of 19.80 q/ha was noted under granular alachlor at higher dose of 3000 g/ha. Phytotoxicity study indicated that neither granules nor liquid form of alachlor even with highest dose up to 3000 g/ha was found harmful to the crop. Pendimethalin & fulchloralin with their recommended dose were also not found phytotoxic to crop but oxyfluorfen affected the crop upto considerable extent and reduced grain production significantly, althought it was found very effective against all kinds of weeds in soybean.

CROP WEED COMPETITION STUDIES IN CHICKPEA UNDER RAINFED CONDITION IN *ASHPHODELUS TENUIFOLIUS* DOMINATED WEED COMMUNITY

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Field experiment was conducted for two consequtive years (1997-99) in sandy loam soil of central Uttar Pradesh at Kanput in order to decide critical period of weed competition in chickpea grown in A. *tenuifolius* dominated weed community (92 m^2). The crop was raised entirely under rainfed condition. Weedy condition prevailed throughout crop period caused 80% reductions in grain yield of chickpea. There was progressive increase in grain yield when the weed free duration was prolonged upto 60 days after sowing and thereafter increase in grain yield was nonsignificant. Initial 60 days period after sowing was identified as critical period of weed competition in chickpea grown undemr rainfed condition in *Ashphodelus tenuifolius* dominated weed community.

EFFECT OF SEQUENTIAL APPLICATION OF HERBICIDES ON REGROWTH AND VEGETATIVE PROPAGULES OF *CYPERUS ROTUNDUS* L. AND *CYNODON DACTYLON* L. *PERS* IN HYBRID COTTON

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A field experiment was conducted during 1999-2000 at Main Research Station, Dharwad (Karnataka) on black clayey soil to study the efficacy and dosage of herbicides on regrowth and vegetative propagules of *Cyperus rotundus* and *Cynodon dactylon* in hybrid cotton. The experiment was laid out in a randomised block design with three replications. There were fifteen treatments comprising four levels of glyphosate (1 to 4 kg ha^{-1}), each level was followed by inter-cultivation

(IC) at 45 and 60 days after sowing (DAS), glyphosate at 1 kg ha^{-1} and glufosinate ammonium at 1 kg ha^{-1}. Follow up spray of glyphosate and glufosinate ammonium were applied at 45 days after first spray as directed spray using protective hood. Standard checks viz., weed-free, farmers practice and weedy-check were also included for comparison. *Cyperus rotundus* and *Cynodon dactylon* infested field was selected and these weeds were allowed to grow in the site before imposing the herbicidal treatments. Results indicated that pre-plant application of glyphosate 4 kg ha^{-1} followed by direct spray of either gulfosinate ammonium 1 kg ha^{-1} or glyphosate 1 kg ha^{-1} or inter-cultivation at 45 and 60 DAS recorded lower regeneration percentage of both weeds.

Values recorded on tuber count, tuber dry weight, thizome dry weight, tuber/rhizome control efficiency followed the same trend. Kapas yield of cotton recorded in the above treatments was comparable with weed-free check.

PERSISTENCE OF PENDIMETHALIN IN VERTISOL FOLLOWING ITS PRE-EMERGENCE APPLICATION TO SOYBEAN (*GLYCINE MAX*)

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An experiment was conducted at J. N. Krishi Vishwa Vidyalaya, Jabalpur during *kharif* 2000, to determine the persistence of *pendimethalin* in *Vertisol* following its pre-emergence application to soybean. The half- life of *pendimethalin* at all rates (0.5, 1.0, 1.5, 2.0 and 2.5 kg/ha) of application varied between 29 to 30 days. The data based on semi-logarithmic analysis revealed that the rate of dissipation of pendimethalin did not follow first order kinetics at any rate of application. The initial dissipation of pendimethalin was acute and nearly 30-32 per cent of original value was lost in 15 days at all the rate of application. Nearly 2-3 per cent pendimethalin residues remained in the soil till the harvest of the soybean (90 days after sowing) ,when applied at the rates of 2.0 and 2.5 kg/ha respectively. However, the residues in the soil were not detected when pendimethalin was applied at 0.5, 1.0 and 1.5 kg/ha .

INFESTATION OF PARASITIC WEED – DENDROPTHERA FALCATA (LORANTHUS) ON ECONOMIC TREES

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A survey was undertaken in Southern transition zone around Shimoga – Shikaripura, Kadur, Bhadharavathi; central dry zone around Sira and Tumkur; eastern dry zone around Tumkur; southern dry zone around Mandya regions, to study the intensity of infestation on tress, host range, flowering behaviour, etc. The host range of Dendropthera was seen on all economically useful trees excluding tamarind. It appears that tamarind is not infected by the parasite in all the surveyed area. Based on the survey, it is observed that Dendropthera was seen to an extent of 85 to 95% on mango trees all along the road side and on government lands, 5 to 10% in other hosts namely *Acacia auriculiformis*, Gulmohar, neem, *Ficus* sp and teak on road sides. In central and eastern dry zones, the weed was noticed in mango, neem, *Acacia auriculiformis*, rain tree, *Dalbergia sisu*, *Modhalica latifolia* (Hippe), and Pongamia. The weed was still in flowering stage during December- January months in dry areas, and fruit set had also occurred in Shikaripura area. Depending on the host plants, morphology of the weed appeared to vary. The seeds have gol highly gelatinous material, which help in sticking to the host plant.

HERBICIDE MIXTURES IN AGRICULTURE - A REVIEW

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Weed diversity in the crop fields has always been a hurdle before the farmers to achieve sustained crop yields. Being diverse, weeds pose a serious threat to the cultivation practices of field crops and horticultural crops because of their superiority over the crops in competing for nutrients, water and space. Global loss of food production due to weeds is estimated to be 11.5 per cent of the total food production and in India, weeds account for a loss of 33 per cent of annual agricultural produce (Gautam and Mishra, 1995).

Monoherbicides with same site / mode of action, over the years, have given rise to resistance in weed species as seen in Phalaris minor in wheat with isoproturon particularly in rice -wheat seuence (Malik and Singh, 1993). The other negative impact of monoherbicides is the emergence of new biotype i.e. Cyperus iria with continuous application of butachlor in rice fields. So conventional way of herbicide use may not serve the need of a total long term and economical weed management to the desired levels. Practice of using herbicide combinations in many crops have shown tremendous improvement over the single herbicides viz. anilophos+2,4-DEE(0.3 + 0.4 Kg/ha) in rice (Sreedevi and George Thomas, 1993), 2,4-2.0 +0.75 Kg/ha) in sugarcane (Phogat et al., 1988), diphenamide + alachlor (4.0 + 1.0 Kg/ha) in tobacco (Raghaviaiah and Sannibabu, 1991).

Besides controlling complex weed flora, herbicide mixtures provide an opportunity for increasing herbicide efficiency and arresting weed flora shift. Compatible herbicides in the herbicide mixtures do offer a low dose of each in achieving their same activities through additive, synergistic and enhancement effect which could be seen through an eco-friendly angle towards sustainable food production.

ECONOMICS OF WEED CONTROL IN SUNFLOWER

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The experiment was conducted with KBSH - 1 variety of sunflower on Red loam soil at Main research Station, University of Agril. Sciences Bangalore during the Kharif seasion of 1996-97, to work out the Economics of using crop residues & weed control treatments for the control of weeds in sunflower. The experiment consisted of 15 treatments involving three treatments (Paddy straw incorporation at 5 T/ha, paddy straw burnt at 5 T/ha and No straw) under main flot and 5 treatments (metolachlor at 0.75 kg a.i./ha, pendimethalin at 0..75 kg a.i./ha, weed free throughout, two hand weedings at 4 & 6 was and unweeded check) under sub plot, were laid out in split-plot design with three replications. The evaluated results indicated that the maximum net returns, margional returns and benefit cost ratio was recorded with weed free through out the crop growth period + paddy straw burnt at 5 T/ha (Rs. 12,357/ha, Rs. 5900/ha and 1.84, respectively) followed by metolachlor at 0.75 kg a.i./ha (Rs.11615/ha, Rs. 5590/ha and 1.77, respectively). However, the least net returns (Rs. 8063/ha) and benefit-cost ratio (1.36) was observed with Unweeded control.

INTEGRATION EFFECT OF CROP RESIDUES AND WEED CONTROL ON GROWTH AND YIELD OF SUN FLOWER.

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A field experiment was conducted with KBSH -1 variety of sunflower on Red loam soil at Main Research Station, University of Agricultural Sciences, Bangalore, during the Kharif seasion of 1996-97, to evaluate the effect of crop residues management & weed control on growth and yield of sun flower. The experiment consisted of 15 treatments involving three treatments (Paddy straw incorporation at 5 T/ha, paddy straw burnt at 5 T/ha and No straw) under main plot and 5 treatments (metolachlor at 0.75 kg a.i./ha, pendimethalin at .75 kg a.i./ha, weed free through out, two hand weedings at 4 & 6 was and un weeded check) under sub plot, were laid out in split-plot design with three replications. The results revealed that, Metolachlor at . 75 kg a.i./ha in combination with either paddy straw burnt or incorporation registered the higher seed yield of 1939 kg/ha with the reduced weed population (45.22/m^2), dry weight (10.81 g/0.25 m^2) and increased weed control efficiency (88.24%) as compare to unweed control (1410 kg/ha,102.66m^2, 48.19 g/0.25 m^2, 0.0%, respectively). Among the individual treatment, paddy straw burnt and metolachlor at 0.75 kg/ha performed well in enhancing the seed yields by controlling weeds more efficiently.

WEED DENSITY AS INFLUENCED BY WEED MANAGEMENT PRACTICES AND NITROGEN DOSES AT VARIOUS GROWTH STAGES OF WHEAT CROP

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A field trial was conducted during rabi season of 1998-99, to find out the effect of weed management practices and nitrogen doses on weed density at various growth stages of wheat crop. The result revealed that the wheat crop was severely infested with a divergent weed flora through out its life cycle. The highest weed density was recorded at 30th day stage of crop which decreased at latter stages of crop growth under the effects of both weed management. Practices and nitrogen doses. Thus, it is obvious that at early stage of crop growth, the weed density was more and decreased gradually with the advancement in the age of crop.

STUDIES ON RESIDUES OF HERBICIDES IN POST HARVEST SOILS OF UPLAND DRILLED RICE

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Experiments were conducted at Agronomy Research Farm as well as in Weed Science Laboratory of the N.D. University of Agriculture & Technology Kuma-rganj, Faizabad during Kharif seasons of 1994 & 1995 in a R. B. D. with three replications. Application of anilofos @ 0.3 & 0.4 kg/ha pre-em., butachlor @ 1.5 kg/ha pre-em., 2, 4-D Na Salt @ 0.5 kg/ha 30 DAS alone and tank mixture of anilofos @ 0.3 kg/ha pre-em. + 2, 4-D Na salt @ 0.5 kg/ha pre-em. & anilofos @ 0.4 kg/ha pre-em. + 2, 4-D Na salt @ 0.5 kg/ha pre-em. did not cause significant variations in germination, plant height and dry matter production of cucumber grown in sampled soil taken after the harvest of rice. Therefore, anilofos, butachlor, 2,4-D Na salt alone and tank mixture of anilofos with 2,4-D Na salt and butachlor with 2,4-D Na salt when applied at above mentioned doses and time of application in upland drilled rice to control the weeds did not leave their harmful toxic level of residues in post harvested soil of the experimental field during both the years of study.

ECONOMICS OF INTEGRATED WEED CONTROL METHOD IN OKRA (*ALBELMOSCHUS EXCULENTUS* (L.) MOENCH)

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A field experiment was conducted during 1994 at farmers field Chintamani taluk, Kolar district to test the effect of herbicides on Okra yield and economics. The experimental results revealed that pre emergence application of alachlor at 1.5 kg a.i. ha^{-1} super imposed with one hand weeding at 45 days after sowing (DAS) and alachlor at 1.5 kg a.i. ha^{-1} alone gave highest pod yield (9277-9078 kg ha^{-1}) respectively and there by recorded maximum net return (Rs. 8695-8029 ha^{-1}), marginal return (Rs. 14130-13712 ha^{-1}) and cost benefit ratio (1:12-1:10) respectively, followed by alachlor and fluchloralin both at 1.5 and 0.75 kg a.i ha^{-1} supplemented with one hand weeding at 45 DAS; among the herbicidal weed control treatments.

WEEDS: A SOURCE FOR VALUABLE MEDICINAL DRUGS

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Biodiversity of plants have taken immense importance over the past few decades. Weeds being a major component in the agriculture system and also associated with waste lands, marginal lands, back yards etc. contributing to the richness of the species diversity of the land. Further, the diversity also has very great importance in the economic and social sphere of the human community. The reduction of crop yield in crop lands by way of competition, alternate hosts for several diseases and pests and other related effects have made weeds a vulnerable group of plant species in the plant diversity. Nature has provided a vast array of provisions for plants and animals by way them having both useful and harmful effects. The useful effects of the weeds when properly managed becomes one of the major component of plant diversity that helps maintain a better environment and health of the human beings. It is in this context that weeds have a grater scope of being utilized and properly managed as medicinal plants

The global scenario is quite precarious in respect of the diversity of plants and received considerable attention for the past three decades among the scientific, industrial and general public. The loss of worlds genetic resources are steadily increasing . This is due to the fact that various destructive processes like habitat destruction, over exploitation of species and other related anthropogenic pressures. The habit diversity of plants show that Herbs, Shrubs and Trees occupy almost equal proportion. Most of the herbaceous plants are considered to be of weedy type. These weedy species are considered as the enemy of farmers on one hand and are also found to be valuable source of medicine for human kind as revealed by the usage in the folk, traditional and codified systems of medicine.

The traditional usage of plants accounts for approximately 8000 species of plants of which about 2500 species are found to be of herbaceous plants. Since a majority of herbaceous species are categorized as weedy plants, they are put to enormous pressures from both the farming community as unwanted weeds and from the pharmaceutical industries as useful medicinal plants.

This conflicting approach to these groups of plants is a paradoxical situation for both conservationist and weed managers. The 7000 species plants listed in Indian system of medicine mainly Ayurveda, Sidda and Unani along with Homeopathic system of medicine besides a vast array of folk traditions, it is essential to look at the extent of the herbaceous / weedy species being used. A look at the qualitative and quantitative aspects of these species reveal that the in most cases the entire plant is used. Pharmacological investigations also have revealed the indications claimed by the various systems of medicine as having the curative property and also have specific chemicals being used in the allopathic system. The distribution of medicinal plants across the different families of flowering plants show that the top ten families dominated by herbaceous genera. Out of 386 families and 2200 genera having medicinal plants, families Asteraceae, Euphorbiaceae, lamiaceae, Fabaceae, rubiaceae, Poaceae, Acanthaceae, Rosaceae and Apiaceae share the larger proportion of medicinal plants. About 95% of medicinal plants used by industries are obtained from the wild sources only a small proportion is grown and less than 20 species are grown on commercial basis.

Demand for medicinal plants

As on date there are 7843 licensed pharmacies of Indian system of Medicine in addition to 857 Homeopathy and number of unlicensed small scale processing units engaged in the manufacture of medicines to meet the requirement of 4.6 lakh registered practioners of ISM&H and other users in the country. Apart from these there are several herbal industries which export plant extracts for use in different systems of medicine. The available information shows that a conservative estimate of economic value of medicinal plant trade in India is to the tune of Rs. 1000 crores/year and world over it approximately $60 billion.

Certain data from CHEMEXIL the total annual demand of the order 31780 tones of raw herbal material. The figures for 1998-99 shows Rs. 450 crores worth raw drug is exported. The available data for Karnataka shows that Natural remedies a major player in the field, the raw material requirement during 1999-2000 was approximately 6771 belonging to 84 species of which herbaceous weedy forms account 32 species and 1000 tons. In Kerala, 55 species account for 32994 ton having about 30 weedy species account for more than14000 tons. On all India basis, out of 55 major species, 16 herbaceous species account for 15000 tons.

The present paper attempts throw light on the facts about the weeds of the peninsular India as a potential source of medicinal plants.

FUTURE RESEARCH STRATEGIES IN WEED SCIENCE

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Since independence the challenge of meeting the domestic food requirement remained the first and foremost social concern before India and thus the major emphasis was given to food production. Strategic planning coupled with comprehensive scientifically oriented research and development brought a sea change in the agriculture scenario of the country over the years. With the advent of green revolution country achieved self-sufficiency in food production (209 m tons), with appreciable quantities of food grains, being stored as buffer stock (about 45 m tons). The ever increasing population pressure would need about 230 m tons of food grains by the end of this ninth plan i.e. an increase of 30-35 m tons in the next five year plan. Thus a challenging target in agricultural production has to be achieved with the efficient management of all the inputs including water, fertilizer and pesticides. Pest management in general and weed management in particular will play a pivotal role in attaining and sustaining self-sufficiency in agricultural production in the near fUture.

Weeds have been of great concern to the man since the inception of crop production and are in fact the most severe and wide spread constraints on crop productivity. Of the total annual loss of agricultural produce from various pests, 'weeds accounts 45 percent. Being highly adaptable and competitive, weeds infest all crops and inflict heavy losses in crop yields. In fact without weed control in the critical early stages of crop growth there would be poor efficiency of the applied inputs and hence there may not be harvestable and marketable crop produce. Thus effective and economical weed management measures have become essential in the modem scientific agriculture.

Considering the problems of weeds in field crops, a coordinating weed control scheme on wheat-rice and sugarcane was initiated as early as 1952 by ICAR followed by the initiation of research projects by the state agriculture universities pertaining to the major problems of weeds and their management. Another break through was in 1978, when All India Coordinated Research Program was started which is now operating at about 25 institutes in the country. These projects assisted the farming communities through the development of weed management technologies by way of alleviating sufferings due to the weeds in field crops. The foundation of national research center for weed science during 1989 at Jabalpur was another landmark in the history of weed management with a mandate to provide leadership through basic and applied multi disciplinary research, training and information. The collective efforts of the different weed scientist working in different SAUs, AICRP-WC and NRC helped in identification and proper assessment of the potential problems of weed management and developing the technology for utilizing the nutrients and water under weed free environment and thus, enhancing the different field crops. In the present scenario, non-availability of labour and increasing labour cost are the two major factors, increasing the farmers' dependence on herbicide use. The use of herbicide is found to increase due to the shortage of working hands in a farmer's family earlier engaged in manual weeding and most of the farmers now depend upon hired labours which are ineffective and uneconomical and hence there is increased dependability on herbicides. The weed management with the use of synthetic

organic herbicides have become the backbone of modern weed control programme and a principal tool in many parts of the world because of being effective and economical, as the gross financial return (cost benefits) on every rupee enlisted may vary from Rs. 4 to 7.

Although herbicides play a major role in most weed management programmes but refocusing away from a predominantly single tool towards more integrated, long-term weed management approaches will require greater understanding of biological system. The agricultural community has become increasingly concerned about the survival / selection of the best-adopted weed species and the evolution of resistance to herbicides in weeds. In the modern era of agriculture, the thinking is more towards the use of eco-friendly weed management approaches as the public is feeling more concerned about the hazardous effects caused by the herbicides. Thus, the development of cost effective, environmentally safe and users friendly technology is need of the day to overcome the weed menace in India and at global level. It is thus imperative that weed scientists must become the leaders of collaborative integrated approaches to agriculture system research in order to develop new methods of weed management that will supplement or replace herbicides.The greater understanding is required to some of new research needs listed as under:

Weed Ecophysiology : The basic disciplines of ecology, evolution, genetics and physiology of weeds needs to be strengthened to understand the basic biology of weeds to predict how species, populations and biotypes evolve in response to selection pressure. The study of phenology or timing of development stages in relation to environmental events, crop planting date is essential for developing sound and viable weed management technology. The study of weed-crop competition and weed-weed competition, which provides information on weed impacts on crops as well as the mechanism causing these impacts in the development of economic thresholds and management models for weeds. Use of threshold concept will help eliminating unnecessary input cost for weed control. Process level research on weed ecophysiology may help to understand the productivity and limitation of weeds in a particular environment.

Crop varieties with enhanced competition potential : Development of new crops/crop cultivars which may create varying pattern of resources competition, allelopathic interference and soil disturbance that prevent proliferation of weeds are some. of new concepts which need attention of the weed scientists. It is the non-chemical approach of weed control and played an important role prior to the introduction of herbicides. As a part of the production system these approaches are designed to create an environment that allow the crop to interfere weed to the greater extent possible. There have been reports indicating that several of major crops have variation in trials that could be explored to develop varieties that interfere more with weeds. It is thus essential to develop plant breeding and crop-weed ecology programme that focus on the development of crop varieties with enhanced crop interference capabilities.

Weed seed bank dynamics : Many weed scientists are actively involved in studying seed behaviour in soil as to understand the dynamics of seed bank of weeds in relation to crop and weed management regimes. It is essential in an improvement of the decision -making processes relative and different weed control measures and plan future strategies on a site. A critical appraisal and evolution of the dynamics processes that control seed bank behavior is a challenge for weed seed bank management in arable land to enable enhancing the crop productivity in the absence of weed competition. To develop sound alternatives for sustainable weed management increased emphasis for these types of fundamental research is essential.

Alternate crops : The cultivation of high yielding crop varieties responsive to high fertilizer and irrigation use coupled with intensive cropping system resulted in the complexity of weed problems in different crops. Further several specific weeds have developed and an intricate association with crops because prevailing monoculture system which aided in augmenting the high population pressure of weeds which require high level of crop production practices. The economic and environmental benefits of diverse crop rotation are well known over that of crops grown in monoculture. The alternate crop rotations help in decreasing weed population level because of deviation from monoculture by breaking the specific weed crop association. There is need to explore the development of crop rotations to manage weeds problems in the future which may also help in reducing the herbicide load on the soil while maintaining crop yields and profitability.

Biocontrol Technology : The detrimental effect of herbicides on the surface and ground water quality has stimulated an extensive re-evaluation of weed control practices in developed countries. Even the biological practices are being developed worldwide to augment current cultural and chemical weed control methods. If biological weed management techniques are to be successful, these must be developed in concert with the cropping system. New sustainable cropping systems must be developed that not only support highly productive crop growth but also provide an environment that supports biological weed management system. Therefore, feasible programme are to be taken on bio-control technology using pathogens, insects, microorganisms, developing botanicals from various plants and using allelochemical approaches for weed management. Even till date, in case of developing and underdeveloped countries no attention has been paid. Only few classic examples are available for the control of aquatic weeds or the weeds of undisturbed terrestrial waste land situations. In India mush research is needed to attract the attention of the weed scientists to ensure that the bioagents operate to the entire satisfaction of the user, all the year round, particularly in temperate and sub-temperate situations.

Herbicide resistant crops : With the increasing use of herbicides over time for weed management, the problem pertaining to herbicide resistance in weeds posed a threat to the successful cultivation of some of the crops. Over the past decade there has been rapid increase in the incidence of herbicide resistance worldwide. Herbicide resistant weeds threaten the continuing success of herbicide technology to contribute to world crop production. Molecular biological approaches to develop transgenic crops resistant to ecofriendly herbicides have been developed in developed countries such as Round-up ready corn/cotton/maize/soybean etc.

Integrated weed management : Development of integrated weed management (IWN) for crops having total dependence on herbicide will help in reducing the various problems relating excessive herbicide use. Integration of all possible control measures to achieve effective control of weeds at less cost and ecofriendly means can help rectifying ill effects of herbicides. The fully utilized IWM, it is must to know more about herbicide-related and ecological shifts in weeds. Also the sound knowledge of ecophysiology of weeds, crop practices manipulations and crop/varietal interactions are of utmost importance to implement IWM effectively and economically so as to attain sustainable weed management system sand crop productivity. The integration of cost effective methods as solarization, flooding and crop rotations needs to be supplemented with other means.

Application Technology : This programme needs to be undertaken in a big way as majority of user are losing because inadequate knowledge relative to precision application of

natural products, bioagents and synthetic herbicides. Wrong application techniques prevalent with the farming community not only lead to poor control of weeds but also adds detrimental effects of the herbicides to the environment and users. Investigation on the improved application technology for greater efficiency against target vegetation and minimum pollution hazards is required to be undertaken. Similarly technology for the increased efficiency and accuracy of detecting herbicides from water, soil and produce needs to be developed. Emphasis should focus on increasing the simplicity and accuracy of such analysis. Transfer of technology : The best weed management information is useless if it cannot be delivered to users in a timely manner. New system for information delivery are needed to ensure that growers will have ready access to accurate, field specific diagnostic services to facilitate weed management decisions. The development of rapid information delivery systems utilizing computerized decision aids will help growers make full use of new technology as it is developed. For the future, computer will be an integral part of the weed scientists arsenal of tool helping growers to identify and to trim cost in most prudent manner as per the recommendation sheet. Cooperative research : The idea is to have the collective efforts of farmers, research scientists, extension specialists and chemical companies to tackle the problem of weeds. These days weed science is hardly a solitary pursuit. New herbicide discoveries and development depend upon a cooperative programme bringing together researchers from different organizations and finally the collaborative efforts to deliver goods to the farming community for sustainable weed management system. Even, these days, the situation specific research lead to develop sound technology with collective efforts than the research done under simulated conditions. It is happy to quote that chemical industry have strengthened their product development wings for doing farmers/scientists participatory research which is generalizing viable weed management technologies.

Financial aid to Weed science : A major constraint to 'the research programme needed in weed science is the lack of adequate funding for weed scientist of different institutions. The fluids allocated to weed scientists are far below the need and much less to the other counter-parts of pest management (Entomology, Pathology/Nematology). All the fields of pest management are obviously important to agriculture. However, based on the relative crop impact, amount of money spent on control or any other measures of relative importance. Weed science come out equally as important as other fields of pest management. Thus the finding inequity must be rectified if weed scientists are to provide the management options necessary for a fully integrated pest management system.