NATIONAL BIENNIAL CONFERENCE

INDIAN SOCIETY OF WEED SCIENCE

APRIL 6 – 9, 2005

EXTENDED SUMMARIES

Organized by

ISWS

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DEPARTMENT OF AGRONOMY AND AGROMETEOROLOGY
PUNJAB AGRICULTURAL UNIVERSITY
LUDHIANA, PUNJAB

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Organizing Secretary
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PREFACE

Available estimates show that by 2020 India would need about 294 million tones of food grains for a projected population of around 1.3 billion. So to meet the demand of burgeoning population an additional 4 to 5 million tones of food will be required per annum mainly through increased productivity. Weed management has a greater role to play in increasing productivity. Weeds go hand in hand with all types of crops and one cannot imagine a successful crop without proper weed management. The concept has changed from weed control to weed management wherein the weeds are not only controlled in a particular crop but manage keeping crop rotations for longer duration of time. To achieve this the impetus is on weed dynamics, soil weed seed bank studies, herbicide residues and threshold limits of weeds for competition. Special attention be given to phenomenon of herbicide resistance as has been observed in case of *Phalaris minor* against Isoproturon. Search should be on for newer, more effective and eco-friendly molecules to used as future herbicides. Biotechnology also has a greater role to play in weed management. Herbicide tolerant crops have already been developed. The high competitive traits could be introduced in the crops through genetic engineering.

The theme areas proposed for the present National Biennial Conference will try to address the above mentioned issues and it is hoped that some recommendations will be made at the conclusion of conference which will indicate the future trend in weed management research.

Extended summaries numbering 183 covering various aspects have been compiled in this volume. A publication of such a large magnitude would not have been possible without relentless efforts of the Publication Committee and the Editors. It is hoped that this publication will be useful to all as reference material.

L S BRAR
Organizing Secretary

CONTENTS

RICE

1- Studies on the Effect of Weed Management Practices in Two Transplanted Rice Crops Grown in Sequence

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INTRODUCTION

Weeds growing in association with the rice crop reduce the vegetative potential of the crop, which ultimately result in substantial yield losses. Weeds vary in their growth habit and life cycle. In command area, monocropping of rice-rice is being practiced over years. As such aquatic and semi-aquatic weeds can colonize rice fields. In a rice-rice cropping pattern, a reduction in weed growth in one crop may produce a carryover effect on the weeds and yield of next crop. The present study was made with the objectives to quantify the weed flora in the second crop of rice, and yield losses due to grasses and non-grasses in second rice crop.

MATERIALS AND METHODS

The experiment was carried out during rabi and kharif seasons at Tamil Nadu Agricultural university in transplanted rice rice cropping system with the following treatments. Main plot (I. Rice crop in kharif season): M_1 - farmer's practice (HW twice 20 & 45 DAT); M_2 - pretilachlor 0.75 kg/ha (3 DAT). Sub plot: (II. Rice crop in rabi season): S1 - unweeded control; S_2 - HW once at 45 DAT; S_3 - 2,4-DEE 0.8 kg/ha (3 DAT); S_4 - butachlor 1.25 kg/ha (3 DAT); S_5 - narrow spacing 15 x 10 cm (normal spacing 20 x 10 cm). During *kharif* season, the two main plots were laid out and weed control treatments were imposed in the I rice crop. Each main plot was sub-divided into five sub-plots and weed control treatments given above were given to II rice crop in the *rabi* season. The observations on weeds and crop were made in the II rice crop, as the major objective was to study the effect of weed control treatments of I rice crop on weeds and yield of the II rice crop. The trial was laid out in split plot design with three replication.

RESULTS AND DISCUSSION

Effect of treatments on weed density

The weed management practices (HW twice or pretilachlor) adopted in the I rice crop (*Kharif*) did not influence density of monocot, dicot as well as total weeds in II rice crop. However, the weed control treatments followed in the II rice crop significantly influenced the density of all weeds. Pre-emergence application of butachlor (S_4) or HW once significantly reduced the monocot weeds, compared to application of 2, 4 -DEE or adoption of narrow spacing. Among the treatment sequence, irrespective of weed control treatment in the I crop, the monocot weeds was maximum in unweeded control plot in the II crop. Use of pretilachlor for I crop and adoption of narrow spacing in the II crop was also inferior in control of monocot weeds. The treatment combination of pretilachlor (I crop) - butachlor (II crop) was superior in controlling the dicot weeds (Table 1). Consequent to effective control of both monocot and dicot weeds by butachlor treatment in II crop, the density of total weeds also significantly less in this treatment, as compared to HW or 2,4 –DEE. The interaction of pretilachlor (I crop) - butachlor (II crop) recorded significantly lower total weed density in the II crop, as against a maximum total weed density with the treatment sequence HW twice in (I crop) - no weeding in II crop.

Effect of treatments on weed dry weight and WCE

Hand weeding twice in the I crop significantly reduced the weed dry weight, compared with pretilachlor application in the I crop. Control of weeds with herbicides in the II crop (butachlor or 2,4-DEE) recorded significantly lower weed growth, compared to manual weeding or narrow spacing. However, pretilachlor application in the I crop with the followup treatment of either 2,4-DEE or butachlor contained weed dry weight substantially, followed by HW twice in I crop-narrow spacing in II crop. The treatment combinations of HW twice or pretilachlor (I crop) - unweeded in II crop and pretilachlor (I crop) - narrow spacing in II crop was the most ineffective treatments to control the weed growth in the II crop.

The data on WCE of treatments in II crop revealed that at 40 DAT butachlor (43.3%) and at 90 DAT HW once (45.9%) had higher WCE, followed by 2,4-DEE at 40 DAT (36.4%) and butachlor at 90 DAT (29.4%) (Table.1). Least WCE of 10.5% and 1.0% at 40 and 90 DAT, respectively were evident with narrow spacing treatment.

Effect of treatments on yield

Neither the panicle production nor the grain yield of II crop was significantly influenced by the weed control treatment applied for I crop. The grain yield was significantly more and comparable with butachlor and 2,4-DEE treatments in the II crop (5.47 and 5.37 t/ha). There was a yield reduction of 9.5% with HW once and as high as 19.8% with narrow spacing, as compared to butachlor treatment. Leaving the II crop unweeded caused a yield reduction of 31.2%. Though the grain yield did not vary significantly for the combined effect of weed control treatments of I and II crops, more yield of 5.67 t/ha was obtained with pretilachlor in the I crop with butachlor for the II crop. It was followed by 2,4-DEE application to II crop (5.37 t/ha), irrespective of HW twice or pretilachlor in the I crop. These results are in accordance with the findings of Kathirvelan and Vaiyapuri (2004).

There has been a considerable impact of weed control treatments adopted in I crop on the weeds and yield of II crop, grown in sequence. A sequential weed control treatment of pretilachlor (I crop) with butachlor or 2,4-DEE (II crop) enhanced yield in II crop (5.67 & 5.37 t/ha, respectively) (Table 1).

Table 1 Effect of weed control treatments on total weed density and weed dry weight

Treatments	*Total weed density /m²*			*Weed dry weight (g/m²)*			*WCE (%)*		*Grain yield (kg/ha)*		
	M_1	M_2	*Mean*	M_1	M_2	*Mean*	*40 DAT*	*90 DAT*	M_1	M_2	*Mean*
Unweeded control	1.99(100.8)	1.88(75.5)	1.94(88.1)	115.5	121.5	118.5	0.0	0.0	3988	3538	3763
HW (45 DAT)	1.50(31.5)	1.72(53.0)	1.61(42.3)	91.0	93.3	92.1	22.3	45.9	4713	5188	4950
2,4-D 0.8 kg/ha	1.64(45.0)	1.62(41.8)	1.63(43.4)	84.8	66.0	75.4	36.4	18.4	5369	5375	5372
Butachlor 1.25 kg/ha	1.62(41.5)	1.32(20.8)	1.47(31.1)	79.5	54.8	67.1	43.3	29.4	5269	5669	5469
Narrow spacing (15 x 10 cm)	1.68(47.8)	1.86(73.0)	1.77(60.4)	77.8	134.5	106.1	10.5	1.0	4256	4506	4381
Mean	1.69(53.3)	1.68(52.8)	1.69(53.0)	89.7	94.0	91.9	-	-	4719	4855	4787
CD at 5% M		NS			3.71					NS	
S		0.12			15.2					339	
M at S		0.17			19.5					NS	
S at M		0.16			21.5					NS	

Figures in parenthesis are original values

M_1 – HW twice (20 and 45 DAT); M_2 – Pretilachlor 0.75 kg/ha

REFERENCE

Kathirvelan, P. and V. Vaiyapuri, 2004. Effect of pretilachlor alone and in combination with 2,4 D on weeds and grain yield of rice. *Indain J. Weed Sci.* **36** (3&4): 267-268.

2- Evaluation of Pyrazosulfuron–ethyl for Weed Control Efficiency in Transplanted Rice

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INTRODUCTION

In transplanted lowland rice, high weed infestation is a major constraint, which causes severe reduction in the grain yield. Impacts of weed competition usually occur early in growing season. Hence, a longer weed free environment during early crop growth stage can be ensured by the use of pre-emergence herbicide that controls the weeds right at germination stage itself. Continuous use of the same herbicide always results in resistant biotypes of weeds and buildup of residue in the soil. Thus necessitates going for bio-efficacy evaluation of various herbicides for weed control in transplanted rice. Hence a field experiment was conducted with the objective to evaluate the bio-efficacy of pyrazosulfuron – ethyl for weed control efficiency in transplanted paddy.

MATERIALS AND METHODS

Treatments consisted of T_1 – weedy check, T_2 – hand weeding twice, T_3 – bbutachlor 50 EC 1000 g a.i. / ha, T_4 – pyrazosulfuron – ethyl 10 WP (Rallis) 20 g a.i. / ha, T_5 - pyrazosulfuron – ethyl 10 WP (Rallis) 25 g a.i. / ha, T_6 - pyrazosulfuron – ethyl 10 WP (Rallis) 35 g a.i. / ha, T_7 - pyrazosulfuron – ethyl 10 WP (Saathi) 20 g a.i. / ha, T_8 - pyrazosulfuron – ethyl 10 WP (Saathi) 25 g a.i. / ha, T_9 - pyrazosulfuron – ethyl 10 WP (Saathi) 30 g a.i. / ha and T_{10}-pretilochlor. 0.75 kg/ha. The trial was carried out during rabi 2003-04 in transplanted rice (Variety: CO 43). The experiment was laid out in randomized block design with three replications.

RESULTS AND DISCUSSION

Effect of treatments on weeds

Density of grasses (4.0/m^2) was lower with pyrazosulfuron (Rallis) 10 WP (25g) followed by butachlor 50 EC (1000 g), pyrazosulfuron (Saathi) 10 WP (20 g) and pyrazosulfuron (Rallis) 10 WP (30 g) at 30 DAT. Pyrazosulfuron (Rallis) 10 WP (20 g) recorded significantly higher density of weeds than these four treatments. Hand weeding and pyrazosulfuron (Saathi) 10 WP (30 g) were least effective as they were on par with unweeded control. The sedges population was minimum with butachlor 50 EC (1000 g), pyrazosulfuron (Rallis) 10 WP (25 g) and pyrazosulfuron (Rallis) 10 WP (30 g). There was no sedges in butachlor and pyrazosulfuron (Rallis) 10 WP (25g) treatment and 1.33 /m^2 in pyrazosulfuron (Rallis) 10 WP 30g. Butachlor 50 EC (1000g) controlled the broad-leaved weeds completely and was comparable with pyrazosulfuron (Rallis) 10 WP (252 30 g), pyrazosulfuron (Saathi) 10 WP at all three doses (30, 20 & 25 g) and pyrazosulfuron (Rallis) 10 WP (20 g). Weed density in total was minimum with (5.33/m^2) pyrazosulfuron (Rallis) 10 WP (25 g) followed by butachlor 50 EC (1000g) and pyrazosulfuron (Rallis) 10 WP (20 & 25 g). Choudhary and Thakuria 1998

Weed dry weight was less with pyrazosulfuron (Rallis) 10 WP (25g) (24.69/m^2). Butachlor 50 EC (1000g), (31.61g/m^2), pyrazosulfuron (Saathi) 10 WP (20 g), (36.6g) and pyrazosulfuron (Rallis) 10 WP (30 g), (51.3g/m^2). Hand weeding, pyrazosulfuron (Saathi) 10 WP (30 g) were recorded comparable weed density with the untreated control. The WCE of herbicide treatments (test herbicides and standard butachlor) were higher (73.0 to 95.8%) and better than HW treatment (35.4%) at 30 DAT. The lowest value was recorded by pyrazosulfuron (Saathi) 10 WP (30 g) with 60.0% and the highest WCE recorded with pyrazosulfuron (Rallis) 10 WP (25 g) at 60 DAT, maximum WCE (84.5%) was recorded with butachlor 50 EC (1000 g) followed by pyrazosulfuron (Rallis) 10 WP (25 g) with WCE of 82.3%.

There were significant grain yield differences recorded between the herbicide treatments. The recorded ranged of grain yield was 2371 to 4156 kg ha^{-1}. Higher grain yield of 4156 kg ha^{-1} was recorded with the application of pyrazosulfuron (Saathi) 10 WP (20 g). However this treatment was statistically at on par with pyrazosulfuron (Saathi) 10 WP (25 g) followed by pyrazosulfuron (Rallis) 10 WP (30 g) which was on par with pyrazosulfuron (Rallis) 10 WP (20 g), butachlor 50 EC (1000 g) and pyrazosulfuron (Rallis) 10 WP (25 g). The lowest grain yield was recorded by the unweeded control followed by pyrazosulfuron (Saathi) 10 WP (30 g) and hand weeding.

Table 1 Effect of treatments on weeds and weed control efficiency in transplanted rice

Treatments	*Weed density/m²*	*Weed dry weight (kg/ha)*	*WCE (%)*	*Grain yield (kg ha⁻¹)*
T_1- Un weeded control	1.77 (58.7)	2.52 (345.6)	-	2371
T_2- HW twice	1.80 (93.3)	2.06 (138.7)	59.9	3419
T_3- Butachlor– 1 kg / ha	0.92 (7.33)	1.45 (31.6)	90.9	3563
T_4- Pyrozosulfuron– 20 g /ha	1.32 (30.7)	1.70 (54.5)	84.2	3625
T_5- Pyrozosulfuron– 25 g /ha	0.82 (5.33)	1.33 (24.6)	92.9	3552
T_6- Pyrozosulfuron – 30 g /ha	1.14 (14.0)	1.66 (51.3)	85.2	3729
T_7- Pyrozosulfuron – 20 g /ha	1.10 (16.7)	1.54 (36.6)	89.4	4156
T_8- Pyrozosulfuron – 25 g /ha	1.28 (23.3)	1.94 (93.2)	73.0	3958
T_9- Pyrozosulfuron – 30 g /ha	1.58 (47.3)	2.12 (138.2)	60.0	3198
T_{10}-Pretilachlor. 0.75 kg/ha	0.87 (8.67)	0.91 (14.6)	95.8	4260
CD at 5%	0.495	0.475	-	227

Figures in the parenthesis are original value

REFERENCE

Choudhary, J.K. and R.K. Thakuria, 1998. Evaluation of herbicides in wet seeded late *sali* (winter) rice in Assam. *Indian J. Agronomy* **43**: 291-294.

3- Evaluation of Efficacy of Bensulfuron Methyl on Weed Control and Productivity of Transplanted Rice

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INTRODUCTION

In transplanted lowland rice, high weed infestation is a major constraint which causes severe reduction in the grain yield. Impacts of weed competition usually occur early in growing season. Hence, a longer weed free environment during early crop growth stage can be ensured by the use of pre-emergence herbicide that controls the weeds right at germination stage itself. Continuous use of the same herbicide always results in resistant biotypes of weeds and buildup of residue in the soil. Thus necessitates going for bio-efficacy evaluation of various herbicides for weed control in transplanted rice. Besides, application of single herbicide alone may not control all the kinds of weeds such as grass, broad leaf weeds and sedges and increase the resurgence over particular weeds. Hence, the field experiment was carried out in transplanted rice with the objectives to evaluate the efficiency of bensulfuron methyl (Londax 60 DF) for weed control in transplanted rice and to evaluate the efficacy of bensulfuron methyl (Londax 60 DF) + butachlor tank mix against weeds in transplanted rice.

MATERIALS AND METHODS

Treatment details: Pre-emergence application of T_1 - bensulfuron methyl (Londax) 60% DF – 40 g a.i. / ha (3 DAT); T_2 - bensulfuron methyl– 50 g a.i. / ha (3 DAT); T_3 - bensulfuron methyl– 60 g a.i. / ha (3 DAT); T_4 - bensulfuron methyl + butachlor 50 EC – 40 + 938 g a.i. / ha (3 DAT); T_5 - bensulfuron methyl + butachlor 50 EC – 50 + 938 g a.i. / ha (3 DAT); T_6 - bensulfuron methyl + butachlor 50 EC – 60 + 938 g a.i. / ha (3 DAT); T_7 - bensulfuron methyl– 100 g a.i. / ha (3 DAT); T_8 - bensulfuron methyl– 120 g a.i. / ha (3 DAT)*; T_9 – butachlor 50% EC – 938 g a.i. / ha (3 DAT); T_{10} – Hand weeding on 25 & 50 DAT; T_{11} – Unweeded check. The experiment was laid out in randomized block design with three replications.

RESULTS AND DISCUSSION

Effect of treatments on weeds

Reduction in weed density and subsequent reduction in dry weight was recorded in all the herbicide treatments compared with the unweeded check. Bensulfuron methyl (Londax) 60% DF 60g + butachlor 50 EC 60 + 938 g a.i. / ha reduced the weed density and weed dry weight to the lowest levels however, it was comparable with bensfulfuron methyl + butachlor 50 and 40 g a.i. / ha. Highest weed control efficiency with lowest weed dry weight was recorded with bensulfuron methyl 60 g + butachlor and was followed by bensulfuron methyl 50 g, 40 g + butachlor.

Effect on grain yield

Bensulfuron methyl 60 g with butachlor recorded the highest grain yield and the treatments butachlor, bensulfuron methyl at 50, 40 g/ha with butachlor and bensulfuron methyl alone at 60 g /ha and at higher doses 100, 120 g / ha were statistically. Similarly higher grain yield of transplanted rice was obtained by

Table 1. Effect of treatment on weed dry weight, weed control efficiency, yield and economics of transplanted rice

Treatments	*Weed dry weight (kg ha⁻¹)*	*WCE (%)*	*Grain yield (kg/ha)*	*Net return(Rs/ ha)*	*B:C ratio*
T_1- Bensulfuron methyl 40 g/ha	1.92 (87.7)	77.3	3395	12205	2.38
T_2- Bensulfuron methyl 50 g/ha	1.99 (98.9)	74.4	3937	15163	2.69
T_3- Bensulfuron methyl 60g/ha	1.93 (85.9)	77.8	4041	15606	2.71
T_4- Bensul 40g + Buta.1kg/ha	1.31 (22.4)	94.2	4770	19637	3.11
T_5- Bensul 50g + Buta.1 kg/ha	0.86 (7.6)	98.0	4833	19840	3.10
T_6- Bensul 60g + Buta.1 kg/ha	1.24 (17.7)	95.4	5125	21361	3.22
T_7- Bensulfuron methyl 100 g/ha	1.45 (32.2)	91.7	4270	16299	2.67
T_8- Bensulfuron methyl 120 g/ha	1.62 (59.7)	84.6	4729	18622	2.85
T_9- Butachlor 1 kg/ha	1.83 (70.9)	81.7	4979	21460	3.48
T_{10}- HW twice	1.81 (77.7)	79.9	2479	5609	1.55
T_{11}- Unweeded control	2.58 (386.5)	-	1583	2408	1.29
CD at 5 %	0.390	-	1137	-	-

the application of fenaxoprop at 56.25 g/ha on 10 DAT (Singh *et al,* 2004). Uniform with the bensulfuron methyl 60 g the lowest grain yield was recorded by unweeded control and hand weeding twice. bensulfuron methyl 60 g a.i. / ha and 50 g a.i. / ha alone and with butachlor and higher doses of bensulfuron methyl 120 g a.i. / ha registered the significantly higher and comparable straw yield. Lowest straw yield recorded by unweeded control and hand weeding twice.

Highest weed control efficiency with lowest weed dry weight was recorded with bensulfuron methyl 60 g + butachlor and was followed by bensulfuron methyl 50 g 40 g + butachlor. Bensulfuron methyl 60 g with butachlor registered the highest grain yield of 5125 kg/ha. Comparable grain yield to this treatment was recorded by bensulfuron methyl 50, 40 g / ha with butachlor and bensulfuron methyl alone and at higher doses at 100, 120 g / ha.

REFERENCE

Singh, V.P., G. Singh and M. Singh, 2004. Effect of fenoxaprop-p-ethyl on transplanted rice and associated weeds. *Indian J. Weed Sci.* **36** (3&4): 190-192

4- Performance of Herbicides in Bed Planting Technique of Transplanted Paddy

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INTRODUCTION

In transplanted crop of paddy herbicides like butachlor, anilofos, pretilachlor are very widely used by the Punjab farmers under puddled conditions. A new technique i.e., transplanting rice seedlings on beds/ ridges made in the unpuddled field, is becoming popular in order to reduce water consumption by the crop. The growth and development of weeds in ridge planted crop is different than that under recommended practice, i.e., flat transplanting after puddling. So, these studies were initiated to evaluate the bio efficacy of rice herbicides in this new technique.

MATERIAL AND METHODS

This trial was laid out in split plot design by keeping planting techniques in main and five herbicide treatments in sub-plots. Three planting techniques, i.e., bed planting with 33 and 22 plants/ m^2 as well as flat planting with 33 plants/ m^2 were kept. Five weed control treatments, i.e., butachlor alone 1.5 kg/ha (within 3 DAT), butachlor 1.5 kg/ ha followed by clomazome + propanil (200 g/ha), pretilachlor alone (0.75 kg/ha), pretilachlor 0.75 kg/ ha f.b. clomazome + propanil (200 g/ha) and unweeded control were kept in sub plots. During final year (2003) hand pulling was done instead of application of clomazome + propanil. About 30 days old seedlings of PR-116 variety of rice were transplanted on 19/6/01, 17/6/02 and 16/6/03 as per treatments. Crop was raised with recommended agronomic and plant protection measures. The field had enough populations of *Echniochloa crusgalli, Cyperus iria, Caesulia axillaries, Fimbristyllis sp.* etc. during all the years of study. Beds were prepared under dry conditions (67.5 cm apart) and transplanting was done after flooding the field with water. In flat transplanting treatment, normal puddling of field was done.

RESULTS AND DISCUSSION

A significant reduction in dry matter accumulation by weeds was recorded in flat transplanted crop as compared to bed transplanted crop with 33 or 22 plants/ m^2 during all the years of investigations (Table 1). Among the ridge planting treatments, significantly higher dry matter was recorded in lowest crop density, i.e., 22 plants/ m^2 as compared to recommended plant density of 33 plants/ m^2 under puddled conditions. During all the years, herbicide treatments resulted in significant reduction in dry matter accumulation by weeds as compared to unweeded (control) treatment. However, among herbicide treatments, alone application of either butachlor or pretilachlor resulted in significantly higher accumulation of dry matter by weeds as compared to the treatments in which these were followed by clomazome + propanil or hand pullings.

Crop raised with flat planting technique produced significantly higher seed yield of paddy during 2002 and 2003 as compared to bed planting techniques either with 22 or 33 plants/ m^2. Among the bed planting techniques, transplanting 33 plants/ m^2 significantly increased seed yield during 2001 and 2002, however, such differences during 2003 were non-significant (Table 1). Among the sub-plot treatments, significantly higher grain yield was recorded in pre-emergence application of butachlor/ pretilachlor f.b. post-emergence application of clomazome + propanil or hand pullings as compared to their alone application during 2002 and 2003. All the herbicide treatments significantly increased grain yield as compared to control treatment.

Table 1 Dry matter of weeds and grain yield of paddy as influenced by different planting techniques and herbicide treatments.

Treatments	*Dry matter of weeds (q/ ha)*				*Seed yield (q/ ha)*			
	2001	*2002*	*2003*	*Mean*	*2001*	*2002*	*2003*	*Mean*
Main plots								
Flat planting, 33 plants/ m^2	0.0	4.3	5.5	3.3	42.6	50.1	33.0	41.9
Bed planting, 33 plants/ m^2	5.5	28.8	11.8	15.4	39.0	31.4	20.3	30.2
Bed planting, 22 plants/ m^2	9.0	34.2	16.4	19.9	31.7	25.3	18.5	25.2
CD at 5%	2.3	5.9	3.3	3.6	8.1	4.63	6.24	4.8
Sub-plots								
Butachlor alone (1.5 kg/ha)	7.1	21.3	15.0	14.5	34.1	31.8	18.9	28.3
Buta f.b. clomazome + propanil (200 g/ha)	2.2	12.5	4.0	6.2	40.4	49.7	35.7	41.9
Pretilachlor alone (0.75 kg/ha)	5.3	18.0	12.9	12.1	40.2	32.7	17.1	30.0
Pretila f.b. clomazome + propanil (200 g/ha)	2.5	12.9	3.4	6.3	43.7	46.5	41.3	43.8
Unweeded (control)	12.0	47.3	21.1	26.8	27.1	17.3	6.6	17.0
CD at 5%	2.9	10.4	2.17	5.40	11.2	8.87	6.7	8.9

CONCLUSION

On an average of three years, flat transplanting of paddy in the puddled field increased the seed yield by 38.7 and 66.3 per cent as compared to bed planting with 33 and 22 plants/ m^2, respectively. Post-emergence application of clomazome + propanil/one hand pulling after the pre-emergence application of butachlor or pretilachlor, increased seed yield by 48.1 and 46.0 per cent as compared to alone application of butachlor and pretilachlor, respectively.

5- Bioefficacy of Anilofos + 2,4-D (Ethyl Ester) and Other Herbicides in Transplanted Rice (*Oryza sativa* L.)

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INTRODUCTION

Weed menace in rice field is ever increasing in spite of constant efforts to get rid of them. Weeds by their manifold harmful effects on the growing crop, ranked prime enemies in rice production accounting for 49 to 59 per cent of yield loss (Singlachar *et al.*, 1978). A large number of weed species cause economic losses of rice in India. Although manual and mechanical practices are important components of weed management programme for rice, due to scarcity and expensiveness of the labour, more emphasis needs to be bestowed on use of herbicides. Specially anilofos and 2,4-D ethyl ester has proved highly effective for the control of most annual and some broad leaved weeds in rice. These herbicides either singly or in combinations for control of wide spectrum of weeds effectively are gaining momentum as these are considered to be cost effective. Further, attempts were made to compare the performance of tank mix of the said herbicides with the ready mix as tank mix will suit varying field conditions which will combat the weed menace and to enable the rice crop to make use of their habitat effectively.

MATERIALS AND METHODS

Field experiments were conducted to evaluate the bioefficacy of anilofos + 2,4-D (Ethyl ester) and other herbicides on transplanted rice in sandy clay loam soil at Zonal Agriculture Research Station, Mandya, Karnataka during *kharif* seasons of 2002 and 2003. The experiment comprised 20 treatments of emulsified chemicals such as using ready mix from the manufacturers viz., anilofos + 2,4-D (ethyl ester) varying in concentration from 0.56 to 0.84 kg ha^{-1} while some were used as tank mix prepared on the spot at the time of application as required viz., anilofos +2,4-D (ethyl ester) with the concentration of 0.90 kg ha^{-1} and butachlor + 2,4-D (ethyl ester) with concentration of 1.75 kg ha^{-1}, besides weed free and unweeded control treatments. The remaining herbicides viz., anilofos (0.375 kg ha^{-1}), 2,4-D ethyl ester (1.20 kg ha^{-1}), butachlor (2.50 kg ha^{-1}), pretilachlor (1.00 kg ha^{-1}) and oxyfluorfen (0.075 kg ha^{-1}) were tested individually. The experiment was laid out in RCBD with three replications. Spraying of herbicide was done as per the treatments. The rice cultivar IR-20 was transplanted with a spacing of 20 cm X 10 cm, which are raised in the nursery.

RESULTS AND DISCUSSION

Grain and straw yield were higher in weed free check (6334 & 7281 kg ha^{-1}) followed by herbicidal application of mixtures of anilofos +2,4-D (EE) at 0.90 (6271 & 7029 kg ha^{-1}), butachlor + 2,4 D (EE) at 1.75 (6208 & 6944 kg ha^{-1}), anilofos +2,4-D (EE) at 0.84 (6187 & 7155 kg ha^{-1}), pretilachlor at 1.00 (6149 & 6650 kg ha^{-1}) butachlor at 2.50 (6061 & 6902 kg ha^{-1}) and anilofos +2,4-D (Ethyl ester) at 0.70 (5976 & 7113 kg ha^{-1}) kg ha^{-1} applied at 4 DAT and anilofos +2,4-D (EE) at 0.84 kg ha^{-1} (5955 & 6313 kg ha^{-1}) applied at 8 DAT. These were at par with each other.

The highest weed control efficiency was observed in weed free check (100%), whereas the treatments with mixture of anilofos +2,4-D (EE) at 0.70, 0.84 and 0.90 kg ha^{-1} sprayed at 4 DAT showed relatively higher WCE (89.03, 88.41 and 92.34%, respectively). The weedy check plot showed highest weed index value (33.88 %) as compared to other treatments and the weed index value was lower with weed free check followed by herbicidal mixtures of anilofos +2,4-D (Ethyl ester) at 0.90, 0.84 and 0.70 kg ha^{-1} applied at 4 DAT (0.99, 2.32 and 5.65 %, respectively).

Benefit cost ratio indicates that application of mixture of anilofos + 2,4- D (EE) at 0.90 (6.76) or 0.84 (6.73) or 0.70 (6.66) kg ha^{-1} at 4 DAT are highly effective in substituting the hand weeding in rice.

Table 1 Effect of anilofos + 2,4 D (EE) and other herbicides on grain and straw yield (kg ha^{-1}), weed index (%), weed control efficiency (%) and benefit cost ratio in transplanted rice.

Treatments/ dose kg ai/ha / time of application	*Grain yield (kg ha^{-1})*	*Straw yield (kg ha^{-1})*	*Weed index (%)*	*Weed control efficiency (%)*	*B: C ratio*
Anilofos +2,4-D (EE) 0.56 kg ha^{-1}, 4 DAT	5787	6187	8.64	73.78	6.45
Anilofos +2,4-D (EE) 0.56 kg ha^{-1}, 8 DAT	5450	6067	13.96	56.38	6.12
Anilofos +2,4-D (EE) 0.56 kg ha^{-1}, 12 DAT	5429	5934	14.29	53.07	6.07
Anilofos +2,4-D (EE) 0.70 kg ha^{-1}, 4 DAT	5976	7113	5.65	89.03	6.66
Anilofos +2,4-D (EE) 0.70 kg ha^{-1}, 8 DAT	5703	5976	9.96	72.05	6.21
Anilofos +2,4-D (EE) 0.70 kg ha^{-1}, 12 DAT	5556	5892	12.28	65.42	6.06
Anilofos +2,4-D (EE) 0.84 kg ha^{-1}, 4 DAT	6187	7155	2.32	88.41	6.73
Anilofos +2,4-D (EE) 0.84 kg ha^{-1}, 8 DAT	5955	6313	5.98	78.19	6.38
Anilofos +2,4-D (EE) 0.84 kg ha^{-1}, 12 DAT	5535	6149	12.61	60.04	5.98
Anilofos +2,4-D (EE) 0.90 kg ha^{-1}, 4 DAT	6271	7029	0.99	92.34	6.76
Anilofos +2,4-D (EE) 0.90 kg ha^{-1}, 8 DAT	5535	6187	12.61	75.98	5.97
Anilofos +2,4-D (EE) 0.90 kg ha^{-1}, 12 DAT	5303	5934	16.28	73.08	5.72
Anilofos 0.375 kg ha^{-1}, 4 DAT	5471	6103	13.62	53.31	6.08
2,4-D (EE) 1.20 kg ha^{-1}, 4 DAT	5661	6271	10.63	66.94	6.22
Butachlor 2.50 kg ha^{-1}, 4 DAT	6061	6902	4.31	89.99	5.96
Butachlor +2,4-D (EE) 1.75 kg ha^{-1}, 4 DAT	6208	6944	1.99	94.69	6.50
Pretilachlor 1.0 kg ha^{-1}, 4 DAT	6149	6650	2.92	84.13	6.62
Oxyflurofen 0.075 kg ha^{-1}, 4 DAT	5408	6103	14.62	78.05	6.02
Weed free (once in 15 days)	6334	7281	0.00	100.00	5.05
Unweeded control	4188	4588	33.88	0.00	5.09
CD at 5 %	494	891	-	-	-

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6- Integration of Seeding Methods and Weed Control Practices in Drum Seeded Rice

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INTRODUCTION

The transformation in rice crop establishment from direct seeding (wet or dry) has resulted in substantial changes in the types and intensity of weed infestation. Among the various weed control methods, hand weeding is widely practiced, but it is not only expensive, but also quite difficult in broadcast wet seeded rice due to dense rice plant population. Use of selective herbicide forms an integral part of crop production technology. The present study was made with the objectives to evaluate the method of seeding and effect of integration of seeding methods and weed control practices on weed density. WCE, yield and economics in drum seeded rice.

MATERIALS AND METHODS

The experiment was carried out during *kharif* 2004 at Tamil Nadu Agricultural University in drum-seeded rice with the following treatments. Main plot (seeding methods): M_1 – drum seeding 75 kg / ha; M_2 – drum seeding 75 kg / ha + Daincha; M_3 – broadcasting 100 kg / ha. Sub plot (weed control methods): S_1 – fenaxoprop -p-ethyl 60 g / ha (15 DAS); S2 – pretilachlor (safener) 450 g / ha (5 DAS); S_3 – hand weeding twice (20 and 45 DAS). The trial was laid out in split plot design with four replications.

RESULTS AND DISCUSSION

Effect of treatments on weed density

Larger variations in grass weed density were observed for sowing methods at 30 DAS. The grass weeds were significantly more in broadcasting method of sowing at 30 DAS compared to drum seeding methods. Among the weed control methods, pretilachlor (s) recorded significantly lower grass weeds (7.1/ m^2), compared to fenaxoprop (26.1 / m^2) and HW treatment (31.3/m^2), and both were at par. In contrast to grass weeds, sedge weeds were significantly less in drum seeding + daincha at 30 DAS. Pretilachlor (s) was superior in suppressing the sedge weeds substantially. The data on density of BLW at 30 DAS revealed that drum seeding method (with or without daincha) significantly reduced the BLW, compared to broadcast method of sowing. Considering the density of total weeds, drum seeding + daincha consistently proved its superiority to suppress all kind of weeds, recording nearly half of the weeds compared to other treatments. Broadcasting method had more weeds and drum-seeding method was considered to be in between. Among the weed control treatments, pretilachlor (s) control the weeds effectively and significantly reduced the total weed population. At 30 DAS, the total weeds were more with HW twice and were on par with fenaxoprop. (Table 1).

Effect of treatments on weed dry weight & WCE

Intercropping daincha as weed smother crop with drum seeding significantly suppressed the weed biomass, as compared to either drum seeding or broadcasting methods, which were on par with each other. Compared to broadcasting method, the WCE was more by 23.5%, with drum seeding, while the WCE was further increased to 45.0% for drum seeding with daincha. It could be inferred that inclusion of daincha under drum seeding has offered about 25% of additional WCE. With regard to weed control methods, pretilachlor (s) had higher WCE of 72.0%, as a result of superiority in containing the weed biomass. These results are in accordance with the findings of Chinnusamy *et al* (2002).

Table 1 Effect of seeding and weed control methods on weeds, rice yield and economics of drum seeded rice

Treatments	*Weed density (No./m²) 30 DAS* *Grass*	*Sedges*	*BLW*	*Total*	*Weed dry weight (g/m²)*	*WCE %*	*Grain yield (kg/ha)*	*Net income (Rs/ha)*	*B:C ratio*
M_1 - Drum seeding (75 kg/ha)	1.19(16.4)	1.45(51.5)	0.88(10.0)	1.73(77.9)	23.1	23.5	4675	18315	2.91
M_2 - Drum seeding (75 kg/ha) + Daincha (25kg/ha)	1.26(18.0)	1.07(12.2)	0.92(8.2)	1.58(38.4)	16.6	45.0	5374	22084	3.25
M_3 – Broadcasting (100 kg/ha)	1.35(30.1)	1.73(75.5)	1.35(22.8)	2.01(128.5)	30.2	-	4450	16341	2.59
CD at 5%	NS	0.196	0.097	0.113	7.24	-	684	-	-
S_1 – Fenaxoprop - p-Ethyl 60g / ha (15 DAS)	1.44(26.1)	1.66(66.0)	1.08(13.5)	1.96(105.7)	26.2	23.4	4518	17797	2.94
S_2 – Pretilachlor (S) 450g /ha (5 DAS)	0.93(7.08)	0.96(10.0)	0.76(6.83)	1.37(24.0)	9.57	72.0	4893	20501	3.37
S_3 – Hand weeding twice (20 & 45 DAS)	1.43(31.3)	1.63(63.1)	1.31(20.6)	2.00(115.1)	34.2	-	5087	20339	3.05
CD at 5%	0.102	0.132	0.087	0.048	7.24	-	443	-	-

The figures in the parenthesis are original value

Effect of treatments on yield and economics

The data on grain yield indicated that broadcasting recorded the lower yield of 4.45 t/ha, while, drum seeding improved the yield further by 0.23 t/ha and drum seeding + daincha enhanced yield to 5.37 t/ha, which was more by 0.92 t/ha compared to broadcasting method of sowing. Such favourable influence might be cumulative effect of better weed control and substitution of nutrients by daincha. Evidently, the net income and B:C ratio (Rs.22,084 / ha and 3.25, respectively), compared to broadcasting method (Rs.16341/ha and 2.59 respectively). Considering the weed control methods, post emergence herbicide application caused an yield reduction of 11.2% compared to HW twice with significantly higher grain yield of 5.09 t/ha. Pretilachlor(s) produced a grain yield of 4.89 t/ha, which was on par with HW twice. The net income realised with these treatments were comparable, but the B:C ratio was substantially more with pretilachlor (3.37) as against 3.05 with HW twice.

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7- Effect of Herbicides Against Non-Grassy Weeds and Transplanted Rice

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INTRODUCTION

In rice, alternate wetting and drying condition throughout the growing season causes heavy infestation of weeds. Uncontrolled weeds may cause 50 % yield loss in transplanted rice (Singh *et al.*, 2003). Butachlor, pretilachlor and anilofos are some of the herbicides, which are being used in rice as pre-emergence to control weeds (Mukherjee and Bhattacharya, 1999). However, these herbicides provide control of grassy weeds and at the same time continuous application of the same herbicides with same mode of action may develop resistance in the weed species. Most of the herbicides, which are presently being used are ineffective to control non-grassy weed species. Keeping these facts in view, present investigation was undertaken to study the effect of some new herbicides molecules and their mixture on different non-grassy weeds in transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted during rainy seasons of 2001and 2002 at the Research farm of Institute of Agricultural Sciences, Banaras Hindu University, Varanasi to find the efficacy of herbicides on non-grassy weed distribution pattern and yield of transplanted rice. The soil was sandy clay loam having pH 7.3, organic carbon 0.44% and available N, P_2O_5 and K_2O 205, 14.9 and 232.8 kg ha^{-1}, respectively. The experiment comprised various doses of metsulfuron methyl (MSM), chlorimuron ethyl (CME), Almix, MSM + 2, 4-DEE, CME + 2, 4-DEE, Almix + 2, 4-DEE, anilofos and anilofos +2, 4-DEE along with hand weeding and weedy check (Table 1). The experiment was laid out in randomised block design with three replication. Twenty-five days old seedlings of rice variety Sarju 52 were transplanted on July 22 and 24, 2001 and 2002, respectively. One third of the recommended dose of N (40 kg ha^{-1}) and full dose P_2O_5 and K_2O (60 kg ha^{-1} each) were applied before transplanting and remaining amount of N was top dressed in two equal splits, half at active tillering (30 DAT) and half at panicle initiation stages (45 DAT). Herbicides were sprayed 8 days after transplanting (DAT) using 500-litre water ha^{-1} with the help of knapsack sprayer, fitted with flat fan nozzle. The data on total weed population and weed biomass were taken at 30 DAT.

RESULTS AND DISCUSSIONS

Predominant non-grassy weed species that infested the field were consisted of sedges [*Cyperus rotundus* L., *Cyperus iria* L., *Cyperus difformis* L., *Fimbristylis miliaceae* (L.) Vahl] and broad-leaved weeds [*Ammania baccifera* (L.) Rottb, *Ludwigia parviflora* L.]

Of the herbicides, almix 25 g ha^{-1} was the most potential killer of weeds and significantly superior to all herbicidal treatments to check weed population. It eliminated *Cyperus rotundus, Cyperus difformis, Fimbristylis miliaceae, Ammania baccifera, Ludwigia parviflora.* It was the only herbicidal combination that paralyzed severely the growth of sedges and broad-leaved weeds. The next best treatment was almix + 2,4- DEE 15+500 g ha^{-1}, and was on par with almix 25 g ha^{-1}, to control of these non-grassy weeds. This corroborates the findings of Bhattacharya *et al* (2002). The entire weed controlled treatments reduced total weeds density significantly over weedy check. Almix + 2, 4-DEE 15 +500 g ha^{-1} was found superior to other measures in reducing the total weed density by 80.60 and 78.05% as compared to weedy check in

2001 and 2002. Metsulfuron methyl and chlorimuron ethyl at lower doses, recorded the highest density of total weeds among the herbicides due to poor efficacy on various non-grassy weeds.

Maximum grain yield of 5930 kg ha^{-1} and minimum 3147 kg ha^{-1} were obtained in season long weed free and unweeded situation (Table 1). Among herbicidal treatments, maximum grain yield (5838 kg ha^{-1}) was obtained with tank mixture of almix + 2, 4 -DEE 15+500 g ha^{-1}, which was on par with hand weeding thrice. However, all the weed control treatments produced significantly higher grain yield than weedy check. The monetary advantage based on 2 years of experimentation indicated that the maximum net return (Rs 46,392) and benefit : cost ration (2.97) were obtained with almix + 2,4-DEE 15+500 kg ha^{-1}.

Table 1 Effect of treatments on total weed density, weed biomass, yield and economics of rice (pooled data of two years).

Treatment	*Dose*	*Weed density (No.m^{-2})*		*Weed biomass (g m^{-2})*		*Grain yield (kg ha^{-1})*	*Net return (Rs ha^{-1})*	*Benefit: Cost ratio*
		2001	*2002*	*2001*	*2002*			
Unweeded	-	13.0 (167.3)	13.6 (183.3)	9.0 (79.8)	9.0 (80.8)	3147	20382	1.48
HW 20,40,60)	-	0.7(0.0)	3.2 (10.0)	0.7 (0.0)	1.2 (0.9)	5930	45809	2.67
MSM	4	8.2 (66.3)	8.9 (78.3)	6.2 (38.4)	6.9 (47.1)	3553	24110	1.67
MSM	6	7.5 (55.7)	8.2 (66.3)	5.6 (31.2)	6.4 (41.2)	4165	30514	2.1
MSM	8	6.8 (46.3)	7.4 (53.7)	5.3 (27.1)	5.4 (28.4)	4540	34798	2.37
CME	10	7.9 (62.0)	8.7 (75.3)	5.8 (32.9)	6.0 (35.9)	3805	27250	1.85
CME	15	7.2 (50.7)	8.2 (66.7)	5.4 (29.0)	5.6 (30.7)	4240	31071	2.07
CME	20	5.0 (25.3)	5.7 (32.0)	3.9 (14.8)	3.9 (14.6)	4750	35479	2.31
Almix	15	7.3 (52.7)	8.0 (63.7)	5.6 (30.6)	5.9 (33.7)	3962	28256	1.83
Almix	20	5.55 (30.3)	6.98 (48.3)	4.15 (16.7)	4.46 (19.4)	5341	40942	2.57
Almix	25	4.6 (21.0)	5.0 (24.7)	2.9 (7.9)	3.9 (14.7)	5576	42704	2.6
MSM+2,4 DEE	4+500	7.4 (54.0)	7.0 (49.3)	4.9 (23.6)	5.0 (25.2)	5008	39133	2.69
CME+2,4-DEE	10+500	6.4 (40.4)	5.5 (29.7)	4.9 (23.2)	5.0 (24.6)	5147	40045	2.69
Almix+2,4DEE	15+500	1.9 (3.0)	2.9 (7.7)	1.9 (3.1)	2.2 (4.4)	5838	46392	2.97
Anilophos	500	6.5 (42.3)	7.7 (58.7)	5.3 (28.1)	5.58 (29.6)	4438	33403	2.32
Anilophos +2,4 -DEE	400+500	5.8 (33.3)	6.2 (37.3)	4.4 (18.7)	4.5 (19.5)	5257	41318	2.83
CD at 5%		0.35	0.38	0.25	0.35	121	-	-

Figures in parenthesis indicate original values

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8- Weed Management in Transplanted Rice

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INTRODUCTION

Due to continuous use of herbicide killing grassy weeds like anilofos, butachlor and pretilachlor, the broad leaved weeds and sedges are coming up at a faster rate in transplanted rice to the great extent. Likewise infestation of broad leaved weeds like *Caesulia axillaris* Roxb., *Oxalis* Spp. and *Eclipta alba* is on increase in *Tarai* area of Uttaranchal particularly low lying fields with high percolation rates.

MATERIALS AND METHODS

During *kharif* 2002 and 2003 a field experiment was carried out at Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar to find out the efficacy of metsulfuron methyl, chlorimuron ethyl, almix and 2,4-D for the control of mixed weed flora in transplanted rice. Rice cv. Narendra 359 was transplanted during July with recommended package of practices. Two to three seedlings were transplanted per hill manually at a spacing of 20 cm x 15 cm. Treatments comprised of metsulfuron methyl (0.004 and 0.008 kg ha^{-1}), chlorimuron ethyl ((0.004 and 0.008 kg ha^{-1}) almix, (0.004 and 0.008 kg ha^{-1}) and 2, 4-D (0.500 kg ha^{-1}), hand weeding twice at 30 and 45 days after transplanting (DAT), weed-free and weedy check were tried in randomized block design with three replications.

The major weed species were *Caesulia axillaris* (35%), *Echinochloa colona* (14%), *Echinochloa crusgalli* (13%), *Paspalum distichum* (13%) and *Cyprus* spp. (15%).

RESULTS AND DISCUSSION

All weed control treatments significantly reduced the weed density and total weed dry weight, recorded at 60 DAT as compared to weedy check, during both the years. 2, 4-D at 0.500 kg ha^{-1} had significantly lower total weed density over metsulfuron methyl at 0.004 and chlorimuron ethyl at 0.004 and 0.008 kg ha^{-1} but during second year almix at 0.008 kg ha^{-1} had significantly lower total weed density at par with metsulfuron methyl at 0.008 kg ha^{-1}. Almix at 0.008 kg ha^{-1} had lower total weed dry weight over other herbicidal treatments. Hand weeding at 30 and 45 DAT proved superior over all the herbicidal treatments in reducing both total weed density and dry weight during both the years. All the herbicidal treatments were found statistically at par with weed-free check in producing grain yield during both the years except chlorimuron ethyl at 0.004 kg ha^{-1} during second year. Metsulfuron methyl at 0.008 kg ha^{-1} proved superior in producing highest grain yield among the herbicidal treatments in first year but almix at 0.008 kg ha^{-1} recorded highest grain yield during the second year.

9- Eco-friendly Chemical Weed Management in Transplanted Kharif Rice

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INTRODUCTION

Rice, the staple food crop in India, suffers severe yield loss of 35-55% due to uncontrolled weed growth (Gautam and Mishra, 1995). The use of herbicides, which is an alternative to the most commonly used method of hand weeding, is gaining popularity among the farmers due to its superior weed controlling ability in transplanted *kharif* rice. Besides repeated use of butachlor, one of the most common rice herbicide used in this region since last decade have been resulting shift in weed flora from annual grasses to perennials and sedges and also developing resistance in *Echinochloa spp.* to this herbicide. Therefore, the present investigation was carried out to determine the bio-efficacy of carfentrazone ethyl, a new molecule along with pyrazosulfuron ethyl and other standard herbicides and microbial population in the rhizosphere of transplanted rice.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* season of 2003 at the farmer's field at Kalyani, Nadia, West Bengal, India. The soil was clay loam having organic carbon 0.63 %, total nitrogen 0.062 %, available phosphorus 19.7 kg ha^{-1}, available potash 125.8 kg ha^{-1} and a pH of 6.8. 30 days old seedlings of the variety *Satabdi*, IET4786 were transplanted at 20cm x 10cm spacing during last week of July. The treatments replicated thrice in a RBD consisted of carfentrazone ethyl at 15, 20, 25, 30, 40 g ha^{-1}, 2,4-D ethyl ester 850 g ha^{-1}, pyrazosulfuron ethyl 30 g ha^{-1}, twice hand weeding at 20 and 40 DAT and weedy check. All the herbicides were applied as post emergence at 15 days after transplanting in a spray volume of 500 l ha^{-1} through knapsack sprayer. Recommended package of practices was adopted to raise the crop. The viable count of the colonies formed by total bacteria and non-symbiotic N-fixing bacteria was done on agar plates containing appropriate media viz.Thornton's agar medium and Jensen's agar medium respectively.

RESULTS AND DISCUSSION

The predominant weeds were *E. glabrescens, Leersia hexandra, Cyperus difformis, Fimbristylis littoralis, Ammania baccifera, Alternanthera philoxeroides* and *Marsilea quadrifolia.* The herbicides were not toxic to the rice crop at their tested doses. All the herbicides significantly lowered the dry weight of weeds at 25 and 45 DAT. The greatest reduction of weed dry weight was obtained by hand weeding at 20 and 40 DAT followed by carfentrazone ethyl 40 g ha^{-1}and pyrazosulfuron ethyl 30 g ha^{1}(Table1). Carfentrazone ethyl 40 g ha^{-1} recorded maximum no. of effective tillers hill^{-1} followed by pyrazosulfuron ethyl whereas the maximum no. of filled grains panicle^{-1}was obtained by hand weeding followed by pyrazosulfuron ethyl and carfentrazone ethyl 40 g ha^{-1}. Hand weeding twice recorded the highest grain yield, which was at per with pyrazosulfuron ethyl 30 g ha^{-1}. Both 2,4 DEE and carfentrazone ethyl resulted a significant increase in the proliferation of total bacteria over that of control in the rhizosphere soil of *kharif* rice (Table2). Pyrazosulfuron ethyl reduced the population drastically upto 10 DAA but it did not persist and on 50th DAA, the some herbicide significantly increase the population of total bacteria. All the herbicides reduced the population of non-symbiotic N-fixing bacteria upto 10 DAA followed by their rapid increase from 15 DAA onwards. The reduction was more in carfentrazone ethyl as compared to pyrazosulfuron ethyl and 2,4 DEE.

Table 1 Effect of treatments on weed dry weight, yield parameters and grain yield

Treatment	*Dose (gha^{-1})*	*Time of application (DAT)*	*Dry weight of weeds ($g\ m^{-2}$)* 25 DAT	45 DAT	*Effective tillers $hill^{-1}$*	*Filled grains $panicle^{-1}$*	*Grain yield ($t\ ha^{-1}$)*
C E	15	15	2.22	5.18	10.87	102.55	3.42
C E	20	15	1.58	3.42	11.60	102.33	3.57
C E	25	15	1.52	4.24	11.25	102.88	3.73
C E	30	15	1.50	3.88	11.95	113.66	3.96
C E	40	15	1.14	1.36	12.35	114.44	4.26
2,4-D EE	850	15	3.54	6.16	10.45	99.77	4.03
PSE	30	15	1.24	1.88	12.30	123.88	4.40
Hand weeding	-	20 and 40	0.68	1.02	11.85	126.33	4.57
Weedy check	-	-	7.98	11.52	10.00	98.55	3.27
CD at 5%			1.68	4.64	2.94	38.97	1.06

C E – Carfentrazone ethyl, 2,4-D EE - 2,4-D ethyl ester, PSE - Pyrazosulfuron ethyl

Table 2 Effect of treatments on bacterial population in the rhizosphere soil of *kharif* rice

Treatment	*Dose (gha^{-1})*	*Time of application (DAT)*	*Bacterial population (CFU x $10^5 g^{-1}$)* *Total bacteria* 5 DAA	10 DAA	15 DAA	20 DAA	*Non symbiotic N-fixing bacteria* 5 DAA	10 DAA	15 DAA	20 DAA
C E	15	15	90.45	88.40	102.44	105.54	24.12	21.29	35.19	45.33
C E	20	15	90.44	82.45	103.46	121.67	24.23	20.10	37.23	48.56
C E	25	15	89.33	81.33	105.47	137.47	24.19	22.89	32.72	45.35
C E	30	15	82.45	76.34	97.75	149.76	25.26	24.80	33.25	47.23
C E	40	15	81.46	75.77	108.35	155.43	23.24	22.33	32.19	49.23
2,4-D EE	850	15	76.25	87.50	111.75	130.50	26.79	33.38	43.28	52.62
PSE	30	15	72.56	65.73	78.56	96.30	27.38	24.23	39.98	44.23
Hand weeding	-	20 and 40	81.40	92.63	102.53	89.60	35.70	37.23	40.43	34.36
Weedy check	-	-	84.60	88.33	94.43	102.50	31.50	33.45	36.13	40.65
Mean			83.21	82.42	100.52	119.12	26.60	26.62	36.71	45.28
		Source		CD at 5%					CD at 5%	
		Treatment (T)		4.03					1.35	
		Days (D)		3.28					1.05	
		T x D		9.83					3.31	

C E – Carfentrazone ethyl, 2,4-D EE - 2,4-D ethyl ester, PSE - Pyrazosulfuron ethyl

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10- Studies on Weed Management Efficiency of Low-Dose High Efficiency Pyrazosulfuron Ethyl (PSE) Herbicide in Transplanted *Kharif* Rice

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INTRODUCTION

In transplanted *kharif* rice, both semi-aquatic and aquatic weeds under broadleaves, grasses, sedges and filamentous types predominate and they come up in sequence. In rainfed areas and in some locations supplemented by irrigation, good land preparation and management of water, nutrients, and crop are very often erratic. In this crop, choice of varieties as well as timing of transplanting also differ. All these results in the infestation of various types of weeds with varying population densities and dry matter production. Weed infestation alone causes yield reduction to the tune of 10 to 50 per cent as reported by Mukhopadhyay, 1995. Rice is the staple food crop occupying the largest area in India and the second largest area in the world. Up to the recent past different types of rice herbicides have been developed and successfully utilized for weed management. Currently environmental consciousness against the use of chemical is going to forbid use of higher dose of most effective herbicides. Considering all these points a low dose high efficiency eco-friendly rice herbicide and botanicals of herbal origin have opened up a great scope to meet the desired result without any adverse and persistent effect on field. Pyrazosulfuron ethyl (PSE), a new herbicide under sulfonyl group is one of these. For comparing the efficiency of different doses of PSE with standard rice herbicides namely, butachlor, anilofos and three herbal substances (botanicals) and traditional mechanical weed management have been evaluated in the present investigation.

MATERIALS AND METHODS

Experimental rice crop (*Oryza sativa* cv. IR 36) was grown at Agricultural Farm of the Institute of Agriculture, Visva-Bharati; Sriniketan during warm-wet season, 2003. The soil of the field was towards neutral in reaction (pH 6.8), low in organic carbon, available nitrogen and phosphorus and medium in available potash. After thorough land preparation, a basal dose of 40: 60 : 60 kg ha^{-1} of N : P_2O_5 : K_2O was applied. The crop was transplanted with 25 days old seedlings on August 3, 2003 at 25 cm x 20 cm row and hill spacing with three seedlings hill^{-1} in 5 m x 4 m plots. The experiment was laid out under RBD consisting of three replications of 12 treatments. Chemical herbicides were applied at 3 DAT, while chopped and macerated green leaves of herbal materials at the rate of 200 kg ha^{-1} were applied during transplanting. Mechanical weed management was scheduled at 30 DAT by running a Japanese paddy weeder. For weed-free-check (WFC) weeds were removed at 15, 35 and 55 DAT. Two top dressings at the dose of 20 kg N ha^{-1} were done at 30 and 45 DAT. The crop was irrigated as per the requirement to maintain soil under saturation to submergence over and above 646 mm of rainfall and 500 hrs of bright light received during the crop growing period. No plant protection measure was required. Crop was harvested at 95 DAT.

RESULTS AND DISCUSSION

Effect of treatments on reducing weed population and dry weight

The effects of treatments on weed population and dry weight at 40 DAT were highly correlated. Unweeded control had more than 2.5 times weed population and 2.0 times weed dry weight than that of the most efficient weed management treatment namely, PSE 20 a.i. ha^{-1} (WCE 58.68 %) that was equivalent with weed-free-check. These were significantly superior to PSE 15 g having 41.17 % WCE and that was more effective than that of butachlor 1.5 kg a.i. ha^{-1} in reducing weed population but was equivalent with anilofos. butachlor 1.5 kg and PSE 10 g a.i. ha^{-1} in reducing weed dry weight. Butachlor 1.5 kg was equivalent with anilofos and PSE 10 g. These were equivalent with butachlor 1.0 kg in reducing both weed population and dry weight. Again PSE 10 g and butachlor 1.0 kg were equivalent with *Vitex* and *Adhatoda* in reducing weed population and these were equivalent with *Azadirachta* in reducing weed dry weight. All these treatments were significantly superior to mechanical weeding having only 25.49 % WCE.

Effect of treatments on crop plant, production of yield components and grain yield

Final crop height was not affected by any weed management treatment. PSE 20 g produced the highest number of effective tillers, filled grains panicle^{-1}, heaviest grains and maximum grain yield with 56.46 % grain yield advantage indicating that weeds reduced grain yield to the tune of 14.29 q ha^{-1} i.e. 63.9 %. This was succeeded by weed-free-check, PSE 15 g, anilofos, butachlor 1.5 kg, PSE 10 g, and butachlor 1.0 kg that were in descending order in yield performance. These treatments produced grain yields more than 40 % that of unweeded control and had the weed index values less than 10.0. Both butachlor 1.0 and *Vitex* were equivalent and were significantly superior to *Adhatoda* and *Azadirachta* that were equivalent. These were significantly superior to mechanical weeding at 30 DAS indicating that even the sub-optimal dose of butachlor and herbal substances were higher grain yielding weed control treatments than that of the traditional farmers' practice. All the weed management treatment produced more than 32.75 % grain yield and less than 14.20 WI value that of unweeded control having WI value of 35.35.

Table 1 Effect of treatments on population and dry weight of weeds, crop growth, yield components and yields

Treatments	*Weed population*	*Weed dry wt. g m^{-2} at 40 DAT*	*Effective tiller m^{-2}*	*Filled grains panicle^{-1}*	*Test weight (g)*	*Grain yield (q ha^{-1})*
PSE 10 g a.i. ha^{-1}	25.33	3.24	192.33	75.43	23.30	36.00
PSE 15 g a.i. ha^{-1}	20.33	3.00	201.33	78.83	23.56	37.66
PSE 20 g a.i. ha^{-1}	17.33	2.26	206.66	83.76	23.76	39.60
Buta 1.0 kg a.i. ha^{-1}	26.67	3.38	189.66	73.50	23.20	35.53
Buta 1.5 kg a.i. ha^{-1}	23.00	3.10	194.33	76.23	23.36	36.66
Anilo 400 g a.i. ha^{-1}	24.33	3.08	195.33	77.40	23.46	37.15
Adha 200 kg ha^{-1}	27.00	3.46	184.33	70.50	22.83	34.41
Vitex 200 kg ha^{-1}	27.67	3.40	187.00	72.46	23.03	35.18
Aza 200 kg ha^{-1}	32.33	3.50	182.00	69.46	22.70	34.28
Mec 30 DAT	35.33	3.80	178.33	66.93	22.60	33.60
WFC at 15, 35 and 55 DAT	17.67	2.28	205.00	81.73	23.66	45.15
Unweeded control	42.67	5.10	171.33	61.20	22.50	25.31
CD at 5%	2.38	0.29	4.53	2.97	0.18	0.43

PSE = Pyrazosulfuron ethyl (10 WP), Buta = Butachlor (50 EC as Machete), Anilo = Anilofos (Arozin 30 EC), *Adha* = Adhatoda vesica, *Vitex* = *Vitex negundo, AZA* = *Azadirachta indica,* Mec.= Mechanical weeding, WFC = Weed-free-check, DAT = Days after transplanging

All the herbicides were applied at 3 DAT and Botanical herbicides (substances) were applied just before transplanting

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11- Productivity and Economics of Scented Rice Varieties as Influenced by Integrated Weed Management in Terai Region of West Bengal under Rainfed Condition

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INTRODUCTION

Cultivation of aromatic rice is increasing every year owing to higher demand in international market and higher return. Aromatic rice varieties are poor competitor to weeds due to their initial slow growth. Transplanted rice faces 35-39% yield reduction due to uncontrolled weeds (Raju and Reddy, 1995). There is a need to emphasize on proper agronomic management practices for controlling weeds in aromatic rice. Herbicide alone is not effective in controlling weeds for longer period or for second flush of weeds. So, there is a need to develop a holistic weed control programme throughout the growing period.

MATERIALS AND METHODS

A field experiment was conducted at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, west Bengal ($20^0$19' 86" N latitude and 89^0 23' 53" E longitude and at an altitude of 43 meters above mean sea level) during kharif seasons of 2002 and 2003 to study the effect of integrated weed management practices on scented rice varieties in *terai* region of West Bengal under rainfed condition. The experiment was laid out in a split-plot design with three replications. Three scented rice varieties viz. Pusa Basmati 1, Basmati 370 and Karnal Local were assigned to main plots and six levels of weed control measures viz. butachlor @ 1.5 kg ha^{-1}, butachlor @ 1.5 kg ha^{-1} + one hand weeding at 40 days after transplanting (DAT), wheat straw mulch @ 5.0 t ha^{-1}, paddy weeder (twice) at 20 & 40 DAT, hand weeding (twice) at 20 & 40 DAT and unweeded control were assigned to sub-plots.

RESULTS AND DISCUSSION

Among the varieties significant influence on weed density and weed dry matter production was recorded. A significant increase in yield attributing characters was observed due to different varieties. High yielding varieties Pusa Basmati 1 and Basmati 370 resulted in significant increase in yield and yield attributing characters over Karnal Local. The increase in grain yield was recorded 39.5 and 31.1% with Pusa Basmati 1 and Basmati 370 respectively over Karnal Local.

Among the methods of weed control, hand weeding (twice) significantly recorded highest grain yield, lowest weed density & dry weight of weeds and highest weed control efficiency followed by paddy weeder (twice). Butachlor + hand weeding (once), butachlor alone and straw mulch due to higher yield attributing characters and grain yield of rice. Unweeded control plot recorded the least grain yield of paddy (2.57 t ha^{-1}) due to severe weed competition. Gogoi (1995) also reported similar findings.

Among the varieties, net income and benefit : cost ratio were recorded higher under Pusa Basmati-1 followed by Basmati 370 and Karnal Local. Among the weed control measures, highest net income was recorded under hand weeding (twice) followed by butachlor + hand weeding, paddy weeder (twice), butachlor alone, wheat straw mulch and least net income was recoded under control plot due to lowest production.

Higher benefit : cost ratio was recorded under paddy weeder (twice) followed by butachlor, Hand weeding (twice), butachlor + hand weeding, wheat straw mulch and lowest was recorded under control plot.

The unweeded control was found un-economical. Thus when labour is limited paddy weeder (twice) may be used for effective weed control due to highest benefit : cost ratio.

Table 1 Effect of treatments on weed growth, weed control efficiency, yield attributing parameters, yield and economics of scented rice varieties (average of two years)

Treatment	*Panicle length (cm)*	*1000 grain weight (g)*	*Grain yield (t/ha)*	*% increase over control*	*Weed population (no./m2)*	*Weed dry weight (g/m2)*	*Weed control efficiency (%)*	*Net income*	*Benefit cost ratio*
Variety									
Pusa Basmati 1	27.4	26.65	3.95	39.5	8.67	107.9	-	48480	4.50
Basmati 370	26.1	23.68	3.71	31.1	10.19	127.5	-	44880	4.17
Karnal Local	24.9	23.30	2.83	-	12.35	196.8	-	31680	3.94
CD at 5%	1.23	0.31	0.21	-	1.41	19.3	-		
Weed control measures									
Butachlor @ 1.5 kg a.i. ha^{-1}	25.5	22.93	3.41	32.7	10.48	134.1	44.3	40080	3.62
Butachlor @ 1.5 kg a.i. ha^{-1} + hand weeding at 40 DAT	27.4	23.66	3.93	52.9	8.24	93.5	61.5	46080	3.58
Straw mulch @ 6.0 t/ha	24.8	22.73	2.91	13.2	12.76	215.8	11.2	32580	2.94
Paddy weeder (twice) at 20 & 40 DAT	26.6	23.50	3.72	44.7	9.34	104.8	56.9	44430	3.91
Hand weeding (twice) at 20 & 40 DAT	27.9	23.86	4.40	71.2	7.26	73.1	69.9	51630	3.59
Unweeded control	24.1	22.71	2.57	-	14.31	243.1	-	27780	2.58
CD at 5%	1.20	NS	0.48	-	1.20	33.1	-		

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12- Bioefficacy and Phytotoxicity of Fenoxaprop-p-ethyl in Transplanted Rice

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INTRODUCTION

Rice is predominant crop of India contributing 45 % to the total food grain production. Uncontrolled weeds cause a reduction of 35-55% of grain yield under transplanted conditions (Gautam and Mishra, 1995; Saikia and Purshothamam, 1996). Therefore, timely weed control is imperative for realizing desired level of productivity. Barnyard grass (*Echinochloa* sp.) is a major weed in rice system. Although, many herbicides such as butachlor, anilophos, oxadiazon etc. are available for successful control of this weed under transplanted condition, when applied as pre-emergence. At present no herbicide is available which may provide effective control of annual grasses under post-emergence condition. Continuous use of herbicides with similar mode of action has to be restricted to avoid undesirable weed shifts. In view of above facts, it would be desirable to develop alternative herbicides, which may provide wide weed control spectrum with wide application window. Therefore, the present investigation was undertaken to find out the effect of fenoxaprop-p-ethyl on weeds in transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted during rainy seasons of 2003 and 2004 at the National Research Centre for Weed Science, Jabalpur. The recommended fertilizer level of 120-60-60 kg N, P_2O_5 and K_2O/ha was given to the crop. While all the P and K fertilizers were given basally, nitrogen was given in 3 splits – half at planting and the rest in two equal splits each at active tillering and panicle initiation stages. Five weed control treatments comprised of fenoxaprop at three doses i.e. 45, 56.25 and 112.5 g ha^{-1} applied at 25-30 DAT. The treatments were replicated thrice in randomized block design. Fenoxaprop-p-ethyl (Whip super 9 % EC) was applied at spray volume of 600 l ha^{-1} using flat fan nozzle. All the other recommended agronomic and plant protection measures were followed to raise the crop. The data were recorded for weed population in quadrats (0.5 m x 0.5 m) randomly at 60 DAS. The weed biomass was also recorded by 60 DAS. Grain yield of rice was taken from net plot of 22.5 m^2 and converted per hectare. The data on weed population is subjected to squares root transformation.

The major weed population of experimental plot consisted of *Echinochloa colona, Echinochloa crusgalli* and *Commelina communis*. Other weed species of minor infestation were *Alternanthera sessilis* and *Caesulia auxillaris*. In untreated control, the bulk of the weed flora comprised of *Echinochloa colona* (69 %).

RESULTS AND DISCUSSION

The data on weed population and weed dry weight at 60 days after sowing revealed that application of fenoxaprop at 56.25 g ha^{-1} reduced the weed population and weed dry weight to a greater extent as compared to other treatments of weed control. Though, the application of fenoxaprop at 112.5 g ha^{-1} recorded the lowest value of weed population and weed dry weight but it was slightly phytotoxic to rice plant. This phytotoxicity was later on recovered. The weed control efficiency was the highest 79.4 % under fenoxaprop application. Weed free plot produced significantly highest grain yield of 6.87 t ha^{-1} over all other treatments and gave an advantage of 72 % over weedy check. Fenoxaprop treated plots also produced higher yields and gave an increase of 55 and 58 % under the dose of 45 and 56.25 g ha^{-1}, respectively, over weedy check. Singh *et al* (2004) also reported similar results.

The grain yield of rice crop was the highest under weed free situation followed by fenoxaprop application. There was no phytotoxicity of fenoxaprop at 45 and 56.25 g ha^{-1} on rice crop. At 112.5 g ha^{-1} the fenoxaprop was slightly phytotoxic, but the crop recovered later on to a greater extent. The study revealed that fenoxaprop gives an excellent control of grass in transplanted rice.

Table 1 Effect of fenoxaprop on weed population (species wise) in transplanted rice

Treatment (g ha^{-1})	*Weed population (species wise)*			
	Echinochloa Colona	*Commelina communis*	*Alternanthera sessilis*	*Caesulia auxillaris*
Fenoxaprop 45	9	6	7	3
Fenoxaprop 56.25	7	3	6	5
Fenoxaprop 112.5	4	5	4	2
Weed free	-	-	-	-
Weedy check	19	9	8	-
CD at 5%				

Table 2 Effect of fenoxaprop on total weed population, weed dry weight, weed control efficiency, % increase of yield over weedy check and grain yield of rice (Average of two years)

Treatments(g ha⁻¹)	*Total Weed Population (No. m⁻²)*	*Weed dry weight (g m⁻²)*	*Weed control efficiency (%)*	*Grain yield (t ha⁻¹)*	*% increase in yield over weedy check*
Fenoxaprop 45	6.13	23.3	67.6	6.20	55.00
Fenoxaprop 56.25	5.76	21.5	70.0	6.32	58.00
Fenoxaprop 112.5	5.60	14.3	79.4	6.35	58.00
Weed free	0.71	-	100	6.87	72.00
Weedy check	7.02	72.1	-	4.00	-
CD at 5%	0.55	4.52	-	1.3	-

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13- Efficacy of New Herbicides in Controlling Weeds in Transplanted Rice (*Oryza sativa* L.)

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INTRODUCTION

In like other cereal crops, rice suffers more from weed competition. The degree of competition and extent of yield loss vary with rice cultures on average, 15-20% yield is reduced due to weeds in transplanted rice (Pandey and Shukla, 1990). Thus to realize maximum benefit of applied costly inputs and higher yield, control of weeds in time is of paramount importance. A number of pre-emergence herbicides are being applied for weed control in transplanted rice for the last decade, out of which butachlor and anilophos are most important, ethoxysulfuron and cinmethylin new pre-emergence herbicide (Saini *et al.* 2001), the efficacy of which will have to be worked out under low land condition of Allahabad. Therefore, the present study was conducted o find out the most effective dose of ethoxysulfuron and cinmethylin for controlling weeds in transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted at Crop Research Farm Department of Agronomy, Allahabad Agricultural Institute-Deemed University, Allahabad during kharif season of 2003-2004. The soil was sandy loam in texture with pH of 7.1 rice varieties "Pusa Basmati-1" was sown in first week of August. The crop received fixed does of 120 kg N/ha, 60 kg P/ha and 60 kg K/ha, in nine irrigation were given to the crop, seven treatment consisting five herbicides, ethoxysulfuron 0.10 kg/ha cinmethylin 0.75 kg/ha, anilophos 0.50 kg/ha, butachlor 1.50 and butachlor + 2,4-D at 1.00 + 0.75 kg/ha, hand weeding two and unweeded.

RESULTS AND DISCUSSION

The predominant weed in experiment field were *Caesulara axillanes, Ammania baceifer, Echinochloa colonum, Cyperus iria* and *Fimliristylis miliacea*, among the herbicide treated plots, ethoxysulfuron at 0.10 kg/ha and reducing weed population and dry eight, resulting in higher number of panicle/plot, grains/ panicle and test weight which resulted in higher grain yield. Next to hand weeded plot then the herbicide treated plant butachlor 1.00 kg/ha with combination of 2,4-D and herbicide treated plot pre-emergence application of anilophos 0.75 kg/ha were found to be statistically at par. Maximum benefit cost ratio (1.22) was recorded in plots hand weeded plot (20 and 40 DAT), followed by herbicide treated plot pre-emergence application of ethoxysulfuron at 0.10 kg/ha with benefit cost ratio (1.20). It may be concluded that two hand weeded plots 20 and 40 DAT, followed by pre-herbicide treated plot-emergence application of ethoxysulfuron at 0.10 kg/ha has been found to the economical treatment in controlling weeds getting yield and better net returns with maximum benefit cost ratio.

Table 1 Effect of different weed control treatments on weed density weed biomass and weed control efficiency at 60 DAS.

Treatments	*Rate (kg/ha)*	*Application time*	*Weed index*	*No. panicle/hill*	*Grain/ panicle*	*Grain yield (q/ha)*	*B.C.R.*
Ethoxysulfuron	0.10	Pre-emergence	1.94	15.4	131.87	45.33	1.20
Cinemethylin	0.75	Pre-emergence	25.09	13.33	118.93	34.63	0.69
Anilophos	0.50	Pre-emergence	25.09	13.73	121.93	37.03	0.86
Butachlor	1.50	Pre-emergence	19.90	14.13	120.47	41.83	10.84
Butachlor + 2,4-D	1.0+0.75	Pre and post-emergence	18.97	14.73	131.00	46.23	1.05
Hand weeding	-	20 and 40 DAT	9.51	15.47	132.67	46.23	1.22
Unweeded	-		32.07	13.27	112.33	31.4	0.55
Mean	-			12.27	125.31	39.13	
CD at 5%				1.50	12.21	9.16	

DAT = Days after transplanting

CONCLUSIONS

Ethoxysulfuron at 0.10 kg /ha was found to be the best in controlling and reducing weed population and dry weight, resulting in higher number of panicles/plant, grain/panicles and test weight which resulted in higher grain yield next to hand weeded plot.

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14- Economic Feasibilities of New Herbicides for Controlling Weeds in Transplanted Rice (*Oryza sativa* L.)

A. CHAUBEY, JOY DAWSON AND THOMAS ABRAHAM
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INTRODUCTION

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MATERIALS AND METHODS

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RESULTS AND DISCUSSION

The predominant weed in experiment field were *Caesulara axillanes, Ammania baceifer, Echinochloa colonum, Cyperus iria* and *Fimliristylis miliacea*, among the herbicide treated plots, Ethoxysulfuron at 0.10 kg/ha recorded the highest number of panicle/hill, grain/panicle and lowest weed index (Lee *et al.* 2000), which resulted in higher grain yield. Next to hand weeded plot then the herbicide treated plant butachlor 1.00 kg/ha with combination of 2,4-D and herbicide treated plot pre-emergence application of anilophos 0.75 kg/ha were found to be statistically at par. Maximum benefit cost ratio (1.22) was recorded

Table 1 Effect of different weed control treatments on weed index, number of panicle/hill, grain/panicle, grain yield and B.C.R.

Treatments	*Rate (kg/ha)*	*Application time*	*Weed index*	*No. panicle/hill*	*Grain/ panicle*	*Grain yield (q/ha)*	*B.C.R.*
Ethoxysulfuron	0.10	Pre-emergence	1.94	15.4	131.87	45.33	1.20
Cinemethylin	0.75	Pre-emergence	25.09	13.33	118.93	34.63	0.69
Anilophos	0.50	Pre-mergence	25.09	13.73	121.93	37.03	0.86
Butachlor	1.50	Pre-emergence	19.90	14.13	120.47	41.83	10.84
Butachlor + 2,4-D	1.0+0.75	Pre and post-emergence	18.97	14.73	131.00	46.23	1.05
Hand weeding	-	20 and 40 DAT	9.51	15.47	132.67	46.23	1.22
Unweeded	-		32.07	13.27	112.33	31.4	0.55
Mean	-			12.27	125.31	39.13	
CD at 5%				1.50	12.21	9.16	

DAT = Days after transplanting, B.C.R. = Benefit cost ratio.

in plots hand weeded plot (20 and 40 DAT), followed by herbicide treated plot pre-emergence application of ethoxysulfuron at 0.10 kg/ha with benefit cost ratio (1.20). It may be concluded that two hand weeded plots 20 and 40 DAT, followed by pre-herbicide treated plot-emergence application of ethoxysulfuron at 0.10 kg/ha has been found to the economical treatment in controlling weeds getting yield and better net returns with maximum benefit cost ratio.

CONCLUSIONS

Ethoxysulfuron at 0.10 kg /ha was found to be the best in controlling and reducing weed population and dry weight, resulting in higher number of effective tiller/plant, weed control efficiency and weed index which resulted in higher grain yield next to hand weeded plot.

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15- Efficacy of New Herbicides to Manage Weeds in Transplanted Rice

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INTRODUCITON

Weed competition is one of the major factor of reduced yield in transplanted rice. Uncontrolled weeds cause a reduction of 35-55% of grain yield under transplanted conditions (Gautam and Mishra,1995).Therefore, timely and effective weed management is imperative for realizing desired level of productivity. The continuous use of herbicides with similar mode of action has to be restricted to avoid undesirable weed shifts. Therefore, present investigation was undertaken to find out the effect of doses and times of application of alternative herbicides to control weeds in transplanted rice.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* seasons of 2001 and 2002 at the Research Farm of Department of Agronomy, CSK, Himachal Pradesh Krishi Vishvavidyalya, Palampur. The area represents the mid hill wet temeprate Zone of Himachal Pradesh. The soil of the experimental field was silty clay loam in texture having a pH of 5.7, medium in available nitrogen and phosphorus and high in available potassium. The experiment was laid out in a randomized block design with 12 treatments and three replications. Treatments consisted of oxadiargyl 70,100 and 130 g/ha (5 DAT), ready mix of arozin + ethoxysulfuron 1.25 and 1.50 kg/ha (10 DAT), acetachlor 150 g (5 DAT), 150 g (10 DAT), anilophos 0.6 kg/ha (10 DAT), butachlor 1.5 kg/ha (5 DAT), butachlor 1.50 kg/ha (5 DAT) fb 2, 4-DEE 1.0 kg/ha (30 DAT), hand weeding twice and unweeded check. The herbicides were applied with knapsack sprayer fitted with flat fan nozzle at spray volume of 700 l ha^{-1}. Thirty days old seedlings of rice variety RP-2421 were transplanted on 12[th] and 10[th] July during 2001 and 2002, respectively following all recommended package of practices except the treatments. The data on species wise and total weed dry weight were recorded at harvest of crop using quadrate of 50 cm x 50 cm and expressed as number and g m^{-2}.

RESULTS AND DISCUSSION

The major weeds of the experimental field were *Echinochloa colona, Cyperus iria, Commmelina communis, Digitaria sanguinalis* and *Panicum dichotomiflorum.* Acetachlor 150g ha^{-2} (10DAT) being statistically at par with anilophos 600g ha^{-2} (10 DAT) was effective to reduce both count and dry matter of weeds during both the years of study. However, anilophos 600g ha^{-2} remained statistically at par with arozin+ethoxysulfuron 1.25 kg and 1.5 kg ha^{-2} (10DAT) and butachlor 1.5 kg fb 2,4-DEE 1.0 kg (30 DAT) with respect to weed density during both the years of study. However, in case of total dry matter of weeds, anilophos 600g ha^{-2} remained statistically at par with oxadiargyl 100 and 130 g ha^{-2} (5DAT), butachlor 1.5Kg/ha (5DAT), butachlor 1.50 kg/ha fb 2,4 DEE 1.0 kg/ha (5 DAT fb 30 DAT), acetachlor 150 g/ha (5 DAT) and hand weeding twice during first year. All the herbicide treatment expect oxadiargyl 70 g/ha and 130 g/ha being statistically at par were significantly superior to increase the grain yield of transplanted rice. However oxadiargyl at 70 and 130 g/ha dose was significantly superior to unweeded check to increase grain yield of rice

Table 1 Effect of herbicides on total weed count, total dry matter of weed and grain yield of transplanted rice

Treatment	*Doses (g ha^{-1})*	*Time (DAT)*	*Weed density (No.m^{-2})* 2000-2001	2001-2002	*Weed dry matter (g m^{-2})* 2000-2001	2001-2002	*Grain yield (kg ha^{-1})* 2000-01	2001-02
Oxadiargyl	70	5	14.4 (205.3)	179 (353.3)	5.3 (27.4)	13.7 (189.3)	1586	2296
Oxadiargyl	100	5	13.9 (192.0)	16.8 (296.0)	4.2 (16.4)	13.6 (188.2)	1846	2607
Oxadiargyl	130	5	12.7 (160.0)	14.6 (216.0)	4.2 (16.4)	10.3 (108.5)	1660	2495
Arozin + Ethoxysulfuron	1250	10	12.4 (152.0)	15.0 (245.3)	5.9 (34.0)	12.4 (156.8)	2021	2945
Arozin + Ethoxysulfuron	1500	10	12.0 (142.7)	12.3 (158.6)	4.4 (18.3)	10.4 (110.4)	1994	2859
Anilophos	600	10	11.5 (132.0)	11.7 (138.6)	3.2 (9.3)	6.0 (34.5)	2244	3067
Butachlor fb 2,4-DEE	1500fb 1000	5 fb 30	12.4 (152.0)	13.1 (197.3)	3.5 (11.2)	11.3(130.0)	2160	3162
Acetachlor	150	5	13.1 (170.7)	13.7 (197.3)	3.5 (11.2)	10.5 (110.9)	1838	2709
Acetachlor	150	10	10.6 (112.0)	11.7 (138.6)	2.2 (4.0)	8.3 (68.1)	1865	2789
Butachlor	1500	5	12.5 (154.7)	13.5 (182.6	4.2 (16.9)	12.8 (163.7)	2118	3015
Hand weeding twice		30 and 60 DAT	13.9 (192.0)	13.1 (185.3)	3.7 (11.2)	11.8 (143.7)	1994	2945
Unweeded			17.6 (309.3)	20.9 (460.0)	7.4 (54.7)	17.4 (306.1)	1008	1178
CD at 5%			0.94	2.15	1.02	2.58	417.7	639.0

DAT-days after transplanting fb - followed by
Figures in the parentheses are the means of original values

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16- Weed Management in Transplanted Rice and Associated Weeds

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INTRODUCTION

Rice is predominant crop of India contributing 45% of the total food grain production. Weed management is one of the major factor which affects rice yield. Uncontrolled weeds cause a reduction of 30-50% of grain yield under transplanted conditions (Singh, Govindra *et al.*, 2004). Therefore timely weed control in imperative for realizing desired level of productivity. Therefore, there is necessity that bulachlor which is being used as pre emergence in transplanted rice on large scale is supplemented with other herbicides to follow up application to widen weed control spectrum particularly with respect to non grasses and annual sedges. In the light of these facts. The present investigation was conducted to assess the effect of 2, 4 -D EE, anilophos alone and in combination with clomazone, fenoxaprop and pretilachlor on transplanted rice and associated weeds.

MATERIALS AND METHODS

A field experiment was conducted at JNKVV-Regional Agricultural Research Station Bagwai, Campus of Agriculture College, Gwalior (M.P.) during kharif seasons of 2003 and 2004. The soil of the experimental field was sandy clay loam in texture with 7.5 pH and conductivity 0.54 dSm^{-1}. It was low in available nitrogen (180 kg/ha) and phosphorus (4.65 kg/ha) while medium. In available potassium (292 kg/ha). The Kranti variety of rice was transplanted on 10.8.03 and 3.8.2004 and harvested on 26.11.03 and 30.11.04. Twelve treatments consisting of butachlor pendemethalin, anilophos, 2, 4 – D EE alone and with combination of clomozone, fenoxaprop, pretiloachlor were compared with unweeded control and weed free (Table 1). Treatments were tested in randomized block designed with three replications. All the recommended package of practices were adopted to raise the crop. Herbicides were applied as per treatments. Observation on weed biomass and yield were recorded at harvest.

RESULTS AND DISCUSSION

Effect of weeds

The dominant weed flora observed in the experimental field consisted of *Cyperus difformis, Fimbristylis millicea, Cyanotis axillaris,* Monochoria vaginalis, Ichaemum rugosum and *Fchinochloa crusgalli.* All the weed control treatments signficcantly reduced the weed density and dry matter accumulation over weedy check. Treatment weed free resulted lowest weed dry weight (76 kg/ha). The next best treatment were pendimethalin (147 kg/ha), clomazone + 2, 4 – D EE (199 kg/ha) and butachlor (122 kg/ha). These treatments were comparable with weed free treatment. The unweeded control recorded the highest weed dry weight (673 kg/ha) and it was at par with farmer's practice (537 kg/ha) and both these treatments were significantly higher with rest of the treatment (Table 1).

Effect on crop

The maximum grain yield (5099 kg/ha) and minimum weed biomass was obtained under weed free plot (76 kg/ha) resulting into higher weed control efficiency (88.7%). The next best treatment in respect of the yield were pretilachlor, clomazone + 2, 4- D EE and anilophos and reduced the weed biomass effectively.

Uncontrolled weeds reduced 41% grain yield of transplanted rice as compared to weed free plot. These results are in conformity with the findings of Singh, Govindra *et al.* (2004).

Table 1 Effect of Weed control treatments on weed biomass, and yield of transplanted rice.

Treatment	*Weed biomass (kg/ha) at harvest*		*Mean*	*WCE*	*Crop yield (kg/ha)*		*Mean*
	2003	*2004*		*%*	*2003*	*2004*	
Butachlor 1.5 kg/ha PE	127	118	122	81.9	3541	4493	4017
Pendimethalin 1.0 kg/ha PE	182	113	147	78.1	3532	4640	4086
Anilophos 0.4 kg/ha PE	225	243	234	65.2	3814	4942	4378
2,4-DEE 0.5 kg/ha POE	142	216	179	73.4	3539	4716	4127
Clomazon+2, 4 DEE 750 g/ha PE	283	115	199	70.4	3601	5347	4474
Butachlor +2,4 DEE PE 1500 + 500g/ha	183	166	174	74.1	4185	4415	4300
Pretilachlor 1.0 kg/ha PE	205	221	213	68.3	4113	5028	4570
Farmers practices	482	593	537	90.2	2783	4249	3516
Unweeded control	727	619	673	-	2637	3320	2978
2,4 DEE + fenoxaprop POE 500 + 75g/ha	124	250	188	72.0	3140	4436	3788
2, 4-DEE + pretilachlor PE 500 + 1000 g/h	139	164	151	77.6	3745	4307	4026
Weed free	57	96	76	88.7	4828	5370	5099
CD at 5%	178	124	151	-	955	1201	-

CONCLUSIONS

The highest grain yield 5099 kg/ha and minimum weed biomass 76 kg/ha were obtained under weed free plot resulting into higher weed control efficiency (88.7 percent). Uncontrolled weeds reduced 41 percent grain yield of transplanted rice as compared to weed free plot. Herbicide pretilachlor, clomazone + 2, 4 –D EE and anilophos reduced the weed biomass effectively and gave 53.4%, 50.2% and 47.0% percent higher grain yield respectively over weed check.

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17- Effect of Pre-Emergence Herbicides on Growth and Yield of Direct Seeded Puddled Rice (*Oryza sativa* L.)

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INTRODUCTION

Rice (Oryza sativa L.) is one of the important cereal crop and is the chief food for more than 60% of the World's population. The production of rice is mainly enumerated in the lands of small poor farmers, where in generally employ labour intensive methods for the production.In most rice production areas, rice is grown by the transplanting method, which is time consuming, laborious and costly, where ever the labour is limited, herbicidal application especially in direct seeded rice is optimum practice for the effective control of weeds. In this connection an experiment entitled "Effect of pre-emergence herbicides on growth and yield of direct seeded puddled Rice (*Oryza sativa* L.)" was conducted at Regional Research station, Mandya, University of Agricultural Sciences, Bangalore, to screen the suitable pre-emergence herbicides.

MATERIALS AND METHODS

The experiment consisted of fourteen treatment as indicated in Table -1, laid out in Randomized complete Block Design with three replications. The observations and weed growth, and yield of rice are recommended as per the procedure.

RESULTS AND DISCUSSION

The predominant weed specious of the experimental site were *Echinochloa colonum (L.), Echinochloa crusgalli L., Leptoghloa chinansis Nees, Panicum repens L., Cyperus irria L., Cyperus difformis L., Monochoria vaginalsis* and *Spilanthus calva.*

The evaluated treatments shown that, the hand weeding at 20 and 40 days after sowing recorded the higher grain yield (5562 kg/ha), which was closely followed by butachlor + safener (5334 kg/ha) and pretilachlor + safener (5100 kg/ha). The increased grain yield was mainly attributed to the effective control of weed population (11.70, 18.3 and 18.0/m^2 area, correspondingly) reduced weed dry matter (14.93, 34.93 and 42.50 g/0.25 m^2 area, correspondingly). These results are inline with the findings of Muralikrishnaswamy et al., 1988 and Mahadevaswamy (1991). Rest of the treatments recorded how to moderate control of weeds and so as the performance of rice also. However, the lesser control of weeds was noticed with anilofos @ 0.3 kg ai/ha, anilofos @ 0.4 kg ai/ha and pendimethalin @ 1.0 kg ai/ha and the same treatments recorded the least growth and grain yields in direct seeded rice.

Finally to conclude, the pre-emergence application of butachlor @ 1.0 kg ai/ha + safener and pretilachlor @ 0.4 kg ai/ha + safener performed equally better as that of hand weeding at 20 and 40 days after sowing in controlling weeds and increasing the growth and grain yield of direct seeded rice.

Table1 Effect of pre-emergence herbicides on weeds and growth as well as grain yield of direct seeded puddled rice

Treatments	*Dose*	*Total weeds population per m^2 area*	*Total dry matter production (0.25) m^2 area*	*Leaf area cm^2 per plant*	*Grain yield (kg/ha)*
Anilofos 30EC	0.4	5.08 (25.34)	8.6 (74.03)	715.07	3705
Anilofos 30 EC	0.3	5.10 (26.30)	8.9 (78.67)	692.30	3666
Anilofos + 2,4-D 24+ 32 EC	03 + .4	4.90 (23.60)	8.3(68.57)	619.48	3695
Pendimethalin 30EC	1.0	4.70(22.40)	7.1(51.00)	565.55	4000
Pendimethalin 30EC	0.5	4.70(22.30)	7.0(48.83)	556.30	4541
Pendimethalin 30+36 EC	05.+0.5	4.60(20.96)	607(44.83)	473.80	4543
Butachlor 50EC	1.5	4.40(19.00)	6.2(38.13)	578.13	4643
Butachlor + safener 50EC	1.0	4.30(18.30)	5.9(34.53)	704.30	5334
Butachlor+safeber+2,4-D30+36	0.5+0.5	4.20(17.30)	5.7(32.87)	596.87	4565
Pretilachlor 50EC	0.5	4.20(17.40)	6.7(45.27)	579.23	4577
Pretilachlor + safener 30EC	0.4	4.30(18.00)	6.5(42.50)	644.51	5100
Pretilachlor + safener+2,4-D30+36	0.3+0.4	4.00(15.70)	6.4(40.13)	501.35	4734
Handweeding at 20 & 40 days after sowing	-	3.40(11.70)	3.9(14.93)	861.78	5562
Un weeded control	-	6.10(37.30)	9.6(92.6)	385.73	3452
CD at 5%	-	1.70	1.027	3.562	4.047

Figures in the parenthesis are original values

18- Effect of Weed Management and Establishment on Weed Dynamics and Grain Yield of Rice

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INTRODUCTION

Economic factors and developments in rice production technology are the major drivers that have led to the adoption of direct seeding methods for rice establishment in place of transplanting in Asia (Pandey and Valasco, 2002). In the 21st century along with population pressure, the rising scarcity of agricultural land and water, and continuing shortage of labour will maintain pressure for a shift towards direct seeding methods. The direct seeding does not require the large quantity of water for puddling prior to rice transplanting. Farmer growing direct seeded rice are however likely to encounter greater problems related to weed management because of lack of weed suppression by standing water. The transition to direct seeding of rice can therefore only be successful if accompanied by effective weed management practices. To determine the impact of crop establishment methods on the cropping system, and to improve weed control measures, experiments were designed to explore a range of available options for weed management and direct seeding of rice using either dry or pre germinated seeds.

MATERIAL AND METHODS

Field experiment was conducted at sugarcane research Station, Kashipur, Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar, U.S. Nagar, during *kharif* season of 2003 and 2004. Four rice establishment methods in main plots and four weed management practices in subplots were compared in split plot design. Rice establishment methods were Conventional transplanting of 21 days old seedling after soil puddling (TPR), Wet seeding - pre germinated drum seeded after soil puddling (WSR), Dry seeding after conventional tillage (DSR), Dry seeding without tillage after flush irrigation (ZTR). In sub plot, four weed management practices were applied Weedy check (WC_1), anilophos 1.5 kg ha^{-1}+ one hand weeding at 30 DAS (WC_2), pendimathalin 1.0 kg ha^{-1}+two hand weeding at 30 DAS (WC_3), and two hand weeding at 30 and 60 DAS (WC_4). From each subplot weed density and biomass by species were taken from 0.25 m x 1 m quadrats covering 5 crop rows from two places at 28, 56, 84 and at harvest stages from all the systems of establishment

RESULTS AND DISCUSSION

The major weed species recorded in weedy plots were *Cyperus rotundus* (21.4%), *Elusien indica* (19.8%), *Dactyloctenium aegyptium* (16.9%), *Echinochloa colona* (10.2%), *Corchorus actutangulus* (9.9%), *Alternantera sessilis* (9.9%) and *Leptochloa chinensis* (8.0%) The density of the *E. colona, D. aegyptium, L. chinensis and E. indica* was higher in wet seeded rice(WSR) followed by direct seeded (DSR) and zero tilled rice(ZTR). However, the maximum density of *A. sessilis, C. actutangulus* and *C. rotundus* was recorded in ZTR than in DSR. There were no significant differences between the transplanting and other rice establishment method with respect to density of *E. colona* and *E. indica*, while transplanting caused significant reduction in density of *D. aegyptium* in comparison to other establishment methods. WSR had less density of *L. chinensis* than other establishment methods where as minimum density of *A. sessilis* was recorded in ZTR. The maximum reduction of weed species was obtained with application of herbicides as pre emergence supplimented by two hand weeding at 30 and 60 DAS (WC_3). Rice transplanting in puddled condition significantly reduced the total dry matter of weeds than other establishment systems of rice. The highest weed dry matter was recorded in ZTR than in DSR. Pre emergence application of herbicide followed by two hand weeding significantly reduced the weed population over all the weed management practices. The maximum weed dry matter reduction was achieved under herbicides + 2 hand weeding (WC_3) in TPR followed by two hand weeding (WC_4) in wet seeding and application of herbicide supplemented with two hand weeding (WC_3) in zero till rice crop.

The higher grain yield (4304 kg ha^{-1}) was obtained by transplanting (TPR) than wet seeding (WSR), zero till (ZTR) and direct seeded rice (DSR). The maximum yield of rice achieved by the application of Herbicides supplemented with two hand weeding at 30 and 60 DAS (WC_3) gave significantly higher yield of rice (3929 kg ha^{-1}) than the pre emergence application of herbicide + one hand weeding (WC_2) and only two hand weeding (WC_4).The main reason for higher yield in transplanting and wet seeded was due to better control of weeds resulting from puddling and water stagnation at early stage of crop. The reductions in yield were 40.3, 4.9 and 5.6 per cent by uncontrolled weeds (WC_1), application of herbicide supplemented with one hand weeding (WC_2) and two hand weeding (WC_4) respectively, when compared with the application of herbicide followed by two hand weeding (WC_3). Interaction effect between the rice establishment and weed management treatments with respect of grain yield were significant. The highest yield (4623 kg ha^{-1}) was achieved by application of herbicide supplemented with two hand weeding in transplanted rice (TPR) which was significantly higher than the other treatments. Among the direct seeding of rice the maximum yield (4222 kg ha^{-1}) was recorded under wet seeding (WSR) employed with two hand weeding (WC_4) which was on par with the application of herbicide followed by one hand weeding (WC_2) under transplanted rice (TPR). Similar results were also reported by Singh *et. al.*, 2003. Two hand weding done in DSR produced significantly less grain yield than the herbicide supplemented with on or two hand weedings.

Table 1 Interaction effect of rice establishment and weed management on total dry matter of weeds (gm^{-2}) and grain yield (kg ha^{-1}) of rice (Pooled 2003-04)

Rice establishment	*Weed management*									
	Weed dry matter (gm^{-2})					*Grain yield of rice (kg ha^{-1})*				
	WC_1	WC_2	WC_3	WC_4	*Mean*	WC_1	WC_2	WC_3	WC_4	*Mean*
DSR	16.8 (2.77)	0.79 (0.57)	0.36 (0.30)	1.23 (0.74)	4.81 (1.10)	1447	3618	3614	3138	2663
WSR	11.8 (2.36)	1.52 (0.90)	0.43 (0.35)	2.33 (0.10)	4.03 (1.17)	2655	3896	3926	4222	3675
ZTR	15.9 (2.76)	1.47 (0.89)	0.29 (0.25)	3.58 (1.45)	5.32 (1.34)	1400	3207	3688	2939	2789
TPR	1.90 (0.85)	0.94 (0.65)	0.0 (0.0)	1.00 (0.73)	0.98 (0.56)	3876	4224	4623	4496	43.4
Mean	11.6 (1.04)	0.11 (0.75)	0.27 (0.22)	2.08	3.79 (0.10)	2344	3736	3929	3708	

	CD at 5%	
	Weed dry matter	*Grain yield of rice*
Rice Establishment	0.32	127.94
Weed management	0.28	92.97
Weed management at same level of rice establishment	0.56	185.94
Rice establishment at same level of weed management	0.58	205.39

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WHEAT

19- Studies on Management of Complex Weed Flora with Herbicide Mixtures in Wheat

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INTRODUCTION

Herbicides like clodinafop, fenoxaprop and sulfosulfuron are recommended for managing the resistant population of Phalaris minor in wheat. But these herbicides provided only selective control of grasses. For the control of broadleaf weeds, 2,4-D alone or in combination with isoproturon is being used but certain weed species such as *Rumex retroflexus, Lathyrus aphaca* and *Vicia spp.* are not being effectively controlled by this herbicide. This warrants for the use of other broad-spectrum herbicides either alone or in combination with grassy weed killers for the management of complex weed flora in wheat. Keeping above in view, the present investigation carried out to evaluate the efficacy of metsulfuron-methyl as tank mixture or sequential application with new grassy herbicides viz., clodinafop, fenoxaprop and sulfosulfuron for controlling the complex weed flora in wheat.

MATERIALS AND METHODS

A field experiment was conducted during *Rabi* 2002-03 at the Agronomy Research Farm of Chaudhary Charan Singh Haryana Agricultural University, Hisar. Wheat cv. WH 343 was sown on Nov. 14, 2002 on furrow irrigated raised beds using100 kg ha^{-1} seed and harvested on April 7, 2003. The experiment consisting of the tank mix spray of metsulfuron (4g/ha) with clodinafop (60g/ha), fenoxaprop (120g/ha) and sulfosulfuron (25g/ha) as well as its sequential application (7 days) with these herbicides As per treatment, herbicides were sprayed with knapsack sprayer fitted with multiple (two) flat fan nozzle boom using a spray volume of 600 L ha^{-1} at 33 DAS and follow up application was made at 7 days after previous spray.

RESULTS AND DISCUSSION

The field was dominated with grassy weeds comprised of *Phalaris minor* Retz (29.7%) and *Avena ludoviciana* L. (40.1%), whereas the dominant broad leaf weeds were *Lathyrus aphaca* L. (8.8%) and *Chenopodium album* L. (8.2%).

All the weed control treatments effectively controlled the weeds and gave significantly higher grain yield than the weedy check. Post-emergence application of fenoxaprop at 120 g ha^{-1} and clodinafop at 60 g ha^{-1} alone provided excellent control of *P.minor* Retz. and *A. ludoviciana* Dur. Metsulfuron-methyl at 4 g ha^{-1} proved very effective against all broadleaf weeds except *C.arvensis* and *L.aphaca*. Sulfosulfuron at 25 g ha^{-1} in addition to grassy weeds moderate control of broad leaf weeds. Application of clodinafop *fb* metsulfuron (7 DAS) and fenoxaprop *fb* metsulfuron (7 DAS) effectively controlled the complex weed flora and produced grain yield of wheat equal to weed free treatment. Visual control of grassy as well as broadleaf weeds was cent per cent in clodinafop *fb* metsulfuron and fenoxaprop *fb* metsulfuron treatments.Application of metsulfuron as tank mixture or one week earlier than the application of clodinafop and fenoxaprop reduced their efficacy against grassy weeds but efficacy of metsulfuron was not affected in any of the treatment combination Similar findings was recorded by Yadav et al (2002).

Table 1 Effect of weed control treatments on yield attributes of wheat

Herbicides	Dose ($g\ ha^{-1}$)	Density (no. /m^2)		Total dry wt. of weeds (g/m^2)	Visual control (%)		Grain yield (kg/ha)
		P. minor	A ludoviciana		Grassy weeds	Broadleaf weeds	
Fenoxaprop	120	2.07 (3.3)	1.3 (0.7)	29.4	92	0	5061
Clodinafop	60	1.38 (1.0)	1.0 (0.0)	28.7	100	0	5184
Sulfosulfuron	25	4.16 (16.3)	3.6 (12.0)	65.9	42	50	4445
Fenoxaprop+metsulfuron-methyl	120+4	3.74 (13.0)	2.8 (7.0)	27.1	88	63	5244
Clodinafop+metsulfuron-methyl	60+4	2.84 (7.11)	1.6 (1.7)	13.9	95	98	5853
Sulfosulfuron+metsulfuron-methyl	25+4	4.57 (20.0)	4.5 (19.7)	44.2	48	80	4659
Metsulfuron *fb* fenoxaprop	4 & 120	3.36 (10.3)	2.8 (6.0)	18.9	96	93	5426
Metsulfuron *fb* clodinafop	4 & 60	2.64 (6.0)	2.6 (5.3)	15.2	99	100	5625
Metsulfuron *fb* sulfosulfuron	4 & 25	4.99 (24.0)	4.9 (23.0)	41.8	48	100	5076
Fenoxaprop *fb* metsulfuron	120 & 4	1.48 (1.3)	1.3 (0.7)	13.0	100	100	5976
Clodinafop *fb* metsulfuron	60 & 4	1.00 (0.0)	1.0 (0)	12.8	100	100	6008
Sulfosulfuron *fb* metsulfuron	25 & 4	4.35 (18.0)	3.7 (13.0)	67.3	33	80	4600
Metsulfuron-methyl	4	6.85 (46.0)	5.4 (28.0)	121.2	0	93	3666
Weedy check	-	6.99 (48.0)	6.2 (37.7)	170.3	0	0	2972
Weed free	-	1.00 (0.0)	1.0 (0.0)	0.0	100	100	6074
CD at 5%		1.23	0.32	9.8	12.21	11.28	530

fb: Followed by one week

The value are transformed by square root (Öx+1) transformation & actual values are given in parenthesis

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20- Influence of Prometryn Alone and Tank Mixture with Other Herbicides against Weed Flora in Wheat

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INTRODUCTION

Resistance development in weed species against a chemical which has been continuously in use emerged as serious problem. Isoproturon is being used successfully since 1982 for the control of *Phalaris minor*, which has been most effective, economical and safe herbicide in wheat crop. To keep this problem in mind, there are increasing and ongoing efforts by the industries and scientist to tackle this problem if arise. With this aim, different types of chemicals are being tested for different weed flora. Prometryn can be used as pre-emergence against mixed weed flora in wheat. Therefore, the present investigation was conducted to study the bioefficacy of prometryn.

MATERIALS AND METHODS

Field experiment was conducted at CCS HAU Regional Research Station, Karnal for two *rabi* season i.e. 2002-03 and 2003-04 using wheat cv. PBW 343 in a randomized block design, replicated thrice in a plot size of 5.4 x 2.1 m^2. Crop was sown on 29.11.2002/2.12.03 and harvested on 28.4.2003/10.4.04. The soil of the experimental field was sandy clay loam in texture having a pH 8.1 and organic carbon 0.35 %. Prometryn treatments were applied as per the detail in the table and were compared with standard checks of sulfosulfuron, weedy and weed free. All the herbicides were applied by knapsack sprayer using flat fan nozzle delivering 300 l/ha volume. Crop was raised according to package of practices of the region. Observations were recorded for weed population, their dry matter accumulation, crop yield and yield parameters. Data was statistically analyzed using analysis of variance.

RESULTS AND DISCUSSION

In general prometryn had poor weed control and has phytotoxicity on the wheat crop which was increased with the increase in the dose of prometryn (Singh *et al.*, 2004). Application of prometryn alone or in combination with Isoproturon (IPU) or clodinafop did not show any promising effect in the control of *Phalaris minor* in the year 2002-03 but this effect was prominent during second year. This may be possible because of variation in weather particularly in the first year. During second year prometryn applied alone at 750 and 1000 g/ha provided upto 87 % control of *P. minor* were controlled (Table 1). Application of IPU in either year did not provide optimum control of *P. minor*. Application of tank mix IPU + prometryn at 500 to 1000 g/ha provided 67 to 78 % control of *P. minor* in 2003-04. Tank mixing of prometryn with clodinafop provided excellent control of *P. minor* (78 to 90 %). Similar trend was observed in recording of density and dry weight of *P. minor* (data not given). With increase in dose of IPU +prometryn from 500 to 1000 g/ha there was decreasing trend in yield of wheat crop besides the decrease in number of effective tillers and increase in the dry weight of weeds, possibly due to some antagonist effects being shown by prometryn in combination with IPU. But the application of prometryn with clodinafop recorded grain yield at par with Sulfosulfuron and Clodinafop (Table 1)

Table 1 Influence of prometryn alone and tank mixture with other herbicides on percent control of weeds and yield attributes in wheat

Treatment	*Dose (g/ha)*	*Application time*	*% Control (P. minor)*		*Effective tillers (No. m)*		*Grain yield (kg/ha)*	
			2002	*2003*	*2002*	*2003*	*2002*	*2003*
Prometryn	500	PRE	23	59	81	82	4468	5190
Prometryn	750	PRE	38	88	86	85	4909	5230
Prometryn	1000	PRE	42	87	88	87	4869	5650
Isoproturon	750	PRE	37	63	86	85	5232	5310
Isoprotruon	1000	PRE	40	63	89	84	5467	5250
IPU+prometryn(1:1)	500(250+250)	PRE	27	67	83	87	5408	5360
IPU+prometryn(1:1)	750(375+375)	PRE	27	77	84	89	5291	5600
IPU+Prometryn(1:1)	1000(500+500)	PRE	30	78	79	89	4938	5640
CDF+Prometryn(1:10)	500(45+455)	35 DAS	73	87	78	96	5387	5920
CDF+Prometryn(1:10)	750(68+682)	35 DAS	78	88	81	96	5478	5830
CDF+Prometryn(1:10)	1000(91+909)	35 DAS	82	90	85	96	5456	5800
Clodinafop	50	35 DAS	80	90	86	98	5338	5850
Sulfosulfuron	25	35 DAS	88	87	94	98	5587	5770
Weedy	-	-	0	0	65	79	4233	3750
Weed free	-	-	100	95	96	99	5808	5970
CD at 5 %					9	3	814	230

Note : IPU = Isoproturon, CDF = flodinafop

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21- Standardization of Dose and Time of Application of Clodinofop propargyl to Manage Weeds in Wheat

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INTRODUCTION

Wheat (*Triticum aestivum*) is one of the most important *Rabi* food grain crop grown in Himachal Pradesh. Heavy infestation of grass weeds has become a serious problem for increasing and sustaining productivity of wheat. It is estimated that weeds on an average reduce wheat yield by more than 66% (Singh and Singh, 2002). The existing herbicides do not control some of the weeds. Morphological similarities of grass weeds with wheat make it difficult to weed ward them out by manual methods. Moreover, continuous use of isoproturon in Punjab has resulted in development of resistance in *Phalaris minor* (Walia *et al.*, 1997). Therefore, the present investigation was undertaken to standardize the dose and time of application of clodinofop propargyl as an alternative herbicide to control all grass weeds effectively and for herbicide rotation to avoid resistance problem.

MATERIALS AND METHODS

Field experiment was conducted in randomized block design with 12 treatments combinations and 3 replications at the Research Farm of Department of Agronomy CSK Himachal Pradesh krishi vishvabidyalya, Palampur during *rabi* seasons of 2000-2001 and 2001-2002. The treatments consisted of four doses of clodinofop-propargyl (45, 60, 75 and 90 g/ha) and two times of application (20 and 35 DAS), two times of application of isoproturon 1.0 kg/ ha + surfactant 0.1% (20 and 35 DAS), hand weeding twice and weedy. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.5), medium in organic carbon (0.7%), low in available nitrogen (226.2 Kg/ha), medium in available phosphorus (17.8 Kg/ha) and high in available potassium (306.5 kg/ha). Herbicides were applied with Maruyama pump adjusted for herbicide spray by using 600 l water per hectare. Wheat variety Aradhna was sown on 23rd December, 2000 and on 12th December, 2001. Recommended package of practices other than weed control was adopted to grow the experimental crop. Weed count and their dry matter were recorded from two randomly selected quadrates (0.25 m^2) in each plot and were expressed on square metre basis.

RESULTS AND DISCUSSION

The dominant weed flora of the experimental field comprised of *Phalaris minor, Avena leudoviciana, Lolium temulentum, Vicia sativa, Poa annua, Coronopus didymus, Anagallis arvensiss, Ranunculus arvensis* and *Polygonum alatum.* Results of the experiment presented in Table 1 reveal that clodinofop 75g/ha (35 DAS) behaving statistically similar with isoproturon 1.0 kg/ha + surfactant 0.1% (35 DAS) resulting in significantly lower density of weeds during both the years of study. Similarly, clodinofop 75 g/ha (35 DAS) behaving statistically alike with two hand weedings (30 and 60 DAS) resulted in significantly lower dry matter accumulation by weeds during both the years of study. Weeds in unweeded check reduced the grain yield of wheat by 52.8% and 47.6% over the best treatment i.e. clodinofop 75g/ha (35 DAS) during both the years of study, respectively. The latter helped in increasing the grain yield of wheat by 9.9% and 36% over hand weeding twice as it was effective to control all grass type weeds. Application of clodinofop at 35 DAS at all the doses was significantly superior over its application at 20 DAS. Clodinofop 75 g/ha (35 DAS) being statistically at par with its application at 60 and 90 g/ha (35 DAS) resulted in significantly higher grain yield of wheat by effective control of weeds.

Table 1 Effect of doses and times of application of clodinofop propargyl on weed density, dry weight and grain yield of wheat

Treatment	*Dose (gha^{-1})*	*Time of application*	*Weed density ($No.m^{-2}$)*		*Weed dry matter (gm^{-2})*		*Grain yield ($kg\ ha^{-1}$)*	
			2000-01	*2001-02*	*2000-01*	*2001-02*	*2000-01*	*2001-02*
Clodinofop propargyl	45	20 DAS	11.7(136.0)	14.8 (219.3)	169.4	138.0	1917	2616
Clodinofop propargyl	45	35 DAS	10.8 (116.6	12.8 (165.3)	146.8	94.0	1894	3239
Clodinofop propargyl	60	20 DAS	11.5 (130.6)	13.3 (177.6)	144.1	150.0	1940	3029
Clodinofop propargyl	60	35 DAS	11.3 (126.0)	10.5 (113.3)	117.8	67.0	2169	3856
Clodinofop propargyl	75	20 DAS	11.7 (136.6)	11.3 (128.0)	129.4	138.0	2227	2823
Clodinofop propargyl	75	35 DAS	8.4 (70.0)	7.5 (57.3)	68.6	52.0	2433	3948
Clodinofop propargyl	90	20 DAS	11.9 (141.0)	10.8 (116.6)	79.7	146.0	2330	2846
Clodinofop propargyl	90	35 DAS	8.6 (73.3)	7.5 (56.6)	54.5	94.0	2386	3351
Isoproturon + surfactant	1000 +0.1%	20 DAS	8.9 (80.0)	11.7 (138.3)	100.5	109.0	2261	3213
Isoproturon + surfactant	100 +0.1%	35 DAS	7.7 (58.3)	9.4 (90.6)	106.5	157.0	2238	2846
Hand weeding twice		30 and 60 DAS	12.5 (156.3)	12.4 (156.0)	36.2	54.0	2192	2525
Unweeded			14.9 (223.3)	17.4 (304.3)	245.6	274.0	1148	2066
CD at 5%			0.88	2.33	32.58	58.42	285	698

DAS-days after sowing

Figures in the parentheses are the original values

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22- Studies on Bioefficacy of Triasulfuron and Carfentrazone-ethyl for the Control of Broad Leaf Weeds from Wheat

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INTRODUCTION

Wheat is the most important cereal crop of the Punjab state and is badly infested with grassy as well as broad leaf weeds. *Phalaris minor* is the predominant weed of rice-wheat system whereas *Avena ludoviciana* creates problem in non rice-wheat system. However, the infestations of broad leaf weeds in wheat are irrespective of cropping sequence. The population of broad leaf weeds is on the increase due to the availability of very effective herbicides like clodinafop, sulfosulfuron and fenoxaprop-p-ethyl. Two herbicides namely 2,4-D and metsulfuron are recommended for controlling broad leaf weeds from wheat. In order to create competition in the market, two new herbicide namely triasulfuron (Logran 20 WP) and carfentrazone-ethyl 40 WP were evaluated.

MATERIAL AND METHODS

Field experiments were conducted at the experimental area of Department of Agronomy and Agromet. During 2002-03 and 2003-04. Post-emergence application of Logran was made at 10, 15 and 20 g a.i./ha during first year but during second year its application with surfactant (Hasten) was also made. Application of carfentrazone at 15, 20 and 25 g/ha was also done as post-emergence (30-35 DAS). Apart form these treatments, recommended treatments, i.e., 2,4-D/ metsulfuron along with unweeded (control) were also kept. PBW 343- a variety of wheat was sown during both years. Crop was raised with recommended agronomic and plant protection techniques.

RESULTS AND DISCUSSION

Application of triasulfuron at 10, 15 and 20 g/ha produced dry matter of broad leaf weeds as well as grain yield of wheat at par with the already recommended herbicide, i.e., 2,4-D / metsulfuron during 2002-03. However, all weed control treatments produced significantly higher grain yield of wheat and significantly less dry matter of broad leaf weeds as compared to control. Triasulfuron was found very safe to the wheat crop as indicated by plant height and effective tillers production by the crop (Table 1).

Table 1: Weed biomass and crop parameters as influenced by different herbicide treatments (2002-03).

Treatments	*Weed biomass (q/ ha)*	*Plant height (cm)*	*Effective tiller/ m row*	*Ear length (cm)*	*Grain yield (q/ ha)*
Triasulfuron 10 g/ha	1.63 (1.77)	66.2	73.3	10.52	51.85
Triasulfuron 15 g/ha	1.0 (0.0)	63.9	75.3	10.06	54.86
Triasulfuron 20 g/ha	1.0 (0.0)	65.9	77.8	10.55	54.17
2,4-D 0.5 kg/ha (standard)	1.0 (0.0)	63.3	76.0	10.16	48.81
Metsulfuron 5 g/ha (standard)	1.0 (0.0)	64.3	74.7	10.38	54.63
Control (Unweeded)	2.38 (5.15)	57.2	61.3	8.84	42.13
CD at 5%	0.70	4.36	5.45	0.61	6.65

Figures in parenthesis are original.

During second year, weed intensity was higher than first year due to slightly poor stand of the wheat crop. All the herbicide treatments significantly reduced dry matter of weeds as compared to unweeded control and hence, grain yield was found to be significantly low in all the herbicide treatments as compared to unweeded control treatment. Post-emergence application of triasulfuron 20 g/ha alone or 15 g/ha + surfactant resulted in significant reduction in dry matter production by weeds as compared to the recommended treatments, i.e., 2,4-D (Table 2). Application of triasulfuron 20 g alone, triasulfuron 15g + surfactant and carfentrazone 25 g/ha produced significantly higher grain yield than the recommended treatment, i.e., 2,4-D, whereas all other herbicide treatments were found at par with the already recommended treatment. Both these herbicides were found safe to wheat crop during this year also.

Table 2: Weed biomass and crop parameters as influenced by different herbicide treatments (2003-04).

Treatments	*Weed biomass (q/ ha)*	*Plant height (cm)*	*Effective tiller/ m row*	*Ear length (cm)*	*Grain yield (q/ ha)*
Triasulfuron 10 g/ha	6.30	60.83	52.50	9.45	35.90
Triasulfuron 15 g/ha	4.07	62.20	53.33	9.24	41.58
Triasulfuron 20 g/ha	2.04	62.33	63.67	9.71	48.78
Triasulfuron 10 g/ha + surfactant	3.59	61.07	61.33	9.25	39.10
Triasulfuron 15 g/ha + surfactant	2.59	64.07	62.17	9.33	45.28
Carfentrazone 15 g/ha	6.67	61.53	52.17	8.77	34.03
Carfentrazone 20 g/ha	4.63	62.57	53.67	9.13	41.68
Carfentrazone 25 g/ha	3.33	65.63	61.83	9.61	44.20
2,4-D 0.5 kg/ha (standard)	5.19	63.00	59.33	9.83	37.90
Control (Unweeded)	8.52	57.63	42.83	9.06	29.98
CD at 5%	1.86	NS	9.11	NS	5.58

23- Efficacy of Clodinafop-propargyl 10 EC Against *P. minor* in Wheat

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INTRODUCTION

In Punjab use of isoproturon for long time has resulted into the problem of resistance in *P. minor* to this herbicide. It is, therefore, necessary to have number of herbicides for controlling weeds. Presently some alternative herbicides have been recommended for the control of *P. minor*. Still it is desirable to search some more herbicides against *P.minor* a most serious weed of wheat in the state. Therefore, a field experiment was conducted to evaluate the efficacy of EC formulation of clodinafop-propargyl against *Phalaris minor* in wheat.

MATERIALS AND METHODS

For the control of resistant populations of *P. minor* in wheat with a new liquid formulation of clodinafop-propargyl 10 EC, a field experiment was conducted in the Department of Agronomy and Agrometeorology, PAU, Ludhiana, during 2002-03 and 2003-04. Ten treatments comprising clodinafop 10 EC 0.04, 0.05, and 0.06 kg/ha with and without surfactant were evaluated against *Phalaris minor* in wheat and compared with clodinafop WP 0.06 kg/ha, Isoproturon + 2, 4-D (0.94 + 0.5) kg/ha, hand weeding and unweeded control. The herbicide was sprayed 35 days after sowing. The experiment was conducted in randomized block design with four replications. Wheat cultivar PBW 343 was sown at 22.5 cm row spacing during the first week of November in each year. The crop received recommended fertilizer and other inputs. The crop was harvested and thrashed manually during the second week of April. The data on dry matter accumulation by weeds and grain yield of wheat was recorded and presented in Table 1. Two trials were also conducted at farmers' fields in the Village of Kum Kalan and Jhande in the district of Ludhiana during 2002-03. The herbicide was sprayed 40 days after sowing. Wheat variety PBW 343 was sown by the farmers at both the sites. The data on weed dry matter and grain yield of wheat was recorded and given in Table 2.

RESULTS AND DISSCUSSION

The EC formulation of clodinafop-propargyl with and with out surfactant gave good control of *P. minor* in wheat at 0.04 and 0.05 kg ha^{-1}, these doses were less as compared with earlier recommended dose of clodinafop-propargyl WP 0.06 kg ha^{-1}. The data in Table 1 showed that different doses (0.04 to 0.06 kg ha^{-1}) of liquid formulation of clodinafop-propargyl gave an excellent control of *P. minor* in wheat and thereby produced significantly higher grain yield of wheat as compared with unweeded control and was at par with earlier recommended WP formulation of clodinafop-propargyl at 0.06 kg ha^{-1} with respect to control of *P. minor* and yield of wheat. The new liquid formulation was also tested on big plots at farmers' field (clodinafop-propargyl, Topic 10 EC) and gave an excellent control of isoproturon resistant population of *P. minor* in wheat at 0.04 and 0.05 kg ha^{-1} with and without surfactant, and comparable with earlier recommended dose of clodinafop-propargyl WP formulation 0.06 kg ha^{-1} and thereby helped in substantial increase in grain yield of wheat and this new formulation was safe to the crop (Table 2). Clodinafop-propargyl 10 EC formulation gave good control of *Phalaris minor* in wheat at Hisar (Anonymous, 2003).

Table 1 Effect of EC formulation of clodinafop-propargyl against *P. minor* in wheat and on wheat

S. No.	Treatment dose kg ha^{-1}	Weed dry matter of P. minor(q/ha) 2002-03	Weed dry matter of P. minor(q/ha) 2003-04	Grain yield(q/ha) 2002-03	Grain yield(q/ha) 2003-04
1	Clodinafop EC 0.04	2.18	3.66	45.36	43.98
2	Clodinafop EC 0.04 + surfactant	0.93	3.66	48.17	45.83
3	Clodinafop EC 0.05	0.83	2.16	46.06	46.30
4	Clodinafop EC 0.05 + surfactant	0.45	2.86	49.58	44.91
5	Clodinafop EC 0.06	0.75	3.05	46.77	44.68
6	Clodinafop EC 0.06 + surfactant	0.38	2.58	48.52	48.61
7	Clodinafop WP 0.06	0.85	2.49	47.71	45.37
8	Isoproturon 0.94 + 2,4-D 0.5	22.2	13.79	28.12	27.55
9	Hand weeding	1.6	4.22	46.53	42.13
10	Unweeded control	41.5	20.26	17.22	20.83
	CD at 5%	4.98	2.58	4.67	10.37

Table 2Effect of clodinafop (Topik 10 EC) against *P. minor* in wheat at farmers' fields during *rabi* 2002-03.

S. No.	Treatment dose kg ha^{-1}	Site 1 P. minor dry matter (q ha^{-1})	Site 1 Grain yield (q ha^{-1})	Site 2 P. minor dry matter (q ha^{-1})	Site 2 Grain yield (q ha^{-1})
1.	Clodinafop EC 0.04	0.63	46.5	0	44.0
2.	Clodinafop EC 0.04 + surfactant	0	48.0	0	43.8
3.	Clodinafop EC 0.05	0.72	49.5	0	43.0
4.	Clodinafop EC 0.05 + surfactant	0	47.5	0	43.6
5.	Clodinafop WP 0.06	0.42	49.0	0	44.5
6.	Unweeded control	34.4	25.0	21.0	31.0

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24- Evaluation of Carfentrazone-ethyl for Weed Control in Wheat (*Triticum aestivum* L.)

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INRODUCTION

Wheat gets infested by complex weed flora comprising both grassy as well as non-grassy weeds. 2,4-D provides good control of some of the non-grass weeds but causes malformed spikes in many wheat cultivars (Balyan and Panwar, 1997). The weeds like *Melilotus indica*; *Melilotus alba* and *Medicago denticulata* are not controlled effectively by 2,4-D. Hence, there is an urgent need to evaluate new herbicide for the control of weeds in wheat field which may provide wider weed control spectrum.

MATERIALS AND METHODS

A field experiment was conducted to study the effect of carfentrazone-ethyl on broad leaf weeds and wheat yield during winter season of 2003-04 at Anand Agricultural University, Anand. The soil of experimental field was sandy loam in texture, low in nitrogen, medium in phosphorus and high in potassium. Experiment was laid out in randomized block design with ten treatments and four replications. Treatments consisted of three doses of carfentrazone-ethyl (15, 20 and 30 g ha^{-1}) 2,4-D Na salt at 500g ha^{-1} metsulfuron methyl at 4 g ha^{-1} isoprotaron at 500 g ha^{-1}, pendimethalin at 500 and 1000 g ha^{-1}, weed free (Two hand weeding at 20 and 40 days after sowing) and weedy. Pendimethalin was applied as pre-emergence while rest was applied as post emergence at 30 days after sowing using knapsack sprayer fitted with flat fan nozzle at 500 l ha^{-1} spray volume. Wheat variety GW-496 was sown on November 24, 2003 at 22.5cm spacing and keeping 120 kg seed ha^{-1}. Recommended package of practices other than weed control was adapted to grow the experimental crop.

RESULTS AND DISCUSSION

Major weed flora of the experimental field consisted of *Chenopodium album, Chenopodium murel, Melilotus alba, Eragrostis major, Commelina benghalensis, Amarcenthus viridis, Digera arvensis, Phyllanthus nirur, Eleusine indica* and *Dactyloctenium aegyptium.*

Effect on weeds

Weed dry weight recorded at 45 DAS and at harvest of wheat was significantly influenced by various treatments. The weed control efficacy of carfetrazone at 30 g ha^{-1} was 65.6 % and it was comparable with metsulfuron methyl and isoroturon. The efficacy was reduced at 15 g ha^{-1}. Carfentrazone at all three levels had better efficacy than 2,4-D on the basis of weed dry weight (g m^{-2}) recorded at 45 DAS.

Effect on crop

Uncontrolled weeds resulted in 22.9 % reduction in the grain yield (Table1). All the treatments yielded significantly higher than the weedy check. The grain yield recorded with carfentrazone at 30 g ha^{-1} and isoprotuson at 500 g ha^{-1} were similar to weed free treatment. Similar results were obtained by Govindra Singh et al. (2004) at Pantnagar. There were significantly less wheat yield due to carfentrazone-ethyl at 15 and 20 g ha^{-1} than the MSM and higher doses of carfentrazone-ethyl. No spike malformation was observed in 2, 4-D and MSM treated wheat crop.

Table 1 Effect of treatments on weeds and wheat

Treatments g ha^{-1}	*WDWg m^{-2} 45 DAS*	*WCE %*	*WDWkg ha^{-1} harvest*	*WCE %*	*Grain yield kg ha^{-1}*	*WI %*	*Straw yield kg ha^{-1}*
Pendi 500 PE	51.75	74.5	337.50	69.2	3935	9.3	8033
Pendi 1000 PE	30.75	84.9	168.25	84.6	4248	2.1	8125
2, 4-D 500 30DAS	124.75	38.6	237.50	78.3	3924	9.6	8166
MSM 4 30DAS	61.50	69.7	140.75	87.2	4282	1.3	8311
Carft 15 30DAS	102.50	49.6	393.50	64.1	3623	16.5	8079
Carft 20 30DAS	91.75	54.9	289.75	73.6	3819	12.0	8380
Carft 30 30DAS	70.00	65.6	174.75	84.1	4317	0.5	8970
IPU 500 30DAS	67.75	66.7	211.2	80.7	4335	0.1	8762
WF (HW 20, 40 DAS)	00.00	100	36.25	96.7	4340	-	9144
Weedy Check	203.25	-	1096.25	-	3345	22.9	7836
CD at 5%	11.33	-	39.13	-	253	-	485

DAS: Days After Sowing WDW: Weed Dry Weight WCE: Weed Control Efficiency

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25- Effect of Dicamba Alone and in Combination with Isoproturon on Control of Weeds and Wheat Yield

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INTRODUCTION

Wheat is the second most important food grain crop of India, Its yield can be reduced drastically because of infestation of uncontrolled weeds. Therefore proper management of weeds is necessary to obtain good productivity. Regarding this aspect, several Herbicides have been found effective and among them isoproturon is being used from last two incades for weed control in wheat, though it is not found excellent against all broad-leaved weeds (Panwar *et al.,* 1995). Excellent control of broad leaved weeds can be achieved with the application of 2,4-D, but chances of the development of deformities is a major concern associated with its application (Balyan *et al.*, 1990). Application of dicamba alone has been found excellent against broad-leaved weeds but had lees effect on grasses (Singh *et al* 2003). Therefore, the present investigation was undertaken to study the response of dicamba alone and in combination with isoproturon on control of weeds and wheat.

MATERIALS AND METHODS

A field experiment was curried out during Rabi season of 1999-2000 and 2000-01 at Pantnagar to evaluate the weed control efficacy of dicamba alone and in combination with isoproturon at 125, 250, 500 and 1000 g ha^{-1} in combination with isoproturon at 100 + 1000, 150+1000, 200+1000 and 250 + 1000 g ha^{-1} and with 2, 4-D at 125 + 500 g ha^{-1} along with isoproturon at 1000 gha^{-1}, 2-4-D at 500 g ha^{-1} and weedy check were replicated thrice in a randomized block design. The soil of experimental fied was silty day, medium in organic carbon (0.68%), available phosphorus (18 kg P ha^{-1}) and available potassium (214 kg K ha^{-1}) with pH 7.1. Wheat variety UP-2382 was sown on 3rd and 1.5th December during 1999 and 2000, respectively at 100 kg seed ha^{-1}. Herbicides were applied using 600 litres water ha^{-1} at 35 days after sowing (DAS) of wheat.

RESULTS AND DISCUSSION

Phalasis minor (58.9%), *Melelotus spp* (10.4%), *Coronopus didymium* (9.0%) and *Medicago denticulata* (5.0%) were the major weeds in the weedy plots at 60 DAS. The other weeds (16.8%) were *Chenopodinm album, Polygonum* spp, *Anagalis arrvensis, Fumaria parviflora, Avena lndoviciana* and *Vicia sativa*, Dicamba at 250 g ha^{-1} and above was effective against Melilotus spp. *C. didymus and M. dnticulata.* It had no effect on *P. minor* but in combination with isoproturon, it was found compatible to control *P. minor* successfully. Dicamba in combination with isoproturon at 150 + 1000, 200 + 1000 and 250 + 1000 ha^{-1} as well as with 2, 4-D at 125+ 500 g ha^{-1} provided excellent control of broad leaved weeds. All the weed control treatments provided significantly lower density and dry weight of total weeds when compared with weedy check. Dicamba in combation with isoprotnron at 200 + 1000 g ha^{-1} gave the best result, which was found at par for the same combination at 250 + 1000 g ha^{-1} and effect of both the doses was closely followed by dicamba in combination with isoproturon at 150 + 1000 g ha^{-1}.

All the weed control treatments increased the grain yield of wheat over weedy check. Application of dicamba at various doses as tank mixture with isoproturon at 1000 g ha^{-1} recorded significant increase in the wheat yield over its application alone, which might be due to better weed control efficiency and higher values of yield attributes under these treatments. Dicamba at 150 g ha^{-1} or more as tank mixture with isoproturon at 1000 g ha^{-1} also produced significantly higher grain yield in comparison to application of isoproturon alone or dicamba at 1000 g ha^{-1} as tank mixture with isoproturon at 1000 g ha^{-1}, 2, 4-D at 500 g ha^{-1} produced less grain yield of wheat than dicamba at various doses as tank mixture with isoproturon or isoproturon alone. The highest wheat grain yield was recorded with dicamba at 200 g ha^{-1} as tank mixture application with isoproturon at 1000 g ha^{-1} over rest of the treatments except application of dicamba at 250 g ha^{-1} as tank mix application with isoproturon.

Table 1 Effect of dicamba alone and in combination with isoproturon on density and dry weight of weeds and grain yield of wheat (mean data of two years)

Treatment	*Dose (g ha^{-1})*	*Weed density (No. m^{-2}) at 60 DAS*					*Total weed dry weight ($g\ m^{-2}$) at 60 DAS*	*Weed control efficiency %*	*Grain yield (kg ha^{-1})*
		P minor	*Melilotns spp.*	*C didymus*	*M denticulate*	*Total*			
Dicamba	125	238	25	14	9	5.71 (301)	5.22 (184.7)	27.6	2802
Dicamba	250	239	0	3	4	5.52 (249)	5.09 (162)	36.4	3031
Dicamba	500	232	0	0	0	5.46 (234)	4.99 (146.4)	42.6	2720
Dicamba	1000	253	0	0	0	5.54 (253)	5.06 (156.3)	38.7	2379
Isoproturon	1000	16	21	8	18	4.39 (80)	3.68 (38.7)	84.8	4322
Dicamba + Isoproturon	100 + 1000	19	7	5	9	3.84 (45)	3.17 (22.9)	91.0	4511
Dicamba + Isoproturon	150 + 1000	14	0	0	4	3.00 (19)	2.86 (16.4)	93.6	4746
Dicamba + Isoproturon	200 + 1000	13	0	0	0	2.64 (13)	2.36 (9.55)	96.2	5000
Dicamba + Isoproturon	250 + 1000	16	0	0	1	2.89 (17)	2.56 (12.0)	95.3	4798
2, 4-D	500	274	5	0	9	5.69 (296)	5.15 (171.2)	32.8	3256
Dicamba + 2,4-D	125 + 500	246	0	0	0	5.52 (249)	5.03 (151.8)	40.5	3065
Weedy		271	47	41	23	6.15 (472)	5.54 (255.0)	0.0	2018
CD at 5%		-	-	-	-	0.26	0.23	-	225

Figures in parentheses are original values

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26- Studies on Bio-efficacy of Trifluralin for *Phalaris minor* Control in Wheat

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INTRODUCTION

Rice-wheat system is the popular cropping system being adopted on large scale in the north-western states of India where *Phalaris* minor is the major problem in wheat cultivation. Continuous use of isoproturon from the last over two decades in wheat, has resulted in the evolution of resistant biotypes of *P. minor* in Punjab (Walia *et al.* 1997). For sustaining wheat productivity the control of this weed is very essential. Although alternative herbicides like clodinafop, fenoxaprop-p-ethyl and sulfosulfuron have been recommended but there are chances of cross resistance in *P. minor* to these herbicides. Moreover these new herbicides are very costly. To delay resistance in *P. minor* to these alternative herbicides and make some cheap herbicide available to the farmer of the region, trifluralin (Treflan 48 EC) was evaluated against isoproturon resistant *P. minor in wheat*

MATERIALS AND METHODS

Field experiments were conducted during winter season of 2001-02 and 2002-03 at the KVK Nawanshahr. The soil of the experimental field was sandy loam in texture and having pH of 8.3. Experiment with seven treatments and four replications was laid out in Randomized Block Design. The wheat variety PBW 343 was sown on November 10 and 12 during 2001 and 2002, respectively, using 100 kg seed per hectare. Pre-emergence application of trifluralin was done one day after sowing of wheat. In post-emergence application of trifluralin, hoeing of the wheat crop was done before first irrigation, then herbicide was applied 4 days after first irrigation (35DAS). Isoproturon at 0.94 $kgha^{-1}$ and fenoxaprop-p-ethyl at 0.10 $kgha^{-1}$ were applied at 35 DAS and after applying first irrigation. Spray solution for trifluralin and isoproturon was 500 l ha^{-1} and for fenoxaprop-p-ethyl was 200 l ha^{-1}.

RESULTS AND DISCUSSION

Effect on *P. minor*

Minimum dry matter was accumulated by the weeds in trifluralin at 1.25 kg ha^{-1} applied as pre-emergence which was statistically at par with its lower dose of 1.00 kg ha^{-1} during both the years but significantly less than post emergence application of trifluralin and isoproturon and fenoxaprop-p-ethyl. Isoproturon reduced the weed dry matter than unweeded control but it was found inferior to trifluralin and fenoxaprop-p-ethyl.

Effect on crop

Highest grain yield of 5075 and 4980 kg ha^{-1} as obtained with pre-emergence application of trifluralin 1.25 kg ha^{-1} and 1.00 kg ha^{-1} during 2001-02 and 2002-03 respectively which was statistically at par with its other dose applied as pre emergence and post emergence application of fenoxaprop-p-ethyl. These treatments gave significantly better grain yield than unweeded and isoproturon treatments during both the years. It might be due to significantly reduced dry matter accumulation by *P. minor* in these treatments and more wheat spikes m^{-2}. These results are in line with Singh et *al.* 2003. So trifluralin at 1.00 kg ha^{-1} can be used for control of *Phalaris minor* in wheat.

Table 1 Effect of different treatments on dry matter of *Phalaris minor* and wheat.

Treatments	*Dose (kg ha⁻¹)*	*Stage of Application*	*Dry Matter Accumulation by Phalaris minor (g m⁻²)*		*No. of spikes m⁻²*		*Grain Yield (kg ha⁻¹)*	
			2001-02	*2002-03*	*2001-02*	*2002-03*	*2001-02*	*2002-03*
Trifluralin	1.00	Pre-emergence	19.0	21.0	400	395	5025	4980
Trifluralin	1.25	Pre-emergence	12.6	18.0	406	403	5075	4810
Trifluralin	1.00	Hoeing fb irrigation fb herbicide applicaion	107.3	93.1	341	344	4325	4115
Trifluralin	1.25	Hoeing fb irrigation fb herbicide applicaion	73.0	81.0	366	371	4625	4528
Isoproturon	0.94	AFI	189.6	200.2	292	280	3575	3389
Fenoxaprop-p-ethyl	0.10	AFI	44.2	34.0	349	355	4700	4808
Unweeded(control)	-	-	333.0	350.0	265	254	3125	2908
CD at 5%			10.11	13.45	28	28	455	437

fb – followed by
AFI – After first irrigation

CONCLUSIONS

Trifluralin applied at 1.00 kg ha^{-1} as pre-emergence reduced the dry matter of *Phalaris minor* and increased wheat yield due to more spikes m^{-2} than post-emergence application of trifluralin, isoproturon and fenoxaprop-p-ethyl.

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27- Efficacy of Isoproturon in Controlling Weeds of Rainfed Wheat with Specific Reference to Wild Oats and Rye Grass under Mid-hill Conditions of Himachal Pradesh

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INTRODUCTION

Wheat is an important *rabi* crop and weed infestation is one of the major constraints in its cultivation in Himachal Pradesh. Grass weeds, particularly wild canary grass (*Phalaris minor* Retz.), wild oats (*Avena fatua* L.) and rye grass (*Lolium temulentum*) are commonly occurring weeds in wheat in Himachal Pradesh and cause enormous losses in wheat grain yield (Saini and Angiras, 1991). Isoproturon has shown good promise as grass weed killer in wheat. For the last decade it is being extensively used by the farmers. However, poor efficacy of isoproturon has been reported from various places in controlling wild oats and rye grass, which otherwise, depends largely on time and method of its application (Pandey *et al*., 1996). So far, information on these aspects is scanty. Hence, the present study was undertaken to work out the efficacy of isoproturon with and without surfactant in controlling wild oats and rye grass with respect to its dose and time of application.

MATERIALS AND METHODS

A field experiment was conducted under rainfed conditions during *rabi* 2001-2002 and 2002-2003 at Chaudhary Sarwan Kumar, Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India. The soil of the experimental field was clay loam in texture, acidic in reaction, medium in available nitrogen and phosphorus and high in available potassium. The experiment was laid out in randomized block design with three replications and ten treatments. The treatments consisted of two doses of isoproturon (1.0 and 1.5 kg ha^{-1}) with and without surfactant and two times of application (20 and 35 DAS), hand weeding twice (30 and 60 DAS) and weedy check. Wheat variety *Surbhi* (HPW-89) was sown using seed rate 100 kg/ha in the second week of November following all recommended package of practices during both the years. Species-wise weed population and total weed dry weight were recorded at 120 days after sowing using 50 cm x 50 cm quadrate.

RESULTS AND DISCUSSION

The weed flora of experimental field mostly consisted of *Avena fatua*, and *Lolium temulentum* constituting about 53.5 and 33.6 % of total weed flora during first year and 47.5 and 38.2 % during second year, respectively.

All weed control treatments resulted in significantly lower species-wise weed population and total weed dry weight over weedy check (Table1). Irrespective of time of application isoproturon 1.5 kg ha^{-1} + surfactant being at par with isoproturon 1.5 kg ha^{-1} without surfactant both at 20 and 35 DAS resulted in significantly lower population of *Avena fatua* over other treatments. Isoproturon 1.0 kg ha^{-1} + surfactant was also as effective as isoproturon 1.5 kg ha^{-1} without surfactant in controlling *Avena fatua* at both the times of application. Isoproturon 1.5 kg ha^{-1} + surfactant being at part with hand weeding twice controlled *Lolium temulentum* effectively to significantly lowest density over all other treatments both at 20 and 35 DAS. The next best treatment in controlling this weed was isoproturon 1.0 kg ha^{-1} + surfactant. Without surfactant isoproturon did not control *Lolium temulentum* effectively even at 1.5 kg ha^{-1}. Irrespective

Table 1 Effect of treatments on species-wise weed density, total weed dry weight and wheat grain yield

Treatment	*Dose (kg ha^{-1})*	*Time of application*	*Weed density(No.m^{-2})*				*Total weed dry weight (g m^{-2})*		*Grain yield (q ha^{-1})*	
			Avena fatua		*Loliumtemulentum*					
			2001-02	*2002-03*	*2001-02*	*2002-03*	*2001-02*	*2002-03*	*2001-02*	*2002-03*
Isoproturon	1.0	20 DAS	6.8(45)	5.9(3.2)	7.8(6.2)	8.7(7.4)	32.2	34.6	21.3	26.8
Isoproturon	1.5	20 DAS	4.2(16)	4.6(23)	6.5(43)	6.3(39)	19.8	21.4	27.9	28.4
Isoproturon	1.0+Surfactant	20 DAS	5.5(22)	5.1(25)	5.6(32)	6.1(38)	24.4	17.3	25.8	30.7
Isoproturon	1.5+Surfactant	20 DAS	2.7(21)	4.2(16)	3.9(14)	4.4(18)	21.3	18.9	28.3	30.5
Isoproturon	1.0	35 DAS	7.3(52)	6.6(42)	8.4(70)	8.2(64)	30.6	34.7	20.5	25.2
Isoproturon	1.5	35DAS	5.0(24)	4.3(19)	7.2(50)	6.5(40)	21.4	23.8	29.2	27.9
Isoproturon	1.0+Surfactant	35DAS	6.1(35)	5.4(28)	5.9(34)	5.2(25)	25.6	21.6	27.5	31.4
Isoproturon	1.5+Surfactant	35 DAS	4.4(18)	3.1(9)	3.2(11)	3.7(14)	18.7	14.7	28.2	32.9
Hand weeding twice	-	30 & 60DAS	4.7(22)	4.0(15)	4.3(18)	4.1(16)	12.8	15.7	27.0	33.6
Weedy check	-	-	11.2(124)	9.9(97)	8.9(78)	9.2(84)	98.4	154.3	18.2	21.3
CD at 5%	-	-	2.1	1.5	1.1	1.3	7.5	4.2	4.2	2.5

DAS = days after sowing; $\sqrt{x+1}$ transformation used; Figures in the parentheses are the means of original values.

of time of application isoproturon 1.5 kg ha^{-1} + surfactant was at par with isoproturon 1.0 kg ha^{-1} + surfactant and hand weeding twice in producing significantly lower total weed dry weight over other treatments, however, these treatments were also at par with isoproturon 1.5 kg ha^{-1} without surfactant during first year of study.

Isoproturon 1.5 kg ha^{-1} with and without surfactant, isoproturon 1.0 kg ha^{-1} with surfactant and hand weeding twice being at par with each other resulted in significantly higher wheat grain yield over other treatments due to significantly lower weed population and dry weight and higher values of all the yield attributes over rest of the treatments both at 20 and 35 DAS.

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28- Economic Analysis of Weed Management Practices in Late Sown Wheat (*Triticum aestivum* L.)

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INTRODUCTION

For successful cultivation of wheat, weed control is important. The chemical weed control through herbicides is becoming popular with the farmers. There are now many herbicides available for weed control in wheat. The application rate and cost of these herbicides are different. Therefore a field study was conducted to find out most economical practice of weed management.

MATERIALS AND METHODS

The field experiment was conducted at Agronomy Research Farm of the University during *rabi* season 2001-02 in a three replicated randomized block design with ten treatments. The sowing of wheat variety HUW-234 using 125 kg seed ha^{-1} was done in lines 18 cm apart on December 14, 2001. In all, four irrigations including pre-sowing irrigation were applied to the crop. Winter showers of 42.3 mm received during January to February, 2002 compensated the requirement of two irrigations. New molecules of herbicides namely, Sulfosulfuron 25 and 30 g ha^{-1} and Clodinafop 60 and 80 g ha^{-1} along with old molecules i.e. Isoproturon 1.0 kg ha^{-1} and pendimethalin 0.75 and 1.0 kg ha^{-1} were used. Hand weeding at 20 and 40 DAS was also done with the help of hand chisel. Grain and straw yield under the effects of different treatments were recorded. Economics was calculated on one hectare basis. Common cost of cultivation and treatment-wise cost of cultivation were calculated separately at the prevailing rates of the experimental year. Finally, the total cost of cultivation was obtained by adding common cost of cultivation and treatment-wise cost of cultivation.

RESULTS AND DISCUSSION

The results presented in Table 1 make it amply clear that the highest cost of cultivation (Rs.20,710.19 ha^{-1}) incurred in weed free treatment on account of repeated weeding to maintain the weed free situation while the lowest (Rs.15,176.99 ha^{-1}) was associated with weedy check treatment. As for net income is concerned, hand weeding 20 and 40 DAS recorded the highest net income of Rs.9,143.71 ha^{-1} followed by post-emergence application of Clodinafop 60 g ha^{-1} (Rs.8,255.07 ha^{-1}). Net income $Re.^{-1}$ investment and benefit cost ratio was found maximum (0.49 and 1:1.49) under the post-emergence application of Clodinafop 60 g ha^{-1} followed by hand weeding at 20 and 40 DAS which recorded Rs.0.48 as net income Re^{-1} investment and benefit cost ration of 1:1.48. Although, hand weeding at 20 and 40 DAS provided higher grain yield of crop higher yield yet, it is not feasible for the places where labour wages are high due to scaricity of labaourers. Hence, post-emergence use of Clodinafop 60 g ha^{-1} has been found most remunerative.

Table 1. Economics of different treatment for one hectare wheat cultivation

Treatment	*Grain yield (q ha^{-1})*	*Straw yield (q ha^{-1})*	*Gross incime Rs,*	*Total cost of cultivation Rs.*	*Net income Rs.*	*Net income Re^{-1} investment Rs.*	*Benefit cost ratio*
Weedy	26.13	34.68	17,673.30	15,176.99	2,496.31	0.16	1.16
Weed free	42.60	47.49	28,360.50	20,710.19	7,650.31	0.37	1.37
Hand weeding 20 and 40 DAS	42.00	47.49	28,009.50	18,865.79	9,143.71	0.48	1.48
Isoproturon 1.0 kg ha^{-1} post-em.	32.65	45.57	21,894.50	15,874.59	6,019.91	0.38	1.38
Sulfosulfuron 25 g ha^{-1} post-em.	37.49	43.81	25,059.40	17,434.31	7,625.09	0.44	1.44
Sulfosulfuron 30 g ha^{-1} post-em.	37.68	44.48	25,208.80	17,874.02	7,334.78	0.41	1.41
Clodinafop 60 g ha^{-1} post-em.	37.55	43.90	25,100.50	16,845.43	8,255.07	0.49	1.49
Clodinafop 80 g ha^{-1} post-em.	37.82	44.12	25,276.20	17,338.86	7,937.34	0.46	1.46
Pendimethalin 0.75 kg ha^{-1} pre-em.	32.37	39.17	21,704.20	16,863.98	4,840.22	0.29	1.29
Pendimethalin 1.00 kg ha^{-1} pre-em.	32.70	40.10	21,952.00	17,362.82	4,589.18	0.26	1.26

29- Effect of Herbicides Alone and in Combination on Late Sown Wheat

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INTRODUCTION

Excessive tillage, unfavourable soil condition and poor power sources are common reason for long turn around in rice-wheat sequence of eastern Indo-Gangetic plains of India. Late harvest of rice commonly delays wheat planting with considerable poor wheat yields. In late sown wheat, due to poor crop growth in early stages, both broad leaf and grassy weeds significantly reduces wheat yield (Singh, *et al.*, 1997). Wheat yields are further threatened by the herbicide resistance that appearance in *Phalaris minor* against isoproturon (Malik and Singh, 1995). Thus, herbicide rotation and mixes, appears to be of considerable significance to reduce interference of weeds in late planted wheat cultivation.

MATERIALS AND METHODS

This study was conducted during *Rabi* seasons of 2002-03 at Agriculture Research Form of Banaras Hindu University. The soil of experimental field was sandy clay loam with pH 7.4. The available N, P and K content were 204.6, 12.9 and 165.6 kg ha^{-1} respectively. Eleven herbicide treatment combinations (Table

1) were compared with weedy check in a randomized block design with three replication. The herbicides were applied alone or as tank mixed application at 30 DAS. Spray volume of 500 l ha^{-1} was applied by foot sprayer fitted with flat fan nozzle. At 40 days after sowing weeds enclosed in quadrate (0.25 m^2) were randomly collected from each plot. After sun drying, samples were oven dried at 70°C for 48 hrs. The dry matter is expressed in g 0.25 m^{-2}. Observations were also recorded on yield attributing characters and yield of wheat. The weed control efficiencies (%) were calculated on the basis of weed dry weight at 40 days after sowing.

RESULTS AND DISCUSSION

The dominant weeds in the present study were *Phalaris minor* Retz. (42.2%), *Rumex dentatus* L. (16.2%), *Cyperus rotundus* L. (14%) and *Chenopodium album* L. (8%). Weeds dry weight was significantly less under mixed application of herbicides than their individual application. Sulfosulfuron + 2,4-D as tank mix was most effective in reducing weed dry weight, but was at par to clodinafop + 2, 4-D. A similar trend was observed in their individual effect on weeds dry weight. The better eccicacy of herbicide mixes can be attributed to control of both grassy and broad leaf weeds. Whereas, individually they affected either of one group of weeds (Punia *et al.*, 2002).

The yield attributed of crop viz. earhead m^{-2}, grain ear^{-1} and weight of 1000 grains were significantly maximum in tank mix application of sulfosulfuron + 2, 4-D, but remained at par to clodinafop + 2, 4-D. Although sulfosulfuron and clodinafop when applied alone produced comparable grain yield, the higher efficiency of sulfosulfuron + 2, 4-D on weeds and in enhancing yield attribute led to significantly higher grain yield under this treatment than other herbicidal combination. Similarly weed control efficiency (92.5%) in this treatment compared with other herbicides applied alone or in combination with 2, 4-D.

Table 1 Effect of herbicides on weeds dry matter, grain yield of wheat and weed control efficiency.

Treatments	*Rate (kg ha^{-1})*	*Weed dry weight (g)*	*Grain yield (kg ha^{-1})*	*Weed control efficiency (%)*
Isoproturon	0.75	24.67	2289	44.56
2, 4-D	0.50	25.67	2210	42.31
Metribuzin	0.25	25.00	2213	43.82
Triasulfuron	0.02	24.33	2324	45.32
Triasulfuron	0.025	22.60	2432	49.21
Sulfosulfuron	0.025	9.53	2558	78.58
Clodinafop	0.06	12.53	2544	71.84
Isoproturon + 2, 4-D	0.75 + 0.50	23.57	2365	47.03
Clodinafop + 2, 4-D	0.06 + 0.50	5.00	2685	88.76
Sulfosulfuron + 2, 4-D	0.025 + 0.50	3.40	2725	92.53
Metribuzin + 2, 4-D	0.25 + 0.50	20.50	2455	53.93
Weedy check		44.50	2207	-
CD at 5%		3.04	79.00	-

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30- Efficacy of Different Herbicides in Controlling *Phalaris minor* and Associated Weeds in Wheat

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INTRODUCTION

Wheat is an important food grain crop of India. The infestation of little seed canary grass(*Phalaris minor* Retz.) in wheat has posed a serious threat to its successful cultivation. Due to morphological similarity, this weed escapes manual weeding and hence its control through herbicides has been popular option amongst farmers. From the last 4-5 years there are many herbicides including Clodinofop, fenoxaprop and Sulfosulfuron against resistant *Phalaris minor* (Malik and Yadav, 1997) in this crop. Hence an experiment was conducted to study the performance of different herbicides with different doses on controlling *Phalaris minor* in wheat.

MATERIALS AND METHODS

A field experiment was conducted to study the efficacy of different herbicides in controlling *Phalaris minor* in wheat during *rabi* season of 2000-01 at the Agronomy Crop Research Farm of Allahabad Agricultural Institute -Deemed University, Allahabad. The soil of the experimental field was sandy loam in texture, medium inorganic carbon (0.47 %), low in available nitrogen, high in potassium (40.1 kg/ha) content with pH 7.5. The experiment involving 13 treatments (Table 1) and three replications was laid out in randomized block design. Wheat variety HD 2643 was sown with 20 cm row spacing. Recommended package of all other agronomic and plant protection other than weed control was adopted to grow the experimental crop. Weed population, weed biomass, crop yield and net income due to weed control were recorded during the experimentation and economics worked out for different treatments.

RESULTS AND DISCUSSION

Effect of *Phalaris minor*

All the weed control treatments significantly reduced the dry matter accumulation by *Phalaris minor* as compared to unweeded (control). *Phalaris* population in unweeded plots increased up to 80 DAS and decreased subsequently at later stages of crop growth. This showed that the majority of the weed spp. emerged before 80 DAS. The dry matter was also high at 80 DAS and it is decreased later stages of crop growth. The weed control efficiency was recorded high in the plots treated with sulfosullfuron at 27.5 g ha^{-1}(100%). This treatment was very much efficient in giving a net return of Rs. 21543.31 ha^{-1}. Similar results were found by Chauhan *et al.* (2000).

Effect on crop

Data pertaining to number of spikes/plant, number of grains/plant, 1000-grain weight, grain yield of wheat were significantly more in all weed control treatments than control (unweeded) (Table 1). Sulfosulfuron at 27.5 g ha^{-1} recorded highest grain yield among the herbicidal treatments. Similar results were also found by Shukla *et al* (1995).

Table 1 Effect of different herbicide treatments on *Phalaris* population, dry weight, total weed dry weight, wheat yield and cost of benefit ratio.

Treatment	*Dose (kg ha⁻¹)*	*Phalaris population (no./m²)*	*Phalaris dry weight(g/m²)*	*Total weed dry weight (g/m²)*	*Grainyield (q ha⁻¹)*	*Net return (Rs ha⁻¹)*	*Benefit cost ratio*
Isoproturon	750	23.33	37.67	85.67	49.00	13528.60	1.66
Isoproturon	1000	16.67	33.67	51.00	51.60	15574.06	1.77
Isoproturon	1250	3.33	4.67	29.37	51.33	15726.96	1.79
Clodinofop	40	3.33	3.33	43.00	47.93	13833.93	1.66
Clodinofop	50	10.00	2.33	34.00	51.37	15469.11	1.74
Clodinofop	60	0.00	0.00	43.10	47.57	12215.46	1.57
Sulfosulfuron	25	3.33	1.67	17.36	55.00	17648.76	1.81
Sulfosulfuron	27.5	0.00	0.00	6.00	61.60	21543.31	2.00
Sulfosulfuron	30	0.00	0.00	2.00	60.13	20161.55	1.93
Fenoxaprop	80	3.33	8.00	46.03	42.03	9077.48	1.44
Fenoxaprop	100	3.33	0.33	26.00	51.50	14529.06	1.67
Fenoxaprop	120	0.00	1.00	54.67	46.03	10680.84	1.50
Control	-	66.67	227.67	242.00	38.77	8584.85	1.44
CD at 5%		16.49	71.51	13.16	7.20	-	-

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31- Evaluation of Carfentrazone Alone and in Combination with Metsulfuron Against Broadleaf Weeds in Wheat

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INTRODUCTION

At present 2,4-D and metsulfuron are being used against broadleaf weeds in wheat crop. These herbicides do not provide satisfactory control of some difficult to control weeds like field bind weed (*Convolvulus arvensis* L.) and wild pea (*Lathyrus aphaca* L.). So a new herbicide carfentrazone developed by FMC Pvt. Ltd. was evaluated against these weeds and compared with existing recommended herbicides in wheat.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Research area of CCS HAU Hisar using wheat cv. PBW-343 in a randomized block design, replicated thrice in a plot size of 7.0 x 2.1 m². Crop was sown on7.11.2003 and harvested on 9.4.2004. The soil of the experimental field was sandy loam in texture having a pH 8.7 and organic carbon 0.29%. Treatments consisted of carfentrazone at 15, 20 and 25 g/ha alone and with metsulfuron at 4g/ha (tank mixed), metsulfuron at3 & 4 g/ha and 2, 4-D at 400,450 and 500 g/ha were compared with weedy and weed free. All the herbicides were applied at 35 days after sowing by knapsack sprayer using flat fan nozzle delivering 300 L water/ha. Grassy weeds in experimental plots were controlled by post emergence spray of fenoxaprop-p- ethyl and hand weeding as and when required. Crop was raised according as per recommended package of practices. Observations on density and dry matter accumulation by broad leaf weeds were recorded at 70DAS. Data on density and dry weight of weeds was subjected to X+1 transformation before analysis. Visual estimates of per cent grass control were recorded at 120 DAS using a scale of 0%(no control) to 100% (Plant death). .Foliar chlorosis, necrosis and plant stunting were considered when making visual estimates

RESULTS AND DISCUSSION

Experimental field was dominated with *Chenopodium album* L., *Lathyrus aphaca* L., *Convolvulus arvensis* L. and *Rumex retroflexus* L.

Carfentrazone at all doses proved very effective against all broadleaf weeds except *Lathyrus aphaca* in wheat. It caused mild bleaching on leaves of wheat after 2-3 days of application which recovered in due course of time. Weed population and dry weight of weeds also confirm the above observations (Table 65). Complete control of *C.arvensis* was observed regardless of application rate of carfentrazone where as application of metsulfuron and 2, 4-D caused only stunting in growth of this weed. Stunted growth of *Lathyrus aphaca* was observed with the application of metsulfuron. Tank mixing of carfentrazone with metsulfuron did not show any additional advantage as the density and dry weight of weeds in these treatments was same to carfentrazone alone. Carfentrazone did not show any residual activity as growth of few plants of *C. arvensis* germinated after first irrigation or after spray was not checked. Dry weight of weeds in carfentrazone treated plots was significantly lower than metsulfuron and 2, 4-D treated plots. Grain yield and number of tillers were maximum under weed free treatment which were at par with carfentrazone treatments but significantly higher than all 2,4-D treatments and treatment of mesosulfuron + iodosulfuron .Application of carfentrazone irrespective of application rate provided sufficient weed suppression such that yields were equal to weed free treatment. Lower grain yield in metsulfuron and 2,4-D treated plots was due to lack of field bind weed and wild pea control. Tank mixing of carfentrazone with metsulfuron did not cause any toxic effect on wheat as number of effective tillers /m2 and grain yield in these treatments was similar to carfentrazone application alone.

Table 1 Effect of carfentrazone on the density, dry weight and grain yield of wheat.

Treatments	*Dose (g a.i./ha)*	*Weed density (No./m²)*			*Weed dry weight (g/m²)*	*Effective tillers (No./m.r.l)*	*Grain yield (kg/ha)*
		C.arvensis	*Lathyrus aphaca*	*Other BLW*			
Carfentrazone	15	1(0)	5.2(26)	1(0)	4.42	403	5380
Carfentrazone	20	1(0)	4.8(22)	1(0)	3.38	405	5450
Carfentrazone	25	1(0)	4.8(22)	1(0)	3.15	411	5480
Metsulfuron	3	2.8(7)*	4.2(17)	1(0)	12.16	409	5400
Metsulfuron	4	3(8)*	1.7(2)	1(0)	14.7	406	5380
Metsulfuron	6	3(8)*	5.4(28)	1(0)	16.8	404	5420
Carfentrazone+metsulfuron	15+4	1(0)	4.6(20)	1(0)	5.3	407	5470
Carfentrazone+metsulfuron	20+4	1(0)	4.2(17)	1(0)	4.6	403	5380
Carfentrazone+metsulfuron	25+4	1(0)	3.6(12)	1(0)	4.5	406	5398
2,4-D	400	3(8)*	4.7(21)	2.6(6)	26.9	388	5220
2,4-D	450	2.4(5)*	5.2(26)	3.3(10)	28.6	390	5284
2,4-D	500	3(8)*	5.1(25)	2.8(7)	27.8	386	5220
Meso +iodosulfuron	25	2.8(7)	4.4(18)	2.4(5)	34.7	380	5100
Weed free	—	1(0)	1(0)	1(0)	0	412	5480
Weedy	—	3.1(9)	5.5(29)	4.7(20)	42.4	340	4420
CD at 5 %		0.3	0.7	0.4	2.6	9	103

32- Evaluation of Different Herbicides against Resistant Population of *P. minor* at Farmer's Fields in Haryana

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INTRODUCTON

Little seed canary grass *(Phalaris minor)* is most serious weed of wheat crop in North-Eastern districts of Haryana. Isoproturon was introduced as a very effective and economical herbicide for the control of this weed in wheat but due to its continuous use for 25 years, *P.minor* in some pockets of Haryana and Punjab has developed resistance to isoproturon (Malik and Malik, 1994).To tackle the resistance problem, alternate herbicides fenoxaprop-p-ethyl, sulfosulfuron and clodinafop- propargyl have been recommended and are being used by the farmers on large scale. Purpose of present investigation was to evaluate the bioefficacy of new formulations of clodinafop (Topik 10EC) and fenoxaprop (puma power 10 EC) in comparison with existing formulations being used by farmers to manage resistant population of *P.minor*.

MATERIAL AND METHODS

Present experiment was conducted at farmer's fields in six districts of the state viz.Ambala, Kurukshetra, Yamuna Nagar, Sonepat, Jind and Fatehbad, where rice- wheat is most popular cropping sequence and alternate herbicides are being used by the farmers since last 5-6 years. Experiment consisting of 8 treatments (Table1), was conducted in randomized block design with three replications at each site, keeping a big plot size of 500 m^2.Wheat variety PBW-343 was grown at all sites by following all the recommended package of practices of CCS Haryana Agricultural University, Hisar. All the herbicides were sprayed at 35-40 days after sowing with hand operated knapsack sprayer fitted with flat fan nozzle delivering 300 litres of water / ha. Hasten cationic surfactant at 0.2%, was used with clodinafop (EC) where as surfactant puma activator (0.3%) was used with puma power (fenoxaprop). Per cent control of *P.minor* was recorded at 120 DAS, on 0-100 scale where 0 means no control and 100 means complete control and grain yield was recorded at harvest on per plot basis and converted to Kg /ha.

RESULTS AND DISCUSSION

Both formulations of clodinafop (WP) at 60 g ha^{-1} and clodinafop (EC) at 50 g ha^{-1} provided excellent control of *P.minor* (Table1). Isoproturon provided only 45% control of this weed indicating presence of resistance in *P.minor* against this herbicide at all sites. Regeneration of this weed after 15 days of sulfosulfuron spray was observed at Jind, Fatehbad and Ambala. Higher dose of fenoxaprop (120 g ha^{-1}) provided significantly higher control of *P.minor* than fenoxaprop (puma power) at 100 g ha^{-1} + surfactant (puma activator).Minimum efficacy of isoproturon (25%) was recorded at Fatehbad, where as it was highest in Sonepat (60%). On an average highest grain yield (5045 kg ha^{-1}) was recoded with the use of clodinafop (WP) at 60 g ha^{-1} + surfactant closely followed by clodinafop (EC) at 50 g ha^{-1} +surfactant which was 48.3 % higher than isoproturon at 1.0 kg ha^{-1} (3402 kg ha^{-1}).

CONCLUSIONS

Bioefficacy of clodinafop (EC) at 50 g ha^{-1} with surfactant was at par with clodinafop (WP) at 60 g ha^{-1} and higher than fenoxaprop and sulfosulfuron against resistant population of *P.minor*. Efficacy of fenoxaprop at 120 g ha^{-1} is more than its use at 100 g ha^{-1} along with surfactant.

Table1 Grain yield (kg ha^{-1}) of wheat and *P. minor* control (%) as affected by different treatments

Herbicide	*Dose (g ha^{-1})*	*Grain Yield (kg ha^{-1})*						
		Ambala	*Jind*	*Kurukshetra*	*YamunaNagar*	*Sonepat*	*Fatehbad*	*Mean*
Fenoxaprop	120	4480 (87)	4600 (88)	4650 (90)	4180 (88)	5500 (93)	5400 (90)	4788 (88.1)
Clodinafop(WP)	60	4700 (95)	4820 (96)	4680 (100)	4450 (95)	5600 (97)	5750 (98)	4999 (96.8)
Sulfosulfuron	25	4380(78)	4160 (65)	4300 (8)	4120 (85)	5240 (80)	5140 (70)	4556 (76.3)
Clodinafop10EC+ Hasten(S)	60+0.2%	4800 (100)	4880 (95)	4590 (94)	4500 (98)	5600 (100)	5900 (100)	5045 (97.8)
Clodinafop10EC+ Hasten(S)	50+0.2%	4850 (100)	4860 (95)	4600 (95)	4580 (98)	5564 (95)	5725 (98)	5021 (96.8)
Fenoxaprop + puma activator(S)	120+0.3%	4750 (100)	4625 (86)	4600 (90)	4240 (90)	5520 (93)	5400 (90)	4862 (91.5)
Fenoxaprop + puma activator(S)	100+0.3%	4460 (80)	4410 (81)	4550 (8)	4000 (75)	5200 (80)	5200 (82)	4336 (80.5)
Isoproturon	1000	3825 (45)	3490 (35)	3200 (37)	2980 (35)	4050 (60)	2870 (25)	3402 (45.3)
CD at 5 %		94	232	109	172	164	139	

* Values in parenthesis are weed control efficacy of *P.minor*

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33- Effect of Surfactant on Bio-efficacy of Isoproturon for Control of *Phalaris minor* Retz. in Wheat in Floodplain Zone of Punjab

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INTRODUCTION

Wheat (*Triticum aestivum* L.) yields are reduced by 30-80% depending upon the severity of *Phalaris minor* Retz.infestation (Brar & Singh 1997). Isoproturon has been the most effective, economical, and safe herbicide since 1980s for control of this weed. However under heavy textured soils and humid environment conditions of floodplain *Phalaris minor* controlled less when the herbicide applied at 25 days after sowing .due to drying of top soils and when it is applied after first irrigation at 35 days after sowing either the application is delayed or by that time *Phalaris minor* attains robust growth. Thus the investigations were conducted to study the effect of surfactant (Washing detergent) on bio-efficacy of isoproturon for control of *Phalaris minor* in wheat in floodplain conditions.

MATERIALS AND METHODS

A field trial was conducted during 1995 and 1996 at the Punjab Agricultural University Ludhiana's Regional Research Station Ropar consisting of ten treatments including isoproturon (0.94 & 1.25 kg ha^{-1} 15, 25, 35 DAS), Isoproturon (0.94 & 1.25 kg ha^{-1})+ surfactant (0.2 %) 35 DAS, Isoproturon (1.25 kg ha^{-1})+ surfactant (0.2 %) 45 DAS, and unweeded control. These treatments were arranged in Randomized Block Design. The soil of the experimental field was loamy in texture, having pH of 8.3, low in available nitrogen, phosphorous but medium in available potassium. All the recommended package of practices was followed to raise the experimental crop except application of isoproturon.

RESULTS AND DISCUSSION

Effect on Weeds

The minimum dry matter of weeds were recorded from the application of isoproturon at 1.25 kgha^{-1} + surfactant (0.2 %) (35DAS, AFI) which was significantly less than all other treatments but statistically at par with isoproturon applied at 1.25 kg ha^{-1} + surfactant (0.2 %) (45 DAS AFI) and isoproturon applied at 0.94 and 1.25 kg ha^{-1} at 15 days after sowing during both years of studies (Table 1). Same dose of isoproturon (0.94 & 1.25 kg ha^{-1}) when applied at 35 DAS (AFI) with surfactant (0.2 %) significantly reduced the weed dry matter than its application without surfactant at 35 days after sowing after first irrigation and 25 days after sowing before first irrigation.

Effect on Crop

The maximum grain yield of wheat was recorded from application of isoproturon at 1.25 kg ha^{-1}+surfactant (0.2 %) (35 DAS AFI) which was statistically at par with isoproturon applied at 1.25 kg ha^{-1} + surfactant (0.2 %) 45 days after sowing (AFI), isoproturon at 0.94 kg ha^{-1} + surfactant (0.2 %) (35 DAS AFI) and isoproturon at 0.94 & 1.25 kg ha^{-1} 15 days after sowing (BFI) during both the years of studies. It might be due to better weed management in these treatments. Application of isoproturon (0.94 & 1.25 kg ha^{-1}) after first irrigation applied with surfactant produced significantly higher grain yield than its application without surfactant 25 (BFI) and 35 (AFI) daya after sowing. Hence surfactant (Surf @ 0.2 %) improved the bio-efficacy of isoproturon for the control of *Phalaris minor* in wheat.

Table 1 Dry matter accumulation of *Phalaris minor* at harvest *and* grain yield of wheat as influenced by different treatments.

Treatments	*Dose (kg ha^{-1})*	*Application time (DAS)*	*Dry matter accumulation by Phalaris minor (q ha^{-1})*		*Grain Yield (q ha^{-1})*	
			1995	*1996*	*1995*	*1996*
Isoproturon	0.94	15 (BFI)	1.70	2.10	51.7	48.0
Isoproturon	1.25	15 (BFI)	1.66	1.90	52.2	48.9
Isoproturon	0.94	25 (BFI)	5.50	7.52	47.3	42.4
Isoproturon	1.25	25 (BFI)	4.49	6.02	48.2	44.9
Isoproturon	0.94	35 (AFI)	3.81	6.84	48.3	45.4
Isoproturon	1.25	35 (AFI)	3.29	6.06	49.4	46.6
Isoproturon	0.94 + 0.2% Surf	35 (AFI)	1.75	2.00	52.2	49.4
Isoproturon	1.25 + 0.2% Surf	35 (AFI)	1.20	1.41	52.7	49.7
Isoproturon	1.25 + 0.2% Surf	45 (AFI)	1.51	2.31	52.0	48.5
Unweeded control	-	-	8.2	15.55	35.8	24.3
CD at 5%			0.58	0.74	2.6	2.5

DAS...Days after sowing BFI...... Before first irrigation AFI..... After first irrigation

CONCLUSIONS

Washing detergent used @ 0.2 % solution as surfactant improved the bio-efficacy of isoproturon (0.94 & 1.25 kg ha^{-1}) for control of *Phalaris minor* in wheat even if application delayed up to 45 days after sowing. Alternatively this herbicide may be applied at 15 days after sowing when this weed plants are at two leaf stage.

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MAIZE

34- Herbicidal Control of *Acrachne racemose* from Maize with Tank Mix Application

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INTRODUCTION

For the control of annual grassy and broad leaf weeds in maize, pre/ post – emergence application of atrazine is recommended. A grass type weed namely *Acrachne racemose* is poorly controlled with this recommendation. Moreover, due to long residual effect and with the wrong application of atrazine, the preceding crops like berseem, wheat, raya, etc. are sometimes adversely affected. So, to obtain the effective control of annual weeds along with *Acrachne racemose*, bio efficacy of tank mix application of this herbicide with pendimethalin, trifluralin and alachlor was studied.

MATERIAL AND METHODS

Field experiments were conducted from 2001 to 2003 on the experimental farm of Department of Agronomy and Agrometeorology, PAU, Ludhiana. Alone application of atrazine @ 1.0 kg/ha, pendimethalin @ 1.0 kg/ha, alachlor @ 2.5 kg/ha along with their tank mix combinations were applied as pre-emergence (details in Table 1). Maize var. Paras was sown on 11.6.01, 26.6.02 and 9.6.03 by using 20 kg seed /ha. Crop was raised with recommended agronomic and plant protection measures.

Table 1 Dry matter of weeds (q/ha) as influenced by tank mix application of different herbicides.

Treatments	*Dose (kg/ ha)*	*Dry matter of weeds (q/ ha)*				
		2001	*2002*		*2003*	
			Grasses	*BLW*	*Grasses*	*BLW*
Atrazine, pre	1.00	5.3 (28.0)	1.5 (1.8)	2.6 (12.1)	1.1 (0.2)	1.5 (1.2)
Pendimethalin	1.00	2.8 (8.0)	1.0 (0)	1.2 (0.6)	1.0 (0)	2.3 (4.3)
Atrazine + pendi	0.50 + 0.75	2.2 (5.3)	1.0 (0)	1.0 (0)	1.4 (1.3)	1.6 (1.5)
Trifluralin	1.00	4.7 (24.5)	1.0 (0)	1.3 (0.9)	1.0 (0)	2.2 (3.8)
Atrazine + triflu	0.50 + 0.75	3.5 (12.5)	1.0 (0)	1.0 (0)	1.1 (0.3)	1.5 (1.4)
Alachlor	2.50	2.2 (5.3)	1.3 (1.1)	1.2 (0.6)	1.0 (0.1)	1.8 (2.3)
Atrazine + alachl	0.50 + 1.25	2.2 95.0)	1.0 (0)	1.0 (0)	1.0 (0.1)	1.5 (1.2)
2 H.W.	-	3.2 (19.0)	1.90 (4.5)	4.1 (20.4)	1.0 (0)	1.1 (0.1)
Control	-	7.0 (49.0)	3.4 (11.6)	7.1 (50.1)	1.6 (1.7)	2.7 (6.2)
CD at 5%	-	1.54	0.92	1.34	0.22	0.36

RESULTS AND DISCUSSION

Dry matter accumulation by weeds was found to be higher in alone application of atrazine, pendimethalin and alachlor as compared to their tank mix application, i.e., atrazine + pendimethalin (0.5 + 0.75 kg/ha), atrazine + trifluralin (0.5 + 0.75 kg/ha) and atrazine + alachlor (0.5 + 1.25 kg/ha). However, dry matter production was significantly less in all the herbicide treatments as compared to unweeded (control) during all the three years of study. On an average of three years, highest grain yield of 64.0 q/ha was obtained in pre-emergence application of atrazine + pendimethalin (0.50 + 0.75 kg/ha), which was followed by atrazine + trifluralin (0.50 + 0.75 kg/ha) and atrazine + alachlor (0.50 + 1.25 kg/ha) treatments. All these treatments were at par with hand hoeing treatments (standard) and significantly superior to unweeded control with respect to grain yield production.

Table 2 Grain yield of maize (q/ha) as influenced by tank mix application of different herbicides.

Treatments	*Dose (kg/ ha)*	*Grain yield (q/ ha)*			
		2001	*2002*	*2003*	*Mean*
Atrazine, pre	1.00	29.9	72.1	70.2	57.4
Pendimethalin	1.00	34.9	77.6	71.7	61.4
Atrazine + pendi	0.50 + 0.75	44.0	74.6	73.4	64.0
Trifluralin	1.00	35.5	67.2	69.6	57.4
Atrazine + triflu	0.50 + 0.75	40.6	77.4	71.1	63.0
Alachlor	2.50	36.2	77.8	69.3	61.1
Atrazine + alachl	0.50 + 1.25	39.3	74.8	70.5	61.5
2 H.W.	-	35.0	81.0	72.0	62.7
Control	-	22.9	60.2	37.3	40.1
CD at 5%	-	6.07	10.5	9.57	5.6

CONCLUSION

All the tank mix application treatments i.e., atrazine + pendimethalin (0.5 + 0.75 kg/ ha), atrazine + trifluralin (0.5 + 0.75 kg/ ha) and atrazine + alachlor (0.5 + 1.25 kg/ ha) increased maize grain yield by 11.5, 9.8 and 7.1 per cent, respectively, over the recommended treatment i.e., alone application of atrazine @ 1 kg/ha.

35- Economics of Herbicides Applied as Alone and in Mixtures in *Kharif* Maize (*Zea mays* L.)

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INTRODUCTION

Maize is one of the most important cereal crops in the world's agriculture economy both as food for human being and feed for animals. Being a rainy season and widely spaced crop, it is infested with variety of weeds and subjected to heavy weed competition, which often inflicts huge losses ranging from 28-100 per cent. For weed control in maize, most of the presently available herbicides provide only narrow spectrum weed control. Many of these are active only on annual species while a few are effective only against perennials. Therefore, it is desirable to incorporate the strength by mixing two or more herbicides into one complementary mixture. Mixtures of herbicides allow control of wider spectrum of weeds with less total active ingredient. Keeping in view, an attempt was made to find out effective and economical herbicidal mixtures for weed control in maize.

MATERIALS AND METHODS

A field experiment was carried out for two consecutive rainy (*Kharif*) seasons of 2001-2002 and 2002-2003 at College Agronomy Farm, Anand Agricultural University, Anand. The soil was sandy loam in texture having low in available nitrogen and medium in available phosphorus and high in potassium with pH 7.8. The experiment was laid out in randomized block design with four replications involving 16 treatments comparising atrazine, alachlor and metolachlor each at 1.0 kg/ha, metribuzin 0.30 kg/ha, pendimethalin 0.50 kg/ha and their feasible mixtures were applied at half of the rate and compared with twice hand weedings carried out at 20 & 40 DAS and weedy check. All the herbicides were applied as pre- emergence using 500 l of water/ha. Maize variety GM-4 was sown at a row distance of 60 cm during first week of July in both the years. Full dose of phosphorus and half dose of the nitrogen through diammonium phosphate and urea were applied at the time of sowing and remaining quantity of nitrogen was applied at knee-high stage. The crop received 484.00 mm rainfall during 2001-02 and 1110.00 mm during 2002-03. Dry weight of weeds at harvest, weed control efficiency (WCE), grain and stover yields were recorded and economics were worked out.

RESULTS AND DISCUSSION

The predominant weed flora in the experimental field were *Eleusine indica* (L.) Gartn., *Dactyloctinum aegyptium* (L.) P. Beauv., *Echinochloa crusgalli* P. Beauv., *Eragrostis major* Host., *Digitaria Sanguinalis* (L.) Scop., as narrow leaved weeds and *Phyllanthus niruri* L., *Digera arvensis* Frosk., *Euphorbia hirta* L., *Boerhavia diffusa* L. as broad leaved weeds.

Effect on Weeds

Herbicidal treatments reduced the dry weight of weeds significantly as against weedy check (Table 1). Pre emergence application of atrazine (0.50 kg/ha) in conjunction with pendimethalin (0.25 kg/ha) recorded significantly lower dry weight of weeds as compared to rest of the treatments barring treatments of twice hand weedings carried out at 20 and 40 DAS and atrazine mixed either with alachlor or metolachlor each applied at 0.50 kg/ha. The maximum weed control under herbicide mixture treatment was probably due to physiological or biochemical reactions occurring after the entry of chemicals into plants and affect translocation and metabolism as reported by Dixit *et al.* (2000). Manual weeding (twice HW) recorded more than 98 per cent weed control efficiency. In general, application of herbicidal mixtures proved their superiority with respect to weed control over herbicide applied as alone. Thomson (1984) also suggested combination of atrazine with pendimethalin for broad-spectrum weed control.

Effect on crop

Grain yield of maize were recorded significantly higher under pre-emergence application of atrazine in conjunction with pendimethalin closely followed by twice hand weedings treatment, pre emergence application of atrazine with alachlor and metolachlor plus metribuzin (Table 1). Among herbicidal treatments, significantly the lowest grain and stover yields were recorded under pre-emergence application of metribuzin @ 0.30 kg/ha due to its phytotoxic effect on maize crop. The maximum yield under mixture of atrazine with pendimethalin treatment might be due to enhanced efficacy of herbicides applied as mixture which might have prevent the rapid detoxification and maintained their potent action for a longer period leading to increased the nutrient uptake and thereby growth and yields of crop. The yield reduction due to weeds under unweeded control was recorded to the tune of > 44 per cent over manual weeding.

Economics

Looking to the economics of different weed control treatments, herbicides mixtures showed its superiority as compared to applied as alone (Table 1). Maximum net realization (Rs. 15831/ha) and additional net return (Rs. 9562/ha) over weedy check was obtained from the treatment of pre-emergence application of atrazine (0.50 kg/ha) mixed either with pendimethalin (0.25 kg/ha) or alachlor (0.50 kg/ha) followed by twice hand weedings carried out at 20 and 40 DAS (Table 2).

Table 1 Effect of herbicide applied alone and as mixtures on dry weight of weeds, WCE, grain and stover yields of maize

Treatment	*Dose (kg/ha)*	*Dry weight of weeds at harvest (kg/ha)*		*Grain yield (kg/ha)*		*Net profit (Rs./ ha)*
		2001-02	*2002-03*	*2001-02*	*2002-03*	
T_1: Atrazine	1.00	599.80	667.41	3473	3299	14296
T_2: Alachlor	1.00	987.00	1097.50	3407	3107	13988
T_3: Metolachlor	1.00	1019.84	1213.30	3312	2818	11594
T_4: Metribuzin	0.30	1053.57	1284.60	2514	2364	6916
T_5: Pendimethalin	0.50	739.50	905.25	3370	3259	13537
T_6: Atrazine + Alachlor	0.50 + 0.50	55.56	74.41	3687	3477	15779
T_7: Atrazine + Pendimethalin	0.50 + 0.25	28.77	40.50	3766	3538	15831
T_8: Atrazine + Metolachlor	0.50 + 0.50	157.40	238.80	3612	3484	15039
T_9: Atrazine + Metribuzin	0.50 + 0.15	280.36	347.25	3592	3386	14761
T_{10}: Metolachlor + Metribuzin	0.50 + 0.15	185.76	262.30	3679	3309	14556
T_{11}: Metolachlor + Pendimethalin	0.50 + 0.25	255.90	349.35	3655	3328	14537
T_{12}: Alachlor + Metolachlor	0.50 + 0.50	547.62	617.60	3375	3167	13515
T_{13}: Alachlor + Pendimethalin	0.50 + 0.25	347.42	413.89	3603	3415	15167
T_{14}: Alachlor + Metribuzin	0.50 + 0.15	503.97	600.55	3369	3112	13944
T_{15}: Weed free (HW at 20 & 40 DAS)		48.50	64.98	3729	3587	15687
T_{16}: Weedy check		3065.48	3598.21	2083	1812	6269
CD at 5%		155	142	242	281	-

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36- Weed Control in Winter Maize (*Zea mays* L.)

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INTRODUCTION

Maize is grown in rainy as well as in winter season. The growth rate of maize in its early stage is rather slow than weeds. It has been found that during the first 2-3 weeks of its emergence, weeds put fourth 15-18% of their growth white the maize plants attained only 2-3% of it (Gupta. 1998), which helps weeds to offer effective competition. The extent of losses due to infestation of weeds in maize crop has been found to be 30-50%. (Rout and Satapathy, 1996).

MATERIALS AND METHODS

A Field experimental was conducted during the *Rabi* season of 2003-2004 at crop Research Farm, Department of Agronomy, Allahabad Agricullural Institute- Deemed University, Allahabad. The soil of the experimental field was sandy loam in texture with pH 7.5, 11 treatments comprised, viz., weedy check, weed free, Hoeing at 15 DAS, pre-emergence application of alachlor @ 1.5kg/ha, pre-emergence application of atrazine @ 2.0 kg/ha, post-emergence application of 2,4- 0 at 30 DAS @ 0.500 kg/ha, Hoeing at 25 DAS, pre-emergence application of alachlor and hoeing at 30 DAS, pre-emergence application of atrazine + hoeing at 30 DAS, pre-emergence application of alachlor + post emergence application of 2, 4-0 at 30 DAS and pre- emergence application of atrazine + post-emergence application of 2, 4-0 at. 30 DAS were tested in R.B.D. with 3 replications. Maize variety "Nutan KH 101" was sown at 60 x 25 cm spacing in second week of Oct. Crop was fertilized at 160 kg N,. 60 kg P_20_5 and 80 kg K_20 per hectare full dose of P_20_5 and K_20 and half dose of N were applied at the time sowing and half dose of N was applied top dressed in two equal splits at 30 and 60 DAS. Weeds were collected from an area of 0.25 m^2.

RESULTS AND DISCUSSION

The weed flora of the experimental field was dominated by *Cyperus rotundus,. Cynodon dactylon, Chenopodium album, Anagallis arvensis, Melilotus spp, Digitaria sanguinallis, Sorghum halepense, Parthenuum hysteropllOrus* etc. All herbicide treatments significantly reduced the dry matter accumulation of weed compared with the unweeded plots. Pre-emergence application of atrazine + hoeing at 30 DAS resulted in significantly lower weed population and weed dry weight as compared to unweeded plot followed by pre-emergence application of atrazine+ post emergence application of 2,4-D at 30 DAS.

Higher weed control efficiency were recorded in pre emergence application of atrazine + hoeing at 30 DAS. It is followed by pre-emergence, application of atrazine + post emergence application of 2, 4-D at 30 DAS and lower weed index were recorded in atrazine + hoeing at 30 DAS which was at par pre emergence application of atrazine + post-emergence application of 2, 4-D at 30 DAS.

No. of grain/row/cob, no. of grain per cob, No. of grain rows/cob was recorded higher in weed free plots, which was followed by alachlor, atrazine (pre-emergence), Grain yield, stover yield was recorded higher in weed free plots. Which was at par with pre-emergence application of atrazine, pre-emergence

Table 1 Effect of various method of weed control treatments by herbicides.

Treatments	*Weed Population (No. /0.25m^2)*	*Weed dry weight (g/0.25m^2)*	*Weed control efficiency (WCE)*	*Weed Index*	*Grain (g/ha)*	*Stover (g/ha)*	*Benefit cost Ratio (BCR)*
Weedy check	19.00	5.83	1.0	40.57	30.4	113.16	1.212
Weed free	-	-	-	-	51.16	127.9	1.804
Mechanical weeding	13.66	5.16	11.49	21.03	40.4	115.53	1.497
Alachlor	10.66	4.53	22.29	18.29	41.8	120.6	1.588
Atrazine	9.68	2.53	56.60	14.85	43.56	123.53	1.667
2, 4-D at 30 DAS	13.33	5.53	5.14	28.65	36.5	113.56	1.443
Mechanical weeding	12.66	4.6	21.09	18.68	41.6	116.9	1.541
Alachlor+Mechanical weeding at 30 DAS	10.33	2.9	50.25	18.17	41.86	123.1	1.483
Atrazine+Mechanical Weeding at 30 DAS	9.33	1.7	70.84	6.45	47.86	127.33	1.707
Alachlor+2,4-D at 30 DAS	10.00	2.8	51.97	15.94	43.0	123.26	1.620
Alrazine +2,4-D at 30 DAS	9.66	2.3	61.54	8.60	46.76	125.00	1.775

application of atrazine + post emergence application of 2,4-D but significantly lower seed yield and stover yield was reported in weedy check. This finding is in close conformity with results reported by Prasad *et al* (1990) and Singh *et al* (1995).

Higher profitability (benefit cost ratio) was recorded in weed free plots, and lowest B.C.R. was recorded weedy check plots.

CONCLUSIONS

Alachlor at 1.5 kg/ha and atrazine 2.0 kg/ha were applied as pre-emergence herbicides while 2,4-D was applied as post-emergence at 30 DAS. Weed dry weight and weed population remained significantly with all the treatments compared to unweeded plots. Pre-emergence atrazine + hoeing at 30 DAS resulted in significantly lowered weed population, dry weight and higher maize yield attributes and yield as compared to herbicide treatment and un-weeded was found to be best. Pre-emergence application of atrazine at 2.0 kg/ha was at par with pre-emergence atrazine + post-emergence 2,4-D at 0.500 kg/ha.

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COTTON

37- Weed Management in Cotton (*Gossypium hirsutum*)

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INTRODUCTION

Cotton (*Gossypium hirsutum*) is very sensitive to weed infestation due to its slow initial growth as well as wider spacing gives better chance for weed infestation. Both grassy and broadleaved weeds emerge with cotton seedlings and cause heavy losses in cotton yield, being 30-80 per cent, depending on the weed intensity, soil, rainfall and its distribution. Like fertilizer, irrigation, insect and pest control measures, effective weed control practices also play a vital role to boost the production of cotton. The type of weed flora under north-west Rajasthan is so variable and intensive that it is very difficult to control weeds for a longer period especially during initial stages when growth of cotton is very slow and spacing is wide (67.5 x 30 cm). Hence, this investigation was carried out on weed management in cotton (*Gossypium hirskutum*).

MATERIALS AND METHODS

The field experiment was conducted at Agricultural Research Station, Sriganganagar, Rajasthan for two consecutive seasons during *kharif* (2003 and 2004). The experiment was laid out in randomized block design consisting of six treatments [control, farmers practice (one hoeing at 35 DAS + two intercultural operations), pendimethalin @ 0.50 kg/ ha + one hoeing at 35 DAS, pendimethalin @ 0.75 kg/ ha + one hoeing at 35 DAS, pendimethalin @ 1.0 kg/ ha + one hoeing at 35 DAS, pendimethalin @ 1.50 kg/ ha + one hoeing at 35 DAS] with four replications. The soil of experimental field was sandy loam in texture, low in available nitrogen and available phosphorus and high in available potassium. The crop was raised as per package of practices.

RESULTS AND DISCUSSION

The data (Table 1) revealed that farmers practice recorded significantly higher plant height, number of bolls/ plant, boll weight and seed cotton yield over control, pendimethalin @ 0.50 kg/ ha + one hoeing at 35 DAS and pendimethalin @ 0.75 kg/ ha + one hoeing at 35 DAS. Whereas farmers practices remained at par with pendimethalin @ 1.00 kg/ ha + one hoeing at 35 DAS, pendimethalin @ 1.50 kg/ ha + one hoeing at 35 DAS. Farmers practices gave 51.2 per cent higher seed cotton yield over control. The lowest weed population and dry weight at 60 DAS was observed under farmers practices which was significantly lower over control, pendimethalin @ 0.50 kg/ ha + one hoeing at 35 DAS and pendimethalin @ 0.75 kg/ ha + one hoeing at 35 DAS.

Table 1. Weed management in cotton

Treatment	*Plant stand/ ha*	*Number weed at 60 DAS*	*Dry weight of weeds at 60 DAS*	*Plant height (cm)*	*Number of bolls/ plant*	*Boll weight (g)*	*Seed cotton yield (kg/ha)*
Control	40800	22.0	109.3	114.0	21.5	2.15	1603
Farmer practice (one hoeing at 35 DAS + two intercultural operations	41584	15.4	79.0	148.3	34.8	2.59	2424
Pendimethalin @ 0.50 kg/ha+one hoeing at 35 DAS	40540	20.3	99.5	131.0	27.1	2.23	1794
Pendimethalin @ 0.75 kg/ha+one hoeing at 35 DAS	40743	19.2	94.5	135.5	28.8	2.32	1941
Pendimethalin @ 1.00 kg/ha+one hoeing at 35 DAS	40047	17.0	84.6	138.8	33.3	2.51	2291
Pendimethalin @ 1.50 kg/ha+one hoeing at 35 DAS	41496	16.5	82.5	143.0	34.5	2.55	2357
CD at 5%	NS	2.2	7.9	13.4	3.5	0.18	324

38- Weed Management Studies in American Cotton (*Gossypium hirsutum* L.)

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INTRODUCTION

Cotton is an important commercial crop which provides almost 80 per cent of raw material for textile industries in the country. It is also called as money spinner. Cotton, being a wide spaced and relatively slow growing crop in early stages, is subjected to a severe infestation with a large number of grassy and broad leaf weeds and sedges. Shelke and Bhosle (1990) reported that weed infestation in cotton caused yield reduction upto the extent of 74 per cent. These weeds are not only pose a severely competition during initial stages with the crop but also appear in a rank growth with the onset of monsoon rains or after the application of first irrigation. However, this investigation was carried out to evaluate the efficacy of different herbicides for controlling weeds particularly after the onset of monsoon rains.

MATERIALS AND METHODS

A field experiment was conducted at Punjab Agricultural University Regional Research Station, Bathinda during the *kharif* season of 1997. The soil of the experiment field was sandy loam in texture, low in available N and P but high in available K with a soil pH of 8.5. The experiment was laid out in a Randomized Block Design with four replications. The details of different treatments are given in Table 1. American Cotton cv. F846 was sown on 15th May in 67.5 cm on apart rows using 25 kg/ha seed rate. The herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle using a spray volume of 500 litres ha^{-1}. Recommended package of practices other than weed control was adopted to grow the experimental crop. The data on dry weight of weeds were recorded at 90 days after sowing. Weed control efficiency was also computed on the basis of dry weight of weeds at 90 DAS.

RESULTS AND DISCUSSION

Major weed flora observed in the experimental field were *Digera arvensis, Trianthema portulacastrum, Eleusine aegyptiacum, Cenchrus catharticus, Cynodon dactylon* and *Cyperus rotundus*.

Different herbicide treatments significantly reduced the dry weight of weeds as compared to weedy check (Table 1). One hand weeding at 30 DAS followed by pendimethalin at 45 DAS was produced minimum dry weight of weeds (0.12 q ha^{-1}) as compared to unweeded check (8.21 q ha^{-1}). Integrated weed control by one hand weeding at 30 DAS followed by application of pendimethalin and trifluralin at 45 or 60 DAS showed better weed control efficiency 90.7 to 98.5 per cent. Sole application of directed spray of glyphosate at 45 or 60 DAS also gave better control of weeds and showed weed control efficiency of 94.9 to 98.1 per cent. Two hand weedings recorded 93.3 per cent weed control efficiency.

All the weed control treatments produced significantly higher seed cotton yield than weedy check. Maximum seed cotton yield of 22.9 q ha^{-1} was recorded with one hand weeding at 30 DAS followed by pendimethalin spray at 60 DAS which produced 50.7 per cent higher seed cotton yield than weedy check. Byro and York (1985) also reported efficient weed control and increase in seed cotton yield with the application of pendimethalin and trifluralin. Directed spray of glyphosate at 45 DAS and two hand weedings produced 40.8 and 33.6 per cent higher seed cotton yield than unweeded control. The increase in seed cotton yield was due to effective control of weeds by the application of herbicides and hence resulting in more number of bolls per plant. Nadanassababady and Kandasamy (2002) reported that glyphosate at 2.05 kg ha^{-1} fb HW produced comparable seed cotton yield as in weed free treatment of 4 hand weeding.

Table 1 Effect of different treatments on dry matter of weeds and seed cotton yield

Treatment	*Dose (kg ha^{-1})*	*Dry weight of weed (q ha^{-1}) at 90 DAS*	*Weed control efficiency %*	*Sympods per plant (no.)*	*Bolls per plant (no.)*	*Seed cotton yield (q ha^{-1})*
1 HW (30 DAS) + Pendimethalin 45 DAS	0.75	0.12	98.5	11.3	16.6	21.1
1 HW (30 DAS) + Pendimethalin 60 DAS	0.75	0.30	96.3	12.6	16.9	22.9
1 HW (30 DAS) + Trifluralin 45 DAS	1.2	0.14	98.3	11.3	16.8	20.3
1 HW (30 DAS) + Trifluralin 60 DAS	1.2	0.76	90.7	11.9	15.2	18.9
Glyphosate (45 DAS) - Directed spray	1.0	0.42	94.9	11.6	16.4	21.4
Glyphosate (60 DAS) - Directed spray	1.0	0.16	98.1	12.2	15.7	19.1
2 HW (30 and 60 DAS)	-	0.55	93.3	12.1	16.2	20.3
Weedy	-	8.21	-	9.7	11.3	15.2
CD at 5%	-	2.11	-	NS	3.6	3.3

CONCLUSIONS

The weed flora associated with American Cotton during crop season comprised mainly *Trianthema portulacastrum, Digera arvensis, Eleusine aegyptiacum, Cenchrus catharticus, Cynodon dactylon* and *Cyperus rotundus*. The herbicides pendimethalin, trifluralin at 0.75 and 1.2 kg ha^{-1} along with 1HW (30 DAS) and glyphosate at 1.0 kg ha^{-1} (directed spray) 45 DAS were comparable to 2HW at 30 and 60 DAS interms of weed control efficiency and seed cotton yield.

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39- Weed Management in Irrigated Cotton

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INTRODUCTION

Cotton being a wide spaced and relatively slow growing crop in early stages is subjected to a severe weed menace. Weed infestation in commercial crops, particularly in cotton has been reported to offer severe competition and causing yield reduction to the extent up to 74 per cent in the cotton crop (Shelke and Bhosle, 1990). Continuous use of the same method leads to build up of tolerant weeds. The basic phenomenon helping weed control upon soil solarization is build up of lethally high temperature in topsoil where most of the dormant and viable weed seeds are present. Being a tropical country, many locations in India experienced hot summer and soil solarization can be best practiced for efficient weed control. Hence, this investigation was carried out to determine the effect of off-season weed management practice along with cropping season weed control measures on weed control and yield of cotton.

MATERIALS AND METHODS

A field experiment was carried out during April 2002 to November 2002 at Annamalai University Experimental Farm, Annamalainagar. The soil of the experimental farm was clayey in texture with 0.71 % organic carbon, neutral in soil reaction (7.5 pH), low in available N, medium in available P and high in available K. Field experiment was conducted in split plot design with five off-season land management practices viz., fallow, application of pressmud at 6t/ha, glyphosate at 1.5kg ha^{-1}, twice summer ploughing and soil solarization for 40 days and six cropping season weed control measures viz., unweeded control, twice hand weeding (25 and 45 DAS), pre-sowing soil incorporation of fluchloralin (1.5 kg ha^{-1}), half dose of fluchloralin at (0.75 kg ha^{-1})+ mulching with sugarcane trash (12 t ha^{-1}) on 25 DAS, half dose of fluchloralin(0.75 kg ha^{-1})+ intercropping with blackgram ADT-3 and fluchloralin 0.75 kg ha^{-1}+ one hand weeding on 45 DAS. Observations on weed biomass and pod yield were recorded

RESULTS AND DISCUSSION

Effect on weed

Soil solarization was effective in reducing the infestation of all the dominant weed species namely *Cyperus rotundus, Cleome viscosa, Cynodon dactylon* and *Trianthema portulacastrum.* This could be attributed to the direct killing of seeds stimulated to germinate in the moistened mulched soil and killing of germinating seeds whose dormancy is broken in the heated soil as suggested by Katan and Devay (1991). Soil solarization reduced the viability of weed seeds in the top 5 cm soil layer due to increased soil temperature up to 49.9°C by soil solarization. In respect of cropping season weed control measures half dose of fluchloralin (0.75 kg ha^{-1}) + intercropping with blackgram performed superior by registering the lowest weed biomass and the highest WCE on 60 DAS. This could be attributed to efficient and prolonged weed control by the herbicide, efficiently supplemented by intercrop. Intercropping of short duration legume as live mulch in between wide spaced cotton reduces weed intensity with increased yield of cotton.

Effect on yield

Soil solarization recorded the highest number of bolls per plant (30.3) and seed cotton yield of 1779 kg ha^{-1} (Table1) followed by pressmud application. The least number of bolls per plant and seed cotton yield were registered in fallow. Fluchloralin at 0.75 kg ha^{-1} + intercropping with black gram recorded the highest number of bolls per plant (26.9) and seed cotton yield of 1733 kg ha^{-1}. This was on par with twice hand weeding. The lowest number of bolls per plant (17.4) and seed cotton yield of 981 kg ha^{-1} were recorded in unweeded control.

This is primarily because of better weed control and suppression of weed competition. However, increased mobility of nutrients, disease and pest control due to solarization might have also added for the better performance of the crop. Elimination of weeds perfectly by pre sowing application of fluchloralin + intercropping with black gram during crop duration providing a perfect weed free environment all throughout the crop growth led to the highest yield. Carry-over effect of off-season land management supplementing the efficient weed control measures through half dose of herbicide on succeeding crop season contributed for significant interaction among the main and sub-treatments.

Table 1 Effect of off-season and cropping season weed management practices on weed observations and yield observations

Treatment	*Total weed biomass (g m⁻²) 60 DAS*	*WCE (%)*	*Number of bolls per plant*	*Seed cotton yield kg ha⁻¹*
Main treatments				
Off-season fallow	89.3	-	16.1	967
Off-season pressmud application	32.9	69.1	26.0	1585
Off-season glyphosate spray	68.7	34.9	22.8	1380
Off-season summer ploughing twice	86.0	16.7	19.6	1161
Off-season soil solarization	30.0	71.9	30.3	1779
CD at 5%	1.8	1.9	3.12	194
Sub-treatments				
Unweeded control	71.0	-	17.4	981
Twice hand weeding (25 and 45 DAS)	54.6	47.7	26.8	1628
Fluchloralin (1.5 kg ha^{-1})	67.1	35.3	19.7	1136
Fluchloralin at 0.75kg ha^{-1} + Intercropping	53.0	49.2	26.9	1733
Fluchloralin at 0.75 kg ha^{-1}+ mulching	58.3	44.0	24.5	1466
Fluchloralin at 0.75 kg ha^{-1} + one HW	64.0	38.4	22.4	1302
CD at 5%	2.1	2.3	2.0	154

CONCLUSIONS

Off-season soil solarization with transparent white polyethylene sheet of 0.05mm thickness for 40 days followed by presowing soil incorporation of fluchloralin (0.75 Kg ha^{-1}) + intercropping with black gram was performed the best in controlling weed population, weed biomass and increased the input use efficiency and also increased the seed cotton yield, followed by pressmud application with fluchloralin (0.75 Kg ha^{-1}) + black gram intercrop.

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40- Acetolactate Synthase Inhibitor (God- Hoo1) A New Herbicide Molecule For Weed Management In Irrigated Cotton

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INTRODUCTION

Weeds pose a serious problem under irrigated cotton due to availability of wider spacing, sunlight, nutrients and optimum soil moisture during initial stages of the crop. The conventional practices of weed control in cotton are widely followed at present. The use of the herbicides to control weeds is a promising approach in irrigated cotton. Progress made in the past with regard to use of new herbicides for controlling weeds in cotton are fewer. With this background, a testing of new herbicides molecule "Acetolactate synthase inhibitor" was tried for weed management in irrigated cotton.

MATERIALS AND METHODS

A field experiment was conducted during kharif 2001 on clay loam soil of Agricultural research station, Hiriyur, coming under central dry zone of University of Agricultural Sciences, Bangalore. The study was conducted to know the comparative performance of Acetolactate synthase inhibitor 10% EC (Sulfonyle group formulated as GOD-H001 by m/s Godrej Agrovet Ltd, Mumbai) in controlling weeds, crop safety as well as seed cotton yield. The eleven treatments comprised of pre-emergence application of Acetolactate synthase inhibitor (37.5, 50.0, 62.5, 75.0 and 100.0 g ai/ha) at 3 days after sowing (DAS) followed by (fb) hand weeding at 30 DAS, Acetolactate synthase inhibitor 50 g ai/ha + pendimethalin 250 g ai/ha at 3 DAS fb hand weeding at 30 DAS, Acetolactate synthase inhibitor 50 g ai/ha + pendimethalin 500 g ai/ha at 3 DAS fb hand weeding at 30 DAS, pendimethalin 1000 g ai/ha at 3 DAS fb hand weeding at 30 DAS and butachlor 1000 g ai/ha at 3 DAS in comparison with farmer's practice (interculturing at 35 DAS fb hand weeding at 45 DAS) and unweeded control. These treatments were tried in RCBD with three replication. The hybrid used for sowing was DCH-32 and the recommended package of practices were followed for cultivation of the irrigated cotton.

RESULTS AND DISCUSSION

The major weeds observed in the experimental field were *Cyperus rotundus* (a sedge), *Dactyloctenium aegyptium, Cynodon dactylon, Echinochloa colona, Digitiria marginata, Dinebra retroflex, Chloris babata (Among grasses), Parthenium hysterophorus , Cynotis oxillaris, Phyllanthus niruri, Digera arvensis, Sida acuta, Euphorbia hirta* (among broad leaved weeds).

Application of Acetolactate synthase inhibitor 10% EC at all the doses from 37.5 to 100 g ai/ha at 3 DAS caused a slight phototoxic effect interms of wilting, puckering, reduced size and scorching effect on older leaves for about 20 days after herbicide application. This effect faded away gradually by 35th day and the crop appeared normal. Similarly in the above said doses recorded higher weed control ratings (8.9 to 9.6) as compared to other herbicides (8.0 to 8.3) and un weeded control (2.0) at 30 DAS (Table- 1). Pre-emergence applications of Acetolactate synthase inhibitor 10% EC applied at 3 DAS from 50 to 100 g ai/ha lowered the total weed population (8.8 to 11.3 / 0.25 m^2) as compared to other herbicides (13.8 to 22.0/ 0.25 m^2) and farmer's practice (30.7 / 0.25 m^2). The higher seed cotton yield was obtained from the pre-emergence application of Acetolactate synthase inhibitor 10 % EC (3 DAS) at 75 g ai/ha fb hand weeding at 30 DAS (1445 kg/ha) as compared to remaining treatments (1186 to 1396 kg/ha) while, un weeded control recorded lowest seed cotton yield (563 kg/ha) in the experiment (Table 1). Similar results in unweeded control was also reported by Rajvir Sharma (2004).

From this study it can be inferred that, application of Acetolactate synthase inhibitor 10 % EC (GOD-HOO1) at 50 to 75 g ai/ha applied at 3 DAS can be used safely for weed control in irrigated cotton, further provided with one hand weeding at 30 DAS to remove the weeds likely to emerge subsequently around 30 DAS produced the higher seed cotton yields comparable to farmers practice.

Table 1 Effect of doses of Acetolactate synthase inhibitor 10% EC on phytotoxicity rating (PHTR), Weed control rating (WCR), Seed cotton yield and weed index (WI) in irrigated cotton.

Treatments, g or kg ai/ha	*PHTR*		*WCR*	*Seed cotton*	*WI (%)*
	25 DAS	*35 DAS*	*30 DAS*	*yield, kg/ha*	
GOD- H001- 37.5 g – 3 DAS fb hand weeding – 30 DAS	0.5	0.0	9.0	1186	6.3
GOD- H001- 50.0 g – 3 DAS fb hand weeding – 30 DAS	0.5	0.0	9.0	1236	2.3
GOD- H001- 62.5 g – 3 DAS fb hand weeding – 30 DAS	0.8	0.0	8.9	1332	-5.3
GOD- H001- 75.0 g – 3 DAS fb hand weeding – 30 DAS	0.5	0.0	9.5	1445	-14.2
GOD- H001- 100.0 g – 3 DAS fb hand weeding – 30 DAS	1.4	0.20	9.6	1239	2.1
GOD- H001- 50 g + Pendimethalin 250g – 3 DAS fb hand weeding – 30 DAS	0.8	0.0	9.0	1309	-3.5
GOD- H001- 50 g + Pendimethalin 500g – 3 DAS fb hand weeding – 30 DAS	0.5	0.0	9.2	1396	-10.4
Pendimethalin (30 EC) -1.0 kg/ha – 3 DAS	0.0	0.0	8.0	1388	-9.7
Butachlor (50 EC) – 1.0 kg/ha – 3 DAS	0.0	0.0	8.3	1380	-9.1
Interculturing (35 DAS) fb hand weeding (45 DAS)	0.0	0.0	5.0	1265	-
Unweeded control	0.0	0.0	2.0	563	55.5
CD at 5%				569	

PHTR: 0 = No phytotoxic effect, 10= 100% adverse effect
WCR: 0 = Zero weed control, 10= Excellent weed control

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SUGARCANE

41- Effect of Intercrops and Weed Management Practices on weed suppression and productivity in spring planted Sugarcane

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INTRODUCTION

Spring planted sugarcane is the major cash crop in *tarai belt* of Uttaranchal and Western parts of Uttar Pradesh. Accounting to delayed germination, slow growth and wider row spacing weeds cause 30 - 70% reduction in sugarcane yields (Singh *et al.* 1980). Intercropping, not only gives additional yield and economize sugarcane cultivation, but also suppress weed growth and their infestation. Intercropping can go a long way in economizing sugarcane cultivation with additional yields and their smothering effect on weeds, though it invites careful selection of weed management options. Therefore, the present investigation was carried out to search the appropriate weed management practices for various spring sugarcane based intercropping system.

MATERIALS AND METHODS

A field experiment was conducted to during 2000-2001 and 2001-2002 on silty clay loam soils, rich in organic carbon, medium in available P and K with neutral soil reaction at Crop Research Farm of G.B.Pant University of Agriculture & Technology. Treatments comprising of combinations of 4 cropping systems (Sugarcane sole, and intercropped with cowpea, green gram and black gram) and five weed management options (weedy, weed free, manual hoeing at 20,40,60 DAP and after harvest of intercrop, pre- em. application of pendimethalin at 1 kg ai ha^{-1}/ atrazine at 1.5 kg ai ha^{-1}) were tested in factorial RBD with three replications. Sugarcane cv. Co Pant 90223 was planted in first fortnight of March and raised with recommended package of practices and intercropped with cowpea, black gram and green gram. In atrazine treated plots, the sowing of intercrops was done a month later. Cowpea was raised for green pods. Sugarcane crop was harvested on 1^{st} fortnight of Feb. Sugarcane was fertilized with 120:60:40 kg of N: P_2O_5: K_2O /ha whereas intercrops were given with 16:48:30 kg of N : P_2O_5 : K_2O on row basis.

RESULTS AND DISCUSSION

Effect of intercropping

Cowpea proved most effective in controlling weeds significantly, followed by green gram and black gram. Reduction in weed population with cowpea against sugarcane alone was 55.0, 66.0 and 42.0% at 30, 60 and 90 days after planting stages, respectively. Weed dry matter followed the similar trend as population. Weed control efficiency was highest 71.7% with cowpea as intercrops as against sugarcane alone (34.6%). All the intercrops led to significant reduction in cane yield (Table 1). The reduction in yield was 5.2, 10.4 and 8.4 percent with cowpea, black gram and green gram, respectively. The reduction was attributed to cumulative effect of lower number of millable canes and individual cane weight. Cane equivalent yield was recorded to be highest in sugarcane + cowpea (108.4 t/ha) followed by sugarcane + green gram (77.8 t ha^{-1}), sugarcane + black gram (77.4 t ha^{-1}) and sole sugarcane (77.0 t ha^{-1}). Ravichandran *et al.* (1996) have also recorded higher cane equivalents and net return with intercropping of black gram. Among the intercrops the highest yield of green pods was obtained with cowpea leading to highest cane equivalent yield (108.4 t ha^{-1}) and net returns (Rs. 68684), being significantly higher than other cropping systems including sole sugarcane.

Weed management

All the weed control measures led to significant reduction in weed population. Manual hoeing at 20,40,60 days after planting of cane and after harvest of intercrops reduced weed population significantly being. 90.0, 90.1 and 94.0%, respectively as against control treatments. Pendimethalin and atrazine remained at par, however, the later had an adverse effect on intercrops. None of the treatment could reach to the level of weed free conditions. Among the measures, hoeing at 20, 40, 60 and at harvest of intercrops proved better though it could not equalize to weed free conditions. Almost similar trend was observed in respect of number of millable canes. Cane equivalent yield was recorded to be highest of 97.0 t ha^{-1} in crop grown under weed free conditions though it was at par with that given hoeing at 20, 40, 60 days after sowing and at harvest of inter crops (94.0 t ha^{-1}) and significantly superior to others. A similar trend was followed by gross return. All the intercrops gave highest grain/pod yield under weed free conditions followed by that with hoeing at 20, 40, 60 days stages and at harvest of intercrops. Yield of intercrops were badly influenced by atrazine as the germination of the crops was greatly hampered. Yield losses by weeds in cowpea, green gram and black gram were 27.9, 20.5 and 28.6 %, respectively

Table 1 Effect of cropping systems and weed management practices on weeds and sugarcane productivity

Treatments	*Weed population (No. m^{-2})*		*Total weed dry matter g m^{-2}*		*WCE (%)*	*NMC (000 ha^{-1})*	*Cane yield (t ha^{-1})*	*Cane equivalent yield(t ha^{-1})*	*Net return (Rs. ha^{-1})*
	60	*HI*	*60*	*HI*					
Cropping Systems									
Sugarcane sole	6.94 (66)	5.31(42)	3.98(16.0)	3.63 (12.5)	34.6	101	77.0	77	43264
Sugarcane +Cowpea	3.64 (21)	3.18(13)	1.32 (9.2)	0.91 (5.4)	71.7	96	73.0	108.4 (112.8)	68684
Sugarcane + Black gram	5.94 (48)	3.92(22)	3.68 (13.4)	2.98 (8.5)	55.6	92	69.0	77.4 (3.12)	42567
Sugarcane + Green gram	4.90 (33)	3.74(19)	3.10 (12.9)	2.38 (8.1)	57.6	95	70.5	77.8 (2.84)	42211
CD at 5%	0.32	0.27	0.05	0.02	-	NS	5.5	8.6	3910
Weed management									
Control	10.88 (122)	8.63(78)	3.70 (16.3)	2.68 (19.1)	-	85.8	59.5	70.5	37663
Hoeing at 20,40,60 & after harvest of intercrops	3.04 (11)	2.32 (5)	2.91 (8.5)	2.04 (3.0)	84.0	101.3	79.0	94.0	56342
Pendimethalin 1.5 kg ai ha^{-1}	6.55 (44)	4.77 (24)	2.72 (15.3)	2.53 (6.3)	67.0	95.0	71.7	85.0	49688
Atrazine at 1.5 kg ai ha^{-1}	5.61 (32)	3.88 (15)	2.88 (11.4)	2.74 (6.1)	68.0	89.5	67.6	79.32	46260
Weed free	0.7 (0)	0.7 (0)	2.89 (0.0)	2.38 (0.0)	-	108.5	84.2	97.0	55954
CD at 5%	0.36	0.23	0.05	0.02	0.64	8.7	6.2	9.6	4372

Figures in parenthesis indicate actual values, which were transformed to $\sqrt{x+0.5}$ for analysis

Bold value is intercrop yield q/ha

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42- Post-emergence Management of *Striga asiatica* (L.) Kuntze. in Early Planted Sugarcane

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INTRODUCTION

Weed management is one of the important cultivation practices for increasing the cane productivity. Among the various constraints the major challenge involved in the cultivation of sugarcane to achieve better productivity was weed management practice. Nowadays, *Striga asiatica* dominates as a notorious weed in sugarcane fields in Western Zone of Tamil Nadu. Unlike other weeds, parasitic weeds remove nutrients and extract water from the host plants causing heavy losses to agricultural crops. The effect of these parasitic weeds has been so devastating, the crop yield losses of 10 to 100 per cent have been recorded, leading to complete failure and sometimes abandonment of land. Promising and effective management practices for controlling *Striga* sp. are seldom available. Hence a field experiment was conducted to evaluate an efficient post emergence management of *Striga asiatica* in main season early-planted sugarcane.

MATERIALS AND METHODS

A field experiment was conducted during the main season (January planting) of 2003-2004 in the farmer's field at Western Zone of Tamil Nadu. Sugar cane variety Co 86032 was used for this study. Field experiment was laid out in randomized block design with three replications. The treatments consisted of hand weeding either all weeds or except Striga sp. on 90 and 120 DAP, post-emergence directed spraying of either paraquat 6 ml / lit or glyphosate10 ml/lit, post-emergence application of either 2,4-D Na salt 5 g /l alone or with urea 20 g / lit, urea or sodium chloride 200g / lit, trash mulching 5 t / ha, and unweeded control. Observations on *Striga* density, dry weight, and weed control efficiency were recorded along with yield attributes and cane and sugar yields.

RESULTS AND DISCUSSION

Post emergence application of 2,4-D Na salt 5 g/l (0.5%) + urea 20 g/l (2%) on 90 DAP recorded lesser *Striga* density, dry weight and highest control efficiency from 60 DAHS onwards followed by post emergence application of 2,4-D Na salt 5 g/l (0.5%) on 90 DAP or trash mulching 5 t/ha on 90 DAP. Lesser total density weed dry weight, nutrient removal with higher weed control efficiency were also registered by post emergence directed spraying of glyphosate 10 ml/l (1.0%) on 90 DAP closely followed by trash mulching 5 t/ha on 90 DAP. Trash mulching 5 t/ha and post emergence directed spraying of paraquat 6 ml/l (0.6%) on 90 DAP reduced the *Striga*, and total weed densities at early stages of treatment application, but their effectiveness was lesser at later stages. Whereas the unweeded control and hand weeding except striga on 90 and 120 DAP recorded higher weed densities, dry weight with lower weed control efficiency. Higher yield attributes like number of millable cane at harvest were observed with post emergence spraying of 2,4-D Na salt 5 g/l + urea 20 g/l on 90 DAP.

Post-emergence spraying of 2,4-D Na salt 5 g/l (0.5%) + urea 20 g/l (2%) on 90 DAP resulted in higher cane (161.86 t/ha) and sugar (20.62 t/ha) yields. Cane quality parameters like brix per cent, sucrose per cent, purity co-efficient and commercial cane sugar were not significantly influenced by various Striga post-emergence management treatments.

Table 1 Effect of treatments on *Striga asiatica* and Sugarcane

Treatments	*Striga density (No/ m²)*		*Striga dry weight (g/ m²)*		** Striga WCE (%)*		*NMC*	*Cane yield (t/ha)*	*Sugar yield (t/ha)*
	15 DAHS	*60 DAHS*	*15 DAHS*	*60 DAHS*	*15 DAHS*	*60 DAHS*	*At harvest*		
T_1	10.08(99.72)	10.40(106.32)	9.04(79.80)	9.33(85.00)	0.00	0.00	89600	38.65	3.72
T_2	2.58(4.74)	6.70(43.07)	2.40(3.80)	6.03(34.41)	91.60	56.63	101067	98.45	10.21
T_3	9.71(92.30)	9.71(92.30)	8.70(73.81)	8.70(73.81)	5.53	15.81	91235	42.89	5.00
T_4	1.91(1.70)	2.63(5.01)	1.83(1.14)	2.44(4.00)	97.45	95.21	120457	138.65	16.23
T_5	4.96(22.74)	2.57(4.74)	4.49(18.20)	2.40(3.76)	70.53	95.46	121853	144.68	17.89
T_6	2.37(3.75)	4.04(14.32)	2.23(3.00)	3.66(11.44)	95.29	86.45	111245	115.45	12.96
T_7	5.29(26.03)	3.27(8.75)	4.77(20.81)	3.00(6.96)	64.51	92.77	118439	130.12	14.99
T_8	2.88(6.30)	5.80(31.70)	2.65(5.04)	5.23(25.41)	91.76	67.59	111879	118.45	13.26
T_9	2.56(4.70)	5.45(27.71)	2.40(3.76)	4.91(22.20)	94.61	72.02	112458	120.54	14.08
T_{10}	3.97(14.04)	1.72(1.02)	3.63(11.20)	1.67(0.84)	83.34	99.06	122400	161.86	20.62
CD at 5%	0.58	0.46	0.21	0.30	—	—	8374	16.80	1.18

T_1 - Unweeded control from 90 DAP ; T_2 – Hand weeding twice on 90 and 120 DAP

T_3 - Hand weeding twice except *Striga sp.* On 90 and 120 DAP

T_4 - Trash mulching 5 t/ha on 90 DAP ; T_5 – Post-emergence spraying of 2,4-D Na salt 5g/l (0.5%) 90 DAP

T_6 - Post-emergence spraying directed spraying of paraquat 6 ml/l (0.6%) on 90 DAP

T_7 - Post emergence directed spraying of glyphosate 10ml/l (1.0%) on 90 DAP

T_8 - Post-emergence spraying of sodium chloride 200 g/l (20%) on 90 DAP

T_9 - Post-emergence spraying of urea 200 g/l (20%) on 90 DAP

T_{10}- Post emergence spraying of 2,4-D Na salt 5 g/l (0.5%) + urea 20 g/l (2%) on 90 DAP

* Data not statistically analysed; Figures in the parenthesis are original values; BHS – Before herbicide spraying; DAHS: Days after herbicide spraying

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43- Screening of New Herbicides for Effective Weed Control in Spring Planted Sugarcane

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INTRODUCTION

Crop-weed competition in sugarcane has long been recognized as one of the major cause of low productivity. Checking weed growth for a longer duration as in sugarcane to minimize crop-weed competition is cumbersome and costly by repeated weeding/hoeing. In past efforts have been made to control weeds in sugarcane by various mechanical and chemical means. Generally application of chemical solely does not bring desired level of weed control in sugarcane. So, it requires a systematic management consisting of hoeing coupled with pre-emergence (PRE) or post-emergence (POST) application of suitable herbicide. Keeping the above objectives in view, the experiment was conducted to find out the suitable herbicide for chemical and integrated method of weed management in spring planted sugarcane.

MATERIALS AND METHODS

A field experiment was conducted for two years during 2003-04 and 2004-05 at Karnal on clay loam soils having pH 7.9, organic carbon 0.26%, available P 11.3 kg/ha and available K 118.5 kg/ha. Sugarcane variety CoH 56 was planted during second week of March during both the years of study. There were ten treatments as per details given in the table. The trial was laid out in randomized block design with three replications. The sugarcane crop was raised as per the package of practices for the Haryana state.

RESULTS AND DISCUSSION

The experimental results indicated that maximum dry weight of weeds was recorded in weedy check (control) treatment which was significantly higher than those obtained from other treatments applied. The minimum dry weight of weeds was recorded from T_2 (Three hoeing) treatment which was followed by treatment T_7 (Metribuzin 1.0 kg a.i./ha+2,4-D 1.0 kg a. i. /ha at 60 DAP+ one hoeing at 90 DAP), T_8 (Glyphosate 1.0 l /ha 20 DAP+ one hoeing at 90 DAP), T_{10} (T_9+ one hoeing at 90 DAP) and T_9 (Hexazinone+ Diuron mixture 60% WP 1.2 kg a.i./ ha as pre)

All the weed control treatments led to significantly higher number of tillers, millable canes and cane yield over control. This may be attributed to lower weed crop competition either by eliminating weeds through mechanical and chemical means (Singh and Singh 1988 and Singh *et al* 2002). Highest cane yield was recorded under three hoeing treatment, being at par with metribuzin 1.0 kg/ ha + 2,4-D 1.0 kg/ ha at 60 DAP + one hoeing at 90 DAP. The sugarcane yields during 2003-04 in all herbicide treatments except hexazine + diuron mixture 1.2 kg a.i./ ha were found at par with three hand hoeing treatment. However, during 2004-05 all herbicide treatments except metribuzin 1.0 kg pre followed by 2,4-D 1.0 kg integrated with one hand hoeing produced significantly less sugarcane yield than best treatment i.e., three hand hoeings. Germination and CCS percentage were not significantly affected by weed management treatments applied in the experiment.

Table1 Effect of weed control treatments on weed dry weight, growth and yield of spring planted sugarcane

Treatment	*Weed dry weight (g/m^2)*		*Tillers (000/ha)*		*Millable canes (000/ha)*		*Cane yield (t/ha)*	
	2003-04	*2004-05*	*2003-04*	*2004-05*	*2003-04*	*2004-05*	*2003-04*	*2004-05*
T_1- Control	589.0	635.0	125.1	109.2	105	88	35.8	30.1
T_2-Three hoeings (30,60,90DAP)	1.0	9.7	272.5	247.5	192	179	78.2	72.7
T_3-Atrazine 2.0 kg a.i/ha (PRE)+2,4-D 1.0 kg a.i./ha (60DAP)	81.1	74.8	222.1	201.6	172	138	68.5	54.9
T_4- Metribuzin 1.0 kg a.i/ha (PRE)+one hoeing (60DAP)	74.3	65.6	224.5	209.5	171	155	69.7	61.7
T_5-Ametryn 2.0 kg a.i/ha (PRE)+one hoeing (60DAP)	45.2	64.5	226.4	206.1	170	147	69.8	60.2
T_6-Metribuzin 1.0 kg a.i/ha (PRE)+2,4-D 1.0 kg a.i./ha (60DAP)	49.2	63.8	231.7	204.5	174	145	69.5	58.8
T_7- T_6+ one hoeing (90 DAP)	15.8	12.9	236.5	235.8	173	174	71.6	71.9
T_8- Glyphosate 1.0 lt a.i./ha 20DAP (uniform spray)+one hoeing (90DAP)	11.8	13.4	203.6	198.2	169	144	69.3	55.1
T_9- Hexazinone (46.8%) + Diuron (13.2%) mixture 60WP 1.2 kg a.i./ha	14.1	15.2	214.2	183.8	179	135	61.5	48.3
T_{10}-T_9+ one hoeing (90DAP)	12.2	14.3	231.0	212.8	180	147	69.7	56.8
CD at 5%	32.1	9.7	10.7	12.8	4.1	11.7	5.3	6.7

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PULSES

44- Efficacy of Chlorimuron-ethyl on Weeds in Soybean (*Glycine max*) and its Residual Effects on Succeeding Wheat (*Triticum aestivum*) Grown on Vertisols of Rajasthan

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INTRODUCTION

Soybean (*Glycine max* L. Merrill) is one of the most important *kharif* oil seed crop being succeeded by wheat in South-eastern Rajasthan. Heavy infestation of weeds has become a serious problem for increasing and sustaining productivity of soybean. . It is estimated that on an average weed infestation bring down the soybean yield by 20-77 per cent (Kurchania *et al.*, 2001). Some of the weeds are not controlled by the traditional herbicides and mostly regenerates after hand weeding. With the changing scenario of weed management, farmers need herbicides having high efficacy, low phytotoxicity and cost effective as well as no residual effects on succeeding crops. Many new herbicides have been introduced and chlorimuron-ethyl is one of them to control broad leaf weeds which can be used at low rate.

MATERIALS AND METHODS

A field experiment was conducted during 1999-2000 and 2000-01 at Agricultural Research Station, Kota of Maharana Pratap University of Agriculture & Technology, Udaipur. The soil of the experimental field was clay-loam (vertisol) having P^H 7.96, EC 0.42 dSm^{-1}, O.C. 0.56 %, available N, P_2O_5, K_2O: 335, 24 and 315 kg ha^{-1}, respectively. Treatments consisted of chlorimuron-ethyl at 6.25 and 9.37 g ha^{-1} as post-emergence (POE) at 5,10,15,20 and 25 DAS, alachlor 2.0 kg ha^{-1} as pre-emergence (PE), two hand weedings at 35 and 45 days after sowing, farmer's practice (one hand weeding) and weedy check. The treatments were laid out with three replications in randomized block design. Chlorimuron-ethyl was sprayed with surfactant (0.1 %) using spray volume of 500 l ha^{-1}. The soybean variety JS335 was sown with the onset of monsoon and harvested in the month of October. Weed species and their dry matter at 45 days of crop growth were recorded from two randomly selected quadrates (0.25 m^2) in each plot and expressed as number and g m^{-2}. All the recommended package of practices other than weed control were followed to raise the crops. The treatments were applied only in soybean and evaluated for their residual effects in succeeding wheat grown on same site using variety Raj3765 in the month of November in the respective years.

RESULTS AND DISCUSSION

Effect on Weeds

Major weed flora observed in the experimental field were *Celosia argentea*, *Digera arvensis*, *Commelina benghalensis*, *Trianthema portulacastrum* among broad leaf weeds and *Echinochloa colonum*, *E. crusgalli*, *Cyperus rotundus* and *Dinebra arabica* were among grasses and sedges. The field was mainly dominated and colonized of broad leaf weeds (60%) especially by *Celosia argentea* (37%) whereas grasses and sedges contributed to 40 %. Chlorimuron-ethyl gave excellent control of broad-leaved weed species and better than alachlor, farmer's practice (one hand weeding) and weedy check. Chlorimuron-ethyl at 9.37 g ha^{-1} was found very effective but either of the doses i.e. 6.25 and 9.37 g ha^{-1} did not prove effective against grasses and have only little suppressing effects on sedges. Weed control efficiency of Chlorimuron-ethyl at 6.25 and 9.37 g ha^{-1} applied at 5, 10, 15, 20 and 25 DAS°was 42.3, 53.4, 55.8, 47.4, 40.2 and 55.8, 62.6, 63.6, 56.1, 51.2, respectively.

Effect on Yield

Chlorimuron-ethyl at 9.37 gha^{-1} caused higher increase in yield than alachlor and farmer's practice. The number of pods and 1000- seed weight were influenced significantly being highest in two hand weeding closely followed by Chlorimuron-ethyl applied at 9.37 g ha^{-1} and were minimum in weedy check elucidating the effect of competiting weeds. The highest grain yield of 19.13 q ha^{-1} was recorded under two hand weedings being at par with chlorimuron-ethyl at 9.37 g ha^{-1} at $_{15}$ DAS. Chlorimuron-ethyl at 9.37 g ha^{-1} was significantly superior to 6.25 g ha^{-1} recording mean seed yield of 17.64 q ha^{-1}. Unweeded control had recorded significantly lowest seed yield (9.55 q ha^{-1}). The increase in crop yield was due to increase in pods per plant and 1000 seed weight owing to decrease in crop-weed competition due to better control of weeds. Singh *et al* (2004) have also reported better control of broad-leaved weeds and increase in soybean yield due to chlorimuron-ethyl at 9 g ha^{-1} as compared to 6 g ha^{-1}.

Residual effect on succeeding wheat crop

Residual studies at same site on wheat (Raj 3765) showed that either of the doses of chlorimuron-ethyl did not have any residual toxicity to the succeeding wheat crop. The succeeding wheat did not show any visual phytotoxic symptoms as the plant stand, growth and yield attributes and yields were not affected due to residual effects of chlorimuron-ethyl.

Table 1 Effect of chlorimuron-ethyl on weed density, weed dry weight and yield of soybean and succeeding wheat (Pooled of two crop seasons)

Treatment	*Dose (g ha^{-1})*	*Spray DAS*	*Weed density (m^{-2}) 45 DAS*			*Total weed dry weight (g m^{-2}) 45 DAS*	*WCE %*	*Seed yield (q ha^{-1})*	
			Broad leaved	*Sedges*	*Grasses*			*Soybean*	*Succ. Wheat*
Chlorimuron ethyl	6.25	5	17	19	51	85.8	42.3	13.33	33.46
Chlorimuron ethyl	6.25	10	14	10	45	69.3	53.4	15.05	39.20
Chlorimuron ethyl	6.25	15	13	11	42	65.7	55.8	15.77	38.73
Chlorimuron ethyl	6.25	20	16	17	46	78.2	47.4	14.96	38.62
Chlorimuron ethyl	6.25	25	20	21	49	89.0	40.2	13.31	38.25
Chlorimuron ethyl	9.37	5	11	12	43	65.7	55.8	14.94	38.36
Chlorimuron ethyl	9.37	10	8	9	38	55.6	62.6	17.54	39.67
Chlorimuron ethyl	9.37	15	7	9	38	54.1	63.6	17.64	39.45
Chlorimuron ethyl	9.37	20	9	14	42	65.3	56.1	15.98	38.93
Chlorimuron ethyl	9.37	25	12	17	44	72.6	51.2	14.66	38.38
Alachlor	2000	1	22	21	32	75.9	48.9	14.15	38.10
Two hand weedings			1	0.5	3	4.5	96.9	19.13	40.52
Farmer's practice			18	27	13	57.6	61.3	12.30	38.42
Weedy check			41	50	59	148.8	-	9.55	36.50
CD at 5%			4	3	6	6.5	-	1.53	NS

DAS-Days after sowing; NS- Not Significant; WCE- Weed Control Efficiency;
Succ. - Succeeding

CONCLUSIONS

Chlorimuron-ethyl found most effective on broad-leaved weeds in soybean without any phytotoxicity and residual effects on succeeding wheat. Chlorimuron-ethyl (9.37 g ha^{-1}) at 10-15 DAS was better than 6.25 g ha^{-1} and gave higher seed yield of soybean compared to alachlor 2 kg ha^{-1}.

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45- Post–emergence Herbicidal Weed Management in Soybean (*Glycine max* (L.) Merrill)

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INTRODUCTION

Being a rainy season crop, soybean faces severe weed competition throughout the growing season but early growth stages are most important. Intense weed infestation is one of the major constraints for the lower productivity of soybean in India especially in Rajasthan ranking 3rd in production as well as acreage. Weed infestation exerts greater stress and reduced more than 61 % yield in soybean (Chandel and Saxena 2001, Singh *et al* 2004). Use of pre-plant or pre-emergence herbicides helps to minimize the weed infestation but due to sowing compulsions farmers compel to forego the spray of these two types of applications. Introduction of new post-emergence herbicides may helps to have a wide spectrum of application time as well as according to weed specificity and may be an effective tool for site specific weed management.

MATERIALS AND METHODS

A field experiment was conducted during the rainy season of kharif 1998 and 1999 at Agricultural Research Station, Kota (Rajasthan). Treatments comprised of post-emergence herbicides viz; imazethapyr at 75 and 100 g ha^{-1}; lactofen at 90 g ha^{-1}; Pre-emergence herbicides alachlor (PE) at 2.0 kg ha^{-1}; trifluralin at 1.0 kg ha^{-1} as pre plant incorporation; two hand weedings at 30 and 45 days after sowing (DAS); farmer's practice (one hand weeding at 30-50 DAS) and unweeded check were tested in randomized block design with three replications. Soybean (JS335) was sown with the onset of monsoon with recommended production technology and the post emergence herbicides were applied at 15- 25 DAS. Observations on dry matter of weeds and weed density were recorded at 30 and 60 DAS and the effects of various treatments on growth and yield parameters as well as phytotoxicity were recorded using 0-10 point scale at different phenophases of the soybean crop.

RESULTS AND DISCUSSION

Effects on weeds

Major weed species belonging to different groups observed were *Echinochloa spp, Celosia argentia , Cyperus rotundus, Digera arvensis, Commelina benghalensis , Trianthema spp., Eclipta alba , Xanthium spp.* contributing to the maximum infestation due to uncontrol (weedy). The minimum weed density was observed in two hand weedings followed by post-emergence application of imazethapyr at 100 and 75 g ha

$^{-1}$ resulted in maximum decrease in dry matter of weeds. Post-emergence application of imazethapyr resulted in effective control of most of grasses and broad leaf weeds. The total weed density and dry matter accumulation at 30 and 60 DAS was significantly lower in imazethapyr treated plots resulted in higher weed control efficiency.

Effect on yield

Among herbicidal treatments highest seed yield (20.22 q/ha) was recorded with imazethapyr 100 g ha^{-1} which was at par with its lower dose (75 g ha^{-1}). Imazethapyr also gave higher yield as compared to lactofen, alachlor and trifluralin application. Lactofen was found inferior (14.61q ha^{-1}) as compared to imazethapyr. Rana and Angiras (1996) and Chandel and Saxena (2001) reported that application of imazethapyr at 100 g ha^{-1} as post- emergence was effective to reduced weed dry matter, weed population and increasing soybean seed yield and weed controlling efficiency. However, maximum yield (23.62 q ha^{-1}) was observed in two hand weedings at 30 and 45 DAS and minimum in weedy check (9.50 q ha^{-1}). A critical evaluation of the treatments showed that weeds in unweeded check reduced the grain yield of soybean drastically by 149 per cent. Post-emergence herbicides did not show adverse effect on plant population, plant height and dry matter production and also not showed any phytotoxicity to the soybean. Rana and Angris (1996) also reported non- phytotoxic effect of imazethapyr on soybean crop.

Table 1 Effect of herbicidal weed management on weed density, weed dry matter and yield of soybean (Pooled over two years)

Treatment	*Weed density*(m^{-2})*		*Weed dry matter (g m^{-2})*		*Weed control efficiency (%)*		*Seed yield*
	30 DAS	*60 DAS*	*30 DAS*	*60 DAS*	*30 DAS*	*60 DAS*	*(q ha^{-1})*
Weedy check	13.1(170)	14.1(196)	292.6	415.5	-	-	9.50
Farmer's practice	12.9(168)	9.5(89)	290.1	194.2	-	46.6	13.83
Two hand weeding30 & 45 DAS	0.7(00)	5.1(25)	00.0	53.7	99.9	81.6	23.62
Alachlor 2.0 kg ha^{-1}PE	7.5(56)	7.8(61)	64.8	124.2	77.9	57.6	16.45
Trifluralin 1.0 kg ha^{-1} PPI	8.8(77)	8.9(80)	83.6	158.0	71.4	46.0	15.70
Imazethapyr 75 g ha^{-1} POE	5.5(35)	6.3(40)	41.8	84.8	85.7	71.0	19.30
Imazethapyr 100 g ha^{-1} POE	5.3(32)	6.1(36)	37.3	79.0	87.3	73.0	20.22
Lactofen 90 g ha^{-1} POE	7.1(57)	8.0(64)	66.2	123.5	77.4	57.8	14.61
CD at 5%	0.31(8.7)	0.27(12.6)	11.2	21.1	-	-	1.44

*Data subjected to Ö X+0.5 transformation and figures in parenthesis are original
PE - pre emergence, POE- Post emergence

CONCLUSIONS

Post-emergence application of imazethapyr at 75 g ha^{-1} controlled weeds effectively and enhanced the productivity of the soybean. This is safer to the soybean crop and could be used for efficient weed management.

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46- Impact Assessment of Weed Management Practices in Soybean in South-eastern Rajasthan

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INTRODUCTION

Soybean has attracted the Indian farmers and due to several merits, its cultivation has gained momentum in several states of the country especially in Madhya Pradesh, Maharastra and Rajasthan and becoming an important and integral component of cropping system by replacing traditionally grown pulses and other crops during 'kharif ' season. Productivity of soybean in Rajasthan is deplorably (691 kg ha^{-1}) low as compared to Maharastra (980 kg ha^{-1}), India 891 kg$ha^{-1}$and the world (2290 kg ha^{-1}). This necessitates to develop site specific soybean production technology which can enhance its productivity. Soybean is rainy season crop and faces severe weed-crop competition. Yield reduction in soybean due to weeds may vary from 12-85 per cent. Due to unpredictability of rains, entailing to non-workable conditions of soil in rainy days and non-availability of labour, weed management in soybean had really been a challenging task. Hand weedings in short period of *kharif* are not feasible. Therefore, in such situations, the only alternative is herbicidal weed control. On the other hand, farmers are in practice of controlling weeds through conventional hand weeding which still continuous to provide for equivalent or sometimes still better means than herbicidal weed control if applied timely, but it lags behind herbicides in terms of economics. Thus, considering the facts a study was under taken to evaluate the impact and constraints in using herbicidal weed control in soybean by the farmers.

METERIALS AND METHODS

The field trials were conducted at farmer's fields as front line demonstrations during 2003 and 2004. Fifteen farmers were selected and were supplied herbicides for controlling weeds i.e. and alachlor 2.0 kg ha^{-1} liquid as pre-emergence, chlorimuron-ethyl 9.37 g ha^{-1}, quizalofop-ethyl 50 g ha^{-1} and imazethapyr 75 g ha^{-1} as post- emergence and these were evaluated against farmers practices i.e. alachlor 2.0 kg ha^{-1} granules, Trifluchloralin 1.0 kg ha^{-1} as pre plant incorporation, one hand weeding 30-50 DAS , two hand weedings at 30 and 45 DAS and weedy check. Survey was made regarding the farmers view to adopt herbicidal weed management in soybean and their constraints.

RESULTS AND DISCUSSION

Among the different weed control practices post-emergence herbicides gave higher net returns as compared to pre-emergence and pre plant incorporated herbicides. The choice of any weed control method ultimately depends on economics and efficiency in controlling weeds. The cost of chemical weed control is actually less than that of manual weeding. This has been a major intensive to many farmers to switch over to herbicides. Among the different weed control treatments, post-emergence application of imazethapyr 75 g ha recorded highest total cost because of higher unit cost of weed control but was most liked by the farmers because of control of broad as well as some narrow leaved weeds. Their next liking was granular alachlor due to easy applicability. The herbicides chlorimuron–ethyl was most accepted by the farmers having the problem of broad-leaved weeds but their most demand was towards quizalofop-ethyl where farmers switch over to soybean by leaving paddy cultivation having more *Echinichloa spp.* infestation.

Table 1 Economics of weed control practices in soybean (Mean over two years)

Treatment	*Seed Yield (kg ha^{-1})*	*Gross returns (Rs ha^{-1})*	*Treatment Cost (Rs ha^{-1})*	*Net returns (Rs ha^{-1})*	*IBCR*	*Rank as farmers Preference*	*Preference after Demonstration*
Weedy check	900	11964	0	11964		IX	IX
One hand weeding	1283	17010	2555	14455	0.97	I	VI
Two hand weedings	2168	28899	5110	23789	2.31	II	V
Trifluralin 1.0 kg ha PPI	1305	17415	950	16465	4.74	VIII	VIII
Alachlor 2.0 kg G PE	1503	20058	1000	19058	7.09	IV	VII
Alachlor 2.0 kg L PE	1358	18152	850	17302	6.28	VII	IV
Chlorimuron- ethyl 9.37 g ha^{-1} POE	1705	22745	1020	21725	9.57	V	II
Quizalofop-ethyl 50 g ha^{-1} POE	1635	21801	1250	20551	6.87	VI	III
Imazethapyr 75 g ha^{-1} POE	1900	25346	1450	23896	8.23	III	I

G- Granules, L- Liquid, IBCR – incremental benefit cost ratio

CONCLUSIONS

Timely availability and proper methodology of post-emergence herbicides to control weeds in soybean had a greater impact in adoption of herbicidal weed management in the zone. If farmer could not apply pre-plant incorporated, pre-emergence herbicides and hand weeding timely, then the post-emergence herbicides could be a better option of weed control.

47- Effect of Imidazolinone Herbicides (Imazaquin Alone and in Combination) on Monocot and Dicot Weeds in Soybean (*Glycine max* M.) Cultivation

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INTRODUCTION

The grassy and broad-leaved weeds infest soybean fields and cause a yield loss of 59 -86 per cent (Chandel, 1989). The effective and economic weed control on large scale is not possible through manual or mechanical means. Therefore, herbicides are the only alternative left for under such circumstances. The herbicides like alachlor, fluchloralin and pendimethalin are effective on grasses and their continuos use leads to weed shift to broad-leaved weeds, so there is an emerging need for a broad-spectrum herbicide. Thus the study was formulated to evaluate the bioefficacy of Squadron.

MATERIALS AND METHODS

There were 8 treatments used in the experiment including the control with three herbicides like Sceptor 120, 150, 240 g a.i. ha^{-1}, Stomp 1.0 kg a.i. ha^{-1} and Squadron 3.0, 4.0, 8.0 l ha^{-1} (FP); all applied as PPI. The control was an unweeded check. The chemical names of the herbicides used were Scepter (imazaquin), Stomp (pendimethalin 30 EC) and Squadron (imazaquin 17.5 WSC (3.4 %) + pendimethalin 30 EC (30%)). The experiment was conducted in randomized block design with three replications.

RESULTS AND DISCUSSION

The Squadron @ 4.0 l ha^{-1} (FP) and Squadron @ 3.0 l ha^{-1} (FP) effectively controlled the dicot weeds during both the seasons over the control. The range of dicot weeds density was from 6.0 to 48.0 m^{-2} in summer and 5.0 to 55.0 m^{-2} in *kharif* seasons during 20 DAS (Table 1&2). A similar trend was observed in 40 and 60 DAS also. The higher doses of Scepter @ 150 g a.i. ha^{-1} followed the Squadron. Control recorded the highest dicot weed density throughout the crop period (Table-1&2). Squadron @ 4.0 l ha^{-1} (FP) and Squadron @ 3.0 l ha^{-1} (FP) also recorded meager population of monocot weeds like grasses. The percent increase over control during 20,40 and 60 DAS in summer and *kharif* were 91.30, 92.02, 89.10 and 90.48, 76.23, 80.21 per cent respectively. Here also the control with unchecked weed growth recorded highest grass weed density. The other group of monocots namely sedges was not in considerable amount and did not represent a uniform population in the experimental plot. The application of Squadron @ 4.0 l ha^{-1} (FP) and Squadron @ 3.0 l ha^{-1} (FP) proved to be effective in controlling both monocot and dicot weeds due to its broad spectrum activity and may be due to dual mode action. The herbicides like Scepter gives effective grass weed control only when tank mixed with graminicides. Manley *et al.* (1998) also approved the above results. The highest grain yield was obtained with the treatment Squadron @ 4.0 l ha^{-1} (FP) followed by Squadron @ 3.0 l ha^{-1} (FP) (Table 1&2). The percent increase of yield over the control Squadron @ 4.0 l ha^{-1} (FP) was 93.04 per cent and 104.6 per cent during summer and *kharif* seasons respectively. The higher dose of Scepter @ 150g a.i. ha^{-1} recorded the next best higher yield and also significantly higher yield than Stomp @ 1 kg a.i. ha^{-1}. The reduction in yield in control was due to reduced yield attributes as the result of heavy weed infestation and its competition for nutrients, light, moisture etc.

The application of Squadron @ 4.0 l ha^{-1} (FP) gave effective control over dicots and grasses of monocots while the sedge weed population was non significant. The Squadron @ 3.0 l ha^{-1} (FP) was also equally effective.

Table1 Effect of Scepter, Stomp and Squadron on monocot and Dicot weeds (no. m^{-2}) and grain yield (kg ha^{-1}) of soybean during summer of 2000

Treatments	*Dicots (no. m^{-2})*			*Monocots (no. m^{-2})*			*Grain yield*
	20 (DAS)	*40(DAS)*	*60(DAS)*	*20(DAS)*	*40(DAS)*	*60(DAS)*	*(kg ha^{-1})*
Scepter @ 120g a.i. ha^{-1}	16.0(4.06)	17.3(4.22)	19.0(4.41)	'27.3(5.27)	42.3(6.92)	53.0(7.31)	1802
Scepter @ 150g a.i. ha^{-1}	25.3(5.08)	13.3(3.72)	28.0(5.34)	23.4(4.80)	54.0(7.65)	58.0(7.65)	1699
Scepter @ 240g a.i. ha^{-1}*	24.7(5.02)	17.7(4.24)	20.3(4.56)	17.3(4.21)	43.0(6.60)	53.3(7.33)	1831
Stomp @ 1 kg a.i. ha^{-1}.	21.0(4.64)	20.3(4.50)	26.0(5.15)	26.7(5.21)	46.0(7.21)	57.0(7.58)	1690
Squadron@ 3.0 l ha^{-1} (FP)	14.0(3.81)	8.0(2.91)	11.7(3.43)	8.0(2.91)	32.0(5.70)	38.0(6.20)	2465
Squadron@ 4.0 l ha^{-1} (FP)	12.7(3.62)	6.0(2.55)	8.7(3.02)	6.0(2.55)	27.7(5.64)	32.0(5.34)	2574
Squadron@ 8.0 l ha^{-1} (FP)*	12.0(3.49)	5.3(2.41)	8.0(2.82)	2.0(1.56)	24.0(5.20)	26.7(5.20)	1319
Control	28.0(5.33)	23.3(4.88)	34.7(5.87)	44.0(6.62)	117.7(11.76)	122.7(10.90)	1120
CD at 5%	(0.60)	(0.22)	(0.53)	(0.22)	(0.60)	(0.60)	103

* Tested for phytotoxicity only. DAS – days after sowing FP – Field product
(Figures in parentheses are transformed values)

Table2 Effect of Scepter, Stomp and Squadron on monocot and Dicot weeds (no. m^{-2}) and grain yield (kg ha^{-1}) of soybean during *kharif* of 2000

Treatments	*Dicots (no. m^{-2})*			*Monocots (no. m^{-2})*			*Grain yield*
	20 (DAS)	*40(DAS)*	*60(DAS)*	*20(DAS)*	*40(DAS)*	*60(DAS)*	*(kg ha^{-1})*
Scepter @ 120g a.i. ha^{-1}	18.0(4.30)	27.0(5.24)	36.0(6.04)	'19.0(4.42)	26.7(5.21)	32.0(5.70)	1944
Scepter @ 150g a.i. ha^{-1}	23.0(4.85)	30.7(5.58)	36.3(6.09)	24.0(4.93)	29.3(5.46)	34.7(5.92)	1834
Scepter @ 240g a.i. ha^{-1}*	17.0(4.18)	26.3(5.17)	32.0(5.70)	18.0(4.30)	27.7(5.39)	30.0(5.52)	1963
Stomp @ 1 kg a.i. ha^{-1}	23.0(4.25)	30.7(5.54)	35.0(5.96)	23.0(4.85)	30.3(5.53)	35.0(5.96)	1844
Squadron@ 3.0 l ha^{-1} (FP)	12.0(3.54)	18.3(4.34)	23.7(4.92)	13.3(3.71)	19.3(4.44)	26.0(4.78)	2588
Squadron@ 4.0 l ha^{-1} (FP)	10.7(3.54)	16.7(4.14)	21.0(4.64)	12.0(3.54)	17.0(4.18)	23.7(4.91)	2702
Squadron@ 8.0 l ha^{-1} (FP)*	8.7(3.03)	13.0(3.67)	15.7(4.01)	10.0(3.24)	15.0(3.94)	21.3(4.67)	1384
Control	32.0(5.70)	60.0(7.78)	64.0(8.03)	38.0(6.20)	59.0(7.71)	70.0(8.39)	1176
CD at 5%	(0.30)	(0.29)	(0.25)	(0.26)	(0.31)	(0.28)	86

* Tested for phytotoxicity only. DAS – days after sowing FP – Field product
(Figures in parentheses are transformed values)

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48- Effect of Imidazolinone Herbicides (Imazethapyr Alone and in Combination) on Weeds in Soybean (*Glycine max* M.) Cultivation

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INTRODUCTION

The chemical weed control is gaining momentum with decreased availability of agricultural labors as a cause of industrialization in many areas. Moreover, the varied climatic conditions with sudden rainfall coupled with heavy soils hamper manual weeding operations wherein, the use of herbicides is compulsory. The surging need for a new herbicide with total weed control has necessitated the study for evaluating the bio-efficacy of pursuit plus in soybean.

MATERIALS AND METHODS

There were 8 treatments used in the experiment including the control with three herbicides applied like Pursuit @ (100 g a.i. ha^{-1} as PPI, 75 and 100 g a.i. ha^{-1} as early post) , Stomp @ 1.0 kg a.i. ha^{-1} as PPI and Pursuit plus @ (2.5, 3.0, 6.0 l ha^{-1} (FP)) as PPI. The control was an unweeded check. The chemical names of the herbicides used were Pursuit (imazethapyr), Stomp (pendimethalin 30 EC) and Pursuit Plus (imazethapyr 10 WSC (2.0%) + pendimethalin 30 EC (22%)). The experiment was conducted in randomized block design with three replications. The soil was sandy clay loam with a pH of 7.5.

RESULTS AND DISCUSSION

The important weed species recorded in the experimental fields were *Trianthema portulacastrum* Linn. *Eclipta alba* Hassak. *Cleome viscose* Linn. *Cynodon dactylon* Pers. *Echinochloa colonum* Linn. *Cyperus rotundus* Linn *Fimbristylis miliacea* (L.) vahl. The Pursuit plus @ 3.0 l ha^{-1} (FP) and Pursuit plus @ 2.5 l ha^{-1} (FP) recorded the highest weed control with lowest weed density (Table-1). Pursuit Plus provides both early season and residual control of over 45 broad-leaved weeds and grasses (Anonymous, 1999). The control with unchecked weed growth recorded highest weed density. The percentage increase of total weed population in Pursuit plus @ 3.0 l ha^{-1} (FP) application over the control during both the seasons on 20, 40 and 60 DAS were 74.03, 76.1, 74.16 and 65.75, 73.55, 68.29 per cent respectively. The application of Pursuit @ 100 g a.i. ha^{-1} as early post and Pursuit @ 100 g a.i. ha^{-1} as PPI were comparable with each other and followed the Pursuit plus. Pursuit plus being a broad-spectrum herbicide effectively controlled the weeds, and also, the PPI application effectively controlled the emerging weed seedlings giving total weed control at earlier stage itself. The season long persistence maintains the weed free condition at all critical stages of the crop. Imazethapyr @ 110 and 140 g a.i. ha^{-1} applied as pre-sowing incorporation controlled more than 85 per cent of red rice (*Oryza sativa*) in soybean (Nastasi and Smith, 1989).

The weed dry matter production (Table-2) was highest in control due to unchecked weed growth leading to increased number and biomass of weeds. The treatments Pursuit plus @ 3.0 l ha^{-1} (FP) and Pursuit plus @ 2.5 l ha^{-1} (FP) recorded the lowest WDMP from early stages itself and it was due to the early control of weeds by these chemicals and their residual season long control of weeds. The range of WDMP were 85 to 613, 163 to 1069, 278 to 1341 kg ha^{-1} in summer and 105 to 590, 168 to 906, 302 to 1112 kg ha^{-1} in *kharif* seasons respectively on 20, 40, and 60 DAS. The highest yield (Table-2) was obtained with the treatments Pursuit plus @ 3.0 l ha^{-1} (FP) followed by Pursuit plus @ 2.5 l ha^{-1} (FP). The percent increase over control was to the tune of 129.82 and 120.09 per cent during both the seasons (summer and *kharif*) for the treatments Pursuit plus @ 3.0 l ha^{-1} (FP) followed by Pursuit plus @ 2.5 l ha^{-1} (FP). Pursuit plus is a broad-spectrum herbicide it provides an unbeatable weed control in soybean and the dose that can be recommended is Pursuit plus @ 3.0 l ha^{-1} (FP). Pursuit Plus @ 2.5 l ha^{-1} (FP) were also found to be equally effective in controlling the weeds.

Table 1 Effect of Pursuit, Stomp and Pursuit plus on weed density (no m^{-2}) in soybean

Treatments	*Summer (2000)(no. m^{-2})*			*Kharif (2000)(no. m^{-2})*		
	20 DAS	*40 DAS*	*60 DAS*	*20 DAS*	*40 DAS*	*60 DAS*
Pursuit @ 100g a.i. ha^{-1}	43.3(6.54)	59.7(7.79)	72.0(8.51)	40.0(6.36)	57.7(7.63)	64.0(8.03)
Pursuit @ 75g a.i. ha^{-1} as EP	48.7(7.01)	67.3(8.24)	86.0(9.30)	51.0(7.18)	66.0(8.15)	76.0(8.74)
Pursuit @ 100g a.i. ha^{-1} as EP *	42.0(6.49)	60.7(7.82)	73.6(8.61)	39.0(6.28)	56.0(7.51)	65.0(8.09)
Stomp 1 kg a.i. ha^{-1}	47.6(6.94)	66.3(8.17)	83.0(9.14)	48.0(6.96)	65.0(8.09)	73.0(8.57)
Pursuit plus 2.5 l ha^{-1} (FP)	22.0(4.71)	40.0(6.36)	49.7(7.08)	27.3(5.27)	39.7(6.34)	51.7(7.22)
Pursuit plus 3.0 l ha^{-1} (FP)	18.7(4.32)	33.7(5.84)	40.7(6.39)	24.7(5.02)	32.0(5.70)	45.1(6.79)
Pursuit plus 6.0 l ha^{-1} (FP) *	14.0(3.81)	29.3(5.46)	34.7(5.92)	20.7(4.6)	30.0(5.52)	41.0(6.44)
Control	72.0(8.44)	141.0(11.89)	157.3(12.55)	72.0(8.51)	121.0(11.02)	144.0(12.02)
CD at 5%	0.380	0.342	0.306	0.186	0.178	0.206

*Tested for phytotoxicity only. DAS – days after sowing FP – Field product
(Figures in parentheses are transformed values)

Table 2 Effect of Pursuit, Stomp and Pursuit plus on weed dry matter (g m^{-2}) and grain yield (kg ha^{-1}) in soybean

Treatments	Weed dry matter (g m^{-2})						Grain yield (kg ha^{-1})	
	Summer (2000) (DAS)			*Kharif* (2000) (DAS)			Summer (2000)	*Kharif* (2000)
	20	40	60	20	40	60		
Pursuit @ 100g a.i. ha^{-1}	174	379	996	169	386	846	1802	1944
Pursuit @ 75g a.i. ha^{-1} as EP	194	420	1144	206	439	1011	1699	1834
Pursuit @ 100g a.i. ha^{-1}* as EP	169	353	1002	166	368	872	1831	1963
Stomp 1 kg a.i. ha^{-1}	190	426	1156	210	444	1026	1690	1844
Pursuit plus 2.5 l ha^{-1} (FP)	106	206	359	128	223	432	2465	2588
Pursuit plus 3.0 l ha^{-1} (FP)	85	163	278	105	168	302	2574	2702
Pursuit plus 6.0 l ha^{-1} * (FP)	66	106	186	82	102	173	1319	1384
Control	613	1069	1341	590	906	1112	1120	1173
CD at 5%	14	38	59.9	18	43	119	103	86

*Tested for phytotoxicity only. DAS – days after sowing FP – Field product

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49- Weed Management in Mungbean and Urdbean in Summer Season

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INTRODUCTION

Mungbean [*Vigna radiata* (L.) Wilczek] and urdbean [*Vigna radiata* (L.) Hepper] are important pulse crops in summer season in India. Weed infestation is very high as these crops are short statured and are grown under irrigated conditions. Weeds compete with crop plants for nutrients, moisture, space and sunlight and thereby reduce crop yields considerably (Singh *et al.*, 1995; Bhandari *et al.*, 2004). To obtain high yields it is essential to control weeds at proper time with suitable method(s). Studies were, therefore, undertaken to find out effective weed control measures in newly released varieties of mungbean and urdbean in summer season.

MATERIALS AND METHODS

Two field experiments were conducted during summer season of 2002 at the Punjab Agricultural University, Ludhiana to study the effect of different weed control treatments on weeds and grain yields of mungbean and urdbean. Seven treatments, as given in Table 1, were tested in a Randomized Complete Block Design having three replications. Fluchloralin and trifluralin were applied as pre-sowing incorporation whereas pendimethalin was applied as pre-emergence with knapsack sprayer fitted with flat fan nozzle using 500 litres of water ha^{-1}. Hand weedings (HW) were done as per the treatments using *khurpa*. Both the crops were sown on 14 April 2002 in rows 22.5 cm apart. In case of mungbean, variety SML 668 was sown using 37.5 kg seed rate ha^{-1} whereas in case of urdbean, variety Mash 414 was sown using 50 kg seed rate ha^{-1}. Varieties SML 668 and Mash 414 have been recently recommended for general cultivation in the Punjab state. The major weed flora in the experimental field included *Trianthema portulacastrum*, *Cyperus rotundus*, *Dactyloctenium aegyptium*, *Commelina benghalensis* and *Eragrostis pilosa*. Dry matter of weeds was recorded at harvest.

RESULTS AND DISCUSSION

In mungbean, the maximum grain yield was obtained with two hand weedings done 25 + 40 days after sowing (DAS) (Table 1). However, the treatments pendimethalin 0.45 kg ha^{-1} + HW 25 DAS or pendimethalin 0.75 kg ha^{-1} or fluchloralin 0.675 kg ha^{-1} were on par with two hand weedings. These herbicides controlled weeds very effectively, as reflected in dry matter of weeds and weed control efficiency. Trifluralin was not effective in controlling weeds as well as for obtaining higher yields. The weedy check produced the lowest grain yield, which was only 1/3 of the effective weed control treatments. Presence of weeds, therefore, resulted in 67.12% yield loss due to crop-weed competition. In urdbean, uncontrolled weeds resulted in 32.25% reduction in the grain yield (Table 1). Effects of herbicides on weeds and crop yields were similar as observed in mungbean.

It is concluded that pendimethalin 0.45 kg ha^{-1} + hand weeding 25 days after sowing, pendimethalin 0.75 kg ha^{-1} and fluchloralin 0.675 kg ha^{-1} provided effective weed control and high grain yields of mungbean and urdbean, which were similar to those obtained with two hand weedings done 25 + 40 days after sowing.

Table 1. Effect of different treatments on weed control and grain yield of summer mungbean and urdbean

Treatment (kg ha^{-1})	Mungbean			Urdbean		
	Weed dry matter (kg ha^{-1})	Weed control efficiency %	Grain yield (kg ha^{-1})	Weed dry matter (kg ha^{-1})	Weed control efficiency %	Grain yield (kg ha^{-1})
Pendimethalin 0.45 kg ha^{-1} + hand weeding 25 DAS	299	89.05	2556	258	91.73	976
Pendimethalin 0.75 kg ha^{-1}	483	82.32	2430	564	81.93	895
Fluchloralin 0.675 kg ha^{-1}	514	81.19	2412	724	76.80	769
Trifluralin 0.50 kg ha^{-1}	1037	62.05	1622	905	71.01	621
Trifluralin 0.75 kg ha^{-1}	867	68.27	1767	624	80.01	706
Two hand weedings 25 + 40 DAS	253	90.74	2680	262	91.60	992
Weedy check	2733	-	881	3122	-	672
CD at 5%	240	-	393	268	-	108

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50- Yield and Economics of Green Gram as Influenced by Different Weed Management Practices in Kandi Region of Punjab

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INTRODUCTION

Green gram (*Phaseolus radiatus* L.) is grown during *kharif* season as a rainfed crop in Kandi region of Punjab. One of the major limiting factors in achieving potential yield of green gram in this region is the severe weeds infestation during rainy season. Dungarwal *et al.* (2003) reported reduction in seed yield of green gram up to 79 per cent due to season long weed infestation. Manual weeding is expensive, time consuming and often gets delayed. Under such situations, chemical weed control may prove an economical and effective alternative. However, information on chemical weed management in rainfed green gram is lacking. An attempt was, therefore, made to find out an effective weed management strategy based on herbicides applied alone and in combination with hand weeding.

MATERIALS AND METHODS

To generate information regarding effective weed management for green gram under rainy conditions, a field study was conducted during *kharif* 2003 and 2004 at PAU Zonal Station for Kandi Area, Ballowal Saunkhri. The soil of experimental field was sandy loam in texture, slightly alkaline in reaction, low in organic carbon and available nitrogen and medium in available phosphorus. A three time replicated trial with twelve treatments combinations as per details given in Table 1 was laid out in randomised block design. Green gram cultivar SML 668 was sown on 11th July 2003 and 15th July 2004 following recommended agronomic practices. The crop was harvested on 20th September 2003 and 14th September 2004. The herbicides were applied as per treatments with a manually operated knapsack sprayer using flat jet nozzle with a spray volume of 500 lt/ha. Species wise weed population was recorded at 30 days after sowing (DAS) and at harvest by randomly placing a quadrat of 0.5m X 0.5m at two places in each plot. The dry matter accumulation of weeds was also recorded at 30 DAS. The economics of different weed control treatments were also worked out by using the prevailing market price of the produce and the inputs used.

RESULTS AND DISCUSSION

The dominant weeds were *Cyperus rotundus, Cynodon dactylon, Commelina benghalensis* and *Digera arvesis*. Weed density at 30 DAS and at harvest as well as weeds dry matter recorded at 30 DAS were significantly reduced with application of herbicides applied compared to weedy check (Table 1). Higher dose of herbicide in general caused greater reduction and weeds dry matter over lower dose. Pre-plant incorporation of trifluralin proved more effective in controlling weeds and reducing weeds dry matter compared to its application as pre-emergence. Two HWs practised at 25 and 40 DAS resulted in lowest weed population at harvest, which was at par with integrated weed control comprising pre-emergence application of pendimethalin (0.56 kg/ha) + one HW at 30 DAS or trifluralin (0.50 kg/ha) as pre-emergence/ pre-plant + one HW at 30 DAS.

Application of pendimethalin and trifluralin significantly increased the seed yield of green gram over control (Table 1). However, higher dose of herbicides (0.75 kg/ha) was not superior to lower dose (0.56 kg/ ha in case of pendimethalin and 0.50 kg/ha in case of trifluralin). Integration of lower dose of herbicides with one HW at 30 DAS significantly increased the seed yield (925-1007 kg/ha) over application of herbicides alone (672-787 kg/ha) and one HW at 30 DAS (703 kg/ha) but was at par with two HWs (905 kg/ha). Higher seed yield with herbicidal application over control and integration of herbicide with one HW as compared to herbicide alone was due to better weed control through out crop growth period consequently resulting in significant increase in number of pods per plant and 1000-seed weight. The highest seed yield (1007 kg/ha) recorded with pre-plant application of trifluralin 0.50 kg/ha + one HW was 5.9, 8.9, 11.3, 43.2 and 146.8 % higher than pendimethalin (pre-em 0.56 kg/ha) + one HW, trifluralin (pre-em 0.50 kg/ha) + one HW, two HWs (25 and 40 DAS), one HW (30 DAS) and weedy check, respectively. Similarly stover yield of green gram (4364 kg/ha) with pre-plant application of trifluralin @ 0.50 kg/ha + one HW was statistically similar with trifluralin @ 0.75 kg/ha applied as pre-plant (4121 kg/ha) and pre-emergence (4011 kg/ha), trifluralin (0.50 kg/ha) as pre-emergence + one HW (4040 kg/ha) and HW twice (3908 kg/ha) but was significantly superior to rest of the treatments.

Pre-plant incorporation of trifluralin integrated with one HW resulted in highest net returns (Rs 6274/ha). Pre-emergence application of pendimethalin + one HW and trifluralin + one HW resulted in similar net returns. Net returns of herbicides applied alone (Rs 3044-4567/ha) or in integration with one HW (Rs 4929-6274/ha) were higher than HW once (Rs 1878/ha) or twice (Rs 2295/ha). The crop left unweeded incurred losses of Rs 714/ha.

Table 1 Effect of weed control treatments on weed density and dry weight, yield attributes and yield of green gram and their economics under rainfed conditions

Treatments	*Weed density (No/0.25m²) at harvest*	*Pods per plant*	*Seed yield (kg/ha)*	*Net returns (Rs/ha)*
Pendimethalin 0.56 kg/ha (pre-em)	3.1 (8.7)	12.9	787	4567
Pendimethalin 0.75 kg/ha (pre-em)	2.9 (7.3)	12.8	729	3236
Pendimethalin 0.56 kg/ha (pre-em) + one HW at 30 DAS	2.7 (6.3)	16.9	951	4985
Trifluralin 0.50 kg/ha (pre-plant)	3.5 (11.0)	13.6	756	4401
Trifluralin 0.75 kg/ha (pre-plant)	3.1 (9.0)	12.9	764	4446
Trifluralin 0.50 kg/ha (pre-plant) + one HW at 30 DAS	2.3 (4.3)	15.4	1007	6274
Trifluralin 0.50 kg/ha (pre-em)	3.5 (11.0)	12.1	701	3622
Trifluralin 0.75 kg/ha (pre-em)	3.7 (12.7)	12.6	672	3044
Trifluralin 0.50 kg/ha (pre-em) + one HW at 30 DAS	2.8 (6.7)	14.0	925	4929
One HW at 30 DAS	3.9 (14.7)	12.2	703	1878
Two HWs at 25 and 40 DAS	2.2 (4.0)	14.5	905	2295
Weedy check	5.6 (30.7)	11.1	408	-714
CD at 5%	0.6 (4.3)	2.1	104	-

Values in parentheses indicate actual weed population

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51- Chemical Weed Control in Mungbean (*Vigna radiata* L.) with Trifluralin – Farmer's Participatory Approach

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INTRODUCTION

Mungbean, a major kharif pulse of the state is badly infested by various weeds due to continuous rains in the monsoon season. Due to frequent rains sometimes manual hoeing becomes very difficult. The growth of the mungbean crop is very slow during early stages of the crop and weeds overgrow the crop. Vats and Sidhu (1977) reported that more than 50 percent reduction in yield of mungbean was caused due to weeds under Punjab conditions.

METHODS AND MATERIALS

The experiment was conducted at PAU, Regional Station, Bathinda during 1999, 2000 and 2001. The soil was low in N, medium in P, high in K and sandy loam having pH of 8.5. On the basis of 3 years data the best treatment was selected. The best one treatment (trifluralin @2.0l/ha) was compared with already recommended herbicide i.e. Stomp @ 2.5 l/ha. The adaptive research trials were conducted at 17 different locations in Punjab during kharif, 2002. The soil type at various locations vary from light to heavy. The treatments were pre emergence application of Stomp @ 2.5 l/ha , pre plant application of trifluralin@ 2.0 l/ha and unweeded control. The crop at various locations was sown during first fortnight of July and harvested at different dates at various locations. All the package and practices of Punjab Agricultural University were followed regarding fertilizers, insect and pest control. The predominant weeds at different locations were *Digera arvensis, Eleucine indica, Poa annua, Tribulus terrestris, Cynodon dactylon* etc.

Table 1 Grain yield (q/ha) of mungbean under various treatments at 17 different locations of Punjab

Sr No	*Name and address of the farmer*	*Grain yield (q/ha)*		
		Trifluralin 48 EC @ 2.0 l/ha (Pre-plant)	*Stomp 30 EC @ 2.5l/ha (pre-emer)*	*Unweeded control*
1	Sh. Joginder Singh Distt. Amritsar	10.00	10.50	8.00
2	Sh. Jagir Singh V.P.O. Pandher Distt Amritsar	9.50	10.00	8.00
3	Sh. Harinder Singh V.P.O. Chabal Distt Amritsar	9.00	9.00	7.50
4	Sh. Balbir Singh V.P.O. Dharamgarh Distt Patiala	11.25	10.75	7.75
5	Sh. Paramjit Singh V.P.O. Jalveri Distt Patiala	10.37	10.05	7.45
6	Sh. Gurnaib Singh V.P.O. Balwara Distt Patiala	10.65	10.25	7.77
7	Sh. Mehar Singh V.P.O. Karura Distt Ropar	10.50	10.75	8.75
8	Sh. Amarinder Singh V.P.O. Mahalan Jhallian Distt Ropar	7.00	7.00	6.80
9	Sh. Shangara Singh V.P.O. Hiarlpur Distt Ropar	9.50	9.25	7.80
10	Sh. Jagtar Singh V.P.O. Khassan Distt Kapurthala	9.20	8.00	7.40
11	Khalsa Farm V.P.O. Rampur Sunera Distt Kapurthala	7.60	7.30	6.40
12	Sh. Darshan Singh V.P.O. Dawali Distt Jallandhar	8.80	9.05	8.10
13	Sh. Jaswinder Singh V.P.O. Manik Rai Distt Jallandhar	9.75	9.25	8.50
14	Sh. Fatehpal Singh V.P.O. Pattar Kalan Distt Jallandhar	8.65	8.90	7.40
15	Sh. Ajaib Singh V.P.O. JhanduKe Distt Bathinda	16.70	16.40	13.00
16	Sh. Jagdish Singh V.P.O. Dunewal Distt Bathinda	14.20	14.40	11.00
17	Sh. Jagtar Singh V.P.O. Mehma Sarja Distt Bathinda	17.00	16.60	12.00
	Mean Grain yield (q/ha)(17 locations)	10.57	10.44	8.45

RESULTS AND DISCUSSION

The results in Table 1 showed that in all the 17 locations, both Stomp and trifluralin gave effective control of weeds as compared to unweeded control.. The average grain yields of 17 locations were 10.57 q/ha, 10.44 q/ha and 8.45 q/ha under trifluralin, Stomp and unweeded control respectively. Both the herbicides gave effective control against weeds at all the locations. Trifluralin seems to be more persistant in the soil as compared to Stomp. Sekhon et al (1994) also reported that pre-plant application of fluchloralin or pre-emergence application of pendimethalin gave effective control of weeds in mungbean. Application of triluralin @ 2.0 l/ha as pre-plant application gave effective control of weeds as in case of Stomp @ 2.5 l/ha as Pre emergence application.

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52- Effect of Fenoxaprop-p-ethyl on *Echinochloa spp*. Control in Blackgram Grown as a Relay Crop

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INTRODUCTION

In Krishna-Godavari zone of A.P blackgram is mostly grown as a relay crop, where in the sprouted seeds of blackgram are broadcast in standing rice crop 2 to 3 days before its harvest. The crop sown in this system survives entirely on residual moisture and fertility only. As there is no field preparation, the weed growth particularly *Echinochloa spp.* effectively compete with the crop for residual moisture, nutrients and reduce yields up to 53 per cent (Appanna *et al* 1998). The information available on post emergence control of *Echinochloa* in rice fallow blackgram is very much meagre. Therefore the present investigation was conducted in order to evaluate the efficacy of fenoxraprop-p-ethyl on *Echinochloa* control in rice fallow blackgram at various doses and time of application.

MATERIALS AND METHODS

A field experiment was conducted during rabi season of 2001-02 at Pulse Project area of Regional Agricultural Research Station, Lam, Munipalle, (Guntur Distt) A.P. The experiment consisting of twelve treatments (Table 1) was laid out in a randomized block design with three replications. The soil of the experimental field was clay with pH of 7.5 and medium in fertility status. The sprouted seeds of blackgram (cv. LBG 685) were broadcast in standing paddy crop three days before its harvest. Fenboxaprop-p-ethyl at different doses was sprayed at 15 and 20 DAS using a spray volume of 500 l/ha. The crop survived entirely on residual moisture except for one supplemental irrigation given at 40 DAS and also received a rainfall of 90 mm on the next day of irrigation. The data on weed density was recorded at 30 and 60 DAS and dry weight at harvest.

RESULTS AND DISCUSSION

All the fenoxaprop-p-ethyl treatments caused significant reduction in density and dry weight of *Echinochloa spp.* Compared to weedy check (Table 1). Among the different doses, post emergence application of fenoxaprop-p-ethyl at 56 to 68 g/ha applied at 15 and 20 DAS was found to be more effective in reducing the *Echinochloa* population and dry weight at harvest which was on par with its highest dose (135 g/ha). At harvest these treatments recorded a weed control efficiency (WCE) ranging from 77 to 81 per cent when applied at 15 DAS and 84 to 88 per cent when applied at 20 DAS. Hand weeding done at 22 DAS recorded a higher (WCE of 89 per cent at harvest.

Fenoxaprop-p-ethyl 135 g/ha applied at 15 and 20 DAS caused initial injury to blackgram crop causing yellowing, puckering and below normal expansion of youngest leaves and persisted up to 20 days after spray. Even though injury symptoms disappeared gradually, the yield components were affected resulting in lower yield. Fenoxaprop-p-ethyl 68 g/ha applied at 20 DAS recorded maximum seed yield (805 kg/ha) and was on par with it's all other doses except the lowest (34 g/ha) and highest (135 g/ha) doses applied at 15 and 20 DAS. The increased yield in these treatments is perhaps the result of reduced weed density and dry weight of *Echinochloa* and higher WCE. Further it was observed that seed yields did not vary significantly due to time of application at all doses of fenoxaprop-p-ethyl ranging from 34 to 135 g/ha. The unchecked weed growth during the crop season reduced the seed yield to the extent of 31 per cent compared to hand weeding which recorded the highest seed yield (810 kg/ha). Whereas, post-emergence application of fenoxaprop-p-ethyl 34 to 68 g/ha applied at 20 DAS recorded an increase of 83 to 89 per cent in blackgram yield over weedy check. Thus it could be summarized that post emergence application of fenoxaprop-p-ethyl at 45 to 68 g/ha was more effective in controlling *Echinochloa* and increased blackgram yield without any phytotoxicity.

Table 1 Effect of different treatments on Echinochloa density, dry weight and yield and yield components of blackgram grown as relay crop

Treatment	*Dose (g/ ha)*	*Appl. time (DAS)*	*Echinochloa density (No./ sq. m) at* 30 DAS	60 DAS	*Echinochloa dry wt. (g/ sq. m) at harvest*	*No. of seeds /plants*	*100 seeds wt. (g)*	*Seed yield (kg/ha)*
Fenoxaprop-p-ethyl	34	15	9.8(96.0)	11.9(142.0)	92	70	4.0	560
Fenoxaprop-p-ethyl	45	15	6.0(36.0)	11.2(126.0)	70	75	4.1	690
Fenoxaprop-p-ethyl	56	15	4.0(16.0)	10.0(100.0)	58	76	4.2	701
Fenoxaprop-p-ethyl	68	15	2.8(8.0)	10.0(100.0)	50	76	4.2	705
Fenoxaprop-p-ethyl	135	15	2.8(8.0)	9.4(89.0)	50	74	4.1	625
Fenoxaprop-p-ethyl	34	20	8.9(80.0)	10.8(118.0)	80	74	4.1	610
Fenoxaprop-p-ethyl	45	20	4.9(24.0)	8.5(74.0)	68	82	4.2	775
Fenoxaprop-p-ethyl	56	20	3.2(10.0)	6.8(46.0)	40	84	4.4	800
Fenoxaprop-p-ethyl	68	20	2.9(8.0)	5.3(28.0)	38	84	4.5	805
Fenoxaprop-p-ethyl	135	20	2.5(6.0)	4.4(19.0)	32	75	4.0	660
Fenoxaprop-p-ethyl	-	25	0.7(0.0)	5.3(28.0)	28	84	4.4	810
Fenoxaprop-p-ethyl	-	-	23.5(552.0)	22.1(488.0)	256	65	3.8	425
CD at 5%	-	-	1.4	1.4	12	8	NS	125

Note: DAS – Days after sowing, *Echinochloa* density data is x + 0.5 is transformed for statistical analysis
Original values are given in parenthesis.

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53- Weed Management Studies in Black Gram under Rainfed Conditions

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INTRODUCTION

Crop cultivation in the Kandi region of Punjab depends entirely on rains where black gram (*Vigna mungo* L.) is an important pulse crop. However, the crop faces severe weed competition due to its slow initial growth. An initial period of 20-40 days is very critical (Saraswat and Mishra, 1993) and season long weed competition has been found to reduce black gram yield to the extent of 87 per cent depending on the type and intensity of weed flora (Singh *et al.*, 2002). Rainfed farmers often practise manual weeding, which is very expensive, time consuming and frequent rains often do not allow or delay the weeding. Chemical weed management in crops has been found effective and economical. However, information on chemical weed management in rainfed pulse crops is lacking. An attempt was, therefore, made to find out an effective weed management strategy based on herbicides applied alone and in combination with hand hoeing.

MATERIALS AND METHODS

A field study was conducted during *kharif* 2003 and 2004 at PAU Zonal Station for Kandi Area, Ballowal Saunkhri on sandy loam soil testing low in organic carbon and available nitrogen and medium in available phosphorus. The twelve treatments of herbicides alone and in combination with hand hoeing were laid out in randomised block design with three replications as per details given in Table 1. Black gram cultivar Mash 338 was sown on 11th July 2003 and 15th July 2004 by following recommended agronomic practices. The crop was harvested on 18th September 2003 and 25th September 2004. The herbicides were applied as per treatments with a manually operated knapsack sprayer using flat jet nozzle with a spray volume of 500 litres/ha. The economics of different weed control treatments were also worked out by using the prevailing market price of the produce and the inputs used.

RESULTS AND DISCUSSION

The field was infested mainly with *Cyperus rotundus* and *Cynodon dactylon* among grasses and *Commelina benghalensis* and *Digera arvesis* among broadleaf weeds. All the weed control treatments provided effective control of weeds and significantly reduced weed population recorded at harvest as compared to weedy check (Table 1). Higher dose of each herbicide in general caused greater reduction in number and dry weight of weeds over its respective lower dose. However, integration of one hand weeding (HW) at 30 DAS with lower dose of pendimethalin (0.56 kg/ha) and trifluralin (0.50 kg/ha) proved more effective in reducing the weed density at harvest in comparison to both doses of herbicides applied alone. Pre-emergence application of trifluralin (0.50 and 0.75 kg/ha) provided significantly better weed control at harvest compared to its application as pre-plant.

All the weed control treatments significantly increased the seed and stover yields of black gram over weedy check (Table 1). The highest seed yield (1129 kg/ha) was achieved with pre-emergence application of trifluralin 0.50 kg/ha + one HW at 30 DAS which was statistically at par with its application as pre-plant at same dose + one HW at 30 DAS (1106 kg/ha) and also with HW twice at 25 and 40 DAS (1083 kg/ha). Seed yield with each herbicide at its both doses was statistically similar. However, integration of herbicide with one HW significantly increased the seed yield as compared to both doses of herbicides applied alone.

Pre-emergence application of trifluralin (0.50 kg/ha) + one HW resulted in highest net returns (Rs 7808/ha) followed by its application as pre-plant + one HW (Rs 7459/ha) and both these treatments increased the net returns by Rs 2359 and 2010, over two HWs inspite of statistically similar yields (Table 1). Except pre-emergence application of pendimethalin 0.75 kg/ha, all other treatments of herbicides applied alone or in integration with hand weeding recorded higher net returns than HW once at 30 DAS. Pre-emergence/ pre-plant application of trifluralin (0.50 kg/ha) + one HW at 30 DAS increased the net returns by Rs 7292/ 6943 per ha over weedy check (Rs 516/ha). Increase in net returns with pre-emergence application of pendimethalin (0.56 kg/ha) over weedy check was Rs 4902/ha.

Table 1 Effect of weed control treatments on weed density and dry weight, yield attributes and yield of black gram and their economics under rainfed conditions

Treatments	*Weed density ($No./0.25m^2$) At harvest*	*Seed yield (kg/ha)*	*Net returns (Rs/ha)*
Pendimethalin 0.56 kg/ha (Pre-em)	3.5 (11.8)	738	3546
Pendimethalin 0.75 kg/ha (Pre-em)	3.0 (8.2)	717	2828
Pendimethalin 0.56 kg/ha (Pre-em) + one HW at 30 DAS	2.9 (7.7)	993	5418
Trifluralin 0.50 kg/ha (Pre-plant)	3.3 (10.3)	769	4380
Trifluralin 0.75 kg/ha (Pre-plant)	3.6 (10.3)	821	4975
Trifluralin 0.50 kg/ha (Pre-plant) + one HW at 30 DAS	2.6 (5.7)	1106	7459
Trifluralin 0.50 kg/ha (Pre-em)	2.9 (7.3)	796	4752
Trifluralin 0.75 kg/ha (Pre-em)	2.8 (6.7)	785	4379
Trifluralin 0.50 kg/ha (Pre-em) + one HW at 30 DAS	2.3 (4.5)	1129	7808
One HW at 30 DAS	3.9 (14.0)	847	3879
Two HWs at 25 and 40 DAS	2.4 (4.8)	1083	5449
Weedy check	6.2 (37.3)	490	516
CD at 5%	0.4 (2.7)	133	-

Values in parentheses indicate actual weed population

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54- Bio-efficacy of Herbicides in French Bean (*Phaseolus vulgaris* L.) Grown for Seed

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INTRODUCTION

Weed competition is a major limiting factor to the productivity of french bean. Slow growth of the crop during early stages and frequent irrigation favour luxuriant growth of weeds. Malik *et al.* (1993) recorded 70% reduction in yield by leaving the crop unweeded. Weeds reduce the productivity of crops by competing for essential resources, by allelopathic effects, inducing attack of diseases and pests (Sardana and Grewal, 2003). But, the time and frequency of weeding have an important bearing in minimizing the yield loss and earn higher profits.

MATERIALS AND METHODS

Therefore, in view of the above facts, a field experiment was conducted to study the effect of weed control treatments on yield of french bean during spring season of 2003-2004 at the Vegetable Research Centre of G.B. pant University of Agriculture and Technology, Pantnagar (U.S.Nagar). Sixteen weed control treatments (Table 1) were tested in a randomized block design with 3 replications. Pendimethalin, metribuzin and chlorimuron ethyl (CME) at their respective doses were sprayed just after sowing the crop as pre-emergence application. Fluchloralin at 1.0 kg ha^{-1} was incorporated in to the soil before planting the crop. Isoproturon at 1.0 kg ha^{-1} was applied at two stages (just after planting and 15 days after sowing). French bean variety Pant Anupama was sown on Jan. 15, 2004 and was harvested on May 10, 2004. Seeds were sown using 100 kg ha^{-1}, 50 cm apart in rows. The crop was fertilized uniformly with 120 kg N, 80 kg P_2O_5 and 60 kg K_2O per ha through urea, SSP and MOP, respectively. Recommended package of practices other than weed control was adopted to raise the experimental crop.

RESULTS AND DISCUSSION

The experimental field was predominantly infested with *Cyperus rotundus, chenopodium album, Fumaria parviflora, Phalaris minor* and *Anagalis arvencis*. The other notable weeds were *Melilotus indica, Vicia hirsuta, Oxalis corniculata* and *Cynodon dactylon*. All the weed control methods significantly reduced the weed number and their dry weight as compared to weedy check at 30 DAS and at harvest. Significantly higher seed yield of french bean was recorded under weed free treatment.

On an average, the uncontrolled growth of weeds resulted in to 81.1 per cent reduction in yield of french bean when compared with weed free check (Table 1). Two hand weedings at 20 and 40 DAS, pendimethalin at both the dose and metribuzin at 250 g ha^{-1} with or without hand weeding at 40 DAS, one hand weeding at 30 DAS, chlorimuron ethyl 4.0 g ha^{-1} + weeding 40 DAS and post emergence spray of

Table 1 Effect of weed control treatments on seed yield of french bean, weed density and their dry matter.

Treatments	*Dose* ($g\ ha^{-1}$)	*Seed yield* ($q\ ha^{-1}$)	*Weed density (No. m^{-2})* 30 DAS	*Weed density (No. m^{-2})* At harvest	*Weed dry matter ($g\ m^{-2}$)* 30 DAS	*Weed dry matter ($g\ m^{-2}$)* At harvest
Pendimethalin, pre-em.	750	14.04	2.76 9 (15)	4.27 (71)	1.12 (2)	4.90 (134)
Pendimethalin + HW 40 DAS, pre-em.	750	15.63	2.68 (14)	4.06 (57)	1.05 (2)	4.34 (76)
Pendimethalin, pre-em.	1000	15.60	2.49 (11)	4.01 (54)	0.83 (1)	4.81 (122)
Fluchloralin, pre-plant	1000	10.94	3.42 (30)	4.83 (127)	1.50 (3)	5.47 (238)
Isoproturon, pre-plant	1000	11.5	2.79 (15)	4.57 (98)	1.31 (3)	5.17 (178)
Isoproturon, post-em.	1000	14.16	2.44 (11)	4.26 (70)	0.16 (0)	4.73 (113)
Metribuzin, pre-em.	250	13.21	3.00 (20)	4.69 (108)	1.32 (3)	5.27 (195)
Metribuzin, pre-em. + HW 40 DAS	250	13.92	3.07 (21)	4.12 (61)	1.32 (3)	4.42 (83)
Metribuzin, pre-em.	350	10.73	2.90 (17)	4.07 (58)	1.09 (2)	4.95 (142)
CME	4.0	9.90	3.24 (25)	4.9 (147)	1.38 (3)	5.45 (233)
CME, pre-em. + HW 40 DAS	4.0	13.71	3.16 (23)	4.36 (78)	1.34 (3)	4.56 (95)
CME, pre-em.	6.0	10.98	2.96 (19)	4.84 (127)	1.27 (3)	5.32 (205)
1 hand weeding	-	13.91	0.0 (0)	4.72 (112)	0.0 (0)	5.05 (157)
2 hand weeding	-	15.78	2.13 (8)	4.16 (63)	0.07 (0)	4.30 (73)
Weed free	-	16.80	0.0 (0)	0.0 (0)	0.0 (0)	0.0 (0)
Weedy	-	3.17	3.83 (47)	5.25 (190)	1.88 (6)	5.96 (390)
CD at 5%		3.66	0.35	0.19	0.13	0.16

isoproturon 1.0 kg ha^{-1} being on par with weed free treatment provided significantly higher seed yield than rest of the treatments.

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55- Studies on Weed Control in Pigeonpea (*Cajnus cajon* L.)

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INTRODUCTION

Pigeonpea is an important kharif pulse crop grown extensively under rainfed upland conditions in Northern hills zone of Chhattisgarh . Among the production constraints, weeds alone reduces the yield to the tune of over 50% , particularly early slow growth of pigeonpea provides a better opportunity for higher growth of weeds. Since effect of herbicides like fluchloralin is short lived and does not give desirable weed control, hence combination of weedicide alongwith culture/manual weeding has been under taken.

MATERIALS AND METHODS

The field experiment was conducted during kharif 1995 and 96 under upland sandy loam soil conditions at Zonal Agricultural Research Station (Presently RMD, College of Agriculture) Ambikapur. The rainfall during the the cropping season was 1061mm the soil of experimental field was Low in nitrogen (168 kg/ha) and available phosphorus (8.2kg/ha) and sufficient in potassium (281 kg/ha). The experiment was laid out in a randomized block design with 15 treatment combinations of two herbicides i.e. fluchloralin @ 1.0 and 1.5 kg a.i. /ha and alachlor @ 1.00 kg and 1.25 kg a.i. /ha, conventional weeding by spade (1& 2), mechanical weeding by Kakurra rotatory weeder (1& 2) and handweeding (1&2) crop was grown following the recommended package of practices. The crop was sown in the first fortnight of July and harvested in the II fortnight of February each year.

RESULTS AND DISCUSSION

The major weeds observed in the experimental field were. *Sylotia argentia, Ajaratum conjoides, Parthenium hysterophorus L. Eleusine indica, Digitaria ciliaris, Cyperus rotundus, Cyperus iria, Amaranthus viridis, Commelina benghalensis and Eclipta alba etc.*

Among the treatments, two hand weeding at 25 and 50 DAS (1093kg) alachlor 1.25 kg a.i./ha + one weeding by spade (1042 kg/ha) fluchloralin 1.5 kg a.i. /ha + one weeding by spade (998 kg/ha) and alachlor 1.25 kg and one weeding Kakurra rotatory weeder (916 kg/ha) gave at par and significantly higher yield of pigeonpea and less no. of weeds and weed dry weight than other treatments. All the weed control treatments gave significantly higher yield than weedy check.

Table1 Effect of weed control treatments on weed dry wt. and yield of Arhar.

Treatment	*Yield (kg/ha)*	*Weed drywt (g/m²)*	*WCE (%)*
Unweeded control	178	496	-
Conventional weedings by spade at 25DAS	593	222	55.24
Mechanical weeding by Kakurra at 25 DAS	562	252	49.19
Two mechanical weeding by Kakurra	876	183	63.10
Conventional Weeding by spade at 25 & 50 DAS	936	153	69.15
One hand weeding at 25 DAS	604	196	60.48
Two hand weeding at 25 & 50 DAS	1093	39	92.13
Fluchloralin 1.25 kg a.i./ha.soil incorporated	496	302	39.11
Fluchloralin 1.5 kg a i/ha soil incorporated.	536	242	51.20
Alachlor 1 kg a i/ha, Pre-emergence.	582	141	71.57
Alachlor 1.25 kg a i/ha, Pre-emergence.	709	136	73.58
Fluchloralin 1.25 kg a.i./ha + one weeding by Kakurra at 50 DAS.	996	59	88.10
Fluchloralin 1.5 kg a.i./ha. + One weding by Kakurra at 50 DAS.	816	132	73.38
Alachlor 1.25 kg ai/ha, one weeding by spade at 50 DAS	1042	41	91.73
Alachlor 1.25 kg a i/ha + one weeding by Kakurra at 50 DAS.	916	82	83.46
CD at 5%	161.13	41.56	

56- Relative Efficacy of Mechanical and Chemical Weed Control Practices on Chlorophyll Content and Enzymatic Activities in Lentil (*Lens culinaris* Medic L.)

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INTRODUCTION

The effect of mechanical and chemical weed control practices on chlorophyll content, nitrate reductase, nitrite reductase, catalase and peroxidase activities in leaf samples was studied in Lentil.

MATERIALS AND METHODS

A field study was carried out during winter season of 2004-05 at Agronomy Research Farm of the university in a three replicated randomized block design. The sowing of lentil var. HUL 35 was done in lines on October 19, 2004. Four treatments were applied to the crop viz. i) weedy ii) hand weeding (H.W.) at 20 and 40 days of sowing (DAS) iii) quizalofop-ethyl (10EC) @ 50 g/ha post –emergence at 20 DAS iv) pendimethalin @ 1.0 kg/ha pre –emergence. Hand weeding was done with the help of hand chisel. Herbicides were sprayed with the help of a manual operated Knapsack sprayer fitted with flatfan nozzle using 500 litres/ha. All the biochemical and enzymatic studies were done at 45 DAS in leaf samples. Total chlorophyll content was estimated by the method as suggested by Arnon (1949). Nitrate reductase, nitrite reductase, catalase and peroxidase activities were measured by the methods as given by Jeworski (1971), Ferari and Varner (1971), Sinha (1972) and Mc-Curne *et al.* (1959), respectively.

RESULTS AND DISCUSSION

It is evident from the results (Table1) that H.W. 20 and 40 DAS being at par with pre-em. application of pendimethalin @ 1.0 kg/ha has been found promising to enhance total chlorophyll content in fresh leaves of crop plant significantly as compared to weedy and post-em. application of quizalofop-ethyl @ 50 g/ha, means quizalofop-ethyl has adverse effect on chlorophyll content in leaves.

Considerable variations in nitrate and nitrite reductase activities due to different weed control practices have been noted. H.W. 20 and 40 DAS encouraged significantly the activities of both the enzymes as compared to rest of the treatments which was closely followed by the pendimethalin applied at 1.0 kg/ha as pre-em. only in case of nitrate reductase activity. Thus, it is obvious that quizalofop-ethyl used @ 50 g/ha as post-em. affected the activities of both the enzymes adversely.

By and large, application of pendimethalin @ 1.0 kg/ha and quizalofop-ethyl @ 50 g/ha enhanced the activities of both catalase and peroxidase enzymes as compared to weedy and hand weeding treatments. However, the enhancement in the activities of both the enzymes due to quizalofop-ethyl was significantly more than pendimethalin.

Table1 Effect of different weed control practices on chlorophyll content, nitrate reductase, nitrite reductase, catalase and peroxidase activities in leaves of lentil.

Treatment	*Total chlorophyll (mg/g fresh wt)*	*Nitrate reductase (μ mole NO_2^- produced/g f.w./h)*	*Nitrate reductase (μ mole NH_4 produced/g f.w./h)*	*Catalase (unit/g f.w.)*	*Peroxidase (unit/g f.w.)*
Weedy	3.20	31.20	52.72	36.25	94.45
H.W. 20 and 40 DAS	3.97	39.00	63.85	30.13	85.30
Quizalofop-ethyl @ 50 g/ha post-em. at 20 DAS	3.21	29.30	46.22	63.10	146.60
Pendimethalin @ 1.0 kg/ha pre-em.	3.94	34.40	58.25	50.40	122.23
CD at 5%	0.63	5.27	5.06	5.81	12.14

CONCLUSION

H.W. 20 and 40 DAS and pre-em. application of pendimethalin @ of 1.0 kg/ha have been found favourable to enhance the chlorophyll content, nitrate and nitrite reductase activities in leaves. While, in case of catalase and peroxidase activities, quizalofop-ethyl used @ 50 g/ha as post-em. and pendimethalin @ 1.0 kg/ha pre-em. developed stress condition in crop plant due to which the activities of both the enzymes were high.

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57- Relative Efficacy and Economic of Mechanical and Chemical Weed Management in Chickpea (*Cicer arietinum* L.) in Eastern Part of Uttar Pradesh

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INTRODUCTION

Field experiments were conducted to compare the mechanical and chemical weed management practices in chickpea as well as to calculate the economics of different weed control practices.

MATERIALS AND METHODS

The field experiment was conducted at Agronomy Research Farm of the University in a randomized block design with four replications during *rabi* 2003-04. Sowing of chickpea cv. Udai was done in lines at 30 cm apart using 80 kg seed ha^{-1} on Oct. 30, 2003. A common dose of 100 kg DAP/ha was given to the crop as ploughsole placement. The soil was silt loam in texture with medium fertility. In mechanical method, the weeding was done with small hand tool locally known as khurpi and pul and push type weeder. In herbicide treatment, pendimethalin 1.0 kg/ha as pre emergence and fluchloralin 1.0 kg/ha as ppi were used.

RESULTS AND DISCUSSION

The predominant weeds infesting the crop were *Cyperus rotundus* of sedge group, *Cynodon dactylon* and *Phalaris minor* of grass group and *Chenopodium album*, *Convolvulus arvensis*, *Vicia sativa*, *Launea asplenifolia*, *Gnaphalium pulvinatum*, *Polygonum plebejum* and *Cirscium arvena* of BLW group.

By and large, the performance of all the mechanical and chemical weed management practices were significantly better than weedy treatment to reduce the weed density as well as weed dry weight per unit area. Hand weeding at 35 DAS was significantly better than weeding with weeder at 35 DAS to reduce the weed dry weight but both were similar in respect of weed density. Further, it is clear from the results that mechanical method of weed control was as effective as chemical method of weed control to reduce the weed density. Integration of pendimethalin 1.0 kg/ha or fluchloralin 1.0 kg/ha + H.W. 35 DASD has been found most effective to reduce the weed density as compared to mechanical as well as chemical method when applied alone. Malik *et al.* (1982) from HAU, Hisar have also reported the significant effect of mechanical weeding to destroy the weeds in chickpea.

In respect of weed dry weight, chemical method alone or with integration of mechanical method showed significant effect to reduce the weed dry weight as compared to mechanical method only. No doubt, integrated approach (chemical + mechanical) provided significantly reduced weed dry weight as compared to chemical only.

Significantly the highest grain yield of chickpea was registered in weed free treatment. Pre-emergence application of pendimethalin 1.0 kg/ha provided grain yield significantly higher than mechanical weeding. Integrated method (Pendimethalin 1.0 kg/ ha as pre. em. fb H.W. 35 DAS) being statistically on par with fluchloralin 1.0 kg/ha as ppi fb H.W. 35 DAS provided significantly higher grain yield of chickpea than rest of the treatment. Unchecked weed growth hampered the crop yield by 39.6 per cent when compared with the yield of registered by weed free treatment

Pre-emergence application of pendimethalin 1.0 kg/ha alone has been found most economical fb use of fluchoralin alone 1.0 kg/ha as ppi. Saxena and Ali (1995) also reported from IIPR, Kanpur that pre-emergence application of pendimethalin 0.75 kg/ha + H.W. 50 DAS provided significantly higher grain yield over weedy treatment. Singh and Singh (1992) from Pantnagar have also reported 49.5 per cent reduction in yield of chickpea by weeds.

Table 1. Effect of different weed control treatments on weed density, weed dry weight, yield of chickpea and economics

Treatment	*Weed density (no. m^{-2})*	*Weed dry wt. (gm^{-2})*	*Grain yield ($q\ ha^{-1}$)*	*Cost Benefit ratio*
Weedy	9.00(77)	9.76(94.40)	12.97	-
Weed free	1.00(0.00)	1.00(0.00)	21.48	2.47
Hand weeding at 35 DAS	7.36(53)	8.45(70.40)	15.52	1.94
Weeding with weeder at 35 DAS	7.67(58)	9.11(82.00)	14.73	2.66
Pendimethalin 1.0 kg ha^{-1} as pre-em.	7.08(49)	7.45(54.50)	17.01	3.68
Pendimethalin 1.0 kg ha^{-1} as pre-em. + HW at 35 DAS	6.05(36)	5.63(30.80)	18.41	2.59
Fluchloralin 1.0 kg ha^{-1} as ppi	7.47(55)	7.96(62.40)	16.13	3.38
Fluchloralin 1.0 kg ha^{-1} as ppi + HW at 35 DAS	6.5(42)	6.60(42.60)	18.15	2.72
CD at 5 %	0.52	0.28	1.15	-

Figures in parentheses are original values and transformed by / x + 1

HW – Hand weeding DAS – Days after sowing PPI – pre-plant incorporation

CONCLUSION

Next to weed free treatment, pre-emergence application of pendimethalin 1.0 kg/ha or pre-plant incorporation of fluchloralin 1.0 kg/ha or pre plant incorporation of fluchloralin 1.0 kg/ha each coupled with one H.W. at 35 DAS provided the highest grain yield of chickpea and was most effective to control the weeds. However, the most remunerative treatment was pre-emergence application of pendimethalin 1.0 kg/ha alone.

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OILSEEDS

58- Alternative Approach to Manage the Post-emerging Weeds through Pre-emergence Herbicides in Irrigated Peanut

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INTRODUCTION

Groundnut faces severe competition from weeds, which appear in several flushes during the crop season. In addition, groundnut being a leguminous crop fixes atmospheric nitrogen and encourages the weed growth throughout the crop period. The second flush of weeds emerged during late season will seriously affect the pegging and development of pods apart from disrupting digging and harvesting operations and causes pods to be stripped from vines, thus rendering them unharvestable. Considering the importance of late season weeds, the present study was formulated and conducted to identify suitable combination of chemical and cultural method of managing the late emerging weeds in groundnut.

MATERIALS AND METHODS

The field experiment was laid out in randomized block design with three replications. The sequential application of herbicides metolachlor and fluchloralin were compared with control and pre emergence application. Calculated quantities of different doses of the herbicides metolachlor and fluchloralin were mixed with sand and broadcasted uniformly with the standing water (40 DAS). The sand mixed herbicides retained by the growing tip was removed by shaking the plant with the help of a stick. Weed population and weed dry matter productions were recorded in periodic intervals.

RESULTS AND DISCUSSION

Effect of herbicides on weeds

Sequential application of metolachlor 1 kg ha^{-1} immediately after sowing and at 40 DAS as sand mix in combination with hoeing and earthing up at 40 DAS significantly reduced the population and dry matter production of grasses, sedges and broad leaved weeds. This might be due to the effective control of weeds at critical stages and sustained weed free condition for the rest of the crop growth period. The finding of Grichar *et al.* (1996) lends support to the present investigation. Performance of fluchloralin was poor compared to metolachlor because of its higher volatilization and photodecomposition nature of fluchloralin.

The WCE was higher at Sequential application of metolachlor 1 kg ha^{-1} immediately after sowing and at 40 DAS as sand mix in combination with hoeing and earthing up at 40. Hand weeding recorded lower WCE because of emergence of weeds at later stages.

The highest pod yield of 2423 kg ha^{-1} was recorded in weed free check followed by the sequential application of metolachlor 1 kg ha^{-1} after sowing + soil application of metolachlor at 40 DAS after earthing up (2295 kg ha^{-1}) because of effective utilization of all the available resources. There was in increased yield by 67.5 and 66.7 per cent in these treatments over control. Haulm yield was also higher for the above treatment. Based on the above results it can be concluded that sequential application of metolachlor at the time of sowing and 40 DAS as sand mix application reduces the population and drymatter production of weeds and increases the growth, yield attributes and yield.

Table1 Effect of weed control treatments on weed parameters and yield of groundnut

Treatments	Weed density (No.m^{-2})	Weed dry weight (kg ha^{-1})	WCE (%)	WCI (%)	Dry pod yield (kg ha^{-1})	Haulm yield (kg ha^{-1})
M_1+EU_{40}	2.22(165.00)	2.38(237.47)	67.20	82.78	1434	2199
F_1+EU_{40}	2.30(197.00)	2.44(273.73)	60.83	80.15	1377	2112
M_1+EU_{40}+M_1	1.65(43.00)	2.07(116.07)	91.45	91.58	2295	2527
F_1+EU_{40}+F_1	1.97(90.67)	2.34(220.50)	81.97	84.01	1793	2312
M_1+EU_{40}+F_1	1.88(74.29)	2.32(209.10)	85.23	84.84	1803	2389
F_1+EU_{40}+M_1	1.70(48.36)	2.08(120.16)	90.39	91.29	2208	2502
H_{20}+EU_{40}	2.49(306.36)	2.74(545.28)	39.09	60.46	1312	1971
H_{20}+EU_{40}+M_1	1.72(50.86)	2.11(130.57)	89.89	90.53	2140	2471
H_{20}+EU_{40}+F_1	1.96(90.11)	2.34(218.43)	82.09	84.16	1754	2278
Weedy check	2.70(503.00)	3.14(1379.13)	-	-	781	1801
Weed free check	0.92(6.40)	1.13(11.41)	98.73	99.17	2423	2600
CD at 5%	0.08	0.13	—	—	209.57	143.29

M_1-Metolachlor pre emergence 1.00 kg ha^{-1} H_{20}-Hand weeding at 20 DAS
F_1-Fluchloralin pre-emergence 1.00 kg ha^{-1} EU_{40}-Earthing up at 40 DAS
Figures in the parenthesis indicate the original values

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59- Screening of Pre-emergence Herbicides for Managing the Late Emerging Weeds (LEW) in Irrigated Groundnut

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INTRODUCTION

Groundnut (*Arachis hypogaea*) is one of the major edible oilseed crops extensively cultivated in India. It faces severe competition from weeds, which appear in several flushes during the crop season. (Vasisht and Pandey, 1999). Because of pulverization of soil and adequate soil moisture, in every hoeing, the weed seeds, which are lying just below the soil surface, are brought to surface and germinate vigorously. The second flush of weeds emerged during late season will seriously affect the pegging and development of pods apart from disrupting digging and harvesting operations. Much work has been done to manage the weeds emerged during initial growth stage of groundnut Considering the importance of late season weeds, the present study was formulated and conducted with the following objective of to screen the optimum dose of pre-emergence herbicides, metolachlor and fluchloralin for the late season application in groundnut.

MATERIALS AND METHODS

Herbicide screening trial was conducted in P2 Farm, Millet Breeding Station, Coimbatore during July to November, 2002. The herbicides metolachlor and fluchloralin with four different doses were tested. The treatment details are metolachlor 0.75, 1.0, 1.25 and 1.5 kg/ ha and fluchloralin 0.75, 1.0, 1.25 and 1.5 kg/ ha along with unweeded (control) treatment. The herbicides were mixed with known quantity of sand and uniformly broadcasted in the standing water immediately after irrigation. Weed population and weed control efficiency were worked out for fixing the optimum dose of herbicides.

RESULTS AND DISCUSSION

Comparison of different doses of herbicides in screening trial

In both the herbicides, the highest dose of 1.5 kg ha^{-1} has exhibited more efficiency in controlling the late emerged weeds as well as increasing the pod yield and on par with1.25 kg ha^{-1} and1.0 kg ha^{-1}. Higher doses of both herbicides were equal in their performance with respect to weed control and pod yield, considering the economics and effect of herbicides on microbial population, the optimum dose of 1.0 kg ha^{-1} for metolachlor and fluchloralin was fixed for controlling late emerging weeds.

Weed characters

Pre-emergence herbicides applied at 40 DAS, metolachlor recorded lesser weeds and more WCE of 86.94 per cent at 60 DAS, followed by 1.25 kg (85.70 %) and 1.00 kg ha^{-1} (84.57 %), respectively compared to fluchloralin at 60 DAS irrespective of the doses. Metolachlor at 1.00 kg ha^{-1} and 1.25 kg ha^{-1} were equally effective as that of 1.5 kg ha^{-1}. The same trend was maintained upto harvest and the number of weeds were increased towards maturity.

Different doses of fluchloralin applied at 40 DAS, 1.5 kg ha^{-1} recorded the least number of grasses and broad-leaved and recorded more weed control efficiency and it was on par with 1.0 and 1.25 kg ha^{-1}.

Phytotoxicity rating

Both the herbicides applied at 40 DAS, as sand mix immediately after earthing up and irrigation were not affected the growth and development of the crop. There were no phytotoxic symptoms observed at all doses of herbicides. The phytotoxicity rating scale of zero was observed at all the doses and were similar to that of control.

Yield of groundnut

Metolachlor treatments, 1.50 kg ha^{-1} recorded significantly higher yield (2028 kg ha^{-1}) compared to 0.75 kg ha^{-1} and no herbicide application and comparable with that of 1.25 and 1.00 kg ha^{-1}. Application of fluchloralin at 1.50 kg ha^{-1} recorded significantly higher pod yield (2003 kg ha^{-1}) compared to 0.75 kg ha^{-1} (1460 kg ha^{-1}) and on par with 1.25 and 1.0 kg ha^{-1}.

Considering the economics and biological reasons, the herbicide dose at 1.00 kg ha^{-1} was fixed for both metolachlor and fluchloralin to manage the late emerging weeds in conjunction with cultural practices in the main field experiment.

Table 1 Effect of different doses of herbicides on yield of groundnut

Treatments	*Weed density*	*Weed control efficiency (%)*	*Pod yield (kg ha^{-1})*
Metolachlor 0.75 kg ha^{-1}	1.85(70.14)	74.33	1513
Metolachlor 1.00 kg ha^{-1}	1.79(59.62)	81.21	1905
Metolachlor 1.25 kg ha^{-1}	1.76(55.24)	85.09	2011
Metolachlor 1.50 kg ha^{-1}	1.72(50.48)	86.21	2028
Fluchloralin 0.75°kg ha^{-1}	1.92(81.36)	66.80	1460
Fluchloralin 1.00 kg ha^{-1}	1.87(71.64)	77.47	1929
Fluchloralin 1.25 kg ha^{-1}	1.83(66.57)	73.78	1948
Fluchloralin 1.50 kg ha^{-1}	1.80(63.35)	79.96	1987
Control	2.59(386.38)	—	980
CD at 5%	0.11m	—	248.75

Figures in the parenthesis indicate the original values

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60- Effect of Herbicides on Weed Control and Yield of Indian Mustard

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INTRODUCTION

Indian mustard is a potential winter season oilseed crop in south-western region of Punjab. Heavy infestation of weeds has become a serious problem for increasing the seed yield of Indian mustard particularly under irrigated conditions. Due to severe weed competition, the yield reduction in Indian mustard may go as high as 70% (Tiwari and Kurchania 1993). Use of herbicides for control of weeds has been found to be more effective, economical and quicker than hand weeding. Hence the present investigation was undertaken.

MATERIALS AND METHODS

The field experiments were conducted during winter seasons of 1997-98 and 1998-99 at PAU, Regional Research Station, Bathinda. The soil of the experimental field was sandy loam with soil pH 8.4, low in available N and P but high in available K. The experiment was laid out in a randomized block design with four replications. The treatment details are given in Table 1. The Indian mustard cv. RLM 619 was sown on 21 November 1997 and 13 November 1998 at 30 cm apart by using 5 kg ha^{-1} seed rate. All other package of practice were followed as per recommendations. Herbicides were sprayed at 500 l ha^{-1} spray volume using knapsack sprayer fitted with flat fan nozzle. The data on dry matter of weeds were recorded at 75 days after sowing.

RESULTS AND DISCUSSION

Weed flora of the experimental field consisted of *Chenopodium album, Anagallis arvensis, Melilotus indica, Fumaria perviflera* and *Asphodelus tenuifolius*. Dry weight of weeds was significantly reduced by all the treatments as compared to weedy check (Table 1). Minimum dry weight of weeds (0.96 q ha^{-1}) was recorded with post emergence application of isoproturon at 750gha^{-1}. Pre emergence application of trifluralin at 1200 g, pendimathalin at 750 g and post emergence application of pendimethalin at 750 g ha^{-1} produced statistically similar dry weight of weeds as compared to two hand weeding. Weed control efficiency ranged between 50.2 to 84.6% with different herbicides. Among different weed control measures, isoproturon 0.75 kg ha^{-1} (post-emergance) resulted in the highest weed control efficiency (84.6%) followed by trifluralin 1.2 kg ha^{-1} (pre-emergence) pendimethalin 0.75 kg ha^{-1} (post and pre-emergence).

Plant height was significantly decreased with the post emergence application of pendimethalin. Maximum seed yield (9.92 qha^{-1}) was obtained with trifluralin 1.2 kg ha^{-1} (pre-emergance) which was on par with two hand weeding, pendimethalin (pre-emergance) at 750 g and isoproturon at 0.75 kg ha^{-1} (post-emergance). All these treatments produced significantly higher seed yield than weedy check. Application of trifluralin recorded 83.4% higher seed yield than weedy check.. Higher seed yield under these treatments may be attributed to better weed control efficiency, more number of siliquae per plant and seeds per siliqua. Results are in conformity with those of Tomar & Namdeo (1991).

Table 1 Effect of herbicide treatments on dry matter of weeds and seed yield of Indian mustard. (Pooled data of two years)

Treatment	*Dose (g ha^{-1})*	*Dry weight of weeds (q ha^{-1})*	*Weed control efficiency (%)*	*Plant height at harvest (cm)*	*Number of siliquae per plant*	*Number of seeds per siliqua*	*Seed yield (q ha^{-1})*
Trifluralin (Pre-em.)	1200	1.35	78.4	166.4	197.5	15.2	9.92
Pendimethalin (Pre-em.)	375	3.11	50.2	163.5	186.8	14.8	7.27
Pendimethalin (Pre-em.)	750	1.78	71.5	161.5	196.1	15.5	8.29
Pendimethalin (Post-em. 30DAS)	750	1.63	73.9	143.9	178.7	14.5	7.41
Isoproturon (Pre-em.)	750	3.05	51.2	155.1	196.2	15.4	7.46
Isoproturon (Post-em.30DAS)	750	0.96	84.6	162.0	193.5	14.8	7.89
2 HW (30&60DAS)	-	1.82	70.9	164.0	198.9	14.8	9.03
Weedy	-	6.25	-	158.7	157.2	13.0	5.41
CD at 5%		1.05	-	8.2	5.2	0.9	2.30

CONCLUSIONS

Isoproturon (post-emergence) at 750 g, trifluralin (pre-emergence) at 1200 g, pendimethalin (post-emergence) at 750 g and pendimethalin (pre-emergence) at 750 g ha^{-1} proved most effective in controlling weeds. Maximum seed yield was obtained with the application of trifluralin (pre-emergence) which was 83.4% higher than weedy check, but was on par with two hand weedings, pendimethalin (pre-emergence) at 750g and isoproturn (post-emergence) at 750 g/ ha.

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61- Phytotoxicity of Pendimethalin in Mustard Under Terai Agro-Climatic Region of West Bengal

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INTRODUCTION

The productivity of rapeseed-mustard crop in West Bengal is still far behind than that the leading oil seed producing states of India. One of the major causes of low oil seed productivity is high weed pressure in mustard especially under terai agro-climatic region due to heavy rainfall and multiple micronutrient deficiency. Present study was, therefore, undertaken with the objective to evaluate bio-efficacy of preemergence herbicides like pendimethalin and fluchloralin in mustard in order to achieve control on weeds.

MATERIALS AND METHODS

A field experiment was carried out in the farm of Uttar Banga Krishi Viswavidyalaya during the rabi season of 2002–03 and 2003-04. Different doses of pendimethalin like 0.75,1.00,1.25,1.50 kg ha^{-1}; doses of fluchloralin like 1.00, 1.25, and 1.50 kg ha^{-1}, two hand weeding at 20 and 40 DAS, weedy check and complete weed-free situation were evaluated in the experiment through the adoption of randomized block design.

RESULTS AND DISCUSSION

Effect on crops and weeds

Both the herbicides registered high value of weed control efficiency, however, pendimethalin at all the doses became phytotoxic on mustard plants. The lowest dose of pendimethalin at 0.75 kg ha^{-1} caused the growth reduction on account of 66.97%. Fluchloralin at 1.50 kg ha^{-1} became phytotoxic in limited extent and caused the growth reduction to the tune of 36.99% (Table 1). Fluchloralin at 1.00 kg ha^{-1} was non-phytotoxic to mustard and initial growth suppression of 20.93% was recovered completely at the later part of the crop growth. The herbicide pendimethalin has failed to ensure the operation of depth protection mechanism in making selectivity of herbicide under high soil moisture situation of light textured soils a characteristic feature of the region.

Plant population

Similar effects were seen in the population of the crops where pendimethalin treated plots showed very low plant population; in some cases it was even lower than the value obtained in the weedy plot.

Weed index and weed control efficiency

Fluchloralin at 1.25 and 1.00 kg ha^{-1} registered high value of weed control efficiency as well as low value of weed index (Table 1). Fluchloralin with these doses proved to become effective as selective preemergence herbicide in order to control weeds in mustard without causing phytotoxicity on mustard plant.

Yield

Highest seed yield of mustard was obtained in completely weed-free plot (10.86 – 12.88 q ha^{-1}), which was statistically similar with the treatments fluchloralin at 1.25 (9.16 – 11.61 q ha^{-1}) and 1.00 kg ha^{-1} (8.9 – 10.67 q ha^{-1}).

Keeping the fact in mind that black necrotic spots at the base of the plant were observed during siliqua development stage in the plot treated with fluchloralin at 1.25 kg ha^{-1}. However, these spots were disappeared at later part of crop growth. Therefore, in order to minimize risky proposition relating to phytotoxicity in mustard due to herbicide application fluchloralin at 1.00 kg ha^{-1} was recommended as selective preemergence herbicide in mustard. Pal *et al.* (2000) also found that preemergence application of fluchloralin at 1.00 kg ha^{-1} was more effective in minimizing the weed pressure in Indian mustard fields compared to the same doses of pendimethalin in southern parts of West Bengal. Anand *et al.* (2000) also reported the similar findings.

Table 1 Effect of treatments on phytotoxicity on crop plant, plant population, seed yield, weed control efficiency and weed index.

Treatment	*Crop injury (% GR)*	*Plant population (plant m^{-2})*		*Seed yield (q ha^{-1})*		*WCE (%) at 90DAS*		*%*
		2002	*2003*	*2002*	*2003*	*2002*	*2003*	*2003*
Pendimethalin at 0.75 kg ha^{-1}	66.97	9.50	10.68	2.80	3.13	64.50	66.12	75.66
Pendimethalin at 1.00 kg ha^{-1}	79.79	7.63	8.48	2.23	2.46	71.33	73.78	80.86
Pendimethalin at 1.25 kg ha^{-1}	85.79	5.41	6.22	1.62	1.86	76.68	79.35	85.57
Pendimethalin at 1.50 kg ha^{-1}	93.70	1.30	2.00	0.24	0.39	79.78	82.49	96.97
Fluchloralin at 1.00 kg ha^{-1}	20.93	30.53	36.59	8.90	10.67	57.78	58.46	17.16
Fluchloralin at 1.25 kg ha^{-1}	24.98	31.59	40.00	9.16	11.61	62.88	63.75	09.86
Fluchloralin at 1.50 kg ha^{-1}	36.99	23.64	26.26	6.31	6.93	65.07	66.02	44.80
HW at 20 and 30 DAS	–	25.93	28.82	6.41	7.11	58.15	58.65	46.21
Weedly	–	4.49	4.59	0.77	0.72	–	–	94.37
Weed-free	–	36.92	44.30	10.86	12.88	–	–	–
CD at 5%	–	1.55	1.78	3.21	4.44	–	–	–

GR – Growth reduction, WCE- Weed control efficiency (%), DAS-Days after sowing, HW- Hand weeding

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FODDERS

62- Weed Management in Persian Clover (*Trifolium resupinatum* L.)

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INTRODUCTION

Persian clover popularly known as *shaftal*, is a winter leguminous fodder crop which is highly nutritious, palatable and relished by animals. It supplies green fodder from November to mid-May. Moreover, it is highly resistant to stem-rot disease and is thus suitable particularly for disease infested areas. The growth of Persian clover is relatively slow in the initial stages and the weed infestation offers severe competition resulting in low fodder yield. Since no work has been done on the weed management of Persian clover, therefore, the present study was undertaken.

MATERIALS AND METHODS

A field experiment was conducted during the winter seasons of 2002-03 and 2003-04 to study the effect of weed management in Persian clover. The experimental site was loamy sand in texture, low in available nitrogen and medium in available phosphorus and potash with 8.1 pH. The 12 treatments (Table 1) replicated 3 times were laid out in randomized block design. Fluchloralin was incorporated in soil before sowing and pendimethalin and butachlor were sprayed 2-3 days after sowing the crop using 500 l ha^{-1} spray volume. The variety *Shaftal*-69 was sown in third week of October at a row spacing of 30 cm by *kera* method using 10 kg seed ha^{-1}. Five cuttings of the fodder were taken during both the years. The other cultural practices were uniformly applied to all the treatments.

RESULTS AND DISCUSSION

Effect on weeds

The major weed flora consisted of *Cichorium intybus, Poa annua, Trianthema portulacastrum, Rumex dentatus* and *Lepidium sativa*. The weed infestation was more severe up to first cutting and reduced during later cuttings because of more tillering of the crop in the later cuttings. The dry matter of weeds was suppressed significantly by fluchloralin and butachlor herbicides; and hand weeding treatments over weedy check in all the 5 cuttings. Fluchloralin herbicide was only effective against *Poa annua* weed, while butachlor herbicide controlled *Cichorium intybus* weed. *Rumex dentatus* and *Lipidium sativa* were not controlled by any of the herbicides. Pendimethalin though controlled the weeds in the first cutting but was toxic to the crop and more space was available for the establishment of the weeds resulting in significantly higher dry matter of weeds in the later cuttings.

Effect on fodder yield

The green fodder and dry matter yields of Persian clover increased significantly by two hand weeding (30 and 45 day after sowing); fluchloralin at 0.90 and 1.12 kg ha^{-1}; and butachlor at 1.5 and 2.0 kg ha^{-1} over weedy check but the differences among different doses of herbicides and hand weeding treatments were non-significant. Pendimethalin at all the doses, fluchloralin at 1.12 kg ha^{-1} and butachlor at 2.0 kg ha^{-1} though controlled the weeds but had toxic effect on the crop. The crude protein content of Persian clover (21.8 to 22.8 %) was improved with all the weed management treatments over weedy check (20.6 %). Similar results have also been reported by Tiwana *et al* (2002) in *berseem*.

Table 1 Effect of weed management on weeds, crop growth and fodder yield of Persian clover (Mean of 2 years)

Treatments	*Dose (kg ha⁻¹)*	*Weeds dry wt. (g m⁻²)*			*Green fodder (t ha⁻¹)*	*Dry fodder (t ha⁻¹)*	*Crude Protein (%)*
		1st cut	*3rd cut*	*5th cut*			
Weedy check	-	107.4	50.6	25.3	72.3	9.0	20.6
Hand weeding, 30 DAS	-	50.2	42.7	20.0	79.1	10.3	21.8
Hand weeding, 30 & 45 DAS	-	24.3	38.5	19.6	84.7	10.8	22.4
Pendimethalin	1.00	59.3	74.5	42.8	56.5	7.2	22.4
Pendimethalin	1.25	46.8	78.4	46.5	50.0	6.3	22.0
Pendimethalin	1.50	24.5	73.3	44.0	46.8	6.0	22.2
Fluchloralin	0.67	77.7	42.8	16.2	79.4	10.0	22.8
Fluchloralin	0.90	48.7	40.7	9.1	84.1	10.8	22.4
Fluchloralin	1.12	38.9	36.2	7.7	81.9	10.5	22.8
Butachlor	1.00	87.0	38.1	6.9	78.6	10.1	22.4
Butachlor	1.50	55.7	37.4	6.4	85.4	10.9	22.4
Butachlor	2.00	41.7	32.6	5.4	83.1	10.5	22.8
CD at 5%		12.51	7.06	4.13	6.97	0.95	-

CONCLUSIONS

The weed infestation was more severe up to first cutting. The dry matter of weeds was suppressed significantly by fluchloralin and butachlor herbicides; and hand weeding treatments over weedy check in all the 5 cuttings. Fluchloralin herbicide was only effective against *Poa annua* weed, while butachlor herbicide controlled *Cichorium intybus* weed. *Rumex dentatus* and *Lipidium sativa* were not controlled by any of the herbicides. Pendimethalin showed toxic effect on the crop. The green fodder and dry matter yields of Persian clover increased significantly with two hand weeding (30 and 45 day after sowing); fluchloralin at 0.90 and 1.12 kg ha^{-1}; and butachlor at 1.5 and 2.0 kg ha^{-1} over weedy check. All the weed management treatments improved the crude protein content of Persian clover over weedy check.

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63- Pendimethalin for Weed Control in Guar (*Cyanopsis tetragonoloba* L.) under Irrigated Conditions

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INTRODUCTION

Guar (Cyanopsis tetragonoloba L.) is important leguminous crop grown during kharif season in south-western Punjab. The area under this crop is continuously increasing with the adoption of the crop under contract farming by the Government of Punjab. Guar, being a rainy season crop is badly infested with different categories of weeds. Being a slow growing crop during the initial stages of the growth, weeds overgrow the crop and compete with the crop for nutrients, water space. If not timely controlled inflict heavy losses in straw and grain yield of the crop.

MATERIAL AND METHODS

An experiment was conducted at PAU, Regional Station, Bathinda during kharif, 2000, 2001 and 2002 to study the effect of different weed control treatments on weed dry matter, yield attributing characters and seed yield of *guar* sown under irrigated conditions. The experiment was conducted on loamy sand soil low in nitrogen, medium in phosphorus and potash. The pH of the soil was 8.5. The experiment was laid out in randomized block design (RBD) with four replications. The treatments were unweeded control, pendimethalin @ 1.25 kg/ha, pendimethalin @ 1.88 kg/ha, pendimethalin @ 2.50 kg/ha, fluchloralin @ 1.25 kg/ha, fluchloralin @ 1.88 kg/ha, fluchloralin @ 2.50 kg/ha and hand weeding 5 WAS. Pendimethalin was applied as pre emergence, where as fluchloralin applied as pre plant. The variety sown was AG-112 and the crop was sown during first fortnight of July during all the three years.

RESULTS AND DISCUSSION

The results showed that pendimethalin gave effective weed control and significantly increased the mean seed yield by 45 per cent over unweeded control and over hand weeding by 20 per cent. The highest mean seed yield (1987 kg/ha) was recorded when pendimethalin was applied @ 1.88 kg/ha as pre-plant application. There was consistently higher seed yield in this treatment during all the three years. Although higher dose of pendimethalin @ 2.50 kg/ha also gave effective weed control, but toxicity of herbicide was observed on the crop due to loamy sand texture of the soil, which resulted in yield decline due to toxicity on the crop. Pendimethalin at all the doses proved better as compared to fluchloralin. The mean dry matter of weeds at 50 days after sowing (DAS) was the lowest in hand weeding (2.5 q/ha) followed by pendimethalin @ 2.50 kg/ha, (3.3 q/ha). All the treatments significantly reduce weed dry matter over control. The highest yield recorded in pendimethalin @ 1.88 kg/ha may be due to lower weed dry matter, higher number of grains per pod (8.3) and higher number of pods per plant (53.1) as compared to control and other treatments. Similarly, significantly higher straw yield (3760 kg/ha) was recorded in pendimethalin @ 1.88 kg/ha as compared to all other treatments. For efficient weed control in *guar* sown under irrigated conditions on loamy sand soil, pre-emergence application of pendimethalin @ 750 ml / acre proved very effective and significantly increase seed and straw yield. Kumar and Singh (2002) reported application of trifluralin and fluchloralin for control of weeds in guar.

Table 1 Effect of Different Weed Control Treatments on yield attributing characters, weed dry matter, straw and Grain Yield of Guar.

Treatments	*Grain Per Pod**	*1000 grain wt (g)**	*Weed dry matter* (q/ha) 30 DAS*	*Weed dry matter* (q/ha) 50 DAS*	*Pods/ Plant**	*Straw yield* (kg/ha)*	*Grain yield* (kg/ha)*
Unweeded Control	8.1	2.43	7.0	11.0	36.8	2460	1369
Pendimethalin @ 1.25 kg /ha, pre-emergence	8.3	2.50	3.3	4.9	48.1	3190	1812
Pendimethalin @ 1.88 kg /ha, pre-emergence	8.3	2.52	2.6	3.7	53.1	3760	1987
Pendimethalin @ 2.50 kg /ha, pre-emergence	8.2	2.53	2.1	3.3	50.0	3380	1821
Fluchloralin @ 1.25 kg /ha, pre-plant	8.2	2.51	3.0	4.4	43.6	3000	1666
Fluchloralin @ 1.88 kg /ha, pre-plant	8.3	2.53	2.5	4.1	47.2	3290	1748
Fluchloralin @ 2.50 kg /ha, pre-plant	8.1	2.54	2.2	3.6	51.8	3340	1824
Hand Weeding 5 DAS	8.2	2.52	6.6	2.5	46.6	3250	1661
CD at 5 %	NS	NS	1.0	1.2	7.2	268	228

* Mean of three years

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64- Yield and Intensity of Different Weed Species During Winter and Summer Months in Perennial Lucerne as Influenced by Different Weed Control Measures

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INTRODUCTION

Lucerne is an important fodder crop of arid and semi-arid regions of northwestern India. This crop is severely affected by weeds during initial growth phase, which results in poor plant stands and fodder yield. Perennial lucerne crop faced the competition with weeds not only at initial stage but also during later stage. Flushes of weeds comes with the change in seasons, which not only compete with the crop for the resources like nutrients, water, light and space but also reduce the quality of fodder crops when mixed with the fodder at the time of cutting.

MATERIALS AND METHODS

A field experiment was conducted at Indian Grassland and Fodder Research Institute, Jhansi during 1998-99 and 1999-2000 on lucerne cv. LH-84. The experiment was laid-out in randomized block design with four replications. The fourteen treatments were consisted viz. weedy check, weed free, weeder-cum-mulcher and hand weeding at four-week crop stage. Pre-emergence application of imazapyr 0.25, metribuzin 0.5, alachlor 2.5, pendimethalin 1.0 and as PPI fluchloralin 1.0 kg ai/ha, five treatments having half dose of above herbicide with hand weeding at six weeks crop stage. The number of cuttings obtained during 1st, 2nd and 3rd year were 5, 7 and 7, respectively. Species wise weed population was recorded during each cut.

RESULTS AND DISCUSSION

Analysis of three years data revealed that *Coronopus didymus, Rumex dentatus, Spergula arvensis, Anagallis arvensis, Medicago denticulata, Cichorium intybus, Parthenium hyterophorus* and *Melilotus species* emerged with the lucerne germination. Most of them disappeared after 1st cut of lucerne. However, *Rumex dentatus, Cichorium intybus* were found up to 3rd to 4th cut or up to the month of May. *Parthenium hysterophorus, Cynodan dactylon* and *Cyperus rotundas* species were found during whole growing season.

Among different weed control measures metribuzin and imazapyr with and without hand weeding was found most effective and controlled weeds completely like weed free situation. However, these chemicals found phytotoxic to lucerne crop and reduced the plant stand and yield of lucerne drastically. Pendimethalin 0.5 kg/ha with hand weeding at 6 week crop stage was found most effective treatment and the lowest intensity 10.0, 2.0, 8.0, 1.5 and 2.3 weeds/m^2 of *Coronopus didymus, Spergula arvensis, Anagallis arvensis, Melilotus spp. and Medicago denticulata,* respectively were recorded from this treatment as compared to remaining treatments. The intensity of *Rumex dentatus* was highest in weedy check treatment. It disappeared after third cut during first year and after 4th cut and 5th cut during 2nd and 3rd years, respectively. The lowest mean intensity of this weed was found 1.5, 0.5 and 1.1 weeds/ m^2 during 1st, 2nd and 3rd years, respectively in pendimethalin @ 0.5 kg/ha with hand weeding at 6 week crop stage treatment. The *Cichorium intybus* also followed the same trend but it disappeared slightly earlier than *Rumex dentatus. Parthenium hysterophorus, Cynodan dactylon* and *Cyperus rotundas* were present during whole growing season of the lucerne. The intensity of *Parthenium hysterophorus* did not fluctuate with the seasonal changes, however intensity of *Cynodan dactylon* and *Cyperus rotundas* increased in summer and rainy season as compared to the winter season.. The intensity of these weeds were significantly lower with the application of pendimethalin 0.5 kg/ha with hand weeding at 6 week crop stage as compared to remaining treatments except the lowest intensity was recorded with the application of metribuzin and imazapyr with and without hand weeding.

Pre emergence application of pendimethalin 0.5 kg/ha followed by hand-weeding at 6 weeks crop stage exhibited superiority to other treatments for green fodder (60.7 tonnes/ha), dry matter (13.2 tonnes/ha) and crude protein (2.19 tonnes/ha) yields during the all growing seasons. Among different weed control treatments the lowest fresh (8.2 and 9.6 tonnes/ha) and dry (1.7 and 1.8 tonnes/ha) biomass of weeds were recorded with the application of imazapyr 0.25 kg/ha and with its half dose + hand weeding, respectively.

The study indicated that pre-emergence application of pendimethalin 0.5 kg/ha + hand-weeding at 6 weeks crop stage was effective for obtaining higher forage yield of perennial lucerne with suppression of different weed species below threshold level during winter and summer season of crop growth.

65- Evaluation of Weeding Devices for Upland Rice in Kandhamal District of Orissa, India

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INTRODUCTION

Excessive use of herbicides results in pollution, residues, resistance problems in weeds. So, the use of mechanical weeders for weed control can overcome these problems

MATERIALS AND METHODS

An experiment was conducted at Dry land Research farm, Phulbani during 1998-2000 Kharif(3 years) with 8 treatments. The characteristic features of the weeders tested are shown in Table-1.Of these five weeders , the Phulbani dry land weeder was developed by the center.The arrangement of pegs is zigzag in case of rake weeder and wheel finger weeder .If for some reason , weeding operation is delayed the over growth of the weeds ,block the zigzag pegs .These weeders alongwith the rotary peg weeder are nit suitable when rice seeds are sown in 15 cm spacing . They cause damage to the tillers during the second weeding operation. Due to the pointed tips and longer pegs the Phulbani dryland weeder shows excellent perfomance in all type of soils with varied , soil moisture levels as well as intensity of weeds.It also acts as the best crust breakers.

RESULTS AND DISCUSSION

Out of five weeders tested Phulbani dryland weeder has registered the highest rice yield (37.14 q ha^{-1}), shown the highest cost benefit ratio (1.86) as well as reduced the man power in weeding operation to a considerable extent per unit cropped area. Other advantages of this weeder are that it works as the best crust breaker, a potato and groundnut digger and it can be used as a very good garden tool. From the yield observations, the Phulbani dry land weeder had registered the highest rice yield (34.87 q ha^{-1})(Annonymous-2000 & Subudhi 2004) as compared to other weeders.The man power engaged in weeding by Phukbani weeder was the least(57 per ha) saving nearly 57% labour as compared to hand weeding (127 per ha).The Phulbani dryland weeder has better weed control efficiency compared to other weeders tested .Though use of herbicide shown comparable yield ,but due to its adverse effect on environment, its use may be limited to the cropped field.The cost of the Phulbani dryland weeder is so low, it is very popular among the farmers of the state of Orissa.

Table 1 Characteristics features of the weeders

Name of weeders	*Widtth (cm)*	*Cost (Rs)*	*No of blades/pegs*	*Arrangement of pegs*
Rake weeder	8	46.00	4	Zigzag
Wheel finger weeder	15	428.00	5	Zigzag
Rotary peg weeder	17	398.00	1 blade	-
Gadi (local weeder	2	30.00	1	-
Phulbani dry land weeder	5	15.00	4	Straight line

CONCLUSION

It can be concluded that the Phulbani dry land weeder which takes minimum labours compared to other weeders & saves 57% of labour as compared to hand weeding shoulds be recommended for all the crops for weeding.It can be used for crust breaking and harvesting & digging of ground nut & potato.

ACKNOWLEDGEMENT

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66- Impact of mechanical weeding on weed incorporation and rhizosphere soil stirring in low land hybrid rice

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INTRODUCTION

Increasingly labour availability for agricultur purposes is becoming scarce. The cultivation aspects such as planting and harvesting are being mechanized and but the labour demanding operations like weeding is not yet mechanized. The use of Japanese rotary weeder for weeding and in situ green manure trampling was experimented and reported earlier but their use in real condition is obscure. In this circumstance the introduction of System of Rice Intensification (SRI) developed in Madagascar (Uphoff, 1999) paved the way for reintroduction of this weeder in rice cultivation to reduce the labour requirement for weeding as well as increasing the rice productivity.

MATERIALS AND METHODS

This paper discribes the results of two field experiments aimed at understanding the effect of two weed management practices (conventional weeding: In the wet season, weeds removed by manual weeding (three times). In the dry season, pre-emergence application with herbicide butachlor followed by manual weeding (Two times) vs mechanical weeding: Weeds mechanically incorporated with a rotary weeder, used on rows and column five times during the growing season) is described in detail in terms of yield, labour requirement, dry matter production, spikelet differentiation and tiller density.

RESULTS AND DISCUSSION

In both the seasons, mechanical weed control significantly increased grain yields. In the wet season, the use of the rotary weeder resulted in a 10 per cent yield increase of about 650 kg ha^{-1} while in the dry season yields were on average 200 kg ha^{-1} (3%) higher (Fig 1). The dry matter accumulation during the growing season shows that differences between the weed control treatments occur primarily after flowering (Table 1). Mechanical weed control has been reported to minimize weed competition besides improving soil aeration and root pruning (Misra and Sahoo, 1971). Dinesh and Manna (1990) showed that mechanical weeding with a rotary weeder increased the grain yield in dry season but not in the wet season.

The higher grain yield recorded for the use of mechanical weeder may be due to continued stirring of soil for 5 times and prolonged active leaves (LAI) (Table1) and productive tillers (252 and 277m^{-2} in wet season, 350 and 378m^{-2} in dry season for conventional and mechanical weeding, respectively). The yield attributes measured as panicle length, total spikelets per panicle, filled grains per panicle, sterility percentage and weight of individual grains and harvest index did not explain the yield variations clearly. The positive yield effect in both experiments due to mechanical weed control may be due to soil aeration, root pruning (Misra and Sahoo, 1971) but, needs further investigation in the application of tillage methods during the growing season.

In the wet season, labour productivity (Rs. crop output /Rs. labour input) for conventional and mechanical weeding were significantly different (3.69 and 4.4 for conventional and mechanical weeding respectively). The difference is caused by the lower labour requirements (75 women and 60 men labour days ha^{-1} for manual and mechanical weeding, respectively) and higher yields using mechanical weed control (Fig 1). In dry season, differences in labour productivity between manual and mechanical weed control are smaller since less time was spent on manual weeding (Pre-emergence herbicides + 50 women labour days ha^{-1}) than in the wet season. Initially weeds were controled in the dry season crop with a pre-emergence herbicide application followed by hand weeding.

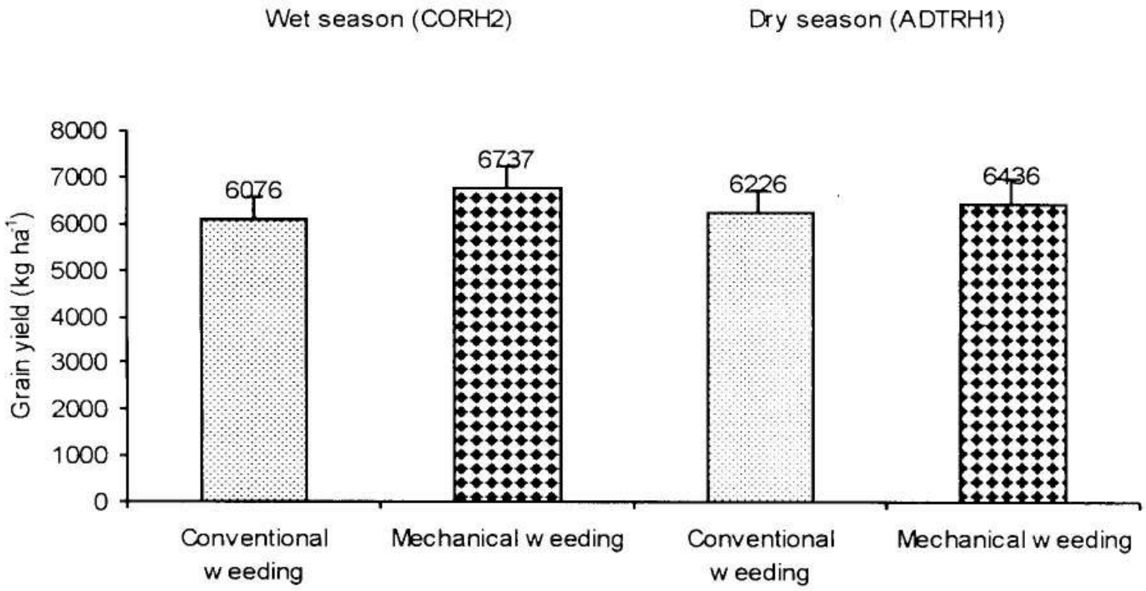

Fig 1. Grain yield as influenced by weeding methods in wet (CORH2) and dry season (ADTRH1) (Error bar indicates LSD)

Table 1 Total dry weight and Leaf Area Index during the growing season as influenced by weeding methods

Treatments	*Active tillering*	*Panicle initiation*	*Flowering*	*Grain filling*	*Harvest*
a) Total dry weight (kg ha^{-1})Wet season (CORH2)					
Conventional weeding (W1)	1748	4006	11539	14197	16292
Mechanical weeding (W2)	1930	4065	11558	15074	16906
CD at 5%	181	NS	NS	845	NS
Dry season (ADTRH1)					
Conventional weeding (W1)	682	2609	10133	11624	12699
Mechanical weeding (W2)	665	2617	10452	11621	14372
CD at 5%	NS	NS	NS	NS	1727
b) Leaf Area IndexWet season (CORH2)					
Conventional weeding (W1)	1.093	3.591	4.614	3.033	-
Mechanical weeding (W2)	1.096	3.733	4.02	3.485	-
CD at 5%	NS	NS	NS	0.3470	-
Dry season (ADTRH1)					
Conventional weeding (W1)	0.4955	2.657	4.304	3.22	-
Mechanical weeding (W2)	0.4961	2.719	4.274	3.52	-
CD at 5%	NS	0.1030	NS	NS	-

NS: Not Significant; CD (5%): Critical Difference at 5%probability level.

CONCLUSIONS

The mechanical weeding showed positive effect on grain yield compared to manual weeding alone or a combination of chemical and manual weeding. Repeated disturbance of the soil through rotary weeder and incorporation of weeds if any emerged in between the weedings increased the grain yield compared to conventional weeding, in both the seasons via higher LAI till maturity, higher productive tillers, higher dry matter accumulation after panicle initiation. The labour productivity was found improved by rotary weeding in the wet season.

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67- Efficacy of Plant Residues as Management Practices for Weed Control in Transplanted Rice (*Oryza sativa* L.)

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INTRODUCTION

Rice exports from India have grown steadily during the last decade reaching 4.1 million tons during the year 2002. India now occupies second position in rice exports, next only to Thailand, among the rice trading countries of the world. (Dr. B. Mishra, 2004). Rice grain production in India is reported to suffer at year loss of 15 million tones due to weed competition. Weeds pose major problems in rice production, which not only compete with crops but also hinder quality of the produce thereby increasing the cost of production. Echinocloa spp. a predominant and problematic rice weed, takes its origin in the rice nursery from the seeds entering as an admixture with crop seeds and perpetuates into the main field with seedlings during transplanting (Parthiban and Kathiresan, 2002).

MATERIALS AND METHODS

The field experiments were conducted at Allahabad Agricultural Institute-Deemed University, Allahabad was carried out during 2003-2004. The trial regarding main field was laid out in randomized block design with 8 treatments and three replications. The soil of the experimental field was sandy loam with pH 7.4. The treatments comprised press mud at 8 t/ha, Neem cake at 0.4 t/ha, fresh Eucalyptus leaves at 4 t/ha, fresh Subabul leaves at 4 t/ha, Fresh Calotropis leaves at 4 t/ha, twice hand weeding (20 and 40 DAT) and Butchlor at 1.25 kg/ha. The plant leaf materials were incorporated as per the layout and thin film of water was maintained for seven days to allow better decomposition. The field was leveled and transplanted with rice seedlings in the puddle soil. The data on weed density and weed dry weight were recorded at 100 DAT.

RESULTS AND DISCUSSION

C. difformis, *C. rotundus*, contributed largely for the total weed count, *E. crusgalli* and *E. alba* occurred only in negligible densities. Eucalyptus leaves at 4 t/ha reduced densities of major four species. The performance of subabul at 4 t/ha was also comparable. The lowest weed counts weed dry weight and WCI were recorded in twice hand weeding treatment, which was on par with Eucalyptus leaves at 4 t/ha and highest weed control efficiency was recorded in hand weeding twice ensured physical removal of all the existing weed species resulting in better weed free environment (Table 1).

Treatments that rendered a better weed free environment like twice hand weeding and Eucalyptus leaves favoured the crop ensuring adequate nutrient availability at requisite physiological stage like maximum tillering, panicle primordial initiation and flowering. These cumulative benefits were ultimately reflected on higher grain yield. Hand weeding twice recorded the highest grain and straw yield (55 q/ha, 127 q/ha). However, incorporation of plant materials also increased the grain and straw yield significantly over weedy check (Table). Among the plant materials, Eucalyptus leaves at 4 t/ha recorded the highest grain and straw yield (48.50 q/ha and 105.50 q/ha). Hence, application of plant materials like Eucalyptus leaves or leaves of subabul at 4 t/ha may serve as an effective component for weed management.

It may be concluded that hand weeding twice recorded the highest grain yield of (55 q/ha) which was statistically at par with Eucalyptus leaves at 4 t/ha (48.50 q/ha). Among the plant materials, Eucalyptus leaves at 4 t/ha served as effective components for weed management.

Table 1 Influence of weed control treatments on weed parameters, grain yield and straw yield.

Treatments	*Dose*	*Weed density (No./m²) at 100 DAT*	*Weed dry weight (g/m²) at 100 DAT*	*Weed control Efficiency (%) at 100 DAT*	*Weed index (%)*	*Grain yield (q/ha)*	*Stover yield (q/ha)*
Unweeded	-	113.33	13.66	-	3	38.5	80.50
Sugarcane press mud	8 t/ha	100	12.33	9.73	22.43	42.66	89.33
Neem cake	0.4 t/ha	100	13.66	0	28.49	39.33	87.50
Eucalyptus leaves	4 t/ha	83.33	7.66	43.92	11.81	48.50	105.500
Subabul leaves	4 t/ha	90	8.66	36.60	14.85	46.83	99.83
Calotropis leave	4 t/ha	96.66	11.33	17.05	17.89	45.16	95.33
Hand weeding	-	63.33	5.33	60.98	0	55.00	127.50
Butachlor	1.25kg/ha	90	10	26.79	16.36	46.0	99.00
CD at 5%		21.49	3.50	-	-	7.71	18.17

*DAT = Days after transplanting.

CONCLUSIONS

Hand weeding twice caused significant reduction in weed density and biomass in rice field favouring maximum grain yield. Among plant materials Eucalyptus leaves at 4 t/ha gave the highest yield. These treatments were significantly superior to Butachlor at 1.25 kg/ha.

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68- Cultural Methods of Weed Control in Wet Seeded Rice (*Oryza sativa*)

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INTRODUCTION

Transplanting of rice has been the traditional system of rice establishment but cultivation of wet seeded rice is gaining momentum in India due to the demand of labour during peak season of transplanting and availability of water for shorter periods. Weed management is one of the most critical factors for successful production of wet seeded rice as the soil conditions favour simultaneous germination of weed seeds along with paddy seeds. In recent years, soil health deterioration by the application of chemical fertilizers alone has paved the way for judicious combination of organic manures and inorganic fertilizer to improve soil fertility for sustainable rice production. To develop effective and feasible integrated nitrogen management practices, the present investigation was undertaken.

MATERIALS AND METHODS

Field experiments were conducted during *kharif* 2002 and Rabi 2002-03 at Agricultural College and Research Institute, Coimbatiore. The experiment was laid out in a randomized block design with seven nitrogen management methods (75% N + *Sesbania aculeate*, 75% N + azolla, 75% N + *Sesbania aculeate* + azolla, 100% N + *Sesabania aculeate*, 100% N + azolla, 100% N + *Sesbania aculeate* + azolla, 100% N). The treatments were replicated three times. Sprouted seeds of ADT 44 (*kharif*) and Co 47 (*Rabi*) were line sown at 80 ka/ha using drum seeder at spacing of 20 cm between rice onto puddle soil on 4th July 2002 and 23rd Oct 2002. The intercrop of Daincha (*Sesbania aculeate*) was also sown with a seed rate of 15 kg/ha at 2 : 1 (rice : *Sesbania*) ratio. Dual crop of azolla (*Azolla microphylloa*) was inoculated 15 days after sowing (DAS) at 1.0 t/ha. The intercrop of *Sesbania* and *Azolla* was trampled into the soil using conoweeder on 35 DAS.

RESULTS AND DISCUSSION

Weed flora of the experimental field was composite in nature consisting of grasses, sedges and broadleaved weeds (BLW). The major graminaceous weeds were *Echinochloa colona, E. cruss-galli* and *Leptochloa chinensis* and weed species belonging to family cyperacea viz., *Cyperus difformis, C. rotundus* and *Cyperus iria*. The BLW included *Ecilipta alba* (Asteraceae), *Ammania baccifera* (Lythraceae), *Ludwigia partiflora* (Ongraceae), *Marsilea quadrifolia* (Marsileaceae) and *Monochoria vaginlis* (Pontedeciaceae).

Intercropping of *Sesbania* and dual cropping of *Azolla* treatments recorded comparatively lesser weed density and dry weight of weeds (Table 1) when compared to *Sesbania* intercropping and *Azolla* dual cropping treatments. However, *Sesbania* intercropping and *Azolla* dual cropping treatments recorded substantially lower weed density and dry weight of weeds than the 100% N alone. Similar findings on the impact of *Sesbania* intercropping in reducing weed density and dry weight was reported by Ravisankar (2002) while, Divakaran and Sundaram (1998) reported on the reduced weed density and dry weight by *Azolla* dual cropping Application of 100% N + *Sesbania* intercropping + *Azolla* dual cropping produced higher grain yield of 5798 kg and 5502 kg during *kharif* and *rabi* season respectively. The treatments which included intercropping or dual cropping recorded higher grain yield when compared to 100% N alone. From the results, it is obvious that integrated use of nitrogen through organic and inorganic means produced more grain yield than the inorganic fertilizer alone.

Table 1 Effect of intercropping and dual cropping on weed density (No.m^{-2}), dry weight (g m^{-2}) and yield of wet seeded rice

Treatment	*Kharif 2002*				*Rabi 2002-2003*			
	Weed density (35 DAS)	*Weed dry weight (35 DAS)*	*Weed smothering efficiency (35 DAS)*	*Grain yield (kg ha^{-1})*	*Weed density (35 DAS)*	*Weed dry weight (35 DAS)*	*Weed smothering efficiency (35 DAS)*	*Grain yield (kg ha^{-1})*
75 % N + *Sesbania*	8.00 (74.0)	6.38 (47.5)	30.8	5086	8.13 (74.2)	6.50 (47.6)	32.5	4870
75 % N + *Azolla*	8.96 (91.1)	7.24 (59.3)	13.6	4772	9.08 (91.1)	7.22 (57.7)	18.2	4706
75 % N + *Sesbania* +*Azolla*	8.00 (73.6)	6.36 (47.2)	31.2	5406	7.65 (66.7)	6.05 (41.4)	41.3	5149
100 % N + *Sesbania*	8.35 (76.9)	6.68 (49.5)	27.8	5541	8.15 (74.7)	6.59 (49.1)	30.4	5292
100 % N + *Azolla*	9.31 (95.3)	7.42 (61.5)	10.3	5238	9.31 (95.8)	7.45 (61.1)	13.3	5096
100 % N + *Sesbania*+ *Azolla*	8.04 (74.9)	6.32 (46.2)	32.7	5798	7.52 (65.3)	6.01 (41.5)	41.1	5502
100 % N	9.76 (106.0)	7.81 (68.6)	-	4490	9.90 (108.0)	8.01 (70.5)	-	4467
CD at 5%	0.35	0.14	-	194	0.42	0.18	-	205

Numbers in parentheses are original values; Weed density and dry weight were subjected to square root transformation

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69- Effect of Seed rates, Planting Geometry and Weed Management Practices on Weeds and Late Sown Wheat Yield

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INTRODUCTION

Paddy – wheat cropping system is most popular among the farmers of Gujarat and hence, wheat is sown generally late during first fortnight of December after harvesting of late maturing rice varieties. Wheat requires longer days of cold during its tillering period but shorter winter days in Gujarat do not coincide with the tillering stage. Preparation of seed bed, sowing and germination of seeds take longer time there by plant stand and crop growth are adversely affected due to high soil moisture condition and low temperatures prevailing later part of December. Late sown wheat crop influences the yield attributes and finally the grain yield. Adoption of proper planting geometry and optimum seed rate affect the most important micro environment and growth pattern of individual crop plant leading to an over all increase in yield. Farmers manage weeds by hoeing and hand pulling which are not compatible for close sown or bi-directionally sown crop and it is costly, cumbersome and time consuming as compared to chemical weed control. Meager information is available with respect to seed rates, planting geometry and weed management practices on weed growth and yield of late sown wheat under middle Gujarat. Conditions and hence, field experiment was planned during late rabi season of 2002-2003.

MATERIALS AND METHODS

Field experiment was conducted during winter season of 2002-2003 at college Agronomy Farm, Anand Agricultural University. The soil of the experimental field was loamy sand in texture with pH 7.89 having organic carbon 0.62%, total nitrogen 0.053%, available phosphorus 41.39 kg/ha and available potassium 353.76 kg/ha. The experiment was laid out in Factorial Randomized Block Design with four replications. The treatment comprised two levels of seed rate (150 and 200 kg seeds/ha), two planting geometries (Row spacing at 22.5cm and Cross sowing at 22.5 cm) and three weed management practices (Weedy check, Weed free and pre-emergence application of pendimethalin 1.0 kg/ha). Late sown wheat variety GW-173 was used as test crop and sown on December 9, 2002. A uniform common does of 120 kg nitrogen and 60 kg P_2O_5/ha was applied in all the plots. Pendimethalin was applied as pre-emergence with Knapsack sprayer using 500 litre of water per hectare. Periodical observations on dry weight of weeds, WCE, leaf area, number of productive and total tillers, length of spike, number of grains/spike, test weight and grain yield were recorded.

RESULTS AND DISCUSSION

Effect of seed rates

The results (Table 1) revealed that differences in dry weight of total weeds recorded at various growth stages was found significant between seed rates. Significantly lower dry weight of weeds were recorded under 200 kg/ha of seed rate as compared to seed rate of 150 kg/ha at 30, 45, 60 DAS and at harvest with the weed control efficiency of 15.29 per cent. Further results given in Table 2 indicated that leaf area, length of spike, number of grains/spike and test weight were remarkably influenced due to seed rates and the values of these traits were recorded maximum under 150 kg seeds/ha except number of productive tillers and total tillers/m^2, which were noted higher under higher rate of seeds.

Effect of planting geometry

The results given in Table 1 further indicated that dry weight of total weeds at different growth stages was significantly recorded higher under row sown crop at 22.5 cm as compared to criss-cross sowing of 22.5 cm. Criss-cross sowing also recorded the weed control of efficiency of 19.89 per cent. The yield attributes such as leaf area, number of productive tillers, length of spike, number of grains/spike and test weight were significantly recorded more under criss-cross sowing as evident from the results presented in Table 2. Treatment of criss-cross sowing registered significantly higher grain yield (4602 kg/ha) as compared to row sown crop. These findings are in close conformity with those by Singh and Singh (1996) who reported significance increase in yield due to cross-sowing of wheat in late sown condition.

Effect of weed management practices

Results (Table 1) further showed that dry weight of total weeds at all the growth stages was found significantly the highest under weedy check treatment. Obviously, weed free treatment recorded zero dry weight of weeds as compared to weedy check and pendimethalin pre emergence 1.0 kg/ha. Similarly, weed free treatment and pendimethalin, 1.0 kg/ha (PE) recorded 100 per cent and 84.55 per cent WCE, respectively over weedy check. Results presented in Table 2 further revealed that yield attributes such as leaf area, number of productive and total tillers/m^2, length of spike, number of grains/spike and test weight were significantly recorded higher under weed free treatment and pendimethalin 1.0 kg/ha as pre-emergence. The difference in grain yield between weed free and pendimethalin as pre-emergence treatments was not

Table 1 Effect of seed rates, planting geometry and weed management practices on periodical dry weight of total weeds (g/m^2) and WCE (%) in late sown wheat

Treatment	*Dry weight of total weeds (g m^{-2})*				*W C E (%)*
	30 DAS	*45 DAS*	*60 DAS*	*At harvest*	
Seed rates (R)					
R_1: 150 kg/ha	4.000	17.047	25.767	34.017	—
R_2: 200 kg /ha	3.450	14.333	21.750	28.683	15.29
CD at 5%	0.404	1.364	3.318	3.573	—
Planting geometry (S)					
S_1: Row spacing, 22.5 cm	4.000	17.333	26.350	34.817	—
S_2 Cross sowing, 22.5 cm	3.450	14.017	21.167	27.883	19.89
CD at 5%	0.404	1.364	3.318	3.573	—
Weed control methods (W)					
W_1 : Weedy check	9.725	40.925	61.525	81.575	—
W_2 : Weed free	0.000	0.000	0.000	0.000	100
W_3 : Pendimethalin	1.450	6.100	9.750	12.475	84.55
CD at 5%	0.495	1.670	4.064	4.375	

significant. This indicated that chemical weed control in late sown wheat was found beneficial for control of weeds without adversely affecting the grain yield. These results are in agreement with the findings of Panda *et al.* (1996).

Thus, maximum yield with effective control of weeds under late sown wheat variety GW-173 can be achieved through cross-sowing at 22.5 cm along with 200 kg/ha of seed rate following either weed free condition or chemical weed control by pre-emergence application of pendimethalin 1.0 kg /ha.

Table 2: Effect of seed rates, planting geometry and weed management practices on yield and yield attributes of late sown wheat

Treatment	*Leaf area (cm²)*			*No. of tillers/ m²*		*Length of spike (cm)*	*No. of grains/ spike*	*Test weight (g)*	*Grain Yield (kg/ha)*
	45	*60*	*75*	*Productive*	*Total*				
Seed rates (R)									
R_1 : 150 kg/ha	140.35	167.35	195.99	440.75	451.75	7.44	36.37	37.30	4097
R_2 : 200 kg /ha	130.33	162.94	190.65	536.71	550.75	7.08	34.50	36.29	4590
CD at 5%	2.36	2.89	3.75	6.34	10.53	0.32	0.88	0.82	427
Planting geometry (S)									
S_1 : Row spacing, 22.5 cm	133.92	164.39	189.67	469.00	481.96	7.04	34.90	36.25	4084
S_2 : Cross sowing, 22.5 cm	136.76	165.89	197.28	508.46	520.54	7.48	35.96	37.35	4602
CD at 5%	2.36	NS	3.75	6.34	10.53	0.32	0.88	0.82	427
Weed management practices (W)									
W_1 : Weedy check	122.99	149.69	175.50	477.00	494.56	6.98	34.61	35.75	3743
W_2 : Weed free	142.55	174.10	203.69	500.25	510.50	7.73	36.41	37.60	4699
W_3 : Pendimethalin	140.48	171.63	200.78	488.94	498.69	7.07	35.28	37.05	4588
CD at 5%	2.89	3.54	4.59	7.88	12.90	0.39	1.08	1.00	523

CONCLUSIONS

Criss-cross sowing using seed rate of 200 kg seeds/ha and following weed free condition or application of pendimethalin @ 1.0 kg/ha as pre-emergence was found more beneficial practices for better grain yield over row sown crop with the seed rate of 150 kg/ha.

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70- Effect of Tillage System on the Little Seed Canary Grass (*Phalaris minor*) Population in Wheat (*Triticum aestivum*)

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INTRODUCTION

The grain yield of wheat is influenced with many factors. The weed population is one of the most important factor which has significant effect on the yield. *Phalaris minor* is the most serious weed in wheat which cause tremendous loss in yield if it is not controlled timely. Keeping in view the above under consideration, the information collected regarding the grain yield of wheat and population of *Phalaris minor* before chemical spray in the zero tillage demonstrations conducted at different locations in Punjab.

MATERIALS AND METHODS

For acceleration the adoption of zero tillage wheat through the Farmer's participatory mode, 54 and 170 zero tillage wheat demonstrations were carried out through out the state in cooperation with university FASS and KVK centres at the farmer's field in different districts of state during 2002-03 and 2003-04, respectively. Besides this, five zero tillage demonstrations were conducted at the permanent sites on the Farmer's field for the evaluation of zero tillage technology during 2003-04. Wheat was sown after rice with zero till drills using same inputs as recommended by zero tillage and conventional tillage in an area of one acre each. Residue of combine harvested rice crop was managed as per the practice of the area. The *Phalaris minor* and other weeds were controlled by using clodinafop or sulfosulfuron with the application at 35-40 days after sowing as post emergence.

RESULTS AND DISCUSSION

The average grain yield normally either similar or slightly higher was observed under zero tillage as compared to conventional tillage (Table 1). The highest average grain yield of wheat was recorded under zero tillage and conventional tillage in Kapurthala district followed by Jalandhar. However, the maximum increase in the average zero till wheat of about 5.7 q/ha was observed over the conventional tillage wheat in Muktsar district. The similar results have been reported by Kumar (2002).

The average population of *Phalaris minor* (m^2) considerably lower under zero tillage (26.2) as compared to conventional tillage (34.9) before the spray of herbicide. The results are in conformity with the findings of Mahey *et al.* (2002). However, the herbicidal control of weed was equally effective in both the cases of tillage. The maximum weed count of *Phalaris minor* was observed in the zero and conventional tillage demonstrations in Fatehgarh Sahib followed by Patiala might be due to the heavy soil. The *Phalaris minor* population was higher when sown after mid November (Table 2). The data on *Phalaris minor* count indicated that its population increases with the delay of sowing in zero and conventional tillage wheat. The low *Phalaris minor* under zero tillage wheat could be due to the minimum disturbance of soil.

CONCLUSIONS

The grain yield of wheat normally either equal or slightly more was recorded under zero tillage as compared to conventional tillage. The population of *Phalaris minor* was less before the chemical spray under zero tillage than conventional tillage but chemical control of weeds was equally effective in both the cases. But it was higher under zero till wheat when sown after mid November. It showed that population of *Phalaris minor* increases with the delay of sowing under zero and conventional tillage wheat.

Table 1. Average grain yield (q/ha) and *Phalaris minor* population (m^{-2}) before herbicide spray under zero and conventional tillage wheat

District	*Grain yield (q/ha)*		*Phalaris minor population before herbicide spray (m^{-2})*	
	Conventional tillage	*Zero tillage*	*Zero tillage*	*Conventional tillage*
Amritsar	45.2	45.5	12.1	15.5
Bathinda	42.0	44.9	39.3	54.8
Faridkot	42.6	42.9	-	-
Fatehgarh Sahib	41.6	42.9	69.7	112.0
Ferozepur	44.6	45.0	12.5	16.6
Gurdaspur	44.4	45.9	14.2	22.4
Hoshiarpur	39.8	41.0	27.0	29.5
Jalandhar	48.5	48.6	3.7	4.2
Kapurthala	50.1	52.2	27.8	31.9
Ludhiana	44.6	46.9	11.4	19.2
Mansa	44.4	45.9	41.8	48.1
Moga	43.1	44.3	20.6	30.5
Muktsar	42.3	48.0	-	-
Nawanshahar	45.4	45.0	36.8	22.8
Patiala	42.8	43.4	35.3	65.6
Ropar	42.7	42.8	14.0	21.2
Sangrur	45.6	44.2	26.4	19.5
Mean	44.1	45.2	26.2	34.9

Table 2. *Phalaris minor* count (per m^2) in wheat before herbicide spray

Permanent site	*Date of sowing*	*Zero tillage*	*Conventional tillage*
Jitwal, Distt. Sangrur	29.10.03	2.0	12.0
Hathan, Distt. Sangrur	24.10.03	8.0	16.0
Deh Kalan, Distt. Sangrur	1.11.03	7.0	22.0
Panjoli Kalan, Distt. Fatehgarh Sahib	23.11.03	36.0	26.0
Kharori, Distt. Fatehgarh Sahib	4.11.03	-	2.0

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71- Studies on the Tolerance of *Durum* Wheat (*Triticum durum* Desf.) Cultivars to Herbicides

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INTRODUCTION

Triticum durum Desf. is the second most important cultivated species of genus *Triticum* in the world as well as in India. It is found infested with various grass and broadleaf weeds which compete with the crop for nutrients, moisture, light, space, CO_2 etc. Amongst the various recommended herbicides for weed control in wheat, clodinafop and sulfosulfuron have been proved better (Brar *et al* 1999) and there is every likelihood that *durum* wheat cultivars may behave differentially to these herbicides. Differential response of bread wheat cultivars to herbicides has been reported by Paul and Gill (1982). Therefore, the present studies were planned to study the tolerance of *durum* wheat varieties to herbicides clodinafop and sulfosulfuron and to find out optimum time and dose of herbicide(s) for desirable weed control.

MATERIALS AND METHODS

A field experiment was laid out in strip plot design at Punjab Agricultural University, Ludhiana during *rabi* 2003-04. Treatments comprised of two *durum* wheat cultivars PDW 274 and PDW 233 and twelve weed control treatments *viz.* isoproturon 940 g/ha, clodinafop 60 and 75 g/ha, sulfosulfuron 25 and 31.25 g/ha applied at 35 and 45 days after sowing (DAS), unweeded check and weed free. Crop was sown on 3rd November, 2003 and was harvested on 13th April, 2004. Periodic observations at 35, 60, 90, 120 DAS and at harvest included plant height, dry matter accumulation by the crop and weeds (both grass and broadleaf), effective tillers, ear length, number of grains per ear, thousand grain weight, grain and straw yields and weed count (species wise).

RESULTS AND DISCUSSION

The varietal differences were non significant for the various growth and yield parameters of the crop observed at periodic intervals (35, 60, 60, 120 DAS and at harvest) while significant differences were found among the herbicides. The plant height showed non significant differences due to herbicide treatments at all the crop growth stages except at 60 days stage where the application of herbicides at 35 DAS had some suppressing effect but the crop recovered from this shock later on. Dry matter accumulation by the crop was significantly higher under clodinafop and sulfosulfuron as compared to isoproturon and unweeded check at all stages. Further, dry matter accumulation was higher under higher doses of clodinafop and sulfosulfuron (75 and 31.25 g/ha, resp.) as compared to their lower doses (60 and 25 g/ha, resp.) and when applied at 35 DAS as compared to 45 DAS. Significantly higher grain and straw yields (42.2 and 84.3 q/ha, respectively) were obtained under weed free which were on par with clodinafop (60 and 75 g/ha), sulfosulfuron (25 and 31.25 g/ha) both applied at 35 DAS and sulfosulfuron 31.25 g/ha applied at 45 DAS (Table 1). The highest grain yield was obtained under sulfosulfuron (40.05 q/ha) due to its broadspecturm control of weeds followed by clodinafop(37.02 q/ha) which could control only grass weeds and isoproturon

(25.80 q/ha) which failed to control *Phalaris minor* but controlled only broadleaf weeds. Both clodinafop and sulfosulfuron at the rates tested and applied at either time (35 and 45 DAS) gave significant reduction in density and dry matter accumulation by *P. minor* as compared to unweeded control.

Table 1 Grain and straw yields as influenced by *durum* wheat cultivars x herbicides

Treatment	*Grain yield (q/ha) 35 DAS*			*Straw yield (q/ha) 60 DAS*		
	PDW 274	*PDW 233*	*Mean*	*PDW 274*	*PDW 233*	*Mean*
Iso 0.94 kg/ha 35 DAS	24.9	20.8	22.8	64.2	69.7	66.9
Iso 0.94 kg/ha 45 DAS	31.1	26.5	28.8	79.1	71.1	75.1
Clod 60 g/ha 35 DAS	38.1	39.1	38.6	74.8	74.3	74.5
Clod 60 g/ha 45 DAS	36.2	34.8	35.5	78.3	76.8	77.5
Clod 75 g/ha 35 DAS	38.3	38.4	38.3	78.3	80.5	79.4
Clod 75 g/ha 45 DAS	34.9	36.6	35.7	75.8	70.6	73.2
Sulfo 25 g/ha 35 DAS	43.6	40.8	42.2	84.1	90.5	87.3
Sulfo 25 g/ha 45 DAS	33.1	34.7	33.9	74.2	75.6	74.9
Sulfo 31.25 g/ha 35 DAS	40.3	45.7	43.0	79.2	83.8	81.5
Sulfo 25 g/ha 45 DAS	40.2	42.1	41.1	74.4	80.1	77.2
Weed free	41.9	42.6	42.2	82.7	86.0	84.3
Unweeded (control)	30.2	28.9	29.5	74.2	69.3	71.7
Mean	36.1	35.9	—	76.6	77.3	—

CD at 5%
GRAIN YIELD STRAW YIELD
Varieties: NS Varieties: NS
Herbicide treatments: 4.2 Herbicide treatments: 8.3

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72- Effect of Soil Solarization with Tillage and Moisture Regimes on Weed Dynamics and Yield of Baby Corn

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INTRODUCTION

Weeds represent one of the major resource consuming and limiting factors in crop production. Weeds cause substantial losses in yield through competition for resource or through production of growth inhibiting compounds a phenomenon referred as allelopathy (Yaduraju *et al.,* 2005). Weeds by their manifold harmful effects on the growing crop plants account for 33 per cent of yield loss (Gautam and Mishra, 1995). Manual and mechanical weeding are effective but costly and time consuming and many a time not possible due to unfavorable weather condition and labour availability. An additional expenditure on herbicides for controlling the weeds is also dominating the total expenses on pesticides. Although the use of herbicides for weed control is highly successful, there is growing apprehension among ecologists about its negative impact on environmental safety and human health. Moreover, these features coupled with more stringent and costly registration and regulation of chemical pesticides and evolution of herbicide resistant weed biotypes necessitates the search for alternate methods of weed management. 'Soil Solarization' - method of heating the surface soil by using plastic sheets placed on moist soil to trap solar radiation (Katan, 1981) could be an efficient, economically viable, ecologically sound and non-hazardous preventive measure.

MATERIALS AND METHODS

A field experiment was conducted during 2003 to study the effect of soil solarization with tillage practices and moisture regimes on weed dynamics and yield of baby corn at the Agronomy Field Unit, Main Research Station, University of Agricultural Sciences, Bangalore. The experiment having 18 treatments combination was laid out in split plot design with three replications. The treatment combination included three tillage practices in the main plot (one ploughing+harrowing, thorough land preparation and unploughed control) and six sub plots with solarization and moisture regimes (solarization with irrigation upto FC, 40 mm, 20 mm and control (dry) with a non-solarized weedy and weed free check).

RESULTS AND DISCUSSION

Among the tillage treatments, significantly higher husked baby and fodder yield of baby corn was recorded with thorough land preparation (114.51 q ha^{-1} & 46.64 t ha^{-1}) followed by one ploughing+harrowing. Thorough land preparation recorded superior yield components *viz*., number of babies (4.84), length (18.9 & 10.4 cm), girth (7.1 & 5.4 cm) and weight (81.84 & 28.65 g $hill^{-1}$) of husked and dehusked baby respectively, lower weed count (57.5 m^{-2}) and dry weight (4.62 g 0.25 m^{-2}).

Among the solarization with moisture regimes, 45 days solarization with irrigation upto FC recorded significantly higher husked baby and fodder yield (118.29 q ha^{-1} & 50.40 t ha^{-1}) followed by solarization with 40 mm irrigation. Similar trends were also observed with respect to different yield attributes. Weed count and dry weight recorded was significantly lower in 45 days solarization with irrigation upto FC followed by 40 mm irrigation (Table 1).

Thorough land preparation with fine seed bed and irrigation upto field capacity are essential before solarization. This will enhance the solarization effect in terms of controlling weeds and increasing the yield of baby corn. Under extreme conditions one ploughing + harrowing and 40 mm of irrigation are required for effective solarization.

Table 1 Yield, yield attributes and weed dynamics at harvest in baby corn as influenced by tillage and soil moisture regimes with soil solarization

Treatments	*Baby length (cm)*		*Baby girth (cm)*		*Baby weight (g hill⁻¹)*		*No. of babies hill⁻¹*	*Husked baby yield (q ha⁻¹)*	*Fodder yield (t ha⁻¹)*	*Weed count (No. m⁻²)*	*Weed dry weight (g 0.25 m⁻²)*
	Hus-ked	*Dehu-sked*	*Hus-ked*	*Dehu-sked*	*Hus-ked*	*Dehu-sked*					
Main plot : **Tillage**											
M_1 : One ploughing + harrowing	18.1	10.0	6.7	5.0	78.51	27.49	4.52	110.13	45.18	7.3 (64.1)*	2.20 (4.98)
M_2 : Thorough land preparation	18.9	10.4	7.1	5.4	81.84	28.65	4.84	114.51	46.64	6.9 (57.5)	2.13 (4.62)
M_3 : Unploughed	16.4	9.1	6.1	4.6	73.67	25.78	3.72	99.51	42.32	8.3 (82.0)	2.52 (6.66)
C.D. at 5%	1.19	0.73	0.28	0.22	5.55	1.95	0.32	1.31	NS	0.17	0.04
Sub-plot : **Moisture regimes with solarization**											
S_1 : Irrig. up to FC + TPE 0.05 mm for 45 days	19.7	10.8	7.4	5.6	89.91	31.50	4.65	118.29	50.40 (50.7)	7.1 (4.04)	2.12
S_2 : 40 mm Irrig. + TPE 0.05 mm for 45 days	19.0	10.5	7.0	5.2	84.69	29.63	4.51	112.87	47.47 (57.9)	7.6 (4.56)	2.24
S_3 : 20 mm irrig. + TPE 0.05 mm for 45 days	17.5	9.6	6.5	4.9	75.73	26.52	4.37	107.52	43.89 (74.4)	8.6 (5.92)	2.52
S_4 : Control (dry) + TPE 0.05 mm for 45 days	16.5	9.1	6.3	4.7	69.90	24.47	4.18	101.88	41.22 (88.9)	9.4 (7.08)	2.75
S_5 : Non-solarized weedy check	15.5	8.5	5.8	4.4	63.01	22.06	3.91	95.30	37.24	11.6 (135.3)	3.37 (10.92)
S_6 : Non-solarized weed free check	18.8	10.4	6.9	5.2	84.79	29.69	4.54	112.43	48.07	0.7 (0.0)	0.71 (0.00)
C.D. at 5%	0.9	0.49	0.32	0.24	3.74	1.31	0.09	4.23	2.03	0.19	0.06
Interaction (**M X S**)											
S at same level of M C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.33	0.10
M at same or different S levels of C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	0.34	0.10

* Figures in the parenthesis indicate the original values

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73- Sustainable Weed Management in Maize with Incorporation of Bioresources

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INTRODUCTION

Use of organic manures has been the traditional way of nourishing crops in small holder farms. This approach of enhancing and maintaining soil health gains further significance with the recent surge in the concept of sustainability in food production. These organic manures do influence other integral components of farming like pest and weed complex in addition to fertility enhancement. Some of them suppress the weed flora in a positive manner through constituent of metabolite principles or favour weed infestation occasionally by virtue of enriching the soil seed bank.

MATERIALS AND METHODS

Accordingly the impact of different organic manures viz., Farm Yard Manure @ 12.5 t ha^{-1}, goat manure @ 12.5 t ha^{-1}, pressmud 6 t ha^{-1}, pungam 6 t ha^{-1}, glyricidia 6 t ha^{-1} were studied on the weed flora of maize in a randomized block design with three replications at Annamalai University Experimental Farm, Annamalainagar, Tamilnadu. The organic manures incorporated in the field during the final land preparation in plots of size 4m x 5m. Maize crop cv. Variety Co1 was sown at a spacing of 60 x 20 cm and raised with requisite care. Nutrients added through different manures were calculated and the respective quantities were deducted in the inorganic fertilizer doses @ 1: 0.5 : 0.5 kg NPK ha^{-1}. Manual weeding was given at 20 DAS. Individual weed counts were taken on 30 DAS and total weed count and weed DMP was also recorded. The crop was harvested on November 2004.

RESULTS AND DISCUSSION

The major weed flora comprised *cyperus rotundus, Cyanodon dactylon* and *trianthema portulacastrum*. The highest weed control efficiency of 30.6% and 30.2% were observed in treatments involving neem cake and pressmud incorporation (Table 1). Neem cake incorporation favored weed suppression and crop growth through its allelopathic metabolites and active principles. Incorporation of pressmud destroyed the weeds by virtue of reduced soil pH and allelochemicals produced from the native microbes of pressmud. Better weed suppression and reduced weed competition in these treatments contributed for favouring the growth and yield performance of crop that recorded the highest yield of 4000 kg ha^{-1} and 3815 kg ha^{-1}, respectively in these treatments. Application of farm yard was observed to aggravate the weed infestation with increased weed population in general. This could be because of enrichment of weed seed bank through the process of endozoochory. these results were similar to the reports of parthiban and Kathiresan (2002) and Gnanavel and Kathiresan (2002).

CONCLUSION

Results revealed that neem cake and pressmud incorporation @ 6 t ha^{-1} followed by one hand weeding at 20 DAS recorded 30.6 and 30.2 per cent WCE, respectively and enhanced higher grain yield of 1050 and 865 kg / ha^{-1} over control.

Table 1 Treatment effect on weed density, DMP and Grain yield

Treatment	*Rate of application t / ha*	*Total weed density no. m^{-2}*	*Total weed dry weight $g\ m^{-2}$*	*Grain yield kg ha^{-1}*
Unweeded control	-	268 (16.39)	142.5 (11.96)	2950
Farm yard manure	12.5	291 (17.07)	159.8 (12.7)	2180
Goat manure	12.5	249 (15.79)	131.2 (11.48)	3450
Pressmud	6.0	186 (13.66)	93.9 (9.72)	3815
Neem cake	6.0	187 (13.69)	94.3 (9.73)	4000
Pungam	6.0	201 (14.20)	110.3 (10.53)	3000
Glyricidia	6.0	251 (15.86)	135.6 (11.67)	2950
CD at 5%		0.74	0.84	59.7

(Figures in parenthesis are transformed values)

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74- Repetitive Use of Transperent Polyethylene for Soil Solarization in Groundnut

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INTRODUCTION

Weed menace in agricultural field is ever increasing in spite of constant efforts to control them. Weeds by their manifold harmful effect on the growing crop plants, interference with land uses, ranked prime enemies in crop production and account for 33 per cent of yield loss (Gautam and Mishra, 1995). Weed control by mechanical and cultural means have some limitations as these are laborious, time consuming and controlled by weather fluctuations. Besides, manual weeding involves drudgery and becoming scarce and costly. Chemical methods, although very effective have environmental threat. Besides, these methods were employed only after the crop has attained certain stage of growth, causing sufficient damage to the crop. Hence, there is a need for alternate method of weed control which is effective and non-hazardous. Soil Solarization has emerged as a preventive and non-hazardous option for weed management.

MATERIALS AND METHODS

A field experiment was conducted to study the possibility of repetitive use of transparent polyethylene (TPE) for solarization in groundnut during summer 2004 in the red sandy loam soil at the Agronomy Field Unit, Main Research Station, UAS, Hebbal, Bangalore under irrigated conditions. The study involved two thickness of transparent polyethylene (0.05 and 0.10 mm) covered once (between April 15 to May 15), twice (March 1 to April 15 and April 15 to May 30) and thrice (Jan 15 to Feb end, March 1 to April 15 and April 15 to May 30) in the same season for 45 days duration with a weedy and weed free check replicated thrice in a randomized complete block design. Groundnut cultivar TMV-2 was sown on June 11 2004 at a spacing of 30 cm x 15 cm. Observations on soil temperature, weed count and dry weight, yield components and pod yield of groundnut were recorded and analysed statistically.

RESULTS AND DISCUSSION

At 45 days after polyethylene spread, soil temperature due to solarization with TPE 0.05 mm twice (49.1° & 45.7°C) and TPE 0.10 mm twice (48.6° & 45.0°C) at 5 and 10 cm soil depth, respectively was higher compared to weedy check (36.4° & 32.8°C). This rise in soil temperature resulted in significantly lower weed count and weed dry weight with TPE 0.05 mm twice (26.7 m^{-2} & 6.21 g 0.25 m^{-2}, respectively) and TPE 0.10 mm twice (36.7 m^{-2} & 9.26 g 0.25 m^{-2}, respectively) compared to weedy check (86.7 m^{-2} & 21.56 g 0.25 m^{-2}, respectively). Solarized treatments recorded significantly lower weed count and weed dry weight compared to weedy check.

Pod yield varied due to repetitive use of TPE (Table 1). Among the solarized treatments TPE 0.05 mm twice (23.15 q ha^{-1}) or once (22.23 q ha^{-1}) or TPE 0.10 mm twice (21.25 q ha^{-1}) or once (20.88 q ha^{-1}) recorded significantly higher pod yield of groundnut as compared to weedy check (8.52 q ha^{-1}) due to effective control of weeds. Similar trend was observed with respect to number of pods per plant and pod yield per plant. Using TPE 0.10 mm or 0.05 mm thrice resulted in reduced pod yield of groundnut due to mutilated condition of the TPE for the third time use, which was not very effective in controlling weeds. Hence, solarization twice with in the season is found to be better for control of weeds and for realizing higher pod yield of groundnut.

Table 1 Effect of repetitive use of polyethylene on soil temperature, weed count, weed dry weight, yield and yield attributes of groundnut as influenced by soil solarization.

Treatments	*Soil temperature (°C) at 45 DAPS*		*Weed count (No. m^{-2})*	*Weed dry weight (g 0.25 m^{-2})*	*No. of pods $plant^{-1}$*	*Pod yield (g $plant^{-1}$)*	*Pod yield (q ha^{-1})*
	5 cm	*10 cm*					
T_1: TPE 0.10mm once	45.6	43.3	7.5 (56.0)*	3.80 (13.93)	20.40	14.30	20.88
T_2 : TPE 0.10mm twice in the same season	48.6	45.0	6.1 (36.7)	3.12 (9.26)	21.57	13.78	21.25
T_3 : TPE 0.10mm thrice in the same season	42.0	38.1	8.2 (67.6)	3.93 (14.97)	15.78	10.99	13.73
T_4: TPE 0.05mm once	45.8	43.0	6.9 (46.7)	3.51 (11.87)	21.27	14.90	22.23
T_5 : TPE 0.05mm twice in the same season	49.1	45.7	5.2 (26.7)	2.59 (6.21)	22.48	14.15	23.15
T_6 : TPE 0.05mm thrice in the same season	43.0	38.0	7.0 (48.4)	3.46 (11.56)	16.24	11.16	14.81
T_7: Weed free check	-	-	0.7 (0.0)	0.71 (0.00)	25.17	16.34	25.39
T_8: Weedy check	36.4	32.8	9.3 (86.7)	4.69 (21.56)	10.53	9.27	8.52
CD at 5%	-	-	1.1	0.26	4.25	2.25	4.09

*Figures in the parenthesis indicate original values DAPS: Days after polyethylene spread

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75- Efficacy of Mulching to Minimize Weed Density in Crops Grown in Tripura

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INTRODUCTION

Agricultural land in Tripura is comprised of upland, medium upland and lowland and upland ecology where traditional agriculture of almost monocropping is being practiced and it covers nearly 60 per cent of the land. Besides lowland rice, the productivity of various crops grown in Tripura is below the national average and out of the various constraints prevailing, the weed competition is the most important. The weed growth is luxuriant in nature due to humid subtropical climate is a matter of great concern particularly in crops grown in upland condition.

Conventional hand weeding involving manual labour is generally in practice but it was revealed (Mitra, 2000) that pre-emergence application of butachlor or pretilachlor @ 2.0 kg a.i./ha followed by one hand weeding at 40 DAS recorded 3.7 to 3.8 times higher yield of upland rice and 2.5 times lower weed mass at harvest as compared to unweeded control. Similarly, one manual weeding could be saved through pre-emergence application of butachlor in green gram.

MATERIAL AND METHODS

In order to avoid the chemical control of weed biomass, use of leaf, straw, grass and jute agro-textiles may be made popular among the farming community. Besides bio-mulches, polymulch may also be used.

RESULTS AND DISCUSSION

The effect of mulching to minimize weed biomass in pulse and oilseed is presented in Table 1.

Table 1. Effect of mulching in black gram and groundnut

Treatment	*Weed Density ($g\ m^{-2}$)*	
	Black gram	*Groundnut*
Control	102.2	36.7
Polythene	48.6	18.3
Gliricidia leaf	-	15.0
Acacia leaf	-	24.3
Chhan grass	67.8	21.7
Paddy straw	69.7	-
CD at 5%	18.7	12.9

The trend of weed control in black gram ascends as follows : Paddy straw < Chhan grass < Polythene. It indicates that the introduction of plastic film (50 micron IPCL grade) was highly effective to control 52 % weed density in black gram. On the other hand, weed control in groundnut shows the following ascending trend. Acacia leaf < Chhan grass < Polythene < Gliricidia leaf. Nearly 60 % weed growth was suppressed by locally available gliricidia leaf. Jute agro-textiles available from jute industry was also used to suppress the weed. Weed density was estimated in the crops grown with various materials. The data are presented in Table 2.

Table 2. Weed density (kg m^{-2})

Treatment	*Sesamum*	*Black gram*	*Upland rice*
Control	0.47	0.86	0.88
Jute	0.27	0.52	0.72
Polythene	0.20	0.35	0.20
Broom grass	0.33	0.26	0.73
Mean	0.32	0.49	0.63
CV (%)	30.1	46.8	40.9

The use of jute agro-textiles (300 GSM) showed a decline of 42.6 %, 39.5 % and 18.2 % in weed density in sesamum, black gram and upland rice over control, respectively.

So the non-chemical approaches for weed management may be done with the use of bio mulches and the economic viability of mulching in crops may be of high magnitude considering the availability of local material. Polymulches considering its durability may also show a great promise in minimization of weed in crops.

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76- A Non – Pesticidal Cultural Method for Controlling Weeds in Irrigated Groundnut

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INTRODUCTION

The scientists all over the world are in search of effective method of weed control. There has been an increased emphasis on reduced pesticide or nonpesticidal control methods. Soil solarization is a nonpesticidal 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. Solarization during the hot summer months can increase soil temperature to levels that kill many disease-causing organisms (pathogens), nematodes and weed seed and seedling. It leaves no toxic residues and can be easily used on a small or large scale. There are many locations in India experiencing extreme summer and in these areas soil solarization can best practiced for efficient weed management. Hence, a study was undertaken to find out the effect of off-season soil solarization on the weed management in groundnut.

MATERIALS AND METHODS

Field experiments were conducted during 2000 and 2001 at Tamil Nadu Oil seeds Growers Federation (TANCOF), Neyveli, Tamil Nadu. The pH of the soil was 6.10 and the organic carbon was 7.90 per cent. Nine treatments with different thickness (0.05 mm & 0.1 mm) of transparent polyethylene sheets and different duration of solarization viz., 20, 30 & 40 days, unweeded control, weed free check and normal practice were also included for comparison. The transparent polyethylene sheets were removed after the respective period of solarization. The soil temperatures were recorded with the help of digital soil thermometer at regular intervals. Before spreading of polyethylene sheets, a light irrigation was given to increase the soil temperature and to hasten the weed seed germination. Immediately after solarization period the groundnut variety TMV-7 was sown. Observations on weed biomass and pod yield were recorded. Weed control efficiency was worked out by the formula suggested by Misra and Tosh (1979) and recorded in percentage.

$$WCE = \frac{\text{Weed biomass in unweeded control plot - Weed biomass in treated plot}}{\text{Weed biomass in unweeded control plot}} \times 100$$

RESULTS AND DISCUSSION

Effect on weeds

The experimental field comprised of different weed flora. *Cleome viscosa, Vernonia cinerea, Corchorus olitorius, Cyperus rotundus, Cyperus iria, Cyanodon dactylon* and *Echinochloa colonum* were present predominantly and significantly altered by weed control treatments. Total weed biomass on 60 DAS was significantly influenced by all the treatments (Table.1). Among the different thickness and duration of soil solarization compared, solarization for 40 days with 0.05 mm recorded the least weed biomass (86.32 and 83.06 kg ha^{-1}), which was on par with weed free check. The best treatment recorded the highest weed control efficiency of 91.61 and 91.60 per cent over control at 60 DAS. This can be ascribed to the effect of high temperature achieved by soil solarization. At 5 cm depth, the temperature in solarized plots reached up to 50.1°C, and on an average the difference in maximum soil temperature between the nonsolarized plots and solarized plots was 8°C (higher in solarized plots). Similar weed count and weed biomass reduction due to solarization has also been reported earlier by Nasr-Esfahani (1993). This type of reduction in weed population and weed biomass due to solarization could be attributed to the indirect killing of the weed seeds weakened by sub lethal heating through microbial activity; direct killing of the seed stimulated to germinate in the moistened mulched soil; and killing of germinating seeds whose dormancy is broken in the heated soil.

Table 1 Effect of Off-season Soil Solarization (SS) on Weed Biomass at 60 DAS (kg ha^{-1}), Weed Control Efficiency and Pod yield (t ha^{-1})

Treatment	*Weed biomass at 60 DAS (Kg/ha)*		*WCE (%)*		*Pod yield (t/ha)*	
	2000	*2001*	*2000*	*2001*	*2000*	*2001*
T_1 – Off-season SS (20 days) – 0.05 mm	648.96	594.32	36.93	39.93	1.97	1.80
T_2 – Off-season SS (30 days) – 0.05 mm	512.46	482.64	50.19	51.21	2.08	1.92
T_3 – Off-season SS (40 days) – 0.05 mm	86.32	83.06	91.61	91.60	2.47	2.49
T_4 – Off-season SS (20 days) – 0.1 mm	806.32	782.21	21.63	20.90	1.79	1.67
T_5 – Off-season SS (30 days) – 0.1 mm	670.08	620.53	34.87	37.28	1.90	1.85
T_6 – Off-season SS (40 days) – 0.1 mm	277.76	256.51	73.00	74.07	2.26	2.25
T_7 – No SS – unweeded check	1028.96	989.40	0.00	0.00	1.22	1.00
T_8 – No SS – weed free check	-	-	100.00	100.00	2.46	2.48
T_9 – No SS – Normal practice	310.08	285.80	69.86	71.87	2.19	2.20
CD at 5%	138.32	3121.20	-	-	0.18	0.19

Effect on yield

The highest pod yield of 2.47 and 2.49 t ha^{-1} was recorded in the off-season soil solarization for 40 days with 0.05 mm thickness treatment. This treatment was followed by off-season soil solarization with 0.1 mm thickness, which recorded pod yield of 2.26 and 2.25t ha^{-1}. The least pod yield (1.22 and 1.00 t ha^{-1}) was recorded with the non-solarized unweeded control. The better growth of groundnut in terms of its plant height, number of leaves, leaf area and total dry matter accumulation might have helped in the better availability of growth resources to the crop with longer duration of solarization. Yield increase in groundnut under weed free situation was observed by Mudalagiriyappa *et al.*, (1999).

CONCLUSION

Significant reduction in weed population due to Off-season soil solarization was noticed at all the stages of crop. Off-season soil solarization with 0.05 mm transparent polyethylene sheets for 40 days was effective in controlling weeds than the 0.1 mm thickness and the lesser duration of soil solarization. Soil solarization with 0.05 mm thickness for 40 days recorded significantly higher pod yield over control.

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77- Weed Management in Soybean Through Soil Solarization A Non-Chemical Method

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INTRODUCTION

Soil solarization is a hydrothermal disinfection method based on covering the water saturated soil with transparent polyethylene sheet and thus increasing the soil temperature by the solar energy. Such a treatment was reported to result in certain physical, chemical and biological changes that favour plant health and growth while producing deleterious effect on weeds, pathogens and pests. Therefore, investigations were undertaken to study the effect of soil solarization on weed control efficiency of different weed species emerging in soybean field.

MATERIALS AND METHODS

The experiment was conducted in a farmers field situated 30 km away from the Annamalai University. Layout was in a Randomised Block Design with three replications. The size of individual plots were 4 x 3 m. The treatments included solarization for 20, 30 and 40 days after which biofertilizers like *Rhizobiyum* and phosphobacteria were inoculated individually and in combination in the solarized plots along with an absolute and actual control. For solarization transparent polyethylene sheets of 0.05 mm thickness was laid close to the soil surface and the sides were tucked into the soil to prevent any heat loss. After removal of polyethylene sheets, the soybean seeds were sown and the weed population on 90 DAS were recorded.

RESULTS AND DISCUSSION

The predominant monocot weeds were *Echinochloa colonum* and *Cyanodon dactylon;* Dicots like *Cleome viscosa, Trianthema portulacastrum, Commelina benghalensis, Chrosopora rottleri* and the sedge, *Cyperus rotundus* were wide spread.

The weed control efficiency slightly decreased as the number of days after sowing increased. Observations taken after 90 days of sowing recorded the highest WCE of 91.85 per cent for *Echinochloa colonum*. This was followed by 88.06 per cent for *Cleome viscosa*, 87.36 per cent for *Trianthema portulacastrum* and 80.90 per cent for both *Commelina benghalensis* and *Chrosopora rottleri* in 40 days solarized plots. This corroborates the findings of Haripriya (1998) in chilli. Solarization produced two different complementary effects like foliar scorching of emerged plants under plastic cover and decreased weed emergence after removing the plastic sheets. This residual effect on weeds is considered as the principal benefit of the treatment. Thus, it is evident that solarization for 40 days resulted in the highest weed control efficiency followed by solarization for 30 and 20 days in order.

The apparent major effect of solarization was upon the propagules that were in the initial process of germination. These findings are in line with those of Horowitz *et al.*(1983) and Habeeburrahuman (1992).

Table 1. Effect of solalrization and biofertilizers on weed control efficiency at 90 DAS in soybean

Treatment	*Weed control efficiency at 90 DAS**				
	Echinochloa colonum	*Cyanodon dactylon*	*Cleome viscosa*	*Trianthema portulacastrum*	*Commelina benghalensis*
T_1 – Control	0.0(0.00)	0.00(0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
T_2 - Handweeding at 20 and 40 DAS	70.42(88.80)	50.83(60.12)	66.19(83.69)	62.07(78.02)	59.38(74.44)
T_3 - Solarization for 20 Days	51.26(60.81)	29.17(23.77)	58.59(72.83)	60.18(75.27)	55.39(58.54)
T_4 - Solarization for 20 Days + R	50.50(59.54)	27.74(21.67)	56.53(69.57)	59.45(74.17)	54.42(57.43)
T_5 - Solarization for 20 Days + P	49.49(57.76)	26.25(19.57)	56.53(69.57)	58.74(73.06)	54.44(57.43)
T_6 - Solarization for 20 Days + R + P	48.43(55.98)	23.10(15.38)	53.19(64.12)	57.71(71.43)	52.99(56.32)
T_7 - Solarization for 30 Days	65.22(82.43)	34.55(32.16)	62.96(79.31)	64.41(81.30)	60.95(74.51)
T_8 - Solarization for 30 Days + R	64.48(81.41)	33.71(30.76)	61.46(77.16)	62.43(78.56)	59.91(73.40)
T_9 - Solarization for 30 Days + P	63.18(79.64)	33.24(30.05)	60.74(76.09)	61.67(77.47)	59.91(73.40)
T_{10} - Solarization for 30 Days R + P	61.59(77.35)	31.47(27.26)	59.28(73.90)	60.54(75.80)	58.33(69.09)
T_{11} - Solarization for 40 Days	73.43(91.85)	37.09(36.36)	69.82(88.06)	69.19(87.36)	66.62(80.90)
T_{12} - Solarization for 40 Days + R	72.15(90.58)	36.65(35.65)	67.10(84.80)	68.26(86.25)	65.40(78.75)
T_{13} - Solarization for 40 Days + P	71.16(89.56)	36.23(34.95)	67.10.(84.80)	67.81(85.71)	64.78(78.75)
T_{14} -Solarization for 40 Days + R + P	69.79(88.4)	34.95(32.84)	65.36(82.61)	66.48(84.07)	64.20(77.63)
CD at 5%	0.65	1.34	1.64	1.31	1.81

*Values are square angular and those in parenthesis indicate original
R – *Rhizobium* ; P – Phosphobacteria

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78- Soil Solarization: A Non-chemical Approach for Weed management in Brinjal Nursery

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INTRODUCTION

Weeds come up rapidly in the vegetable nurseries due to application of organic manure, frequent irrigation and cause enormous losses to the seedlings in nursery beds. Soil solarization is a special mulching technique in which moist soil is covered by polyethylene (PE) film and heated by solar radiation for several weeks. Northern India (Punjab) has high air temperature during summer (May-June) and high soil temperature (50-60^{0}C) can develop in soil covered with transparent polyethylene sheets (Kumar *et al.*, 1993). The potential of the method has recent become a subject of interest in northern parts of India particularly for nurseries grown in the summer (May-June) season where no any herbicides has been recommended for weed control and appears to provide a good opportunity for control of weeds by soil solarization. Hence there is urgent need to study the effect of different period of soil solarization for effective control of weeds. Therefore, a field study was conducted to evaluate the effect of soil solarization on weed populations and the growth behaviour of brinjal nursery.

MATERIALS AND METHODS

The experiment was carried out at the experimental station of department of Soil and Water Engg. PAU, Ludhiana during 2004. One week before the beginning of mulching, the soil was disked three times and beds 1m wide and 5 m long were made. The soil was irrigated upto field capacity one day before mulching with transparent PE films of 50 μm thickness. For solarization treatments (25, 35 and 45 days) plastic films were laid on the smoothed beds, stretched close to the soil surface and their edges and ends were burried in trenches 10 cm deep and covered with soil. An unsolarized control treatment was also included. So, in all there were four treatments that were tested in randomized block design with three replications. All beds including those for the uncovered treatment were constructed at the same time. At the end of period of solarization , the films were removed without soil disturbance. Weed emergence was recorded over a period of 2 months. Thee nursery was planted in rows spaced 10 cm apart in June 25, 2004. During the nursery season, weed biomass and density were assessed in three 0.25m x 0.25 m randomly collected samples at 25, 35 and 45 days after the films had been removed.

RESULTS AND DISCUSSION

In the study the weeds recorded were i.e. *Triathema monogyna, Cyperus rotundus, Commelina benghalensis, Cynodon dactylon, Eleucine aegyptiacum, Digera arvensis, Digitaria sanguinalis, Eorostis pilosa, Echinochloa sp.* but the *T. monogyna* and *C. rotundus* were the dominant weeds. Soil solarization for 35 or 45 days decreased the emergence of *Trianthema monogyna* and other annual weeds by over 90 %. The factors involved in solarization are soil temperature, moisture and probably gases (Horowitz *et al.*, 1983). High temperature may cause damaging changes in enzyme activity, membrane structure and protein metabolism. On the other hand, a high concentration of CO_2 in the soil atmosphere, which has been observed during solarization (Horowitz *et al.*, 1983), can induce seed dormancy (Mayer and PoljaKoff-Mayber, 1989). As a result, soil solarization reduces the number of weed seedling and weed biomass of heat sensitive species. Emergence of *Cyperus rotundus* from tubers was increased by soil solarization. Furthermore, seed germination of *Commelina benghalensis* was increased by soil solarization. By differentiating equation fitted for both dry matter accumulation and plant density of *C. benghalensis* w.r.t.

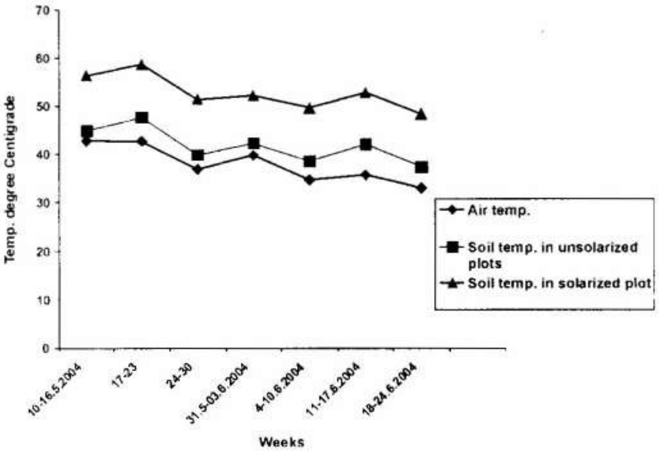

Fig1. Maximum mean weekly soil temperature at 5 cm depth versus air temperature during mulching period of 10 May- 24 June 2004

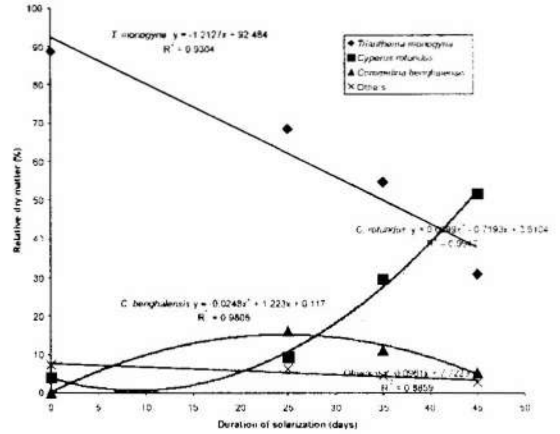

Fig. 2. Realtive weed dry matter at 45 days after film removal

time, it was estimated that the stimulatory effect of solarization on this weed was greater at 25 days of PE mulching. Therefore, this indicate that about 3 weeks of solarization induce the germination of *C. benghalensis* dormant seeds and that period of mulching greater than 35 days either reduce the viability of seeds or induce secondary seed dormancy. Soil solarization even for 25 days decreased weeds emergence, but to a lesser extent than 35 or 45 days treatments. The main solarization effect was restricted to the 0-5 cm layer of soil. The maximum temperature at 5 cm depth was about 8-10^{0}C warmer in solarized soil than in control plots. It was concluded that soil solarization with transparent polyethylene film for 35 or 45 days caused healthy seedling of brinjal by increasing the dry matter production of seedlings and proved very useful technique for controlling more than half of the species recorded without any use of chemical. So, this study indicated that this technique may be useful for weed control in brinjal nurseries and producing healthy seedlings of brinjal, where there is little scope of herbicide use for reducing weed competition, due to more involvement of risk.

Table 1 Total weed dry matter accumulation and weed density at 15,30 and 45 days after the films had been removed

Solarization times (days)	*15 days after film removal*		*30 days after film removal*		*45 days after film removal*	
	Weed density ($No./m^2$)	*Weed dry matter (g/m^2)*	*Weed density ($No./m^2$)*	*Weed dry matter (g/m^2)*	*Weed density ($No./m^2$)*	*Weed dry matter (g/m^2)*
0	145	142.0	238.0	245.8	248.0	242.1
25	73	88.1	125.0	125.8	103.0	108.6
35	22.0	41.4	30.0	30.7	24.0	19.6
45	17.0	22.5	22.0	22.6	13.0	10.4
3CD at 5%	21.0	20.0	39.1	32.2	12.7	44.3

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79- Microbial Management of Weeds in India: Current Status.

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The designation of a plant species as a weed is rarely unanimous and substantial disagreement often arises. For instance, a species might be designated as weed – based on its detrimental effect on agriculture or the environment, but actually may benefit beekeepers, wild flower and fruit gatherers, herbalists and others. The concept of ' weed ' is very subjective. A plant may be a weed to one person but the same plant may be useful to another. Weeds have been recognized as a nuisance since farming in prehistoric times. Some plants are naturally weedy and became a nuisance when agriculture practice was started in the areas where they already existed while often plants developed into weeds only since people started to cultivate crops. Due to their adaptive nature in different environmental conditions weeds thrive better than cultivated plants and reproductive success and dispersal seem to be the focal factors that determine the seriousness of a weed in an environment.

Chemical pesticides have been proved to be excellent tools in today's crop protection technology, but sometimes cause formidable problems. Rosentein stated that today we live in constant threat of man created irreversible phenomena. Man can literally change the face of the earth and the composition of his environment before the public and the protective agencies are aware of the impending danger. This statement is particularly applicable to pesticides, for in the case of DDT, the lag time between its first use and the public's general awareness of the danger it presents to the environment has been in the order of a quarter of a century. People were greatly alarmed. And this was over a pesticide that, a few years ago, won a Nobel Prize for its development. It is particularly ironic that Sweden, the country that presented the Nobel Prize for DDT, has now severely restricted its use. India is one of the few countries in the world where the use of DDT or PCB's is not yet banned. The cost factor remains one of the reasons for India not banning the using of these pesticides. Even with proper use, chemicals may be hazardous indirectly in various ways, namely toxicity of residuals, injury to non target crops and endangered species, development of resistance and resurgence at more serious levels. Widespread use of chemical pesticides in the home and in agriculture has led, inevitably, to greater misuse and greater risks to the user and the consumer. Significant health and environmental hazards have risen at specific non – agricultural sites as our requirement for synthetic chemical pesticides increased.

Storage, transportation and disposal of toxic materials and waste products are an increasing risk to the country as our dependence upon chemical pesticides grows. As a result of outcries against the tragedies, the discovery and development of alternatives to chemical pesticide is an essential agenda for agricultural scientists faced with the daunting task of protecting crops and livestock on a large scale over a wide range and ever shifting spectrum of agricultural pests. Biological control of weeds with microorganisms has provided an effective and eco- friendly management for many weed problems.

Microbial-based strategies have now revolutionized the weed management technology. Several microorganisms as such or their secondary metabolites have been patented and successfully commercialized. Some of the well-known examples are – Collego, DeVine, BioMal, Velgo and Bialaphos.

Through survey of literatures leaves impression that despite of extraordinary microbial diversity nourished with diverse ecoclimatic conditions no serious effects have been made in India in this direction

(Pandey *et al* (2001), Pandey *et al* (2003). Therefore the aim of this paper is to highlight the status and possibilities of its exploitation for weed management in India.

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80- Influence of *In Situ* Soil Moisture Conservation and Nutrient Management Practices on Weed Dynamics and Grain Yield in Rainfed Cowpea

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INTRODUCTION

Productivity of pulses in rainfed agriculture has remained low and unstable owing to climate and soil related constraints (Swindale, 1982.) Weeds are wastefully using the soil moisture under moisture stress condition and compete with crop plants for moisture, nutrients and other growth factors and cause reduction in crop yield under rainfed ecosystem. Weed management through organic mulch is an eco-friendly option, which leaves no residual toxicity to the environment as it provides a physical barrier against emerging weeds. Hence, field experiments were conducted at the demonstration fields of M. S. Swaminathan Research Foundation, Ariyamuthupatti, Pudukottai district of Tamil Nadu to study the effect of different *in situ* soil moisture conservation and nutrient management practices on weed dynamics and yield of cowpea under rainfed ecosystem.

MATERIALS AND METHODS

Field experiments were conducted at the demonstration fields of M. S. Swaminathan Research Foundation, Ariyamuthupatti, Pudukottai district of Tamil Nadu during *rabi* season 2002 and 2003. The experimental field soil is shallow to moderately deep, medium textured, acidic in reaction and non-calcareous, which is derived from lateritic parent material. The treatments consisted of four different *in situ* soil moisture conservation practices (ridges and furrows, compartmental bunding alone and along with mulching) and three different nutrient management practices (recommended dose of inorganic fertilizers, raw compost and enriched compost), compared to farmers' practice of moisture conservation (disc ploughed once during pre-monsoon showers and subsequently country plough tillage was given once during sowing) and no nutrient application. During 2003, there was a change in the treatment structure where tied ridges replaced the compartmental bunding and raw compost application was replaced by application of 50 per cent inorganic fertilizers and 50 per cent enriched compost. The recommended dose of nitrogen and phosphorus at the rate 12.5 and 25 kg ha^{-1} and recommended dose of raw compost and enriched compost at the rate of 2.5 t ha^{-1} were applied on the slope of the ridges according to treatment schedule. Mulching was done with locally available crop residues of groundnut, horse gram, and greengram and sugarcane trash at the rate of 2.5 t ha^{-1} on dry weight basis on 15 days after sowing. Cowpea variety Pusa 152 was used in this experiment. The weed floras noticed in the experimental field were *Celosia argentia, Alysicarpus rogosus, Cyperus rotuntus, Fymristylis spp and Euphorbia prostrata.*

RESULTS AND DISCUSSION

The results on weed dynamics revealed that mulching practice with locally available crop residues in moisture conservation practice was found significantly reduced the weed population and weed dry matter in cowpea irrespective of ridges and furrows, compartmental bunding and tied ridges alone. Significantly lesser total weed density (25 Nos. m^{-2}) and total weed dry matter (110.6 kg ha^{-1}) were registered in ridges and furrows with mulching followed by compartmental bunding with mulching during 2002 and ridges and furrows with mulching (53 Nos. m^{-2} and 209.2 kg ha^{-1} respectively), followed by tied ridges with mulching during 2003 over treatments which received no mulching in both the years. Nutrient management practices did not produce any significant variation in weed density as well as dry matter during both the years.

Higher grain yield of cowpea was obtained under ridges and furrows with mulching by 20 per cent during 2002 and tied ridges with mulching by 42.9 per cent during 2003 over farmers' practice of moisture conservation respectively. Among the nutrient management practices, application of enriched compost during 2002 and integration of 50 per cent inorganic fertilizers and 50 per cent enriched compost during 2003 registered significantly higher grain yield than farmers' practice of no nutrient application in both the years (Table 1). This might be due to application of organic mulch on the soil surface, which would have cut off the sunlight on the surface caused shade to soil which in turn created poor environment for germination as well as growth of weeds and also the mechanical obstruction of the covered mulch materials on the growth of weeds. In addition, under mulching presence of higher soil moisture favoured better crop growth resulting in more foliage cover, which caused reduction in weed growth. Similarly, the beneficial effect of mulch on weed management was reported by Tindall *et al.* (1991).

Table 1 Effect of *in situ* soil moisture conservation and nutrient management practices on weed dynamics and yield in cowpea

Treatments	*2002*			*Treatments*	*2003*		
	Weed density (No. m^{-2})	*Weed dry matter (kg ha^{-1})*	*Grain yield (kg ha^{-1})*		*Weed density (No. m^{-2})*	*Weed dry matter (kg ha^{-1})*	*Grain yield (kg ha^{-1})*
Moisture (M)				**Moisture (M)**			
Farmers' Practice	98.4(1.99)	427.4	572.2	Farmers' Practice	164.0(2.21)	712.2	169.7
Ridges & Furrows (R&F)	84.0(1.99)	412.5	662.8	Ridges & Furrows (R&F)	140.0(2.15)	687.5	208.5
Compart. Bunding (CB)	92.3(1.96)	429.0	627.8	Tied ridge (TR)	159.0(2.20)	715.0	223.2
R& F + Mulching	25.0(1.39)	110.6	715.9	R& F + Mulching	50.0(1.68)	221.2	279.0
CB + Mulching	26.5(1.42)	108.8	688.9	TR + Mulching	53.0(1.71)	209.2	297.4
CD at 5%	0.29	88.5	49.5	CD (P=0.05)	0.32	147.6	29.1
Nutrient (N)				**Nutrient (N)**			
Farmers' Practice	67.3(1.77)	308.2	560.1	Farmers' Practice	116.0(2.02)	521.7	156.6
Rec. NPK	72.1(1.79)	305.5	691.3	Rec. NPK	124.0(2.04)	524.2	237.9
Raw compost	65.8(1.77)	303.9	632.1	50% NPK+ 50% Enriched compost	113.6(2.02)	521.6	284.5
Enriched compost	55.8(1.62)	273.2	730.7	Enriched compost	99.2(1.89)	468.8	263.2
CD at 5%	NS	NS	32.3	CD (P=0.05)	NS	NS	20.3

Figures in parenthesis refer to log (x + 0.5) transformation

CONCLUSION

From the above study, it could be concluded that sowing of cowpea on either ridges and furrows or tied ridges along with mulching by locally available crop residues at the rate of 2.5 t ha^{-1} could be viable practice for reducing the total weed population and dry matter and increasing the yield of cowpea under rainfed *alfisol* ecosystem.

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81- Need of Intensified Introduction of Mexican Beetle for Biological Control of *Parthenium* in India

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Parthenium has emerged as one of the worst weed of India. This is the most defamed weed among the people owing to its properties to cause many health-associated problems in man and animals besides loss in crop productivity. Earlier *Parthenium* was considered a major weed of uncultivated land only but now it has spread its in almost all type of cereals and vegetable crops besides in orchards. Now, it is also being seen in many forest areas including National Parks and Reserved forest. Since the inception of *Parthenium* problem, much emphasis has been given to control *Parthenium* through various methods like mechanical, chemical and biological. Among these, biological control has been considered most cost effective, environmentally safe and practical method of managing *Parthenium* in spite of some limitations. Exotic Mexican beetle, *Zygogramma bicolorata* (Coleoptera: Chrysomelidae) has achieved spectacular success at many places in India in varied climate of south and north after its introduction and has helped to restore native vegetation (Jayanth, 1987; Sushilkumar, 2004). But introductory releases of this beetle throughout the country suffered a severe setback after reports of beetle's feeding on sunflower, however, Mexican beetle won the battle against sunflower controversy (Sushilkumar and Saraswat, 2002). This paper discusses the present spread and infestation of *Parthenium* in India and the scope and need of further intensified introduction of Mexican beetle in the newer areas where beetle has not been introduced so far.

Scope of beetle's introduction in newer areas

After first field release of Mexican beetle at Bangalore in 1984, it got established at the released sites and showed considerable success in *Parthenium* suppression in the subsequent years (Jayanth, 1987). However, the success of this beetle received a severe jolt after reports of its feeding on sunflower in a few locations in Karnataka. This report led to the establishment of the Fact Finding Committee (FFC) by the Indian Council of Agricultural Research (ICAR) in November 1992 to find out the truth. The Govt. of India imposed a ban on the intentional release of the beetle in 1993. This ban remained effective up to 1999 till the acceptance of the findings of FFC, which declared the beetle safe to sunflower. Controversy emerged over the feeding of beetle on sunflower and imposition of ban by Govt. of India hampered the introductory releases of this beetle drastically in newer areas hence its spread and distribution. By 1992, beetle had spread and established in Karnataka, Tamil Nadu and Andhra Pradesh besides in some parts of Maharashrtra and in Vindhyanagar of district Sidhi of Madhya Pradesh. Introductions made during 1989-1992 by Indian Institute of Horticultural Research, Bangalore also yielded good success by the beetle in some areas of Punjab, Himachal Pradesh and Jammu and Kashmir in subsequent years. Further efforts made by National Research Center for Weed Science, Jabalpur after lifting of ban on beetle's release helped in the establishment of beetle in some parts of Madhya Pradesh, Haryana, Delhi, Lower Uttaranchal and Western Uttar Pradesh. Initially, it was thought that Mexican beetle will be suitable only in moderate climate and will not be able to establish well in the areas having low and high temperature extremes below and above 15 and 35°C, respectively (Jayanth, 1993). But recent survey by the author betrayed this assumption as beetle was found to cause large-scale defoliation in and around Jabalpur (Madhya Pradesh), Rudrapur, Kashipur, Panthnagar, Jaspur, Roorkee, Dehradun, Rishikesh, Haridwar (Uttaranchal), Gajiabad, Bijnor, Saharanpur (Uttar Pradesh). In Punjab, beetle was found well established in Jalandhar, Ropar, Ludhiana and near Wagha border of India and Pakistan. In Haryana, beetle was found established in some parts of Rohatak, Sonipat and Karnal. The beetle was also recovered in Delhi in 2004 from the released sites after its introduction in 2002. These regions in north and central India represent low and high temperature regime thus further strengthened the evidences of potential of Mexican beetle for biological control of *Parthenium* throughout the country.

There seems to be extremely good scope of Mexican beetle in some situations like organic farming, Wild Life Sanctuaries, National Parks and Reserved forests where the use of pesticides is completely restricted. The occurrence and spread of *Parthenium* has already been noticed in forest areas (Pandey and Saini, 2002) and in crops being cultivated organically. In such situations, inoculative and augmentative releases of the Mexican beetle will be of immense value

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82- Effect of Weed Management Practices on Productivity of Rice under Different Methods of Crop Establishment.

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INTRODUCTION

There are three principal methods of rice establishment viz., dry seeding, wet seeding and transplanting. As the seeds are sown directly, the dry and wet seeding methods are jointly referred to as direct seeding. Direct seeding holds special significance in the present day production systems with regard to saving time, labour, energy, profitability and increase in cropping intensity by reducing turn around period and to avoid arduous operations like nursery preparation and hand transplanting (Pandey,1995). Crop establishment and weed control techniques are critical in rice farming especially in direct seeded rice. Thus, suitable methods of seeding coupled with cost effective weed control methods will improve the performance of wet seeded rice.

MATERIALS AND METHODS

Field experiments were conducted during summer and *kharif* seasons of 2001 at Agricultural Research Station, Honnavile, University of Agricultural Sciences, Bangalore. The experiment was laid out in a split plot design with three planting systems as main plots i.e., broad cast sowing (M_1), drum seeding (M_2) and line transplanting (M_3) and five weed management practices as subplots i.e., reduced tillage (W_1): one ploughing / puddling followed by two irrigations to moisten the soil and activate the weed germination and growth. After 15 days glyphosate at 2.5 L ha^{-1} sprayed on the weed flora. After 5 days of spraying, field flooded to soften the soil, fertilizers broadcasted and sowing/planting of rice. Pre-emergence application of pretilachlor + safener at 1 l ha^{-1} on 4 DAS/DAT (W_2), hand weeding twice on 20 and 40 DAS/DAT (W_3), pre-emergence application of pretilachlor + safener at 1 l ha^{-1} on 4 DAS/DAT + one hand weeding on 30 DAS/DAT (W_4) and unweeded check (W_5) replicated thrice.

RESULTS AND DISCUSSION

The pooled data of two seasons indicated that total density and dry weight of weeds recorded at 60 DAT in line transplanting system (19.27 / 0.25m^2 and 520.6 kg ha^{-1}) and direct seeding using drum seeder (20.15 / 0.25m^2 and 541.7 kg ha^{-1}) was at par and inturn significantly lower compared to broadcast sowing (24.1/ 0.25m^2 and 644.1 kg ha^{-1}). Among weed management practices total weed dry weight recorded in treatment W_4 i.e., application of herbicide followed by hand weeding on 30 DAS (51.4 kg ha^{-1}) was at par with treatment W_3 i.e., two hand weedings on 20 and 40 DAS / DAT (78.5 kg ha^{-1}) and inturn was significantly lower compared to other treatments. Treatment combination M_2W_4 i.e., drum seeding with application of herbicide followed by one hand weeding recorded lower total weed count (4.19 / 0.25 m^2) and total weed dry weight (35.1 kg ha^{-1}) compared to other treatment combinations but it was at par with M_3W_4 (4.32 / 0.25 m^2 and 47.5 kg ha^{-1}), M_3W_3 (5.75 / 0.25 m^2 and 60.3 kg ha^{-1}), M_2W_3 (6.62 / 0.25 m^2 and 74.8 kg ha^{-1}) and M_1W_4 (6.67 / 0.25 m^2 and 71.8 kg ha^{-1}).

Line transplanting system recorded significantly higher grain yield (5533 kg ha^{-1}) compared to direct seeding using drum seeder (5429 kg ha^{-1}) and broadcast sowing (3853 kg ha^{-1}). These results are in accordance with the findings of Choudhury and Thakuria (1998). Among weed management practices grain yield recorded in W_4 i.e., application of herbicide + one hand weeding (6233 kg ha^{-1}) was at par with W_3 i.e., two hand weedings (6024 kg ha^{-1}) and inturn these two treatments were significantly superior over other treatments. These results are in line with the findings of Raju *et al.* Treatment combination M_2W_4 i.e., direct seeding using drum seeder with application of herbicide followed by hand weeding on 30DAS recorded significantly higher grain yield (7061 kg ha^{-1}) compared to other treatment combinations except M_3W_4 (6995 kg ha^{-1}), M_3W_3 (6904 kg ha^{-1}) and M_2W_3 (6866 kg ha^{-1}) with which it was at par. Sowing in lines spaced at optimum distance and depth helped in vigorous establishment of the crop. Pre-emergence application of pretilachlor + safener and subsequent one hand weeding imposed on 30 DAS/DAT provided relatively weed free condition. This conducive environment enhanced the growth and yield components of rice which inturn was reflected in terms of significantly higher grain yield.

Table 1: Total weed count (No. Per 0.25m^2), total weed dry weight (kg ha^{-1}) at 60 DAS/DAT and grain yield (kg ha^{-1}) as influenced by planting systems and weed management practices (pooled data of two seasons).

Treatments	*Total weed count (No. Per 0.25m^2)*				*Total weed dry weight (kg ha^{-1})*				*Grain yield (kg ha^{-1})*			
	M_1	M_2	M_3	*Mean*	M_1	M_2	M_3	*Mean*	M_1	M_2	M_3	*Mean*
W_1 Reduced tillage	6.30	6.01	5.77	6.03	32.99	30.66	29.44	31.07	3617	4288	4749	4218
	(39.17)	(35.73)	(32.84)	(35.91)	(1087.7)	(940.9)	(866.6)	(965)				
W_2 Herbicide	3.69	3.20	3.20	3.37	18.16	15.72	15.84	16.61	4065	6098	5949	5371
	(13.13)	(9.80)	(9.84)	(10.92)	(329.7)	(247.0)	(251.3)	(276)				
W_3 Hand weeding	3.27	2.65	2.47	2.82	10.25	8.34	7.73	8.84	4302	6866	6904	6024
	(10.29)	(6.62)	(5.75)	(7.56)	(105.4)	(74.8)	(60.3)	(78.5)				
W_4 Herbicide +	2.65	2.11	2.15	2.32	8.48	5.92	6.83	7.16	4644	7061	6995	6233
Hand weeding	(6.67)	(4.19)	(4.32)	(5.06)	(71.8)	(35.1)	(47.5)	(51.4)				
W_5 Unweeded	7.19	6.70	6.63	6.84	40.32	37.63	37.06	38.36	2636	2834	3067	2846
check	(51.26)	(44.42)	(43.58)	(46.42)	(1625.8)	(1416.2)	(1376.1)	(1472.7)				
Mean	5.00	4.54	4.44		25.38	23.27	22.80		3853	5429	5533	
	(24.1)	(20.15)	(19.27)		(644.1)	(541.7)	(520.6)					
Main plots (M)												
CD at 5%				0.28				1.32				57.4
Subplots (W)												
CD at 5%				0.38				1.80				259.3
Interaction												
Subplot at same level of main plot												
CD at 5%				0.54				2.81				449.1
Main plot at same or different levels												
of subplot CD at 5%				0.68				3.10				739.5

(Figures in the parenthesis indicate original values)

M_1 : Broadcast sowing M_2 : Drum seeding M_3 : Line transplanting

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83- Integrated Weed Management in Rice + Groundnut Intercropping under Rainfed Conditions of Nagaland

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INTRODUCTION

The north east region is richly endowed with abundant rainfall and most of the crop production is based on rain water. Rice is the major crop of North East region (Sharma and Singh, 1998). Groundnut is the new introduction to this region. These crops are grown under upland rainfed conditions which face severe weed competition during the critical stages of the crop growth. Therefore, the present investigation was undertaken to develop an integrated weed management system for rice and groundnut intercropping.

MATERIALS AND METHODS

A field experiment was conducted at research farm of School of Agricultural Sciences and Rural Development, Nagaland University, Medziphema campus during the *kharif* season of 2002. The soil was sandy loam, high in organic carbon (1.04%), medium in available N (282.6 kg/ha), low in available P_2O_5 (19.2 kg/ha) and K_2O (112 kg/ha), acidic in reaction (pH – 4.6). The experiment comprised of two cropping system viz., sole rice and rice + groundnut and five weed control measures viz., hand weeding at 20 DAS, hand weeding at 20 and 40 DAS, pre emergence application of oxyfluorfen 0.20 kg / ha , oxyfluorfen 0.20 kg / ha + hand weeding at 40 DAS and weedy , replicated thrice in randomized block design. Row spacing of rice was 30 and 40cm in case of sole and intercropping, respectively. Rice and groundnut was sown in 1:1 row ratio. A uniform dose of 60 kg N, 40 kg P_2O_5 and 40 kg K_2O/ ha through urea single super phosphate and muriate of potash. One third dose of nitrogen and full dose of P_2O_5 and K_2O were applied as basal dose, remaining two third of nitrogen was applied at 30 and 60 DAS. All the biometrical parameters were recorded and analyzed using standard techniques.

RESULTS AND DISCUSSION

The dominant weed flora found in the experimental field were *Amaranthus viridis, Boreria hispida, Digitaria sanquinalis, Elusine indica, Euphorbia hirta, Mimosa pudica* . and *Steria glauca.*

Intercropping of rice + groundnut significantly reduced the weed dry weight this might be due to vertical growth of rice and lateral growth of groundnut resulting in smothering effect on weeds. Among the weed control measures. oxyfluorfen 0.20 *kg* a.i / ha + hand weeding at 40 DAS recorded the minimum weed dry weight which was at par with hand weeding twice and significantly better than hand weeding at 20 DAS, and oxyfluorfen 20 *kg* / ha

Grain yield in sole rice was higher than intercropping which might be due to better performance of yield attributing characters viz., number of panicles / hill, number of effective grains / panicle and 1000 grains weight in sole cropping. Among the weed control treatments, hand weeding at 20 and 40 DAS recorded the maximum grain yield which was statistically at par with oxyfluorfen 20 kg / ha pre emergence + hand weeding at 40 DAS. The maximum pod yield of groundnut was obtained from oxyfluorfen 0.20kg / ha pre-emergence + hand weeding at 40 DAS which was significantly superior to all other weed management treatments. Inclusion of groundnut as a intercrop with rice gave significantly higher rice equivalent rice as compared to sole rice. Oxyfluorfen 0.20 kg / ha pre-emergence + hand weeding at 40 DAS recorded the highest rice equivalent yield which was significantly more than weedy. The integration of chemical and mechanical measures recorded the maximum rice equivalent yield. It corroborate that integration is better over alone application of weed management practices.

Table 1. Effect of intercropping and weed control measures on yield attributes, yield and rice equivalent yield.

Treatment Inter cropping	*Weed dry weight (g/m²)*	*No. of panicles /hill*	*No. of effective grains/panicle*	*1000 grain wt (g)*	*Rice grain yield (kg/ha)*	*Pod yield (kg/ha)*	*Rice equivalent Yield (kg/ha)*
Rice	211.71	9.97	138.83	21.12	1057	—	1057
Rice + Groundnut	157.33	9.38	116.25	21.23	895	1356	7676
CD at 5%	21.49	NS	NS	NS	NS	—	577
Weed management							
HW at 20 DAS	162.66	9.40	122.20	21.27	1027	605	3880
HW at 20 and 40 DAS	106.73	10.83	106.7	22.27	1336	869	5505
Oxyfluorfen 0.20 a.i. kg/ha	229.24	9.85	229.2	21.07	833	704	4177
Oxyfluorfen 0.20 kg/ha + HW at 40 DAS	84.73	10.72	84.7	21.53	1146	1170	6824
Weedy	339.25	7.57	339.2	19.75	539	217	1448
CD at 5%	33.98	1.26	33.98	1.16	284	216	912

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84- Integrated Weed Management in Transplanted Rice

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INTRODUCTION

Weed management in transplanted rice is accomplished by mechanical, cultural, chemical methods and combinations of two or more of these practices. Though hand weeding is very effective but it is tedious, time consuming and up to some extent expensive for large farmers. Continuous rains in rainy season make weed control more difficult. In such situations, herbicides hold great promise as they can arrest weed growth right from beginning of crop growth and there by can increase crop growth and crop yield.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2002-03 in an Aquic Hapludoll silty loam soil at Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar to assess the impact of different aspects of weed control in transplanted rice by herbicides and other weed management practices. The field experiment consisted of twelve weed control treatments in randomized block design with four replications. Twenty five days old seedlings of rice variety 'Jaya' were transplanted on June 25, 2002 at 20 cm x 20 cm spacing with recommended dose of fertilizers (120 kg N + 60 kg P_2O_5 + 40 K_2O ha^{1}).

RESULTS AND DISCUSSION

The major weed species found were *Echinochloa* spp.(16%) *Cyperus* spp. (36%), *Caesulia axillaries* (15%) and *Commelina banghalemis* (14%). Weed control treatments had significant effect on total weed density. The highest total weed density was recorded 44 m^{-2} in T_{10} (Non-weeded control) and the lowest total weed density 11 m^{-2} in T_9 two hand weedings). Excellent control of these weeds was achieved by two hand weeding followed by integrated weed management i.e. butachlor + one hand weeding and almix + butachlor treatments. The weed control treatments had significant effect on grain yield of rice. All the weed control treatments produced significantly higher grain yield over the non weeded control. Integrated weed management treatment gave the highest grain yield (5.92 t ha^{-1}) and was significantly *at par* with two hand weedings (5.71 t ha^{-1}).

85- Integrated Weed Management in Konkan Coastal Zone of Maharashtra

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INTRODUCTION

At the national level, in general and Konkan coastal zone of Maharashtra in particulars, hand weeding goes as a major method of weed control, which however gets handicapped due to a higher cost and timely non-availability of the labours. Never the less, now there are chemicals which are expected to meet the situation to a certain extent. Herbicides combined with mechanical weed control measures and considering the dangers involved in relying on any single weed control method, has necessitate for an integrated weed management. Similarly the cultivation of rice by transplanted method, proved more expensive due to more requirement of labours compared to directed seeded rice (De Datta as Herdt, 1983). The butachlor and anilophos are suitable and easily available in market. The organic mulch have also been reported effective in checking the weed growth.

Drilling, dibbling, rahu, and broadcast are some of the common methods of direct seeding in Maharashtra State, however these are meagerly followed in Konkan Coastal Zone of Maharashtra. The present study was, therefore, carried out to evaluate the performance of various weed control measures under different methods of direct seeding in rice.

MATERIALS AND METHODS

Series of field trials were conducted during rainy season at Agricultural Research Station, Phondaghat (Sindhudurg district, Maharashtra). The treatments were replicated thrice in split plot design. The main plots comprised of four methods of rice seeding (broadcast, rahu, drilling and dibbling) and sub plots include weed control measures (hand weeding – twice at 15 and 30 DAS, pre-emergence application of butachlor, anilofos and spreading of paddy straw in the field with unweeded control). In rahu the pre-germinated rice seeds are broadcast on the prepared field. The paddy straw, which was not preferred by cattle was used in this experiment.

RESULTS AND DISCUSSION

The grain yield of rice was significantly influenced by different weed control measures during all the years of experimentation (Table 1). The hand weeding twice at 15 and 30 DAS gave significantly maximum yield. The butachlor application at 1.5 kg/ha was next effective and profitable wed control measure and proved significantly superior over other weed control measures. Anilofos and paddy straw recorded significantly less yield though found better than unweeded control. On an average drilling, dibbling and rahu methods were at par in recording the grain yield and were significantly superior over broadcast method (Table 1). Data presented in Table 1 reveal that rahu sown crop with hand weeding recorded maximum yield of 30.44 q/ha and crop sown either by drilling or dibbling and controlling the weeds either by hand weeding or butachlor has yielded statistically equal. Rahu method under butachlor received, however, significantly lesser yield when compared under hand weeded treatment. Drilling, rahu and broadcast methods under paddy straw and anilofos showed about equal performance, but were significantly inferior over dibbling with butachlor.

Table 1. Grain yield of rice (q/ha) as influenced by different treatments (pooled mean of 1990, 1991 and 1992)

Sowing methods	*Weed control measures*					
	Unweeded	Hand weeding	Butachlor	Anilofos	Paddy straw	Mean
Drilling	11.09	28.99	24.99	19.62	17.77	20.49
Rahu	9.77	30.44	23.02	20.65	18.33	20.44
Dibbling	11.75	28.99	25.88	20.84	16.60	20.81
Broadcast	9.09	26.34	22.41	17.34	18.21	18.68
Mean	10.43	28.69	24.08	19.61	17.73	
		CD at 5%				
	Weed control		1.69			
	Sowing methods		1.50			
	Interaction		4.03			

Dry Matter of Weed

Hand weeding treatment has significantly reduced the dry matter of weed at harvest over other weed control measures. Application of butachlor and anilofos were equally effective in controlling the weeds. Paddy straw was found effective only to some extend over unweeded control (Table 2).

Table 2. Dry matter of weed harvest (kg/ha) as influenced by weed control measures.

Season	*Unweeded Control*	*Hand weeding*	*Butachlor*	*Anilofos*	*Paddy straw*	*CD at 5%*
Rainy season 1990	3555	1217	2170	2231	2839	413
Rainy season 1991	3398	837	909	1072	1799	330
Pooled mean	3477	1027	1540	1651	2319	118

As indicated in Table 3, cost of hand weeding comes to Rs.1440 which is about three and half times more than the cost of chemical weeding. Use of paddy straw also cost double than the use of weedicides.

Cost of sowing methods

Lowest cost of treatment under sowing methods comes for rahu methods closely followed by broadcast which is not usually followed by the farmers. Drilling cost Rs.284/ha while dibbling Rs.216/ha.

Effect of weed control measure

Maximum net return of Rs.1362/ha was obtained through hand weeding followed by butachlor applications which recorded a net return of Rs.1130. Paddy straw and anilofos were failure in securing the return. The rahu method and hand weeding combination gained maximum net return followed by drilling or dibbling with hand weeding or butachlor combination. However, combination of, both weedicides with rahu drastically bought down the net return, being Rs.987 and 324 respectively for butachlor and anilofos.

Table 3. Mean net returns (Rs./ha) as influenced by different treatments.

Season	*Unweeded Control*	*Hand weeding*	*Butachlor*	*Anilofos*	*Paddy straw*	*Cost of treatment*
Drilling	-2186.99	1312.48	1307.23	106.84	-1027.67	284
Rahu	-2405.47	1764.54	987.08	324.69	-740.03	140
Dibbling	-1950.97	1266.49	1473.80	166.02	-1279.30	216
Broadcast	-2549.79	1105.63	750.68	-432.42	-806.71	183
Mean	-2273.31	1362.29	1129.70	41.28	-963.44	
Cost of treatments	—	1440	429	354	768	

Hand weeding practice, due to its highest weed control efficiency, reflected in better yield and highest net profit, alongwith owing to higher labour cost. Singh (1993) also reported the similar results. Butachlor and anilofos though were equally effective in controlling the weeds in rice, significant yield differences between them, indicate more pronounced toxicity of anilofos. Sreedevi and Thomas (1993) found severe stand loss due to toxicity of anilofos to rice crop.

It can be concluded from the results of these experiments that pre-emergence application of butachlor at 1.5 kg/ha be used for successful and economic control of weeds in direct seeded rice for short duration rice varieties, particularly in drilled or dibbled rice under the circumstances when labour are not available at reasonable charges.

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86- Effect of Integrated Weed Management Practices on Weed Density and Sugarcane Productivity in Late Planted Sugarcane

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INTRODUCTION

To see the effects of various herbicides alone or in combination with or without Interculture and also to see the effect of some intercrops.

MATERIALS AND METHODS

An experiment with three replications in randomized block design was conducted during 2001-02 and 2002-03 on sandy loam soils of Janta Vedic (PG) College, Baraut. Fifteen treatments comparing weed management practices involving herbicide (PE, Po-em), herbicide + hoeing/weeding, herbicide (Pre-em. fb post-emergence), hoeing (30, 60 and 90 DAP), intercrops (urd, moong and cowpea) fb pendimethalin 1.0 kg ha^{-1} and one hoeing after intercrop harvest and trash mulching were tested two consecutive years 2001-02 and 2002-03. CoS 767 variety of sugarcane was planted on May 7^{th} and April 16^{th} during 2001-02 and 2002-03, respectively. Sugarcane was fertilized with 120 : 60 : 40 kg ha^{-1} N, P_2O_5 and K_2O.

RESULTS AND DISCUSSION

Total weed population was increased up to 90 days stage and reduced thereafter irrespective of the treatments. The highest weed population (552 m^{-2} during 2001-02 and 370.7 m^{-2} during 2002-03) was recorded in weedy check and reduced significantly due to weed management practices during both the years. Total weed population was also recorded considerably lower (10.5 during 2001-02 and 10.0 during 2002-03) in the treatment of metribuzin 1.0 ha^{-1}(Pre-emergence) + 2,4-D 1.0 kg ha^{-1} (post-emergence), which was significantly lower then the rest of the treatments at 60 days stage. *Trianthema monogyna* was reduced in trash mulching and the population, in general, was lowered in all the treatments during both the years.

Significantly higher cane yield (84.6 t/ha during 2001-02 and 80.6 t/ha during 2002-03) was recorded in weed free treatment over rest of the treatments. As far as the losses caused by weeds are concerned 43.4 per cent yield during 2001-02 and 43.9 per cent during 2002-03 was reduced due to weeds in weedy plot. The higher yield in these treatments was attributed with higher millable cane, cane weight; cane length and low shoot mortality (%) during both the years. Commercial cane sugar (CCS) was also recorded significantly higher (10.1 t/ha during 2001-02 and 9.3 t/ha during 2002-03) in weed free treatment over rest of the treatments except the treatment of three hoeings (30, 60 and 90 DAP). CCS (t/ha) was recorded significantly higher in all the weed control treatments over weedy check during both the years. For higher production weeds should prevent sugarcane crop particularly in formative stage (tillering) either by pre-emergence herbicides followed by manual hoeings or by cultural method of weeds management. In pre-emergence metribuzin 1.0 kg/ha followed by one hand weeding at 60 days will be effective to control the weeds and to increase the productivity

87- Impact of Integrated Weed Management in Spring Planted Sugarcane

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INTRODUCTION

Sugarcane is cultivated under wise range of agro-ecological systems in India. Trarai belt of Uttaranchal and Western Uttar Pradesh occupies a sizeable area under the crop. Weed infestation is one of the major barriers realizing high yields of sugarcane in the area having fertile soils with sufficient moisture. Additionally, sugarcane, being a widely spaced crop with slow initial growth, provides a congenial ambiance to weeds for their growth and development. Weeds by virtue of their competitiveness reduce sugarcane yields to the extent of 60-75 per cent. The situation is further aggravated due to inaccessibility to manual hoeing owing to labour shortage and soil wetness. Under such conditions, chemical options can help in augmenting proper weed management. Therefore, the present investigation was conducted to study the effect of herbicides in combinations in spring planted sugarcane.

MATERIALS AND METHODS

The field experiments were conducted during 1999-2001 at crop research center of GB Pant University of Agriculture& Technology, Pantnagar. The experimental soil was silty loam, rich in organic carbon, medium in available phosphorus and potassium with pH 7.3. Treatments comprising, hoeing at 30 days after planting (DAP), atrazine at 2.0 kg ha^{-1}, metribuzin at 1.5 kg ha^{-1} and pendimethalin at 2.0 kg ha^{-1} applied alone as pre-emergence or each supplement with 2,4-D at 1.0 kg ha^{-1} at 60 DAP, glyphosate at 1.0 kg ha^{-1} directed spray at 3- DAP and oxyfluorfen at 3.0 kg ha^{-1} as pre-emergence were tested in randomized block design with three replications, sugarcane variety CoS 767 was planted in furrows 75 cm apart on March 05 and 10 during 1999 and 2000, respectively the crop was fertilized with 120 : 60 : 40 kg ha^{-1} of N : P_2O_5 : K_2O, respectively. Hoeing at 30 DAP, atrazine at 2.0 kg ha^{-1} caused significant reduction in weed population (69.4 %) and weed dry matter (70.5 %) over untreated crop.

RESULTS AND DISCUSSION

Treatment 2,4-D at 60 DAP coupled with pre-emergence application of metribuzin or pendimethalin increased weed control efficiency markedly over their respective sole application. Glyphosate at 1.0 kg ha^{-1} remained at par with one hoeing at 30 DAP followed by atrazine application. Cane yield was significantly higher when any of the weed control measures was adopted as compared to weedy conditions. Significantly highest mean cane yield of 99.6 kg ha^{-1} was recorded with one hoeing at 30 DAP followed by application of atrazine which was at par with three hoeing done at 30, 60 and 90 day stages. The respective incerease in mean cane yields under three hoeing, one hoeing + atrazine, atrazine or metribuzin or pendimethalin supplemented with 2,4-D at 60 DAP treatments over weedy crop 52.4, 49.7, 34.2, 37.4 and 31.9 per cent. Such increase might have accrued to suppression of weed growth. Commercial cane sugar yield, a function of cane yield and sucrose content followed the similar trend to the cane yield. Respective CCS was 48.9, 50.3, 37.4, 40.3 and 34.5 per cent more than weedy crop.

88- Integrated Effect of Tillage and Weed Control Methods on Weed Dynamics in Maize (*Zea Mays* L.) under Rainfed Conditions of Himachal Pradesh

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INTRODUCTION

Maize being grown during rainy season in hills suffers heavily due to severe weed infestation owing to congenial weather conditions and wider row spacing. Season long infestation of composite weed flora in maize reduces grain yield by 28-100% (Pandey *et al.*, 2001). Tillage influences the rate of weed seed emergence from different depths and the efficacy of weed control tactics, thus affecting weed population. Therefore, it is imperative to integrate tillage with weed control methods to obtain effective, economical and environmentally sound weed management in maize.

MATERIALS AND METHODS

A field experiment to study the integrated effect of tillage and weed control methods on weed dynamics in maize was conducted during *Kharif* 2002 and 2003 at the experimental farm of Department of Agronomy, CSK HPKV, Palampur. Experiment was conducted in split plot design by keeping three tillage methods *viz.* zero, conventional and raised seed bed in main plots and four weed control methods *viz.*, unweeded, acetachlor 0.75, acetachlor 1.25 and atrazine 1.5 kg ha^{-1} in sub plots with three replications. The soil of the experimental field was silty clay loam in texture, acidic in reaction, medium in available nitrogen and phosphorus and high in potassium. Maize hybrid variety PSCL-3438 was sown in second week of June by adopting recommended package of practices except treatments. Power tiller driven zero till machine and raised bed maize planter was used for sowing maize in zero tillage and raised seed bed planting, respectively. All the herbicides were applied as pre-emergence with flat fan nozzle attached to power sprayer using 600 l of water ha^{-1}. The data on species wise and total dry matter at maximum dry matter accumulation stage were recorded from randomly placed quadrate of 50 cm x50 cm size and subjected to square root transformation.

RESULTS AND DISCUSSION

Results of the study presented in Table-1 reveal that raised seed bed resulted in significantly lowest dry matter of *Digitaria sanguinalis, Echinochloa colonum, Brachiaria ramosa, Panicum dichotomiflorum* and thus total dry matter of weeds. The zero tillage remain at par with conventional tillage in reducing the dry matter of *Brachiaria ramosa* and *Echinochloa colonum* during both the years of study and of *Panicum dichotomiflorum* during *Kharif* 2003. Zero tillage caused significant increase in dry matter of grasses like *Digitaria sanguinalis* during both years and *Panicum dichotomiflorum* in *Kharif* 2002, over conventional tillage. Teasdale *et al.* (1991) also reported higher densities of *Digitaria sanguinalis* in the no-tillage compared with conventional tillage. While, dry matter of *Commelina benghalensis* was significantly reduced by zero tillage, the raised seed bed resulted in significantly highest dry matter. Among herbicidal treatments acetachlor 1.25 kg ha^{-1} being at par with atrazine 1.5 kg ha^{-1} produced significantly lower dry matter of *Digitaria sanguinalis, Panicum dichotomiflorum* and total weed dry matter during both the years and of *Commelina benghalensis* in the first year. However, with regard to significant dry matter reduction of *Echinochloa colonum* acetachlor 1.25 kg ha^{-1} took the next place to atrazine 1.5 kg ha^{-1}.

Table 1 Effect of tillage and weed control methods on species-wise dry matter of weeds (g m^{-2}) and grain yield of maize (kg ha^{-1}).

Treatment	Dry matter of weeds (g m^{-2})												Grain Yield (kg ha^{-1})	
	Digitaria sp.		*Echinochloa* sp.		*Commelina* sp.		*Panicum* sp		*Brachiaria* sp.		Total weeds			
	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003	2002	2003
Tillage methods														
Zero	7.18	7.66	5.11	5.67	2.57	3.43	2.62	3.47	2.04	1.84	10.03	11.31	5862.30	5735.87
	(58.93)	(65.1)	(29.20)	(34.83)	(6.30)	(11.83)	(6.37)	(11.70)	(3.62)	(2.67)	(113.08)	(139.33)		
Conventional	6.07	6.57	4.66	5.48	3.33	4.22	2.28	3.64	1.97	1.81	9.21	11.00	6872.07	6686.67
	(41.87)	(47.37)	(25.87)	(33.01)	(11.32)	(18.05)	(5.00)	(13.10)	(3.27)	(2.53)	(96.07)	(130.98)		
Raised seed	4.98	6.03	3.94	4.84	4.34	4.93	1.42	2.54	1.69	1.64	8.07	9.78	6638.21	6551.86
bed	(29.05)	(41.26)	(17.63)	(25.75)	(19.67)	(25.78)	(1.27)	(6.17)	(2.07)	(1.88)	(74.12)	(107.38)		
CD at 5%	0.48	0.25	0.46	0.37	0.32	0.36	0.24	0.23	0.15	0.12	0.34	0.28	236.45	446.30
Weed Control Methods														
Unweeded	10.28	10.83	7.94	8.45	4.97	5.99	3.09	4.39	2.38	2.18	14.79	16.31	4379.10	4171.97
	(106.51)	(116.93)	(62.67)	(70.63)	(24.98)	(36.02)	(9.02)	(18.49)	(4.75)	(3.78)	(219.15)	(265.32)		
Acetachlor	5.65	6.48	4.06	5.22	3.74	4.61	2.26	3.59	1.98	1.81	8.78	10.76	6382.80	6542.27
0.75 kg ha^{-1}	(32.47)	(42.09)	(16.00)	(26.64)	(13.69)	(20.62)	(4.58)	(12.38)	(2.78)	(2.31)	(77.40)	(115.82)		
Acetachlor	4.22	4.98	3.39	3.97	2.63	3.25	1.55	2.49	1.00	1.00	6.56	7.98	7527.37	7151.97
1.25 kg ha^{-1}	(17.53)	(24.14)	(10.78)	(14.98)	(6.35)	(9.82)	(1.64)	(5.49)	(0.00)	(0.00)	(42.51)	(63.05)		
Atrazine	4.15	4.74	2.89	3.67	2.32	2.92	1.54	2.39	2.25	2.07	6.30	7.75	7540.85	7432.99
1.5 kg ha^{-1}	(16.62)	(21.80)	(7.49)	(12.55)	(4.69)	(7.75)	(1.60)	(4.93)	(4.20)	(3.35)	(38.62)	(58.95)		
CD at 5%	0.50	0.39	0.26	0.22	0.35	0.21	0.32	0.23	0.22	0.17	0.36	0.24	311.74	289.31

Values in parentheses are means of original values.

Raised seed bed being statistically similar to conventional tillage resulted in significantly higher grain yield of maize by reducing dry matter of weeds during both the years of study. During both years acetachlor 1.25 kg ha^{-1} being at par with atrazine 1.5 kg ha^{-1} resulted in significantly higher grain yield of maize due to significantly lower dry matter accumulation in weeds.

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89- Effect of Cultural, Intercropping and Herbicides on Weed Growth and Productivity of Maize (*Zea mays*)

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INTRODUCTION

Weeds are the main hurdle in exploiting potential yield of rainy season maize (*Zea mays* L.). The yields are reduced to the extent of 25-75 % due to weed competition. Integrated weed management is the preferable approach to minimize the crop-weed competition, alleviate the residue and pollution problems besides giving economical return. The present study was planned and undertaken to find out the effect of intercropping, inter and intra cultivation and low doses of herbicides towards weed suppression in maize crop.

MATERIALS AND METHODS

The field experiment was conducted at Oilseed Research Farm, Kalyanpur, Kanpur, during rainy season of 2001 in randomized block design with 10 treatments replicated thrice (Table 1). The experimental field was sandy loam in texture with 0.44% organic carbon, 27 kg ha^{-1} available phosphorus, 175 kg ha^{-1} available potassium and soil pH of 7.1.

A composite maize cultivar 'Azad Uttam' was sown at plant geometry of 60 x 25 cm on July 1 in the year 2001 and harvested in September 30 in 2001. Two rows of blackgram Cultivar 'T -9' was sown in between the rows of maize as per treatment. An uniform application of 80 : 60 : 40 kg ha^{-1} of N, P_2O_5 and K_2O was applied in the form of urea, dia-ammonium phosphate and muriate of potash. Herbicide was sprayed using 500 l spray volume ha^{-1} as per treatment. The experimental crop was raised under recommended package of practices. Weed count data were subjected to šX + 0.5 transformation.

RESULTS AND DISCUSSION

The experimental field was infested with *Cuperus rotundus, Digera arvensis, Phyllanthus niruri* and *Commenlina benghalensis.* Weed density and their dry matter accumulation declined due to two hand weedings done at 15 and 30 days after sowing. Atrazine (0.5 kg ha^{-1}) supplemented with one hand weeding was found second in order (64.26% WCE). Inclusion of blackgram in between rows of maize suppressed the weed growth to the extent of 28.28 %. Intercultivation done at 20 days after sowing proved advantageous in reducing weed competition. Intercultivation in rows of sole maize coupled with removal of weeds from intra spaces registered 57.49 % weed control efficiency. Maize equivalent grain yield maximized (5026 kg ha^{-1}) in case of maize + blackgram intercropping treated with pendimethalin (1 kg a.i. ha^{-1}) followed by intercropping of blackgram + one hand weeding (4356 kg ha-1). These findings are in support of results reported by Sinha *et al.* (2003). Atrazine (0.5 kg ha-1) + one hand weeding yielded at par with manual weeding twice.. Highest net return was received (Rs 19075 ha-1) when blackgram was intercropped with maize supplemented with pre-emergence application of pendimethalin (1 kg ha-1) followed by intercropping of blackgram + one hand weeding (Rs 16318 ha-1). The lowest net return was obtained in case of intercultivation done at 20 days after sowing.

Table1 Effect of integrated weed management on weed density, total weed dry matter production, grain yield and net return

Treatment	*Weed density (No. m^{-2}) 45 DAS*				*Total weed dry matter ($kg\ ha^{-1}$) 45 DAS*	*Maize equivalent yield ($kg\ ha^{-1}$)*	*Net return ($Rs\ ha^{-1}$)*
	C. rotundu	*D. arvensis*	*P. niruri*	*C. benghalensis*			
Weedy check	5.4 (29.4)	5.1 (25.3)	5.0 (24.5)	6.4 (40.5)	2952	2051	2680
Hand weeding twice at 15 and 30 DAS	4.2 (17.4)	4.2 (17.6)	3.9 (14.9)	5.1 (25.7)	360	3230	10672
Intercropping of blackgram	5.3 (28.1)	4.4 (18.9)	4.8 (22.6)	7.2 (50.9)	2117	4004	13318
Intercropping of blackgram Fb pendimethalin (1 kg a.i. ha-1) as pre-em.	5.3 (27.3)	4.1 (18.5)	4.6 (20.5)	6.6 (43.3)	2049	5026	19075
Intercropping of blackgram Fb hand weeding at 15 DAS	4.9 (23.7)	4.2 (17.2)	4.3 (18.2)	5.4 (29.3)	1559	4356	16318
Sole maize Fb intercultivation at 20 DAS	5.00 (24.5)	4.3 (18.1)	4.4 (18.9)	6.2 (38.1)	1768	2412	5148
Sole maize Fb intercultivation at 20 and 30 DAS	4.6 (21.1)	4.1 (16.2)	4.4 (18.6)	5.2 (26.3)	1453	2779	7096
Sole maize Fb intercultivation at 20 and 30 DAS Fb removal of weeds from intraspaces	4.5 (19.4)	4.0 (15.4)	4.1 (16.8)	5.0 (25.1)	1255	2875	9090
Sole maize Fb atrazine (0.75 kg a.i. ha-1) as pre-em.	4.8 (22.3)	4.1 (16.6)	4.2 (16.9)	5.1 (25.6)	1668	2651	7428
Sole maize Fb atrazine (0.50 kg a.i. ha-1) as pre-em + one hand weeding	4.4 (18.5)	3.8 (14.1)	4.0	4.8 (15.9)	1055 (22.5)	3146	10204
LSD (P=0.05)	0.67	0.33	0.27	0.92	60	213	–

Figures in parenthesis show original value; DAS, Days after sowing

CONCLUSION

Result revealed that inclusion of two rows of blackgram in between the rows of maize followed by pre-emergence application of pendimethalin (1 kg a.i. ha-1) demonstrated weed suppression to the extent of 30.59%, enhanced grain yield (2975 kg ha-1) and fetched more net return (Rs 16395 ha-1) over no weeding in sole maize.

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90- Integrated Weed Management in Clusterbean (*Cyamopsis tetragonoloba* L.)

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INTRODUCTION

Clusterbean (*Cyamopsis tetragonoloba* L.) is considered as one of the good remunerative crop owing to its diversified usages. Due to ever increasing demand lead to increased area under clusterbean cultivation. It is grown under *Kharif* season. Clusterbean was used only as cattle feed earlier but now with diverse usages viz., superior quality gum and other industrial uses. Slow growth at initial stages of the crop favours recurrent flushes of weeds, which compete with crop for essentials of growth and cause heavy reduction in its seed yield. Application of herbicides in clusterbean control weeds effectively. Due to continuous rain in *Kharif* season, removal of weeds by manually or mechanically is sometime difficult. Recent works on the control of weeds in clusterbean through use of herbicides have proved more economical, convenient and efficient than that of the cultural practices. Therefore, present study was undertaken to find out effective integrated weed control measures in clusterbean.

MATERIALS AND METHODS

Field experiments were conducted during *Kharif* 2001-2003 at AICRP on Weed Control Farm to find out most effective weed management practices in *Kharif* clusterbean. The treatments consisted of pre emergence application of fluchloralin, pendimethalin and butachlor each at 0.50 and 1.0 kgha^{-1}, oxadiazon at 0.25 and 0.50 kgha,$^{-1}$ weed free and weedy check. Common inter culturing (IC) was done in lower application of herbicide at 30 DAS. The experiment was laid out in completely randomized block design with four replications. Crop variety GG-1 was sown by using 20 kg/ha seed rate in rows 45 cm apart during 1st week of July in all the years of experimentation. The soil of the experimental field was sandy loam in texture having low in nitrogen, medium in phosphorus and high in potassium. The crop was fertilized with 20 kg N and 40 kg P_2O_5/ha. Half nitrogen and full phosphorus were applied as basal at sowing and reaming N was applied as top dressing at 30 DAS.

RESULTS AND DISCUSSION

Weed flora and dry weight of weeds

Dry weed weight recorded at 30 DAS and at harvest was significantly influenced by various weed management practices during all the years as well as in the pooled analysis (Table-1). All the herbicidal treatments were found to be significantly superior with respect to decreased in dry weed weight recorded at 30 DAS and at harvest as compared to weedy check in pooled analysis. Weed control efficacy was also calculated at harvest and varies between 88 to 98 percent.

Effect of weed control measures on seed yield of clusterbean

A perusal of data given in Table-2 revealed that seed yield of clusterbean was significantly influenced by various weed control measures in all the years as well as in the pooled analysis. Results showed that significantly higher seed yield was recorded in twice IC + HW done at 30 and 45 DAS treatment and it was at par with all the herbicidal treatments during the year 2001 and 2002 as well as in the pooled analysis. Significantly lowest seed yield of clusterbean was recorded in weedy check treatment during all the years as well as in the pooled analysis. Weed index was calculated and varies between 1.02 to 5.65 % among herbicidal treatments. Maximum yield reduction (32.1 %) was recorded in weedy check treatment. Yadav et al., (1991) recorded 61 per cent reduction in seed yield of clusterbean due to weeds.

Table 1 Dry weed weight as influenced by weed management practices at 30 DAS and at harvest

Sr. No.	*Treatment (kg/ha)*	*Dry weed weight (g/m²) at 30 DAS*				*Dry weed weight at harvest (kg/ha)*				
		2001	*2002*	*2003*	*Pooled*	*2001*	*2002*	*2003*	*Pooled*	*WCE %*
1	Fluchloralin 0.5 + IC	45.40^{bc}	39.40^{d}	35.30^{def}	40.03^{cde}	403^{b}	445^{b}	431^{b}	426^{bc}	89
2	Fluchloralin 1.0	37.02^{bcd}	28.80^{d}	31.10^{f}	32.30^{def}	352^{b}	388^{bc}	309^{c}	350^{bc}	90
3	Trifluralin 0.5 + IC	52.46^{b}	65.71^{b}	35.48^{b}	57.88^{b}	519^{b}	502^{b}	428^{b}	483^{b}	88
4	Trifluralin 1.0	44.43^{bc}	42.42^{cd}	47.28^{bc}	44.71^{c}	399^{b}	410^{bc}	383^{b}	397^{bc}	90
5	Pendimethalin 0.5 + IC	35.69^{bcd}	34.16^{d}	41.85^{cde}	37.23^{cde}	231^{b}	358^{bc}	422^{b}	337^{bc}	91
6	Pendimethalin 1.0	32.30^{bcd}	27.98^{d}	30.68^{f}	30.32^{ef}	157^{b}	267^{bc}	366^{bc}	263^{bcd}	93
7	Butachlor 0.5 + IC	48.48^{bc}	63.33^{bc}	56.52^{b}	56.11^{b}	490^{b}	398^{bc}	408^{b}	432^{bc}	89
8	Butachlor 1.0	37.06^{bcd}	42.98^{bcd}	43.32^{cd}	41.12^{cd}	403^{b}	291^{bc}	360^{bc}	351^{bc}	91
9	Oxadiazon 0.25 + IC	30.41^{cd}	33.70^{d}	39.45^{cdef}	34.52^{cdef}	315^{b}	289^{bc}	296^{c}	300^{bcd}	92
10	Oxadiazon 0.50	18.20^{d}	24.44^{d}	31.82^{ef}	24.82^{f}	292^{b}	241^{bc}	201^{d}	245^{cd}	94
11	WF 2 IC + 2 HW at 30 & 45 DAS	0.00^{e}	0.00^{e}	0.00^{g}	0.00^{g}	79^{b}	107^{c}	112^{c}	99^{d}	98
12	Weedy Check	177.96^{a}	192.58^{a}	166.08^{a}	178.87^{a}	4190^{a}	3809^{a}	3690^{a}	3896^{a}	-
S.Em±		6.34	6.76	3.22	3,31	194.90	100.23	22.46	70.61	
CD at 5%		Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	

Table 2: Seed yield of clusterbean as influenced by weed management practices

Treatments (kg/ha)	*Seed yield (kg/ha)*				*Additional profit over control (Rs/ha)*	*WI %*
	2001	*2002*	*2003*	*Pooled*		
Fluchloralin 0.5 + IC	3653^{a}	3550^{a}	3554^{ab}	3585^{a}	7738	3.99
Fluchloralin 1.0	3680^{a}	3581^{a}	3561^{ab}	3607^{a}	7725	3.40
Trifluralin 0.5 + IC	3507^{a}	3526^{a}	3557^{ab}	3530^{a}	7271	5.46
Trifluralin 1.0	3524^{a}	3507^{a}	3564^{ab}	3532^{a}	7088	5.41
Pendimethalin 0.5 + IC	3687^{a}	3594^{a}	3576^{ab}	3619^{a}	7797	3.08
Pendimethalin 1.0	3668^{a}	3547^{a}	3560^{ab}	3591^{a}	7129	3.83
Butachlor 0.5 + IC	3487^{a}	3642^{a}	3553^{ab}	3560^{a}	7826	4.66
Butachlor 1.0	3516^{a}	3511^{a}	3544^{ab}	3523^{a}	7611	5.65
Oxadiazon 0.25 + IC	3692^{a}	3697^{a}	3693^{ab}	3694^{a}	8515	2.52
Oxadiazon 0.5	3732^{a}	3653^{a}	3705^{a}	3696^{a}	8182	1.02
WF 2 IC + 2 HW at 30 & 45 DAS	3758^{a}	3729^{a}	3715^{a}	3734^{a}	8675	0.00
Weedy Check	2468^{b}	2523^{b}	2621^{c}	2537^{b}	-	32.1
S.Em±	162.75	140.94	59.89	68.62		
CD at 5%	Sig	Sig.	Sig.	Sig.		

CONCLUSION

Results of three years (2001 to 2003) and pooled analysis concluded that herbicides viz., oxadiazon, fluchloralin, pendimethalin, trifluralin or butachlor applied at low rate with inter culturing at 30 DAS or higher application of any one herbicide is equally effective to control weeds in clusterbean and is substitute of twice inter culturing and hand weeding at 30 and 45 DAS. The economic evaluation of the weed management practices for the crop (Table-3) revealed that maximum (10175 Rs./ha) additional profit over control was observed in twice IC and hand weeding at 30 and 45 DAS treatment. Among herbicidal treatments, additional income over control varies between 8441 to 9852 Rs./ha.

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91- Effect of Weed Management Practices and Seed Rates on Nutrients Uptake by Urdbean and Associated Weeds in *Kharif* Season

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INTRODUCTION

Weeds are the serious pest of crops and reduce the yield to a greater extent. Uncontrolled weeds at critical period of crop weed competition reduce the yield of urdbean to the tune of 80-90% depending upon type and intensity of weed infestation (Kumar *et al.*, 2000). Intense weed flora can be managed either by adopting different weed control measures or by increasing competition with weeds. Increasing crop density upto a certain extent may be able to compete with weeds efficiently without significant reduction in yield. The present investigation was, therefore, conducted to assess the effect of different weed management practices and seed rates on relative nutrient removal by weeds and urdbean crop.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2003, at Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Uttaranchal). The soil of experimental site was silty clay loam in texture, having medium organic carbon (0.75%) and available K (246.4 kg/ha) and rich available P (35.8 kg/ha) with pH 7.3. The treatments consisted of 5 levels of weed management (Weedy, HW 20 DAS, HW 40 DAS, Alachlor 2 kg/ha and Alachlor 1.5 kg/ha + HW 40 DAS); and 3 levels of seed rates (Normal i.e. 15 kg/ha, 30 and 50 per cent higher than normal), were laid out in randomized block design with four replications. The urdbean variety 'Pant U-35' was sown in rows, 30 cm apart, on July 28, 2003 and harvested on October 30, 2003. The crop was fertilized with 50 kg DAP/ha applied as basal. N, P and K contents of crop plants (grain and straw) at harvest and weeds at maximum dry matter production stage i.e. 70 days after sowing was estimated by suitable procedure. The uptake of nutrients (N, P and K) by weeds and crop was estimated by multiplying the concentration with the weed dry weight and crop yields (grain and straw), respectively. The protein content of the grain was calculated by multiplying N content with 6.25 (A.O.A.C., 1960).

The important weed species in the experimental field of urdbean were : *Echinochloa colona, Cynodon dactylon, Eleusine indica* (Grassy), *Trianthema monogyna, Commelina benghalensis* (broad leaf weed) and *Cyperus rotundus* (Sedges). *Echinochloa colona* was the dominant weed spp. at all the stages and constituted, on an average of 87.3 per cent of total weed population. The density of all other weeds was 12.7 per cent only.

RESULTS AND DISCUSSION

Total dry matter of weeds was significantly reduced by all weed management practices compared to weedy check. The maximum reduction in weed dry matter was recorded in alachlor 1.5 kg /ha (Pre-emergence) + HW 40 DAS and use of 50 per cent higher seed rate than normal (Table 1). The difference in the total loss of nutrients by weeds was positively associated with the weed biomass production. The minimum nutrients (N, P and K) depletion by weeds was recorded under alachlor 1.5 kg/ha + HW 40 DAS and 50 per cent higher seed rate.

Application of weed control treatments increased the uptake of N, P and K by urdbean over weedy check (Table 1). Application of alachlor 1.5 kg/ha + HW 40 DAS increased the N, P and K uptake by the crop to the tune of 47.6, 66.7 and 41.8 per cent, respectively over weedy check. Varying levels of seed rate failed to bring significant effect on total N, P and K uptake by the crop. Increased nutrient uptake by crop under above treatment was due to the fact that initial weed control by chemical and mechanical manipulation of soil at optimum crop growth created favourable environment for plant and consequently made more nutrients available to the crop. Increased nutrient uptake by the crop under weed control treatments was also reported by Kundra *et al.* (1991).

Table 1 Effect of weed management practices and seed rates on weed dry matter, nutrient uptake by weeds and crop, grain yield and protein content of urdban

Treatments	*Weed dry matter (70 DAS g/m²)*	*Nutrient uptake (kg/ha)*						*Grain yield (kg/ha)*	*Protein content (%)*
		Weeds (70 DAS)			*Crop (at harvest)*				
		N	*P*	*K*	*N*	*P*	*K*		
Weed management									
Weedy	17.9(320)	31.0	7.8	28.9	35.9	5.4	20.6	625	20.84
HW 20 DAS	9.1(80)	8.0	1.9	7.6	47.8	7.0	27.5	958	20.96
HW 40 DAS	5.1(30)	2.9	0.8	2.7	47.3	7.8	28.8	917	21.69
Alachlor @ 2.0 kg/ha	16.1(208)	26.3	6.3	24.3	38.0	6.1	23.5	708	21.17
Alachlor @ 1.5 kg/ha + HW 40 DAS	3.1(9)	0.9	0.2	0.8	53.0	9.0	29.2	1125	21.50
CD at 5%	0.9	2.4	0.9	2.2	6.6	1.2	6.0	115	0.44
Seed rate (kg/ha)									
Normal (15 kg)	1.2(193)	18.8	4.8	17.3	42.3	6.7	24.2	792	22.01
30% higher	10.2(138)	13.2	3.3	12.1	45.2	7.3	25.8	875	21.19
50% higher	8.7(99)	9.6	2.2	8.9	45.7	7.2	27.8	938	20.49
CD at 5%	0.7	1.8	0.7	1.7	NS	NS	NS	90	0.34

Original values in parentheses,
DAS – Days after sowing ,
HW – Hand weeding

The highest protein content (21.69%) was observed in HW 40 DAS which was closely followed by alachlor 1.5 kg/ha + HW 40 DAS and alachlor 2.0 kg/ha. Among the different seed rate, use of normal seed rate i.e. 15 kg/ha gave higher protein content than others. Higher protein content under above treatments was due to comparatively more nitrogen content in grains in respective treatments.

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92- Effect of Weed Management Practices in Mothbean (*Vigna aconotifolia* (Jacq.) Marechal) under Rainfed Condition

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INTRODUCTION

Mothbean (*Vigna aconitifolia* (Jacq.) marechal) is the most important pulse crop of arid and semi-arid regions of north-western states of India. It is most drought resistant, useful against wind erosion in sandy soils, and being legume improvers soil fertility by fixing atmospheric nitrogen. Mothbean crop occupies 13.5 lac ha in India giving 2.91 lac tones production with 215 kg ha^{-1} productivity. (Sharma and Kakani, 2002). But Rajasthan has maximum area (about 12 lac ha) of this crop with highest production (23 lac tones). Being poor competitor weed infestation poses a serious threat to the successful cultivation of this crop. Hence the study was undertaken to find out suitable weed management method in this crop.

MATERIALS AND METHODS

The experiment was conducted at Research Farm of Choudhary Charan Singh Haryana Agricultural University, Regional Research Station, Bawal (Rewari) during kharif season of 2003. The soil of experimental field was loamy sand in texture, poor in organic carbon (0.15%), medium in potash (240 kg ha^{-1}) and phosphorus (9.0 kg ha^{-1}) and alkaline in nature (pH 8.4). The experiment consisted of twelve treatments viz. hand weeding (HW) at 20 DAS, hand weeding 30 DAS, HW 40 DAS, HW 20 and 30 DAS, HW 20 and 40 DAS, HW 30, and 40 DAS, Pre-emergence application of pendimethalin at 0.75 and 1.0 kg ha^{-1} alone and in combination with one hand weeding at 30 DAS, weedy and weed free check. The experiment was laid out in randomized block design with three replications. Mothbean (RMO-40) was shown with the onset of monsoon on 8 July. Penedimethalin was sprayed pre-emergence as per treatments. The crop received 589.1 mm of rains during its growth period during 2003.

RESULTS AND DISCUSSION

Effect on weeds

The dominant weeds in the experimental field were *Cyperus rotundus* L., *Dactyloctenium aegyptium* L., *Digera asvensis* and *Trianthema portulacastrum*. All weed control practices reduced dry matter production of weeds significantly over weedy check (Table 1). The lowest dry matter of weeds (67.7 g m^{-2}) was recorded space in the plots which were subjected to the treatment of pendimethalin @ 1.0 kg ha^{-1} + HW 30 DAS. This was also found to be statistically at par with all other herbicidal treatments.

Effect on Crop

Plant population of mothbean reduced to the extent of 29 and 36% with pendimethalin at 0.75 and 1.0 kg ha^{-1}, respectively. Occurrence of rains after sowing during 2003 might have led to leaching of pendimethalin to seeding zone which caused mortality of germinating seedling thereby reducing plant population drastically. Rathore (2003) also expressed similar view. Pendimethalin also had adverse effect on plant height at 40 DAS (Table 1) but it recovered later on.

Maximum grain yield and stover yield (740 and 1682 kg ha^{-1}) were recorded with weed free treatment (Table 1) which was at par with 2 HW at 20 and 40 DAS (710 kg ha^{-1} and 1668). Similar results were reported by Kumar *et al.* (1996).

The maximum returns (Rs. 4235 ha^{-1}) were obtained when 2 hand weedings were done at 20 and 40 DAS followed by 20 and 30 DAS (Table 1).

Table 1 Effect of different weed control practices on dry matter of weeds and plant population and plant height and yield and yield attributes, and monetary return of mothbean

Treatments	*Dry weight of weeds ($g\ m^{-2}$)*	*Plant population (No. m^{-2})*	*Plant height (cm)*	*No. of pods/ plant*	*1000-seed weight (g)*	*Grain yield (kg ha^{-1})*	*Net return (Rs. ha^{-1})*
	40 DAS	*20 DAS*	*At harvest*				
Weedy check	274.8	10.6	35.1	14.6	18.0	378	2519
Weed free	0.0	10.6	36.8	25.0	19.7	740	2921
HW 20 DAS	178.2	10.6	34.2	19.8	19.1	550	3453
HW 30 DAS	192.0	10.3	35.3	19.9	19.3	535	3273
HW 40 DAS	265.7	10.0	34.1	19.1	19.0	510	2787
HW 20 and 30 DAS	151.0	11.0	35.6	21.6	18.6	682	3869
HW 20 and 40 DAS	181.0	11.6	35.9	23.1	19.6	710	4235
HW 30 and 40 DAS	172.6	10.3	34.3	20.8	18.6	582	2450
Pendimethalin 0.75kg ha^{-1}	68.0	7.5	31.6	23.6	17.6	466	2592
Pendimethalin 0.75kg ha^{-1} + HW 30 DAS	55.8	7.6	31.0	24.4	18.2	499	1642
Pendimethalin 1.0 kg ha^{-1}	62.2	6.7	29.3	22.8	17.8	421	1733
Pendimethalin 1.0 kg ha^{-1} + HW 30 DAS	50.6	7.1	31.3	21.6	18.0	451	643
CD at 5 %	24.9	2.0	N.S.	3.2	N.S	141	

HW – Hand weeding
DAS – Days after sowing

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93- Studies on Efficacy of New Herbicides Alone and in Integration with Hand Weeding to Manage Weeds in Onion

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INTRODUCTION

Onion is an important commercial crop in Indian Agriculture and grown on large area throughout the country. Onion, being a slow growing and irrigated crop, is severely infested by weeds. Weeds interfere with the development of onion bulb by competing for moisture, nutrients, light and place space thereby reducing bulb yield to the extent of 40-80% (Verma and Singh, 1996). Hand weeding, no doubt, is effective, but it is time consuming, cumbersome and under many situations becomes uneconomical. Pendimethalin is not effective to controlling all the weeds present in the crop. It was therefore, felt necessary to test the alternative new herbicide alone and in integration with hand weeding to manage weeds in onion.

MATERIALS AND METHODS

Field experiment was conducted during the *rabi* season of 2001 and 2002 at the Research Farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.5), medium in organic carbon (0.7 per cent), low in available nitrogen (228.4 kg/ha), medium in available phosphorus (17.6 kg/ha) and high in available potassium (301.2 kg/ha). The treatments consisted of pendimethalin 1.5 kg/ha, oxadiargyl 0.075 kg/ha, oxadiargyl 0.090 kg/ha, oxyfluorfen 0.20 kg/ha, trifluralin 1.0 kg/ha alone and their fifty per cent dose in integration with one handweeding, hand weeding thrice and unweeded check (Table 1). Experiment with 12 treatments and three replications was laid out in randomized block design. Herbicides were applied as spray volume of 700 l ha^{-1} with knap sack sprayer. Onion variety Nasik red was transplanted on January 17, in 2001 and on January 5, in 2002 respectively. Weed species and their dry matter at harvest stage of crop growth were recorded from two randomly selected quadrates (0.25 m^2) in each plot and expressed as number and g m^{-2}.

RESULTS AND DISCUSSION

The dominant weed flora of the experimental field comprised of *Phalaris minor, Avena leudoviciana, Lolium temulentum, Vicia sativa, Stellaria media, Echinochloa colona, Panicum dichotomiflorum, Coronopus didymus, Bidens pilosa* and *Gallin-soga parviflora.*

Pendimethalin 0.75 kg/ha supplemented with one hand weeding behaving statistically at par with pendimethalin 1.50 kg/ha, oxadiargyl 0.050 kg/ha supplemented with one hand weeding and trifluralin 0.5 kg/ha fb 1 HW resulting in significantly lower weed density as compared to other treatments. But hand weeding thrice was significantly superior to other treatments in reducing the dry weight of weeds. However this treatment behaved statistically alike with pendimethalin 1.5 kg/ha, oxyfluorfen 0.2 kg/ha, trifluralin 1.0 kg/ha, pendimethalin 0.75 kg/ha fb 1 HW and oxyfluorfen 0.1 fb 1 HW.

Weeds in unweeded check reduced the onion bulb yield by 86.1 and 77.6 per cent over hand weeding thrice during first and second year, respectively. Significantly higher bulb yield was obtained with hand weeding thrice during both the years. However, during first year this treatment remained statistically at par with trifluralin 1.0 kg/ha and during second year with trifluralin 0.5 kg/ha fb 1 HW and oxyfluorfen 0.1 kg/ ha fb 1 HW respectively.

Table 1 Effect of treatments on weed density, dry weight of weeds and bulb yield of onion

Treatments	*Dose (kg ha⁻¹)*	*Time*	*Weed density (No. m⁻²)*		*Weed dry matter (g/m²)*		*Onion bulb yield (kg ha⁻¹)*	
			2001	*2002*	*2001*	*2002*	*2001*	*2002*
Pendimethalin	1.5	Pre	14.8 (221.3)	12.8 (166.7)	126.2	129.9	690.3	1195.3
Oxadiargyl	0.090	3 DAT	15.7 (246.6)	18.3 (337.3)	141.8	387.5	542.5	722.2
Oxyfluorfen	0.20	Pre	14.0 (198.6)	18.1 (327.3)	123.5	210.9	568.1	1523.8
Trifluralin	1.0	Pre	11.7 (137.3)	15.6 (244.7)	144.8	187.5	746.0	1538.1
Pendimethalin fb1 HW	0.75	Pre	11.0 (121.3)	10.3 (105.3)	105.9	151.2	673.0	769.9
Oxadiargyl fb 1 HW	0.050	3 DAT	13.8 (192.0)	19.1 (366.7)	189.2	158.3	251.6	1396.9
Oxyfluorfen fb 1 HW	0.10	Pre	12.2 (150.0)	11.6 (134.7)	110.0	180.8	669.8	1952.4
Oxadiargyl	0.075	3 DAT	13.1 (170.6)	16.2 (267.7)	128.6	192.8	677.7	1460.4
Oxadiargyl fb 1 HW	0.040	3 DAT	16.1 (260.0)	16.9 (292.0)	206.3	149.9	546.3	634.9
Trifluralin fb 1 HW	0.5	Pre	15.3 (234.0)	11.1 (122.7)	204.3	141.3	567.4	2158.8
Hand weeding	Thrice	30, 60 & 90 DAT	10.3 (106.6)	13.3 (177.3)	92.8	147.3	823.2	2476.2
Unweded			22.3 (498.6)	23.2 (541.3)	438.2	735.9	108.5	555.6
CD at 5%			1.43	2.8	55.96	95.0	93.6	563.8

fb – followed by; HW – Handweeding; DAT – Days after transplanting
Figures in parentheses are the original values

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94- Integrated Weed Management in Field Pea with Special Reference to *Carthamus oxyacantha*

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INTRODUCTION

The problem of *C. oxyacantha* has been noticed in dwarf pea in sizable area in Jalaun area of Uttar Pradesh (Tewari, 2005). Due to spiny nature, labourers do not easily enter in the crop field for harvesting purposes. In present investigation, an effort has been made to develop an effective technology for controlling *C. oxyacantha* through integrated approach involving varying doses of metribuzin under two modes of application (pre and post emergence), method of sowing (line sowing and cross sowing), use of five tined hoe, manual weeding etc.

MATERIALS AND METHODS

Field investigation was carried out for three consecutive *rabi* season (2001-04) in *Parua* soil of Bariapur village in Jalaun district. The experimental field was deficient in nitrogen and medium in P and K.

A dwarf pea cultivar "*Swati*" was sown during second fortnight of November and harvested during last week of March during all the years. Fifteen treatments (as detailed in Table 1) were arranged in randomized block design replicated thrice.

An uniform application of 18 Kg N and 46 Kg P_2O_5 ha^{-1} (100 kg diammonium phosphate) was applied as basal dose to the crop. The crop was sown at 25 cm apart using seed rate of 100 kg ha^{-1}. In cross sowing, half of the total seeds were sown from each side. Metribuzin as per treatment was dissolved in water (500 l ha^{-1}) and applied at second day after sowing through *Bakpak* sprayer under pre-emergence treatment. In case of post emergence application, it was applied after first irrigation. Hand weeding/inter row hoeing was done after irrigations. The original data on weed density were transformed to šX + 0.5 before statistical analysis. The dry matter of weeds and grain yield data were pooled and analyzed statistically. Economic analysis of the treatments was made keeping in view the current selling rate of produce and purchase rate of herbicides and labour wages. Net income due to weed control were also worked out.

RESULTS AND DISCUSSION

Weed studies

Major weed floras in the experimental fields were *C. oxyacantha*. However, *C. album, A. arvensis, F. purviflora* and *S. arvensis* were also noted. Weed control treatments reduced *C. oxyacantha* and other weeds significantly during all the years. Cross sowing failed to reduce the *C. oxyacantha* population significantly in almost all cases. Similarly, use of 5 tined hoe was not found as effective as manual weeding. No significant variations were found due to increasing doses of metribuzin application from 175 to 350g ha^{-1} in respect of *C. oxyacantha* and other associated weeds mortality during all the years. Increasing doses of metribuzin from 87.5 to 175g ha^{-1} under post-emergence treatment was also not found advantageous in diminishing the weed population under study.

Over all mean dry matter of weeds declined significantly due to the application of weed control treatments (Table 1). Cross sowing suppressed weed growth by 11.02%. Use of five tined hoe brought about significant reduction in dry matter accumulation of weeds showing 18.20-23.94% weed control efficiency. Line sowing followed by two hand weeding, line sowing followed by metribuzin application (175g ha^{-1}) as pre-emergence + one hand weeding and line sowing followed by metribuzin (175g ha^{-1}) as pre-emergence followed by metribuzin (87.5g ha^{-1}) as post-emergence remained statistically at par with respect to dry matter of weeds. Increasing the doses of metribuzin from 175g ha^{-1} to 350g ha^{-1} resulted insignificant reductions in dry matter of weeds. Early findings confirm the efficacy of metribuzin application against *C. album* in pea crop (Tewari *et al.*, 1996).

Yield and Net return

Metribuzin (175g ha^{-1}) as pre-emergence followed by metribuzin (87.5g ha^{-1}) as post-emergence brought about similar grain yield (1941 kg ha^{-1}) to that obtained under metribuzin (175g ha^{-1}) + one hand weeding (1810 kg ha^{-1}) as well as manual weeding twice (1832 kg ha^{-1}). Cross sowing did not increase grain yield significantly. No significant increase could be visualized in grain yield due to increase in the doses of metribuzin. Manual weeding twice, on an average, increased the grain yield by 47.74%. The highest net return of Rs 7112 ha^{-1} was received under metribuzin (175g ha^{-1}) applied as pre-emergence followed by metribuzin (87.5g ha^{-1}) as post-emergence treatment. Metribuzin (175g ha^{-1}) as pre-emergence followed by metribuzin (175g ha^{-1}) as post-emergence under sequential application stood second in order.

Table 1 Effect of weeding treatments on weed growth, grain yield of pea and net income

Treatments	*Carthamus oxyacantha (No. m⁻²)* 2001-02	2002-03	2003-04	*Total Weed dry weight (kg ha⁻¹) (pooled of 3 yrs.)*	*Grain yield (kg/ha) (pooled of 3 yrs.)*	*Cost of treatment (Rs/ha)*	*Net Income (Rs/ha)*
Line sowing (control)	17.83 (4.28)	15.33 (3.95)	18.00 (4.23)	1324	1240	-	-
Line sowing + 2 H W	3.66 (2.03)	7.33 (2.76)	6.66 (2.64)	298	1832	3000	4104
Line sowing fb inter row hoeing through 5 tined hoe	13.00 (3.67)	12.00 (3.50)	10.66 (3.28)	1083	1440	400	2000
Line sowing fb Criss cross hoeing through 5 tined hoe	11.00 (3.39)	14.00 (3.80)	11.33 (3.36)	1007	1447	600	1884
Cross sowing (control)	15.16 (3.95)	18.66 (4.37)	16.66 (4.09)	1178	1345	150	1110
Cross sowing + 2 HW	5.50 (2.44)	8.66 (2.99)	8.00 (2.88)	351	1839	3000	4188
Cross sowing fb metribuzin (175 g/ha) fb1HW	3.66 (2.03)	6.00 (2.53)	10.00 (3.17)	394	1819	2000	4948
Line sowing fb metribuzin (175 g/ha) as pre em	7.33 (2.79)	8.66 (3.02)	13.33 (3.61)	495	1605	800	3580
Line sowing fb metribuzin (262.5 g/ha) as pre emergence	0.00 (0.71)	11.33 (3.42)	14.00 (3.79)	461	1736	1150	4802
Line sowing fb metribuzin (350 g/ha) as pre emergence	3.66 (2.03)	8.66 (2.97)	7.33 (2.78)	385	1776	1400	5032
Line sowing fb metribuzin (175 g/ha) as pre emergence fb metribuzin (87.5 g/ha) as post emergence	1.83 (1.52)	6.00 (2.49)	2.66 (1.44)	371	1941	1300	7112
Line sowing fb metribuzin (175 g/ha) as pre emergence fb metribuzin (131.25 g/ha) as post emergence	2.33 (1.68)	5.33 (2.41)	5.33 (2.17)	497	1859	1450	5978
Line sowing fb metribuzin (175 g/ha) as pre emergence fb metribuzin (175 g/ha) as post emergence	2.33 (1.68)	6.00 (2.49)	4.00 (1.91)	426	1812	1600	5264
Line sowing fb metribuzin (175g/ha) pre emergence fb metribuzin (175g/ha) post emergence fb glyphosate (1.2kg/ha) on *C. oxyacantha* after harvesting of crop.	1.83 (1.52)	4.66 (2.02)	1.33 (1.18)	401	1745	3300	2760
Line sowing fb metribuzin (175 g/ha) + 1HW	3.00 (1.87)	3.33 (1.79)	3.33 (1.79)	437	1810	2250	4590
CD at 5%	(1.52)	(1.02)	(1.54)	181	280	-	-

Figures in parenthesis show transformed value $\sqrt{X + 0.5}$

CONCLUSIONS

Sequential application of metribuzin *i.e.* 175g ha^{-1} as pre-emergence and 87.5g ha^{-1} as post-emergence demonstrated substantial reduction in the population of *C. oxycantha* (93.17%) and over all weed dry weight (71.97%) resulting in increased pea grain yield (56.53%) over untreated and proved at par with metribuzin (175g ha^{-1}) as pre-emergence + one hand weeding (45.96%) and weeding twice through manual labours (47.74%). Use of five tined hoe showed weed mortality to the extent of 18.20 - 23.94% only.

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95- Studies on Integrated Weed Management in Finger millet (*Elusine coracana*)

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INTRODUCTION

Finger millet or Ragi (*Elusine coracana*) is a major food crop of arid and semiarid tropics of Asia and Africa. It has been an indispensable component of the dry farming system as it is found to be drought hardy (Ravishankar et.al., 2004). In India, this crop is cultivated in an area of 9.3 lakh hectares which constitutes 2/3 of the total millets area but with a meager productivity of 1300 kg/ha. The potential of the crop is recorded to be 5000 kg/ha.The reasons for low yields are many including no fertilizer or imbalanced fertilizer application, sub optimum plant population and inadequate weed management practices to name a few. Most of the time in the command areas, weeding in the crop coincides with peak demand for labour for other crops as well. So weed menace poses a severe threat for enhancing the yield of the crop. Hence, studies were conducted for three years to evaluate different weed management practices and their cost benefit analysis at the Zonal Agricultural research station, V.C.farm, Mandya, Karnataka.

MATERIALS AND METHODS

The experiments were laid out in randomized complete block design with three replications. A total of 12 treatment combinations with different chemicals were imposed. Ragi was established under transplanting method with protective irrigation. Fertilizers were applied at the rate of 100:50:50 kg N P_2O_5 K_2O/ha. with two split application of nitrogen. Weed dry weight was recorded at 30, 60 days after planting.

RESULTS AND DISCUSSION

Weed control in finger millet is effectively done by the application of oxyfluorofen 0.1 kg /ha with two inter cultivations. Highest yields were recorded with this followed by herbicide application alone. Highest weed control efficiency was also obtained with the application of herbicide. Hence under transplanted conditions oxyfluorofen can be used for effective weed control in finger millet.

Table 1 Weed dry weight as influenced by weed control treatments

Treatments	*Weed dry weight g/m²*		*WCE %*	
	30 DAT	*60 DAT*	*30 DAT*	*60 DAT*
Weedy check	5.64	11.79	-	-
Two inter cultivations	2.24	6.72	85	69
Butachlor @ 0.75 kg a.i./ha	3.87	7.66	54	57
Oxyfluorofen @ 0.1 kg a.i/ha	2.04	5.94	88	74
Oxyfluorofen @ 0.1 kg a.i/ha + two intercultivations	2.01	4.86	89	84

Table 2 Mean yield of finger millet as influenced by weedicides

Treatments	*Grain yield kg/ha*	*Straw yield kg/ha*	*C:B ratio*
Weedy check	2031	3493	2.63
Two inter cultivations	3382	5073	2.63
Butachlor @ 0.75 kg a.i./ha	3000	4500	3.15
Oxyfluorofen @ 0.1 kg a.i/ha	3708	5563	4.80
Oxyfluorofen @ 0.1 kg a.i/ha + two intercultivations	4178	6268	3.73

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96- Integrated Weed Management Studies in Turmeric (*Curcuma longa* L.)

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INTRODUCTION

Turmeric (*Curcuma longa* L) is an important spice crop of India. The demand of turmeric is increasing in national as well as international market. It offers good scope for diversification of cereal based cropping system of the Punjab. Presently its cultivation is picking up in Punjab. Turmeric is planted from the end of April to first week of May and it takes 35-45 days to complete its emergence. During this period when climate is very hot and dry, light and frequent irrigations are to be given and all this results in heavy weed infestations. These first 40-50 days after planting are considered very critical with respect to weed crop competition. Therefore, weed control at an early stage is absolutely essential in order to realize high yield potential. The use of herbicides not only improves crop yield but also makes available significant labor for productive use of right technology. But herbicides alone fail to give season long control of weeds because of their short period of persistence and late emerging weeds also cause severe reduction in crop yield. Application of post emergence herbicide may prove beneficial to control latter emerging weeds. Thus, the present study was initiated to study the effect of post emergence application of herbicides applied after giving hand hoeings/spray of contact herbicides i.e. glyphosate.

MATERIALS AND METHODS

The study was carried out at Research Farm, Department of Agronomy and Agrometeorology, Punjab Agricultural University Ludhiana during 2003 and 2004. The soil of the experimental field was sandy loam, low in available nitrogen, medium in available phosphorus and potassium. The experiment was conducted in Randomized Block Design with three replications. The treatments consisted of post emergence application of glyphosate 1.0 kg/ha (before emergence of crop; 30 DAS) and hand weeding at 30-35 days after sowing and each was followed by application of metribuzin (0.50 and 0.75 kg/ha), atrazine (0.75 and 1.00 kg/ha), pendimethalin (0.75 kg/ha), hand weeding and control.

Turmeric was planted in the first week of May. The crop was planted in lines 30cm apart with plant to plant spacing of 20 cm. Farm yard manure applied @ 10 t/ha was mixed well during seed bed preparation. A basal dose of 25 Kg/ha of P_2O_5 was applied at planting. 30 kg N/ha was applied in two equal splits i. e. half at sowing and remaining half 50 days after planting. Immediately after planting irrigation was given. Subsequently light and frequent irrigations were ensured in the pre-monsoon periods but during rainy season and after rainy season, irrigations were given as per the requirements of the crop. The crop was harvested in the first week of January.

RESULTS AND DISCUSSION

Digitaria ischamum, Cynodon dactylon, Cyperus rotundus, Eleusine aegyptiacum, Euphorbia hirta, Commelina benghalensis and *Eragrostis pilosa* were the dominant weeds

The effect of different weed control treatments on weed weight was significant. The maximum fresh weed weight was recorded in unweeded / control treatment and it decreased significantly in all weed control treatments.

The effect of different weed control treatments on fresh rhizome yield was significant. On the basis of pooled data, hand weeding followed by atrazine (1.00 kg/ha) produced maximum fresh rhizome yield of 191.7 q/ha and it was statistically at par with HW fb atrazine 0.75 kg/ha (185.4 q/ha), HW fb metribuzin 0.75kg/ha (164.7 q/ha), HW fb pendimethalin 0.75 kg/ha (164.5 q/ha) and hand weedings (177.1 kg/ha) but was significantly superior to all others. The post emergence application of glyphosate at 30-35 days after sowing fb application of metribuzin 0.5 kg/ha, metribuzin 0.75 kg/ha, atrazine 0.75 kg/ha, atrazine 1.0 kg/ha and pendimethalin 0.75kg/ha produced 67.5, 65.6, 63.9 and 47.8 per cent more turmeric rhizome yield than control, respectively and fresh turmeric yield in all these treatments was significantly less than HW fb atrazine 1.00 kg/ha. Krishnamurthi and Ayyaswamy (2000) had reported that highest turmeric yield was under alachlor 2.0 kg/ha with sequential combination of hoeing plus hand weeding at 35 DAS. The control/ unweeded treatment produced the lowest fresh rhizome yield.

Table 1 Effect of different weed control treatments on weed weight, fresh rhizome yield and yield parameters of turmeric.

Treatments	*Dose (kg/ha) (cm)*	*Plant height plant*	*Leaf per plant*	*Fingers per (g)*	*Finger weight (q/ha)*	*Weed weight (q/ha)*	*Rhizome yield*
Glyphosate* fb metribuzin	0.50	65.5	9.9	9.0	10.6	66.6	146.3
Glyphosate fb metribuzin	0.75	69.1	9.9	8.4	12.1	66.8	144.6
Glyphosate fb atrazine	0.75	65.9	10.3	9.2	11.1	62.0	143.1
Glyphosate fb atrazine	1.00	66.5	9.6	8.3	12.4	63.8	145.3
Glyphosate fb pendimethalin	0.75	65.3	8.7	8.0	12.0	70.7	129.1
Glyphosate fb control		64.1	8.9	8.5	11.8	82.9	120.4
Glyphosate fb HW		65.0	9.3	8.4	12.8	53.9	136.9
HW fb metribuzin	0.50	62.0	9.7	8.6	11.8	57.0	128.5
HW fb metribuzin	0.75	68.0	9.2	7.7	13.2	71.8	164.7
HW fb atrazine	0.75	74.9	10.7	9.5	12.5	67.9	185.4
HW fb atrazine	1.00	69.4	9.3	8.4	11.7	66.3	191.7
HW fb pendimethalin	0.75	67.7	9.0	7.9	11.5	61.7	164.5
HW fb control		70.0	9.9	10.3	10.6	67.6	168.2
Hand weeding (HW)		61.4	9.3	8.0	13.5	44.3	177.1
Unweeded		74.5	10.2	10.0	0.2	102.9	87.3
CD at 5%		NS	NS	NS	NS	20.9	40.3

Mean of two years
*30-35 days after sowing

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97- Biological and Chemical Integration for Water Hyacinth Control

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INTRODUCTION

Water hyacinth (*Eichhornia crassipes*), originated in South America is the most gregariously growing aquatic weed in 5 tropical and sub-tropical nations of the world including India. It was introduced in India first time in West Bengal in 1889 as an ornamental plant and by now it has been recorded from all types of water bodies like ponds, canals and drainages in all most all the cities and villages including major river systems-Brahmaputra, Cauvery, Ganges *etc* in India. The rapid spread is due to its capacity to reproduce fast by vegetative and sexual methods. The seeds of water hyacinth are reported to remain viable for as long as 20 years. Under ideal conditions water hyacinth plants can double their number in 10 days. Water hyacinth is well documented for its ability to lose water rapidly through transpiration besides causing tremendous loss to fish production and hydroelectricity. Hence, control of this weed has received prime attention by the planners and Government. Manual or mechanical methods of its control are not cost effective. Use of herbicides is effective and economical but may have potential risks on non-target organisms and water quality. Biological control is cost effective, self-sustaining and eco-friendly but takes long time (20-

36 month after inoculation of bioagent) to control one wave of water hyacinth after first release. The insect bioagent *Neochetina bruchi* and *N. eichhoornae* commonly called *Neochetina* spp. are known biological control agents which have cleared water hyacinth from many aquatic bodies in India (Jayanth *et al.*, Sushilkumar, 2003). Haag (1986) also found integration of bioagent and herbicide effective to control water hyacinth in a pond in Florida. Herewith, an attempt has been made to control water hyacinth through integration of herbicides and bio-agents to reduce the time and chemical load, which would have been caused by using single method.

MATERIALS AND METHODS

About 1000 weevils of *Neochetina* spp. were released on 31st May 2003 as an inoculation over an area of 3000 m^2 in an one-hectare pond of a village, severely infested with water hyacinth for more than 20 years. The inoculated area was marked by thermocoal pads inserted in the nylon rope. To evaluate the effective herbicide, two doses of each recommended herbicides namely 2,4-D (1.5 and 2.0 kg/ha), glyphosate (2.0 and 2.5 kg/ha) and paraquat (0.7 and 1.0 kg/ha) were applied in rest of the area in three replication in the second fortnight of June 2003. In each replication, 10x30 m^2 area was sprayed leaving a buffer of about 2.5-metre. Subsequently, at six-month interval, only higher doses of above herbicides were applied on re-growth and in the second fortnight of December 2003 and June 2004 covering about 15% area of the pond. Population samples of water hyacinth were taken with the help of 1m^2 quadrat before and after herbicide spray at 7, 14 and 21 days interval for all the doses and after one month interval for subsequently sprayed higher doses. The population of weevil was counted quarterly by sampling 25 water hyacinth plants selected at randomly covering entire pond along with the observations on the status of water hyacinth caused by the bioagent.

RESULTS AND DISCUSSION

Results revealed that 2,4-D 2.0 kg/ha proved the best herbicide to control water hyacinth while glyphosate and paraquat were at par with each other (Table-1). The pond was again fully infested by the mid September 2003 due to re-growth, which was highest in paraquat treated area, followed by 2,4-D and glyphosate. In subsequent second spray after six months, herbicides could not work effectively due to drying of upper leaves of water hyacinth by the action of weevils. This caused less control even in higher doses than the lower doses in the first time spray done in June 2003.

Meanwhile, signs of establishment of bioagent were found and sampling revealed spread and increase in population of bioagent in the entire pond. Bioagent also invaded re-growth rapidly resulted after herbicide spray. Water hyacinth started to show die back symptoms by December end, which was an indication of the good biotic pressure on water hyacinth by the weevils within the six-month of their release. After 6 month of release, the adult and larvae of *Neochetina* spp. were recorded about 9 and 5 per plant, respectively. *Neochetina* adult population was found higher in the adjoining area treated with herbicides in December. This increase in number of weevil/plant exerted more damage on water hyacinth adjoining to the chemical treated area. First and second wave of collapse of water hyacinth was observed by April 2004 and March 2005 within a period of 9 and 21 month, respectively (Table 2). There was drastic decrease in flower production in second wave of growth, which reduced to about 2 flower/m^2 from initial 15/m^2. Like wise, there was decrease in height of plant, dry weight and length and width of leaves.

The achieving of two cycles of control within a period of 22 month after initial release of weevils could be possible due to integration of herbicide with the bioagent, which would otherwise have taken minimum 20-36 month by the bioagent alone.

Table 1 Effect of different treatment of herbicides on control (%) of water hyacinth.

Herbicides	*Dose(Kg/ha)*	*Weed population/m² at DAA*			*Control (%) at DAA*		
		7	*14*	*21*	*7*	*14*	*21*
2,4-D	1.5	5.90	4.70	2.39	49.88	70.00	80.57
		34.66	22.66	6.6	58.39	87.85	97.03
	2.0	5.30	3.50	1.65	54.71	75.44	82.84
		28.00	12.00	4.00	66.39	93.56	98.22
Glyphosate	2.0	6.93	4.13	3.84	40.61	72.64	75.44
		48.00	17.33	14.66	42.39	90.71	93.48
	2.5	6.46	2.85	3.12	45.22	78.31	78.30
		41.33	8.00	9.33	50.39	95.71	95.85
Paraquat	0.75	7.24	6.76	3.93	37.79	60.49	75.04
		52.00	45.33	16.00	37.59	75.71	92.89
	1.0	6.34	6.01	3.80	46.15	64.03	75.57
		40.00	36.00	14.66	51.99	80.70	93.48
Control	-	9.14	13.64	15.00			
		83.33	186.66		225.33	-	- -
CD at 5%	-	0.96	1.42	1.56	7.83	4.86	6.00

Table 2 Average *Neochtina* population/plant at quarterly interval with the status of water hyacinth after release in the pond.

Month after release	*Adult/plant*	*Larvae/plant*	*Status of Water hyacinth in the pond*
3	1.65	4.32	**No visual impact**
6	8.72	5.12	Heavy biting scars on leaves started indicating impact of bioagent
9	1.40	4.08	Complete drying of leaves and petioles, only small portions below water left but severely damaged by the bioagent, re-growth and fresh germination started amidst the dried plant. **First wave of collapse**
12	6.53	7.38	3 month old re-growth and new growth of second wave, only scars on the leaves but no die back symptoms.
15	7.38	3.65	6 months old second wave growth, no die back symptoms but heavy biting scars of weevils on leaves
18	3.65	6.91	Drying of upper portion started indicating severe damage by bioagent
21	6.00	5.56	**Second wave of collapse**

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98- Smothering Potential of *Brassica* Genotypes on *P. minor* and Other Winter Season Weeds

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INTRODUCTION

The information on smothering potential of crops on weeds is of great significance during the present period when we often talk about evolving eco-friendly weed control measures in field crops. The growth of some *Brassica* genotypes is quick which should be exploited for controlling weeds during the winter season. The quantification of smothering potential will serve dual purpose in crop diversification by reducing area from wheat to oilseed crops and reducing dependence on herbicides. Keeping this in view, a field experiment was conducted during *rabi* 2001-2002 and repeated in 2002-03 to study the smothering potential of *Brassica* genotypes on *Phalaris minor* and other winter season weeds.

MATERIALS AND METHODS

The experiment was conducted in split-split plot design keeping dates of sowing in main plots and *Brassica* genotypes and weed control treatments in sub plots with four replications. The detail of treatments is given in Table 1. *Raya* (*B. juncea*, cv. RLM 619) and *gobhi sarson* (*B. napus*, cv. GSL 1) was sown on October 20, October 30 and November 10, 2002 and 2003 using 3.75 kg seed/ha. The row to row distance was kept 45 cm in *gobhi sarson* and 30 cm in *raya*. Among two plots of each cultivar, for each date of sowing, hoeing was done in one plot and the other kept unweeded. The crop received 100 kg N and 30 kg P_2O_5/ha. Half dose of N and full dose of phosphorus was drilled at sowing and remaining half dose of N was top dressed with first irrigation. Thinning was done after 25 days of sowing to keep the plant to plant distance of 10 cm. The crop received other inputs as per PAU package of recommendations. The crop was harvested during first fortnight of April during both the years. The weed flora of the experimental field was *Phalaris minor*, *Rumex dentatus*, *Anagallis arvensis*, *Chenopodium album*, *Medicago denticulata*, etc.

RESULTS AND DISCUSSION

The study revealed that *Brassica juncea* helped in reducing population and dry matter of weeds as compared with *Brassica napus*. The suppressing potential of *Brassica juncea* was clear from significantly less dry matter production (1.78 q/ha) of weeds as compared to 2.23 q/ha dry matter of weeds under *Brassica napus* in unweeded treatment during 2001-02 (Table 1). The data (Table 2) further revealed that *Brassica juncea* produced similar seed yield of 17.2 q/ha in unweeded and hand weeded treatment during 2001-02, which clearly showed the excellent smothering potential of this genotype. But on the other hand *Brassica napus* produced 5.0 q/ha more seed yield under hand weeding over unweeded treatment which produced seed yield of 13.9 q/ha hence showed poor smothering potential against weeds. Similar findings were reported by Sharma and Chauhan, 1994 and Singh *et al.*, 1996.

During the second year (2002-03), the trend was similar but experimental crop was severely lodged due to strong wind storm in the month of February and resulted in low yield. The lodging of crop also helped *P. minor* growth, which resulted in more dry matter production by weeds(Table 1) and low seed yield that may be due lodging. The data in Table 1 showed the higher suppressing potential of *B. juncea* as compared with *B. napus* even this type of adverse crop growth conditions. From this study, it may be concluded that the excellent smothering potential shown by *B. juncea* could be exploited for the control of winter season weeds and for reducing dependence on herbicides.

Table 1 Smothering effect of *Brassica* genotypes on weeds and seed yield of crop

Treatment	*Dry matter of weeds (q ha^{-1})*		*Seed yield (q/ha)*	
	2001-02	*2002-03*	*2001-02*	*2002-03*
Date of sowing				
Oct. 20	1.79	8.6	17.9	6.02
Oct. 30	1.85	10.4	16.9	4.32
Nov.10	2.37	12.2	15.7	3.26
CD at 5%	0.32	NS	NS	1.5
Genotypes				
Brassica napus	2.23	11.9	16.4	2.03
Brassica juncea	1.78	8.9	17.2	7.04
CD at 5%	0.38	NS	NS	0.96
Weed Control				
Unweeded	3.01	18.5	15.5	4.21
Weeded	1.00	2.2	18.1	4.85
CD at 5%	0.29	3.3	1.4	0.56

Table 2 Effect of genotypes and weed control on seed yield of *Brassica* genotypes (q/ha) and dry matter of weeds (q/ha) during 2001-02

	Unweeded		*Weeded*		*Mean*	
	Seed yield	*Weed dry matter*	Seed yield	*Weed dry matter*	Seed yield	*Weed dry matter*
Brassicam napus	13.9 (3.5)	11.3	18.9 (1.0)	0	16.4 (2.2)	5.7
Brassica juncea	17.2 (2.6)	6.2	17.2 (1.0)	0	17.2 (1.8)	3.1
Mean	15.5 (3.0)	8.8	18.1 (1.0)	0		

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99- Chemical Weed Control in Cumin-Pearlmillet Cropping System

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INTRODUCTION

Cumin (*Cuminum cyminum* L.) is one of the most important spices crop grown in India. Gujarat and Rajasthan are leading states in production of cumin. It is cultivated in about 107400 hectares with a total production of 43100 tonnes having an average productivity of 401 kg/ha. Cumin is a short stature crop with slow growth at initial stage, which makes incapable of offering competition of weeds. The weed infestation may lead to reduction in seed yield upto the extent of 92 per cent. Removal of weeds manually is tedious, labour consuming and expensive because of sown by broadcast method. Moreover, *Jiri* or *Jirado* (*Plantago psullium*) is difficult to distinguish from cumin field before flowering of cumin plant. Cumin growers are adopting cumin summer pearlmillet cropping system where irrigation facilities exist. Therefore, experiment was planned to know efficient and effective weed management practice in cumin-pearlmillet cropping system.

MATERIAL AND METHODS

Field experiments were carried out at Anand Agricultural University, Anand during the winter-summer season of 1998-99 and 1999-2000. The soil of experimental field was sandy loam having pH 8.19 with 0.018 % N, 71 kg P_2O_5/ha and 361 kg K_2O/ha. The experiment was laid out in randomized block design with four replications. The treatments consisted pre-plant application of trifluralin (0.5 & 1.0 kg/ha), fluchloralin (1.0 kg/ha) & pendimethalin (1.0 kg/ha) along with weed free (twice hand weeding at 30 & 45 DAS) and weedy check. Both the crops were raised according to the package of practices of the region. Pearlmillet crop was sown after harvesting of cumin crop keeping layout as such. Population and dry matter of weeds were recorded at harvest in cumin crop. Plant growth parameters were recorded at different stages of both the crops.

RESULTS AND DISCUSSION

Weed flora was recorded in the experimental field during the crop period of cumin. The major weed flora in the experimental field was: *Chenopodium album* (79.0%), *Melilotus indica* (9.6%), *Asphodelus tenuifolius* (3.2 %), *Eragrostis major* (2.7 %), *Euphorbia hirta*, *Digera arvensis*, *Plantago psyllium* and *Cyperus rotundus*.

Effect of herbicides on weeds

Significantly lower weed population (Table 1) was recorded in weed free treatment (Hand Weeding at 30 & 45 DAS) and was at par with application of pendimethalin, fluchloralin and trifluralin applied at 1.0 kg/ha 0.75 kg/ha. Similar trend was noticed in weed dry matter recorded at harvest. Among herbicidal treatments, weed control efficiency varied between 93.1 to 97.9 per cent.

Effect of herbicides on cumin

Plant stand recorded at 10 DAS and plant height recorded at 30 DAS (Table 2) was not significantly influenced by application of various herbicides. No. of branches/plant recorded at 30 DAS was significantly higher in weed free treatment and it was at par with all the herbicidal treatments. Seed yield was significantly higher recorded in application of pendimethalin 1.0 kg/ha which was at par with application of fluchloralin or trifluralin applied 1.0 kg/ha and twice hand weeding (30 & 45 DAS) treatments. Rathore *et al.*, (1990) confirmed maximum weed control and highest seed yield of cumin with application of pendimethalin 1.0 kg/ha as pre-plant.

Residual effect of herbicides on succeeding pearlmillet

Plant growth of pearlmillet (Table 3) in terms of germination, plant height, no. of tillers/plant and grain yield was significantly lower where pendimethalin or fluchloralin were applied at 1.0 kg/ha in preceding crop. Plant growth and grain yield of pearlmillet was higher in residual effect of trifluralin applied at 1.0 kg/ha in cumin and could be due to trace amount of residues containing NO_3-N which influenced nitrogen content in soil. Patel and Patel (1998) observed higher NO_3–N content in soil with application of fluchloralin at various intervals. Application of trifluralin at 0.75 – 1.0 kg/ha is effective for control of weeds in cumin without showing residual effect on sensitive succeeding pearlmillet.

Table 1 Influence of herbicides on weed density and dry matter in cumin (Average of two years)

Treatments (kg/ha)	*Weed population (No./m²) at harvest*	*Weed dry matter (kg/ha) at harvest*	*Weed control efficiency (%)*
Pendimethalin 1.0	3.0	102	97.6
Fluchloralin 1.0	7.0	89	97.9
Trifluralin 0.75	14.7	287	93.1
Trifluralin 1.0	7.9	116	97.2
Weed free (HW at 30 & 45 DAS)	0.00	0.00	100
Weedy check	378.4	4179	—
CD at 5%	14.0	187	—

Table 2 Effect of herbicides on plant growth of cumin (Average of two years)

Treatments (kg/ha)	*Plant stand (cm)at 30 DAS*	*Plant height (No./m²) at 10 DAS*	*Branches (No./plant) at 30 DAS*	*Seed yield (kg/ha)*	*Weed Index (%)*
Pendimethalin 1.0	368	34.6	4.80	440	—
Fluchloralin 1.0	400	34.7	4.60	435	1.14
Trifluralin 0.75	394	33.6	4.75	349	20.68
Trifluralin 1.0	420	33.9	4.50	427	2.95
Weed free (HW at 30 & 45 DAS)	391	33.1	4.88	413	6.14
Weedy check	367	29.1	2.85	17.2	96.10
CD at 5%	NS	NS	1.1	37.2	—

Table 3: Residual effect of herbicides applied in cumin on succeeding pearlmillet

Treatments (kg/ha)	*Germination (%) at 10 DAS*	*Plant height (cm)at 30 DAS*	*Tillers (No./plant) at 30 DAS*	*Grain yield (kg/ha)*
Pendimethalin 1.0	28.2	32.5	3.2	725
Fluchloralin 1.0	88.5	42.5	3.3	1012
Trifluralin 0.75	93.2	54.0	3.8	2528
Trifluralin 1.0	90.5	62.71	4.0	2575
Weed free (HW at 30 & 45 DAS)	91.0	54.5	3.9	2512
Weedy check	88.2	38.5	3.2	775
CD at 5%	9.1	11.6	0.5	273

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100- Weed Flora in Wheat as Influenced by different Cropping Systems

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INTRODUCTION

Several studies (Singh and Yadav 1990; Singh *et al* 2004) have been made regarding weed flora associated with various crops but there is still vacuum regarding the association of weeds with various cropping systems. The present study was therefore initiated to investigate the influence of various cropping systems on weed density and frequency in wheat.

MATERIALS AND METHODS

Field experiments were conducted at the Research Farm of CCS Haryana Agricultural University, Hisar, India from 2000-01 to 2004-05. The soil of the experimental site was a sandy loam of medium fertility and slightly alkaline (pH 7.9). Agronomic operations and plant protection measures followed local recommendations. The experiment was laid out in Balanced Incomplete Block design with four replications. The experiment consisted of seven cropping systems viz., pearl millet-wheat, pearl millet-mustard, soybean-wheat-cowpea (fodder), sorghum (fodder)-wheat, pearl millet-potato-green gram, pearl millet-field pea-maize (fodder) and cotton-wheat. The weed intensity was recorded using 50 cm x 50 cm quadrats placed at three randomly selected spots in each plots in winter season crops in 2004-05.

RESULTS AND DISCUSSION

Treatment effects on weeds

The weed flora of the experimental field consisted of Phalaris minor, *Avena ludoviciana, Chenopodium album, Melilotus indica, Covolvulus arvensis, Anagallis arvensis, Lathyrus aphaca, Fumaria parviflora, Rumex retroflexus, Vicia sativa* and *Medicago denticulata*. The predominant weeds were *Anagallis arvensis, Phalaris minor, Avena ludoviciana* and *Chenopodium album*. The weed intensity recorded 30 days after wheat crop sowing indicated that the grassy weeds viz. *Phalaris minor* and *Avena ludoviciana* were present

Table 1 Weed dynamics (number m^{-2}) as influenced by different cropping systems

Cropping system	*Grassy*			*Broad leaf weeds*						*Grand Total*
	Phalaris	*Avena*	Total	*Chenopodium*	*Melilotus*	*Convolvulus*	*Anagallis*	Others	Total	
Pearl millet-wheat	(3.0) 8	(2.9) 8	(4.1) 16	(3.1) 9	(1.9) 3	(3.3) 10	(4.4) 18	11	51	67
Pearl millet-mustard	(0.7) 0	(0.7) 0	(0.7) 0	(3.5) 12	(3.9) 15	(2.8) 7	(5.5) 29	18	81	81
Soybean-wheat-cowpea (F)	(3.2) 9	(3.2) 10	(4.5) 19	(3.3) 10	(2.1) 4	(3.0) 8	(4.1) 17	5	44	63
Sorghum (F)-wheat	(3.3) 10	(3.3) 10	(4.6) 20	(3.11) 9	(2.5) 6	(3.0) 8	(4.7 (22)	14	59	79
Pearl millet-potato-green gram	(0.7) 0	(0.7) 0	(0.7) 0	(3.2) 10	(2.8) 7	(2.3) 5	(3.7) 14	11	47	47
Pearl millet-field pea – maize (f)	(0.7) 0	(0.7) 0	(0.7) 0	(3.5) 12	(3.2) 9	(0.7) 0	(3.7) 14	18	53	53
Cotton-wheat	(3.5) 11	(3.2) 9	(4.5) 20	(1.9) 3	(2.5) 6	(3.1) 9	(4.3) 18	21	57	77
CD at 5%	(0.7)	(0.8)	(1.3)	(0.6)	(1.0)	(1.7)	NS	-	-	-

Weed counts transformed to $\sqrt{n + ½}$ are given in parentheses.

only in wheat crop i.e., in pearl millet- wheat, soybean-wheat-cowpea (F), sorghum (F)-wheat and cotton-wheat cropping systems (Table 1). These grassy weeds were not present in mustard, potato and field pea in pearl millet-mustard, pearl millet-potato-green gram and pearl millet-field pea-maize (F) cropping systems. The intensity of *Phalaris minor* and *Avena ludoviciana* in various treatments ranged between 8 and 11, and between 8 and 10, respectively.

The crop was infested with large number of broad leaf weeds (Table 1). *Chenopodium album* was present uniformly in almost all the cropping systems. It was interesting to note that *Melilotus sp.* presence was more dominant in crops other than wheat i.e. mustard and field pea. *Convolvulus arvensis* was present uniformly in all crops except field pea. *Anagallis arvensis* was a predominant weed flora in the experiment and its frequency ranged between 14 and 29 m^{-2}. The frequency was highest in mustard in pearl millet-mustard cropping system and lowest in field pea and potato. Total weeds were maximum in wheat [sorghum (F)-wheat] and minimum in potato (pearl millet-potato-green gram).

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101- Studies of Tillage and Residue Management on Weed Growth and Grain Yield in Rice-Wheat Cropping System

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INTRODUCTION

To see the effects of tillage and residue management in rice-wheat cropping system on weed dynamics and grain yield an experiment was conducted for 3 years (2000-2003) at Crop Research Centre of G.B.Pant University of Agriculture & Technology, Pantnagar, Uttaranchal.

MATERIALS AND METHODS

Experiment was conducted in split-split plot design having four tillage treatments as main plot treatment in rice crop (PR-puddling by rotary puddler – 4 passes; ReP-reduced puddling – 2 passes of rotary puddler; CP-conventional puddling – 4 passes of tractor drawn local puddler with cage wheel; and DSWP – direct seeding without puddling. In wheat crop at same layout using tillage treatments of rice as main treatments and ZT (Zero tillage-wheat seeding by Pantnagar Zero Till Drill) and CT (Conventional tillage – Ploughing by one way disc plough followed by three harrowing, leveling and planting by tractor drawn seed drill) in sub plots; residue management in sub-sub plots (RI – crop residue incorporated and RR-crop residue removed) were kept. All the treatments were replicated four times. Variety Pant Dhan – 12 of rice and UP-2338 of wheat of wheat was sown in the experiment. Uniform dose of 150 kg N + 60 kg P_20_5 + 40 kg K_20 ha^{-1} + 40 kg K_20 ha^{-1} + 25 kg $ZnS0_4$ ha^{-1} in rice and 120 kg N + 60 kg P_20_5 + 40 kg K_20 ha^{-1} in wheat was applied. Direct sowing of rice was done at the rate of 120 kg seed ha^{-1} on the date of sowing in the nursery for transplanting under puddle soil condition. Soils was silty clay loam, highly productive and are classified as Mollisols. *Echinochloa colonum* and *Echinochloa crusgalli* among grasses and *Commelina benghalensis,* *Caesullia axillaries* and *Eclipta alba* among non-grasses were predominant in rice field. *Cyperus rotundus* in non-puddled plots was the major sedges. *Cyperus irria* was more in number in puddle plots than DSWP plots during all the years of experiment.

RESULTS AND DISCUSSION

Total number of weeds m^{-2} increased every year and it was significantly higher in DSWP plots than in puddle plots. Weed intensity was relatively lower in RI than RR plots. *Phalaris minor* population in wheat plots was increased over the year. Effect of tillage (given rice) on *Phalaris minor* population was significantly higher in PR and CP plots than in the ReP and DSWP plots than in ReP and DSWP plots both under ZT and CP conditions but it was higher in CT than ZT plots. Reduction in grain yield of rice due to weeds was 18% in DSWP plots and minimum PR (6%) over three years. Reduction was 12% higher in RR plots than in RI plots but the effect of residue over the four years was non-significant. Contrary to this, reduction in wheat yield was maximum in PR plots and minimum in DSWP plots of rice both in ZT and CT plots. Reduction in yield was relatively less in RI plots than in the RR over the years.

102- Weed Dynamics and Grain Yield in Rice-Wheat Cropping System as Influenced by Tillage Methods

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INTRODUCTION

Rice-wheat is the dominating cropping system of Uttaranchal. Weed dynamics largely depends upon tillage systems and these studies were initiated to study changes in weed flora with different tillage systems.

MATERIALS AND METHODS

Field experiment was conducted in three consecutive years i.e. 1999 to 2002 at Crop Research Centre of G. B. Pant University of Agriculture & Technology, Pantnagar, in split plot design having four methods of tillage in rice (PR-puddling by rotary puddler 4 passes; Re P – reduced puddling 2 pases of rotary puddler; CP – conventional puddling 4 passes of tractor drawn local puddler with cage wheal; DSWP; - direct seeding without puddling) and in wheat ZT – zero tillage (wheat seeding by Pantnagar zero till drill; CT – conventional tillage (Ploughing by one way disc plough fb three harrowing, leveling and planting with seed drill). All the treatments replicated four times in both the crops. Row to row and plant to plant in case of rice was 20x5 cm in transplanted rice whereas in DSWP – direct drilling of seed in dry bed @ 120 kg seed per ha was done. Row to row distance in wheat was kept 23 cm apart. Pan Dhan-12 variety of rice and UP-2338 of wheat was planted/sown. 150 kg N + 60 kg P_2O_5 + 40 kg K_2O ha^{-1} in rice and 120:60:40 kg N, P_2O_5 and K_2O ha^{-1} in wheat was given.

RESULTS AND DISCUSSION

Highest grain yield (5714 kg ha^{-1}) was recorded in PR treatment and lowest (5224 kg ha^{-1}) in DSWP (Av. Of three years). Grain yield was at par in PR and Re P plots. Contrary to rice yield, the overall yield of wheat (Av. Of three years) was maximum under ZT condition of the DSWP plot of rice (4029 kg ha^{-1}) and minimum under ZT condition of PR plots (3456 kg ha^{-1}). The effect of tillage for wheat on grain yield was non-significant. *Echinochloa colonum* and *E.crusgalli* among grasses and *Commelina benghalensis, Caesullia axillaries* and *Eclipta alba* among non-grasses were predominant in rice. *Fymbrystylis dicotoma* in puddled and *Cyperus rotundus* in non-puddled plots were the major sedges. *Cyperus irria* was also higher in puddle plots than DSWP plots during all the three yesrs. Total weed population in rice plots was highest in DSWP plots and lowest in CP. Variation in weed population was non-significant during three years. Effect of tillage for rice on *P.minor* was non-significant, but the tillage given in whet influencd the weeds in wheat. *P.minor* population was higher (205 m^{-1}) in CT against (193 m^{-1}) in ZT. Reduction in grain yield of rice due to weeds was 16% under DSWP and minimum in CP plots of rice under CT condition and minimum in DSWP plots of rice and ZT conditions. Soil of the experimental plots was silty clay loam.

103- Long Term Effects of Herbicide Use in Rice-Wheat System

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INTRODUCTION

Continuous adoption of rice-wheat cropping system has led to a major problem of weed infestation. Crops and weeds have similar requirements for growth and development and compete with each other for limited resources. Weeds by virtue of their wider adaptability and faster growth dominate the crop habitat and reduce the crop yield. In such situations, herbicide hold great promise as they can arrest weed growth right from the beginning of crop growth and thereby increase crop yields. Herbicides not only save time and money but also allow coverage of more area in short period in carrying out timely control of weeds.

MATERIALS AND METHODS

A field experiment was conducted at Crop Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar (Udham Singh Nagar) during 2003-04 to study the long term effects of herbicide use in rice-wheat cropping system and its effect on yield of rice and wheat. This experiment is in progress since 1990-91. Nine treatments consisted of recommended herbicides in rice and wheat, hand weeding and weedy check were used in a randomized block design with three replications. The soil of experimental plot was sandy loam in texture, medium in organic carbon, low in available nitrogen and medium in available phosphorus and potassium with neutral soil reactions. In transplanted rice during *kharif* season of 2003 treatments consisted of butachlor at 1.5 kg ha^{-1} at 3 days after transplanting (DAT) hand weeding (HW) at 30 and 60 DAT and weedy check (WD) and during the following *Rabi* season 2003-04 each treatment of *kharif* was followed by isoproturon at 1.0 kg ha^{-1} at 35 days after sowing (DAS), hand weeding (HW) at 30 and 60 DAS and Weedy-check (WD) were used.

RESULTS AND DISCUSION

Major weed species during *kharif* season were *Echinochloa* spp., *Caesulia axillaris* and *Fimbristylis miliaceae.* Significantly higher grain yield of rice was obtained in HW-WD (7384 kg ha^{-1}) as compared to WD-WD (6602 kg ha^{-1}). Total weed density was reduced in all the treatments.

Total weed density was maximum in WD-WD (310 m^{-2}) followed by HW-WD (297 m^{-2}) and Buta-WD (290 m^{-2}). Wheat grain yield was found maximum in HW-HW (6368 kg ha^{-1}) which was at par with that of Buta-ISO, Buta-HW, HW-ISO, WD-ISO and WD-HW. Minimum grain yield was recorded in WD-WD (2243 kg ha^{-1}). Continuous use of butachlor and isoproturon for weed còntrol in rice-wheat system during past years did not reduce the weed control efficiency of butachlor and isoproturon and these herbicides are still providing satisfactory control. Crop productivity was also not affected over the years due to continuous use of butachlor and isoproduron.

104- Crop Diversification for Weed Management in Wheat-Farmers Participatory Research

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INTRODUCTION

Phalaris minor is the major weed in wheat particularly in rice wheat cropping system which causes 25-30% yield reduction (Malik et.al., 1996) in wheat in north western India. The weed became resistant to isoproturan for its continuous use in Haryana (Malik et.al, 1995) and alternate herbicides have been recommended to control the resistant bio-types of *Phalaris minor*. The alternate herbicides provided 80-95% control of resistant *P.minor* (Yadav and Malik, 2001) but use of these herbicides need certain unavoidable technology in their usage like proper spray techniques (knapsack sprayer fitted with flat fan nozzles, right time of spray, uniformity in spray, optimum dose) and rotation of herbicides every year for their effectiveness in future.

MATERIALS AND METHODS

The farmers were advised to follow the scientific use of alternate herbicides alongwith other methods for the management of resistant *P. minor*. Besides the recommendations of alternate herbicides, alternate crops like lentil, gram, berseem, sunflower and sugarcane were suggested to manage the weeds in wheat through the extension personnels with the involvement of farmers, calling farmers participatory research. Such studies were undertaken by Krishi Vigyan Kendra Kurukshetra at farmers fields in various crop rotations.

The data from five farmers located at five distinct sites of different crop rotations were collected. The farmers of various sites viz site-I (Village Kirmach), site-II (Padlu), site-III (Jainpur Jattan), site-IV (Haripur), site-V(Amin) followed the five different crop rotations (Table) for three years. The crop rotations during the year 2001-2002 were diversified during 2002-2003 and again the same rotation of 2001-02 was tested during 2003-04. The intervention was made for wheat only at different sites during the year 2002-03.

RESULTS AND DISCUSSION

The results obtained at all the sites (Table 1) clearly indicated that the population of P.minor was more during 2001-02 and herbicides were used for its control and the grain yield ranged from 3875 to 4250 kg/ha. The diversification of wheat by lentil, sunflower, berseem, sugarcane and toria decreased the population of P.minor to the tune of 93 to 99 percent. There was no need of herbicides application in the succeeding corresponding wheat crop where the diversification was made by sugarcane and berseem crops. Further, the grain yield of wheat increased by 9-16% recorded during the year 2003-04 as compared to the year 2001-02. From the above farmers participatory research it may be concluded that the problem of P.minor in wheat can be efficiently managed through diversification of wheat by lentil, sunflower, sugarcane, toria and berseem to a greater extent.

Table 1. Role of alternate crops in management of *Phalaris minor* in wheat crop.

Particulars/Year		*2001-02*	*2002-03*	*2003-04*
Site-I	Crop rotation	Rice-Wheat	Rice-Lentil	Rice-Wheat
	P.minor (no/m^2)	386	-	24
	Grain yield	3875	1000	4500
Site-II	Crop rotation	Rice-Wheat	Rice-Potato-sunflower	Rice-Wheat
	P.minor (no/m^2)	327		8
	Grain yield	4000	-	4625
	(kg/ha)		2375	
Site-III	Crop rotation	Rice-Wheat	Rice-Berseem	Rice-Wheat
	P.minor (no/m^2)	280	-	0.6
	Grain yield	4250	75000 (Fodder)	4625
	(kg/ha)			
Site-IV	Crop rotation	Sugarcane	Sugarcane	Rice-Wheat
	P.minor (no/m^2)	-	-	0.2
	Grain yield	81250(cane)	87500 (Cane)	4750
	(kg/ha)			
Site-V	Crop rotation	Sorghum-	Rice-Toria-	Rice-Wheat
	P.minor (no/m^2)	wheat	Sunflower	2.6
	Grain yield	318	-	4625
	(kg/ha)	4125	2000	

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105- Productivity and Economics of Mustard-Based Inter Cropping Systems as Influenced by Integrated Weed Management Practices under Rainfed Condition in Terai Regin of West Bengal

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INTRODUCTION

Mustard based intercropping is the most important system being followed in the *terai* region of West Bengal, under rainfed condition. Since a wide variety of weeds grow in this system, which cause a significant loss in terms of seed production and economic returns, their control measures becomes imperative for obtaining satisfactory yield of both the crops. Traditional methods of weed control i.e. hand weeding are now costly, time consuming and cumbersome.

MATERIALS AND METHODS

A field experiment was conducted during winter seasons of 2002-03 and 2003-04 at Instructional Farm of Uttar Banga Krishi Viswavidyalaya, Pundibari, Cooch Behar, West Bengal (20^0 19' 86" N latitude and 89^0 23' 53" E longitude and at an altitude of 43 meters above mean sea level) to study the comparative performance of different weed control measures in respect of yield and economics of mustard-based intercropping systems. The experiment was laid out in split-plot design with three replications. Four levels of cropping systems viz. sole crop of mustard (M) and inter crops of mustard + faba bean [M + F], mustard + lentil [M + Le] and mustard + lathyrus [M + La] in 2 : 3 row ratio were assigned to main plots and five levels of methods of weed control (M) viz. pre-plant application of glyphosate @ 5ml lit^{-1} of water + post-emergence application of glyphosate @ 5ml lit^{-1} of water (M_1), pre-plant application of glyphosate + hand weeding (once) at 25 days after sowing (DAS) (M_2), hoeing (twice) at 25 and 45 DAS (M_3), hand weeding (twice) at 25 & 45 DAS (M_4) and unweeded control (M_5) were assigned to sub-plots.

RESULTS AND DISCUSSION

Yield and yield attributes were recorded higher under sole crop of mustard and among the intercrops mustard + lentil intercropping situation significantly recorded higher yield and yield attributing characters. Among the methods of weed control, hand weeding (twice) significantly recorded higher yield and yield attributing characters followed by pre-plant application of glyphosate + hand weeding (once) at 25 DAS.

Among the intercrops mustard + lentil situation recorded higher net income and benefit : cost ratio. Among the methods of weed control, hand weeding (twice) recorded higher net income and benefit : cost ratio followed by pre-plant application of glyphosate + one hand weeding at 25 DAS. The unweeded control was found economically poor. Thus when labour is limited, pre-plant application of glyphosate + hand weeding (once) at 25 DAS may be used for effective control of weeds in mustard-based intercropping situation.

Table1 Yield attributes of Mustard as influenced by cropping systems and methods of weed control

Treatments	*No. of siliqua/ plant*		*No. of seeds / siliqua*		*1000 grain weight (g)*		*Siliqua length (cm)*		*Seed yield (q/ha)*		*Net income (Rs. ha^{-1})*	*Benefit : cost ratio*
	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2		
Cropping systems												
M	120.67	12.33	13.36	13.42	4.17	3.90	4.13	4.11	10.79	11.01	11028	2.14
M+F	102.87	103.93	11.67	12.02	3.36	3.53	4.04	3.87	4.89	4.98	8936	1.78
M+Le	110.37	111.73	12.44	12.07	3.37	3.73	4.06	3.93	6.24	6.38	13462	2.32
M+La	106.97	107.43	12.23	12.25	2.93	3.63	4.04	3.92	5.57	5.53	6496	1.66
CD at 5%	3.39	3.43	0.26	0.04	NS	NS	NS	NS	1.62	2.36	-	-
Methods of weed control												
M_1	112.30	113.40	12.91	12.90	3.61	3.98	4.20	3.92	7.03	7.52	4283	1.24
M_2	114.00	116.60	13.29	13.31	3.92	4.21	4.57	4.48	8.23	8.50	6098	1.32
M_3	111.20	111.50	12.10	12.40	3.18	3.41	3.81	3.56	6.55	6.82	2925	1.17
M_4	117.10	119.20	14.05	14.25	4.44	4.96	4.93	4.98	9.47	9.60	8043	1.39
M_5	96.50	92.30	9.75	9.35	1.61	1.90	2.82	2.86	3.08	2.43	9523	-
CD at 5%	1.10	2.40	0.35	0.40	0.33	0.45	NS	NS	0.90	1.02	-	-

106- Effect of Weed Control Treatment on Weed Flora in Rice-Wheat System

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INTRODUCTION

Rice-wheat system being one of the world's most important cropping system is practised on an area of about 11m ha in India. The major constraints to production in rice-wheat system is weed infestation mainly of *Echinochola* in rice and *Phalaris minor* in wheat. Crops and their associated weeds have similar requirements for growth and development and complete with each other for limited resources. Continuous adoption of same crop-rotation coupled with the use of a particular weed management practice may lead to intensity and shift in weed flora with respect to time. Thus, the present investigation was carried out with the objective to study the effect of weed control treatments on weed flora and production of rice and wheat in rice-wheat system.

MATERIALS AND METHODS

The field experiment was conducted in the D_2 plot of the Crop Research Center of GBPUA and T, Pantnagar having subtropical and subhumid climate. The soil of the experimental plot was sandy loam in texture, medium in organic carbon, low in available nitrogen and medium in available phosphorus and potassium. The experiment was laid out in a randomised block design with three replications and seven treatment combinations. The weeds were collected specie wise from each plot using a quadrate of 50cm x 50cm and then expressed on per meter square basis. The samples were dried in hot air oven and dry weigh recorded at different crop growth stages. Similar procedure was followed in case of rice and wheat for obtaining dry weigh, wereas number of shoots per meter square were recorded from 2 meter row length and converted to per meter square.

RESULTS AND DISCUSSION

Among different weed control treatments, at 60 days stage, in rice the total weed population and dry weight was significantly lower under butachlor fb 2, 4-D + organic matter through *Sesbania aculeata* and butachlor + hand weeding having zero weed population which resulted for higher number of shoots and dry matter accumulation thereby giving higher grain yield, whereas in wheat the total weed population and dry weight was significantly lower under isoproturon + hand weeding and isoproturon + 2,4-D with organic matter in kharif and clodinafop fb 2,4-D with organic matter in kharif which resulted in significantly higher number of shoots and dry matter accumulation, particulary under treatment isoproturon + hand weeding and isoproturon + 2,4-D with organic matter in kharif thereby increasing the yield of wheat.

Thus the combined use of herbicides and organic matter has resulted in better weed control and higher productivity of both rice and wheat.

107- Resource Conservation Technology in Rice-Wheat System in District Pratapgarh – A Case Study

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INTRODUCTION

District Pratapgarh falls under eastern plain zone of Uttar Pradesh. Rice is major *kharif* crop with a cultivated area of 116.2 thousand ha (74%) and an average productivity of 2205 kg/ha, whereas wheat is a dominant *rabi* crop (142.9 thousand ha) (76% area) with an average productivity of 1934 kg/ha (2003-04). Low rice productivity in Pratapgarh is due to its cultivation in highly variable and heterogeneous condition. Manual transplanting of Rice after 2-3 puddling operations with 30-50 days old rice seedling is common in the district. However, this system is labour intensive, requires huge tractor usage which often delays transplanting of paddy up to second week of August, it ultimately lead is poor tillering, poor grain formation and low yields of rice. Delayed harvesting of rice also delays sowing of wheat that ultimately reduces wheat grain yield.

MATERIALS AND METHODS

Rice sowing was done by Pantnagar Zero-Till Seed-cum-Fertilizer Drill at a seed rate of 50 kg/ha. Weeds are the major threat in direct seeded rice, therefore, pendimethalin @ 1 kg a.i./ha was applied next day after sowing using 500 l aqueous solution, it was followed by application of 2,4-D 0.5 kg a.i./ha 500 l of water to control broad leaf weeds and sedges at 25 DAS. One manual weeding was also done at 35 DAS to eliminate some of the escaped weeds. Other cultural operations were similar to transplanted rice except application of butachlore 1.25 kg a.i./ha at 2 days after transplanting (DAT).

In case of wheat the first demonstration on zero tillage was planted during Rabi season 2000-01 in village Alapur and a similar demonstration was also laid at KVK farm in comparison with conventional tillage wheat. The initial results were encouraging and since then we have been trying to disseminate zero till wheat in Pratapgarh. Nevertheless, such technology could reach up to 29.5 ha with 18 farmers in 5 villages up to 2003-04.

RESULTS AND DISCUSSION

Good seedling emergence was observed in direct seeded rice at 7 DAS, however, few gaps were observed at 15 DAS which were filled at 1st irrigation 20-25 DAS by uprooting extra seedling from areas having dense plant population, thus maintaining good planting geometry. Weeds started germinating 3-4 DAS.

Table 1. Detail of front-line demonstration on direct seeded rice

S.	*Particulars*	*Locations*			
No.		*Shekhhisampur*	*Alapur-I*	*Alapur-II*	*Dhaurehat*
1	Name of farmer	Sanjay Tiwari	Ram Ajor Tripathi	Urmila Shukla	HariharPratap Singh
2	Cultivated variety	NDR-359	Pant-12	NDR-359	NDR-359
3	Soil type	Clay loam	Loam	Loam	Loam
4	Category of farmer	Small	Large	Large	Medium
5	Source of irrigation	Diesel pump	Electric tubewell	Electric tubewell	Electric tubewell
6	Area (ha)	0.25	0.25	0.25	0.25
7	Date of sowing	8.6.04	12.6.04	12.6.04	4.6.04
8	Date of harvesting	17.10.04	17.10.04	22.10.04	19.10.04
9	Grain yield q/ha	60.0	42.5	48.6	51.4

Major weeds observed in DSR were *Echinocloa sp., Dactyloctenium aegyptium, Paspalum sp.* Among grassy and *Eclipta alba, Caesulia axillaries, Commelina sp.* Among broad leaf weeds and *Cyperus defformis* and *C.rotundus* among sedges. Pendimethalin gave good control of grasses and broad leaf weeds, however, 2,4-D controlled dense population of sedges to some extent. The yield of DSR was higher than transplanted rice at all three locations in both the cultivars with an average yield 5.3 t/ha. However, the yield of transplanted rice was 4.8 t/ha thus a yield increment of 9.4% was observed due to this technology.

The limited tractor uses and controlled water use in DRS reduce the cost of cultivation to Rs.6000/- ha and therefore increases the profit margin to the farmers at Rs. 8000-10000/ha.

Table 2 Energy budget and yield of wheat as affected by tillage at farmers field (2003-04)

Treatment	*Tractor hour/ha*	*Diesel consumption*	*Tractor rent (Rs/ha)*	*Yield* (kg/ha)*
Zero-till wheat	1:54	6.38	380	3022
Conventional tillage wheat	9:30	33.25	1900	2816

*Average of 18 farmes

It was observed that zero tillage leads to higher yield with saving in tillage in cost at the same time less time is required to irrigate crop planted with the zero tillage drill than conventional tillage wheat. Adopting zero tillage also reduces weed emergence and quite low *Phalaris* population was observed than in conventional tillage wheat. In conventional tillage wheat the crop turns pale yellow after 1st irrigation whereas it remain lush green in zero tillage wheat. It might be due to low immobilization of soil nitrogen.

It has been observed that wheat rooting is often restricted conventional tillage plot because sub soil remains wet and compact due to puddling, at the same time in zero tillage favors the root development. Apart from this placement of fertilizer (DAP or NPK mixture) below seed in zero tillage wheat gives added advantage than conventional broadcasting methods of sowing and fertilizer application.

108- Effect of Organic and Inorganic Sources of Nutrition on Weed Dynamics of Wheat in Soybean-Wheat System

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INTRODUCTION

In recent years organic farming is gaining popularity among the farmers, and the people are now preferring take food products from organically grown crops, for their safe health and to keep away from the harmful side effects of chemicals and pesticides which are used in chemical farming. The organic farming avoids the dumping of thousand of tonnes of agrochemicals on the earth every year and give residue free food and safe environment. So, keeping the agro-eco system maintenance, human health in view, these studies on organic vs chemical farming on wheat grain yield and weed dynamics in wheat under soybean-wheat cropping system were planned.

MATERIALS AND METHODS

Long-term field experiment with soybean-wheat sequence was initiated during 1996-97 by keeping organic and chemical farming systems. In the same trial, present investigation was conducted during 2002-

03 with 8 treatments in a randomized block design. In the chemical farming system, recommended fertilizers (Rec.) were applied as per recommendations; while in organic farming, well rotten farmyard manure on air dry weight basis was applied at 10 t/ha to soybean (S_{10}) and 20 t/ha to wheat (W_{20}); 5 t/ha (S_5) to soybean with and without green manuring (*Crotolaria juncea*) and crop residues and 15 t/ha (W_{15}) to wheat with and without crop residues (RI-residue incorporated, R0-residue removed). The sowing of wheat (Var. PBW 343) was done on 3rd November 2002 using 100 kg seed/ha. Weeds were controlled mechanically in organic farming, For wheat one hand hoeing was given 30 days after sowing and later on two hoeings with wheel hoe were given at an interval of 15-20 days. While in chemical farming system, grassy weeds were controlled with the application of Puma super 10 EC (fenoxaprop-p- ethyl) 100 g a.i./ha 30-35 days after sowing with knap sack sprayer with discharge rate of 250 litre /ha of water during both the years. For controlling broad leaf weeds a follow up application of 2,4-D was made at 0.5 kg/ha at maximum tillering stage. The SPAD reading (chlorophyll content) was recorded by meter (SPAD 502).

RESULTS AND DISCUSSION

All the treatments with organic sources of nutrition showed significantly higher population of grassy as well as broad leaf leaves as compared to chemical farming treatments. The population of both types of weeds was found to be significantly higher in pure organic farming treatments i.e. which received FYM as compared to the treatments in which green manuring crops were included. The SPAD reading of weeds recorded 120 days after sowing, the organic farming treatments (S_{10}-W_{20}-RI, S_5-W_{15}- GM- RI, S_5-W_{15}- RI, S_5-W_{15}- R0) and partial organic treatments (Rec.-GM-RI and Rec.-GM-R0) showed higher chlorophyll content of grassy as well broad leaf weeds over Rec. treatment. Similarly, SPAD reading (Chlorophyll concentration) was estimated at heading stage from the flag leaf of wheat. All the fully and partial organic farming treatments showed higher SPAD readings (chlorophyll content) as well as grain yield than alone chemical fertilizer treatments. The higher grain yield and chlorophyll content may be due to more nitrogen availability and their uptake by plants.

Table 1 Effect of organic farming and chemical farming treatments on weed population, SPAD reading and grain yield in wheat under soybean-wheat system

Treatments	*Weeds population/m²*		*SPAD reading (Chlorophyll content)*			*Wheat grain yield (q/ha)*
	Grassy	*Broad leaf*	*Grassy weeds*	*Broad leaf weeds*	*Wheat*	
S_{10}-W_{20}-RI	37	42	30.4	42.5	40.7	55.1
S_5-W_{15}-GM-RI	36	43	28.6	40.1	40.1	53.8
S_5-W_{15}-RI	33	41	27.8	37.4	37.2	51.9
S_5-W_{15}-R0	32	41	27.2	37.3	36.6	51.4
Rec.-GM-RI	25	34	28.3	39.0	39.2	54.9
Rec.-GM-R0	25	33	27.4	38.4	38.4	54.5
Rec.+25% N	26	34	25.6	34.8	35.2	54.6
Rec.	27	37	25.1	34.0	33.6	50.8
CD at 5%	1.7	1.6	1.92	2.90	1.28	1.84

S_{10}, soybean 10 t FYM /ha; W_{20}, wheat 20 t FYM/ha; RI, crop residue incorporation; GM, green manuring; R0, residue removal; Rec., recommended level; 32-62.5-0 (soybean) and 120-60-30(wheat); N-P_2O_5-K_2O; kg/ha

CONCLUSION

Using organic source of nutrition proved a useful tool of resource conservation particularly soil health and enabled to sustain the productivity of wheat more than 5 tonnes/ha under soybean-wheat system in loamy sand soil of Punjab. However, the problems of weeds gets aggravated in organic farming treatments particularly those receiving farmyard manure.

109- Effect of Organic and Chemical Sources of Nutrition on Weed Infestation ond Yield in Maize-Wheat System

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INTRODUCTION

Organic farming is a specified form of diversified agriculture to produce high quality food, generation of more income and working hours (employment) for rural peoples in addition to improvement in soil health.. The total area covered under organic food production at the global level is around 24 million ha, while in India organic farming has been extended to about 37,050 ha area, involving about 5347 farmers (Singh *et al.*, 2004). Growing environmental concerns and global energy crises also necessitates the development of eco-friendly farming techniques. So, keeping the above facts in view, the present study was planned under irrigated maize-wheat agro-eco system.

MATERIALS AND METHODS

The field experiment with maize under maize-wheat cropping system was conducted during 2002-2003 (on already in progress experiment since *kharif* 1996) on loamy sand in a in randomized block design with 4 replications comprised of 8 treatments (Table 1), consisting of 2 farming systems i.e. organic and chemical farming and 4 nutrient supply systems. In organic farming well rotten farmyard manure was applied on air-dry weight basis at 20 t/ha to maize and wheat along with crop residues incorporation for first five years. Later on the quantity of FYM was reduced to 10 t/ha to maize along with green manuring (with and without crop residues incorporation) and 15 t FYM/ha to wheat (with and without crop residues incorporation). Maize (Var. Parbhat) and wheat (Var. PBW 343) were sown on 8^{th} June 2002 and 3^{rd} November 2002, respectively. In chemical farming system, for maize, weeds were controlled with pre-emergence application of atrataf (atrazine 50 WP) at 1 kg a.i./ha, in wheat, applied puma super 10 EC (Fenoxaprop-p-ethyl) 100 g a.i./ha 30-35 days after sowing with knap sack sprayer with discharge rate of 250 litre /ha of water. For controlling broad leaf weeds a follow up application of 2,4-D was made at 0.5 kg/ha at maximum tillering stage. Where as in the organic farming system, for maize, two hand hoeings (20 and 35 days after sowing) followed by two wheel hoeings at an interval of 10-15 days were given, for wheat one hand hoeing was given 30 days after sowing and later on two hoeings with wheel hoe were given at an interval of 15-20 days.

RESULTS AND DISCUSSION

In maize-wheat system, all the organic farming i.e. M_{20}-W_{20}-RI, M_{10}-W_{15}-GM-RI, M_{10}-W_{15}-RI and M_{10}-W_{15}-R0 recorded significantly higher weed population as compared to the crop receiving only recommended levels of chemical fertilizers (Rec.) at all the stages except in maize at maturity. The weed dry matter was significantly higher in organic maize 60 days after sowing and at maturity over chemical farming treatments where as in wheat the weed dry matter was significantly higher in all the organic farming treatments when recorded 30 days after sowing and at maturity as compared to alone chemical farming treatments. M_{20}-W_{20}-RI and M_{10}-W_{15}-GM-RI treatments showed significantly higher weed dry matter at 60 days after sowing stage over Rec. treatment. The highest wheat equivalent yield was obtained in M_{20}-M_{20}-RI treatment, which was followed, by M_{10}-M_{15}-GM-RI, Rec.-GM-RI and Rec.-GM-R0 treatments and these treatments produced significantly higher grain yield than the crop receiving only the recommended dose of chemical fertilizers (Rec.). Similarly pure/partial organic treatments showed higher values for productivity varying from 37.7 to 39.6 kg/day/ha.

CONCLUSION

The weed infestation in the chemical farming was less as compared to organic farming. Using organic source of nutrition proved a useful tool of resource conservation particularly soil health and enabled to sustain the productivity of maize-wheat 10 tonnes/ha under maize-wheat system in loamy sand soil of Punjab.

Table 1 Weed flora, Wheat equivalent yield and total productivity as influenced by organic and chemical farming system.

Treatments	Weed population (no./m^2) and weed dry weight (q/ha)						Wheat equivalent yield (q/ha/annum)	Total productivity (kg/day/ha)
	Maize			Wheat				
	15 DAS	60 DAS	At Maturity	30 DAS	60 DAS	At Maturity		
M_{20}-W_{20}-RI	165(3.2)	105(7.7)	54(11.9)	125(1.8)	87(6.4)	81(10.8)	105.4	39.6
M_{10}-W_{15}-GM-RI	150(2.9)	145(7.1)	53(11.7)	118(1.7)	84(6.2)	77(10.6)	101.4	38.1
M_{10}-W_{15}-RI	162(3.1)	146(7.5)	57(12.1)	115(1.8)	83(5.9)	76(10.9)	96.8	36.4
M_{10}-W_{15}-R0	160(3.1)	149(7.4)	58(12.2)	114(1.8)	82(5.8)	75(11.6)	92.7	34.9
Rec.-GM-RI	128(1.4)	84(5.4)	46(8.5)	109(1.4)	79(5.6)	61(7.4)	101.9	38.3
Rec.-GM-R0	131(1.4)	87(5.5)	47(8.6)	106(1.4)	75(5.6)	58(7.8)	100.4	37.7
Rec.+25% N	134(1.5)	85(5.9)	53(8.8)	106(1.5)	78(5.4)	61(7.9)	98.0	36.8
Rec.	136(1.5)	83(6.1)	55(8.8)	109(1.4)	78(5.6)	60(8.3)	94.0	35.3
CD at 5%	12.0(NS)	5.7(1.2)	1.4(2.2)	2.5(0.2)	1.5(0.4)	4.6(1.2)	4.2	-

Figures without parentheses are number of weeds /m^2; Figures without parentheses are dry matter of weeds

M_{20}, maize 20 t FYM /ha; W_{20}, wheat 20 t FYM/ha; RI, crop residue incorporation; GM, green manuring; R0, residue removal; Rec., recommended level; 120-0-0 (maize) and 120-60-30(wheat); N-P_2O_5-K_2O; kg/ha

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110-Impact Assessment of Weed Management Technologies under Rice-Wheat System

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INTRODUCTION

In agriculture, technologies are being developed for the benefit of farmers and the success of agriculture is directly related to the speed with which a farmer adopts new technology. After adopting these, whether farmers are getting benefit or not is a matter of study. Providing technology without gaining any feedback will not serve the purpose. Continuous analysis of the effect of technologies on the living standards and overall economy of the villages is needed. By doing this we can actually know the impact of adopted technology. If a farmer is not getting any benefit over traditional technologies, then the technology should be amended according to the farmers need. By adopting new technologies farmers should gain significant improvement. Consideration should also be made for the constraints that are coming in the path of adoption and proper utilization of new technology.

MATERIALS AND METHODS

A study was carried out during 2004 with 146 crop growers (73 crop growers each from adopted and non-adopted villages) in Sihora and Jabalpur Tehsil of Jabalpur District (M.P.). The data were collected through questionnaires and the response of the farmers was statistically analyzed to interpret the results. Socio-economic information about farmers and levels of adoption of weed management technologies (WMT) along with their constraints were considered for impact analysis.

RESULTS AND DISCUSSION

The analysis of questionnaires revealed that 52 percent and 60 percent of the crop growers belong to the age group of 20-40 years in demonstrated and non-demonstrated villages, respectively. Remaining 48 percent farmers fall into the category of 41-60 years age in demonstrated and 40 percent in non-demonstrated area. About 90% of the respondents in both adopted and non-adopted villages were found to be literate. About 80% of the population was engaged in farming consisting the classes other than SC and ST in both the villages. Table 1 revealed the fact that farmers of demonstration area had sufficient level of knowledge about weed problems.

From the economic point of view, 29% and 51% farmers had low income (up to 40,000/-), 48% and 33% medium income while 23% and 16% of farmers fall under higher income groups. The data showed that 48% farmers of demonstrated area and 53% of non-demonstrated area have small land holdings. While 33% and 21% have medium and only 19% & 26% have operational holding size of 8 acre or more, the distribution pattern of the family members was almost identical in both the categories of villages. The respondents had almost similar cropping pattern.

Constraints in crop production

In demonstrated area weeds were the main constraints in crop production while insect/disease incidence in non-demonstrated area. Subsequent constraint were labour problems, high input cost, poor supply of electricity and natural calamities. On the contrary in demonstrated area labour problems, insect/ disease incidence, electric supply, non-availability of improved seeds, high cost inputs and natural calamities were among the major constraints.

Table1 Major constraints in crop production under technology demonstrated and non-demonstrated areas

Factors	*Non-demonstrated*		*Demonstrated*	
	Score	*Ranks*	*Score*	*Ranks*
Insect / disease / problems	144	I	90	III
Weed problems	12	II	142	I
Labour problems	116	III	100	II
Electric supply problems	56	IV	76	IV
Non-availability of improved seeds	78	V	54	V
High cost of inputs	100	VI	22	VI
Natural calamities	28	VII	20	VII

Farmer's satisfaction

It is obvious from the findings (Table-2) that in demonstration area 82% and 71% farmers were fully satisfied with new weed management technologies during *rabi* and *kharif* season respectively. However, satisfaction level in non-demonstrated area was very low (5% and 4%), satisfaction level up to some extent were 11% and 23% in demonstrated area and 26% and 21% in non-demonstrated areas. On the contrary, 7% and 5% farmers were unsatisfied in demonstrated areas whose number increased to 68% and 75% in non-demonstrated areas during *rabi* and *kharif* respectively.

Table 2 Level of satisfaction under technology demonstrated and non-demonstrated areas

Level of satisfaction	Non-demonstrated				Demonstrated			
	Rabi		*Kharif*		*Rabi*		*Kharif*	
Fully satisfied	4	(5%)	3	(4%)	60	(82%)	52	(71%)
Up to some extent	19	(26%)	15	(21%)	8	(11%)	17	(23%)
Unsatisfied	50	(68%)	55	(75%)	5	(7%)	4	(5%)

Constraints in adoption

Lack of technical knowledge in non-demonstrated areas and non availability of improved seeds/ herbicides and labour problems in demonstrated areas were the most predominant constraints in the adoption of new weed management technologies while in case of non-demonstrated areas labour problems, non-availability of improved seeds/ herbicides, economic problems and natural calamities in decreasing order were the main constraints in adoption (Table 3).

Table 3 Constraints in adoption under technology demonstrated and non-demonstrated areas.

Factors	*Non-demonstrated*		*Demonstrated*	
Constraints	Score	Ranks	Score	Ranks
Lack of technical knowledge	142	I	48	V
Labour problems	140	II	110	II
Non-availability of improved seeds/ herbicides	134	III	120	I
Economic problems	100	IV	100	III
Natural calamities	96	V	70	IV

CONCLUSION

In demonstrated area weed infestation is the major constraint for crop production while seeds, electric supply, and natural calamities being the next ones. Non-availability of herbicides and scientific equipments in demonstration area and lack of technical knowledge in non-demonstration area was found to be major constraints in adoption of new weed management technology. Study indicated that new technologies offer farmers a new tool to improve crop production.

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111- Weed Dynamics in Relation to Crop Diversification and Intensification Through Various Cropping Systems

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INTRODUCTION

Growing of crops in a sequence and to study their interaction effects with the resources available on the farm and technology available is the common feature of cropping system research. In Punjab rice-wheat is the predominant cropping system covering about 66 per cent of the cultivated area. Its large expansion is accrued on account of its better adaptation, availability of electricity at subsidized rates, committed procurement price and fixed support price. Simultaneously, it has caused several after effects such as decline in water table, soil degradation, appearance of new insect-pests and diseases and new weed flora.

MATERIALS AND METHODS

To know the shift in weed flora as one component of cropping system studies, ten different cropping system were studied. The population of different types of weeds were recorded from rabi season crops in different cropping systems namely rice-wheat, maize-wheat, maize-wheat-mungbean, maize-potato-mungbean, maize-potato-onion, cotton-wheat, cotton-african sarson, cotton-gobhisarson (transplanted), groundnut-toria+gobhisarson and groundnut-potato-bajra.

RESULTS AND DISCUSSION

It is interesting to note that weed flora varied substantially in different cropping systems. In rice-wheat system the initial value about grass weeds was $10/m^2$ which increased on the completion of 4 crop cycles to 58 where as these values were drastically came down in maize-wheat- moongbean, summer groundnut- toria+ *gobhi sarson* and in the other cropping systems the magnitude was not changed too much. But surprisingly, the *Phalaris minor* infestation was reduced discernibly which varied from 2-6 only as against 5-10 as initial value. Likewise, change in broadleaf weeds was also noticed. Summer groundnut- toria+ *gobhi sarson* recorded lowest broadleaf weed population (8) on the completion of fourth crop cycle. The broadleaf weeds in rice-wheat system were also maximum (Table 1). The results further revealed that *Phalaris minor* population is increasing in rice-wheat system where as in all other cropping systems it has reduced (Gill and Brar, 2003). It may be attributed due to the change in the physical conditions of the soils on account of puddling. In other cropping systems, the population of broadleaf weeds increased and the percentage of increase varied from 37.5 to 53.9 except in case of summer groundnut- toria+ *gobhi sarson* where it was reduced by 37.5 per cent. The results further entail that the change in weed flora is mainly observed after 4 years and no discernible change was observed after 2 years in different cropping systems except in rice-wheat. The rice-wheat productivity (13.2 t/ha) was found 11.3, 41.8, 135.9 and 24.5 per cent lower than maize-wheat- moongbean, maize-potato-moongbean, maize-potato-onion and summer groundnut-potato-bajra (fodder), respectively.

The main broadleaf and grass weeds for rice, maize and cotton based cropping system were recorded as under:

Crop system	Grass weeds	Broadleaf weeds
Rice-Wheat	*Phalaris minor*	*Medicago denticulataArenaria serpylifolia Veronica agrestisRumex dentatus*
Maize-Wheat	*Phalaris minorPoa annua*	*Medicago denticulateArenaria serpylifolia Veronica agrestisRumex dentatus*
Cotton-Wheat/African +Sarson	*Phalaris minorPoa annua*	*Gnaphalium purpureum*

The results thus clearly elucidate that the troublesome weed like *Phalaris minor* population can be kept under check by following the different cropping systems approach. The cropping systems namely maize-potato-onion, maize-potato- moongbean and summer groundnut-potato-bajra (fodder) not only gave the more productivity but also kept the weed population within the permissible limits while substantial increase in grass weeds (5.8 times) in rice-wheat was observed.

Table 1 Weed population (per sq. m) as influenced by different cropping systems during *rabi* seasons

Cropping Systems	*2000-01*		*2002-03*		*2004-05*		*Rice equivalent yield (q/ha) (3 yrs mean)*
	Grass	*Broad Leaf*	*Grass*	*Broad Leaf*	*Grass*	*Broad Leaf*	
Rice-Wheat	10(8)*	11	18(13)	17	58(22)	20	132.2
Maize-Wheat	12(9)	13	15(7)	12	10(6)	15	125.6
Maize-Wheat-Mungbean	14(9)	10	16(6)	10	8(4)	11	147.2
Maize-Potato-Mungbean	12(5)	8	13(4)	11	16(2)	15	187.5
Maize-Potato-Onion	17(10)	13	16(8)	13	18(6)	18	311.9
Cotton-Wheat	13(8)	10	16(8)	11	14(6)	12	116.1
Cotton-African Sarson	11(8)	10	17(6)	13	20(4)	12	79.7
Cotton-*Gobhi sarson*(T)	15(9)	12	12(8)	13	16(4)	12	81.3
G.nut-Toria+ *Gobhi sarson*	10(7)	11	8(4)	10	8(4)	8	93.1
G.nut-Potato-Bajra (F)	14(10)	13	18(8)	14	14(5)	14	164.6

*figures in parentheses represent the *Phalaris minor* population

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112- Weed Management in Soybean-Wheat Cropping System

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INTRODUCTION

Soybean- wheat is one of the most important cropping systems after rice-wheat. But its productivity is not being sustained due to severe crop-weed competition, resulting in yield losses up to 77 % and 7-50 % in soybean and wheat, respectively (Singh *et al*, 2001 and Sharma and Pahuja, 2001). The information for weed management in individual crop is available in plenty. However, the information on residual effect of low dose, high potent and soil active herbicides applied in soybean on weeds and productivity of wheat grown in sequence is almost lacking in India. Hence an experiment was conducted to study the influence of herbicide application to soybean and its residual effect on wheat.

MATERIALS AND METHODS

The field experiment was conducted during *kharif* 2003 and *rabi* 2003-04 on fixed site having sandy loam soil of pH 8.1 at Research Farm of Indian Agricultural Research Institute, New Delhi. The treatment consisted of four herbicides for soybean at various doses (pendimethalin @ 1000-1500 g/ha, quizalofop @ 25-50 g/ha, metribuzin @ 250-500 g/ha and chlorimuron @ 6-12 g/ha) along with one and two hand weeding (20 DAS) (20, 40 DAS), weed free and weedy check (Table 1). Pendimethalin and metribuzin were applied as pre-emergence. While other herbicides were applied as early post-emergence (10 DAS). Herbicides were applied as spray using spray volume of 500 litre of water/ha for pendimethalin and metribuzin and 200 litre of water/ha for the rest of the herbicide treatments. The experiment was laid out in randomized block design with three replication. Soybean variety P-9702 and wheat variety HD2687 were sown on 28th July,2003 and 26th November, 2003 respectively. Weeds population and grain yield of both crop were recorded to assess the performance of the applied treatments.

RESULTS AND DISCUSSION

The experimental field during kharif season was infested with *Trianthema portulacastrum, Digera arvensis, Cyperus rotundus, Parthenium hysterophorus* and *Dactyloctenium aegyptium*. While in *rabi* season it was infested with *Melilotous indica, Chenopodium album, Anagallis arvensis, Avena ludoviciana* and *Phalaris minor*. No weed of any type was recorded in metribuzin treated plots with at 500 g/ha but was toxic to soybean plant. However application of chlorimuron ethyl at 12 g/ha was statistically at par with its lower doses, two hand weedings and quizalofop at 50 g/ha in reducing the population of weeds in soybean crop. The highest seed yield of soybean crop (14.93 q/ha) was recorded in weed free environment. However, the application of chlorimuron-ethyl @ 6-12 g/ha, pendimethalin at 1000-1500 g/ha and two hand weeding were statistically at par with each other in increasing seed yield over weedy check.

Significant reduction in weed population in succeeding wheat was recorded in herbicide treated plots over untreated or hand weeded plots. The highest reduction in weed population (65.22 %) was noted due to carry over effects of metribuzin applied in soybean at 500 g/ha over weedy check (in both crops) closely followed by chlorimuron ethyl application at 6-12 g/ha. The highest increase in grain yield of wheat (60.33 q/ha) was recorded in those plots which were kept weed free in both the crops. However this increase was statistically at par with pendimethalin at 1500 g/ha (54.26 q/ha) and chlorimuron ethyl at 12 g/ha (58.11 q/ha) treated plots.

From the present investigation it may be concluded that application of pendimethalin at 1500 g/ha, metribuzin at 250 g/ha and chlorimuron-ethyl at 6-12 g/ha could be used for effective weed management in soybean- wheat cropping system with single application only in soybean.

Table 1 Effect of herbicide treatments on weeds and seed yield of soybean and their residual effects on succeeding wheat

Treatments	Dose (g ai./ha)	Soybean		Wheat	
		Weed* population (No./0.25m^2)	Seed yield (q/ha)	Weed population (No./0.25m^2)	Grain yield (q/ha)
Pendimethalin	1000	5.26	11.20	70.67	50.37
Pendimethalin	1500	4.92	12.26	62.33	54.26
Metribuzin	250	6.46	5.06	43.33	50.59
Metribuzin	500	0.71	3.86	37.33	52.44
Quizalofop ethyl	25	4.49	8.06	67.33	44.45
Quizalofop ethyl	50	4.16	9.60	65.33	48.15
Chlorimuron-ethyl	6	3.71	11.52	51.33	51.56
Chlorimuron-ethyl	9	3.05	11.47	51.67	53.00
Chlorimuron-ethyl	12	2.99	12.32	40.67	58.11
1 Hand weeding	-	4.31	8.80	87.00	41.15
2 Hand weeding	-	2.55	12.53	88.67	40.00
Weed free	-	0.71	14.93	6.33	60.33
Weedy check	-	7.33	5.06	107.33	38.89
CD at 5%	-	1.24	1.98	30.81	6.0

*Transformed Data (ÖX+0.5)

Hand weedings were done in soybean crop only.

Weedy check and weed free treatments were maintained in both the crops

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113- Crop-Weed Competition Studies in Black Gram (*Phaseolus mungo*)

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INTRODUCTION

Identification of critical period of weed competition is an important factor in crop production. Weeds are a major problem for successful cultivation in rainy season black gram as their initial growth is relatively slow. Early emerging weed are thus more competitive. The critical period of weed crop competition is between early growth during which weeds can grow without affecting crop yield and the point after which weed growth does not effect yield (Zimdhal 1980). Establishing the critical period of competition is essential to develop effective and economical weed control measures.

Seed yield reduction up to 46.8% has been reported by Randhawa et al. (2002) due to uncontrolled weeds in black gram. The timely control of weeds during critical crop-weed competition period is important for minimizing losses caused by them. Removing weeds throughout the crop season may not be beneficial and economical. Information on the critical period of crop-weed competition was essential to optimize herbicide use or integration of alternative weed control measures such as stage of mechanical weeding. Therefore, an experiment was conducted to determine the critical period of crop weed competition in black gram.

MATERIALS AND METHODS

To find out the critical period of competition between weed and black gram crop, as field experiment was conducted during *kharif* (Rainy) season 2003 and 2004 at S.V.B. Patel University of Agriculture & Technology, Modipuram, Meerut. The soil of the experimental field was sandy loam having 7.2 pH, organic carbon 0.42 %, available N 208 kg/ha, available P 13.5 kg/ha and available K 159.7 kg/ha

Ten treatments comprising weed free for initial 15, 30, 45, 60 days and weedy thereafter and weedy for the first 15, 30, 45, 60 days and weed free thereafter. Including weed free throughout and weedy check were tried in a randomized block design with three replications. Black gram cv PU 19 was sown in row 30 cm apart on 2 and 5 August 2003 and 2004, respectively, using 20 kg seed ha^{-1}. Black gram was inoculated with *Rhizobium* culture. Repeated hand weeding was done in weed free plots to keep the plots weed free for the whole season. Other recommended cultural practices were followed as per requirement of the crop. The data on dry matter accumulation by different weeds were recorded from two quadrats of 1.0 m^2 of each separately from three different places and sun dried for three days and dried in a hot air oven at 70^{o}C to a constant weight, at the time of crop harvest. Observation on growth characters and yield attributing of wheat seed crop were recorded at the time of harvesting.

RESULTS AND DISCUSSION

Effect on weeds

Weed flora of experimental field was dominated with *Trianthema monogyna Echinochloa crusgalli, Parthenium hysterophorus, Digera arvensis, phyllenthus niruri, Cyperus rotundus and cynodon dactylon.* The weed density and dry weight was 204 m^{-2} and 220.2 gm^{-2}. Dry matter accumulation by weeds decreased with an increase in weed free period. The lowest point population of weeds was noticed in the plots which were free from weeds for initial 60 days after sowing followed by the plots which remained weed infested for 45 days after sowing.

Effect on growth and yield of crop

Black gram crop height was severely hampered by the presence of weeds (Table 1). Maximum height (59.7 cm) was observed in weed free up to harvest and minimum (44.2 cm) in weedy up to harvest. Similarly yield attributes viz. branches per plant, number of pods per plant and number of seed per pod were also significantly influenced due to different weed free and weedy periods. Maximum values regarding all above attributes were recorded in plots kept weed free up to harvest (Table 1) due to least crop weed competition for nutrients, moisture, space and sunlight. The minimum values, however, were recorded in the weedy up to harvest. This was because of emergence of large number of weeds under these plots after 15 DAS while weed free period 30 DAS and longer resulted in yield statistically at par with weed free up to harvest. Maximum grain yield (12.42 q/ha) was recorded in weed free up to harvest while minimum grain yield (4.09 q/ha) was noticed in the plots kept weedy up to harvest (Mishra et al. 1997).

When weeds were allowed to remain beyond 30 days then yield was significantly reduced the weed competition during first is 15 DAS had no significant adverse effect on yield and weed free period beyond 30 DAS had no beneficial effect on yield. Thus crop weed competition during 15-30 DAS was critical.

CONCLUSION

Grain yield loss increased with the increase in the duration of competition and maximum loss (67.02%) occurred due to full season competition. Significantly highest grain yield (12.42 q/ha) and yield attributing characters were obtained in the plots remaining weed free up to harvest. The critical period of weed competition was between 30 to 45 days after sowing during which the crop should be kept free of weeds to prevent the potential loss in black gram grain yield.

Table 1 Effect of crop weed competition on yield attributes and yield of black gram (Pooled data two years)

Treatment	*Weed density no. m^{-2} (at harvest)*	*Dry matter of weed g m^{-2} (at harvest)*	*Plant height (cm)*	*Branches plant^{-1}*	*No. of pods plant^{-1}*	*No. of seeds pod^{-1}*	*Yield (q/ha)*			*Loss of yield (%)*
							2003	*2004*	*Mean*	
Weed free up to										
Weed free for the first 15 DAS	137	170.1	48.2	3.7	35	7.1	8.32	8.43	8.37	32.56
Weed free for the first 30 DAS	102	115.2	52.4	4.2	39	8.2	10.22	10.71	10.46	15.74
Weed free for the first 45 DAS	87	48.9	54.6	4.5	40	8.3	10.65	10.81	10.48	15.61
Weed free for the first 60 DAS	65	20.6	56.8	4.9	43	10.1	11.98	11.54	11.76	5.31
Weed free up to harvest	-	0	59.7	5.3	45	10.6	12.65	12.19	12.42	-
Weedy up to										
Weedy for the first 15 DAS	0	0	55.3	4.6	42	7.8	9.32	9.14	9.23	25.68
Weedy for the first 30 DAS	0	0	53.1	4.2	38	7.4	7.30	7.56	7.43	40.17
Weedy for the first 45 DAS	0	0	51.7	3.7	35	7.2	5.99	5.44	5.71	54.02
Weedy for the first 60 DAS	0	0	48.3	3.3	33	7.0	4.66	4.32	4.49	63.84
Weedy up to harvest	204	220.2	44.2	3.0	31	6.2	3.99	4.20	4.09	67.02
CD at 5%	16.8	18.5	4.2	0.5	4.4	2.3	2.51	2.44	-	-

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114- Studies on *Digera arvensis* Interference in Green Gram

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INTRODUCTION

Digera arvensis is among the most common and troublesome weeds of green gram in *Kharif* season. The ability of weed to compete for nutrient, moisture, light and its ability to physically restrict the normal upright growth of a crop. The objective of present study was to determine the effect of various densities of *Digera arvensis* on yield attributes and yield of green gram.

MATERIALS AND METHODS

A field experiment was conducted during the rainy season of 2003 at Anand. The soil at the experimental site was sandy loam in nature with pH 8.19, low in organic carbon (0.473 %), high in phosphorus (71.61 kg/ha) and high in potassium (361.8 kg/ha). Treatments consisted of ten *Digera arvensis* densities viz., 0, 2, 4, 6, 8, 12, 14, 16 and 18/m^2. The experiment was laid out with four replications in randomized block design. Green gram variety GG-1 was sown in rows 25 cm apart on July 2003. *Digera arvensis* seeds were broadcast in the plots before sowing and densities were maintained as per the treatments at 15 days after sowing. All other weeds except *Digera arvensis* were removed from each plot by hand weeding.

RESULTS AND DISCUSSION

Results (Table 1) indicated that yield of greengram was significantly higher in weed free treatment which was at par with 2 & 4 *D. arvensis*/m^2 treatment. Dry weight of *D. arvensis* recorded in greengram at harvest was significantly lowest in weed free treatment. Maximum yield reduction (68.12 %) was recorded in 18 *D. arvensis*/m^2 treatment. Plant height of *D. arvensis* was not significantly affected by various number of *D. arvensis*/m^2 but it was significant at 60 DAS and at harvest. Mishra and Singh (2001) also reported interference of Ivyleaf Morningglory in Soyabean at Jabalpur.

Table1 Effect of *Digera arvensis* on growth and yield of green gram

No. of D. arvensis/m^2	*Height of D. arvensis (cm)* 45 DAS	60 DAS	At harvest	*Seed yield (g/m^2)*	*Dry weight of weeds at harvest (kg/m^2)*	*Yield reduction(%)*
18 *D. arvensis*	62.0	77.0	88.00	29.648	323.0	68.12
16 *D. arvensis*	61.0	75.0	88.00	34.837	296.0	62.54
14 *D. arvensis*	60.0	73.0	86.00	38.102	274.0	59.03
12 *D. arvensis*	62.0	72.0	82.00	42.482	256.0	54.32
10 *D. arvensis*	59.0	70.0	79.00	44.444	244.0	52.21
8 *D. arvensis*	58.0	70.0	76.00	53.502	232.0	42.47
6 *D. arvensis*	58.0	69.0	75.00	70.996	215.0	23.66
4 *D. arvensis*	57.0	69.0	74.00	86.229	188.0	7.28
2 *D. arvensis*	57.0	68.0	75.00	90.135	167.0	3.08
0 *D. arvensis*	00	0.00	0.00	93.003	0.00	-
CD at 5 %	NS	5.88	3.11	6.37	34.65	-

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115- Traditional Allelopathic Knowledge About Common Weed Chirpoti (*Physalis minima*) in Chhattisgarh, India

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INTRODUCTION

Since generations Traditional Allelopathic Knowledge is in practice in Indian State Chhattisgarh (Oudhia, 2005a). This knowledge is practiced by the natives as well as traditional healers. They use different herbal extracts and leachates in order to enrich the specific plants with medicinal properties and to activate the medicinal contents before the harvest. The knowledge about Traditional Allelopathic uses of common weeds is rich in Chhattisgarh. Through this practice the natives and healers utilize these unwanted plants. Chirpoti (Physalis minima) is a common weed throughout Chhattisgarh (Oudhia, 2005b).

MATERIALS AND METHODS

In order to collect the information on Traditional Allelopathic Knowledge about Chirpoti series of Ethnobotanical surveys were conducted in different parts of Chhattisgarh since year 1994. The surveys revealed that the natives and traditional healers use different plant parts of Chirpoti on over 100 species of

Table 1 Traditional Allelopathic uses of *Physalis minima*.

S. No.	*Name of species*	*Physalis plant parts used for extraction*	*Purpose of use*
1	*Ficus benghalensis*	Whole plant	Growth enhancer
2	*Ficus religiosa*	Whole plant	Protection from fungal infection
3	*Ficus glomerata*	Whole plant	Growth enhancer
4	*Bauhinia variegata*	Whole plant	Increases the Medicinal properties of leaves
5	*Melia azedarach*	Whole plant	Growth enhancer
6	*Azadirachta indica*	Whole plant	Increases the Medicinal properties of bark
7	*Tectona grandis*	Whole plant	Increases the Medicinal properties of flowers
8	*Shorea robusta*	Whole plant	Increases the Medicinal properties of leaves
9	*Putranjiva roxburghii*	Whole plant	Protection from fungal infection
10	*Buchanania lanzan*	Whole plant	Gives New Vigour
11	*Butea monosperma*	Whole plant	Increases the Medicinal properties of roots
12	*Pterocarpus marsupium*	Whole plant	Increases the Medicinal properties of leaves
13	*Alstonia scholaris*	Whole plant	Growth enhancer
14	*Moringa oleifera*	Whole plant	Growth enhancer
15	*Terminalia alata*	Whole plant	Growth enhancer
16	*Terminalia arjuna*	Whole plant	Growth enhancer
17	*Cassia fistula*	Whole plant	Growth enhancer
18	*Stereospermum personatum*	Whole plant	Increases the Medicinal properties of roots
19	*Dalbergia sissoo*	Whole plant	Growth enhancer
20	*Albizia lebbeck*	Whole plant	Protection from fungal infection
21	*Helicteres isora*	Whole plant	Growth enhancer
22	*Diospyros melanoxylon*	Whole plant	Increases the Medicinal properties of bark
23	*Anthocephalus cadamba*	Whole plant	Gives protection against insects
24	*Gmelina arborea*	Whole plant	Increases the Medicinal properties of roots
25	*Abrus precatorius*	Whole plant	Enhances germination
26	*Smilax sp.*	Whole plant	Increases the Medicinal properties of leaves

plants including medicinal trees and shrubs. In majority of the areas the use of extracts is preferred. Besides, enriching the plants they also use it as insect repellent, as growth promoter and in case of injuries. Chirpoti extracts are used both alone and in combination with other herbal extracts. In present paper, the Traditional Allelopathic Knowledge about Chirpoti on 100 important species of common plants has been discussed.

RESULTS AND DISCUSSION

These species are Bar (*Ficus benghalensis*), Doomar (*Ficus glomerata*), Munga (*Moringa oleifera*), Beeja (*Pterocarpus marsupium*), Hingot (*Balanites aegyptiaca*), Nirgundi (*Vitex negundo*), Arusa (*Adhatoda vasica*), Safed Musli (*Chlorophytum* sp.), Dhilcuar (*Aloe vera*), Gulbakawali (*Hedychium coronarium*) etc.

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116- Assessment of Weed Seed Bank in Soil Layers of Lowland and Irrigated Upland Condition

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INTRODUCTION

Weeds are self-grown which appear simultaneously with crop plant and result in intense crop weed competition and cause reduction in grain yield. Reduction in yield may vary from 27-71% depending upon type and intensity of weeds and their times of occurrence. The seed bank is the source of weeds that persist in agricultural fields. Composition of weed flora depends on seed bank composition and its dynamics. Species, which have the capacity to accumulate large number of buried seeds, are extremely difficult to eradicate. The composition and density of weed seed in the soil vary greatly but are closely linked to the cropping history of the land. Changes in the seed bank are influenced by cultivation and herbicide use. Hence a study on weed seed buildup, its dormancy and germinability under different agro ecosystems (low land and irrigated upland conditions) was made so as to predict the population of weed species in subsequent crops.

MATERIALS AND METHODS

Soil samples from 0-15 cm and 15-30 cm depths were collected from different locations of low land and irrigated upland conditions immediately after the harvest of the crops. After through mixing, sub-sampling was done and the soil samples were spread over shallow trays for germination of different weed seeds and observations were recorded on number of weed seeds and species wise emerged weeds. After the observations, all the weed seedlings were uprooted and the soil was treated with GA_3 (100 ppm) to induce the germination of dormant weed seeds and observations were recorded on number of seeds germinated after the treatment.

RESULTS AND DISCUSSION

Under lowland and irrigated upland conditions, significant differences were observed for both total weed seed density and species wise seed density in each soil layer and percent weed seed distribution among the layers. Under lowland with predominantly clay soil condition, grassy weeds dominated the seed bank composition with 61.0 and 15.70 seeds out of total weed seeds 91.55nd 29.54 in 0 - 15 and 15 - 30 cm soil layers respectively. Sedges contributed only 10.13 and 3.14 seeds in 2.5 kg of soil in the two layers respectively (Table 1). But, under irrigated upland with vertisol condition, broad leaved weeds accounted the major portion of seed bank with 33.97 and 14.24 seeds out of total weed seeds 71.75 and 32.14 in 2.5 kg soil taken from 0 - 15 and 15 - 30 cm depths respectively. Similar results were also reported by Buhler (1995) in weed dynamics and management in corn and soybean. Here also sedges stood third position (13.28 & 6.24 seeds) next to grassy weeds (24.48 & 11.66 seeds) in contributing to the composition of seed bank in both the layers respectively.

There is a significant difference between the two layers of soil in total weed seed density and percentage of weed seed distribution in both lowland and upland condition. In all sampling locations, the shallow layer (0- 15 cm) contributed maximum share to the seed bank composition with 91.55 seeds / 2.5 kg of soil or 3.66 seeds / 100 g of soil in clayey lowland and 71.75 seeds / 2.5 kg of soil or 2.87 seeds / 100 g of soil in upland vertisol condition. The percent weed seed distribution between layers was 75.60 in 0 - 15 cm depth and 24.40 in 15 - 30 cm depth in lowland condition. In upland condition it was 69.10 and 30.90 in 0 -15 and 15 - 30 cm depth respectively (Fig. 1). In both low land and irrigated upland conditions, irrespective of soil types upper layer (0-15 cm) recorded more dormant weed seeds (21.76 & 17.44 seeds / 2.5 kg soil) compared to lower layer (15-30 cm) (7.06 & 10.81 seeds/2.5 kg soil).

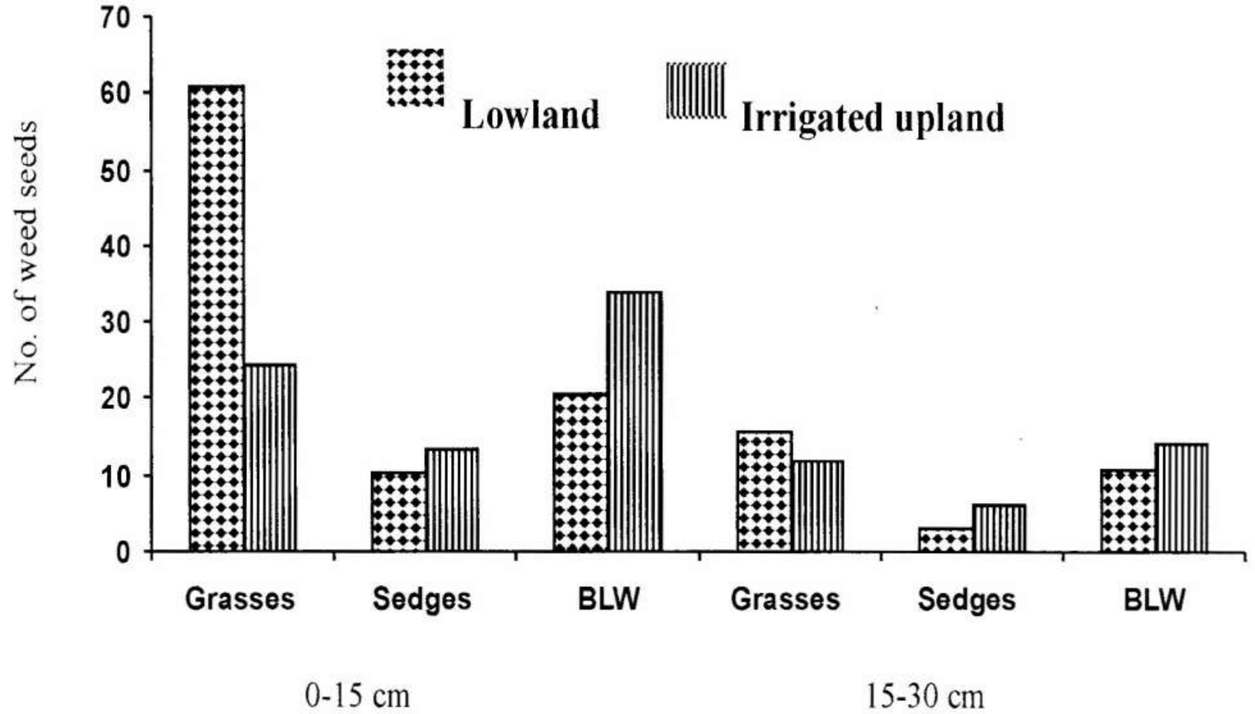

Fig 1. Species wise weed seed density in two different layers of soil under lowland and irrigated upland condition

Table 1 Species wise weed seed density in two different layers of soil under lowland and irrigated upland conditions.

Blocks/ Locations	*Species wise number of weed seeds / 2.5 kg soil*								*No.of seed/100g soil*	
	Soil layers									
	0 - 15 cm				*15 - 30 cm*				*0-15 cm*	*15-30 cm*
	Grasses	*Sedges*	*BLW*	*Total**	*Grasses*	*Sedges*	*BLW*	*Total*		
Lowland - Clay soil										
A	67.7 (14.2)	4.8 (2.5)	21.2 (11.3)	121.70	13.2 (5.1)	3.1(-)	5.4 (2.3)	29.12	4.87	1.16
B	43.6 (12.1)	9.4 (2.4)	18.2 (5.4)	91.10	15.4 (6.1)	3.5 (1.4)	4.2 (1.7)	32.26	3.64	1.29
C	54.6 (17.0)	10.3 (-)	7.4 (7.2)	96.50	16.2 (4.6)	3.4 (-)	6.3 (2.1)	32.60	3.86	1.30
D	62.7 (18.9)	7.2 (4.3)	11.5 (6.8)	88.20	19.3 (2.7)	1.0 (-)	9.4 (4.3)	36.70	3.52	1.47
E	27.3 (11.6)	8.9 (2.0)	11.9 (4.3)	66.00	8.7 (3.2)	1.0 (-)	8.6 (2.4)	23.90	2.64	0.96
L	28.1(7.3)	4.2 (6.3)	14.2 (-)	60.10	6.4 (1.6)	2.3 (1.1)	8.2 (2.1)	21.60	2.40	0.86
O	48.2 (13.7)	3.4 (5.2)	23.6 (-)	94.10	5.2 (2.2)	4.2 (1.2)	12.3 (5.2)	30.40	3.76	1.22
Mean	61.0	10.13	20.42	91.55	15.7	3.14	10.64	29.54	3.66	1.18
Irrigated Upland - Vertisol										
37 A	12.3 (5.8)	14.2 (2.0)	29.30 (10.1)	73.70	6.5 (4.3)	4.1 (1.1)	10.4 (4.1)	30.50	2.95	1.22
37 B	22.7 (10.2)	12.8 (2.0)	33.4 (11.4)	92.50	11.4 (6.3)	4.4 (1.3)	12.5 (9.8)	45.70	3.70	1.83
37 C	14.2 (6.6)	16.8 (3.8)	31.4 (11.8)	84.50	5.5 (5.1)	4.9 (2.5)	8.9 (3.7)	30.60	3.38	1.22
37 D	18.4 (3.0)	4.2 (2.1)	37.0 (8.7)	73.40	7.2 (3.1)	6.2 (3.5)	10.3 (4.1)	34.40	2.94	1.38
37 F	11.7 (3.2)	8.6 (1.2)	20.2 (7.0)	51.90	5.0 (3.2)	2.0 (3.1)	8.0 (2.9)	24.20	2.10	0.97
36 A	22.5 (6.2)	3.7 (2.3)	17.1 (3.7)	55.50	8.4 (4.9)	2.1 (2.0)	11.1 (3.4)	31.90	2.22	1.28
36 C	29.2 (5.1)	18.3 (4.4)	9.4 (7.3)	73.40	7.8 (4.2)	5.3 (2.8)	11.2 (2.2)	33.50	2.94	1.34
36 F	16.7 (8.1)	6.8 (3.1)	23.6 (10.4)	68.70	6.3 (4.1)	3.8 (0.8)	7.3 (4.0)	25.80	2.75	1.03
Mean	24.48	13.28	33.97	71.75	11.66	6.24	14.24	32.14	2.87	1.26

Figures in the parentheses indicating the number of dormant weed seeds germinated by GA_3 treatment

REFERENCE

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117- Seed Production Potential of Predominant Weed Species in Lowland and Irrigated Upland Ecosystems

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INTRODUCTION

Seed production potential of predominant weed populations needs to be taken into account when estimating the long-term impact of any crop management practices. Prediction of weed seed production under field conditions is essential to the successful adoption of crop management practices, which will give the idea about subsequent weed infestations ensuing from a well-stocked seed bank. With this view, the present study on the seed production potential of predominant weed species of lowland and upland ecosystems was made with the objectives to estimate the seed production potential of predominant weeds in lowland and irrigated upland conditions and to asses seed dormancy and viability of predominant weeds under lowland and irrigated upland conditions.

MATERIALS AND METHODS

Predominant weed species under low land (*Echinochloa crus galli, Echinochloa colonum, Ammania baccifera, Eclipta alba, Cyperus iria & Cyperus difformis*) and irrigated upland (*Trianthema portulacastrum, Amaranthus viridis, Panicum repens, Parthenium hysterophorus, Digera arvensis, Dactyloptinium ageyptium & Flavaria australacicum*) conditions were selected for this study. Twenty-five plants in each weed species were selected randomly from the cropped fields of low land and irrigated upland condition and tagged. At maturity, they were carefully harvested and dried. The number of fruits or panicles per plant was counted and 25 fruits or panicles were selected for estimating number of seeds per fruit or panicle. The number of seeds produced per plant and weed seed rain was calculated based on the no. of fruits and seeds per fruit and number of plants per square meter. Matured seeds of all the weeds were collected, dried and stored in plastic containers. After 15 and 30 days of harvest the seeds were sown in plastic pots. Germination count was taken after 2 weeks of sowing and percentage of germination was worked out.

RESULTS AND DISCUSSION

Seed production potential of major weeds in lowland condition

Echinochloa crus-galli was the dominant weed species in low land ecosystem predominantly with clay loam soils. Among the four weed species selected for weed seed rain study, *Echinochloa colona* was the next predominant weed in grasses, *Ammania baccifera* in BLW and *Cyperus difformis* in sedges. Among grassy weeds, higher seed production potential was observed with *Echinochloa colona* (2,756 seeds / plant). But, *Echinochloa crus-galli* contributed for higher weed seed rain of 69,283.2 seeds / m^2 due its higher density (Table1). Among the two predominant broad leaved weeds *Ammania baccifera* had higher seed production potential as well as weed seed rain recording 4,780 seeds / plant and 60,228 seeds/m^2.

Grassy weeds recorded higher 1000 seed weight compared to broad-leaved weeds and sedges. The 1000 weed weight of *Echinochloa crus-galli* and *Echinochloa colona* was 1.63 and 1.43 g respectively and for broad leaved weeds, *Eclipta alba* and *Ammania baccifera*, it was 0.61 and 0.07 g respectively due to their tiny nature. The germination potential of these weeds was studied on 15 and 30 days after harvest (DAH). All the weed species recorded higher germination percentage when they were sown after 30 days of harvest compared to 15 DAH (Table 1).

Seed production potential of major weeds under irrigated upland condition

In upland irrigated condition with red sandy loam soils, *Trianthema portulacastrnium* was the dominant weed closely followed by *Parthenium hysterophorus*. However, the seed production potential was higher with *Parthenium hysterophorus* registering 9,872 seeds/plant compared to *Trianthema portulacastrum* with 4,752 seeds/plant (Table 1). In case of 1000 seed weight, *Trianthema portulacastrum* seeds were heavier (1.68 g/1000 seeds) due to their hard seed coat compared to other weed seeds. *Digera arvensis* stood next to *Trianthema portulacastrum* with 1.29 g for 1000 seed (Table 1). Significant difference was observed in germination potentiality between weed species. Among the weed species selected for this study, *Parthenium hysterophorus* recorded the highest germination percentage (72.0& 86.2 %) both at 15 and 30 DAH, respectively followed by *Trianthema portulacastrum* (66.8 and 82.1 %) (Table 1).

Table 1 Seed production potential of predominant weed species in lowland and upland ecosystem

S. No.	Predominant weeds	No. of weeds / m^2	No. of seeds / plant*	Weed seed rain /m^2	1000 Seed** wt (g)	Germination** % 15 DAH	Germination** % 30 DAH
Lowland ecosystem							
1.	*Echinocloa crusgalli*	33.6	2062(274-2842)	69283	1.62	27.04	56.02
2.	*Echinocloa colona*	22.8	2756(480-3852)	62836	1.43	31.72	52.33
3.	*Eclipta alba*	12.0	772(104-1060)	9264	0.61	57.40	77.24
4.	*Ammania baccifera*	14.6	4780(1230-390)	60228	0.07	52.66	64.15
5.	*Cyperus difformis*	12.6	3008(2368-10,808)	37900	0.03	28.71	37.36
6.	*Cyperus iria*	11.7	6718(2084 -17,628)	78600	0.03	30.10	49.50
Upland ecosystem							
1.	*Trianthema portulacastrum*	30.4	4752(943-7922)	144460	1.68	66.80	82.12
2.	*Amaranthus viridis*	13.0	4468(786-8123)	71084	0.44	46.40	74.13
3.	*Panicum repens*	7.2	4301(1823-7812)	30967	0.31	31.20	48.54
4.	*Parthenium hysterophorus*	25.3	9872(1560-12284)	249761	0.62	72.00	86.25
5.	*Digera arvensis*	14.2	2128(1540-4280)	30217	1.29	51.00	69.46
6.	*Dactyloptenium aegyptium*	14.1	4978(2750-8204)	70189	0.38	27.60	47.17
7.	*Flavaria australacicum*	7.3	2232(732-3477)	16293	0.57	38.43	67.59

*mean of 25 plants; ** non replicated; Figures in parentheses are range of no. of seeds /plant; DAH- Days after harvest

REFERENCE

Annual Report, 2004. All India Co ordinated research project on weed control, Tamil Nadu Agricultural University, Coimbatore. pp. 67-69.

118- Quantification of Biological Characteristics of *Striga asiatica* (L.) Kuntze Infesting Early Planted Sugarcane in Alfisols

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INTRODUCTION

Major challenges involved in the cultivation of sugarcane to achieve better productivity are nutrient, water and weed management practices. Weed infestation is one of the most dominant constraints in sugarcane production. Sugarcane being a widely planted, long duration crop with slow initial growth habit, the weed problem is more acute at its early growth stages. Nowadays *Striga* becomes a notorious weed in sugarcane fields in Western Zone of Tamil Nadu. Since the farmers in these areas have highly acclimatised to sugarcane cultivation due to its high remuneration, they are not in a position to give up sugarcane. So continuous monocropping has been practiced, which leads to buildup of *Striga* population in the cane fields. Detailed study on the biology of striga could pave ways for planning effective weed management strategies. Hence an experiment was conducted with an objective to quantify the biological characteristics of *Striga asiatica* under red sandy loam soils in sugarcane.

MATERIALS AND METHODS

For quantifying the biological characteristics of *S. asiatica*, the pot culture experiment was conducted by collecting soil samples from ten locations in North Western Zone of Tamil Nadu where striga infestation was severe and cane setts were planted to stimulate the germination of *S. asiatica* seeds and biological characteristics like days for emergence and flowering, biomass partitioning and seed production potential were quantified.

RESULTS AND DISCUSSION

Studies on biological characteristics revealed that the *Striga asiatica* seeds took on an average of 49 days for emergence after cane planting with an average dry weight of 1.509 g/plant. *S. asiatica* at 15 days after emergence attained the maximum and minimum fresh weight of 3.23g/plant and 2.33g/plant respectively with the average of 2.58g/plant. The dry weight of *S. asiatica* recorded was a maximum of 0.695g and minimum of 0.530g with an average of 0.587 g/plant. The tiller production varied from 4 to 6 tillers with an average of 4.6 tillers per plant. However, the branching capacity did not show high variations among the plants. It varied from 3 to 4 branches per plant with an average of 3.2 branches. The biomass recorded at 30days after emergence of *S. asiatica* registered the maximum and minimum shoot dry weight of 1.450g and 0.990g respectively, whereas the root dry weight reached a maximum of 0.185g with minimum dry weight of 0.135g. However, the total biomass registered maximum of 1.675g and minimum of 1.135g with an average root and shoot dry weight of 89.53 and 10.47 per cent, respectively to the total biomass of *S. asiatica* recorded at 30 days after emergence. Similar observations were also reported by Ramaiah *et al* (1991).

The flower initiation period of *S. asiatica* varied from 26 to 32 days after emergence. The reproduction capacity of *S. asiatica* is enormous with the production of maximum 320 capsules and minimum of 285 capsules with an average of 306 capsules per plant. The average dry weight of capsules per plant was 0.304 g/plant with maximum and minimum of 0.310g and 0.290 g/plant respectively. Each capsules having thousands of seeds which expressed the seed production potentiality of *S. asiatica* .

Table 1 Biological characteristics of *Striga asiatica* in sugarcane grown under red sandy loam soils

Location	*Emergence (DACP)*	*Seedling weight (g/pl) at 15 DAE*		*Tillers/ clumb*	*Branches/ plant*	*Biomass (g/pl) at 30 DAE*			*Initiation of flowering (DAE)*	*Capsules/plant*	
		Fresh	*Dry*			*Shoot*	*Root*	*Total*		*No.*	*Weight (g)*
1	48	2.336	0.560	5	3	1.505	0.170	1.675	28	285	0.290
2	52	2.409	0.587	5	3	1.561	0.185	1.746	26	320	0.310
3	42	2.330	0.551	4	3	1.260	0.155	1.415	30	310	0.305
4	42	3.026	0.640	6	4	1.450	0.175	1.625	31	315	0.310
5	45	3.190	0.678	5	3	1.428	0.165	1.593	28	295	0.298
6	52	2.400	0.532	4	3	1.185	0.135	1.320	28	305	0.300
7	55	2.338	0.530	4	3	1.371	0.140	1.511	26	290	0.290
8	48	3.230	0.695	5	3	1.480	0.155	1.635	30	320	0.315
9	50	2.340	0.540	4	3	0.990	0.145	1.135	32	315	0.305
10	55	2.242	0.558	4	3	1.280	0.158	1.438	29	305	0.310
Mean	49	2.584	0.587	4.6	3.2	1.351	0.158	1.509	28.8	306	0.304

DACP-Days after cane planting; DAE-Days after emergence; Data not statistically analyzed

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119- Weed Flora in Wheat as Influenced by Integrated Fertilizer Management

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INTRODUCTION

Several studies (Banga and Yadav, 2004; Yadav *et. al.*, 2004) have been made regarding weed and crop association in pearl millet and wheat but very little work has been done in relation to weed development in pearl millet – wheat cropping system as influenced by integrated fertilizer management. The present study has been undertaken to study the weed flora in pearl millet – wheat cropping system as influenced by differential fertilizer management.

MATERIALS AND METHODS

Field experiment was conducted at the Research Farm of CCS Haryana Agricultural University, Hisar, India from 1985-86 to 2004-05. The soil of the experimental site was a sandy loam of medium fertility and slightly alkaline (pH 7.9). Agronomic operations and plant protection measures followed local recommendations. The experiment was laid out in a randomized block design with four replications. The experiment consisted of 12 treatments as listed in Table 1. The weed intensity was recorded using 50 cm x 50 cm quadrets placed at three randomly selected spots in each plot 32 days after wheat sowing in 2004-05.

Table 1 Pearl millet – wheat cropping system

Treatment	*Kharif*	*Rabi*
T_1	Control	Control (no fertilizer)
T_2	50 % Recommended NPK dose through fertilizers	50 % Recommended NPK dose through fertilizers
T_3	50 % Recommended NPK dose through fertilizers	100 % Recommended NPK dose through fertilizers
T_4	75 % Recommended NPK dose through fertilizers	75 % Recommended NPK dose through fertilizers
T_5	100 % Recommended NPK dose through fertilizers	100 % Recommended NPK dose through fertilizers
T_6	50 % Recommended NPK dose through fertilizers + 50 % N through FYM	100 % Recommended NPK dose through fertilizers
T_7	75 % Recommended NPK dose through fertilizers + 25 % N through FYM	75 % Recommended NPK dose through fertilizers
T_8	50 % Recommended NPK dose through fertilizers + 50 % N through WS	100 % Recommended NPK dose through fertilizers
T_9	75 % Recommended NPK dose through fertilizers + 25 % N through WS	75 % Recommended NPK dose through fertilizers
T_{10}	50 % Recommended NPK dose through fertilizers + 50 % N through GM	100 % Recommended NPK dose through fertilizers
T_{11}	75 % Recommended NPK dose through fertilizers + 25 % N through GM	75 % Recommended NPK dose through fertilizers
T_{12}	Farmers' Practice	Farmers' Practice

FYM: Farm yard manure; WS: Wheat straw; GM: Green manure

RESULTS AND DISCUSSION

The weed flora of the experimental field consisted of *Phalaris minor*, *Avena ludoviciana* and broad leaf weeds viz. *Chenopodium album*, *Melilotus indica*, *Convolvulus arvensis*, *Lathyrus aphaca*, *Anagallis arvensis* and *Vicia sativa*.

Treatment effects on weeds

The experimental field was infested with both grassy and broad leaf weeds (Table 2). The intensity of both *Phalaris* m^{-2} among different treatments varied between 13 and 21 and the similar values for *avena* were 13.5 and 22.5. The *phalaris* and *avena* intensity was not influenced significantly due to different treatments. Total grassy weeds in different treatments ranged between 29.5 and 42. The number of broad leaf weeds except *Anagallis arvensis* was not influenced significantly by various fertility treatments. *Anagallis* count was higher where no fertilizer was applied or low dose of fertilizer was applied.

Table 2 Weed dynamics in wheat as influenced by integrated nutrient management

Treatment	*Weed density (Number* m^{-2}*)*										
	P. minor	*Avena ludoviciana*	*Total grassy weeds*	*C. album*	*M. indica*	*C. arvensis*	*L. aphaca*	*Anagallis arvensis*	*Medicago denticulata*	*Vicia sativa*	*Total*
T_1	3.8 (14)	4.2 (17)	31	1.3 (1)	2.1 (6)	4.4 (18.5)	10.2 (104)	7.7 (59)	1.5 (27)	6.3 (52)	291
T_2	4.1 (17.5)	3.8 (13.5)	31	2.1 (4)	1.4 (1)	4.4 (19.5)	4.5 (21)	8.9 (81)	0.4 (2)	2.8 (9)	159
T_3	4.5 (21)	4.6 (21)	42	1.8 (3)	1.5 (1.5)	4.2 (17)	3.9 (15)	6.0 (35)	0.5 (2)	2.8 (7.5)	109
T_4	4.0 (15.5)	4.7 (21)	36.5	1.5 (1.5)	1.0 (0)	4.3 (19)	3.0 (9.5)	6.9 (48)	0.6 (4)	2.5(6.5)	114
T_5	4.3 (18)	3.8 (13.5)	31.5	1.5 (1.5)	1.2 (0.5)	3.1 (10)	5.1 (25)	6.4 (40)	0.5 (3.5)	2.1(5)	106
T_6	3.4 (12)	4.5 (19.5)	32	1.8 (3)	1.3 (1)	3.7 (13)	3.5 (12.5)	5.9 (35)	0.4 (2.5)	2.4(6)	94
T_7	4.1 (17)	4.4 (18.5)	35.5	1.9 (3)	1.4 (1)	3.4 (12.5)	4.1 (16.5)	6.0 (37)	0.4 (1.5)	1.8 (4)	97
T_8	4.3 (18)	3.9 (14.5)	32.5	2.7 (7.2)	1.0 (0)	3.8 (13.7)	2.3 (9.5)	5.6 (31)	0.5 (4)	2.6 (8.5)	97
T_9	4.5 (19)	4.1 (17)	36	2.6 (6.5)	1.7 (2.5)	3.5 (12.5)	2.9 (8.5)	7.1 (51)	0.5 (4)	1.9 (3)	109
T_{10}	3.8 (14)	4.0 (15.5)	29.5	2.7 (7.5)	1.5 (1.5)	3.6 (12.5)	3.4 (13.5)	5.5 (33)	0.8 (6)	2.7 (15)	103
T_{11}	3.8 (14)	4.7 (22.5)	36.5	1.3 (1)	1.0 (0)	3.9 (15.5)	3.9 (16)	5.6 (31)	0.5 (2.5)	2.7 (8.5)	98
T_{12}	3.7 (13)	4.2 (17.5)	30.5	2.3 (4.8)	1.3 (1)	4.1 (16.5)	3.7 (14.5)	6.4 (40)	0.4 (1.5)	3.1 (12)	106
CD at 5%	NS	NS		NS	NS	NS	1.73	1.82	NS	NS	

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120- Effect of Surfactants on Droplet Behaviour in Different Weed Species

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INTRODUCTION

Most of the foliar applied agrochemicals remain on the leaves as a residue. Pests that came in contact with pesticide residue get killed. However, the herbicide has to gain entry and translocated to reach the targeted site of action for herbicide effect. Lack of entry and translocation needs higher amount of herbicide application. Higher dosage and repeated application lead to residue on foliage which causes environmental pollution.

The hydraulic nozzle produces a spectrum of varied diameter of drops. The ideal spectrum of drops is one which maximizes spray efficiency for deposition, transfer of lethal dose into cuticle and minimizes target loss by drift or dip (Elliot and Wilson, 1983). The surfactants aid in wetting, spreading and sticking of spray solutions to the leaf surface has been noticed due to reduced surface tension of spray solution (Devendra *et al.*, 2004). Surfactants are known to enhance biological activity of herbicides by increasing herbicide penetration, improving spray application and retention (Jordan *et al.*, 1989). In the present study, attempts were made to examine the effect of surfactant on droplet behaviour in different weed species.

MATERIALS AND METHODS

Weed leaf was fixed to glass slide using double sided sticker. 5ml of drop with and without surfactant (Triton X 200) was carefully placed on the upper surface of foliage of different weed species and two diameters were taken *viz.*, north - south and east – west. Drop diameter was measured using ocular micrometer of the microscope which was calibrated using the stage micrometer by standard procedure. The eq. 1 was used to measure diameter. The average of the two gives the effective diameter of the drop spread.

Dia. of the drop (mm) = No. of divisions on the ocular micrometer X 0.057 ......(1)

To classify the different hydraulic nozzle using operating pressure (20 strokes), Zeneca AN 0.6 and 2.4 nozzle was attached to Knapsack sprayer ASPEE Lance and sprayed to different weed leaf fixed to slide. Frequency of drops having same diameter was counted by placing under microscope and arrived at cumulative percent number of droplet and which was regressed with drop diameter (mm). For spraying water with or without Triton X 200 (TX 200) was used.

For quantifying the volume of drop needed to cause run off, the leaf surface was tilted by 25° and drop was placed. Initially known volume of water with or without TX 200 was added to existing drop till the drop runoff from the fed spot. Later the known volume of spray solution which causes runoff was applied to leaf surface at once and checked for runoff. This was repeated five times.

RESULTS AND DISCUSSION

Spread of the drop varied significantly among the foliage of different weed species as reflected by the increase in drop diameter (Table 1) as well as reduced height of the drop. Based on the spread, *Digitaria marginata, Oxalis latifolia* and *Dactyloctaneum aeygyptium,* foliage can be grouped as 'difficult to wet type' as drop diameter was significantly less than easy to wet type weed species *viz., Parthenium hysterophorus, Legasca mollis* and *C. odorata.* Difficult to wet type weed species had higher drop height and lesser drop spread, thus need lower volume of water per drop to cause runoff from leaf surface, compared to easy to wet type of weed species.

The percent of increased spread of the drop and percent reduction in volume of spray solution needed to cause runoff from fed spot due to addition of TX 200 over water alone was computed (Table 1). The percent enhancement of spread and reduction in volume needed to cause runoff was relatively more in difficult to wet species than easy to wet species. For instance, the per cent increased drop spread due to TX 200 ranged 35-67 in difficult to wet species whereas it was 9-53 in easy to wet type. Similarly to percent maximum volume of spray solution to cause run off was reduced by 44-53% and 31-53 for difficult to wet and easy to wet type respectively. As per the calculation the volume requirement of spray solution reduced by 44 % due to addition of TX 200 to spray solution per hectare.

Cumulative frequency of drop diameter was regressed with drop diameter and compared with British Crop Protection Council (BCPC) classification of nozzle type. According to BCPC, nozzle which produce drop size spectrum of 50 -150 m very fine, 50-400m fine, 70-600m medium, 150-800m coarse and 200-900m and above very coarse nozzle type. These were the range of drop diameter produced amongst cumulative % volume. Zeneca nozzles 0.6 and 2.4 with and without Triton X produced range of drop diameter on the different weed foliage. The data showed that drop diameter deposited on all the foliage were greater than very coarse nozzle type which ranged between 250 to 3500 m.

This distribution pattern of droplets as observed in *Parthenium hysterophorus* showed that the cumulative per cent frequency of drops to drop diameter curve ranged 250-1500m for water + TX 200 and 300-2000m for water alone spraying with Zeneca AN 0.6 narrow orifice nozzle. Whereas for Zeneca AN 2.4 the ranges were 300-2500m and 350 – 3500m for water with TX 200 and water alone respectively.

Table 1 Effect of surfactant TX200 on drop spread and maximum volume for runoff on foliage of different weed species.

Species	*Drop diameter*			*Maximum volume for runoff*		
	Water	*Water + TX200*	*%enhanced spread due to TX200*	*Water*	*Water + TX200*	*%reduction in volume due to TX200*
Digitaria marginata	2.48	3.35	35.08	122	68	44.26
Oxalis latifolia	2.27	3.80	67.40	144	76	47.22
Dactyloctaneum aeygyptium	2.56	3.69	44.14	153	72	52.94
Cyperus rotundus	3.23	3.53	9.28	117	81	30.76
Parthenium hysterophorus	3.19	3.83	20.06	177	108	38.98
Legasca mollis	2.81	4.03	43.41	180	102	43.33
Chromolaena odorata	2.93	4.50	53.58	221	103	53.39

This data suggests that in both nozzle types addition of TX 200 produced fine drops in more frequency than water alone and the minimum and maximum drop diameter was lower with TX 200. This type of regression line was observed for all weed foliage. Thus both nozzle types can be classified as coarse type according to BCPC.

Maximum deposition occurs in fine drop than coarse drop. Coarse drop (500m) though has 1000 times more concentration and low drop residue on cuticle (38%) than fine drop (50m) (47%), coarse drop were more prone to drift off from targeted foliage than fine drop. Thus herbicide loss due to coarse drop is more than fine drop. Use fine drop producing sprayer get maximum weed control with less chemical pollution to environment.

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121- Crop-Weed Competition Studies in Sesame (*Sesamum indicum* L.)

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INTRODUCTION

In general weeds are more serious in kharif season as compared to rabi & summer seasons. The slow initial growth of sesame, a short duration kharif season oilseed crop, makes it poor competitor with many quick growing tropical weeds. The extent of losses due to weeds depends on intensity of infestation, time of occurrence and type of weeds. Knowledge of critical crop weed competition period which results in the highest yield reduction helps to keep the weeds under control. Thus nullifying the effect of other factors mentioned above. Therefore, studies were conducted at the Regional Research Station, Gurdaspur on a medium textured soil to find out the period of crop weed competition.

MATERIALS AND METHODS

Experiment with 10 weed free periods of variable duration was sown on 4th July in Randomized Block Design. A plot size of 15 square meter was kept and experiment had four replications. All other recommended agronomic practices were followed. Weed free periods were as under:

RESULTS AND DISCUSSION

Results of the study (Table1) indicate that highest seed yield of 583 kg/ha was obtained by maintaining weed free conditions throughout the crop season. Whereas, seed yield realized in control treatment was the least (149 kg/ha) and significantly lower than all treatments except the treatments where crop was kept weedy for 45 days or beyond. Keeping the crop free from weeds up to 45 days or 60 days after sowing or weed free after 15 days of sowing showed no harmful effect by weeds as seed yield under these treatments was found to be at par with weed free crop. However, all the remaining treatments were significantly inferior to weed free with respect to production of seed yield. Rathore (2002) reported that yield loss in sesamum due to weeds ranges from 49 to 70% and critical weed free period is from 15 to 30 days after sowing. However Reddy & Reddi (1992) opinioned that the length of critical period of crop-weed competition depends on variety and growing conditions besides other factors.

Table 1 Effect of duration of weed competition periods on sesame

Treatment	*Height at maturity(cm)*	*Branches / plant (No.)*	*Capsules / plant (No.)*	*Seed yield (kg/ha)*	*Seed yield % of weed free*
Control (weedy check)	100	3.3	22.9	149	25.5
Weed free upto 15 days & weedy thereafter	107	4.07	37.5	312	53.5
Weed free upto 30 days & weedy thereafter	111	4.47	46.8	496	85.1
Weed free upto 45 days & weedy thereafter	115	4.53	47.9	516	88.5
Weed free upto 60 days & weedy thereafter	129	5.13	55.6	531	91.1
Weedy upto 15 days & weed free thereafter	123	4.93	54.9	529	90.7
Weedy upto 30 days & weed free thereafter	117	4.47	43.5	428	73.4
Weedy upto 45 days & weed free thereafter	111	3.67	32.5	180	30.9
Weedy upto 60 days & weed free thereafter	105	3.27	28.1	142	24.4
Weed free throughout	131	5.73	60.0	583	100
CD at 5%	18.7	0.78	6.9	77.5	

CONCLUSION

It can be concluded on the basis of these results that a period of 15 to 45 days after sowing is critical for crop –weed competition in sesame.

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122- Effect of Ammonium Salt of Glyphosate (XL-71AG) for Weed Control in Non-crop Areas

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INTRODUCTION

Due to less human interference weed grows luxuriantly in fallow and wastelands and often encroaches crop field in due course of time. These weeds also harbor many insects and pathogens causing pest attack on crops and ultimately cause economic loss to valuable crop sown in adjacent areas. Weed prevention is, thus, one of the important methods of weed management in today's plant protection. Besides tillage, herbicide is another option for weed management in such problematic situation (Ghosh *et al* 2001).

MATERIALS AND METHODS

Field experiment was design to study the bio-efficacy of ammonium salt of glyphosate XL 71 AG for weed control in non-crop areas on 2003-04 in Kalyani Municipal area of West Bengal. The soil was Inceptisol, sandy clay loam in texture with a pH of 6.9. The total nitrogen was 0.068%, available phosphorus 43 kg ha^{-1} and available potassium was 170 kg ha^{-1}. The experiment consists of eight treatments replicated thrice in a randomized design. Among the treatments, formulation containing 71% ammonium salt of glyphosate (XL71AG) was applied with five different doses viz 3g, 5g, 6g, 9g, 12g per litre of water respectively and glyphosate 41% SL was applied at two different doses of 7.5 ml and 10 ml per litre of water.

RESULTS AND DISCUSSION

The initial weed flora of the experiment field was dominated by *Imperata cylindrica, Oplismenus compositus, Elusine indica* among grasses; *Cyperus arometicus* and *Cyperus rotundus* among sedges and *Parthenium hysterophorus, Cassia tora, Argemone mexicana, Heliotropicum indicum, Sida carpinifolia* and *Colocasia esculenta* among broad leaf weeds. The result revealed that XL 71 AG applied 5, 6, 9 or 12 g /l recorded absolute control of weeds with 30 days after spraying and the resurgence of weeds did not start even after 60 DAS. These treatments recorded slightly higher effective control over glyphosate 41% SL @ 10 ml /l. However, XL 71 AG applied @ 5 or 3 g/l recorded an equivalent effective weed control with glyphosate 41% SL @ 7.5 ml /l. The dry weight of weeds at 20 and 60 DAS exhibited similar effectiveness in weed control by XL 71 AG in comparison to glyphosate 41% SL. The highest dose of XL 71 AG showed maximum reduction in weed dry weight on percentage basis at 20 and 60 DAS XL 71 AG showed phytotoxicity on most of the weed with in 15 to 30 DAS. Lowest dose of this herbicide took longer time for exhibiting phytotoxic effects and also had lesser influence in controlling weeds like *Dioscorea deltoida* or *Ipomea digitata* than higher doses. Excepting the weeds having tuberous, fibrous root system or rhizome containing all other weeds showed very little re growth even 90 DAS of the chemical upto a dose of XL 71 AG @ 6 g /l.

Table 1 Bio-efficacy of XL-71 AG on weed control in non crop areas during 2003-04

Treatment	*Dose/l*	*Percent weed control (number basis)*					*Dry weight of weeds (g/m²)*		
		Days after spraying							
		5	*10*	*15*	*30*	*60*	*Initial*	*20 DAS*	*60 DAS*
XL 71 AG	12 g	60	82	96	100	95	153.6	8.7	4.3
XL 71 AG	9 g	56	74	95	100	92	141.2	10.4	7.2
XL 71 AG	6 g	49	69	93	100	90	127.3	13.5	9.1
XL 71 AG	5 g	44	65	90	100	88	161.6	15.3	11.8
XL 71 AG	3 g	35	47	83	96	81	154.7	16.8	15.4
GLY 41% SL	10 ml	42	68	92	98	90	180.0	15.1	9.5
GLY 41% SL	7.5 ml	37	65	92	95	86	135.4	14.8	9.9
Weedy check	-						148.3	171.5	295

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123- Auto Inhibition in Parthenium Seed Germination: A Character that may Cause its Persistence in Heavy Soils

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INTRODUCTION

Parthenium hysterophorus L. is a major weed along the roadsides, wastelands and in crop field in India. Its detrimental influence in agriculture, horticulture and silviculture is very well known. There are many reports that weed plant leachates exert allelopathic influence on the germination and growth of the test crops. But at the same time the leachates produced by the same plant are auto toxic and autoinhibitic also. The allelopathic potential of *Parthenium* weed results from the release of phytotoxic substances such as, ferulic, caffeic, vanillic, chlorogenic, *p*-coumaric and *p*-hydroxybenzoic acids, parthenin, ambrosin and coronopilin, which inhibit the germination and growth of several crop plants and multi-purpose trees (Basak 1984). The seeds of *Parthenium* do not germinate at once, after maturity. Several inhibitors of seed germination are present in its seed (Kohli *et al.* 1985).

Thus an attempt was made to study the effect of dormancy and germination behaviour of *Parthenium* in the soil.

MATERIALS AND METHODS

A laboratory experiment was conducted at National Research Centre for Weed Science, Jabalpur, MP in the month of December 2004. Mature seeds of *Parthenium hysterophorus* were collected from NRCWS farm in the first week of December. To study the effect of dormancy and germination in *Parthenium hysterophorus* seed, the mature seeds were kept in nylon bags and were subjected to running water for different duration of time (4,8 and 24 hrs) and then the germination was tested in three different media. First was Petridish lined with Whattman's No.1 filter paper. Second medium was autoclaved sandy soil in cups of capacity 100 gm. Third medium was autoclaved clay soil in cups of capacity 100 gm. 75 seeds were taken from the nylon bags and were placed on petridish containing 10ml of distilled water, 25 seeds were placed in sandy soil cups and 25 seeds were placed in clayey cup at 4 hrs of running water. The same was repeated after 8 and 24 hours and then the germination was observed.

RESULTS AND DISCUSSION

In the experiment it was observed that the germination increased with the increased duration of time under water flow. In control, four and eight hours flow treatment, the germination occurred on third day after sowing, but the germination was 20% in control (no water flow), 60% in fours hours flow and 90% in 8 hours flow. In case of continuous water flow for 24 hours 24 hours the seeds germinated within one day in the nylon bag itself and the percent of germination was 100%. The germination might be inhibited by the toxicants present in seed coat and percent germination was enhanced due to the removal of these toxicants by the running water. This might be the possible reason that *Parthenium hysterophorus,* flourishes soon after the monsoon season in India. This observation has also been confirmed by the germination tests under sandy and clayey soils. The germination percent was higher in sandy soils (95%) than in clayey soil (25%) probable because of the leaching out of the toxicants easily in the sandy soil. This character that is auto inhibition of seed germination in *Parthenium hysterophorus* seed may cause their persistence especially in heavy soils.

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124- Relative Tolerance of *Kharif* Crops to Dodder (*Cuscuta chinensis* (Damk) and its Management in Niger (*Guizotia abyssinica* (L.f.) Cass)

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INTRODUCTION

Cuscuta chinensis Damk (dodder), a member of the Convolvulaceae family, is an annual obligate stem parasite, and as such is totally dependent on its host plant for assimilates, nutrients and water supply. Unlike root parasites, *C. chinensis* seeds do not require a specific stimulant to induce germination. However, after emergence, suitable host plants are needed for its further growth and development. Niger (*Guizotia abyssinica* (L.f.) Cass) is an economically important oilseed crop extensively grown on the hill slopes and in costal plains of Orissa, Chhattisgarh, and parts of Madhya Pradesh, Jharkhand, Bihar, Maharashtra, Karnataka, Andhra Pradesh and West Bengal. In many areas niger fields are heavily infested with this parasitic weed. The weed emerges along with the germinating niger seedlings and parasitises them soon by attaching themselves to the host and reduces the seed yield by 55-99% depending upon its intensity (Moorthy *et al.* 2004). Manual removal and frequent inter row cultivation before the parasite attaches the host plant are the usual control measures. However, these methods are laborious and often not effective. Once the parasite is attached to the host it remains parasitic until harvest. Thus, the herbicides, which can inhibit the weed seed germination or kill at early stage of infestation, would greatly aid niger cultivation. Though the promising control of dodder in niger crop by pronamide has been reported (Misra *et al.* 1981) but this herbicide is not available in India.

MATERIALS AND METHODS

The present experiments were therefore, undertaken to investigate the relative tolerance of *kharif* crops to dodder and the efficacy of available herbicides for its control in niger during the rainy seasons of 2002 and 2003 at the National Research Centre for Weed Science, Jabalpur. In all the three experiments, treatments were replicated thrice in a randomized block design and the crops were grown with recommended package of practices. *Cuscuta* seeds were treated with concentrated sulfuric acid for 30 minutes before broadcasting them in the field to break seed dormancy and to facilitate proper germination. In first experiment, nine *kharif* crops *viz.*, soybean (JS 335), sesame, niger, groundnut, cowpea, greengram, blackgram, pigeonpea and rice (Kranti) were evaluated to find out their relative tolerance/susceptibility to *Cuscuta chinensis*. All these crops were tested under *Cuscuta*-infested and *Cuscuta*-free conditions. The plot size adopted was 2 m^2. *Cuscuta* plants were maintained *at* 10 plants m^{-2} area in *Cuscuta* infested condition. The second experiment was conducted to find out the survival of *C. chinensis* without host plant. Treatments consisted of 9 dates of niger sowing. The third experiment was carried out to evaluate the efficacy of different herbicides (Table 1) against *C. chinensis* in niger.

RESULTS AND DISCUSSION

Results revealed that greengram was the most susceptible crop (90.7 % yield loss) followed by niger (79.9 %) sesame (72.1 %), soybean (56 %), blackgram (24.4 %), groundnut (18 %) and pigeonpea (17 %)

whereas rice and cowpea were not affected. *C. chinensis* could survive up to 8 days without host plant. Pendimethalin at 1.0 kg/ha as pre-emergence spray completely checked the *Cuscuta* growth and yielded at par with *Cuscuta* free treatment.

Table 1 Effect of herbicides on *C. chinensis* in niger

Treatments	*Dose (g ha⁻¹)*	*Time of application*	*Number of Cuscuta emerged m^{-2}*	*No. of niger plants attached with Cuscuta**		*Plant height (cm)*	*Seed yield (kg ha^{-1})*
				25 DAS	*50 DAS*		
Fluchloralin	1000	PPI	15.7	9.35 (86.9)	8.20 (66.7)	135	733
Pendimethalin	1000	PE	8.7	0.71 (0.0)	0.71 (0.0)	210	2262
Pendimethalin	500	10 DAS	11.0	9.74 (94.4)	7.34 (53.4)	163	82
Squadran	3000	PE	10.7	2.71 (6.8)	1.66 (3.3)	177	469
Squadran	1500	20 DAS	13.3	7.62 (57.6)	7.99 (63.4)	123	284
Imazethapyr	100	20 DAS	13.0	8.47 (71.3)	5.65 (31.4)	138	645
Imazethapyr	50	20 DAS	13.0	9.03 (81.1)	8.70 (75.1)	155	561
Glyphosate	50	20 DAS	13.3	9.05 (81.3)	9.50 (93.1)	135	836
Glyphosate	25	20 DAS	13.7	9.68 (93.2)	9.30 (86.1)	132	637
Glyphosate	12.5	20 DAS	12.0	9.17 (83.5)	9.73 (94.2)	141	622
Imazethapyr	100+S (0.1%) +A(250g/ha)	20 DAS	13.0	8.57 (72.9)	6.37 (40.1)	146	788
Oxyfluorfen	200	PE	19.7	7.79 (60.2)	7.33 (53.5)	147	564
Trifluralin	1000	PPI	15.0	9.82 (95.9)	9.30 (86.0)	139	616
Cuscuta infested	-	-	25.3	10.03 (100.0)	10.03 (100.0)	139	337
Cuscuta free	-	-	-	0.71 (0.0)	0.71 (0.0)	209	2357
CD at 5%			3.2	0.251	0.294	5	50

*Square root ("X+0.50) transformed; figures in parenthesis are original values in %.

PE-Pre-emergence, PPI-Pre-plant incorporated, DAS-Days after sowing, S-Surfactant (Cyspread), A-Adjuvant (Ammonium sulphate); Squadran- (Ready mix of pendimethalin and imazaquinin)

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125- Quantification of Biological Characteristics of *Cyperus rotundus* and *Cynodon dactylon* in Vertisols under Irrigated Upland Ecosystem

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INTRODUCTION

Cyperus rotundus grows in all types of soils and can survive the highest temperatures and produces an extensive system of underground tubers from which they can regenerate. Although relatively small in stature, this rapid growing plant can quickly form dense colonies due to its ability to produce an extensive system of rhizomes and tubers. Individual tubers are dark reddish-brown when mature, about 12 mm thick and vary from 10-35 mm long. The abundantly produced tubers present an efficient means of dispersal and reproduction.

Cynodon dactylon is considered as a noxious weed in agricultural or horticultural practice at a global level. Once established, it reproduces primarily by vegetative means through extensive rhizomes and stolon development. Keeping above in view an experiment was conducted with the objectives to quantify the biological characteristics of *Cyperus rotundus* and *Cynodon dactylon* and to study the regeneration potential in vertisols under irrigated upland condition.

MATERIALS AND METHODS

In pot culture experiment, tubers were collected in the *Cyperus rotundus* infested area and were immediately transferred to the pot containing soil medium @ 10 tubers per pot and planted to a depth of about 2 cm. Similarly for the *Cynodon dactylon,* the primary, secondary and tertiary stolons were collected from the field and it was incorporated into pots @ 20 nodes per pot to a depth of 2 cm. The experiment was replicated five times. For the field experiment four samples of *Cyperus rotundus* and *Cynodon dactylon* were collected at different places in the field at 1× 1×1 feet area and the population and biomass were recorded.

RESULTS AND DISCUSSION

Germination percent of secondary tubers of *Cyperus rotundus* was upto 81 % but *Cynodon dactylon* registered 62 and 59 % for primary and secondary stolons respectively. There was nil germination with tertiary stolons (Table 1). *Cyperus rotundus* recorded a height of 54.8 cm at 60 DAI. Among *Cynodon dactylon*, the stolons from primary and secondary branches recorded similar height of shoots at 60 DAI.

With regard to number of nodes produced per shoot, primary stolons recorded higher number of nodes per shoots than shoots produced from secondary stolons. The total biomass production was higher under tubers from *Cyperus rotundus* (151.6 g/pot) and stolons from *Cynodon dactylon* – primary stolons and secondary stolons registered 145 and 122 g/pot respectively. Whereas the dry weight was higher in *Cynodon dactylon* -primary stolons (64.80 g/pot) compared to *Cynodon dactylon*-secondary stolons.

The samples from the field also indicated the similar results. From four samples collected in the above weed infested field, *Cyperus rotundus* population in 1× 1×1 feet area in an average gave 78.2 tubers/ sample and tuber weight of 1.73 t/acre (Table 2). Jenkins and Jackman (1941) reported that single tuber produced 146 tubers and basal bulbs in 14 weeks in the green house. Higher dry matter production of

Cynodon dactylon was observed in samples collected from the field compared to pot culture. On an average, it is having a potential of producing 332.5 shoots/ 0.09 m^3 (1x1x1ft) and accumulated 4.42 tonnes /acre of dry matter (Table 1). Horowitz (1972) also reported that the total dry mass of the plant reached upto 7 t/ha, half of it consisting of rhizomes. From the above study, it could be concluded that the *Cyperus rotundus* having quick multiplication rate in shorter period and able to record more dry matter and tubers. The tuber production rate is 9 times more than that of the initial incorporation of tubers within eight weeks. Among the primary, secondary and tertiary stolons of *Cynodon dactylon* used in this study, the shoots produced by primary stolons is vigorous and recorded more number of shoots and dry matter production than that of secondary stolons but no germination was observed under the stolons from tertiary stolons.

Table 1 Biological characteristics of *Cyperus rotundus* and *Cynodon dactylon* under different growth periods (mean of 5 replications)

Treatments	*Germination (%)*	*Height (cm)* DAI				*No. of nodes/shoot* DAI				*Biomass production /pot (g)* 60 DAI			*Dry matter production (g)/pot* 60 DAI		
		15	*30*	*45*	*60*	*15*	*30*	*45*	*60*	*Root*	*Shoot*	*Total*	*Root*	*Shoot*	*Total*
Cyperus rotundus - secondary tubers	81	20.2	31.8	48.2	54.8	-	-	-	-	103.3	48.3	151.6	48.40	16.40	64.80
Cynodon dactylon - primary stolons	62	28.2	38.2	76.8	80.6	4.6	5.4	7.2	8.2	91.7	53.3	145.0	33.90	36.70	70.6
Cynodon dactylon - secondary stolons	59	26.4	35.4	72.8	79.6	3.2	4.4	6.2	7.2	66.7	55.3	122.0	30.20	26.90	57.1
Cynodon dactylon - tertiary stolons	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2 The yield of tubers from *Cyperus rotundus* and biomass production from *Cynodon dactylon* in 4 samples each 1× 1×1 feet of garden land soil

Sample location No.	*Cyperus rotundus* *No. of tubers/sample*	*Fresh weight of tuber* *g/sample*	*mg/ tuber*	*tonnes/acre*	*Cynodon dactylon* *No. of shoot/sample*	*Dry weight (g/sample)*	*tonnes/acre*
1	67	38.32	617	1.70	372	110.4	4.91
2	81	35.73	537	1.58	348	102.1	4.53
3	70	40.13	655	1.78	280	87.4	3.88
4	95	42.60	714	1.89	330	98.5	4.38
Average	78.2	40.00	630.80	1.73	332.5	99.6	4.42

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126- Allelopathic Effect of Different Plant Extracts on *Parthenium hysterophorus* L.

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INTRODUCTION

Parthenium hysterophorus is an aggressive weed, originated in tropical America. It is now widely distributed in a number of tropical and sub-tropical countries. It causes hazards in man and animals leading to socio-economic problems. Infestation of the weed in grassland reduces forage production by 90 per cent besides making the land less fertile. The different methods of control though effective, have their own disadvantages. The mechanical method is time consuming and expensive, physical control by pulling causes allergic effect to human beings. Under these circumstances, the concept of chemical and allelopathic means of controlling parthenium offers a potential alternative. Keeping above in view, the present study was undertaken to explore the allelopathic effect of different plant species on *Parthenium hysterophorus.*

MATERIALS AND METHODS

Laboratory and pot culture experiments were conducted to find out the allelopathic effect of fresh plant extracts of different plant species such as *Cassia sericea, Abutilon indicum, Leucas aspera, Aerva tomentosa* and *Cleome gynandra* on germination and growth of parthenium. For this study fresh seeds were collected from the matured plants of parthenium and were raised in pots. The matured plants were collected from the field and the extracts of five and ten per cent concentrations were prepared. For laboratory experiment, ten healthy seeds of parthenium were placed on filter paper wetted with the above extract in each petridishes and kept at room temperature (25-28 ^{0}C) and it was compared with control using distilled water. The experiment was replicated thrice and maintained for a period of 15 days. The For pot culture study, the pots were filled with soil and ten healthy seeds of parthenium were sown in each pot and the soil was uniformly wetted with the extracts as per treatments. The germination per cent, shoot length and root length were recorded on seventh day and total dry matter accumulation was recorded on 15 and 30 DAS. The vigour index of seedlings was calculated by the method proposed by Abdul Baki and Anderson (1973).

RESULTS AND DISCUSSION

The germination and growth of parthenium seeds significantly suppressed at both concentrations of extract used in petridish experiment. About 50 and 68 per cent inhibition in germination was noticed in *Abutilon indicum, Cassia sericea* and *Aerva tomentosa* at 5 and 10 per cent extracts. The reduction in germination is due to the quantum of allelochemicals produced by each plant species as reported by Evenari (1945). The higher reduction in root growth (44 mm and 36 mm) was recorded in *Aerva tomentosa* treated at 5 and 10 per cent extracts over control (12.6 mm) which supports the view of Sheltel and Balke (1983) who opined that the reduction occurred due to inhibition of cell division and cell enlargement due to the presence of allelochemicals.

Pot culture experiment showed the significant reduction in germination per cent of parthenium with the extracts used in the study. Among the plant extracts used, *Aerva tomentosa* at 5 per cent concentration recorded minimum shoot as well as root lengths. This will give an indication that it may have some allelopathic effect on parthenium. The other plant extracts such as *Cassia sericea* and *Abutilon indicum* showed the inhibitory action against parthenium which were recorded less root and shoot length and were on par with the *Aerva tomentosa* treatment. The vigour index was low under *Aerva tomentosa* treated pots at both the concentrations (5 and 10 per cent extracts) which were 212.3 and 279.0 respectively. Similar effect was also noticed under the pots treated with the extracts of *Cassia sericea* and *Abutilon indicum*. From this study, it may be concluded that the use of *Aerva tomentosa* extract is one of the way to suppress the parthenium to some extent and further research is needed in this line.

Table 1 Effect of plant extracts on germination and growth of *Parthenium hysterophorus*

Treatment	*Petridish*					*Pot culture*								
	Germi nation %	*Shoot length (mm)*	*Root length (mm)*	*DMP (mg/ plant)*	*Vigour index*	*Germi nation %*	*Shoot length (mm)*		*Root length (mm)*		*Dry matter production (mg/plant)*		*Vigour index*	
							DAS		*DAS*		*DAS*		*DAS*	
							7	*15*	*7*	*15*	*15*	*30*	*15*	*30*
Cassia sericea 5 % extract	20.0	9.0	7.6	3.03	60.6	33.3	23.6	35.0	20.0	40.0	4.6	9.6	153.1	319.6
Cassia sericea 10 % extract	23.3	9.6	8.3	3.27	76.2	36.6	26.0	37.6	18.0	41.3	6.0	11.0	219.6	402.6
Abutilon indicum 5 % extract	26.6	9.3	8.6	3.13	83.2	40.0	27.3	38.0	26.3	41.6	7.6	13.3	304.0	532.0
Abutilon indicum 10 % extract	30.0	10.6	9.3	3.17	95.1	40.0	30.3	41.0	27.6	43.6	9.6	14.6	384.0	584.0
Leucas aspera 5 % extract	40.0	11.6	10.0	4.03	161.2	40.0	32.6	42.3	31.0	44.0	12.0	16.3	480.0	652.0
Leucas aspera 10 % extract	50.0	12.0	10.6	4.10	205.0	43.3	36.0	45.3	34.3	45.3	14.3	18.6	619.1	805.3
Aerva tomentosa 5 % extract	16.6	7.6	7.0	2.07	34.3	26.6	17.6	32.3	16.6	36.0	3.3	8.0	87.7	212.8
Aerva tomentosa 10 % extract	23.3	8.6	8.0	2.47	57.5	30.0	19.0	33.3	18.3	38.3	4.3	9.3	129.0	279.0
Cleome gynandra 5 % extract	43.3	12.3	10.0	5.07	219.5	43.3	37.6	45.3	37.0	45.3	14.6	21.0	632.1	909.3
Cleome gynandra 10 % extract	46.6	13.0	10.3	5.10	237.6	46.6	40.3	46.3	41.3	47.0	16.0	22.3	745.6	1039.1
Control	53.3	15.3	12.6	7.33	390.7	66.6	46.3	58.0	57.0	66.6	20.3	28.0	1351.9	1864.8
CD at 5%	13.90	2.77	2.96	1.04	-	18.54	5.97	12.01	8.52	7.71	2.80	2.74	-	-

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127- Effect of Integrated Weed Management, Varieties and Crop Geometries on Weed Dynamics and Grain Yield of Soybean

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INTRODUCTION

Soybean being a rainy season crop, suffers severely due to competitional stress of weeds which results in reduction of grain yield from 20-77% depending on nature and density of weed species (Tiwari and Kurchania, 1990). Hence weed control itself by any method can increase the yield significantly. Different varieties may differ in their canopy structure and growth characteristics, which may play a pivotal role in smothering the weeds. A more equidistant spatial arrangement of crop plants, achieved by manipulating crop geometry is thought to play role in reducing the potential for weed interference by increasing the amount of light that is intercepted by the crop canopy. Hence, the present investigation was carried out to generate information on the suppressing ability of different soybean varieties, crop geometries and weed management practices on weed growth and yield of soybean.

MATERIALS AND METHODS

The field experiment was conducted at Udaipur (Rajasthan) during the *Kharif* seasons of 2001 and 2002. The treatments included three soybean varieties (NRC-37, JS 335 and JS 71-05) and two crop geometries (30cm x 10cm and 20cm x 15 cm) in main plots and six weed management practices (weedy check, two hand weddings at 20 and 40 days after sowing, clomazone at 1.0 kg /ha, clomazone at 1.0 kg/ha + HW at 40 DAS, fenoxaprop-p-ethyl at 75 g/ha at 20 DAS and fenoxaprop–p-ethyl at 75 g/ha + HW at 40 DAS in subplots under split plot design with three replications following the recommended cultural practices. The observations on weed growth and grain yield of soybean were recorded at harvest.

RESULTS AND DISCUSSION

Soybean variety JS-335 produced significantly higher grain yield (16.09 q/ha) than JS 71-05 and NRC 37, though there was no significant differences in weed density. Crop geometries did not show any significant effect on weeds as well as on crop.

Pre-emergence application of clomazone at 1.0 kg/ha reduced the population of *Echinochloa colona, Cynodon dactylon, Cyperus rotundus, Trianthema portulacastrum, Parthenium hysterophorus* and *Commelina benghalensis*, while post-emergence herbicide fenoxaprop-p-ethyl at 75 g/ha (at 20 DAS) was effective against *Echinochloa colona* and *Cynodon dactylon* only. Both the herbicides were failed to control *Amaranthus spinosus* and *Digera arvensis*. The highest weed control efficiency was obtained under clomazone at 1.0 kg/ha pre emergence + HW (at 40 DAS) (88.58%) followed by two hand weedings at 20 and 40 DAS (88.45%). All the weed management treatments significantly enhanced grain yield of soybean over weedy check. However, two hand weedings and clomazone+HW were at par with each other and were found to be significantly superior over rest of the treatments. Increase in yield under these treatments may be due to significant reduction in density and dry matter of weeds, thereby reduction in crop weed competition. The findings corroborate the results of Vyas and Billore (2003)

The results suggest that the two hand weedings produced maximum yield and found equally effective to clomazone+HW. The integration of manual weeding at 40 DAS with either pre emergence or post emergence gave broad-spectrum weed control in soybean as compared to their alone application.

Table 1 Effect of varieties, crop geometries and weed management practices on weed density, total weed dry matter (q/ha) at harvest, WCE and soybean grain yield (q/ha) (Pooled data of 2001 and 2002)

Treatment	*Weed density(No/m²)*			*Total weed dry matter at harvest (q/ha)*	*WCE (%)*	*Soybean grain yield (q/ha)*
	Monocot	*Dicot*	*Total*			
Variety						
NRC-37	6.74 (45.10)	7.64 (58.01)	10.20 (103.61)	12.36	—	12.29
JS-335	6.56 (42.63)	7.44 (54.94)	9.92 (98.00)	11.86	—	16.09
JS 71-05	6.66 (43.90)	7.57 (56.83)	10.08 (101.25)	12.11	—	12.92
CD at 5%	NS	NS	NS	NS	—	0.61
Crop geometry						
30cm x 10 cm	6.60 (43.15)	7.47 (55.48)	9.98 (99.12)	11.93	—	14.02
20cm x 15 cm	6.71 (44.60)	7.62 (57.71)	10.16 (102.78)	12.30	—	13.51
CD at 5%	NS	NS	NS	NS	—	NS
Weed management						
Weedy check	11.23 (125.66)	11.37 (128.85)	15.97 (254.85)	30.46	—	8.48
Two HW at 20 & 40 DAS	4.63 (21.03)	4.92 (23.78)	6.73 (44.89)	3.51	88.45	17.18
Clomazone 1.0 kg/ ha PE	4.70 (21.72)	6.36 (40.07)	7.90 (61.99)	5.61	81.48	15.20
Clomazone 1.0 kg/ ha PE + HW at 40 DAS	4.68 (21.47)	5.15 (26.08)	6.93 (47.61)	3.47	88.58	16.90
Fenoxaprop-p-ethyl 75 g/ha POE	8.45 (70.93)	11.08 (122.49)	13.93 (193.65)	22.97	24.57	10.91
Fenoxaprop-p-ethyl 75 g/ ha POE+HW at 40 DAS	6.23 (38.50)	6.42 (40.77)	8.93 (79.45)	6.65	78.07	13.93
CD at 5%	0.27	0.24	0.29	0.51	—	0.66

Actual values are in parenthesis WCE: Weed Control Efficiency

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128- Effect of Weed Control Measures on Soil Micro Flora in Rice-Wheat Sequence

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INTRODUCTION

Rice-Wheat sequence is one of the world's most important cropping systems. Soil organic matter is the most significant factor affecting adsorption and hence, the behavior of herbicides in soil. Addition of organic matter to soils low in OM content increases the activity of herbicides. Warren (1973) reported that on a soil with 0.7% OM, propachlor leached out so rapidity that it failed to control *Digitaria Sanguinalis*. However, it performed well on a soil of 3% OM; indicating that OM enhanced the absorptive capacity of the soil and hence reduced the leaching losses. The principal organisms in the soil may interact with herbicides. Organic compounds of the soil provide the food for their growth. Warm, moist, well aerated and fertile soil is most favorable to micro-organisms. Under these ideal conditions, the organism can decompose rapidly the organic herbicides. Microbes degrade herbicides predominantly through hydrolysis, alkylation, dealkytation, oxidation, reduction, hydroxylation, ring cleavage and conjugation.

MATERIAL AND METHODS

The experiment was conducted at crop research center of Govind Ballabh Pant University, Pant Nagar during 2001-2002 and 2002-2003 with sub-tropical sub humid climate having sandy loan soil with medium organic carbon, low available nitrogen and medium available phosphorus and potassium. The experiment was laid out in randomized block design with three replications. There were seven treatments both in rice and wheat viz butachlor, butachlor fb 2, 4.D with and without organic matter, bulachlor + hand weeding and weedy check in rice and isoproturon, Isop + 2,4.D with and without organic matter, clodinafob fb, 2, 4-D with and without organic matter, isop+hand weeding and weeding check in wheat. Soil microbiological analysis was carried out by serial dilution and plate count method for azotobector, bacteria and fungus.

RESULTS AND DISCUSSION

The results indicate that the herbicides viz. Butachlor, pretilachlor, isoproturon, clodinafop and 2,4-D which are applied sine 1999 did not have any prolonged effects on soil microflora viz azotobector, bacteria and fungus. Numerically higher population of soil microflora due to use of these herbicides with and without organic matter were observed upto 7days after herbicide treatments (DAHT) and decrease at the later stages irrespective of treatments.(Table 1)

Application of herbicides with organic matter through *Sesbania aculeata* had numerically higher population of soil microflora at all the stages in both rice and wheat. Butachlor in rice and isoproturon in wheat also stimulated the soil microflora population as compared to weedy conditions (Chopra and Magu, 1985). This may be due to the fact that degradation of herbicides may be serving as carbon source for microbes (Paul and Clark, 1989).

CONCLUSION

From the above results it can be concluded that for higher yields and good soil health application of herbicides along with organic matter should be adopted.

Table 1 Soil microflora (CFU x $10^3 g^{-1}$) at various stages as influenced by different treatments in rice and wheat.

Treatments Crops	*Buta. Iso.*	*Buta. Iso. fb + 24-D, 2,4-D*	*Buta. Iso. fb + 24-D 24-D + OM*	*Buta; clodina. rotated fb. with pretila 24-D fb 2, 4-D.*	*Buta. Clodina. rotated fb. with 2,4-D pretila fb. 2,4-D + OM*	*Buta. Iso + + Hw Hw*	*Weedy*
7days after herbicides treatment							
Azotobector							
Rice	15.6	13.6	16.0	13.3	16.1	15.8	13.4
Wheat	36.4	33.6	38.6	33.0	38.0	36.2	31.0
Bacteria							
Rice	40.6	31.8	42.9	32.7	42.0	40.3	34.7
Wheat	55.0	40.0	55.7	38.5	55.6	38.2	38.8
Fungus							
Rice	17.4	15.2	19.0	15.5	18.2	13.7	13.5
Wheat	19.0	10.8	20.2	10.7	19.1	11.9	11.0
30days after herbicide treatment							
Azotobector							
Rice	12.7	11.1	13.4	11.3	13.1	12.9	12.1
Wheat	22.9	25.5	25.8	23.0	25.4	23.0	25.1
Bacteria							
Rice	32.5	31.5	37.9	31.2	37.3	32.95	36.5
Wheat	32.6	31.3	35.7	31.2	34.8	32.5	32.1
Fungus							
Rice	10.0	10.7	11.9	10.2	11.8	11.5	12.0
Wheat	11.4	10.9	12.3	10.8	12.3	12.6	12.4
At harvest of Crop							
Azotobector							
Rice	7.9	7.0	8.3	7.1	8.0	7.8	7.9
Wheat	10.2	10.0	11.8	10.0	11.2	11.2	10.1
Bacteria							
Rice	28.6	26.7	30.1	27.1	28.7	28.1	27.4
Wheat	33.8	32.8	34.4	32.1	34.3	34.4	33.2
Fungus							
Rice	9.6	8.5	9.8	8.8	9.3	9.4	9.6
Wheat	12.1	11.6	13.1	11.4	13.3	13.8	12.7

Note: -Mean Data of two years (2001-2002 and 2002-2003)
CFU – Colonies forming units
OM – Organic matter.

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129- Additional Hosts of *Cassytha filiformis* Linn.

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INTRODUCTION

Fresh observations on host range have been made between 1999-2004, the present study period. All these species with which, *Cassytha filiformis* successfully established haustorial connection has been accessioned as a host. It is a potential source of danger in orchards and plantations and none on field crops, (Srinivasan & Subramanian, 1960). The fact that it is declared as 'public enemy No.1' in Diego Garcia (King, 1974) confirms its potential danger as a pest to 32 dicot hosts and 4 monocot hosts which have been recorded in the present study.

MATERIALS AND METHODS

Field trips

Observations embraced the field trips to the following areas:

1. 'Gangineni' to 'Cheruvumadhavaram' (50 KM away from Nagarjuna University)
2. 'Kavali' to 'Tettu' (160 KM away from Nagarjuna University)
3. Warangal (220 KM west of Nagarjuna University)
4. Anakapalli (230 KM, North of Nagarjuna University
5. Kalajuvvalapadu (250 KM south of Nagarjuna University)
6. Jain temple (Hreenkar Teerdha) rear side, scrub jungle (1 KM away from Nagarjuna University)

Herbaria visited

7. Botanical Survey of India
   a) Botanical Circle Herbarium at Coimbatore
   b) Southern Circle Herbarium at Pune have been visited to see the past records of host range

RESULTS AND DISCUSSION

Cassytha capillaries Meissn.

The second species in India observed at Pune herbarium on *Myristica fragrans,* collected by R.S.Rao in 1960. Among the above, Kavali to Tuttu is much nearer to the coast. It is observed that in areas 1 and 2 above *C. filiformis* grows luxuriantly all along the railway track.

C.filiformis has no host specificity. It prefers woody hosts to herbaceous hosts. The woevine parasitizes either individual hosts or components of a host cluster, termed as Host "complex". This is similar to *Cuscuta.* More than 95% of hosts are found to be woody, shrubs as also stated earlier by Musselman (1982). The nature of spread has been presently elaborated.

The spread of *Cassytha filiformis* is multifold. Either the shoots spread horizontally or the shoots ascent or descend or all the above in their search for new hosts. *C.filiformis* widely spreads on woody thorny scrub species, none of herbs (except in certain special conditions), none or field crops and no attempt to be dispersed by anthropogenic factors – unlike *Cuscuta.*

Medicinal Plants as Hosts

1. Andrographis paniculata (Burm.f.) Wall. - Acanthaceae (Annual herb)

Known to be antidiabetic, anti-turmer herb. Also used the cure of cholera, bronchitis, dysentery, malaria, influenza, itches, piles and importantly in liver troubles.

2. Tylophora indica (Burm.f.) Merr. - Asclepiadaceae (Climing shrub)

Used locally in the treatment of asthma, bronchitis; whooping cough, diarrhea and dysentery and also as an emetic in snake bites.

The fact that two world renowned medicinal plants, mentioned above, are attacked by *Cassytha filiformis* is disconcerting. Illegal trade resulted in reduced populations and now there is a risk of denudation of these two valuable medicinal plants in India.

Host complexes

An interesting combination of hosts was found at 'Gangineni' locality. The road side *Lantana camara* L. (Verbenaceae), several grasses also got intensely parasitized. In several areas, the host complex comprised *Zizyphus nummularia, Acacia nilotica, Pentatropis capensis, Cardiospermum halicacabum, Azadirachta indica.*

More than 95% of hosts enlisted are shrubs or small trees as commented by Musselman's (1982). *Prosopis chilensis,* commonly known as 'Mosquito bean' in which parasite induces leaf fall, drying up of woody stems in this otherwise invincible tough woody, thorny host. Occasionally, herbs also get infected endorsing report of Ghosh and Das (1998).

Self parasitism

This is the first report on self parasitism in *Cassytha filiformis*. However, the frequency of self-parasitism is far less compared to *Cuscuta.* Self parasitism is confirmed with anatomical evidence.

The nutating branches come in touch with each other. At several points, conical outgrowths from juxtaposed positions closely appress the nutating branch. The outgrowth continues to swell assuming a spherical or oblong shape. The margin extends side ways and assumes the characteristic saddle shape.

Anatomically, the 'collapsed zone' a distinctive feature of *Cassytha haustorium*, appears here also. The endophyte of the haustorium takes a turn within the medullary region to establish contact with each one of ring of vascular bundles.

The only plausible explanation for the occurrence of self parasitism could be the non specifichost preference, the general indiscriminate tendency to establish haustorial contact where it is feasible. The blind pursuit of search for hosts as in *Cuscuta* is further confirmed.

A molecular biological explanation is needed. Till then, the promiscuous pursuit of hosts is reaffirmed. Lack of host specificity may be attributed to the silencing of a gene earmarking host specificity or a gene towards this has yet to be expressed. Future genomics study would do well to investigate this aspect.

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130- Effect of Different Densities of *Echinochloa colonum* on Direct Seeded Rice under Puddled Condition

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INTRODUCTION

An experiment was conducted to find out the damage potential of *E. colonum* at varying densities in direct seeded rice under puddled condition.

MATERIALS AND METHODS

Field experiment was conducted at Agronomy Research Farm of the university in a three replicated randomized block design during rainy season of 2004. Treatments consisting of *E. Colonum* with 0, 5, 10, 15, 20, 25, 30 and 35 m^{-2} densities. The plot size was 1 m x 1m (1 m^2). Pre-germinated seeds of rice variety NDR 97 @ 100 kg ha^{-1}were broadcast in well puddled field on July 18, 2004. All other weeds were removed from the plots as an when they appeared. The effect of different densities of *E. Colonum* on reduction in grain yield of puddled seeded rice was recorded.

RESULTS AND DISCUSSION

Results (Table1) revealed that there was a progressive decrease in yield of puddled seeded rice with increasing densities of *E. colonum* as compared to weed free condition. The density of *E. colonum* by 35 numbers m^{-2} hampered the crop yield by 2282 kg ha^{-1} (55 per cent) over weed free plot which was significantly higher than the lower densities of *E. colonum*.

Table 1 Effect of densities of *Echinochloa colonum* on yield of direct seeded rice under puddled condition

E. colonum density(No. m^{-2})	*Grain yield(kg ha^{-1})*	*Decrease in yield over weed free (%)*
0	4023	-
5	3910	2.8
10	3840	4.5
15	3350	16.7
20	2933	27.1
25	2500	37.9
30	2283	43.3
35	1810	55.0
CD at 5%	76.0	

CONCLUSION

Reduction in the yield of puddled seeded rice increased consistently with increasing densities of *E. Colonum*. The losses in yield due to increasing densities of *E. colonum* ranged from 2.8 to 55.0 per cent.

131- Competition Abilities of Different Rice Cultivars with Weeds under Transplanted Condition

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INTRODUCTION

To study the competitive ability of different rice cultivars against weeds in transplanted paddy, and experiment was conducted at research farm of the Department of Agronomy, Narendra Deva University of Agriculture and Technology, Kumarganj, Faizabad.

MATERIAL AND METHODS

Field experiment was conducted at Agronomy Research Farm of the university during rainy season of 2004. Seven cultivars of rice viz. Saryu 52, NDR 359, Hybrid ND 2, Sugandha 2, Sugandha 3, Basmati and Sambha Masuri. For comparison, a weedy plot without crop was also kept. Treatments were replicated thrice in a randomized block design. Transplanting of different cultivars was done in well puddled field at row to row spacing of 20 cm & plant to plant spacing of 10 cm with an object to maintain 50 hills m^{-2} on July 7, 2004. Effects of different rice cultivars on different weed species, total weed density and weed dry weight were recorded at 60 DAS.

RESULTS AND DISCUSSION

By and large, all the rice cultivars included in the experiment have been found better competitors with the weeds which resulted in reduced population of different weed species, total weed density and weed dry weight as compared to control plot. Among the varieties, the response of NDR 359 was significantly better than all the remaining varieties but was on par with sugandha 3 Sambha Masuri & Saryu 52 to reduce the total weed density. But in case of weed dry weight, the performance of Hybrid ND 2 in reducing the weed dry weight was the best (Table1).

Table 1 Effect of different rice cultivars on weed density and weed dry weight.

Rice cultivar	*Weed density (No. m^{-2})*	*Weed dry weight (g m^{-2})*
Weedy	255	90.66
Saryu 52	163	44.33
NDR 359	156	30.43
Hybrid ND 2	210	25.66
Sugandha 2	198	41.70
Sugandha 3	158	39.00
Sambha Masuri	161	45.76
Basmati	184	70.33
CD at 5%	10	26.04

CONCLUSION

Out of the seven rice cultivars, NDR 359 was found significantly better competitors with the weeds which resulted in the lowest weed density which was closely followed sugandha 3, Sambha Masuri & Saryu 52. In respect of reducing weed dry weight Hybrid N.D. 2 was the best one.

132- Effect of Crop Residue Extract on the Germination of Rabi Weeds

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INTRODUCTION

Anagallis arvensis is a major weed of wheat and barley crop. This weed affects the crop growth and reduces the yield. The objective of this study was to work out the effect of different concentrations of crop residue extract on the germination of above weed.

MATERIALS AND METHODS

The experiment was conducted in weed control laboratory of the university during rabi 2002-2003 in complete randomized design. Filter papers were placed in Petri dishes and 100 seeds were sown in each Petri dish. 1,2,3,4 and 5 percent (wt/V) wheat straw extract were applied in Petri dishes. After 10 days, germinated seeds were counted and percentage was calculated.

RESULTS AND DISCUSSION

Data presented in table-1 revealed that 4% wheat straw extract inhibited 96.34 percent germination of *Anagallis arvensis* seeds. Allelopathic effects of weeds on germination and seedling growth of maize and soyabean has also been studied by Angiras *et al.* (1988).

Table1: Effect of wheat straw extract on the germination percentage of *Anagallis arvensis*.

Extract concentration (%)	*Germination percentage*
Control	12.33
1	11.00
2	5.33
3	4.33
4	3.66
5	3.66

CONCLUSION

It was observed that 4% wheat straw extract inhibited maximum germination of *Anagallis arvensis* (96.34 per cent).

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133- Potential of Allelopathic Interactions for Weed Management

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INTRODUCTION

Allelopathy refers to *any direct or indirect positive or negative effect of one plant on the other (including microbes) through the release of chemicals into the environment.* The original concept of allelopathy also includes positive interactions though little emphasis has been given to this aspect. The chemicals responsible for allelopathy and known as *Allelochemicals* are synthesized in the plants as secondary metabolites. These exhibit a variety of structure and functions. Upon release from the plants their amount in soil depends upon a number of biotic and abiotic factors (Rice, 1984). Allelopathy plays an important role in different ecosystems including the agroecosystems. The current focus of research on allelopathy is to exploit this phenomenon for some useful purposes, particularly weed and pest management (Singh *et al.*, 2003). A number of allelopathic plants, especially crops, are being explored for their use in practical weed management. The reason being that allelopathy not only offers eco-friendly and benign method of weed control but also the chemicals involved possess different and novel modes of action worth exploiting in view of increasing herbicidal resistance. Various approaches that are being followed to exploit allelopathy for weed management include use of allelopathic cover or smother or green manure crops, improvement of crops for allelopathic traits through recombinant DNA technology and the direct use of allelochemicals as natural herbicides (Singh *et al.*, 2003).

Use of Allelopathic Crops

A number of allelopathic crops, particularly grown for green manure or as cover or smother crops, provide non-herbicidal and sustainable means of weed control (Singh *et al.*, 2003). Green manure crops especially those belonging to family Brassicaceae and Leguminosae are known to suppress weeds through the release of allelochemicals in soil. Among the various green manure crops crucifers (such as *Brassica campestris*, *B. rapa*, *Raphanus sativus*) and legumes (*Mucuna pruriens*, *Trifolium* spp.) are known to suppress weeds by releasing allelochemicals in soil. Crucifers possess glucosinolates that break down enzymatically in soil into volatile isothiocyanates that suppress weeds and even soil borne pests. They have been regarded as excellent biofumigants. Besides, other crops such as buckwheat (*Fagopyrum esculentum*), rye (*Secale cereale*), sorghum (*Sorghum* sp.), sunflower (*Helianthus annuus*) and foxtail millet (*Setaria italica*) are known to reduce the density and biomass of the weeds by releasing allelochemicals in the soil. To further strengthen this property, efforts are being made using modern DNA recombinant technology.

Allelochemicals as Potential Herbicides

Allelochemicals found in the plants can also be used directly in pure form or in crude form as novel herbicides. These possess a number of advantages over the synthetic chemicals in terms of both economic and environmental considerations. They hold a great promise for the future as evidenced from their phytotoxicity towards weedy species. Some of the crop allelochemicals with herbicidal potential are benzoxazinones found in rye, wheat and maize; sorgoleone found in *Sorghum* and glucosinolates found in crucifers. Besides, essential volatile oils from a number of aromatic plants have been reported to be excellent weed germination inhibitors and possess a great potential for use as bioherbicides (Tworkoski, 2002; Singh *et al.*, 2003).

Improving Crops for Allelopathic Traits

Through molecular-genetic techniques or even conventional breeding present day cultivars showing potential for weed management can be improved further by transferring allelopathic genes from the strongly allelopathic wild relatives. In this direction, wild accessions of crops such as wheat, rice, maize, oat, sorghum, rye etc are being screened (Singh *et al.*, 2003). After selection, such desired traits are being transferred to the present day crop varieties and it holds a great promise for the future. Recently, genes responsible for sorgoleone - an allelochemical of *Sorghum bicolor* with weed suppressing ability, have been identified. Efforts are being also made to make allelopathically stronger rice cultivars.

Thus, from the above discussion it is clear that allelopathy can be used as a tool for future weed management programmes, though more research is required to achieve it.

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134- Weed Flora of Berseem (*Trifolium alexandrinum* L.) Fields in Madhya Pradesh

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INTRODUCTION

Weeds form an integral part of biotic environment of each and every agro-ecosystem and become competitor with the crop for most of the natural resources. The system of irrigation, weed management practices and environmental conditions play significant role on the intensity and type of weed flora. Various cultural, mechanical and chemical methods of weed control are being practiced to overcome the weed problems, particularly in agricultural lands. However, some of the weed species are difficult to control and adversely affect the growth and development of crops. Berseem is infested with a wide variety of weed species which not only compete with the crop but also deteriorate the quality of the fodder as well as seed. The losses in forage yield were estimated from 9.5 to 36.7 %. Present survey was the first attempt in Madhya Pradesh to identify the composition of weed flora associated with berseem crop.

MATERIAL AND METHODS

Extensive weed survey in berseem fields was conducted at mid-growth stage of the crop in Raipur, Bilaspur, Jabalpur, Sehore, Narsinghpur, Morena, Tikamgarh, Indore, Dhar, Khandwa, Khargone, Gwalior and Shivpuri districts covering almost all crop-zones of the state. The survey was made by list count quadrat method (Misra, 1968) using 50x50 cm quadrat. Randomly 10 quadrats were placed in each field, usually of one hectare area and species-wise weed population was recorded from each quadrat. The quantitative parameters viz., frequency percent and importance value index (IVI) were calculated as per method suggested by Misra (1968). Pooled mean values (13 districts) of frequency per cent and IVI of individual weed species were worked out for the state as a whole.

RESULTS AND DISCUSSION

The survey of weed flora associated with berseem crop revealed that in all 49 weed species were associated with the crop, representing 38 from broadleaf group (77.6%), 10 from grasses (20.4%) and only one from sedge (2.0%). Based on IVI *Cichorium intybus* was the most dominant associated weed of berseem having the highest IVI value (91.0) and frequency (90.0%). The severety of this weed was also reported by Peng (1978) in berseem fields. The other major weeds infested the crop comprised of *Chenopodium album* (30.4), *Anagallis arvensis* (19.5), *Cyperus rotundus* (18.0), *Cynodon dactylon* (17.6), *Medicago hispida* (12.2) and *Melilotus alba* (9.0). The frequency of these species varied from 25 to 55 %. The occurrence of aforesaid species was almost uniform in the districts surveyed. In many fields a parasitic weed. Cuscuta spp. was also frequently noted which posing a serious problem (Table 1).

In Raipur, Bilaspur and Jabalpur districts *Trifolium fragiferum* and *Alternanthera sessilis* were the co-dominant weeds. Among grasses *Polypogon monspeliensis* and *Eragrostis* spp. were common. In wheat-

Table 1 Frequency (%) and importance value index of weeds in berseem fields.

Weed species	*Frequency (%)*	*IVI*
Ageratum conyzoides L.	4	3.0
Alternanthera sessilis (L.) DC.	3	1.4
Anagallis arvensis L.	50	19.5
Argemone mexicana L.	10	2.1
Asphodelus tenuifolius cav.	12	4.3
Caesulia axillaries Roxb.	3	0.8
Chenopodium album L.	55	30.4
Cichorium intybus L.	90	91.0
Convolvulus arvensis L.	7	2.6
Cynodon dactylon (L.) pers.	46	17.6
Cyperus rotundus L.	43	18.0
Cuscuta sp.	3	2.8
Echinochloa crusgalli (L.) Beauv.	5	2.2
Eclipta alba (L.) Hassk.	8	2.1
Eragrostis spp.	3	2.2
Euphorbia geniculata Forsk.	10	6.3
Gnaphalium indicum L.	4	2.0
Lagascea mollis Cav.	10	2.2
Lathyrus aphaca L.	8	1.0
Launaea aspleniifolia Hook, f.	10	3.2
Medicago hispida Gaertn.	25	12.2
Melilotus alba Desf.	28	9.0
Melilotus indica (L.) All.	17	6.1
Parthenium hysterophorus L.	7	4.7
Panicum isachane Roth.	3	1.3
Phalaris minor Retz.	3	1.0
Polypogon monspeliensis Desf.	3	1.7
Portulaca oleracea L.	9	4.7
Rumex dentatus L.	16	7.0
Sonchus asper (L.) Hill.	13	5.0
Spergula arvensis L.	20	6.6
Trifolium flagiferum L.	15	2.8
Vicia hirsuta S.F. Gray.	5	1.8
Vicia sativa L.	17	5.1
Others	1-5	6.0

berseem rotation *Phalaris minor* and *Avena fatua* were noted in Tikamgarh and Jabalpur districts. Rainy season weeds viz., *Echinochloa crusgalli* and *Ageratum conyzoides* were also frequently occurred in Raipur and Bilaspur. Caesulia axillaries was recorded specifically at Sehore, Narsinghpur and Jabalpur districts. *Parthenium hysterophorus*, a non-crop weed was found invading the crop in Indore and Jabalpur districts. Paradkar *et al.* (1993) also reported its existence in crops like wheat and vegetables.

CONCLUSIONS

The study indicated that out of 49 weed species, broadleaf weeds contributed to the extent of 77.6 % followed by grasses (20.4%) and sedge (2.0%). *Cichorium intybus* was the most dominant associated weed of berseem having the highest frequency (90%) and importance value index (91.0). The other species viz., *Chenopodium album, Anagallis arvensis, Cyperus rotundus, Cynodon dactylon, Medicago hispida* and *Melilotus alba* also infested the crop with moderate frequency (26-55%) and IVI (9.0-30.4).

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135- Assessment of Crop-Weed Competition of Soybean Cultivars

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INTRODUCTION

Soybean, being a rainy season crop, suffers severely due to competitional stress of weeds which results in reduction of yield from 20-77% depending on nature and density of weed species (Tewari and Kurchania, 1990). Weeding is difficult due to continuous rains and scaresity of laborers. Therefore, suitable herbicide for controlling the weeds are alternative. Herbicides might just not be able to provide sufficient weed control, therefore integration with cultivars which differ in their canopy structure may play a pivotal role in smothering the weeds. The present investigation was, therefore conducted on the suppressing ability of different cultivars of soybean with weed management practices.

MATERIALS AND METHODS

A field experiment was conducted to study the effects of three soybean cultivars of different plant types (PK-1024 narrow leaves and short statured type, JS-335 semi spreading type and PK-1241 spreading type) and four weed control measures (alachlor 2.5 kg ha^{-1}, alachlor 1.875 kg ha^{-1} with weedy and weed-free) on the suppression of weeds at Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar. Twelve treatment combinations were tested in randomized block design with three replications. Alachlor was applied as pre-emergence spray using 500 litre water per hectare on the same day when crop was sown on July 21, 2004 in rows at 60 cm apart with all other recommended practices.

RESULTS AND DISCUSSION

In the experimental area the major weed species were *Trianthema monogyna* (47.08%), *Echinochloa colona* (27.69%) and *Celosia argentia* (11.69%). The other weeds were only 13.54% at 45 days after sowing of the crop. Among cultivars PK-1241 was more effective in reducing the density of all individual as well as density and dry weight of total weeds followed by JS-335 than PK-1024, however the differences were non significant. Weed control measures significantly influenced the density of individual as well as of total weeds and their total dry weight. Alachlor 2.5 kg ha^{-1} showed significantly low density of *T. monogyna*, *E. colona* and density and dry weight of total weeds as compared to weedy condition. However this reduction could not reach up to the level of weed-free condition.

Table 1 Density (No. m^{-2}) and dry weight (g m^{-2}) of weeds at 45 days stage as affected by soybean cultivars and weed control measures

Treatments	Density					*Dry weight of weeds*
	T. monogyna	*C. argentia*	*E.colona*	*Others*	*Total*	
Cultivars						
PK-1024	1.64 (34)	1.41 (7)	1.69 (14)	2.27 (16)	4.20 (71)	5.09 (157.7)
JS – 335	1.74 (11)	1.65 (8)	1.41 (9)	1.97 (13)	3.87 (41)	5.02 (170.7)
PK – 1241	1.68 (14)	1.25 (6)	1.22 (6)	1.72 (9)	3.64 (35)	4.93 (156.2)
CD at 5%	NS	NS	NS	NS	NS	NS
Weed Control						
Weedy	3.40 (56)	2.41 (15)	2.48 (33)	2.61(15)	3.46(119)	5.98 (421.1)
Weed-free	-	-	-	-	-	-
Alachlor 1.875 kg ha^{-1} PE	1.96 (16)	1.86 (8)	0.93 (2)	2.72 (20)	2.87 (46)	4.78 (139.8)
Alachlor 2.5 kg ha^{-1} PE	1.39 (6)	1.48 (6)	1.42 (3)	2.62 (16)	2.55 (31)	4.29 (85.2)
CD at 5%	1.89	1.27	0.85	1.28	0.70	0.87

Note: Original values given in Parentheses were subjected to Log (x + 1) transformation before analysis

Table 2 Grain yield (kg ha^{-1}) of soybean as affected by cultivars and weed control measures

Cultivars	*Weed control measures*				*Mean*
	Alachlor (kg ha^{-1})		*Weed free*	*Weedy*	
	2.5	*1.875*			
PK – 1024	856	489	1111	267	681
JS – 335	867	495	1856	61	820
PK – 1241	1089	984	1645	233	988
Mean	928	656	1537	187	-

CD at 5% = 510

CONCLUSIONS

Grain yield of different cultivars did not differ significantly. The crop weed competition index for PK-1024 was 76 where as it was 97 and 86 for JS-335 and PK-1241 cultivar, respectively. Alachlor 2.5 kg ha^{-1} gave significantly more grain yield (928 kg ha^{-1}) as compared to the yield obtained in weedy (187 kg ha^{-1}). However weed free also produced significantly more grain yield (1537 kg ha^{-1}) than the yield obtained with alachlor 2.5 kg ha^{-1}. Grain yield of JS-335 cultivar with weed-free condition was significantly more than that of all other interaction except the yield of PK-1241 in weed free condition.

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136- Screening of Bioherbicidal Potential of Different Botanicals Against *Cyperus rotundus* Linn.

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INTRODUCTION

Cyperus rotundus Linn. commonly know as purplenutsedge is the most noxious weed distributed throughout the Globe. It has been listed the world's worst weeds in which *C.rotundus* tops the list. It is associated with almost all upland crops and also occurs in non-cropped areas. Its noxicity is evident as it manages to grow through minute cracks of cemented or asphalted walls and roads and is a nuisance of lawns. Aggressiveness and wide distribution of this species are due to its great adaptability to a wide variety of soil types and environmental conditions (Anderson, 1970). Bio-control of *Cyperus rotundus* Linn. (Purplenutsedge). is very essential because of its ecofriendly nature and can be utilized by small farmers who have no easy access to herbicides. In the present investigation, an attempt was made to find out the allelopathic potential of 24 plant species (Table 1) for their allelopathic potential against *C. rotundus*.

MATERIALS AND METHODS

Pot and laboratory experiments were conducted to study effect of the fresh matter mixed with soil in pots (100g fresh biomatters/kg soil) and in which *C. rotundus* were sown. Various observations like shoot length / tuber, shoot dry weight /tuber, dry weight of tuber were taken20 DAS.

RESULTS AND DISCUSSION

The plant residue that affected the reduction of relative shoot length the most were *C. intybus, T. alexandrium, P. rubra, L. usitatissimum, C. album, A. tenuifolius, A. moschatus, C. gigantea, M. denticulate*, and *E. geniculata* having the respective values of relative shoot lengths of 0.3, 0.34, 0.35, 0. 46, 0.47, 0.51, 0.51, 0.54, 0.62 and 0.63. The plant residue that affected the relative shoot dry weight were *M. indica, C. dactylon, C. intybus, B. oxyodonta, T. alexandrium, P. sativum, P. minima, L. usitatissimum*, and *P. hysterophorous* having the respective values of relative dry weight of 0.7, 0.72, 0.72, 0.77, 0.83, 0.85, 0.85, and 0.86. The plant residue that reduced the tuber dry weight were *M. indica, E. globosus, P. hysterophorous, E. geniculata, C. dactylon, A spinosus, P. minima, A. indica, P. rubra* and *Aeschynomene indica* with their respective relative tuber dry weight values of 0.84, 0.94, 0.94, 0.96, 0.98, 0.98, 0.98, 1.02, 1.06, 1.06, and 1.14. The most important species that showed the common adverse effects on shoot and tuber dry weights were *Mangifera indica, Parthenium hysterophorous, Cynodon dactylon* and *Physalis minima* which appeared to be the promising ones for biocontrol of *Cyperus rotundus*.

Table 1 Relative shoot length, shoot dry weight and dry weight of tubers, 20 days after sowing in bio-matter treated soil (100g fresh biomatters/ kg soil).

S. No.	*Plant species*	*Relative shoot length/ tuber*	*Relative shoot dry weight/ Tub.*	*Relative dry weight/ tuber*
1	*Mangifera indica* Linn.	0.89	0.70	0.84
2	*Eucalyptus globules* Labill.	1.29	0.93	0.94
3	*Parthenium hysterophorous* L.	0.82	0.86	0.94
4	*Cynodon dactylon* Pers.	1.48	0.72	0.98
5	*Physalis minima* Linn.	0.97	0.85	1.06
6	*Azadirachta indica* Linn.	1.33	1.31	1.06
7	*Aeschynomene indica* L.	1.6	1.19	1.17
8	*Plumaria rubra Linn*	0.35	0.98	1.14
9	*Euphorbia geniiculata* Orteg.	0.63	1.06	0.96
10	*Amaranthus spinosus* L.	0.68	1.06	0.98
11	*Chenopodium album* Linn.	0.47	0.96	1.77
12	*Rumex acetosa* Linn.	0.94	0.93	2.44
13	*Cichorium intybus* Linn.	0.30	0.72	1.71
14	*Asphodelus tenuifolius* Car.	0.51	1	2.09
15	*Trifolium alexandrium* Linn	0.34	0.83	1.57
16	*Abelmoschus moschatus* Medik.	0.51	1.04	1.43
17	*Lathyrus sativus* Linn.	0.94	0.97	1.85
18	*Linum usitatissimum* Linn.	0.46	0.87	1.82
19	*Medicago denticulate* Willd.	0.62	0.96	1.74
20	*Calotropis gigantea*, Linn.	0.54	0.93	1.58
21	*Blumea oxyodonta* Linn.	1.26	0.77	1.54
22	*Brassica napus*, Linn.	0.90	0.99	1.92
23	*Pisum sativum* Linn.	0.66	0.83	1.79
24	*Cicer arietinum* L.	0.75	0.91	1.71

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137- Control and Regeneration Potential of *Imperata cylindrica* in Lawn with Glyphosate and Glufosinate Ammonium

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INTRODUCTION

Imperata cylindrica is a problem perennial weed of lawns and turfs. It forms a thick mat of rhizome up to a depth of about 10 cm. It reproduces both through rhizome and seed. The only solution for its control in lawn is to cultivate the lawn during summer and allow the rhizome to dry and than clean the field and relay the lawn. The chemical control of this perennial weed is only possible with herbicides which can kill its rhizome system and may not cause a permanent damage to the lawn. Glyphosate and glufosinate ammonium were tried for its control in lawn during summer seasons of 2003 and 2004.

MATERIAL AND METHODS

In the summer season of the year 2003, two systemic herbicides glyphosate and glufosinate ammonium were tried for its control in lawn as per treatments in Table 1. In the subsequent year (2004) it was observed that the plots earlier treated with glyphosate or glufosinate ammonium were almost free from infestation of *I. cylindrica* and did not require herbicide treatment. However, observations on its regeneration potential were recorded.

RESULTS AND DISCUSSION

The periodic observations showed (Table 1) complete mortality of foliage of *Imperata cylindrica* and lawn with both the herbicides. The resprouting of lawn grass was observed in all glufosinate ammonium treatments but it was slow in glyphosate treatment more so in higher dose (1.0 kg ha^{-1}). There was no resprouting of *Imperata cylindrica* in all treated plots of both the herbicides. With higher dose of glufosinate ammonium (0.9 kg ha^{-1}) the resprouting of lawn was slower than its lower doses (0.75 kg and 0.45 kg ha^{-1}).

The final observations for dry matter of *Imperata* rhizome and lawn were recorded 2 months after the spray. The data in Table 1 indicated that *Imperata* shoot population was significantly lower in all treated plots with both the herbicides. The dry matter of its rhizome was also negligible in all treated plots as compared to untreated control. The lawn resprouting as indicated by its dry matter m^{-2} was lower in both the glyphosate treatments but it was higher in all the glufocinate ammonium treatments than untreated control during the first year of study.

During the summer season of 2004, it was observed that the lawn grass had fully covered the area and had no sign of any toxicity. The observations on population of *I. cylindrica* and dry matter accumulation of its shoot and rhizome and that of lawn grass was recorded in the month of November 2004 and presented in Table 1. The data clearly indicate that glufocinate ammonium provided nearly complete control of *I. cylindrica* for two seasons was observed and the control was better with glufosinate ammonium than glyphosate. The *Imperata cylindrica* rhizome was almost absent from glufosinate ammonium treated plots. The data on dry matter of lawn grass indicated that it completely regenerated in plots treated with both herbicides. The low dry matter of lawn grass in control was due to very higher population of *I. cylindrica*. Singh *et. al.* (2004) observed good control of weeds including perennial with these herbicides in American Cotton.

Table 1 Effect of glyphosate and glufosinate ammonium on control of *Imperata cylindrica* in lawn.

Treatment (dose kg ha^{-1})	*I. cylindrica shoots m^{-2}*	*Dry wt. of I. cylindrica rhizome m^{-2} (g)*	*Dry wt. of lawn grass m^{-2} (g)*	*I. cylindrica shoots m^{-2}*	*Dry wt. of I. cylindrica rhizome g m^{-2}*	*Dry wt. of lawn grassg m^{-2}*
		2003			*2004*	
Glyphosate 1.0	9.5	0.63(1.25)	62.99	306(12.46)	23.6(3.89)	250
Glyphosate 0.5	22.0	1.44(1.54)	91.66	536(20.05)	63.9(7.09)	347
Glufosinate ammonium 0.9	8.5	0.275(1.12)	282.08	0.0(1.0)	0.0(1.0)	411
Glufosinate ammonium 0.75	15.5	1.0(1.36)	317.97	0.0(1.0)	1.4(1.39)	520
Glufosinate ammonium 0.45	39.5	2.0(1.69)	404.29	38.9(5.09)	5.6(2.4)	561
Control	202.0	128.32(10.90)	246.31	1067(32.66)	139(11.68)	152
CD at 5%	70.01	(2.28)	150.10	(12.86)	(4.02)	146

Figures in parenthesis are square root (x+1) transformed values

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138- Effect of Glyphosate and Glufosinate Ammonium on Propagation Potential of *Sorghum halepense*

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INTRODUCTION

Sorghum halepense (Johson grass) is a problem perennial weed of *kharif* season crops except rice. It propagates both through seeds and rhizome. For its successful control, a systemic herbicide is required which can kill underground rhizome along with its shoot and prevent seed formation. Two systemic non selective herbicides glyphosate and glufosinate ammonium (BASTA 15 SL) were tried for two years (2003 & 2004) to see their efficacy for its control and propagation potential.

MATERIALS AND METHODES

Sorghum halepense appears in patches in the field. Therefore, to create uniform population of this weed, the rhizomes were collected and planted in experimental plots at equal distance. The plants were allowed to establish and when these were about 30 cm tall, the first spray was made during first week of August. The second and third split applications of these herbicides were done at one week interval as per treatments given in Table 1. To see the regeneration potential of the weed after treatment, the rhizome samples were collected 10 days after last spray. Five rhizome pieces having 4 nodes each from all treatments including control were planted in earthen pots. The observations on regeneration in the form of number of shoots, new rhizome formation, and their dry weight per pot were recorded during third week of November.

RESULTS AND DISSCUSSION

The shoot mortality was quicker and complete in glufocinate ammonium at all doses than in glyphosate. In the field it was observed that the regeneration was more and fast in glufosinate ammonium treatments but in glyphosate, the regeneration in the form of new shoots was very low and slow. By the end of the season considerable regeneration was also observed in glyphosate treated plots.

Table 1 Effect of glyphosate and glufosinate ammonium on regeneration potential of *Sorghum halepense* (Initially 5 rhizome fragments having 4 nodes each from treated plants planted in each pot)

TreatmentDose kg ha^{-1}	Shoot dry matter/pot (g)	Rhizome length/pot (cm)	Rhizome dry matter/ pot (g)	Shoot dry matter/pot (g)	Rhizome length/pot (cm)	Rhizome dry matter/ pot (g)
		2003			2004	
Glyphosate 1.0	0.14(1.06)	4.8(1.86)	0.25(1.01)	0.21(1.10)	0.0(1.0)	0.0(1.0)
Glyphosate 1.5	0.0(1.0)	0.0(1.0)	0.0(1.0)	0.02(1.01)	0.0(1.0)	0.0(1.0)
Glyphosate 0.5 f.b. 0.5	0.0(1.0)	0.0(1.0)	0.0(1.0)	0.11(1.05)	0.0(1.0)	0.0(1.0)
Glyphosate 0.5 f.b. 0.5 f.b. 0.5	0.0(1.0)	0.0(1.0)	0.0(1.0)	0.02(1.01)	0.0(1.0)	0.0(1.0)
Glufosinate ammonium 0.9	1.28(1.48)	71.3(8.46)	4.43(2.30)	1.19(1.46)	35.5(5.99)	3.21(2.02)
Glufosinate ammonium 0.45 f.b. 0.45	2.56(1.83)	109.0(10.27)	7.04(2.76)	0.61(1.26)	22.0(4.62)	1.51(1.56)
Glufosinate ammonium 0.3 f.b. 0.3 f.b. 0.3	3.42(2.09)	150.0(12.23)	9.40(3.17)	1.53(1.55)	22.3(4.26)	2.00(1.69)
Control	3.57(2.10)	173.8(13.07)	9.70(3.26)	1.70(1.64)	53.5(7.28)	5.61(2.56)
CD at 5%	(0.38)	(2.08)	(0.55)	(0.29)	(1.68)	(0.40)

Figures in parenthesis are square root (x+1) transformed values

The observations on pot studies revealed that by end of season there were few sprouts observed in glyphosate 1.0 kg ha^{-1} treatment, whereas in glyphosate 1.5 kg ha^{-1} and two or three split applications of 0.5 kg ha^{-1} each, the number of resprouts were very low as compared to glyphosate 1.0 kg ha^{-1} and all glufosinate ammonium treatments. In glyphosate treatments the sprouts attained height maximum up to 5 cm while it was 10-15 cm in glufosinate ammonium treatments and above 20 cm in control. In all glyphosate treatments the plant could not enter into flowering while it produced seeds in glufosinate ammonium treatments and untreated control. In all glyphosate treatments no new rhizome formation took place, while under glufosinate ammonium new rhizome formation was observed (Table 1). Singh e*t. al.* (2004) observed good control of weeds including perennial with these herbicides in American Cotton. Miller e*t. al.* (1998) reported 90 per cent suppression of *Sorghum halepense* with glyphosate across the rainfall period. The study indicated that glyphosate reduced regeneration potential of *Sorghum halepense* more effectively than glufosinate ammonium by reducing resprouting and new rhizome formation and also seed formation.

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139- Morpho Physiology and Biology of Invasive Weeds: Threat to Biodiversity

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INTRODUCTION

The flora of Chhattisgarh state consists of indigenous as well as alien species. The state has 2000 species of flowering plants of which more than 20% are aliens. The aliens are either invasive or non-invasive naturalized plants. On the basis of their nativity, such species may be grouped into five categories viz. Austro-Asian, Tropical and South African, North African and Arabian, North temperate and Neo-tropical (Khanna and Singh, 2004). It is noteworthy that a number of fast spreading alien species naturalized in the state. Some of the alien species are invasive and affect the natural ecosystems and the indigenous flora adversely ie., *Parthenium hysterophorus L., Lantana camara L , Ipomea carnea Jacq., Eichhornia crassipes (mart) Solms, Argemone mexicana L., Casia tora L., Casia occidentalis L., Croton banplandianum Baill.*. Therefore, the study have been taken to find out the morphophysiological and biological behaviour of invasive species for this region.

MATERIALS AND METHODS

The experiment was conducted in normal growing season via survey study in crop fields and wasteland to find out the floristic composition of native and invasive flora in the field at instructional and research farm as well as in the farmers fields. The quantitative structure of plant communities were measured by using the quadrates methods as sampling techniques and expressed quantitatively both in absolute terms for each species and IVI (importance value index) were taken as a criteria to classify the weed species in major and minor groups. The plants of specific weed species were selected and tagged for collection of weed seeds to quantify the yield potential and seed rain of particular weed species. Dry matter production rate was calculated by taking the dry matter of plant at different time intervals. Physiological observations were taken by using Infra red gas analyzer (IRGA, LiCOR 6400, USA) for stomatal conductance, photosynthesis, transpiration and diffusive resistance. Germination and seedling growth behaviour study was done by using the seed germinator for the collected seed of different seasons. Seeds were collected and kept in the airtight glass containers and tested for the seed viability in petry dishes at different time intervals and temperature on wet germination paper.

RESULTS AND DISCUSSION

The alien weeds pose a serious threat to the useful crops. Their bio invasion reduces the yield and economic returns of the farmer. Many weeds ruthlessly ramify defying mechanical, chemical and biological means of management. Crops and weeds coexist as letters in the alphabet Q and U posing an inseparable bio disaster (Rao, 2004).

Seed germination and biology of kharif season weeds showed that *Galinsoga parviflora, Euphorbia hirta, Ageratum conyzoides* showed no dormancy (zero dormancy) and have given good germination percentages i.e., 25, 20 and 2 at 20 °C in the seed germinator just after two weeks of collection of seeds of weed species. This is the reason that these species have appeared at different times and have multiplied at the cost of indigenous species. They have lain seize of vast areas and driven many natural plants to rare and threatened category (Jain and Biswas, 2004). However, the other remaining weeds species did not show the germination response at this temperature.

Xanthium strumarium, Lantana camera (Gotifule), Celosia argentea (Siliyari), Galinsoga parviflora have shown very good seed yield potential and seed rain /m^2 in vertisols (table 2). These weeds having higher photosynthetic rate as compared to crop plant in field situation and even in waste land conditions (Katiyar and Kolhe, 2002)., *Eichhornia crassipes* showed very high growth even in artificial cultivation in cement pots in both rabi and kharif season (Katiyar, 2003). The quantitative estimates have shown the intervention of these weed species also in crop field (Katiyar and Kolhe, 2002). *Lantana camera (Gotiphool), Celosia argentea (Siliyari), Galinsoga parviflora, Parthenium hysterophorus L, Echhornia crassipes* are now identified as problematic weeds of the state in AICRP-WC programme.

Table 1.Seed production potential and biology of rabi and kharif season weeds

S. No.	*Name of Weed species*	*Local Name*	*100 (SI) seeds wt*	*Induction period for germination 2003 % CY Hrs (24.2 34.5 °C)*		*Induction period for germination 2004 % CY Hrs (12.8-25.5 °C)*		*Seed-ling 15 DAS (cm)*	*Dorm-ancy*
				%	*CY Hrs*	*%*	*CY Hrs*		
1.	*Xanthiun strumarium*	Gokhuru	19.47						
2.	*Galinsoga parviflora*	Jangli Geera	0.12	46	15	52	25	3.6	Nil
3.	*Lantana camera*	Gotiphool	1.86			-	-		
4.	*Celosia argentea*	Silyari	0.030			-	-		
5.	*Euphorbia hirta*	Dudhia	0.67			48	20		Nil
6.	*Ageratum conyzoides*	Mahakawa	0.012			70	2		Nil
7.	*Parthenium hysterophorus*	Gajar ghass	0.039		-	-	-		-
8.	*Croton banplandianum*	Van mirchi	0.009			-	-		-

Table 2.Seed production potential of rabi and kharif season weeds (2004)

SN	Weed SpeciesBotanical name (Local name)	No. of seeds/ plant Av. range	Test wt. (g/1000 seeds)	Seed rain no. seeds/m²	Location Wasteland (WL) Cropland (CL)	Soil type
1.	*Croton banplandianum(Van mirch)*	1.08	-	-	CL	Vertisol
2.	*Fimbristylis millacea (bandar puchia)*	1.58 CL2.40 WL			CLWL	Vertisol
3	*Ageratum conyzoides (Mahakawa)*					
4.	*Lantana camera (Gotifule)*	14.46	18.18	106	WL	Inceptisol
5.	*Celosia argentea (Siliyari)*	6.328.16	0.30 CL	11016	CLWL	Vertisol
6.	*Galinsoga parviflora (Jangali Jeera)*	3.86 WL3.21 CL	1.41 WL			
7.	*Euphorbia hirta (Dudhia)*	1.75	6.80	980	WL	Vertisol
8.	*Xanthium strumarium (gokhuru)*	14.72 WL	19.23	72		Vertisol

CONCLUSIONS

It was observed that the invasive species possessed high adaptability to survive in wide range of environmental conditions, zero or less seed dormancy period, high dry matter production rate, fast propagation. These characteristic features of *Parthenium hysterophorus, Galinsoga parviflora, Lantana camara, Echhornia crassipes,* invasive species of wasteland and *Ageratum conyzoides, Borreria laevis (Lam) Griseb, Croton banplanddianum, Cynodon dactylon and Fimbristylis millacea* of crop land made them aggressive hence they can easily colonize plantations and expanding their zone of occupancy in a quick succession ultimately bringing striking changes in the biological diversity of the region.

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140- Effect of Flooding Timings and Water Depth on the Growth of *Leptochloa chinensis*

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INTRODUCTION

Rice grown in light or medium textured soils is severely infested with *Leptochloa chinensis*. This weed is becoming more and more serious weed in the recent years and now it has become a dominant weed especially in North-Eastern Haryana. A change in dominance of weeds is largely attributed to change in cultivation practices or poor efficacy of herbicides used by the farmers against a particular weed. It is generally said that *Leptochloa* generally grows vividly under shallow flooded condition and seldom grows in deep flooded transplanted rice .There fore some green house trials were conducted at CCS HAU Hisar during Kharif 2004 in order to clarify the effect of flooding timings and water depth on the growth of *Leptochloa chinensis.*

MATERIALS AND METHODS

Seeds of *Leptochloa* were put in plastic buckets containing moist soil and soil was kept moist until germination of *Leptochloa* to its target leaf stage for testing. After attaining desired leaf stage, pots were flooded at 2, 3, 4,5 and 6 leaf stages of the weed at three different water depths (1,3and 5 cms), and same water level was kept during the whole trial period. Percent control of *Leptochloa* was evaluated through visual observations at 7, 15 and 30 days after flooding in accordance with the 0-100 rating system from 0 means no effect and 100 means complete kill.

RESULTS AND DISCUSSION

Table 1 shows the effect of flooding timings and water depth on the growth of weed. When the leaves and stems were covered with water completely, all the plants died regardless of their leaf stages at flooding. On the other hand, when the tips of leaves were above water surface, their growth was inferior to but did not die completely. When some leaves were above water surface, 27-30 % of plant growth was suppressed at 30 DAF. In case most of leaves were above water surface, growth was not effected at all.

From the above results, it was clarified that *Leptochloa chinensis* can not grow under prolonged conditions.

Table1 Effect of flooding timings and water depth on the growth of *Leptochloa chinensis.*

Timing of flooding	*Water depth (cm)*	*Mean % weed control* [1]			*Appearance of L .chinensis at flooding*
		7 DAF	*15DAF*	*30 DAF*	
2.0 L S.	1.0	57	55	55	Tip of the plant was above water surface
	2.0	85	80	80	Tip of the plant was above water surface
	3.0	100	100	100	The plant was covered with water completely
3.0 L.S.	1.0	30	27	27	Some leaves were above water surface
	2.0	68	70	70	Some leaves were above water surface
	3.0	100	100	100	The plant was covered with water completely
4.0 L.S.	1.0	0	0	0	Most part of the leaves and stem were above water surface
	2.0	20	30	30	Some leaves were above water surface

	3.0	70	67	70	Some leaves were above water surface
5.0 L.S.	1.0	0	0	0	Most part of the leaves and stem were above water surface
	2.0	0	0	0	Most part of the leaves and stem were above water surface
	3.0	10	12	10	Some leaves were above water surface
6.0 L.S.	1.0	0	0	0	Most part of the leaves and stem were above water surface
	2.0	0	0	0	Most part of the leaves and stem were above water surface
	3.0	0	0	0	Most part of the leaves and stem were above water surface

Evaluation scale: 0= no effect, 100= complete kill; 1) Average of three replications; 2) DAF= Days after flooding; 3) L.S. = Leaf stage of *Leptochloa chinensis*

141- Weed flora of Pearlmillet in district Hisar of Haryana

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INTRODUCTION

Pearlmillet is an important kharif crop of district Hisar grown mainly under rain fed conditions or under restricted irrigation facility in pearlmillet-mustard or pearlmillet-fallow wheat sequence. Knowledge of weed species associated with a crop in a region is very necessary for planning an effective weed control programme. Some attempts to survey the weed flora of pearlmillet fields in Haryana have been attempted earlier but during the last decade conspicuous changes in cropping system have taken place. The present study is an attempt to document information on most common weeds associated with pearlmillet crop being grown as major Kharif crop in different blocks of district Hisar.

MATERIAL AND METHODS

To study the floristic composition of pearlmillet, 68 pearlmillet fields approximately one month after sowing were surveyed in August2004 in five blocks namely Hisar,Hansi,Barwala,Aadmpur and Uklana.Only one block in the district Narnaund predominated by rice-wheat and cotton –wheat sequence was not surveyed . Weed species infesting pearlmillet fields were recorded on selected routes based on road map after every 10 kms. The location for recording composition and density of weeds was selected 200 meters away from the road side and species wise weed counts were taken using a quadrat of 50x50 cms from four places randomly from a field of one acre usually.

RESULTS AND DISCUSSION

In all 26 weed species were found to infest pearlmillet fields in whole of the district. Out of 26 weed species 7 were of grass family, 2 sedges and 15 belong to broadleaf weeds (Table1). On an average, *Trianthema portulacastrum* was the most dominant weed comprising 35.7 % of total weed flora with a density of 50.4 plants /m2 followed by *Digera arvensis* (18.5%), *Dactyloctenium aegypticum* (10.9%), *Celosia argentia* (5.9%), *Phyllanthus niruri* (4.9%) and *Cyperus rotundus* (3.8%).In all blocks except Barwala, carpet weed (*Trianthema portulacastrum.*) was the most dominant weed where as in Barwala bajra being grown in light textured soils. *Digera arvensis* dominated weed flora (27.7%) flowed by *Trianthema, Phyllanthus niruri.Calotropis* showed its presence in Barwala block although low in density. In Barwala block, this crop is grown under rain fed conditions where as in other blocks farmers apply protective irrigation with slightly brackish tube well water which is responsible for its high density in these blocks.

Table1 Weed flora of pearlmillet in district Hisar.

Weed species	Hisar		Hansi		Barwala		Adampur		Uklana	
	Density (No/m²)	R.D. (%)	Density (No/m²)	R.D. (%)	Density (No/m²)	R.D. (%)	Density (No/m²)	R.D. (%)	Density (No/m²)	R.D. (%)
Trianthema portulacastrum	47.6	35.4	58.2	36.8	20.0	11.5	69.7	47.4	56.4	40.7
Eragrotis pilosa	0.2	0.14	-	-	1.0	0.6	-	-	-	-
Bracharia reptans	0.3	0.22	-	-	2.0	1.2	1.0	1.0	-	-
Chloris barbata	-	-	-	-	0.6	-	-	-	-	—
Dactyloctenium aegypticum	17.5	13	22.6	14.2	9.0	5.4	13.3	10.9	15.1	10.8
Tribulus terrestris	0.6	0.41	0.8	0.5	3.5	2.7	1.7	1.01	2.0	1.44
Setaria gluaca	2.0	1.48	-	-	1.2	0.7	-	-	-	-
Cyperus rotundus	4.3	3.2	9.0	5.6	2.8	2.2	3.4	1.02	7.2	5.19
Cenchrus	1.2	0.8	0.9	0.56	2.4	1.9	2.2	1.49	3.0	2.16
Cyperus compressus	-	-	-	-	1.2	0.95	-	-	2.6	1.87
Sorghum halepense	0.24	0.1	-	-	0.14	0.1	-	-	-	-
Boerhavia diffusa	1.2	0.89	0.9	0.56	2.4	1.90	-	-	-	-
E.hirta	2.6	1.9	2.1	1.3	0.5	0.3	4.0	2.72	1.3	1.0
Cynodon dactylon	2.0	1.4	0.9	0.5	2.7	1.02	1.8	1.22	1.3	1.0
E.colonum	11.1	8.26	6.7	4.2	7.6	10.6	3.0	1.02	8.2	10.5
Portulaca oleracea	2.0	1.4	3.0	1.8	1.7	1.34	-	-	-	-
Phyllanthus niruri	6.0	4.4	7.8	4.9	11.0	10.8	4.3	2.92	3.8	2.73
Panicum	2.0	1.4	-	-	3.6	2.85	-	-	-	-
Calotropis procera	-	-	-	-	0.3	0.2	-	-	-	-
Celosia argentia	6.0	4.4	8.9	7.0	11.2	8.8	9.0	6.12	6.6	4.75
Convolvulus arvensis	1.2	0.8	2.0	1.26	0.6	0.4	1.2	0.9	1.4	1.0
Ipomea purpurea	0.6	0.4	2.1	1.28	2.3	1.8	2.4	2.04	3.0	2.16
Corchorus tridens	2.6	1.7	1.6	1.0	-	-	-	-	-	-
Physallis minima	0.9	0.6	2.1	1.28	3.0	2.38	1.0	0.5	2.0	1.44
Digera arvensis	22.2	16.5	26.1	16.51	34.9	27.7	27.8	11.89	19.6	14.13
Amaranthus viridis	1.3	0.9	2.4	1.51	1.0	0.7	0.6	0.40	5.2	37.4

142- Herbicidal Activity of *Solanum viarum* Dunal. to *Pistia stratiotes* L.

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INTRODUCTION

Modern agriculture depends heavily on pest control and weed management. Though synthetic herbicides and other pesticides have greatly facilitated weed management in crops and reduced labour, yet their use has potential environmental and toxicological costs raising question about our agricultural dependence on these molecules (Macias et al., 2001). Sustained use of herbicides has resulted in development of herbicide resistance in weeds. Thus quest for new, more efficient and specific, and environment friendly pest management strategies and pesticides including herbicides continues. The synthesis of thousands of chemical compounds is required for a chemical that makes it to the market. The natural products and their relatives have been viewed as sources of potential environment friendly herbicides (Duke et. al., 2000). The fete offered by the naturally occurring phytotoxic substances of plant origin for development of newer environment-friendly herbicides and other pesticides and for providing leads for development of newer herbicides and pesticides with novel chemistry is attractive for the obvious reasons. Thus, pest including weed management through natural products is an attractive possibility for sustainable agriculture and for environment protection. Plant parts and their constituents have potential phytotoxicity to aquatic weeds and there are instances of less phytotoxicity to crop than to associated weeds (Pandey 1996). There are no reports in the scientific literature on herbicidal properties of *Solanum viarum* Dunal. and its constituents on aquatic weeds. Hence the present study was undertaken to investigate herbicidal property of *Solanum viarum* on floating aquatic weed *Pistia stratiotes* L.

MATERIALS AND METHODS

Solanum viarum leaves were dried, ground to fine powder (>80 mesh) and suspended in a quarter strength nutrient medium in 20 liter tubs outdoors. Preweighed plants of the floating aquatic weed *Pistia stratiotes* were placed in the medium and phytotoxicity and biomass were monitored. Evapotranspiratory loss of water from the tubs was replenished twice daily. Effect of the lethal concentration of the leaf residue of the *Solanum viarum* on photosynthetic pigments, starch, sugars and amino acids in the leaves and leakage of solutes from the roots of the treated plants of *Pistia stratiotes* were studied by the methods detailed earlier (Pandey 1996).

RESULTS AND DISCUSSION

The experimental results (Table 1) showed that *Solanum viarum* leaf residue was lethal to *Pistia stratiotes* at and above 0.5% (dry weight /v). At lethal concentration the phytotoxicity on *Pistia stratiotes* appeared in 4-6 days. Initially the treated plants developed dull green appearance. This was followed by desiccation of plants from the margins of older leaves and spreading subsequently to the younger leaves. This was followed by desiccation and decay of the treated plants in 5-7 days. Phytotoxicity of the *Solanum viarum* leaf residue on *Pistia stratiotes* was accompanied by development of flaccidity in the roots. There was loss of chlorophyll a, b, total chlorophyll and carotenoids, sugars, starch, amino acids, etc. in the leaves of the treated plants. The roots of the treated plants showed massive leakage of cellular constituents viz., electrolytes, UV absorbing substances, K, P, and sugars. The phytotoxicity of the leaf residue appeared to involve massive damage to cellular membrane integrity in the roots of the treated plants as evidenced by excessive leakage of the cellular constituents. Thus, the phytotoxic constituents in the *Solanum viarum* leaf residue appear to have killed the treated plants by causing root dysfunction derived desiccation and associated syndrome involving loss of cellular structure and function.

There is an urgent need of exploring *Solanum viarum* constituents for herbicidal activity on aquatic weeds for assessing their potential for an ecofriendly management of the weed by using phytotoxins as herbicides.

Table 1. Phytotoxicity of *Solanum viarum* leaf residue (LR) on *Pistia stratiotes*

A. Effect on biomass (minus hundred % shows death of the treated plants)

Treatment (% LR dry weight / v)	*% Change in biomass over initial value after days*	
	5	10
Control	74.5±15.2	22.2±7.7
0.10	90.9±39.0	14.0±6.2
0.25	-62.6±64.7	-100
0.50	-100	-100
CD at 5%	72.0	9.3

B. Biochemical changes associated with lethal concentration (0.50%) of the LR

Parameter	*Values days after initiation of the treatment*					
	Control	*2*	*4*	*6*	*8*	*LSD at P=0.05*
	Photosynthetic pigments in the leaves (mg g^{-1} dry weight)					
Chlorophyll a	1.82±0.24	1.21±0.16	0.39±0.20	0.05±0.08	0.02±0.02	0.303
Chlorophyll b	0.74±0.15	0.56±0.23	0.11±0.18	0.16±0.14	0.10±0.12	0.310
Total chlorophyll	2.57±0.39	1.79±0.35	0.45±0.42	0.19±0.21	0.13±0.14	0.594
Carotenoids	0.99±0.11	0.80±0.04	0.61±0.28	0.18±0.17	0.03±0.04	0.293
	Starch, sugars and amino acids in the leaves (mg g^{-1} dry weight)					
Starch	58.2±4.3	57.4±1.7	51.0±2.4	42.7±2.2	35.9±4.0	5.69
Sugars	22.7±1.2	20.3±0.61	18.1±1.3	15.9±0.57	14.1±0.4	1.63
Amino acids	-	-	-	-	-	-

C. Solute leakage from roots (g^{-1} dry weight h^{-1} basis)

EC (μ S cm^{-1})	105.5±9.6	130.6±3.6	132.8±5.1	151.4±12.5	165.7±2.6	13.88
Units of OD at 264 nm (0.01 OD = 1 unit)	134.7±6.4	137.1±12.1	264.6±17.7	335.5±12.7	351.6±8.7	22.11
K (mg)	0.72±0.05	1.01±0.02	1.07±0.15	1.13±0.03	1.26±0.03	0.132
P (μg)	295±46.7	461±35.1	610±44.1	730±17.3	816±20.8	63.5
Sugars (μg)	118.6±31.4	286.2±22.5	285.3±50.7	364.4±33.6	313.3±13.3	59.6

The values are means ± SD of three determinations.

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143- Bio-Efficacy and Phytotoxicity of Metribuzin and Pendimethalin in Potato (*Solanum tuberosum* L.) Crop Raised from True Potato Seed

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INTRODUCTION

Potato is considered as most important food crop in international scenario after rice, wheat and maize. In India, this crop is grown in various agro-climatic zones and its importance is increasing in non-conventional areas like central and southern plateau region and north-eastern states, where normal seed production is not possible due to severe incidence of viruses and other diseases. Also, transportation of seed material from north-western plains and hills to crop production areas becomes highly expensive. Therefore, in such areas raising of seedling tubers from TPS and their utilization as seed is very economical. But infestation of weeds in TPS nursery beds in initial stage of seedling development is very acute due to FYM application and slow growth of this crop. Manual weeding is very tedious, time taking and expensive for growers due to mimicry of weed species. The chemical weed control may prove to be a better alternative, which has yet not been tested under Indian conditions. Therefore the study was planned to test the bio-efficacy and phytotoxicity of commonly used weedicides (metribuzin and pendimethalin) for potato seed and ware crop in TPS nursery beds raised for seedlings tubers.

MATERIALS AND METHODS

Field experiment was conducted at Research Farm of Central Potato Research Institute Campus, Modipuram, Meerut during winter season of 2002-2003. The soils of the experimental site was sandy loam with neutral pH, low in available nitrogen, medium in available potash and high in available phosphorus. A set of five treatments (Table 1) were laid out in RBD with three replication. Sowing of the TPS of HPS I/13 for producing seedling tubers was done at 25 x 4 cm spacing and two seeds per hole were sown to facilitate gap filling and to compensate mortality. TPS were sown on 31st October 2002 while weedicides (as per treatments) were sprayed on 26th October 2002 as pre plant incorporation to avoid loss due to volatilization. For better and uniform germination TPS were sown at 0.5 cm depth and covered with a fine layer of FYM. All the recommended package of practices was followed to raise the TPS crop for seedling tuber production (Thakur *et at.*, 2003).

The data on weed count, plant stand and crop injury was recorded at 40 days after sowing. The crop was dehaulmed at 90 days after sowing and harvested ten days later after skin curing. The produce was manually graded into two categories i.e. < 5 g and > 5 g to record the yields.

RESULTS AND DISCUSSION

Effect on Weeds

The dominant weed flora of the experimental site were : *Coronopus didymus, Poa annua, Trianthema spp., Anagallis spp., Rumex spp., Fumaria parviflora* and *Gnapelium indica.* Application of metribuzin (0.3 kg ha^{-1}) resulted in maximum weed control as evidenced by lowest weed count and weed weight (Table 1). The higher dose of pendimethalin (1.0 litre ha^{-1}) showed higher weed control than its lower dose

((0.75 litre ha^{-1}). Weedy treatment resulted in highest weed density and weed fresh weight m^{-2}. Similar findings were earlier reported in seed potato crop (Rana *et at.,* 2004)

Table 1. Phytotoxic effect of weedicides on plant stand and weed flora

Treatment	*Plant stand m^{-2}*	*Crop injury at 40 DAS (%)*	*Weed count m^{-2}*	*Weed fresh wt. (g) m^{-2}*
Weedy	82	18	356	1565
Weed free	100	0	0	0
Metribuzin (0.3 kg ha^{-1})	25	75	2	2
Pendimethalin (0.75 lit. ha^{-1})	43	57	192	235
Pendimethalin (1.0 lit. ha^{-1})	36	64	44	40

Effect on Crop

Both weedicides metribuzin (0.3 kg ha^{-1}) and pendimethalin (0.75 and 1.0 litre ha^{-1}) were phytotoxic to the seedlings and resulted in severe stand loss. Crop injury or stand loss due to pre plant incorporation of weedicides ranged from 57 to 75 percent, highest (75 %) being due to metribuzin (0.3 kg ha^{-1}). Stand loss due to uninterrupted growth of weeds in weedy check treatment was 18 % which can be attributed to the severe inter specific competition between TPS seedlings and weeds (Table 1).

Graded as well as total tuber number and tuber weight m^{-2} were significantly higher in weed free treatment. Phytotoxicity to TPS seedlings due to metribuzin (0.3 kg ha^{-1}) and pendimethalin (1.0 litre ha^{-1}) was so acute that even weedy check treatment surpassed both these treatments as far as graded and total tuber number and tuber weight were concerned. However, lower dose of pendimethalin (0.75 litre ha^{-1}) proved better than weedy check treatment but significantly inferior than weed free treatment (Table 2). The better performance of pendimethalin (0.75 litre ha^{-1}) than weedy check was due to the fact that average tuber number and weight per plant was higher than weedy check because pendimethalin (0.75 litre ha^{-1}) showed weed control efficiency as high as 85 %.

Seeing the severe phytotoxicity to TPS seedlings it may be suggested that much more molecules are needed to be tested at different doses/timings for achieving selective and acceptable weed control in TPS crop raised in nursery beds for seedling tuber production.

Table 2. Effect of weedicides on tuber number and tuber weight

Treatment	Tuber number m^{-2}			Tuber weight (g) m^{-2}		
	< 5 g	>5 g	Total	< 5 g	>5 g	Total
Weedy	261.3	106.2	367.5	520.0	1000.0	1520.0
Weed free	332.0	168.0	500.0	786.5	1592.9	2379.4
Metribuzin (0.3 kg ha^{-1})	116.9	45.3	162.2	222.2	413.3	635.5
Pendimethalin (0.75 lit. ha^{-1})	246.7	147.1	393.8	462.2	1324.4	1786.6
Pendimethalin (1.0 lit. ha^{-1})	110.2	64.0	174.2	222.2	764.4	986.6
CD at 5%	56.4	50.8	67.1	92.2	132.0	147.88

CONCLUSION

Application of metribuzin (0.3 kg ha^{-1}) and pendimethalin (0.75 and 1.0 litre ha^{-1}) pre -plant incorporation (PPI) to True Potato Seed (TPS) raised for seedling tuber production were highly phytotoxic resulting in seedling stand loss as high as 57 - 75 percent. Tuber number and tuber weight m^{-2} were significantly lower in case of metribuzin (0.3 kg ha^{-1}) and pendimethalin (1.0 litre ha^{-1}) treatments even as compared to weedy check plots.

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144- Bio-efficacy of Herbicides to Control Weeds in Potato

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INTRODUCTION

Potato, being slow growing at the initial stages and taking long time for germination, faces severe weed problem. Being a heavy feeder crop its frequent demand for irrigation provides congenial conditions for the growth of weeds. Weeds interfere with the development of potato tubers thereby reducing tuber yield to the extent of 40-65% under uncontrolled weed situation (Tripathi *et al.*, 1989). Manual weeding, no doubt is quite effective, but is time consuming, tedious, costly and some times may cause root injury. Chemical weed control thus would be more efficient, easy and even economical. Therefore, certain new herbicides have been tried with varying rates in the present experiment.

MATERIALS AND METHODS

Field experiments were conducted during spring season of 2001 and 2002 at the Research Farm of Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur. The soil of the experimental field was silty clay loam in texture, acidic in reaction (pH 5.5), medium in organic carbon (0.7%), low in available nitrogen (226.2 kg/ha), medium in available phosphorus (17.8 kg/ha) and high in available potassium (306.5 kg/ha). Potato variety Kufri Jyoti was planted keeping 60 x 20 cm spacing on January 27, 2001 and on January 11, 2002 respectively. The experiment was conducted in randomized block design with 12 treatments and 3 replications. Twelve treatments comprised of prometryn (1.0 and 1.5 kg/ha), Pendimethalin 1.5 kg/ha, metribuzin (0.3 and 0.5 kg/ha), paraquat 0.6 kg/ha, atrazine 1.0 kg/ha, isoproturon 1.5 kg/ha, napropamide 1.0 kg/ha, oxyfluorfen 0.15 kg/ha, farmers practice and weedy check (Table 1). Metribuzine and isoproturon were applied at 30 days after planting and paraquat was applied as pre emergence to crop but post emergence to weeds. The herbicide spray was done with knap sack sprayer fitted with flat fan nozzle using 700 l water ha^{-1}. The data on density and total dry weight at harvest stage of crop growth was recorded from two randomly selected quadrates (0.25 m^2) in each plot and expressed as number and g m^2.

RESULTS AND DISCUSSION

The experimental field was predominantly infested with *Phalaris minor, Ranunculus arvensis, Vicia sativa, Coronopus didymus, Lolium temulentum* and *Anagallis arvensis.* All the weed control treatments significantly reduced the density and dry weight of weeds over unweeded check (Table 1). Among herbicides treatments, Pendimethalin 1.50 kg/ha was most effective in reducing the density of all weeds during both the years of study. Oxyfluorfen 0.15 kg/ha (Pre.) behaving statistically alike with metribuzin 0.3 kg/ha and paraquat 0.6 kg post emergence to weeds were the next best treatments. Pendimethalin 1.5 kg/ha behaving statistically similar with oxyfluorfen 0.15 kg/ha resulted in significantly lower dry weight of weeds during both the years. Significantly higher tuber yield was obtained with pendimethalin 1.50 kg/ha. However, this treatment remained statistically at par with prometryn 1.5 kg/ha during 2001 and with metribuzin 0.3 kg/ha, atrazine 1.0 kg, oxyfluorfen 0.15 kg/ha and farmer's practice during 2002.

Table 1 Effect of different herbicides on weed density, dry weight of weeds and tuber yield of potato

Treatment	Dose ($kg\ ha^{-1}$)	Time of application	Weed count ($No\ m^{-2}$)		Weed dry weight ($g\ m^{-2}$)		Potato tuber yield ($q\ ha^{-1}$)	
			2001	2002	2001	2002	2001	2002
Prometryn	1.0	Pre.	10.3 (105.3)	11.4 (130.7)	67.14	132.5	108.70	68.16
Prometryn	1.5	Pre.	7.7 (58.6)	9.9 (97.3)	58.99	98.7	130.20	82.34
Pendimethalin	1.5	Pre.	5.7 (32.6)	3.9 (14.9)	43.88	91.5	136.53	100.31
Metribuzin	0.3	Post	8.2 (67.3)	9.2 (84.0)	25.77	17.3	96.46	54.01
Metribuzin	0.5	Post	8.1 (66.0)	7.9 (61.3)	25.77	48.5	96.46	97.74
Paraquat	0.6	Post to weeds but pre to crop	7.3 (53.3)	8.7 (74.7)	61.73	40.5	111.29	79.73
Atrazine	1.0	Pre.	9.3 (86.0)	6.3 (38.7)	37.80	96.0	67.68	88.73
Isoproturon	1.5	Post (30 DAP)	8.8 (78.0)	11.3 (126.7)	53.29	117.6	100.95	78.44
Napropamide	1.0	Pre	9.1 (82.0)	11.0 (122.7)	34.99	143.2	103.13	79.73
Oxyfluorfen	0.15	Pre.	6.8 (46.6)	6.2 (38.3)	21.13	4.3	90.68	92.59
Farmer's Practices	-	2 HW & earthing up	7.7 (59.3)	8.3 (69.3)	39.13	20.5	96.19	97.74
Unweeded	-	-	14.0 (197.3)	15.6 (242.7)	142.02	317.3	71.75	37.29
CD at 5%			0.56	1.8	16.97	40.9	16.37	14.59

DAP – Days after sowing; HW – Hand weeding
Figures in parentheses are the original values

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145- Weed Management in Potato (*Solanum tuberosum* L.) under Uttaranchal Tarai Conditions

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INTRODUCTION

Potato is the most important food as well as vegetable crop of the world. It is commonly grown on highly productive and irrigated soils in which the weeds emerge even before the emergence of potato and get established earlier than the crop if not managed at the proper stage. Thus, weeds need to be tackled on top priority due to their competition with the crop and tuber yield reductions. Yield reductions in potato can be as high as 62 per cent (Singh and Bhan, 1999) and 74 per cent (Ahuja *et al.*, 1999).

MATERIALS AND METHODS

The present study was undertaken to study the effect of different weed management treatments on the tuber yield of potato during winter season of 2002-03 and 2003-04 at Vegetable Research Centre of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. The soil of the experimental fields was sand loam in texture, medium in available N and P and high in available K. A field experiment with 8 treatments (Table 1) and 3 replications was laid out in randomized block design. Paraquat at 0.5 kg ha^{-1} was sprayed when the potato emergence was not more than 5 per cent (15 DAP). Paddy straw mulch (5cm thick) @ 5.0 t ha^{-1} was used for mulching. Metribuzin, pendimethalin and prometryn at their respective doses, were sprayed at pre-emergence stage of the crop and weeds with in 3 days of planting. Earthing up was followed at 30 DAS in the treatments where herbicides weresprayed at pre-emergence stage. Kufri Badshah variety of potato was planted in the last week of October and first week of November, respectively during 2002 and 2003 at a row spacing of 60 cm.

RESULTS AND DISCUSSION

The weed flora of the experimental field consisted of *Anagallis arvensis, Melilotus indica, Fumaria parviflora, Chenopodium album, Medicago denticulata, Phalaris minor* and *Vicia sativa. Solanum nigrum, Rumex acetosella, Oxalis corniculata, Phragmites kerka, Cyperus rotundus* and *Cynodon dactylon* were of minor occurrece as recorded at the harvest of the crop. Post emergence spray of paraquat, metribuzin followed by earthing up at 30 days and hand weeding twice at 30 and 60 DAP reduced weeds effectively as compared to other treatments. Maximum dry matter accumulation by the weeds was recorded in weedy plots. All the herbicidal treatments reduced weed dry matter production significantly over weedy check (Table 1) Unchecked weed growth on an average caused more than 39 per cent reduction in tuber yield when compared with two hand weedings at 30 and 60 days. Metribuzin supplemented with earthing up at 30 days being on par with paraquat, pendimethalin, prometryn and hand weeding twice provided maximum tuber production as compared to rest of the treatments.

Table 1 Effect of weed control treatments on potato tuber yield, weed density and dry matter accumulation at harvest (Average of 2 years)

Treatment	*Dose kg ha^{-1}*	*Stage of appli-cation (DAP)*	*Potato tuber yield (t ha^{-1})*	*Weed density (No. m^{-2})*									*Total weed dry weight (gm^{-2})*	*Weed cont-rol effic-iency %*
				A. arven-sis	*M. indica*	*F. parv-iflora*	*C. album*	*M. denti-culata*	*P. minor*	*V. sativa*	*Others*	*Total weeds*		
Paraquat	0.5	15	38.9	10	09	08	08	11	06	06	18	1.88 (76)	1.81 (66)	77.9
Mulching	5.0 t	03	31.5	23	17	11	19	11	12	14	30	2.13 (137)	2.22 (170)	43.1
Mutribuzin Fb. earthing up	0.5	03	39.5	04	12	11	03	17	02	07	32	1.93 (88)	1.74 (55)	81.6
Pendimethalin fb. Earthing up	1.0	30	37.4	22	12	15	14	12	13	05	30	2.09 (123)	1.95 (90)	69.9
Prometryn Fb. earthing up	1.0	30	35.1	27	16	19	13	15	10	14	14	2.11 (128)	1.98 (96)	67.9
Earthing up	-	30	33.2	22	22	14	12	14	08	19	30	2.14 (141)	2.10 (127)	57.5
Hand weedings	-	30 & 60	36.5	23	12	10	11	09	10	14	13	2.00 (102)	2.05 (113)	62.2
Weedy	-	-	22.2	41	24	27	30	24	26	11	30	2.32 (213)	2.46 (299)	-
CD at 5%	-	-	4.6	-	-	-	-	-	-	-	-	0.11	0.14	

Original values in parentheses were subjected to log (x + 1) transformation

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146- Herbicidal Weed Management in Potato

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INTRODUCTION

The potato crop is a heavy feeder of nutrients. So heavy dressing of fertilizers with frequent irrigation encourages weed growth also. The type and density of weed flora have their individuality for reducing tuber yield as well as quality of tuber. The crop will grow under stress of nutrients, water and weather elements due to the competitive ability of infested weeds. The extent of yield loss of potato crop ranged from 16% to 76% (*Nield and Proctor* 1962). *Madhvilata* et al. (1997) indicated clearly that a potato crop should be kept under weed management programme at least up to 40 days of planting. Crop weed competition becomes acute during the early growth stage. Once the crop canopy of potato covered the soil, mostly the annuals are effectively suppressed. So the weed control programme should be scheduled for the first 7 to 12 weeks depending upon the duration of the variety and place of production.

MATERIALS AND METHODS

A field experiment was conducted at the Instructional farm, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, during rabi season of 2002- 03 in order to study the efficacy of some herbicides on potato. The experimental field was under gangetic alluvium, sandy loam in texture, neutral reaction (pH 6.8) and medium fertility. The fraction of sand silt and clay were 56.4, 24.1 and 19.5 respectively. Chemical composition like organic carbon, total nitrogen, available $P_2 O_5$ and $K_2 O$ were 0.59%, 0.76%, 17.782 kg/ha. and 181.835 kg/ha. Respectively. The meteorological position of the experimental site especially maximum and minimum temperature and relative humidity were in the range of 30.75°C (March) to 8.42°C (February) and 97.19% to 52.25% in the month of December respectively. The crop received 82.0 mm rainfall in the month of November, 8.1 mm in February and 54.24 mm in the month of March.

The experiment was laid out in a randomized block design with four treatments and five replications. The treatments were as control, fluchloralin @ 1.5 kg ai. /ha, pendimethalin @ 1.5 kg ai. / ha and hand weeding after 35 days of planting. Planted seed tubers were earthed up completely at planting and spaced 50x20 cm. spacing. Both the pre- emergence herbicides were applied after one day of planting. Potato crop was planted and harvested on 28.11.2002 and 17.3.2003 respectively. Weed sampling was done with the help of quadrant (0.5m X 0.5m) from all the plots for four times with an interval of 15 days. Tuber yield was recorded after 110 days of planting.

RESULTS AND DISCUSSION

Data presented in Table 1 indicated that herbicidal treated plots showed minimum dry weight (3.42 and $2.42 g/m^2$) of weeds at 15 days of planting. Where as control plot measured 6.14 gms. weed dry weight $/m^2$ at the same date.

Table1 Effect of herbicides and cultural method on weed dry weight (g/m^2) in potato crop after different dates of planting.

#D A P	*Control*	*Fluchloralin 1.5kg /ha*	*Pendimethalin 1.5kg /ha*	*Hand weeding 35 DAP*	*Mean wt of weed g /m²*	*C D at 5%*
15	6.14	3.42	2.42	4.97	4.23	0.65
30	23.25	9.07	4.50	19.47	14.04	2.86
45	25.60	10.42	7.90	2.02	11.48	2.18
60	35.40	16.68	11.78	13.70	19.39	3.09

Days After Planting = DAP

Over all performance of pendimethalin was best as well as steady among the applied treatments and dry weight of weeds did not exceeded $11.78 g/m^2$. Once the dry weight of weeds measured as 2.02 g/m2 in hand weeded treatment where manual weeding was done before 10 days of observation. As the age of the crop increased by 15 days from 45 days of planting, the weed dry weight increased rapidly to 13.7 g/m2. Control plots infested maximum with weeds and the recorded weed dry weight was 35.40 g/m2 at 60 DAP. This finding was corroborated with Madhavilata *et al.* (1997).

Table 2 Effect of different treatments on weed control efficiency in potato crop

DAP	*Control*	*Fluchloralin*	*Pendimethalin*	*Hand weeding*
45	0	59.29	69.14	92.10
60	0	52.88	66.72	61.29

It is clear from the Table 2, that the hand weeded plot exhibited maximum (92.1%) weed control efficiency just after 10 days (45 DAP) of weeding operation and efficiency reduced to 61.29% after 25 days (60 DAP) of weeding. Where as the chemical treatments were in the better position and efficiency were in the range of 52.88% to 69.14%. Performance of weed control treatments were in the following order; pendimethalin hand weeding fluchloralin. Prasad *et al.* (1995) considered weed control efficiency of weed management devices had the positive effect on tuber yield.

Applied weed control treatments improved the yield status significantly over control. From the Table 3, it is also clear that the effect of both the methods of weed control, were at per and the tuber yield ranged from 301.0 q/ha to 307.25 q/ha. Whereas the control plot produced 246.5 q/ha. The yield status improved by 24.65%, 24.04% and 22.1% with the applied treatments pendimethalin, hand weeding and fluchloralin respectively. Apparently the application of pre- emergence herbicide, pendimethalin 1.5 kg ai /ha, substituted one hand weeding at 35 days of planting. Reduction of yield due to weed infestation and performance of pendimethalin on tuber yield of potato was reported by Pal et al. (2000).

Table 3 Effect of pre- emergence herbicides and cultural method on tuber yield (q/ha) of potato.

Treatments	*Control*	*Fluchloralin*	*Pendimethalin*	*Hand weeding*	*CD at 5%*
Quintals/ha	246.5	301.0	307.25	305.75	13.97

CONCLUSION

Superiority of pre- emergence herbicides fluchloralin (1.5 kg a i /ha) and pendimethalin (1.5 kg a i/ha) over hand weeded (at 35 DAP) treatment except after 45 DAP where hand weeded treatment was weeded out just before 10 days of observation taken. Continuous suppression of weed flora was observed only in chemically treated plots. Ultimately the herbicides (fluchloralin and pendimethalin) treated plots yielded (301.0 and 307.25 quintals tuber /ha respectively) at per with hand weeded treatment (305.75 q/ha). The control plots yielded 246.5 quintals tuber per hectare.

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147- Integrated Weed Control in Okra (*Abelmoschus esculentus* L.) for Seed

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INTRODUCTION

Okra is an important vegetable crop of the state. This, being a wide row and rainy season crop, faces an acute problem of both grass and broadleaf weeds which may cause more than 70 per cent reduction in yield of green fruits (Singh and Tripathi, 1990). Manual/mechanical weeding is difficult as sometimes frequent rains do not allow timely hoeing operation. The integration of manual weeding with the pre-emergence application of herbicides proved to be more effective as herbicide kept weeds under check during the initial period of crop growth and the later weed flushes due to rain controlled with weeding. Therefore, an experiment was conducted during *kharif* seasons of 2003 and 2004 to find out effective integrated weed management in this crop grown for seed production during the rainy season.

MATERIALS AND METHODS

The soil of the experimental field was loamy sand. Fourteen weed control treatments *viz*; fluchloralin, trifluralin and pendimethalin at 0.75 kg /ha followed by 1 and 2 hand weeding and 1.0 kg/ha as pre-plant incorporation and oxyfluorfen at 0.15 kg/ha followed by 1 and 2 hand weeding and at 0.30 kg/ha as pre emergence were tested and compared with 3 hand weeding and unweeded control in a Randomized Block Design with four replications. Okra (cv. Punjab 7) was sown on second week of July during both the years by *kera* method using a seed rate of 15 kg/ha with row to row spacing of 45 cm and plant to plant of 15 cm. The crop received recommended fertilizer and other inputs according to PAU package of practices. The crop was harvested during the last week of October. The fruits were picked, sun dried and threshed manually.

RESULTS AND DISCUSSION

The major weeds of the experimental field were *Cyperus rotundus, Eragrostis tenella, Eleusine aegyptiacum, digitaria ciliaris, Euphorbia hirta* and *Commelina benghalensis*. The data (Table 1) showed that all integrated herbicide treatments significantly reduced the population of different weeds and their dry matter as compared to unweeded control and gave significantly more seed yield of okra. All herbicide treatments at their lower dose followed by by one or two hand weeding produced significantly less dry matter of weeds as compared to their application alone at higher dose except pendimethalin during 2003. The data further revealed that integration of two hand weeding with lower dose of different herbicides substantially reduced the menace of weeds in this vegetable crop grown during rainy season of the year. Trifluralin and pendimethalin proved more effective against weeds. Amongst the herbicides tested, only oxyfluorfen showed toxicity to the crop which recovered later on during the first year while proved more phytotoxic during second year and reduced the seed yield of okra. The minimum seed yield of 6.32 and 3.58 q ha^{-1} was obtained in oxyflourfen 0.3 kg ha^{-1}, respectively in 2003 and 2004 and these yields were significantly less as compared with its lower dose followed by 2 hand weeding during 2003 and fluchloralin, pendimethalin and trifluralin followed by one or two hand weeding and three hand weeding (Table 1). However, the different weed control treatments proved significantly superior over unweeded control for controlling weeds and seed production in okra. This study revealed that only integrated control of weeds holds good promise in this crop. Singh and Tripathi, 1990; Sandhu and Singh, 1991 and Patel *et al.*, 2004 also reported that use of herbicides namely trifluralin, pendimethalin and fluchloralin helped in controlling weeds in okra.

Table 1 Effect of different treatments on dry matter of weeds and seed yield of okra

Treatment dose (kg ha⁻¹)	*Dry matter of weeds (q ha⁻¹)*		*Seed yield (q ha⁻¹)*	
	2003	*2004*	*2003*	*2004*
Fluchloralin 0.75 fb 1 HW	3.67	0.95	10.14	8.33
Fluchloralin 0.75 fb 2 HW	0.71	0.16	12.64	10.58
Fluchloralin 1.0	8.39	7.30	7.99	7.19
Trifluralin 0.75 fb 1 HW	1.30	0.54	10.97	8.89
Trifluralin 0.75 fb 2 HW	0.23	0.12	12.85	11.0
Trifluralin 1.0	4.0	9.77	6.94	7.36
Pendimethalin0.75 fb 1 HW	1.15	0.78	10.76	8.21
Pendimethalin 0.75 fb 2 HW	0.75	0.19	13.06	10.17
Pendimethalin 1.0	2.41	10.18	8.26	7.15
Oxyfluorfen 0.15 fb 1 HW	0.95	1.72	8.69	5.63
Oxyfluorfen 0.15 fb 2 HW	0.15	0.37	10.76	6.00
Oxyfluorfen 0.3	6.55	5.18	6.32	3.58
Three hand weeding	1.57	0.17	12.15	11.36
Control	16.79	16.65	3.82	2.5
CD at 5%	2.88	3.37	2.52	1.7

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148- Effect of Different Weed Management Practices on Seed Yield of Okra (*Abelmoschus Esculentus* (L) Monch)

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INTRODUCTION

The okra is one of the most popular vegetable in tropical and sub-tropical region. Okra suffers heavy yield losses in rainy season due to weed infestation owing to congenial environmental conditions for luxurious weed growth coupled with wider row spacing and slow growth at early stages due to scarisity of main power weeding is difficult for removal of weeds. Moreover manual weeding it is time consuming and expensive due to high lavaour cost. Unavailability of lavour at the peak time and sometimes unfavourable field condition do not permit manual weedings. Yield losses due to weeds varied from 40 to 50% depending on the type of weed flora. It was therefore, considered necessary to under take a study to find appropriate herbicide for okra crop.

MATERIALS AND METHODS

Field experiment was concluded at AICRP on weed control, college of Agriculture Gwalior during kharif season of 2003 and 04. The soil of experimental field was sandy loam in texture, normal in reaction, low in nitrogen, medium unavailable phosphorus and high in potassium. A set of twelve treatments comprising pre emergence and pre plant incorporation of trifluration and fluchloralin each at 1.0 kg/ha, pre emergence application of alachlor, pendimethalin, metoclachlor and butachlor each at 1.0 kg/ha, two hand weeding at 30 and 60 DAS, one hand weeding 20 DAS and three hand weeding (3, 6 and 9 WAS) and weedy check was laid out in randomized block design with 3 replication. Okra variety Parbhani kranti was sown on 12[th] July and harvested from 14 – 16[th] October during both the study years. All the recommended pack of practices were adopted to raise the crop except weed control treatments. Observation on weeds, yield and dry weight of weeds were recorded and presented in Table 1.

RESULTS AND DISCUSSION

Weed species in the experimental field were *Cyperus rotundus, Echinochloa crusgalli. Trianthema monogyna, Commelina benghalensis, Digera Grvensis, Phylanthus niruri* and *Cynodon dactylon.*

Effect on weeds

The application of herbicides effectively controlled almost all the weeds except *Cyperus rotundus* and *Cynolon dactylon*. Incase of *Echinochloa crusgalli*, the application of Trifluralin 1.5 kg/ha, alachlor 1.0 kg/ha were found most effective to control this weed. While *Commelina benghalensis* was reduced by the application of alachlor, butachlor and metolachlor. The application of alachlor and metolachlor controlled effectively the population of *Digera arvensis* and *Phyllanthus niruri.*

Significantly variation in weed biomass has been found due to different treatments. The lowest weed biomass was recorded in weed free treatment and it was at par with fluchloralin + 1 hand weeding and two hand weedings. Among herbicide application of alachlor and metolachlor reduced the weed bio-mass markedly however, all the herbicidal treatments reduced the weed biomass significantly as compared to weedy check (Table 1).

Effect on crop

Okra seed yield was significantly increased due to weed control treatments (Table1). Significantly higher seed yield was recorded in three hand weeding done at 3, 6 and 9 WAS. Which was at par with tow hand weedings done at 3 and 6 WAS. Among the herbicides the maximum seed yield was obtained in pre emergence application of butachlor 1.0 kg/ha and trifluratin was next in order. In pooled analysis it was found that uncontrolled weeds resulted into 58% reduction in seed yield of Okra as compared to weed free treatment. Additional profit over weedy check was higher with 3 hand weedings (wee free) followed by metolachlor 1.0 kg/ha, butachlor 1.0 kg/ha applied as pre emergence. These results are in agreement with those of Patel *et al.* (2004).

CONCLUSION

Significantly higher seed yield was recorded in three hand weeding (Weed free) done at 3, 6, and 9 WAS, which was at par with two hand weedings done at 3 and 6 WAS. Among the herbicides, the maximum seed yield was obtained in pre emergence application of butachlor 1.0 kg/ha and trifluratin 1.0 kg/ha was next in order. It was also found that uncontrolled weeds resulted into 58% reduction in seed yield of okra as compared to weed free treatment.

Table 1 : **Effect of weed control treatments on weed biomass, seed yield and economics of okra (Pooled data of two years).**

Treatments	Weed biomass kg/ha			W.C.E. %	Seed yield kg/ha			Increasing yield over weedy check (kg/ha)	Net return Rs/ha over weedy check
	2003	2004	Mean		2003	2004	Mean		
Alachlor 1.0 kg/ha PE	907	333	620	77	341	221	281	83	2790
Pendimethalin 1.0 kg/ha PE	836	757	796	70	399	233	316	118	4002
Metolachlor 1.0 kg/haPE	393	801	597	78	483	293	388	190	8060
Butachlor 1.0 kg/ha PE	524	997	760	72	396	345	370	172	7720
Fluchloralin 1.0 kg/ha PPI	981	656	818	69	402	275	338	140	5592
Trifluralin 1.0 kg/ha PPI	890	586	738	72	351	325	338	140	5640
Two hand weeding at 30 & 60 DAS	484	428	456	83	398	365	381	183	6350
One hand weeding at 30 DAS	577	582	579	78	399	318	308	110	4900
Fluchloralin 1.0 kg/ha + One hand weeding	415	233	324	88	438	360	399	201	7342
One hand weeding at 20 DAS fb hoeing at 30 DAS	431	443	437	84	350	326	338	140	4775
Weed free (3, 6 and 9 WAS)	133	142	137	95	538	417	477	279	10325
Weedy check	2425	2954	2689	-	222	175	198	-	-
CD at 5%	344	480	305	-	196	118	108	-	-

* Selling rate of okra seed – Rs. 50/kg, Labour Charges of herbicide application – Rs. 360/ha
Weeding charges – I[st] weeding - Rs. 1625/ha, II[nd] weeding – Rs. 1200/ha, III[rd] weeding – Rs. 800/ha
Hoeing charges – Rs. 600/ha

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149- Effect of Different Herbicides on Weed Spectrum and Yield of Cauliflower

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INTRODUCTION

Cauliflower (*Brassica oleracea* var *botrytis* L.) is the most important vegetable among cole crops being grown in India. Although voluminous work has been carried out in India on various aspects of cauliflower cultivation but the problem of weeds in this crop need special attention, as weeds when present in the field can reduce the yield and impair the quality of the produce. During its growth period, the crop faces competition on account of monocot and dicot weeds. Traditionally, the crop is hand weeded but this method is time consuming and costly. Therefore, the present investigation was planned and executed to assess the effect of different herbicides and traditional methods of weed control on growth and yield of cauliflower cv. Pusa Snowball K-1.

MATERIALS AND METHODS

The investigations were carried out at the experimental farm of HAREC, Dhaulakuan, District Sirmour (HP) during 2000-01 and 2001-02. The farm is situated at an altitude of 468 m above mean sea level. Soil of the farm was sandy loam in texture with acidic in reaction (pH 5.7). Cauliflower cv. Pusa Snowball K-1 was grown in a plot size of 3.60 x 2.25 m^2 at a spacing of 60 x 45 cm. Fourteen treatments included different herbicides, hand weeding and the weed free check. Each of the treatment was replicated thrice in a RBD.

RESULTS AND DISCUSSION

In 2000-01, minimum intensity of *Cronopus didymus* was recorded with the treatment hand weeding at 30 and 60 DAT, which was statistically at par with pendimethalin 1.00 kg ha^{-1} (Table 1). On the other hand, during the second year of experimentation, pendimethalin 1.25 kg ha^{-1} resulted in the minimum weed Intensity, which was at par with alachlor 1.25 kg ha^{-1}, fluchloralin 1.25 kg. In 2000-01, minimum intensity of *Coronopus didymus* was recorded with the treatment hand weeding at 30 and 60 DAT, which was statistically at par with pendimethalin 1.00 kg ha^{-1} (Table 1). On the other hand, during the second year of experimentation, pendimethalin 1.25 kg ha^{-1} resulted in the minimum weed intensity, which was at par with alachlor 1.25 kg ha^{-1}, fluchloralin 1.25 kg ha^{-1} and hand weeding at 30 and 60 DAT.

Intensity of *Cyperus rotundus* was found to be minimum in 2000-01 for the treatment, which was statistically at par with pendimethalin 1.25 kg ha^{-1} and hand weeding at 30 and 60 DAT (Table 1). Contrary to this, in 2001-02, minimum weed intensity was observed in hand weeding at 30 and 60 DAT followed by hand weeding at 60 DAT, which was at par with alachlor 1.25 kg ha^{-1} and fluchloralin 1.25 kg ha^{-1}.

Intensity of *Trifolium spp.* was reduced to the minimum in 2000-01 as well as 2001-02 by hand weeding at 30 and 60 DAT. Among the herbicidal treatments, fluchloralin 0.75 kg ha^{-1} recorded the minimum intensity in first year while alachlor 1.25 kg ha^{-1} registered the minimum weed count in the second year. The minimum weed count for *Ageratum conyzoides* was recorded with the treatment pendimethalin 1.25 kg ha^{-1} in 2000-01 (Table 1). On the other hand, during 2001-02, minimum weed intensity was registered for while alachlor 1.25 kg ha^{-1}, which was statistically at par with pendimethalin 1.25 kg ha^{-1}, fluchloralin 1.25 kg ha^{-1} and hand weeding at 30 and 60 DAT. The highest curd yield per ha was recorded in pendimethalin 1.25 kg ha^{-1} followed by alachlor 1.25 kg ha^{-1} in the first year and fluchloralin 1.25 kg ha^{-1} during the second year of investigations (Table 1).

Weeds were controlled effectively with different herbicides but pendimethalin 1.25 kg ha^{-1} was the most effective in controlling most of the weeds appearing in cauliflower resulting in less crop weed competition and ultimately in good crop growth and curd yield. Similar results in cauliflower have been reported by Singh *et al.* (1983) and Bhayan *et al.* (1985).

Table 1 Effect of different weed control treatments on weed spectrum and curd yield.

Treatment	*Rate kg/ha*	*Coronopus didymus*		*Poa annua*		*Trifolium spp.*		*Ageratum conyzoides*		*Curd yield (q ha^{-1})*	
		2k-2k1	*2k1-2k2*	*2k-2k1*	*2k1-2k2*	*2k-2k1*	*2k1-2k2*	*2k-2k1*	*2k1-2k2*	*2k-2k1*	*2k1-2k2*
Alachlor	0.75	16.33	37.33	15.33	23.33	16.67	7.00	11.00	8.33	54.00	63.83
		(4.15)	(6.19)	(3.56)	(4.92)	(4.19)	(2.83)	(3.46)	(3.05)		
Alachlor	1.00	7.33	29.67	10.33	23.67	24.00	8.00	13.00	5.33	59.70	66.90
		(2.84)	(5.51)	(3.28)	(4.96)	(5.00)	(3.00)	(3.74)	(2.50)		
Alachlor	1.25	7.67	23.00	8.00	16.67	14.67	5.00	8.00	2.00	119.7	106.6
		(2.91)	(4.87)	(3.00)	(4.17)	(3.94)	(2.45)	(3.00)	(1.72)		
Fluchloralin	0.75	20.67	34.67	6.33	27.00	11.67	12.33	15.67	7.33	64.50	64.30
		(4.65)	(5.90)	(2.69)	(5.29)	(3.48)	(3.65)	(4.07)	(2.87)		
Fluchloralin	1.00	11.00	41.33	8.00)	25.00	19.00	10.00	19.00	4.00	63.10	72.00
		(3.45)	(6.46)	(3.00)	(5.09)	(4.41)	(3.28)	(4.46)	(2.23)		
Fluchloralin	1.25	8.00	24.67	2.67	12.33	18.00	5.67	15.00	2.33	119.9	110.3
		(3.00)	(5.07)	(1.79)	(3.65)	(4.36)	(2.58)	(4.00)	(1.82)		
Pendimethalin	0.75	34.33	34.33	7.00	25.67	13.33	11.00	9.00	4.67	43.10	65.47
		(5.85)	(5.93)	(2.55)	(5.16)	(3.77)	(3.46)	(3.05)	(2.35)		
Pendimethalin	1.00	5.33	27.33	3.67	24.33	27.00	9.00	20.00	5.33	54.90	68.77
		(2.47)	(5.30)	(2.14)	(5.03)	(5.19)	(3.16)	(4.56)	(2.51)		
Pendimethalin	1.25	9.67	21.67	4.00	10.00	15.00	6.67	5.33	2.33	126.3	118.7
		(3.19)	(4.71)	(2.05)	(3.28)	(4.00)	(2.76)	(2.46)	(1.79)		
HW at 30 DAT		9.67	42.67	10.00	22.67	12.33	7.00	8.67	5.33	73.60	84.63
		(3.19)	(6.57)	(3.28)	(4.86)	(3.63)	(2.83)	(3.11)	(2.51)		
HW at 60 DAT		27.00	33.33	1.00	10.33	10.67	5.67	1.33	7.67	80.90	86.83
		(5.27)	(5.84)	(1.41)	(3.37)	(3.41)	(2.58)	(1.52)	(2.91)		
HW at 30 and 60 DAT		3.00	22.33	6.67	10.00	7.67	3.67	8.00	3.33	118.4	118.2
		(2.00)	(4.83)	(2.75)	(3.28)	(2.90)	(2.16)	(3.00)	(2.08)		
Weed free		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	133.2	124.7
		(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)	(1.00)		
Weedy check		35.33	57.00	11.33	40.67	16.00	14.33	3.33	12.33	49.10	53.13
		(6.02)	(7.61)	(3.46)	(6.45)	(4.11)	(3.91)	(2.08)	(3.65)		
CD at 5%		1.03	0.63	NS	0.67	1.08	0.13	0.68	0.47	6.63	5.57

Figures in parentheses denote Ön+1 transformed values, DAT= Days after transplanting and HW= hand weeding

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150- Chemical Weed Control in Transplanted Onion

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INTRODUCTION

Onion is one of the most important vegetable crops in India. Owing to its slow growth in initial stages and sparse foliage, weeds offer severe competition throughout the crop growth. The losses due to weed competition can be as high as 70-75% (Mani and Gautam, 1976).Among the selective herbicides for weed control in onion; pendimethalin and oxyfluorfen have been recommended worldwide (Labrada, 1994). It has been experienced that single application of any herbicide may not be effective for desirable weed management through out the crop growth, more particularly in a crop like onion. Hence there is a need to search for newer combinations of weed control methods. Therefore a field experiment was conducted with single application, sequential application of herbicides and their integration with hand weeding for weed control in onion.

MATERIALS AND METHODS

A field experiment on transplanted onion var. N-53 was conducted at NRC for Weed Science during *rabi* season of 2002-03. The soil of the experimental field was clay loam having pH 6.7, low in available nitrogen, medium in available phosphorus and high in available potassium. Fourteen treatment combinations (Table 1) were tested in RBD replicated thrice. Thirty days old onion seedlings were planted at 20 x 10 cm spacing and the onion crop was raised following recommended package of agronomic practices. The treatments were applied as per the schedule (Table 1). Weed population and its dry weight were recorded at 60 days of planting (DAP) and this data was reported after square root transformation (šx + 0.5).

RESULTS AND DISCUSSION

The major weed flora of the experimental site were *Paspalum* sp., *Echinochloa colona*, *Chenopodium album* and *Medicago hispida*. Among single application of herbicides, pendimethalin 1.0 kg/ha as pre. emergence effectively controlled the weeds. Integration of one hand weeding at 30 days with pre emergence application of oxyfluorfen 200 g/ha controlled the weeds even more efficiently. The least dry weight of weeds at 60 DAP (2.2 g/m^2) was achieved by sequential application of pendimethalin 1.0 kg/ha as pre. emergence followed by pendimethalin 1.0 kg /ha at 30 DAP as sand mix application (Table 1).

Highest onion bulb yield of 400 q/ha was obtained by sequential application of pendimethalin 1.0 kg/ha as pre-emergence followed by pendimethalin 1.0 kg /ha at 30 DAP as sand mix application. The other promising treatments in respect of obtaining higher bulb yield were sequential application of pendimethalin 1.0 kg/ha as pre. emergence followed by pendimethalin 1.0 kg /ha at 30 DAP (308 q/ha) and haloxyfop 100g/ha at 10 DAP followed by oxyfluorfen 200 g/ha at 30 DAP (281.52 q/ha) (Table 1).

It may be concluded from this study that for obtaining effective weed control and higher onion bulb yield sequential application of pendimethalin 1.0 kg/ha as pre. emergence followed by pendimethalin 1.0 kg /ha at 30 DAP as sand mix application may be done.

Table 1 Effect of herbicides alone, their combinations, sequential applications and integration with hand weeding on population and dry weight of weeds (60 DAS) and yield of onion

Treatments	Weed population m^{-2}				Total weeds m^{-2}	Weed dry wt. $g\ m^{-2}$	Bulb yield $q\ ha^{-1}$
	Paspalum	*Echinochloa*	*Chenopodium*	*Medicago*			
Haloxyfop 100g ha^{-1} 10 DAP	0.9	1.6	18.6	8.5	21.0	12.6	161.68
Oxadiargyl 90gha^{-1} 3 DAP	16.4	16.1	3.4	5.2	23.3	16.0	238.98
Oxyfluorfen 200gha^{-1} 3 DAP	11.8	18.0	6.9	3.0	23.1	13.1	254.61
Pendimethalin 1.0kg ha^{-1} 3 DAP	6.3	8.4	3.8	7.5	13.6	12.3	250.79
Haloxyfop100g ha^{-1} 10 DAP+ 1HW 30 DAP	1.2	1.5	5.6	5.1	10.9	8.1	225.13
Oxadiargyl 90gha^{-1} 3 DAP +1HW 30 DAP	5.3	6.7	13.9	6.3	15.7	8.7	234.35
Oxyfluorfen200g ha^{-1} 3 DAP +1HW 30 DAP	4.9	7.1	1.5	5.2	10.2	6.7	262.00
Pendimethalin1.0 kg ha^{-1} 3 DAP +1HW 30 DAP	3.9	5.4	1.2	6.7	10.0	7.6	255.54
Haloxyfop100g ha^{-1} 10 DAP + Oxyfluorfen 200gha^{-1} 10 DAP	5.2	4.7	5.6	3.6	12.9	4.7	271.36
Haloxyfop100g ha^{-1} 10 DAPfb Oxyfluorfen 200gha^{-1} 30 DAP	0.7	0.7	2.1	3.0	9.4	3.5	281.52
Pendim.1.0kg (PE) fb Pendim.1.0kg 30 DAP(spray)	5.0	10.8	3.4	2.7	8.5	3.0	308.73
Pendim.1.0kg (PE) Fb Pendim.1.0kg 30 DAP (sand mix)	1.8	2.9	2.7	3.7	5.8	2.2	400.00
2 Hand Weeding (20 & 40 DAP)	5.0	5.6	2.9	2.3	8.6	12.3	128.41
Unweeded	14.9	13.8	14.4	6.4	26.9	18.9	94.39
CD at 5%	3.6	4.3	2.2	1.8	2.6	0.9	61.64

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151- Efficacy of Herbicides and Straw Mulch for Weed Management in Garlic (*Allium sativum* L.)

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INTRODUCTION

Garlic (*Allium sativum* L.) belonging to family Alliaceae in one of the most important crops among spices grown through out the country. It is cultivated as a bulb crop and is the second most important crop after onion in India (Sankar *et al* 1997). In Himachal Pradesh it is emerging as one of the important high export potential crops and the area which was 1500 ha in 2000 has increased to 2898 ha (Anonymous, 2004). Weeds pose a serious problem in this crop. Shorter the initial weed free period or longer the weeds remained in plots before removal, greater is the reduction in yield and quality (Qasem, 1996). The manual weeding is cumbersome and costly due to closer planting of crop. Therefore, management of weeds through herbicides can be an effective method. Further, mulches have suppressing effect on weeds with beneficial effects on growth and yield of crop (Baten *et al* 1995). Keeping this in view the present integrated approach for weed management in garlic was initiated for higher productivity and profitability.

MATERIALS AND METHODS

An investigation was carried out during winter season (2003-04) at HPKV, Palampur for the management of weeds in garlic cv. Agrifond Parvati. The experiment consisted of 16 treatments viz. pendimethalin 0.9 and 1.2 kg/ha, trifluralin 1.0 and 1.5 kg/ha, alachlor 1.0 and 1.5 kg/ha, handweeding and hoeing and weedy check each with and without mulch (Table 1). The experiment was laid out in RBD with 3 replications. All the herbicides were applied as pre-emergence. The rice straw mulch (3t/ha) was applied immediately after the herbicide spray. In one of the handweeding treatments, the straw mulch was applied after one handweeding 60 DAS.

The major weed flora in the experimental field was *Phalaris minor, Avena fatua, Lolium temulentum* and *Poa annua* among grasses and *Coronopus didymus, Anagallis arvensis, Vicia sativa* and *Ranunculus arvensis* among broad leaved weeds.

RESULTS AND DISCUSSION

The data (Table 1) revealed that among herbicidal treatments application of pendimethalin 1.2 kg/ha + mulch recorded the minimum dry matter 100 DAS which was statistically at par with alachlor 1.5 kg/ha + mulch and hand weeding 60 DAS+ mulch and two handweeding and hoeing 60 and 90 DAS at both the stages i.e. 100 and 200 DAS. Further, it was observed that uncontrolled weed growth resulted in 73.6, 73.4 and 72.5 per cent reduction in bulb yield as compared to handweeding 60 and 90 DAS without mulch and mulch alongwith pendimethalin 1.2 kg/ha and alachlor 1.5 kg/ha, respectively. Application of trifluralin remained most ineffective in reducing weed dry weight and gave significantly reduced yield. Mulch application has suppressing effect on weeds. The application of pendimethalin 1.2 kg/ha and alachlor 1.5 kg/ha each with mulch and handweeding (60 and 90 DAS) proved most effective treatments both in productivity and profitability.

Table 1 Effect of treatments on weed dry weight , bulb yield and economic return in garlic.

Treatments	*Dose (kg/ha)*	*Weed dry weight (g/m²)*		*Bulb yield*	*Net return*
		100 DAS	*200 DAS*	*(kg/ha)*	*(Rs./ha)*
Pendimethalin	0.9 + Mulch	48.4	136.4	346	17572
Pendimethalin	0.9	66.6	149.6	320	17082
Pendimethalin	1.2 + Mulch	18.9	81.4	538	45392
Pendimethalin	1.2	41.4	100.3	469	38635
Trifluralin	1.0 + Mulch	100.3	184.6	283	9192
Trifluralin	1.0	123.4	185.2	274	11207
Trifluralin	1.5 + Mulch	69.3	167.6	335	16610
Trifluralin	1.5	97.1	160.1	321	17857
Alachlor	1.0 + Mulch	56.6	142.8	336	17040
Alachlor	1.0	63.4	146.1	308	16251
Alachlor	1.5 + Mulch	24.2	76.2	520	43925
Alachlor	1.5	45.5	96.6	476	40735
Handweeding	60 DAS + Mulch	12.2	89.0	424	29209
Handweeding	60 & 90DAS	5.3	76.1	545	48370
Weedy check + Mulch		18.2	305.8	157	-8408
Weedy check		20.0	313.1	143	-7306
CD at 5%		11.71	14.0	34	-

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152- Bio-Efficacy and Phytotoxicity of Glyphosate + 2,4-D for Weed Control in Tea

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INTRODUCTION

Tea is considered as an important plantation crop of India as it plays a vital role in our national economy. Soil and climate has a profound effect on biology of weeds. The climate of the tea growing areas in West Bengal and the management of the crop is often creating favorable condition for growth of many weed species. In Terai region weeds cause yield loss of Tea to the tune of 15-40% (Samanta and Roy, 2005). Hence, effective weed control particularly during the critical crop-competition period results poor growth weeds and good stands of tea. Thus, the weed management practice in tea needs to be designed by including suitable and effective herbicides to keep the ground weed-free during the critical period. Keeping the above view, a field experiment was carried out to study the efficacy of glyphoshate + 2,4-D on weed control and also to observe phytotoxicity if any, on tea crop.

MATERIALS AND METHODS

The field experiment was conducted at Kamalpur Tea Estate, Darjeeling, West Bengal during summer 2002. The experimental soil was clay loam in texture and grey in colour with a pH of 6.1. Thirteen treatments were evaluated in a randomized block design replicated thrice. The treatments consisted of ready combination of glyphosate IPA salt 13.5%+ 2,4-D IPA salt 13.5% (A) at three doses of 3%, 2.5%and 1.5%, glyphosate 9%+ 2,4-D 18%(B) at 4.5%, 3.5% and 2.5%, glyphosate18%+ 2,4-D 9%(C) at 2.3%, 2.0 and 1.5% along with tank mixture of glyphosate@7.5ml l^{-1}+2,4-D@5g l^{-1}, sole glyphosate@10ml l^{-1}, 2,4-D @ 7.5g $l^{-1}$and control.

RESULTS AND DISCUSSIONS

The initial weed flora before application of herbicide was dominated by *Digitaria sanguinalis*, *Cynodon dactylon* and *Eleusine indica* among grasses, *Cyperus arometicus* and *Cyperus rotundus* among sedges whereas *Borreria hispida, Oxalis corymbosa, Scoparia dulcis, Ludwigia parviflora*, and *Ageratum conyzoides* among broadleaf weeds. Most of the weeds were managed within 30 days after spraying and the resurgence of majority weeds did not start even after 45 DAS. *Borreria hispida, Eleusine indica* and *Cyperus rotundus* showed resurgence from 45-60 days. All the ready combinations of glyphosate + 2,4-D showed higher efficacy of weed management in comparison to tank mixture of glyphosate + 2,4-D or sole application of the either. However, the ready combinations of glyphosate 18% + 2,4-D 9% recorded the maximum weed control followed by glyphosate 9%+ 2,4-D 18% and glyphosate 13.5%+ 2,4-D 13.5%. At 30 DAS, all ready combinations of glyphosate + 2,4-D recorded lower dry weight of weeds below 1.0 g m^{-2} followed by sole application. However, at 60 DAS combination of glyphosate 18%+ 2.4-D 9% at all doses were found more efficient in controlling weeds followed by other treatment combinations of ready mixture. The reduction in weed dry weight on percentage basis was found maximum by application of glyphosate 18%+ 2.4-D 9% at highest dose both at 30 and 60 DAS. Glyphosate and 2,4-D applied alone showed poor efficacy in lowering weed dry weight. At both 30 and 60 DAS, unweeded control recorded maximum dry weight of weeds. The weed flora only having tubers / stolen or rhizome showed little regrowth within 60 days of application of ready mixture of the chemicals. No phytotoxicity was observed on tea plants against any treatment used in this experiment.

Table 1 Dry weight of weeds, percentage weed control and resurgence of weeds in tea

Treatments	Dry weight of weeds (g m^{-2})			Percentage weed control Resurgence		
	Initial	30DAS	60DAS	10 DAS	30 DAS	60 DAS
A-3.0%	48.4	0.53	1.25	87.8	99.6	12.7
A-2.5%	41.2	0.70	1.14	86.3	99.2	14.6
A-1.5%	35.7	0.58	1.30	84.9	98.9	11.4
B-4.5%	42.2	0.76	1.12	89.5	99.9	9.8
B-3.5%	29.4	0.42	1.18	88.6	99.7	9.1
B-2.5%	36.7	0.68	1.20	87.9	99.3	11.4
C-2.3%	46.4	0.18	0.92	95.4	100	7.8
C-2.0%	28.8	0.25	0.95	97.2	100	9.8
C-1.5%	33.8	0.17	0.85	92.4	99.8	10.0
Gly+2,4-D	37.6	1.75	2.30	84.0	92.9	26.9
Glyphosate	30.0	2.08	2.75	79.1	72.8	37.0
2.4-D	39.5	3.10	3.45	47.3	59.3	51.2
Control	35.8	39.45	47.23	0	0	0
CD at 5%						

DAS-Days after spraying

REFERENCE

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153- Weed Management in Orchards

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INTRODUCTION

The cultivation of kinnow, guava, ber, pear and grape has received a boost as commercial crops in Punjab. Area under these fruits has been increasing every year because of their high yield potential and good economic returns. Controlling of weeds is the most important cultural practice for successful cultivation of fruit crops. Weeds cause heavy losses to the fruit crops by competing for nutrients, water and light. Even the roots of some weeds secrete some toxins which adversely affect the growth and bearing of the orchards. Traditional method of weeding i.e. hoeing is now a days becoming very expensive, because of non-availability of manual labour and higher wages. Chemical method of controlling weeds in the orchards is found to be quite successful, less time consuming besides being economical. Among the various problems with which fruit growing is confronted, one serious problem is a excessive weed growth. The sub-tropical climate of Punjab State is very conducive for the rapid multiplication of weeds in the orchards. Therefore, chemical weed control with pre and post emergence herbicides in orchards was carried out at different locations in Punjab for the benefits of fruit growers.

MATERIALS AND METHODS

The adaptive trials were conducted at different locations of Punjab in kinnow, guava, ber, pear and grape orchards. In Kinnow, herbicides were sprayed during March. Glyphosate and paraquat at 1.23 and 0.72 l/ha respectively were superimposed alternatively on each herbicide during 2nd fortnight of July. In guava diuron was sprayed during Ist week of September. Glyphosate and paraquat were sprayed during 3rd week of September. In ber diuron was sprayed during Ist fortnight of August and post-emergence herbicides during 2nd fortnight of August. In pear and grape orchards, diuron was sprayed during Ist fortnight of March, whereas glyphosate and paraquat were sprayed during 2nd fortnight of March. Hand weeding was done at 30 days interval. The herbicides were sprayed with water @ 500 litres/ha with Flood Jet Nozzle (Knapsack Sprayer). Observations on periodic weed count, fruit yield and total soluble solids in fruits were recorded.

RESULTS AND DISCUSSION

Kinnow

Glyphosate + glyphosate (1.64 + 1.23) ranked first in checking the weed flora when counted after 240 days of spray (Table 1). A combination of diuron + glyphosate (4 + 1.23) was the second best combination in controlling broad spectrum of weeds. Jawanda *et al* (1977) in kinnow orchards have reported that these herbicides individually and in combination were more effective than the other herbicides as well as traditional method of hand weeding. The fruit yield was recorded to be the highest under glyphosate + glyphosate (1.64 + 1.23) combination followed by diuron + paraquat (4 + 0.72) and glyphosate + paraquat (1.64 + 0.72). The total soluble solids were recorded higher ranging from 12.5 to 12.8% in all the combinations where glyphosate was used. It was the highest in glyphosate + paraquat (1.64 + 0.72) and was lowest in control.

Guava

The weed count was recorded significantly less in glyphosate @ 1.64 and 1.23 l/ha after 120 days of spray (Table 1). Diuron @ 3.20 kg/ha was found the next best treatment in checking the weeds. The average fruit yield and total soluble solids were also recorded significantly higher under glyphosate 1.64 l/

ha. The yield was noted 51 kg fruits per tree and TSS was recorded 11.0% with this treatment. The results are in close conformity with those reported by Bajwa *et al* (1990) in different fruit crops.

Table 1. Effect of various herbicides on periodic weed count, yield and quality in kinnow and guava orchards.

Kinnow					Guava				
Treatment (a.i/ha)		Weed count (per sq.m.) 240 DAS	Fruit yield (kg/ tree)	TSS (%)	Treatment (a.i/ha)		Weed count (per sq.m.) 120 DAS	Fruit yield (kg/ tree)	TSS (%)
Diuron + glyphosate	4.00 + 1.23	98	66.9	12.7	Diuron	2.40 Kg	61	40	10.4
Diuron + paraquat	4.00 + 0.72	151	67.4	12.4	Diuron	3.20 Kg	52	44	10.6
Glyphosate + glyphosate	1.64 + 1.23	87	68.1	12.7	Glyphosate	1.23 l	31	46	10.6
Glyphosate + paraquat	1.64 + 0.72	153	66.8	12.8	Glyphosate	1.64 l	19	51	11.0
Paraquat + glyphosate	0.96 + 1.23	144	65.7	12.5	Paraquat	0.96 l	77	38	10.2
Paraquat + paraquat	0.96 + 0.72	201	64.7	12.4	Paraquat	1.20 l	63	40	10.4
Hand weeding		93	63.8	12.0	Hand weeding		69	42	10.4
Control		315	61.3	11.5	Control		198	34	10.2
CD at 5%		51.8	3.54	NS	CD at 5%		8.3	6.2	0.20

Ber

Glyphosate and diuron at both the concentrations were significantly better than paraquat, hand weeding and control in checking the weed population at 120 days (Table 2). The average fruit yield and TSS was recorded higher under glyphosate treatments. Diuron treatments also yielded higher TSS in fruits than paraquat and hand weeding treatments.

Pear

After 90 days of weed count, diuron treatments emerged better in checking the weed flora (Table 2). Both glyphosate treatments were equally effective in checking the weeds and stood second in race but the difference among the four treatments was statistically non-significant. Dhillon and Chanana (1973) also reported that diuron is more persistent in the soil and proved superior in checking the weed flora in grapes. The average fruit yield and TSS were recorded higher under glyphosate @ 1.64 and 1.23 l/ha and diuron 4 kg/ha.

Vineyard

The average weed count after 120 days was found better with glyphosate 1.64 l/ha. It was closely followed by diuron at 2.80 kg/ha. The fruit yield and TSS were recorded higher under diuron 2.80 kg/ha.

CONCLUSION

Glyphosate 1.64 l/ha followed by glyphosate 1.23 l/ha proved to be the best combination in checking weeds throughout the year in kinnow orchard. Diuron at 3.2 kg/ha in ber and pear and glyphosate at 1.64 l/ha in guava and grapes proved effectively in controlling the weed population.

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Table 2. Effect of various herbicides on periodic weed count, yield and quality in ber and pear orchard and in vineyard

Ber

Treatment (a.i/ha)		*Weed count (per sq m)* 120 DAS*	*Fruit yield (q/ha)*	*TSS (%)*
Diuron	2.40 kg	7.50	143.8	17.0
Diuron	3.20 kg	6.89	146.8	17.6
Glyphosate	1.23 l	7.55	144.7	17.5
Glyphosate	1.64 l	8.20	149.9	17.8
Paraquat	0.72 l	11.14	135.9	15.8
Paraquat	0.96 l	11.13	138.2	16.4
Hand weeding		11.77	136.8	15.9
Controlling		16.41	128.2	15.1
CD at 5%		1.82	3.46	0.30

Pear

Treatment (a.i/ha)		*Weed count (per sq m)* 90 DAS*	*Fruit yield (q/ha)*	*TSS (%)*
Diuron	3.20 kg	7.34	172	12.08
Diuron	4.00 kg	6.81	175	12.28
Glyphosate	1.23 l	8.79	175	12.20
Glyphosate	1.64 l	7.39	178	12.43
Paraquat	0.72 l	12.49	155	11.69
Paraquat	0.96 l	12.79	160	12.06
Hand weeding		12.53	153	11.94
Controlling		19.44	134	11.63
CD at 5%		2.44	4.8	0.54

Vineyard

Treatment (a.i/ha)		*Weed count (per sq m)* 120 DAS*	*Fruit yield (t/ha)*	*TSS (%)*
Diuron	2.40 kg	67	27.6	16.1
Diuron	2.80 kg	58	28.6	16.3
Glyphosate	1.64 l	53	27.8	16.0
Paraquat	0.96 l	94	26.1	15.5
Hand weeding		70	25.6	16.0
Controlling		184	24.1	15.2
CD at 5%		1.9	2.2	NS

* DAS: Days after spray, *Figures are square root transformation of actual weed population.

154- Effect of Different Herbicides on Weed Control and Seed Yield and in *Helichrysum bracteatum*

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INTRODUCTION

Flower seed production of commercially important annuals is being taken as *rabi* crop during September to April in sub-tropical climatic conditions of India. The chilling days of December-January retard the growth of crop but some weed species like *Steleria media, Rumex dentatus,Poa annua* etc flourish well and further increase the cost of production with manual weeding. Therefore keeping in view the significance of seed production of annuals in diversification programme the present studies were undertaken to study the effect of herbicides on weed intensity and ultimately the plant growth and seed yield.

MATERIALS AND METHODS

The present studies were undertaken in the Department of Floriculture and Landscaping, PAU Ludhiana during the year 2001-2002. Three herbicides viz.,fluchloralin and trifluralin were sprayed as pre emergence 0.75 kg/ha, 0.75 kg/ha +2 hand weedings, 1.0 kg/ha and pendimethalin at the rate of 0.50 kg/ha , 0.50 kg/ ha +2 hand weedings and 0.75 kg/ha in eleven different treatments along with control as unweeded and one hand weeded plot throughout the season. Four week old seedlings of *Helichrysum bracteatum* were transplanted in third week of November and observations were recorded on weed number, weed fresh and dry matter and seed yield per unit area.

RESULTS AND DISCUSSION

No of weeds (after 45 days of transplanting)

The data presented in table -1 shows that the lowest weed population (34.05/m^2) was recorded from pendimethalin of 0.75 kg/ha followed by trifluralin (35.88/m^2) and fluchloralin(37.71/m^2) at the rate of 1.0 kg /ha each. The lower dose of all the herbicides were at par in weed population irrespective of hand weeding.

Weed population (after 90 days of transplanting)

The minimum weed population (70.86/m^2) was recorded from pendimethalin 0.5 kg/ha incorporated with hand weeding which was closely followed by trifluralin 0.75 kg/ha along with hand weeding. The highest weed population (173.39/m^2) was recorded from unweeded plot. However hand weeding coupled with lower dose of all the herbicides resulted in significantly lower weed population and amongst the herbicides alone treatment the higher dose gave significantly lesser weeds than the lower doses.

Weed dry matter (after 45 days of transplanting)

The lowest dry matter (51.88 g/m^2) was recorded from trifluralin treatment of 1.0 kg/ha followed (55.72 g/m^2 and 59.25 g/m^2) by pendimethalin and fluchloralin 1.0 kg/ha respectively.

Weed dry matter (after 90 days of transplanting)

Among the herbicidal treatments,,the lowest dry matter (81.81)was recorded from pendimethalin of 0.50 kg/ha + hand weedings which was significantly lower than that of 88.47 from trifluralin 0.75 kg/ha + hand weeding. Similar results have also been reported by Ivanova(1998) in Helichysum.

Seed yield

The seed yield 22.29 g/m^2 was recorded to be the highest under trifluralin 0.75kg/ha +hand weeding followed (21.97 g/m^2) by pendimethalin 0.75 kg/ha +hand weeding. However the entirely hand weeded plot and pendimethalin 0.75 kg/ha +hand weeding were at par for seed yield .

Table 1. Effect of herbicides on different weed characters and seed yield of *Helichrysum bracteatum*

Treatment	No of Weeds/ m^2		Weed drymatter (g/m^2)		Seed yield
	45 DAP	90 DAP	45 DAP	90 DAP	(g/m^2)
Unweeded (control)	94.65	173.39	123.65	243.81	13.96
Weed free	0.0	0.0	0.0	0.0	21.67
Fluchloralin 0.75 kg/ha	45.40	108.70	64.43	126.66	18.75
Fluchloralin 0.75 kg/ha+ 2 H W	44.13	85.20	66.13	93.64	21.25
Fluchloralin 1.0 kg/ha	37.71	94.95	59.25	106.60	20.21
Trifluralin 0.75 kg/ha	44.88	106.66	62.53	112.08	19.27
Trifluralin 0.75 kg/ha+2 H W	42.36	73.17	60.47	88.47	22.29
Trifluralin 1.0 kg/ha	35.88	86.65	51.88	97.87	20.54
Pendimethalin 0.5 kg/ha	40.13	102.79	65.83	133.94	18.43
Pendimethalin 0.5 kg/ha + 2 H W	42.12	70.86	60.86	81.81	21.97
Pendimethalin 0.75 kg/ha	34.05	83.74	55.72	101.49	20.50
CD at 5%	4.8	6.32	3.27	4.77	2.19

REFERENCE

Ivanova, I., 1998. Study on selective action of some soil herbicides in *Helichrysum bracteatum*. *Rasteniev 'dni-Nauki'* **35**: 565-567.

155- Effect of Different Herbicides on Weed Control and Seed Yield and in *Chrysanthemum carinatum*

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INTRODUCTION

Flower seed production is one of the commercially adopted field especially in Punjab, Haryana, Himachal Pradesh and Andhra Pradesh. Majority of the flower seed crops are grown in winter season as transplants and the cultural operations like transplanting, weeding, seed picking and cleaning, etc are being done manually. A large number of herbicides with different formulations are available which have been reported to be used successfully in many flower crops without adversely affecting the seed yield. Hence chemical weed control alone or its combinations with intercultural operations were tried in *Chrysanthemum carinatum*, a winter season annual to find out the efficiency of selective pre emergence herbicides without any adverse effect on plant growth and seed yield.

MATERIALS AND METHODS

The present studies were undertaken in the Department of Floriculture and Landscaping, PAU Ludhiana during the year 2001-2002. Three pre emergence herbicides viz.,fluchloralin and trifluralin were sprayed as pre emergence at 0.75 kg/ha, 0.75 kg/ha +2 hand weedings,1.0kg/ha and pendimethalin at the rate of 0.50 kg/ha , 0.50 kg/ha +2 hand weedings and 0.75 kg/ha.in eleven different treatments along with control as unweeded and one hand weeded plot throughout the season in randomized block design with three replications. Four-week-old seedlings of *Chrysanthemum carinatum* were transplanted in the third week of November and observations were recorded on weed population per unit area, weed fresh and dry matter and seed yield per unit area.

RESULTS AND DISCUSSION

No of weeds (after 45 days of transplanting)

The minimum weed population (12.56/m^2) was recorded from pendimethalin treatment of 0.75 kg/ha and it was closely followed (13.80/ m^2) by fluchloralin treatment of 1.0 kg/ha. Amongst the lower herbicidal doses, pendimethalin 0.50kg/ha +hand weeding had the minimum (16.08/m^2) weeds.

No of weeds (after 90 days of transplanting)

The results of table 1 indicate that hand weeding coupled herbicidal treatments and higher herbicidal doses irrespective of the herbicide gave lower weed population. The lowest number of weeds (21.73 m^2) were recorded from pendimethalin 0.50kg/ha+ hand weeding.

Weed dry matter (after 45 days of transplanting)

It is revealed by the data that dry matter of weeds was significantly lower in higher herbicide doses as compared with the lower doses. The lowest weed dry matter (25.29 g/m^2) was recorded from pendimethalin of 0.75kg/ha being followed (26.35 and 27.37 g/m^2) by trifluralin and fluchloralin 1.0 kg/ha each respectively.

Weed dry matter (after 90 days of transplanting)

The weed dry matter from the hand weeding coupled herbicidal treatments was found to be significantly lower than that from herbicides alone treatments Among different treatments, the lowest dry matter (32.60 g/m^2) was recorded from pendimethalin treatment of 0.50kg/ha + hand weeding being followed (36.39 g/m^2) by trifluralin 0.75 kg/ha + hand weeding and (39.16 g/m^2) fluchloralin of 0.75 kg/ha + hand weeding.

Seed yield

The highest seed yield 78.90 g/m^2 was recorded to be the highest under trifluralin 0.75kg/ha +hand weeding followed (78.05 g/m^2) by weed free (hand weeded plot). The data recorded on seed yield indicate that it was at par under trifluralin 0.75kg/ha +hand weeding and entirely hand weeded plot which might be due to better plant growth under weed free conditions either due to manual weeding or chemical control. Similar results have been observed by Duczmal (1989) in Antirrhinum, Aster and Zinnia.

Table 1 Effect of herbicides on different weed characters and seed yield of *Chrysanthemum carinatum*.

Treatment	*No of weeds /m^2*		*Weed dry matter g/m^2*		*Seed yield*
	45 DAP	*90 DAP*	*45 DAP*	*90 DAP*	*g/m^2*
Unweeded (control)	30.74	61.54	95.08	160.41	54.68
Weed free	0.0	0.0	0.00	0.00	78.05
Fluchloralin 0.75 kg/ha	17.35	35.99	33.11	55.73	68.30
Fluchloralin 0.75 kg/ha+ 2 H W	18.42	24.35	30.78	39.16	74.14
Fluchloralin 1.0 kg/ha	13.80	29.52	27.37	46.00	71.50
Trifluralin 0.75 kg/ha	16.70	34.65	32.28	54.33	69.75
Trifluralin 0.75 kg/ha+2 H W	18.88	23.46	31.61	36.39	78.90
Trifluralin 1.0 kg/ha	14.25	30.36	26.35	44.54	72.28
Pendimethalin 0.5 kg/ha	16.31	32.94	33.29	62.96	68.62
Pendimethalin 0.5 kg/ha + 2 H W	16.08	21.73	34.37	32.60	76.08
Pendimethalin 0.75 kg/ha	12.56	27.91	25.29	42.60	71.97
CD at 5%	3.18	4.20	3.68	6.23	4.24

REFERENCE

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156- Phyto-Sociological Studies of Rabi Season Weeds of Shahapura Block of Central India

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INTRODUCTION

Weeds have no species of themselves but the very name. "Weed" suggests a spontaneous plant that grows and persists where it is not wanted. Whether a plant is considered as a weed depends not only on its characteristics and habitat but also its relative position with reference to other pants and need of human being. Weeds may spread quickly into natural areas, monopolize resources, and push out native flora and fauna - including endangered crop and plant species. By virtue of their characteristics and habit , weeds quickly get adopted to any type of environment. Weeds have enormous seed production capacity and have the unique ability to get vegetative propagated.

MATERIALS AND METHODS

An ecological survey was conducted in block Shahpura of district Jabalpur (Central India) during *Rabi* 2002 to identify the weeds associated with Pea (*Pisum sativum)* field and explores their phyto-sociological status. The study was conducted in five selected villages of Shahpura block. From each selected villages 20 fields were selected randomly. List count quadrate method (50 X 50 cm) (Misra, 1968, Raju, 1977) was adopted to find out frequency, relative density and relative dominance of major weeds. Based on these data Importance value index and summed dominance ratio was also determined.

$$\text{Frequency (\%)} = \frac{\text{Number of quadrates in which a species occurs}}{\text{Total number of quadrates sampled}} \times 100$$

$$\text{Relative density (RD) \%} = \frac{\text{Number of individual of a species in all quadrate}}{\text{Number of individual of all species in all quadrate}} \times 100$$

$$\text{Relative frequency (RF)\%} = \frac{\text{Number of occurrence of a species}}{\text{Number occurrence of all species}} \times 100$$

$$\text{Relative dominance (RDo)} = \frac{\text{Dry weight of species/plant}}{\text{Dry weight of all species/plant}} \times 100$$

IVI = Importance value index

IVI = RD+RF+RDo (RD Relative density, RF Relative frequency, RDo Relative dominance)

$$\text{Summed dominance ratio (SDR)} = \frac{\text{Importance value index}}{2}$$

RESULTS AND DISCUSSIONS

Forty weed species were found in the phyto-sociological survey of weeds in *Pisum sativum* crop. Out of 40 weed species, 10 were found to be highly associated with *Pisum sativum* crop (table 1). The weeds *Cynodon dactylon, Melilotus indica, Vernonia cinerea, Alternenthera sessilis, Xanthium strumarium, Spharanthus indicus, Solanum nigrum, Lathyrus aphaca, Melilotus alba* and *Spergulla arvensis* were found to be highly aggressive and dominating over other weed species present. Phyto-Sociological studies reported that the IVI was highest in case of *Cynodon dactylon,* followed by *Melilotus indica, Vernonia cinerea, Alternenthera sessilis, Xanthium strumarium, Spharanthus indicus, Solanum nigrum, Lathyrus aphaca, Melilotus alba* and *Spergulla arvensis Melilotus.* Highest frequency was observed *Melilotus indica* followed by *Cynodon dactylon* in and *Solanum nigrum.* Lowest frequency was observed in *Alternenthera sessilis.*

Highest relative dominance was observed in *Cynodon dactylon* followed by *Alternenthera sessilis*. Lowest relative dominance was observed in *Spergulla arvensis* (Table 1).

Table 1 Distribution pattern of important weeds of *Pisum sativum* field of Shahpura block of MP

Name of Species	Frequency %	Relative Density (RD)	Relative Frequency (RF)	Relative Dominance (Rdo)	Importance value Index (IVI)	Summed Dominance Ratio(SDR)
Cynodon dactylon (L.) Pers	88	3.8	9.6	12.9	26.3	13.15
Melilotus indica (L.)	92	5.3	10	6.4	21.7	10.85
Vernonia cinerea (L.)	82	3.3	8.9	9.3	21.5	10.75
Alternenthera sessilis (L.)	70	3.6	7.6	9.4	20.6	10.30
Xanthium strumarium (L.)	80	3.7	8.7	8.1	20.5	10.25
Spharanthus indicus (L.)	65	2.9	7.0	9.2	19.1	9.55
Solanum nigrum (L.)	88	3.9	9.6	4.0	17.5	8.75
Lathyrus aphaca (L.)	76	3.0	8.3	6.2	17.5	8.75
Melilotus alba (Medik)	72	3	7.8	4.0	14.8	7.4
Spergulla arvensis (L.)	80	3.5	8.7	2.6	14.8	7.4

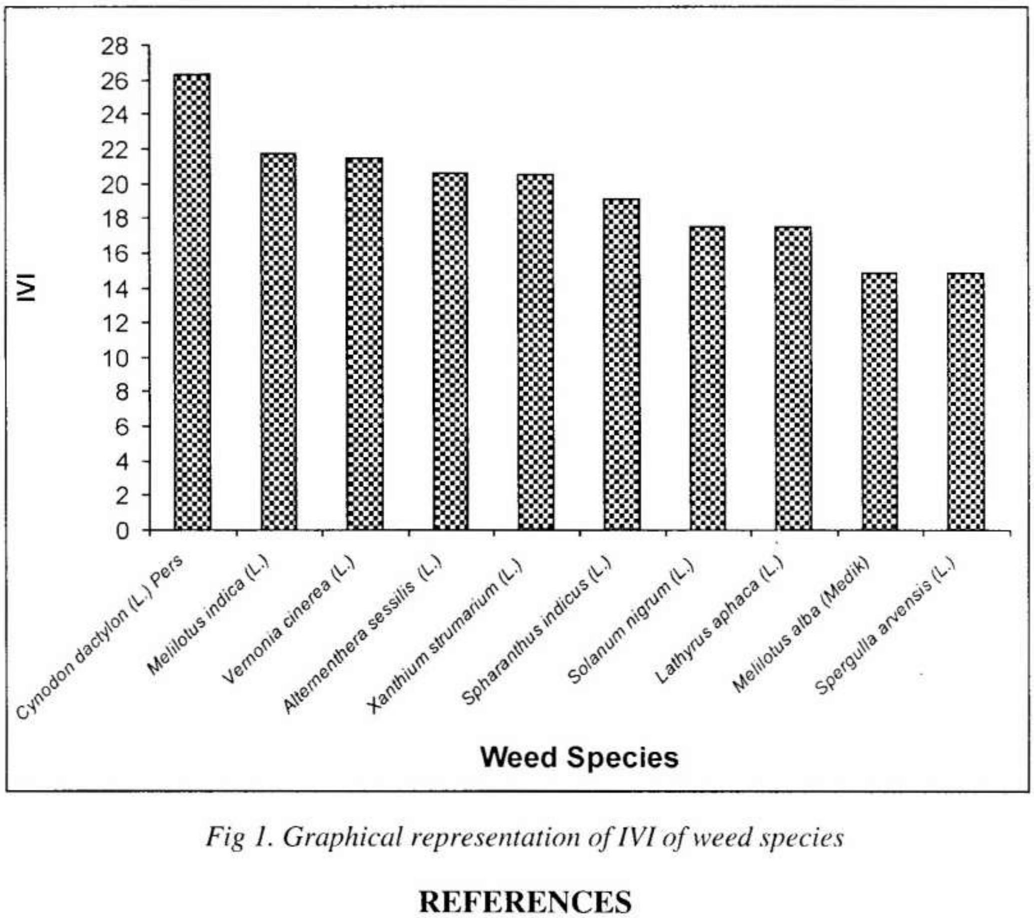

Fig 1. Graphical representation of IVI of weed species

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157- Reduced Phytotoxic Effects of Sulfosulfuron, Clodinafop and Fenoxaprop on *Phalaris minor* in Permanent trials

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INTRODUCTION

Acetolactate synthetase inhibitor, sulfosulfuron and acetyl Co A carboxylase inhibitors clodinafop and fenoxaprop were adopted in 1997-98 for the control of isoproturon resistant *Phalaris minor* (Walia et al.,1998; Balyan, 1999).

MATERIALS AND METHODS

A permanent trial for the assessment of time required to develop cross resistance in this weed was set up in villages Uchana and Sagga around Karnal. Seeds from these locations were collected every subsequent year to assess the change in efficacy of these herbicides on *P. minor*. Seeds from the farms of Regional Research Station, Uchani, Karnal from areas which were not sprayed with these herbicides were also included in the study. These were sown in earthen pots (9" dia) in sandy loam soil in November 2003. Approximately 50 seedlings per pot were maintained in three replicates. When these reached 2-3 leaf stage these were sprayed with graded doses of these herbicides. The doses used were Clodinafop: 15,30,45,60 and 75 a. i. g/ha, sulfosulfuron: 15,20,25,30 and 35 a. i. g/ha and fenoxaprop 60,90,120 and 150 a.i.g/ha. Pots were kept in an 8 sq m area and sprayed with a knapsack sprayer. Data on % mortality, plant height and fresh weight accumulated were recorded after 30 days. Regression anlaysis on the averages obtained was carried to derive LD_{50}/GR_{50} values.

RESULTS AND DISCUSSION

Percent mortality with sulfosulfuron was much lower in the population from Uchana and Sagga as compared to those from RRS, Uchani, Karnal. Similar effects on growth could be observed as seen from the data on plant height and fresh wt. accumulation. LD_{50}/GR_{50} values for fenoxaprop and clodinafop were also seen to be high in populations from Uchana and Sagga (Table 1). While these were 5-10g/ha for sulfosulfuron, 17-30g/ha for clodinafop and 19-22g/ha for fenoxaprop in 1997-98 these are seen to rise 5-10 times in case of sulfosulfuron, and fenoxaprop and 2-3 times in case of clodinafop.The yields are however not affected because of the low population density.

Table 1 LD_{50} and GR_{50} values of different biotypes around Karnal exposed to sulfosulfuron, clodinafop and fenoxaprop for 4-5 years continuosly.

Herbicide	*Biotype*	*LD_{50}*	*GR_{50}*
Sulfosulfuron	Uchani	22	<15
	Uchana	>35	<15
	Sagga	>35	25
Clodinafop	Uchani	<15	14
	Uchana	52	13
	Sagga	22.5	22.5
Fenoxaprop	Uchani	<60	<60
	Uchana	>150	<60
	Sagga	85	<60

CONCLUSIONS

The data is a warning sign for the development of cross resistance to these herbicides. Survey reports show poor efficacy of all these herbicdes at some locations. Extensive surveys and bioassays are required to monitor the efficacy of these herbicides and to develop strategies to control this menace.

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158- Screening of Tomato Cultivars for Glyphosate Resistance at Whole Plant and Pollen Grain Stage

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INTRODUCTION

Glyphosate is an ideal translocative herbicide without any residual effect in the soil. Only drawback of this herbicide is no selectivity. Thus the best approach is development of herbicide resistance lines or screen for cultivar differences for glyphosate resistance. Tomato is facing lot of problem by the root parasite orobanche at Kolar district, Bagepally taluk which supply 80% of Bangalore market demand. Most of the foliar applied glyphosate translocated to orobanche which being a parasite and gets destroyed.

MATERIALS AND METHODS

Five cultivars of tomato Arka aahuti, Arka meghali, Arka vikas, Arka aashish and Pusa ruby of twenty days old seedlings were transplanted into carbonized rubber containers holding 25 kg of potting mixture having red sandy loam: well decomposed FYM 3:1. Two plants per container were maintained with a spacing of 30 cm. After 20 days after transplanting the well-grown plants were sprayed with the different concentrations (0, 75,150,300,750and1500 g.a.i./ha)of glyphosate with four replications per treatment. Ten days after application of glyphosate, fresh weight and dry weight (g/plant) were recorded as biomass reflects the extent of growth of plant. Lower the reduction in biomass of a cultivar per given concentration of glyphosate more the tolerance to glyphosate and vice versa. Further, percent over control response of each replication was regressed with natural logarithm dose of glyphosate for each cultivar separately and ED_{50} was computed using equation 2.

Pollens grains from different cultivars of tomato were collected from fresh flowers early morning hour with in 9.30AM.Pollens were sprinkled on pollen germination medium (PGM -20ml) containing glyphosate (0, 25, 50, 75 and 100ppm) taken in cavity slides. They were incubated at room temp for 90 minutes in closed Petri dishes with moistened filter paper. After incubation period cavity slides were examined for pollen germination under 5 microscopic fields. PGM consists of magnesium sulphate, boric acid, potassium nitrate (each of 200 mg per litre), calcium dinitrate (300mg/l) and sucrose (8%). Percent pollen germination was calculated. The percent response of the various treatments over control (Without glyphosate) was regressed against the corresponding doses of glyphosate. Using linear form of four parametric logistic functions (Eq.1)

$$\text{Log}\ \{(D\text{-}Y)/(Y\text{-}C)\} = b\ (\log (Z)) - a \quad \ldots\ldots\ldots\ldots \quad (1)$$

$$a = b\ (\log (ED_{50})$$

$$\text{Thus } ED_{50} = \text{Anti log } (-a/b) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where D denotes maximum response(assumed as 100), C the minimum response (assumed as zero) at maximum dose, ED_{50} the dose at which average response level between D and C is produced, b the slope around ED_{50} value, Z the log dosage of glyphosate and Y the per cent response over control. a= -b (log ED_{50}) which is "Y" intercept value. LHS of equation 1 is also referred as logit transformed value. The model performance was evaluated by the coefficient of determination (r^2) and the residual sum of square (RRS=•(observed – predicted response).The observed dose response model performance of all cultivars ranged from 0.87 to 0.98 with low RSS.

RESULTS AND DISCUSSION

ED_{50} value indicates level of resistance to glyphosate, higher the value more resistance and vice versa It was interesting to note that, ED_{50} of cultivars of tomato for dry weight basis had higher values, while the pollen germination level was the least (Table 1). This suggests that glyphosate concentration need to reduce the pollen germination to 50 % of control (without glyphosate) was the lower dose than dry weight of whole plant. In other words, pollen germination was most sensitive to glyphosate than whole plant biomass reduction basis. Among different cultivars, Arka aahuti had higher ED_{50} value both at pollen stage and whole plant level (37.8 ppm and 185.4 g.ai/ha) compared to Arka meghali (18.9ppm and 69.6g.ai/ha) respectively. Arka aashish had intermediate ED_{50} (25.4ppm and 117.1 g.ai/ha) compared to Arka meghali followed by Pusa ruby and Arka vikas which were on par with each other. Further a strong relationship r=0.908 between biomass response at whole plant level (dry weight g/plant) and pollen grain germination ability for glyphosate exists amongst tomato cultivars (Fig 1). Thus intrinsic ability of pollen grains *in vitro* for glyphosate tolerance level reflects the whole plant level response. Interestingly even at pollen grain

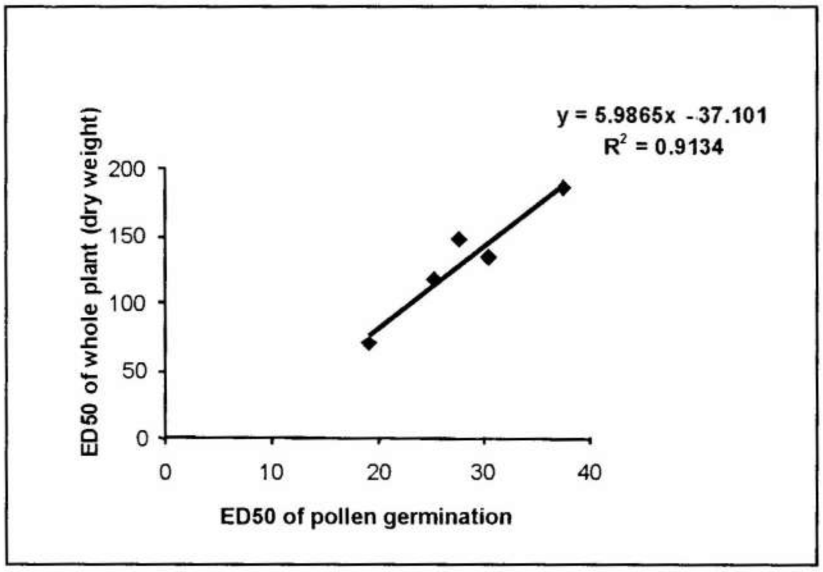

Fig 1 Relationship between ED_{50} at pollen stage and whole plant level of different tomato cultivars

stage itself screening of different cultivars against glyphosate can be made. Screening germplasm for various stress resistances was done in maize for cold tolerance (Kovacs and Beata Barnabas, 1993), high temperature and humidity stress in tobacco pollen (Madhu Bajaj *et al.*, 1993) and herbicide resistance in tomato (Devendra *et al.*, 1999).

Table 1 ED_{50} values for five cultivars of tomato as predicted by dose-biomass functions.

Cultivars	*ED_{50} (g.ai/ ha) values based on*	
	Dry weight	*Pollen germination*
Arka aashish	117.1	25.48
Arka aahuti	185.49	37.80
Arka meghali	69.57	18.99
Pusa ruby	148.26	27.6
Arka vikas	132.90	30.55
CD at 5%	75.20	4.45

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159- Influence of Mutagenic agents on Pollen Ability or Glyphosate Resistance of Tomato Cultivars

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INTRODUCTION

With the intension to increase the tolerance level to glyphosate, pollen pretreatment were made to induce mutagenesis in the various cultivars of tomato using both physical and chemical mutagens. Ethyl Methane Sulfonate (EMS) and UV rays were known to induce mutation in genetic materials of pollen. This may lead the pollen to develop resistance for glyphosate which was assessed as reflected by in vitro pollen germination. Since biotechnological methods are not ecofriendly and fear of antibiotic resistance and gene flow occurs, selective pollen was allowed to fertilize and produced seeds showed resistance to various stresses (for temperature, for moisture, for heavy metal) is well known.

MATERIALS AND METHODS

Pollens grains from different cultivars of tomato were collected from fresh flowers early in the morning with in 9.30AM.Pollens were sprinkled on pollen germination medium (PGM -20ml) which is having glyphosate (0, 25, 50, 75 and 100ppm) and EMS (0, 3, 5, 7, 10 and 15mM) of total 30 treatments with 3 replications. Pollen Germination Media (PGM) consists of mutagenic agents may aid in pollen grains higher resistance to stress with this background several experiments were conducted to alter glyphosate resistance intrinsic ability of pollen. They were incubated in cavity slides at room temp for 90 minutes. In closed petri dishes with moistened filter paper. Cavity slides were examined for pollen germination under 5 microscopic fields. Percent pollen germination was calculated.

To induce physical mutagenesis, using UV radiation, the collected pollen grains of Arka aahuti was placed on the cavity slide and exposed to different durations of UV radiation which is proportional to energy levels (0.050, 0.100, 1.150, 0.200, 0.250 and 0.300 joules).

RESULTS AND DISCUSSION

Results showed that there is variability in pollen response to EMS with respect to different cultivars based on ED_{50} value. Arka aahuti needs 10mM, Arka aashish needs 5 mM and Arka vikas needs 3mM EMS to get enhanced pollen germination per cent in presence of glyphosate in PGM compared to with out EMS by 28.9, 33.0 and 35.0 per cent respectively (Table 1). Other cultivars and Pusa ruby and Arka meghali did not respond to EMS treatment.

Exposure of pollen grains to UV radiation drastically reduced per cent pollen germination compared to control (not exposed to UV). Exposure of pollen grains to UV radiation for about 0.050 joules (10 seconds) was sufficient to reduce pollen germination per cent and tube growth. In presence of 25 ppm of glyphosate per cent pollen germination and tube growth was reduced (Table 2).

Pollen burst was also noticed at about 0.300 joules (60 seconds of exposure) and incubated with glyphosate. Also defective pollen tube growth (zig zag) was observed in the pollens exposed to UV radiation.

This data suggests that pollen pretreatment with UV radiation did not help to increase glyphosate resistance as reflected by the pollen germination in presence of glyphosate. Both mutagens (EMS and UV radiation) did not provide sufficient resistance to glyphosate in PGM. Though EMS pretreatment enhanced pollen germination in presence of glyphosate to a certain extent, powdery nature of pollen grain gets transformed with pollen pretreatment and progeny developed through pollen treatment followed by selective pollination and fertilization technique did not show sufficient glyphosate resistance. Thus intrinsic ability of pollen for glyphosate resistance has to be utilized to develop glyphosate resistant tomato lines using gametophytic competition and selective fertilization technique.

Table 1 ED_{50} (ppm) values for pollen germination of different tomato cultivar (EMS)

	EMS (mM)			
Cultivars	*0*	*3*	*5*	*10*
Arka aahuti	32.1^{h}	35.7^{efgh}	32.9^{fgh}	41.4^{c}
Arka meghali	55.1^{ab}	62.6^{a}	40.5^{def}	35.2^{efgh}
Arka.aashish	37.5^{efgh}	40.4^{def}	49.9^{bc}	47.6^{bcd}
Pusa ruby	39.6^{defg}	37.7^{efgh}	37.5^{efgh}	46.5^{cd}
Arka vikas	29.9^{h}	40.4^{de}	34.9^{efgh}	34.9^{efgh}
Mean	40.4	43.8	40.5	43.7
		CD at 5% for cultivars	3.65	
		EMS	3.65	
		Cultivars x EMS	8.17	

Table 2 Percent pollen grain germination after exposing to different energy levels of UV radiation and glyphosate (25 ppm)

Duration of pollen exposure to UV (seconds)	*Percent pollen germination*	
	PGM alone	*PGM +glyphosate*
Control	76.0^{a}	35.8^{a}
10	56.7^{b}	34.5^{ab}
20	50.3^{bc}	26.9^{bc}
30	46.5^{bc}	20.9^{cd}
40	45.6^{bc}	14.1^{d}
50	42.4^{bc}	13.6^{d}
60	38.7^{c}	13.3^{d}
CD at 5%	16.723	7.962

160- Bio-Efficacy Study of Glyphosate in Transgenic (Herbicide Tolerant) Maize.

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INTRODUCTION

Transgenic crops are increasingly becoming dominant feature in agriculture in several countries like USA, China, Argentina, Mexico and Canada. Area under transgenic crops is also increasing in other parts of world. The estimated global area under approved biotech crops for 2004 was 81.0 million hectares. Out of which 58.6 million hectare was of herbicide tolerant crops, which accounts for 72 % of total biotech crop area. The herbicide tolerant maize occupied 4.3 million hectares, equivalent to 5 % and Bt maize occupied 11.2 million hectares, equivalent to 14% of global biotech area. (Clive James, 2004). Herbicide tolerance in crop plants simplifies chemical based weed management, which involves compounds that are active on a very broad spectrum of weed species with absolute crop safety. Post emergence application on weeds suits well with reduced or zero tillage production methods, which can conserve soil and reduce tillage cost. The bio-efficacy study was conducted to assess phenotypic performance and the effect of herbicide (glyphosate) on herbicide tolerant corn expressing *CP4 EPSPS* gene (NK603) (Round up ready)* for its weed control efficacy and crop safety.

MATERIALS AND METHODS

The field experiment was conducted at Mahatma Phule Krishi Vidyapeeth, Rahuri (MS) during *kahrif* 2005. The genetically modified corn carrying *cp4 epsps* gene for glyphoaste resistance was planted on protected area of 432 m^2 area .The experiment consisted of eight treatments (Table 1) and replicated thrice in RBD. Post emergence application of (glyphosate) was done as per treatments. Observational data was statistically analysed with computational *Unistat. 5.5.*

RESULTS AND DISCUSSION

Weed Flora

The dominant weed flora in the experiment were *Parthenium hysterophorus* (28.7 to 39 %),*Digeria arvensis* (11.7 to 16.7 %), *Ditaria sanguinalis* (5.7 to 11 %), *Phylasnthus niruri* (7.7 to 18.3 %) *Panicum isachami* (9.7 to 14.3), *Cammelina bengalensis, Ipomea spp. Cammelina nudiflora* (1.7 to 4.3 %) *Amaranthus polygamus*, *Chorchorus acutanulus* and *Cyperus rotandus* (1 to 2.7 %).

Effect on Crop

No Injury, stand loss and Phytotoxicity symptoms on corn were reported after 14 and 21 days of treatment. Dry matter accumulation of weeds, weed control efficiency (WCE) and other yield attributes are given in Table 1. Significant higher weed control efficiency observed in all the glyphosate spray treatments which indicated at 100 percent weed control without damaging the crop. Yield attributes and yield were significantly higher than weedy check. Weed control treatment at lower concentration (900 g.a.i/ha) gave highest grain yield (13.13 t/ha) and B:C ratio (1.86) Similar observations were recorded by Dixit (1995).

Table1 Dry matter, weed control efficiency, yield attributes and yield influenced by weed control treatments in transgenic maize.

Treatment	Dosase (g a.i/ha)	Application Time	Dry matter (g/m^2)			WCE % 45DAT	Ear length cm	Shelling (%)	100 grain weght (g)	Grain Yield t/ha	B:C ratio
			15DAT	30DAT	45 DAT						
Glyphosate	900	V2-V4 Single spray	4.0	5.33	6.67	97.5	20.57	80.3	30.0	13.13	1.86
Glyphosate	1800	V2-V4 Single spray	3.67	2.67	4.33	98.4	21.2	79.1	29.4	13.0	1.74
Glyphosate	3600	V2-V4 Single spray	4.0	3.67	3.33	98.7	20.5	79.0	26.9	11.69	1.30
Glyphosate	900+900	V2-V4 +V6-V8	3.33	5.0	3.33	98.7	20.0	80.0	27.9	12.8	1.70
Glyphosate	1800+1800	V2-V4 +V6-V8	4.67	4.67	2.0	99.3	21.0	76.8	26.2	10.83	1.13
Farmers Practice	Intercultivation +hand weeding		36.67	39.0	30.0	88.8	20.5	81.15	26.8	11.4	1.40
Weedy Check	Control		318.67	275.0	271.7	-	18.8	71.55	25.3	7.7	0.74
Weed free			1.06	0.75	0.83		20.1	77.9	26.3	10.5	1.07
CD at 5%			41.43	26.3	12.22		1.39	4.56	4.12	2.85	

V2, V4 – Vegetative phase with 2 leaves and 4 leaves crop stage, respectively.

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161- Herbicide Resistance in *Phalaris minor* and Long- Term Zero –Tillage in Wheat

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The pressure on natural resources and tillage costs is rising day by day. A holistic approach is needed to tackle these second–generation problems and to improve the sustainability. Improved tillage and crop establishment practices, especially for rice, show real potential for sustainably improving the productivity and profitability of rice- wheat systems.

The history of detection of herbicide resistance in weeds began in Washington in 1960's with the discovery and report of triazine resistance in common groundsel (*Senecio vulgaris* L.) in 1964. Currently there are recorded 272 biotypes comprising 163 species (98 dicots and 65 monocots), which have evolved herbicide resistance worldwide. At the moment, there are 53 countries with 210,000 total number of fields infested with resistant weeds and most affected countries are USA, Australia, Canada and France. The first case of herbicide resistance in India was reported during 1992- 1993 in *Phalaris minor* against isoproturon (Malik and Singh, 1995). This was the most serious case of herbicide resistance in the world, resulting in total crop failure under heavy infestation (2000-3000 plants m^{-2}).

The use of alternate herbicides, which remain effective on resistant populations, can be a successful strategy; at least for short-term in some instances, however, if used repeatedly, there is a high risk of resistance developing to the alternate herbicides (Yadav *et al.*, 2002). Avoid using the herbicide to which resistance has been confirmed otherwise resistance factor will increase with the time it will be used as in case of isoproturon against *P. minor* (Yadav *et al.*, 2002). Research findings of last four years (2000-04) pertaining to current trend of herbicide resistance in this weeds indicated that resistance is spreading in adjoining areas in different parts of the country, and seed contamination, antagonism, and cross-resistance are issues of concern. Resistance has been found to multiply with the number of years the same herbicide was used and isoproturon showed its reflection in any herbicide mixture. Resistance has been found to be irreversible once it is evolved and even malathion could also not change this phenomenon. Improving herbicide application accuracy (spray techniques) will help in achieving adequate efficacy besides decreasing the amount of herbicide applied.

Zero-tillage technology has occupied around one million hectare of wheat in India during 2003-04. For the past eight years, the evolution and acceleration of zero-tillage in Haryana has been one of the few big ideas in introducing conservation agriculture. Long-term impact of zero-tillage on weed dynamics, soil health and sustainability goes in strong favor of this technique. Population of *Phalaris minor* has drastically reduced over the years due to continuous zero-tillage coupled with alternate herbicides, and the yields are more or equivalent to conventional tillage. It was possible to escape spray of alternate herbicide against *P. minor* after 3-4 years of adoption of zero-tillage in wheat. Zero-tillage in wheat, barley and oat is also possible under cropping systems other than rice. The yields of rice after long-term zero-tillage wheat have also not been adversely affected.

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162- Studies on GR_{50} Values of New Herbicides for Isoproturon Resistant *Phalaris minor*

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INTRODUCTION

Rice-wheat is the dominating cropping system of the north-western states of India which are grain bowl of the nation. *Phalaris minor* is a troublesome weed of wheat in the entire zone due to the introduction of high yielding fertilizer responsive dwarf wheat varieties. The increased selection pressure due to continuous use of isoproturon over the last one and half decades in the rice-wheat cropping system resulted in the evolution of resistant biotypes of *Phalaris minor* (Walia *et al*, 1997). So, pot studies for estimation of GR_{50} values of isoproturon resistant *Phalaris minor* for clodinafop, sulfosulfuron and fenoxaprop-p-ethyl were started immediately after their recommendation to have an estimate of the time required for development of resistance to these herbicides.

MATERIALS AND METHODS

Pot experiments were carried out at the experimental farm of Punjab Agricultural University, Ludhiana from 2000-01 to 2004-05 by sowing counted number of seeds of isoproturon resistant *P. minor* during first fortnight of November. Spraying of isoproturon, clodinafop, sulfosulfuron and fenoxaprop-p-ethyl were made at 3-4 leaf stage of *P. minor* and their recommended levels are 940 g/ha, 60 g/ha, 25 g/ha and 100 g/ha, respectively. The levels of isoproturon were ½ R (R – recommended), R, 2R, 3R and 4R, where as of other herbicides these were 1/8 R, ¼ R, ½ R, R and 2R during all the years of study. Fresh weight of *P. minor* plants was recorded about one month of their application and data was subjected to log – logistic analysis (Seefeldt *et al*, 1995).

RESULTS AND DISCUSSION

GR_{50} values for isoproturon during 2000-01 was 1403 g/ha (Brar *et al* 2002) against its recommended dose of 940 g/ha. This value came down to 1380 and 1040 g/ha during 2001-02 and 2002-03 crop season (Walia *et al* 2004) indicating improvement in its bioefficacy. GR_{50} for isoproturon during 2003-04 crop season was 980 g/ha and during 2004-05, it was 530 g/ha (Table 1). These studies indicates that level of resistance to *P. minor* by isoproturon is decreasing year by year. The performance of other herbicides i.e., clodinafop, sulfosulfuron and fenoxaprop-p-ethyl was found to be static during all the years of investigations.

Table 1 GR_{50} values for different herbicides on fresh weight basis.

Treatments	Recommened	GR_{50} (g/ ha)				
	dose	2000-01	2001-02	2002-03	2003-04	2004-05
Isoproturon	940	1403	1380	1040	980	530
Clodinafop	60	1.84	2.45	2.50	2.99	3.15
Sulfosulfuron	25	2.50	1.89	2.27	2.49	2.76
Fenoxaprop-p-ethyl	100	4.90	6.62	8.55	9.08	12.34

CONCLUSIONS

The sensitivity of isoproturon resistant *P. minor* biotypes to isoproturon is increasing year after year. There is no meaningful increase in GR_{50} values for clodinafop, sulfosulfuron and fenoxaprop-p-ethyl herbicides since from last five years.

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163-Effect of Organic Matter on the Persistence of Herbicide in Rice-Wheat Cropping System

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INTRODUCTION

Soil organic matter is the most significant factor which influence the herbicide behaviour. Soil organic matter is quite important in preventing the leaching of herbicides in soil. Persistence of herbicide in soil depends on type of herbicide, texture of soil, organic matter content, moisture and temperature. So herbicide phytotoxicity has shown a close relationship between soil organic content and herbicide phytotoxicity.

MATERIALS AND METHODS

A long term study was conducted on the effect of soil organic matter on herbicide persistence in rice wheat system. It has been in progress since 1999-2000. In rice, butachlor 1.5 kg/ha + 2,4-D (0.5 kg ha^{-1}) was applied after green manuring and absence of green manuring. This was followed in wheat by applying isoproturon 0.94 kg/ha + 2,4-D 0.5 kg ha^{-1} at recommended dose. The soil, grain and straw samples collected from the experimental plot were used for the estimation of residues of herbicides applied to the crop. The method of extraction and estimation of isoproturon in soil, grain and straw was followed as described by Kulsherestha (1982). The quantity of 2,4-D in the extract was determined spectrophotometrically at 565 mm using the method of marquardt and Luce (1955) and butachlor residue in soil, grain and straw were analysed by using HPLC as suggested by Singh *et al* (2002) and data are presented in Table 1.

RESULTS AND DISSCUSSION

Herbicide residue analysis in the post harvest soil, grain and straw samples indicate that in wheat crop no residue of isoproturon and 2,4-D was detected. Similarly, in rice crop no residue of butachlor was detected in soil, grain and straw of paddy at harvest. These results were in corraboration with the finding of several other worker (Rajendra *et al*, 1999; Reddy *et al* 1998). No effect of organic matter on the persistence of herbicide was found.

There was no build up of residue of isoprotuon, 2,4-D and butachlor in the presence of organic matter when applied continuously for the fifth year in rice-wheat cropping system.

Table 1 Residue of herbicides in soil and crop produce in rice-wheat cropping system as influenced by organic matter at harvest.

Treatment dose	kg ha^{-1}	Sample	Rabi		Kharif	
Rabi	Kharif		Isoproturon	2,4-D	Butachlor	2,4-D
Isoproturon	Butachlor	Soil	ND	ND	ND	ND
0.94 + 2,4-D 0.5	+2,4-D	Grain	ND	ND	ND	ND
		Straw	ND	ND	ND	ND
Isoproturon	Butachlor	Soil	ND	ND	ND	ND
0.94 + 2,4-D 0.5	+2,4-D +	Grain	ND	ND	ND	ND
	G M	Straw	ND	ND	ND	ND

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164-Uptake of Isoproturon in Different Biotypes of *P. Minor*

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INTRODUCTION

Phalaris minor is the most troublesome weed affecting wheat production in rice-wheat cropping system. It is an annual grass weed. *The P. minor* at many places in Punjab has developed resistance to isoproturon (Sandhu *et al.*,1996 and Tomer and Vivek 2003). The response of resistant biotypes of *P. minor* was seen to isoproturon application.

MATERIALS AND METHODS

In pot experiment population of *P. minor* samples from different places were put to screen test against isoproturon 1.0 and 2.0 kg/ha. Plant samples were taken at 10, 30 and 60 days after spray. The plant samples were extracted by blending with chloroform and clean up by passing the contents through alumina column and eluting with a mixture of hexane and isopropyl alcohol (90 : 10 ml) and analysed spectrophotometrically for isoproturon uptake in plants of *P. minor*.

RESULTS AND DISSCUSSION

The data (Table 1) indicated that after 10 days of application with isoproturon there was only one biotype of *P. minor* ($_{15}$) at higher dose of isoproturon (2 kg ha^{-1}) which showed isoproturon content 0.002 ppm. In all biotypes of *P. minor* isoproturon content was non-detectable at 30 and 60 days after spray.

Table 1 Isoproturon (ppm) in *P. minor* biotypes

P. minor	*10 Days after sowing*		*30 Days after sowing*		*60 Days after sowing*	
biotypes	*1.0 kg ha^{-1}*	*2.0 kg ha^{-1}*	*1.0 kg ha^{-1}*	*2.0 kg ha^{-1}*	*1.0 kg ha^{-1}*	*2.0 kg ha^{-1}*
P_2	ND	ND	ND	ND	ND	ND
P_6	ND	ND	ND	ND	ND	ND
P_8	ND	ND	ND	ND	ND	ND
P_{11}	ND	ND	ND	ND	ND	ND
P_{13}	ND	ND	ND	ND	ND	ND
P_{15}	ND	0.002	ND	ND	ND	ND
P_{19}	ND	ND	ND	ND	ND	ND
P_{20}	ND	ND	ND	ND	ND	ND

The chlorophyll content of leaves in the different *P. minor* biotypes after 10, 30 and 60 days of application of isoproturon showed that there was slight phototoxicity 10 days after its application. The chlorophyll content recorded 60 days after application indicated that there was no phototoxicity in all biotypes (Table 2).

Table 2 Chlorophyll content in different biotypes of *P. minor* in (mg/g) of fresh weight

Dose of IPU kg ha^{-1}	P_2	P_6	P_8	P_{11}	P_{13}	P_{15}	P_{19}	P_{20}
				10 Days after sowing				
1.0 kg ha^{-1}	1.058	0.972	1.002	1.070	1.013	0.917	1.070	1.035
2.0 kg ha^{-1}	0.939	0.864	0.894	0.890	0.980	0.846	0.826	0.881
Control	1.174	1.060	1.043	1.345	1.209	1.174	1.179	1.138
				30 Days after sowing				
1.0 kg ha^{-1}	1.134	1.601	1.435	1.143	1.007	1.284	1.400	1.551
2.0 kg ha^{-1}	1.128	1.052	1.294	1.007	0.846	1.123	1.365	1.058
Control	1.148	1.682	1.581	1.158	1.397	1.485	1.536	1.581
				60 Days after sowing				
1.0 kg ha^{-1}	1.214	1.098	1.531	1.108	1.223	1.360	1.289	1.290
2.0 kg ha^{-1}	0.775	0.579	1.098	1.037	1.188	1.304	1.011	1.047
Control	1.433	1.324	1.818	1.612	1.763	1.818	1.450	1.491

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165-Sensitivity of *Gobhi Sarson* (*Brassica napus* L) and Canola (*B napus*) Genotype to Isoproturon

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INTRODUCTION

Gobhi sarson is an important oil seed crop of the state. Isoproturon is recommended for weed control in different cultivar of *gobhi sarson*. Its leaves are deep green and smooth are commonly used as pot herb. In Punjab, it is called as *Sag*. Therefore, it is very essential to estimate herbicide residue i.e. in vegetative plant parts. Keeping this in view, the residue of isoproturon was estimated at early stages of growth of different *gobhi sarson* cultivars.

MATERIALS AND METHODS

Persistence of isoproturon applied as post-emergence (0.5 and 0.75 kg/ha) to different cultivars of *gobhi sarson* and Canola (124-8888) was studied.

A field experiment was conducted during 2000-2001 to study the persistence of isoproturon (0.5 and 0.75 kg/ha) in plant. Plant samples were collected after 7, 15, and 30 days of herbicide application. The method of extraction and estimation of isoproturon content in plant was followed as described by Katz (1966) and Kulshreshta (1982).

Chlorophyll content and residue of isoproturon in plant samples were detected spectro-photometrically.

RESULTS AND DISSCUSSION

Persistence in Plants

The data (Table 1) indicated that in plants of different cultivars of *Brassica* the residues of isoproturon increased with increase in dose of herbicide applied and decreased with passage of time. In all cultivars of *Brassica* the residue of isoproturon got degraded to non-detectable limits after 30 days of its application.

Table 1. Residue ofisoproturon (ppm) in different *Brassica napus* cultivars

Days after spray	*Cultivars*	*Isoproturon dose (kg/ha)* 0.50	0.75
7	GSL 1GSC 3 AC 124C 8888	0.0090.0110.0100.008	0.0120.0140.0120.010
15	GSL 1GSC 3 AC 124C 8888	0.0050.0060.0070.006	0.0090.0080.0090.006
30	GSL 1GSC 3 AC 124C 8888	0.0030.0040.0030.002	0.0040.0040.0040.002

Chlorophyll content

The chlorophyll content of leaves in all the cultivars of *Brassica* after 7, 15, 30days of application of isoproturon showed increasing trend with each level of isoproturon (0.5 and 0.75 kg/ha). Herbicide application caused phytotoxicity to crop during initial period. The chlorophyll content recorded 30 days after application indicate that there was no phytotoxicity in all cultivars (Table 2).

Table 2. Effect of isoproturon on chlorophyll content (mg g^{-1} fresh weight) in different *Brassica napus* cultivars

Treatment	*Dose (kg/ha)*	***Cultivars*** *GSL 1 C 8888*		*GSC 3A*	*C 124*
		7 Days after spray			
Isoproturon	0.50	0.702	0.808	1.065	0.854
Isoproturon	0.75	0.623	0.586	0.901	0.699
Control		0.788	1.276	1.065	0.946
		15 Days after spray			
Isoproturon	0.50	0.398	0.149	0.292	0.296
Isoproturon	0.75	0.127	0.110	0.247	0.247
Control		0.992	0.508	0.918	0.851
		30 Days after spray			
Isoproturon	0.50	1.298	1.094	1.196	1.104
Isoproturon	0.75	1.238	0.890	1.064	1.025
Control		1.518	1.306	1.329	1.280

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166-Effect of Fluchloralin and Metribuzin Applied with and Without FYM on Herbicide Residues and Soil Properties under Potato Pearlmillet Cropping System

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INTRODUCTION

Potato pearlmillet is a common practices adopted by the farmers in central Gujarat. Fluchloralin and metribuzin herbicides are recommended for weed management in potato crop. Patel and Barevadia (1999) observed greater weed control efficacy in *rabi* season with severe carry over effect on succeeding summer pearlmillet crop were dinitroaniline herbicides were applied as herbigation or pre plant. Therefore in intensive cropping system, it is necessary to see effect of herbicide on soil properties and residues in surface soil.

MATERIALS AND METHOD

A field experiment was conducted during *rabi* season of 2002-2003 at the experimental station of Anand to know the effect of herbicides applied with and without farm yard manure on soil properties and herbicides residues under potato pearlmillet cropping system. The experiment was laid out in completely randomized block design with four replications. The soil at the experimental site was sandy loam in nature with pH 8.19, low in organic carbon (0.473 %), high in phosphorus (71.61 kg/ha) and high in potassium (361.8 kg/ha). The treatments consisted of fluchloralin (1.0 kg/ha), fluchloralin with FYM (10 t /ha), metribuzin (0.35 kg/ha), metribuzin with FYM (10 t /ha) and none chemical control (2 HW). Herbicides residues and microbial population were analyzed at 1, 7, 15 and 30 DAS and at harvest. Fluchloralin residues were estimated by GC equipped with ECD. Soil properties and microbial population were analyzed adopting standard procedures.

RESULTS AND DISCUSSION

Soil properties

The result revealed that pH, electrical conductivity, available phosphorus and available potassium were not significantly affected by application of fluchloralin or metribuzin with or without FYM at harvest. Nitrogen content was significantly higher recorded with fluchloralin and FYM. Rathod and Patel (2003) did not show significant effect of application of dinitroaniline herbicides alone or with FYM in sandy loam soil under mustard crop.

Herbicide residues

Fluchloralin residues in surface soil were decreased as the stage of sampling advanced. Fluchloralin residues were lower at all the intervals in soil with 10 t FYM/ha as compared to fluchloralin alone. Fluchloralin residues were not detected in potato tubers at harvest.

Microbial population

Result revealed that total population of bacteria was significantly affected by application of herbicides upto seven days from the spraying, while fungi was significantly suppressed by the application of herbicides upto fifteen days of the soil.

Table 1 Fluchloralin residues in sandy loam soil under potato crop

Days after spraying	Fluchloralin residues (ppm)	
	Fluchloralin 1.0 kg/ha without FYM	Fluchloralin 1.0 kg/hawith 10 t FYM/ha
1 (24 hrs.)	0.484 (100)	0.406 (100)
7	0.352 (72.7)	0.231 (56.9)
15	0.252 (52.1)	0.158 (38.9)
30	0.104 (21.5)	0.053 (13.1)
At harvest	0.004 (0.8)	0.001 (0.3)

* Figures in parenthesis are percent values

Table 2 Effect of herbicides and FYM on microbial population at various intervals in sandy loam soil

Treatments	Sampling intervals (days)				
	1	7	15	30	At harvest (90)
			Bacteria (x 10^5 g^{-1} soil)		
Flu. 1.0 kg/ha	8.00	10.50	10.82	11.12	8.85
T1 + 10 t FYM/ha	10.38	12.00	11.75	11.37	8.77
Metribuzin 0.35 kg/ha	7.75	9.88	11.15	10.87	8.87
T3 + 10 t FYM/ha	9.25	11.37	12.00	11.75	9.00
Control (2 HW)	10.75	12.25	12.15	12.75	8.87
LSD (p=0.05)	1.22	0.80	NS	NS	NS
			Fungi (x$10^3$$g^{-1}$ soil)		
Flu. 1.0 kg/ha	4.75	5.25	7.45	6.6	6.33
T1 + 10 t FYM/ha	5.78	5.75	8.25	6.55	6.40
Metribuzin 0.35 kg/ha	6.32	6.57	8.20	6.75	6.55
T3 + 10 t FYM/ha	6.80	7.50	8.52	6.95	6.65
Control (2 HW)	8.25	8.30	8.95	6.93	6.78
CD at 5%	0.30	0.43	0.43	NS	NS

Table 3: Physico-chemical properties of the soil after harvest of potato

Treatments	pH 1:2.5 (Soil water) ratio	EC at 25^{0}C (dsm^{-1})	Nitrogen (%)	P_2O_5 (kg/ha)	K_2O (kg/ha)
Flu. 1.0 kg/ha	8.11	0.127	0.026	56.58	350
T_1 + 10 t FYM/ha	7.05	0.127	0.031	59.12	358
Metribuzin 0.35 kg/ha	7.93	0.122	0.023	53.29	349
T3 + 10 t FYM/ha	7.78	0.126	0.026	53.50	352
Farmer's practices (HW 20 & 60 DAS)	8.15	0.125	0.025	54.35	350
CD at 5%	0.25	NS	0.003	NS	NS

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167-Identifying Bacteria for Degradation Atrazine, Metribuzin and Pendimethalin

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INTRODUCTION

Bioremediation is needed because certain xenobiotics tend to accumulate in the environment to levels that threaten human health or environmental quality. In order to search newer methods for remediation, efforts are needed to exploit natural capacity of microorganisms to degrade such persistent compounds. Atrazine, metribuzin pendimethalin are three herbicides reported to be persistent in soil (Gopal & Mukherjee, 1999 and Arora & Gopal, 2004). Global concern has emerged due to residues of atrazine found in water and metribuzin and pendimethalin showed phytotoxicity. There is need of using living organisms (primarily microorganism) to degrade these persistent herbicide. Attempt to detoxify these herbicides will be presented.

MATERIALS AND METHODS

Bacteria have potential for cleaning environment through biotechnological approaches. After screening various microorganisms, two strains were selected for their ability to degrade atrazine and metribuzin. Bacterial isolates were grown in Pikovaskaya medium (Sundra & Sinha, 1963) and analytical grade atrazine, metribuzin and pendimethalin were used for the experiment. 250 ug of each herbicide were applied in 25 ml of mineral salt medium (which have minerals/salts necessary for bacterial growth but were devoid of carbon source). The herbicides were given an carbon source. Isolate A was grown KenKnight medium.

RESULTS AND DISCUSSION

Dissipation pattern were obtained by estimating the concentration of pesticide on 0, 1, 3, 5, 10, 15 and 20 days by GLC. The dissipation pattern and half life of the two herbicides show that *Bacillus subtiles* could degrade atrazine by 53 % and *Pseudomonas straita* could degrade metribuzin up to 86 % in 20 day, where as pendimethalin could be degraded by special filamentous bacteria called isolate A up to 72.75 % in 20 days. The results are summarized below in Table 1.

Table 1. Bacterial degradation of three herbicides

Days	*Atrazine degradation by Bacillus subtilis*	*Metribuzin degradation by Pseudomonas straita*	*Pendimethalin degradation by Isolate A (an actinomycetes)*
0	227.70(-)	227.70(-)	201.34(-)
1	194.37(14.61)	208.34(8.1)	1150.69(5.17)
3	171.24(24.79)	172.22(24.36)	187.61(5.4)
5	147.69(34.14)	107.48(51.76)	174.22(11.97)
10	134.99(39.03)	71.10(66.94)	67.41(63.79)
15	120.38(44.74)	52.50(76.94)	50.60(70.14)
20	97.83(53.44)	29.19(86.30)	44.45(72.75)
Half life (days)	19.29	6.90	7.85

*Mean of three replicates. Figure in parenthesis shows the percent degradation

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168-Impact of Herbicide Application on Soil Physico-Chemical Properties and its Residue in Rice –Rice Cropping System

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INTRODUCTION

The herbicide mixtures are applied to control weeds as well as to enhance the crop yield in cropping system. Under integrated nutrient management system, impact of continues application of herbicide mixture on its residue in soil and crop plants has not been studied. In view of this, permanent herbicide experiment has been in progress for the last few years with the objectives of characterizing the Physico chemical properties of post harvest soil and estimating the herbicide residue in soil and crop produce.

MATERIALS AND METHODS

Series of field experiments involving rice-rice crops have been carried out in wetland farm of Tamil Nadu Agricultural University, Coimbatore. Treatments consisted of hand weeding twice, Butachlor 0.75 + 2,4 DEE 0.4 kg/ha and Butachlor 0.75 + 2,4 DEE 0.4 kg/ha in rabi followed by Pretilachlor 0.75 + 2,4 DEE 0.4 kg/ha in kharif and thus six treatments were imposed with hundred percent nitrogen and seventy five per cent nitrogen plus twenty five percent nitrogen through organic manure. Experiment was conducted in a non replicated randomized block design. Experimental soil was clay loam in texture and initial nutrient status was low, medium and high of nitrogen, phosphorus and potassium respectively. The results of rabi 2002 and kharif 2003 are discussed here under. Organic form of N was supplied through daincha green manure for *kharif* crop only. All the treatments in *rabi* crop were applied with 100% N in inorganic form.

RESULTS AND DISCUSSION

Soil physico-chemical properties

The post harvest soil samples were collected from Rabi 2002 and Kharif 2003 crops. The soil samples were analysed for available nutrients, pH and organic carbon. The organic carbon content and available nitrogen content were significantly influenced by the treatments. While application of either herbicide mixtures or organic source of nitrogen did not show significant effect on available phosphorus and potassium content. However, availability of phosphorus was in the medium range and available potassium in the higher range in all the treatments. Increase in organic carbon content was recorded from 0.47 to 50% for the application of organic source of N equivalent to 25% recommended N during rabi 2002.Similar, increase in organic carbon content from 0.51-0.52% for N applied as green manure, was observed during kharif 2003. Incorporation of organic source of N for treatments viz., W1N2, W2N2 and W3N2 for kharif crop alone had resulted in the increased available nitrogen content in both the seasons. The increased available nitrogen was recorded up to 254 kg/ha and 251 kg/ha during rabi2002 and kharif 2003 crop respectively. Comparing the results of nutrient availability in the post harvest soils of first and seventh crop, there was significant increase in organic carbon and nitrogen content due to application of green manure equivalent to recommended nitrogen.

Herbicide residue

The soil, plant and grain samples collected during *rabi* 2002 and *kharif* 2003 were analyzed for butachlor, 2,4-D and pretilachlor residue. A progressive decline in residue content of butachlor was observed with advancement of crop growth. Applied butachlor was degraded up to 86 to 88% with in 30 days of application in both the seasons (Fig 2). However, butachlor residue was found to be below detectable level in the post harvest soil samples. This is in conformity with findings of Chen and Chen (1979). There was no difference on the degradation pattern of herbicide due to application of either organic source or inorganic source of N. The continuous application of either butachlor + 2,4 DEE herbicide mixtures or butachlor/ pretilachlor + 2,4 -D herbicide mixtures did not show build up of butachlor residue in the post harvest soil of sixth and seventh rice crop. The grain and straw samples were found to have below detectable level of butachlor up to seventh crop. Application of 2,4-D got degraded progressively with advancing crop growth and it recorded 0.01to 0.015 ppm on 45th day for various treatments and it was below detectable level in the post harvest samples during kharif 2003. Nearly, 92 to 95% of applied 2,4-D was degraded in six weeks time after application. There was no residue in grain and straw samples at harvest. Similar degradation pattern of pretilachlor was observed for the soil samples of *rabi* 2002. Nearly 95% of applied pretilachlor got degraded with in one month of application (Fig.1) and it was found below detectable level at harvest. The grain and straw samples of sixth crop had no pretilachlor residue under the treatment of alternate application of butachlor / pretilachlor.

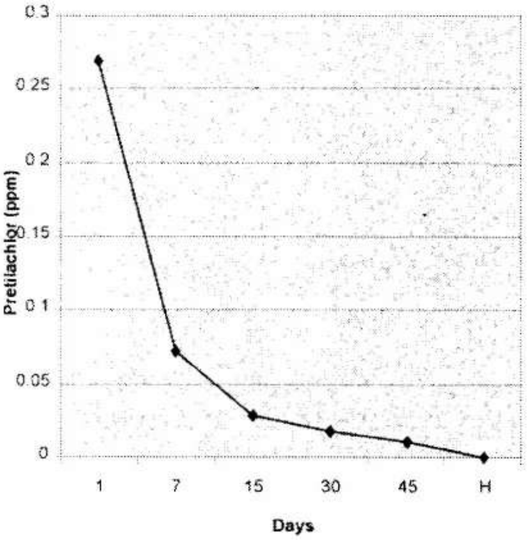

Fig 1.Persistence and degradation of pretilachlor (0.75 kg/ha) in PHT of paddy soil (Rabi 2002)

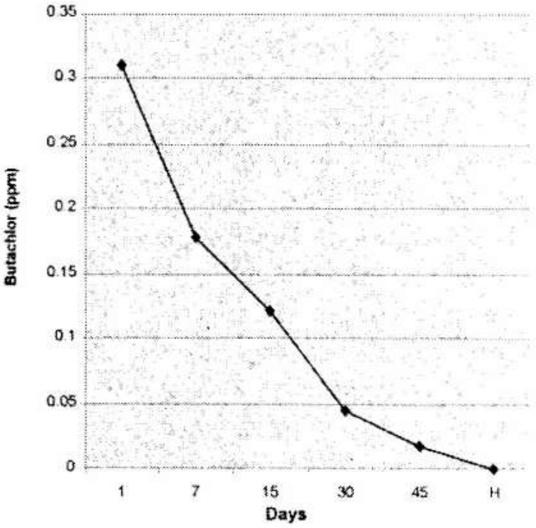

Fig 2. Persisitence and degradation of butachlor (0.75 kg/ha) in PHT of paddy soil (Kharif 2003)

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169-Fate of Atrazine in Sugarcane Ecosystem

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INTRODUCTION

Generally atrazine is widely applied to control weeds in sugarcane. Atrazine is an herbicide used to control broadleaf and grassy weeds. Atrazine is mainly applied to corn and soybean crops, but is also used on sorghum,and sugarcane. This pesticide is a white crystalline solid organic compound that is available in many forms as a dry flowable, flowable liquid, water dispersible granular liquid, and a wetable powder. However, by virtue of its susceptibility to leaching in coarse textured soil and its longer persistence in soil, there is possibility of its entry in to plant, soil and water. In view of this, a field experiment on sugarcane has been initiated to estimate the atrazine residue in soil and sugarcane juice.

MATERIALS AND METHODS

Field experiment on sugarcane (var.CO 864032) was carried out during 2003 at Tamil Nadu Agricultural University, Coimbatore. There were six treatments consisting of five levels of atrazine (1.0 to 5.0 kg/ha) with control in replicated randomized block design. Recommended dose of fertilizer and other management practices were adopted during crop growth. The experimental soil was in clay loam in texture with nutrient status of low, medium and high of nitrogen, phosphorus and potassium.

RESULTS AND DISCUSSION

Soil samples collected periodically from surface (0-15 cm) were analysed for atrazine residue. The samples analysed for pH showed that there was no much variation for various treatments at any of the stages. It ranged from 7.8 to 8.0. Soil samples was extracted for atrazinr as per the standard procedure and injected in GC maintaining standard temperature conditions. Analysis of residue in soil samples showed gradual degradation of atrazine with advancement in crop growth (Fig.1). Application of atrazine at recommended level (2.0kg/ha) got degraded to the extent of 89% on 90th day after application but it was found below detectable level after wards. How ever, as the dose of atrazine was increased to 5kg/ha, the residue was observed up to 180th day. Nearly 64 to 89% of applied atrazine was degraded with in 90 days of application at all levels.

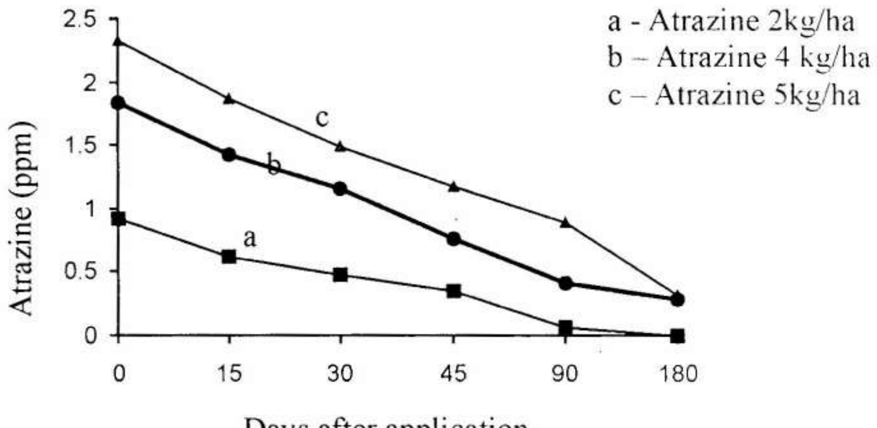

Fig 1.Atrazine persistence and degradation in sugarcane soil

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170-Persistence of Herbicides in Rice-Rice System

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INTRODUCTION

Chemical weed control in rice cultivation has become indispensable, particularly due to high cost and acute scarcity of labourers during the peak periods of demand. As a result, herbicide consumption in the state has shown an increasing trend during the recent years. Butachlor, pretilachlor and 2,4-D are the widely used chemicals in the paddy fields of the state. As there is a possibility of accumulation of herbicide residues in soil and contamination of the environment due to their repeated application, determination of their persistence in soil under continuous and rotated application in rice- rice cropping system is imperative. Therefore, a long-term herbicide trial in rice-rice system was initiated at College of Horticulture, Kerala Agricultural University and persistence of herbicides in the system was evaluated under single and repeated application.

MATERIALS AND METHODS

Field experiments were conducted in first and second crop seasons of 2001 and 2002 with six treatments, namely; (T1) hand weeding twice (25 and 40 DAS); (T2) butachlor fb 2,4-D (with 100% NPK as inorganic fertilizer) in the first and second crop seasons of 2001 and 2002; (T3) butachlor fb 2,4-D (with 100% NPK as inorganic fertilizer) in the first crop season of 2001 and 2002, pretilachlor fb 2,4-D (with 100% NPK as inorganic fertilizer) in the second crop season of 2001 and 2002; (T4) butachlor fb 2,4-D(with 75% NPK as inorganic fertilizer and 25% through FYM) in the first crop season of 2001 and 2002, pretilachlor fb 2,4-D(with 100% NPK as inorganic fertilizer) in the second crop season of 2001 and 2002; (T5) butachlor fb 2,4-D(with 100% NPK as inorganic fertilizer) in the first and second crop of 2001, pretilachlor fb 2,4-D(with 100% NPK as inorganic fertilizer) in the first and second crop of 2002;(T6) butachlor fb 2,4-D in the first and second crop of 2001(with 75% NPK as inorganic fertilizer and 25% through FYM in the first crop and100% NPK as inorganic fertilizer in the second crop), pretilachlor fb 2,4-D the first and second crop of 2002 (with 75% NPK as inorganic fertilizer and 25% through FYM in the first crop and100% NPK as inorganic fertilizer in the second crop).

Residues of the herbicides applied in the first and second crop season of 2002 were estimated by gas chromatographic methods (Sankaran et al., 1993) after collecting soil samples from the treatments at 1 and 30 days after spraying and at the time of harvest.

RESULTS AND DISCUSSION

Persistence of butachlor

More than 95 per cent of the applied herbicide dissipated from the soil by 30 days after spraying (Table 1). Greater losses were observed in the FYM applied plots (97.66 per cent). Since soil microorganisms are involved in the degradation of butachlor (Chen and Wu, 1978) addition of soil organic matter would have enhanced their activity.

Plots that did not receive FYM also had registered higher rate of dissipation during the second crop season.

Persistence of pretilachlor

About 94 to 98 per cent of the applied pretilachlor was lost from the soil by 30 days after spraying (Table 2). Higher losses of pretilachlor were observed in the plots, which received FYM (97.47 to 98.05 per cent). As in the case of butachlor, higher degree of dissipation of pretilachlor was noticed in the second crop season. The results of the present investigation indicated similarities in the pattern of dissipation of butachlor and pretilachlor in the paddy field under a particular soil and climatic conditions.

Table 1 Butachlor residues in the soil ($\mu g\ g^{-1}$) during the first and second crop seasons

Treatments	*First crop*			*Second crop*		
	1 DAS	*30 DAS*	*Harvest*	*1 DAS*	*30 DAS*	*Harvest*
T_1	ND	ND	ND	ND	ND	ND
T_2	0.3310	0.0240	ND	0.3430	0.020	ND
T_3	0.3895	0.0410	ND	ND	ND	ND
T_4	0.3960	0.0200	ND	ND	ND	ND
T_5	ND	ND	ND	ND	ND	ND
T_6	ND	ND	ND	ND	ND	ND

ND - Not detected

Table 2 Pretilachlor residues in the soil ($\mu g\ g^{-1}$) during the first and second crop seasons

Treatments	*First crop*			*Second crop*		
	1 DAS	*30 DAS*	*Harvest*	*1 DAS*	*30 DAS*	*Harvest*
T_1	ND	ND	ND	ND	ND	ND
T_2	ND	ND	ND	ND	ND	ND
T_3	ND	ND	ND	0.2275	0.030	ND
T_4	ND	ND	ND	0.1990	0.010	ND
T_5	0.2150	0.0205	ND	0.2310	0.025	ND
T_6	0.2005	0.0130	ND	0.2500	0.010	ND

* ND - Not detected

Table 3 2,4-D residues in the soil ($\mu g\ g^{-1}$) during the first and second crop seasons

Treatments	*First crop*			*Second crop*		
	1 DAS	*30 DAS*	*Harvest*	*1 DAS*	*30 DAS*	*Harvest*
T_1	ND	ND	ND	ND	ND	ND
T_2	0.385	0.020	ND	0.480	0.016	ND
T_3	0.310	0.035	ND	0.420	0.015	ND
T_4	0.502	0.015	ND	0.400	0.005	ND
T_5	0.390	0.015	ND	0.470	0.010	ND
T_6	0.400	0.010	ND	0.395	0.005	ND

* ND - Not detected

Persistence of 2,4-D

Degradation of 2,4-D in the soil was faster than butachlor and pretilachlor.Up to 97.81 to 99.27 per cent of the applied herbicide had been dissipated by 30DAS, from the plots which received FYM(Table 3). Devi (2002) reported that degradation of 2,4-D in the rice soils of Kerala followed first order rate equation with half-lives ranging from 3.44-10.76 days.

The analytical data gave an insight on the persistence of herbicides under continuous and rotational application of herbicides in rice-rice cropping system. Irrespective of the seasons and treatments, dissipation of butachlor was at a faster rate and the residues were not detected at the time of harvest. Since butachlor had been completely dissipated before the harvest of first crop, its application during the preceding season could not exert any influence on the persistence of pretilachlor sprayed in the succeeding season. Application of FYM enhanced the rate of degradation of butachlor, pretilachlor and 2,4-D in the soil due to its positive influence on the proliferation of microflora

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171-Persistence of Sulfosulfuron Herbicide in Wheat Field Soil

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INTRODUCTION

In India wheat (*Triticum aestivum* L.) is the second important crop, next to rice. *Phalaris minor* is a big problem of wheat especialy in rice-wheat cropping system. The use of selective herbicide particularly isoproturon has played a prominent role in controlling *P.minor* effectively for more than a decade. However, with the sole use of isoproturon continuosly for a longer period, resistance to *P.minor* to this herbicide was developed in Haryana (Malik and Singh, 1993) and Punjab (Walia et al., 1997). Keeping in view the problem of resistance, alternatinve herbicides namely clodinafop, fenoxaprop and sulfosulfuron were recommended for the control of isoproturon resistant *P.minor* in wheat. Sulfosulfuron provides very effective control of *P.minor* and also provide partial control of broad leaved weeds. Since sulfonylurea herbicides are very low dose herbicides and residual activity can affect the next crop in rotation, the persistence of sulfosulfuron was evaluated in wheat field soil.

METERIALS AND METHODS

Field experiment was conducted in the farms of Agronomy Division, IARI, New Delhi. RBD was followed with four replicates and two rates of treatments (20 and 40 g a.i./ha) along with control. Sulfosulfuron, was applied as post-emergent application to wheat crop at two rates of application viz., 20g and 40 g a.i./ha. HPLC method was standardized for the analysis of sulfosulfuron using C_8 column and acetonitrile : 0.1% acidic water (1:1) as mobile phase at 230 nm wave length when it was eluted at 2.8min. Soil samples at 0 (4h), 1, 4, 7, 11, 15days interval after application were drawn, extracted with water, cleaned up and analysed for herbicide residues by HPLC.

RESULTS AND DISCUSSION

Results showed that sulfosulfuron gave 0.0226 and 0.0422?g/g initial deposit @ 20 and 40g a.i./ha at zero day. The residues dissipated with a half life of 5.44 and 6.33 days. The regression equation, half life and correlation coefficient are give in table 1.

Table 1 Regression equation, correlation coefficient and half life of sulfosulfuron in wheat field soil

Rate of application	*Regression equation*	R^2	*Half life*
20 g a.i. ha^{-1}	Y=-0.0553x – 1.5996	0.95	5.44 days
40 g a.i. ha^{-1}	Y = 0.0475x – 1.3782	0.97	6.33 days

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172-Organic Solvent Free Microwave-Assisted Extraction Coupled with Cartridge Cleanup for Metsulfuron methyl from Soil: A Step towards Green Chemistry

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INTRODUCTION

Metsulfuron methyl, a sulfonylurea herbicide, discovered in the mid 70s, is a low application rate herbicide recently registered for use in India. The rate of application of this herbicide is 4-5 g a.i. ha^{-1}. It is a selective, systemic, post-emergence herbicide, absorbed through the root and foliage, with rapid translocation both acropetally and besipetally. It is used to control broad leaved weeds in cereals (rice, wheat, rye, barley), pasture, plantation crop and non-crop situation. Susceptible plant cease growth almost immediately after application and are killed in 7-21 days. Due to the reported persistent nature of metsulfuron methyl, its residue may present in phytotoxic level for the next crop in rotation (Eleni et al, 1993; Noy et al, 2001). The most common approach to determine metsulfuron methyl residue is reverse phase HPLC with either UV or MS detection system (Charls et al, 1998). Although ELISA (Hollaway et al, 1999), capillary electrophoresis, liquid chromatography / mass spectroscopy (LC/MS) etc methods are also available but the real art lies in the extraction of such low dose residues for analysis.

MATERIALS AND METHODS

Extraction of metsulfuron methyl from laboratory fortified soil was carried out by different solvents such as acetone, acetone:ammonium carbonate buffer(0.1M), water:acetonitrile (1:4), water:acetonitrile (4:1) and only distilled water. All the extractions were carried out using mechanical shaker.

RESULTS AND DISCUSSION

The recovery percentage of first two solvents was only 37-67% (Table 1). Although other solvent systems gave 54-89% recovery but many interfering peaks were observed. Hence clean up was tried by partitioning with water immiscible organic solvents such as ethyl acetate, dichloromethane etc. and finally dichloromethane was chosen as the partitioning solvent for best recovery (72-81%).

The method was further improved where shaking was replaced by microwave-assisted extraction (MAE). The use of microwave energy drastically reduced the extraction time was from 1hr to 1-2 min. Microwave conditions like power level, exposure time were standardized and finally 50% power level and 1 min (30s + 30s) time were found to be optimum where no degradation of metsulfuron methyl was observed. The recovery of metsulfuron methyl by MAE was comparable or better than the conventional shaking method.

Chlorinated organic solvents are pollutants for the environment hence efforts were made to replace the dichloromethane partitioning step with solid phase extraction technique (SPE). For this RP-18 SPE cartridges were used to load the water extract of soil and final elution was done by acetonitrile, which was directly injected in HPLC/DAD for analysis. Thus the method employed only distilled water as an extracting solvent with more than 90% recovery of metsulfuron methyl. Such methods are useful to sustain the environment and keep it evergreen.

Table 1. Recovery of metsulfuron methyl from soil using various extraction techniques and extraction solvents

Extraction Technique	*Extraction solvent*	*Cleanup*	*Recovery (%)*
Conventional Shaking	Acetone	Ethyl acetate partitioning	37-40
	Acetone: 0.1 M ammonium carbnate (9:1 v/v)	Ethyl acetate partitioning	58-67
	Water:acetonitrile (4:1 v/v)	Dichloromethane partitioning	54.7-62.2
	Water:acetonitrile (1:4 v/v)	Dichloromethane partitioning	70-73
	Distilled water	Dichloromethane partitioning	72-80.1
	Distilled water	RP-18 cartridge	84-89
Microwave Assisted	Distilled water	Dichloromethane partitioning	75.8-79.5
Extraction (MAE)	Distilled water	RP-18 cartridge	93.1-96

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173-Dissipation of Butachlor in Sandy Clay Loam Soil and Detection of its Residues in Rice Grains and Straw

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INTRODUCTION

Butachlor (N-butoxy methyl-2-chloro-N-2, 6- diethyl acetanilide) is a pre emergence herbicide belonging to chloroacetanilide group. It is very effective against annual grasses and numerous broad-leaved weeds in both seeded and transplanted rice (Narval *et al.*, 2002). It is reported that butachlor dissipates at faster rate in field condition than laboratory condition and follow first order rate kinetics. The objective of this study was to monitor dissipation of butachlor residues in sandy clay loam soil and its bioaccumulation in rice grains and straw at the time of harvesting.

MATERIALS AND METHODS

A field experiment was conducted at the National Research Centre for Weed Science, Farm, Jabalpur, during 2004 in *kharif* (July 2004-December 2004) season in a randomised block design with three replications. Butachlor (50 % EC) was used in rice crop as pre-emergence herbicide and residue analysis was conducted in residue laboratory of National Research Centre for Weed Science, Jabalpur. The soil samples from the butachlor -treated plots were collected at 1, 15, 30, 60, 90 (at harvest) and 120 days after spraying (DAS) from a depth of 0-20 cm and used for residue studies to see the persistence of butachlor residues in soil.

Representative rice grains and straw samples (5 g) were extracted with 100 ml acetonitrile: water (7: 3) on horizontal mechanical shaker for one hour, filtered, concentrated and diluted with 5 % NaCl in water (30 ml) and partitioned with n-hexane (50 ml) and n-hexane layer was concentrated to 5 ml in a rotary vacuum evaporator. Soil samples (10 g) were extracted with methanol (50 ml) and partitioned with n-hexane (50 ml) which was concentrated to 5 ml. Soil, rice grains and straw samples were cleaned on glass column packed with silica and in between two layers of anhydrous sodium sulphate. Elutes were collected and concentrated and made volume of 2 ml in n-hexane and analyzed by a CHEMIRO Gas Chromatography-1000 Series with Electron Capture Detector (ECD). A 10 % SE-30 column (8' length x 1/8' i.d.) was used with temperature conditions, oven 230^{0}C, Injector-240 ^{0}C and detector-270 ^{0}C. The carrier gas was nitrogen with the gas flow 40 ml min^{-1} and 0.5-¼l samples was injected. The retention time of butachlor was found 6. 4 min. The time of dissipation of 50 % (DT_{50}) of the highest concentration was calculated from the equation DT_{50}= 0.693/k.

RESULTS AND DISCUSSION

The initial concentration of butachlor was 1.34 $\mu g\ g^{-1}$, which dissipated to 0.42 μg g 1, 0.32 $\mu g\ g^{-1}$ by 15 and 30 days, respectively. There was a steady decrease in the concentration of butachlor so that by the 60th day the concentration level was down to 0.22 $\mu g\ g^{-1}$. The DT50 value calculated was 18. 11 days (Table 1).

There was rapid dissipation of butachlor residues during initial period and by 15 days approximately 70 % dissipation of butachlor was noticed in the soil (Table 2) and by 90 days butachlor was dissipated to more than 90 % and approximately 100 % dissipation was achieved by 120 days (Table1).

Table 1 Detection of butachlor residues in rice soil under field condition.

Days	*Residues under field condition ($\mu g\ g^{-1}$)*
0	1.340
15	0.420
30	0.320
60	0.220
90	0.110
120	0.005
Half life (days)	18.11

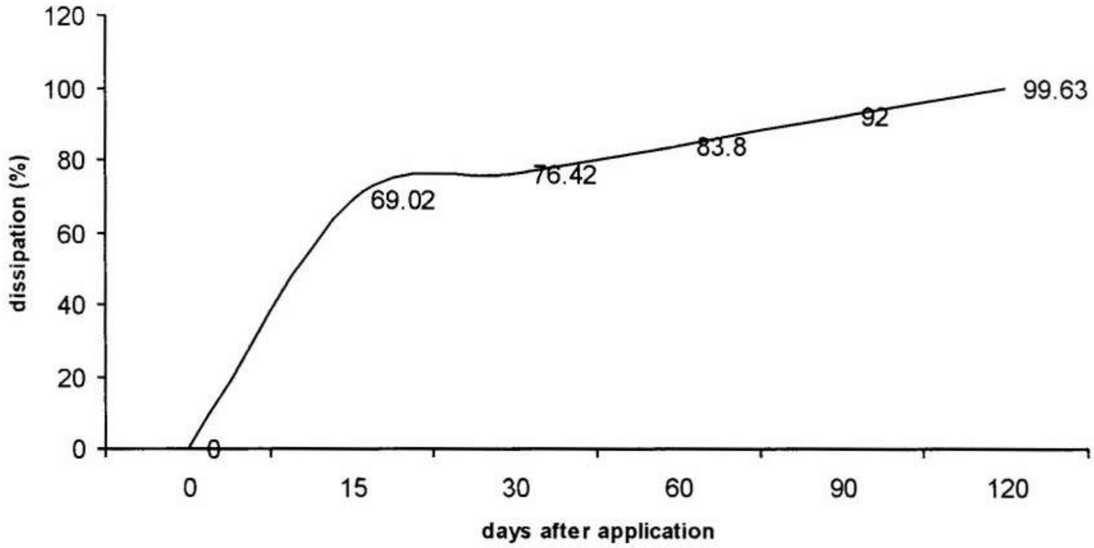

Fig 1 Dissipation of butachlor residues in rice soil (under field condition).

Residues of butachlor in rice grains and straw

Rice grains and rice straw samples collected at the time of harvest from the field showed 0.029 ¼g^{-1} and 0.042 ¼g^{-1} of butachlor residues at detection limit of 0.002 ¼g^{-1}. Those were well below 0.25 ¼g^{-1} MRL (maximum residue limit) value. Fast degradation of butachlor was found under field condition. Similar results were reported by Prakash *et al.* (2000) who found that dissipation of butachlor is faster in field condition than laboratory condition. Though the residues of butachlor were detected in rice grains and straw at the time of harvesting but they were well below the maximum residue level (MRL) of 0.50 $\mu g\ g^{-1}$ at the time of harvesting. All butachlor residues (soil, rice grains and straw) recorded at the time of harvesting were below the maximum residue limit (0.25 mg/kg). The data generated here clearly indicated persistence of butachlor residues in soil upto 120 days and bioaccumulation of residues in rice grains and straw is significant in terms of residual contamination.

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174-Studies on Carryover Effects of Sulfosulfuron on the Succeeding Crops

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INTRODUCTION

Leader 75 WG (sulfosulfuron) belongs to sulfonylurea group of herbicides which is known for its longer persistence in the soil. Sulfosulfuron is an effective broad spectrum herbicide widely used for controlling *P. minor* in wheat. Pot and field studies were initiated to find out carry over effect of sulfosulfuron applied at 25 g/ ha to wheat on many succeeding crops.

MATERIAL AND METHODS

Pot and field studies were conducted at the experimental area of Department of Agronomy and Agrometeorology during summer season of 2004. Sulfosulfuron was applied at 25 g/ ha (recommended) during rabi season of 2003-04 to *P. minor* biotypes growing in pots and under field conditions. After the harvest of these biotypes, ten vegetable and field crops namely okra, bottle gourd, chappan kaddu, tar, maize, moong, groundnut, desi cotton, American cotton and mash were sown in pots and in field in treated (with sulfosulfuron) and untreated situations with eight replications. Five seeds/ pot were sown. These trials was terminated 40 days after sowing after recording plant height and fresh weight of these test crops.

Another pot experiment was also conducted to find out carry over effect of Leader 75 WDG applied continuously for five years to wheat on rabi season crop viz., field pea, carrot, methi, turnip, spinach, sunflower, berseem, gobhi-sarson, raya and winter maize. Soil from this experiment was brought from the farm of S. Sukhdev Singh, Village Kum kalan, district Ludhiana who used this herbicide in wheat for the control of *P. minor* since from last 5 years regularly. Five seeds/ pot were sown and eight replications were kept. Trial was terminated 40 days after sowing after recording plant height and fresh weight of these crops.

RESULTS AND DISCUSSION

Plant height (cm) and fresh weight (g/ plant) of maize and bottle gourd were significantly reduced both in field and pot experiments in sulfosulfuron treated soil as compared to untreated one (Table 1). Fresh weight of moong in pots was significantly less whereas its plant height was less in field trial. There was significant reduction in fresh weight accumulation by chappan kaddu in treated soil both in pot and field experiment. Also carry over effect of Leader was noticed on Tar under field conditions only and not in pot conditions. No carry over effect of this herbicide was noticed on groundnut, desi cotton, American cotton, mash and okra (Table 1).

In the third trial carry over effects of continuous use of sulfosulfuron for five years was observed on field pea, carrot, spinach, sunflower, raya and winter maize (Table 2). The adverse effect of this herbicide was not noticed on methi, turnip, berseem and gobhi-sarson.

Table 1 Effect of application of sulfosulfuron on the succeeding field and vegetable crops.

Crops/ Treatments	*Pot experiment*		*Field experiment*	
	Plant height (cm)	*Fresh weight (g/ plant)*	*Plant height (cm)*	*Fresh weight (g/ plant)*
Maize				
Sulfosulfuron	32.98*	7.25*	38.2*	27.38*
Control	41.31*	8.75*	49.0*	41.25*
Moong				
Sulfosulfuron	24.43	13.93*	36.8*	26.47
Control	27.90	16.13*	45.8*	31.58
Groundnut				
Sulfosulfuron	25.19	12.73	20.0	50.00
Control	25.63	13.03	25.8	56.67
Desi cotton				
Sulfosulfuron	19.10	3.0	32.5	16.0
Control	21.11	3.13	35.2	19.25
American cotton				
Sulfosulfuron	25.94	3.63	25.0	16.25
Control	26.99	3.63	25.4	18.42
Mash				
Sulfosulfuron	21.99	7.25	22.6	18.52
Control	22.39	7.63	23.4	20.8
Okra				
Sulfosulfuron	28.89	5.75	23.2	15.48
Control	31.16	6.58	25.0	17.75
Bottle gourd				
Sulfosulfuron	59.55*	42.50*	89.2*	242.5*
Control	75.14*	59.53*	109.6*	417.50*
Chappan kaddu				
Sulfosulfuron	27.25	19.09*	49.2	138.0*
Control	31.52	23.56*	55.6	166.5*
Tar				
Sulfosulfuron	45.45	20.75	69.0*	146.67*
Control	48.32	22.80	79.6*	177.50*

* indicates that the differences between the two values is significant within the crop/parameter.

Table 2 Effect of continuous application of sulfosulfuron on the dry matter (mg/ plant) of succeeding field and vegetable crops.

Treatments	**Vegetable crops**				
	Field pea	Carrot	Methi	Turnip	Spinach
Sulfosulfuron	171.5**	99.4**	53.1	195.4	133.9**
Control	238.4**	178.1**	54.9	203.9	140.4**
	Field crops				
	Sunflower	Berseem	Gobhi sarson	Raya	Winter maize
Sulfosulfuron	115.1**	40.9	123.9	94.1*	123.1**
Control	201.4**	45.4	127.4	101.3*	169.9**

** indicates that the values were significant at 1% level of significance

* indicates that the values were significant at 5% level of significance

175-Monitoring of Herbcide Residues in Food Chain, Soil and Ground Water in Rice Based Cropping Systems in India

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INTRODUCTION

Rice based cropping system are more prevalent in Indo-Gangatic alluvial, high humid, high rainfall and coastal agro-ecological regions of the country. The major rice based cropping systems are: rice- wheat, rice- rice, rice- mustard and rice- groundnut in different locations of the country. A large quantity of herbicides are used in these crops both under irrigated and rainfed situations. Presently a trial on monitoring of herbicide residues in food chain, water and soil are in progress under All India Coordinated Research Programme on Weed Control. Altogether four long-term trails on rice-based systems are in progress at fourteen locations.

MATERIALS AND METHODS

In order to study the residues of applied herbicides in soil, grain and straw, samples were collected from different coordinating centers in long term herbicide trials in different cropping systems under AICRP-ICAR schemes viz. TNAU Coimbatore, KAU Trisur, AAU Jorhat, CSKHPKV Palampur, NDUA&T Faizabad ANGRAU, Hyderabad, GBPUA&T Pantnagar, UAS Bangalore & PAU Ludhiana. The cropping sequences under these centers was rice-rice or rice-wheat since from last 4 to 10 years.

RESULTS AND DISCUSSION

The herbicide residue study conducted at PAU, Ludhiana on effect of continuous application of isoproturon (0.94 kg/ha) and 2, 4- D (0.5 kg/ha) in wheat and butachlor (1.5 kg/ha) in rice crop for tenth year in rice wheat system indicated that isoproturon, 2, 4-D and butachlor were below the detectable limits in grains and straw. The residues could not be detected in rice grains at UAS, Banglore treated with 0.50 kg/ha and 1.5 kg/ha of butachlor. The butachlor residues were well below detectable limit (<0.001) in the soil samples (after 100 days) treated with butachlor at 0.75 and 1. 0 kg/ha in rice-rice cropping system at KAU, Trissur. Pretilachlor (0.75 kg/ha) residues were dissipated 95 % by 30 days in soil and no residues were detected at harvest in rice grains and straw at KAU, Trissur and TNAU, Coimbatore. Similarly application of 2, 4-D at 1.0 kg/ha in combination with butachlor continuously did not leave residues in soil even after 8^{th} crop at TNAU Coimbatore. Anilophos at 0.4 kg/ha with 2, 4-D and without 2, 4-D (herbicides rotation) in the rice-rice cropping system showed a slight build up of anilophos residue in soil (0.0025 ppm) after 8^{th} crop as compared to that of 1^{st} crop. However, the levels of residues were well below the maximum residues limit. However, the post harvest soil samples of all the experiments in the sequential cropping system showed no detectable level of 2, 4-D. Application of 2, 4-DEE at 0.4 kg/ha continuously did not show detectable level of residue in grains and straw of rice samples. The half-life of 2, 4-D was found 7.3 to 8.0 days in various treatments. Application of pretilachlor in rabi rice left no residues in the post harvest soil samples and degraded to 96.5 to 97.3% on 40^{th} day. The initial residue levels (one day after spraying) of pretilachlor in the soil was in the range of 0.200 to 0.215 $\mu g\ g^{-1}$ in the first crop season and 0.199 to 0.250 $\mu g\ g^{-1}$ in the second crop season at KAU. Half-life of pretilachlor, in soil was found 10.3 to 11.4 days. Dissipation of 2, 4-D in the soil was found faster than butachlor and pretilachlor and up to 97.81 to 99.27 per cent of the applied herbicide had been dissipated from the field by 30 DAS at KAU.

2, 4 D residues, irrespective of applied doses, was not detected at 25 DAA in soil, rice grains and straw at AAU, Jorhat up to 1.0 kg/ha^{-1} application rate but at higher dose (2.0 kg/ha^{-1}) 0.0015 ppm reside was observed, both in grains and straw. The isoproturon and butachlor residue were found to be non detectable at CSKHPKV, Palampur. However Soil samples analyzed at different time interval at AGARU, Hyderabad indicated that the initial deposits of butachlor in rice-rice system ranged from 0.428 ppm to 0.516 ppm and by 30 day 90 to 92 % of herbicide was lost and no residues were found after 45 days of butachlor application. Post harvest soil samples from four long term weed control experiment conducted at HPKV, Palampur on rice-wheat system indicated that non –detectable levels of butachlor residues in all the treatments. At KAU, Trissur initially, 0.58, 0.71 and 0.95 ug g^{-1} of butachlor residues were found in soil at 1.5, 2.0 and 2.5 kg/ha treatments, respectively which after 60 days reached to non detectable level. Further at recommended rate of butachlor (1.5 kg/ha), pretilachlor (0.75 kg/ha) and 2, 4 -D (1.0 kg/ha) residues were not detected in rice grains and straw at KAU, Trissur at the time of harvest. Butachlor residues persisted in soil upto 15 days only. At GBPAUT, Pantnagar no resides of butachlor and isoproturon applied in rice-wheat system were detected in grains, straw and soil at harvest stage of the crop.

Table1 Detection of herbicides residues in different Coordinating Centres in long-term herbicide trials in different cropping system under AICRP-ICAR Scheme.

Centre	*Cropping system*	*Herbicide*	*Dose (kg ha^{-1})*	*Residues at harvest(ppm)*			*Exp. year*
				Soil	*Grain*	*Straw*	
TNAUCoimbatore	Rice-rice	Butachlor	1.25	0.0023	-	0.0031	8th
		2,4-D	1.0	ND	-	-	8th
		Anilophos	0.4	0.0025	-	-	8th
	Rice-rice	Butachlor	0.75	ND	ND	ND	3rd , 4th
			1.0	ND	ND	ND	5th, 6th, 7th
		2,4-D	0.4	ND	ND	ND	7 th
		Pretilachlor	0.75	ND	ND	ND	7 th
KAU, Trissur	Rice-rice	Butachlor	1.25	ND	-	-	
		Pretilachlor	0.75	ND	-	-	
		2, 4-D	1.00	ND	ND	ND	
AAU, Jorhat	Rice-rice	Butachlor	0.5	ND	ND	ND	4th
			1.0	ND	ND	ND	
			1.5	ND	0.0010	0.0010	
			2.0	ND	0.0015	0.0015	
			Flu + FYM	ND	-	-	
CSKHPKV, Palampur	Rice -wheat	Butachlor	1.5	ND	-	-	10 th
		Isoproturon	1.0	ND	-	-	
NDUA&T, Faizabad	Rice-wheat	Butachlor	1.5	ND	-	-	
		Isoproturon	1.0	ND	-	-	
ANGRAU, Hyderabad	Rice-rice	Butachlor	0.75	ND	ND	ND	
GBPUA&T, Pantnagar	Rice-wheat	Butachlor	1.5	ND	ND	ND	4 th
		Isoproturon	1.0	ND	ND	ND	
UAS, Banglore	Rice-rice	Butachlor	0.5	ND	ND	ND	
			1.5	ND	ND	ND	
PAU, Ludhiana	Rice-wheat	Isoproturon	0.94	BDL	BDL	BDL	10 th
		2, 4-D	0.5	BDL	BDL	BDL	

BDL (Below detectable limit), ND (not detected).

At PAU, Ludhiana herbicide residues were monitored in ground water. For this purpose grounds water samples were collected from tube wells where isoproturon in rice-wheat system was being applied at recommended dose 0.94 kg/ha for approximately 20 years. The residue levels indicated that the level of isoproturon was well below detectable limits in all the water samples collected from the districts of Patiala, Gurdaspur and Ludhiana of Punjab. It was observed that isoproturon applied to rice-wheat cropping system at recommended dose was not present in the ground water.

CONCLUSION

Results of the herbicide residue studies conducted so far in various cropping systems *viz* rice-rice, rice-wheat systems under All India Coordinated Research Project at various Centres in India and aquatic system at Trissur and PAU, Ludhiana Centres revealed that the application of herbicides viz anilophos, butachlor, pretilachlor, isoproturon, and 2, 4-D at recommended levels to the cropping system does not result in any build- up of herbicide residues in soil, and food chain. This is because of the rapid degradation of the herbicides by various biological process and chemical process. Loss of herbicide was found rapid at initial stages and no residues were found in rice grains at harvest and in post harvest soils. Results of the long-term herbicide trial conducted clearly indicated that herbicides had been dissipated from the soil to non-detectable level at the time of harvest and hence risk of food grain and ground water contamination due to herbicides is not significant.

176-Evaluation of Pretilachlor Residues in Soil and Transplanted Rice

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INTRODUCTION

Pretilachlor is a new selective herbicide introduced for the control of broad leaved weeds and sedges in transplanted rice. The behaviour of herbicide in the soil is of importance as herbicide use has potential negative effects on both cash flow and environment quality (Watanabe and Takagi, 2000). An ideal herbicide should provide protection from weeds during critical crop growth period, but should not persist in the soil to harm the succeeding crop or cause pollution. After application of a herbicide to soil, it undergoes decomposition and pat of it is taken by plants accumulating in the economic produce requiring monitoring in view of health hazards. This accumulation of herbicide residues should not exceed the maximum residue limit (MRL) prescribed by International and National standards. Not much work has been carried out on this line. The present study was undertaken to determine the pretilachlor residues in post harvest soil and economically important parts of rice as most of the works were only related to increase the rice production.

MATERIALS AND METHODS

Field experiments were conducted in a cropping system of rice-rice during Rabi, 2001 and summer, 2002 at wetlands of Tamil Nadu Agricultural University, Coimbatore. The soil of the experimental site was clay loam in texture, tending towards alkaline in reaction with pH of 8.5 and EC 0.14 dSm^{-1} and possess relatively low N stastus and high P and K stastus. The treastments include five doses of pretilachlor and a commercial pretilachlor formulation (Rifit). The herbicides were applied on 3rd day after transplanting.

The other agronomic practices were carried out regularly. After the application of herbicide, the soil samples of about 500 g at five randomly selected places and plant samples of 250 g from five representative hills of rice crop were collected in the net plot area of the individual plots at harvest during Rabi 2001-02 and summer 2002, to determine terminal residues. The samples were analysed on Gas chromatograph (Chemito 2865 model) equipped with Electron caspture detector. The glass column used was a mixed column (1.5% OV 17 + 1.35% QF on chromosorb AW 80-100).

RESULTS AND DISSCUSSION

The results revealed that the recovery percentage of pretilachlor ranged from 82.5 to 85.6 per cent in the soil fortified with 0.1, 0.5 and 1.0 ppm with an average recovery of 84.0 per cent. The sensitivity of the present method was 0.1 ppm. The minimum detectable limit was 0.01 ppm (Table 1).

The recovery percentage in rice plant ranged from 80.4 to 81.0 per cent with an average of 80.6 per cent. In rice grain, the range was between 80.3 and 83.0 per cent with an average recovery of 81.9 per cent. The average recovery of pretilachlor was 83.6 per cent in husk and 82.2 per cent in bran indicating the validity of the present method. The sensitivity of the present method was 0.1 ppm. The minimum detectable limit was 0.02 ppm.

The herbicide residues in the post-harvest soil, rice grain and straw analysed for various doses of pretilachlor during Rabi, indicated that the residues were BDL.

During summer, all other treatments, except the higher dose of pretilachlor recorded the terminal residues BDL in case of brown rice, husk, bran, straw and post havest soil. The pretilachlor at 3.0 kg ha^{-1} registered 0.022 and 0.011 ppm of residues in rice straw and post-harvest soil, respectively. However, the residues detected in straw was below the MRL value of 10 ppm for straw (Anonymous 1985) and considered to be safe in rice.

Table 1 Recovery studies of pretilachlor

Subtrate	*Quantify fortified (ppm)*	*Amount recovered (ppm)*	*Recovery percentage*
Soil	0.10.51.0	0.0840.4280.825Mean	84.085.682.584.0
Plant	0.10.51.0	0.0810.4020.804Mean	81.080.480.480.6
Grain	0.10.51.0	0.0830.4120.803Mean	83.082.480.381.9
Husk	0.10.51.0	0.0840.4220.825Mean	84.084.482.583.6
Bran	0.10.51.0	0.0840.4120.802Mean	84.082.480.282.2

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177-Degradation Studies of Pretilachlor in Water at Different pH Levels

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INTRODUCTION

Pretilachlor is a new selective herbicide introduced for the control of broad leaved weed and sedges in transplanted rice. Study on degradation and persistence of Pretilachlor in water in water is important in the aspect of its efficiency and residue hazards. Not much work has been carried out on this line. The present lab study was undertaken to determine to degradation pattern of Pretilachlor in water at different levels, in the campus of Agricultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2001-02.

MATERIALS AND METHODS

Acidic, neutral and alkaline water samples of pH say, 5.5, 7.2 and 8.5 were incubated with 25 ppm of Pretilachlor (Rifit) for 60 days in beakers and determined for Pretilachlor residues ast specified incubation periods viz. 0 (1 hr), 1, 3, 5, 7, 10, 15, 30, 45 and 60 days after incubation. The samples were analysed on Gas chromatograph (Chemito 2865 model) equipped with Electron capture detector. The glass column used was a mixed column (1.5% OV 17 + 1.35 % QF on chromosorb AW 80-100).

RESULTS AND DISCUSSION

The results revealed that the recovery percentage of percentage of pretilachlor ranged from 89.0 to 93.4 per cent in the water fortified with 0.1, 0.5 and 1.0 ppm with an average recovgery of 9.13 per cent indicating the validity of the present method. The sensitivity of the present method was 0.1 ppm. The minimum detectable limit was 0.01 ppm. (Table 1).

It is evident from the results that the initial Pretilachlor concentrations of 23.5, 23.3 and 19.8 were detected at 0 DAA (days after application) in the water at pH 5.5, 7.2 and 8.5 respectivedly degraded to 0.733, 1.01 and 0.617 ppm at 15 DAA and attained BDL (below detectable level) at 30 DAA. Thbis shorter persistence of Pretilachl;or may due to increased hydrolysis particularly in extreme pH say acidic (pH 5.5) and alkaline (pH 8.5) (Table 2)

The half-life of Pretilachlor in different pH water varied from 3.05 to 3.50 days and there was not much difference due to increase or decrease in pH of irrigation water. This is confirmed with the findings of Fajordo et al. (2000) who obtained the DT 50 of 3.0 to 3.6 days of Pretilachlor in water (Table 2)

Table 1. Recovery studies of pretilachlor in water

Subtrate	*Quantity fortified(ppm)*	*Amount recovered(ppm)*	*RecoveryPercentage*
Water	0.1	0.089	89.0
	0.5	0.467	93.4
	1.0	0.910	91.0
		Mean	91.3

Table 2 Degradation and persistence of pretilachlor (ppm) in water at different pH

Days after application	*pH 5.5mean residues*	*pH 7.2mean residues*	*pH 8.5mean residues*
0	23.5	23.3	19.8
1	18.8	18.9	15.7
3	7.08	8.60	5.97
5	5.31	5.12	4.48
7	4.28	3.60	3.26
10	1.92	2.27	1.62
15	0.733	1.01	0.617
30	BDL	BDL	BDL
45	BDL	BDL	BDL
60	BDL	BDL	BDL
$T_{1/2}$	3.06	3.05	3.05

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178-Estimation of Residues of Isoproturon in Wheat Plant

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INTRODUCTION

The quantitative determination of herbicide residues helps in understanding the transformation or degradation mechanism of herbicide. Herbicide residue estimation is also useful to determine the duration of herbicide activity. Isoproturon [3-(4-isopropyl phenyl)-1, 1 dimethyl urea] belongs to substituted urea group and is recommended herbicide for wheat. The broad spectrum activity of herbicide has made it a popular treatment (Hance and Holly 1990). The increasing use of recommended herbicide in hilly state has raised concern about its fate. Therefore, the present investigation was undertaken to estimate the residues of isoproturon in wheat plant and in wheat grain.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Farm, CSK HPKV, Palampur in *Rabi* 2003-04 (Nov.-May) in randomized block design. The soil contained 28% sand, 42% silt, 30% clay and 1.27% organic matter and had a pH of 5.16. Isoproturon (Masslon 75 WP) was sprayed as post emergence at three different doses i.e. 1.5 kg ha^{-1}, 2.0 kg ha^{-1} and 2.5 kg ha^{-1}. These chemical treatments were compared with untreated control. All the treatments were replicated thrice. Plant samples were collected immediately following, the application and then at monthly interval and wheat grain samples at harvest of crop. Isoproturon residues were extracted by blending green plants with chloroform and with dichloromethane by soxhlet extraction from grains. For cleanup plant extracts were passed through alumina column and eluted with a mixture of hexane and isopropyl alcohol (90:10). Isoproturon in extracts were analyzed by spectrophotometric method (Katz, 1966 and Kulshreshtha, 1982) at 555 nm for residues remaining in plant and grain. Samples from control plots were also extracted and analyzed under similar conditions.

RESULTS AND DISCUSSION

The data regarding the isoproturon residues (mg g^{-1}) obtained at different time intervals in isoproturon 1.5 kg ha^{-1}, isoproturon 2.0 kg ha^{-1} and isoproturon 2.5 kg ha^{-1} treatments are presented in Table 1. The initial deposits of isoproturon in plant were 0.219, 0.238 and 0.266 mg g^{-1} for isoproturon used at 1.5 kg ha^{-1}, 2.0 kg ha^{-1} and 2.5 kg ha^{-1}, respectively, which metabolized rapidly in plants to 0.011, 0.030 and 0.055 mg g^{-1} at 30 days after herbicide application. Complete dissipation of isoproturon in wheat plant was observed after 60 days of herbicide application in all the three levels of application. Dissipation followed first order kinetics and findings also revealed that isoproturon have moderate persistence with a half life range 8.5-17.9 days. These results are in direct conformity with Kulshrestha (1982). Herbicide residues in wheat grains collected at the harvest of the crop were below detectable limits at all the three levels of application.

Table 1 Residues of isoproturon in wheat plant treated at different doses

Days after herbicide application	*Residues (mg g^{-1})* *Rates of isoproturon application*		
	1.5 kg ha^{-1}	2.0 kg ha^{-1}	2.5 kg ha^{-1}
0	0.219 (0.00)	0.238 (0.00)	0.266 (0.00)
30	0.019 (91.32)	0.036 (87.39)	0.055 (79.32)
60	ND (-)	ND (-)	0.026 (90.22)
90	ND (-)	ND (-)	ND (-)
120	ND (-)	ND (-)	ND (-)

*Values given in parentheses are percent dissipation values
ND: Not detected

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179-Studies on Residues of New Herbicides in Soil of Puddled Seeded Rice (*Oryza sativa*)

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INTRODUCTION

The objective of the experiment is to study the residual effect of herbicides applied to puddles seeded rice in soil through bioassay technique i.e. by raising cucumber as a test plant.

MATERIAL AND METHODS

A field trial was conducted at Agronomy Research Farm of the university during kharif 2003 in randomised block design with three replications and ten treatments (Table –1). After the harvest of rice soil samples were taken from each plot of the experiment. A quantity of two kg soil sample of each treatment was filled in pots. The pots were arranged in the randomised block design in weed control laboratory. Fifteen seeds of cucumber were sown in each pot. Germination count was noted one week after sowing. The height and dry matter production of cucumber seedlings were recorded at 15th day stage. Bioassay techniques are valuable and relevant to determine the phytotoxic residues of herbicides in soil (Kumar *et al* 1988). For bioassay studies, cucumber seeds are used (Corbin and Upchurch 1967 and Kumar *et al* 1988).

RESULTS AND DISCUSSION

Application of anilofos @ 0.4 kg/ha, butachlor @ 1.5 kg/ha, cinosulfuron @ 15 gm and 20gm/ha, oxadiargyl @ 70gm and 100gm/ha and almix @ 4 gm and 6gm/ha at pre-emergence of sowing, 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.

CONCLUSION

It is concluded from the experiment that herbicides used at varying rates did not leave any harmful toxic residues in post harvested soil of the experimental field.

Table 1 Biometric observations of cucumber as influenced by herbicides applied in puddled seeded rice.

S.N.	*Treatment*	*Germination (%)*	*Plant height (cm)*	*D.M.P. (mg/pot)*
1.	Weedy	85.00	14.40	266.33
2.	Weed free	83.33	14.20	225.67
3.	Anilofos @ 0.4 kg/ha pre-em.	81.67	14.13	225.67
4.	Butachlor @ 1.5 kg/ha pre-em.	78.33	14.27	225.33
5.	Cinosulfuron @ 15 gm/ha pre-em.	80.00	13.90	225.00
6.	Cinosulfuron @ 20 gm/ha pre-em.	81.67	13.53	223.67
7.	Oxadiargyl @ 70 gm/ha pre-em.	81.67	13.20	223.00
8.	Oxadiargyl @ 70 gm/ha pre-em.	80.00	13.00	224.00
9.	Almix @ 4gm/ha pre-em.	80.00	12.87	223.33
10.	Almix @ 6gm/ha pre-em.	78.33	12.63	222.33
CD at 5%		N.S.	N.S.	N.S.

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180-Effect of Herbicides on Quality Parameters and Estimation of Herbicide Residues in Grains and Straw of *Durum* Wheat (*Triticum durum* desf.) Cultivars

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INTRODUCTION

Durum or Macaroni wheat is the second most important cultivated species of genus *Triticum* in the world as well as in India. It has more content of proteins, amino acids, b-carotene and fatty acids as compared to bread wheat and its granular and non-binding character makes it suitable for semolina and pasta production. Among the various recommended herbicides for weed control in wheat the residues of isoproturon (Kulshrestha 1982) and sulfosulfruon (Ramesh and Thulasiramaraja 2003) were non detectable from grains and straw of bread wheat. The present investigations were carried out to see the effect of herbicides isoproturon, clodinafop and sulfosulfuron on the quality parameters (semolina recovery, hectolitre weight, b-carotene, protein content, pearling index) of the grain and to estimate the residue to these herbicides in the grains and straw of *durum* wheat cultivars PDW 274 and PDW 233 at harvest. The leaf chlorophyll and total sugars were also analyzed after the spray.

MATERIALS AND METHODS

A field experiment was laid out in strip plot design during *rabi* 2003-04 on sandy loam soil at Punjab Agricultural University, Ludhiana. The treatments consisted of isoproturon 940 g/ha, clodinafop 60 and 75 g/ha, sulfosulfuron 25 and 31.25 g/ha applied at 35 and 45 days after sowing (DAS), weed free and an unweeded control and two *durum* wheat cultivars PDW 274 and PDW 233. Grain and straw samples were collected at harvest of the crop. The methods used for the analysis of quality parameters are presented in Table 1 and the various extractants, clean up processes and determination of residue are presented in Table 2.

RESULTS AND DISCUSSION

Analysis of grain samples taken at harvest revealed that both the varieties were at par in terms of various quality parameters under all the herbicides at the rates tested both at 35 and 45 DAS. Further under all the herbicide and weed free treatments the values of parameters under study were well within the prescribed range, thereby showing that the herbicides under test had no adverse effects on the grain quality. Further analysis of the leaves of the crop at 10 and 30 days after the herbicide spray revealed that there was decrease in chlorophyll and total sugars as the sampling was delayed from 10 to 30 days after the spray as compared to weed free, with minimum chlorophyll and sugar content under isoproturon. Decrease in chlorophyll content by isoproturon spray was also reported by Pullet and Dodge (1980). Range of values obtained for various parameters are presented in Table 3.

Table 1 Procedures used to analyse various quality parameters of *durum* wheat cultivars

Parameter analyzed	*Procedure followed*
Crude protein (%)	Modified Kjeldahl method
Pearling index (%)	[(20-X)/20]X100 X- wt. of grains after 45 seconds of milling (g) 20 – initial wt. of grains (g)
Hectolitre weight (kg/hl)	Grains allowed to fall freely in 100 ml volume of metallic cylinder and weighed
Semolina recovery (%)	500 g sample was conditioned for 48 hrs. before milling. Semolina recovery(%) = (wt. of semolina/wt. of sample) X 100
b-Carotene (ppm)	Sample kept in n-butanol overnight and O.D. readings taken at 490 nm wavelength
Chlorophyll (mg/g) (leaves at 10 and 30 days after spray)	Extraction with 80% acetone and taking OD readings at 645 and 663 nm wavelength
Total sugars (%) (leaves at 10 and 30 days after spray)	Phenol method used and OD readings taken at 490 nm wavelength

Table 2: Extractants, cleanup processes and determination of residue

Herbicide	*Extractant*	*Clean up and partitioning*	*Residue determination*
Isoproturon	Dichloro -methane (Methylene dichloride)	Alumina column cleanup and elution with a mixture of hexane and isopropyl alcohol + Butanol water portioning	Optical density readings at 555 nm on Spectronic 21 spectrophotometer
Sulfosulfuron	Acetonitrile + water (1:1)	Dichloromethane partitioning + florisil column cleanup and elution with 2% methanol in methylene dichloride	Analysis by HPLC using Waters C_{18} (250 x 4.6 mm) column, acetonitrile and water (70:30) as mobile phase, flow rate of 1.5 ml/min,220 nm wavelength, 20 ml injection volume and approx. retention time of 5.0 mins.

Table 3: Range of values obtained for various parameters

Parameter	*Range of values*			
	Minimum		*Maximum*	
Crude protein (%)	12.75		13.15	
Pearling index (%)	17.70		27.40	
Hectolitre wt. (kg/hl)	75.50		78.50	
Semolina recovery (%)	49.90		60.80	
b-Carotene % (ppm)	5.30		5.50	
	Days after spray		Days after spray	
	10	30	10	30
Chlorophyll (mg/g)	1.75	1.50	2.35	2.6
Total sugars (%)	1.45	1.35	3.85	4.0

Analysis of grain and straw samples taken at harvest revealed that these contained residues of isoproturon and sulfosulfuron below the detectable limits. Based on these results, it may be concluded that the application of isoproturon and sulfosulfuron at the doses and times tested for weed management could be considered safe from the point of view of consumption of grains and straw.

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181-Persistence of Herbicides in Soil Applied to Control *Phalaris minor* in Wheat

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INTRODUCTION

Continuous adoption of rice-wheat cropping system in wheat growing regions has lead to the problem of *Phalaris minor* as a troublesome weed of wheat (Brar and Walia, 1993). Isoproturon remained most popular with the farmers during last two decades. However due to its long continuous use, it is not providing satisfactory control on the farmers' field due to the development of resistance (Walia *et al.*, 1997). Therefore a study was conducted on management of herbicide resistance in *Phalaris minor* in wheat using different herbicides.

As persistence of herbicides is an important consideration of its use in arable farming, this study was undertaken to detect the persistence of herbicides at biologically active doses in soil of wheat crop at different time interval using bioassay technique.

MATERIALS AND METHODS

An experiment on effect of some herbicides on the management of herbicide resistance in *Phalaris minor* in wheat was conducted of research farm College of Agriculture, Gwalior in rabi season of 2003-2004 with 12 treatments (Table 1). The replicated soil samples from 0-15cm depth from all the treatments were collected at 0, 15, 30 and 45 days after application (DAA) of herbicides and after harvest of crop from the weed control experiment. Cucumber was used as indicator plant. The soils were filled in pots of 500g capacity and 10 seeds of cucumber were sown in each pot. After seven days of sowing, the plants were thinned to 5 plants in each pot. Pots were watered as and when required. Plant height, fresh weight and dry weight were recorded 25 days after sowing.

RESULTS AND DISCUSSION

Plant height, fresh weight and dry weight of test plant cucumber was significantly affected due to herbicides at different time intervals except after harvest of crop. Initially all the herbicides reduced all the growth parameters as compared to unweeded control (0 DAA).

At 15 DAA, all herbicides reduced the cucumber plant height except metribuzin 250g/ha + 25kg/ha more seed while fresh weight and dry weight /plant was reduced significantly by metsulfuron, sulfosulfuron, metsulfuron + IPU and clodinofop + metribuzin while isoguard and clodinofop could not reduce fresh weight significantly. At 30 DAA sulfosulfuron showed the highest reduction in plant height and dry weight of cucumber followed by metsulfuron and metsulfuron + IPU. Other herbicides could not reduced the growth of cucumber plant showing that their residues were not present in soil at 30 DAA in sufficient levels to reduced the growth significantly. At 45 DAA sulfosulfuron affected the plant height and fresh weight significantly while metsulfuron could reduce plant height only No significant response of any herbicides was recorded in soil after harvest of wheat crop indicating that residues of herbicides were not present in soil.

Table1 : Effect of herbicides applied to wheat on cucumber growth at different intervals

Treatments	0-DAS			15-DAS			30-DAS		45-DAS			After harvest		
	Plant height (cm)	Fresh wt. (g)	Dry wt. (mg)	Plant height (cm)	Fresh wt. (g)	Dry wt. (mg)	Plant height (cm)	Dry wt. (mg)	Plant height (cm)	Fresh wt. (g)	Dry wt. (mg)	Plant height (cm)	Fresh wt. (g)	Dry wt. (mg)
IPU 0.75 kg/ha	6.9	0.30	81	7.9	0.69	80	6.1	78	8.9	0.92	92	8.9	0.80	124
Fenoxaprop ethyl 120 g/ha	6.3	0.30	85	8.0	0.67	71	5.5	68	7.5	0.83	78	8.3	0.81	113
Metsulfuron 6 g/ha	7.7	0.32	86	5.0	0.39	50	4.8	49	6.5	0.73	75	8.5	0.76	112
Sulfosulfuron 25 g/ha	4.3	0.20	65	4.8	0.23	35	3.8	33	4.8	0.36	41	7.7	0.71	102
Metribuzin 250 g/ha	6.1	0.27	75	6.9	0.78	78	5.9	78	9.0	1.16	91	7.9	0.74	101
Metribuzin 250 g/ha +25kg/ha more seed	7.1	0.39	92	9.8	0.79	71	5.8	74	8.6	0.95	80	9.6	0.78	110
Metsulfuron + IPU (4 g+ 750 g)	4.8	0.24	70	6.3	0.57	63	4.9	56	7.4	0.73	60	9.4	0.88	123
Hand weeding	12.5	0.63	100	.9.9	0.88	93	7.2	84	9.9	0.90	90	9.2	0.94	136
Unweeded control	13.0	0.66	104	9.8	0.89	90	6.8	80	9.8	0.88	86	9.3	0.89	124
Isoguard 1 kg/ha	9.8	0.47	90	7.8	0.78	64	7.6	78	8.6	0.78	74	8.7	0.87	112
Clodinafop 60 g /ha	4.5	0.27	76	7.7	0.69	68	5.6	68	7.6	0.68	68	9.2	0.92	136
Clodinafop 60 g /ha + Metribuzin 150g/ha	6.5	0.34	86	6.5	0.54	60	5.9	72	8.3	0.76	77	9.4	0.89	136
CD at 5%	0.80	0.03	9.39	1.8	0.23	24	1.8	22	3.0	0.33	NS	NS	NS	NS

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182-Soil Remediation by Use of Soil Amendment

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INTRODUCTION

Lactofen(1-carboethoxy) ethyl 5- (2- chloro - 4 - (trifluoromethyl)phenoxy) -2-nitrobenzoate, is a member of the diphenyl ether chemical family It is applied as a foliar spray on target weeds. It is commonly used to control broadleaf weeds in soybeans, cereal crops, potatoes, soybeans and peanuts. It presents a high degree of selectivity when applied in post-emergence to soybean and peanut crops. Some of the species generally controlled by Lactofen are: *Bidens* spp., *Solanum rostratum, Ambrosia artemisifolia, Richardia scabra, Physalis wrightii, Sesbania exaltata, Datura stramonium, Amaranthus* spp., *Mollugo* *verticilata, Portulaca oleracea, Xanthium* spp., *Acalypha* spp., *Commelina* spp., *Ipomoea* spp., *Cucumis* spp., *Sida* spp., *Abutilon theophrasti, Euphorbia* spp., *Hibiscus* spp., *Asclepias* spp., *Helianthus annus, Anoda cristata.*

This herbicide is used in early post-emergence, however it has some pre-emergent action. Lactofen is a herbicide which is absorbed by different soil particles. Strictly in pre-emergence, the effectiveness of its absorption by weeds depends on the texture, structure and organic matter content of the soil. When it is applied in post-emergence, a non-ionic surfactant must be included (Triton, etc.) to improve its effectiveness. Some studies indicate that this product is resistant to lixiviation, but tends to dissipate rapidly after application. It has also been noted that the biological action of some of the microorganisms in the soil, lead to the degradation of the product. Lactofen has a mean lifespan of 1-2 months. This product is applied in post-emergence, when weeds have 2 to 6 leaves (2-3 weeks after the sowing of legumes). Some residual pre-emergent effect has been observed in post-emergent applications.

The doses commonly used in post-emergence vary from 0.1 to 0.2 kg. a.i.*ha^{-1} and in pre-emergent applications from 0.2 to 0.4 kg. a.i.*ha^{-1}.

The presences of excessive residues of herbicides in soil often hinder the germination of the next crop. In an attempt to remediate the soil of herbicide residues a multi-disciplinary approach involving the use of phytoremediation techniques are the trends of remediation along with the soil microbes and soil amendments are the thrust of research.

MATERIALS AND METHODS

Four sets of experiment were carried out. Set I- only lactofen was applied in the field without any soil soalrization and amendment, set II soil solarization set III - straw amendment alone and set IV soil soalrization coupled with soil amendment with straw. The experiment was carried out in triplicate, including a set of control plot. 15 plots , of 8 plots, including were covered with polythene and left for 30-days. After one month of solarization the herbicide, lactofen (Cobra 2 EC) was applied @100g a.i./ha and straw was amended to soil in the set II and IV. The soil samples were collected periodically on 0,8,16 and 26 days and soybean grains at harvest. A representative air dried and sieved samples of soil were extracted in a Soxhlet, cleaned up and then analysed by GLC using EC detector.

RESULTS AND DISCUSSION

The herbicide degraded to 66.8 percent in lactofen in set I, followed by 78.4, 72.3, 81.7,and 90.8 per cent respectively in the treatments set II soil solarization, set III - straw amendment alone and set IV soil solarization coupled with soil amendment with straw. The results indicate that the dissipation is faster in soil solarization technique and is enhanced by the straw amendment where almost 90 per cent dissipation is recorded. The half life recorded is 30, 15, 19, and 10 days in the respective treatments set I,II,III and IV.

This technique holds promise in soil remediation methods, except for the use of polythene that can be replaced by other biodegradable material.

183- Comparative Performance of Wheat and Barley Genotypes under Different Herbicides for Managing Isoproturon-resistant *Phalaris minor* Retz.

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INTRODUCTION

In Rice-wheat sequence of Punjab, Haryana and Western Uttar Pradesh, *Phalaris minor* is a predominant weed of wheat. For its chemical control, phenyl-urea herbicides like isoproturon, metoxuron and methabenzthiauron have been widely used during last two decades. Indiscriminate use of isoproturon in the past has created problem of evolution of resistance in *P. minor* to this herbicide (Malik and Singh, 1995). Alternative herbicides like sulfosulfuron, clodinafop and tralkoxydim proved effective in controlling isoproturon- resistant *P. minor* in wheat, but there is a risk of evolution of multiple resistance to these herbicides also. To tackle the herbicide resistance problem, competitiveness of crops and their varieties can be used as a tool in integrated weed management system (Chauhan *et al* 2001). Hence, the present studies were undertaken to tackle the problem of isoproturon- resistant *P. minor* in wheat under Punjab conditions by exploiting competitive ability of wheat and barley varieties.

MATERIALS AND METHODS

Field experiments conducted during *Rabi* season of 2002-03 and 2003-04 consisted of five weed control treatments in main plots (pre-emergence trifluralin 1.0 Kg ha^{-1}, post- emergent isoproturon 0.94 Kg ha^{-1}, clodinafop 0.06 Kg ha^{-1}, weed free and unweeded control) and four wheat and barley varieties (PBW 343, WH 542, PL 419 and PL 426) in sub plots, with three replications. Soil of the experimental field was loamy sand in texture, slightly alkaline in reaction (pH 7.9), low in organic carbon (0.21 %) and available nitrogen (136.5 Kg N ha^{-1}) and medium in available phosphorus (12.6 Kg P_2O_5 ha^{-1}) and potassium (145.5 kg K_2O ha^{-1}). Crop was sown in 1^{st} week of November during both the years with hand drill at row-to-row spacing of 22.5 cm. Inputs like seed, fertilisers and irrigations were used as per recommendations for wheat and barley under Punjab conditions. Pre-emergence and post-emergence application of herbicides was done 1 day and 35 days after sowing (DAS) of the crop, respectively, with the help of Knapsack sprayer fitted with flat-fan nozzel. To assess the competitive behaviour of different crop varieties, plant height, leaf area index (LAI) and light interception was recorded 60 days after sowing of the crop. Dry matter and seed output of *P. minor* was recorded in last week of March. Crop was harvested in 2^{nd} week of April during both the years.

RESULTS AND DISCUSSION

Performance of wheat and barley varieties

Barley recorded significantly more plant height (83 %), leaf area index (11.5 %) and light interception (16.1 %) than wheat as recorded 60 days after sowing of the crop. These parameters provided thick ground coverage and hence effective smothering of *P. minor* by barley in comparison to wheat. This was evident from significantly low values of dry matter of *P. minor* under barley (11.43 q ha^{-1}) compared to 17.25 q ha^{-1} under wheat. Seed output of *P. minor* was also significantly reduced by barley (26.7 g m^{-2}) than that under wheat (36.3 g m^{-2}). Individually, barley variety PL 426 proved more effective in reducing dry matter and seed output of *P. minor* than PL 419. However, wheat varieties did not differ much in their suppression on

P. minor. Though in respect of grain yield, wheat varieties surpassed barley varieties with a margin of 11.5 %, yet in view of low input requirements and more competitive ability, barley genotypes exhibited substantial edge over wheat genotypes. These observations were in corroboration with those reported by Satorre and Snydon (1992) who reported oats and barley to be more competitive than wheat and significant variation in competitive ability among their cultivars.

Performance of weed control treatments

Post- emergence application of clodinafop 0.06 Kg ha^{-1} resulted in significantly less dry matter of *P. minor* than pre- emergence application of trifluralin 1.0 Kg ha^{-1}, post –emergence application of isoproturon 0.94 Kg ha^{-1} and unweeded control. Corresponding values of WCE under clodinafop, trifluralin and isoproturon as 89.5, 84.4 and 17.8 %, respectively, indicated that experimental field was severely infested with isoproturon- resistant *P. minor*. Clodinafop also caused maximum reduction in seed output of *P. minor*, followed by trifluralin and isoproturon. Clodinafop proved to be the best herbicide as it resulted in

Table 1. Effect of weed control treatments and crop varieties on plant height, LAI and crop grain yield

Treatment	*Plant height (cm) 60 DAS*			*Leaf Area Index (60 DAS)*			*Grain Yield (q ha^{-1})*		
	2002-03	*2003-04*	*Mean*	*2002-03*	*2003-04*	*Mean*	*2002-03*	*2003-04*	*Mean*
Weed control									
Isoproturon, 0.94 kg ha^{-1}	33.9	32.5	33.2	3.48	3.42	3.45	35.62	38.48	37.05
Clodinafop, 0.06 kg ha^{-1}	35.4	32.6	34.0	3.96	4.08	4.02	41.89	45.15	43.52
Trifluralin, 1.0 kg ha^{-1}	34.6	32.8	33.7	3.62	3.76	3.69	39.91	44.16	42.03
Weed free	34.5	33.2	33.9	3.86	4.05	3.95	42.93	48.54	45.73
Unweeded Control	30.3	30.0	30.2	3.04	3.08	3.06	32.10	37.12	34.61
CD at 5%	NS	2.4	2.1	0.55	0.61	0.58	4.16	4.78	4.48
Crop variety									
Wheat PBW 343	22.5	24.6	23.6	3.33	3.52	3.42	40.81	45.72	43.26
Wheat WH 542	23.4	22.5	23.0	3.44	3.42	3.43	40.14	45.12	42.63
Barley PL 419	43.6	40.7	42.2	3.75	3.86	3.80	36.30	39.80	38.05
Barley PL 426	45.5	41.0	43.3	3.85	3.89	3.87	35.70	40.12	37.91
CD at 5%	2.8	2.4	2.6	0.10	0.21	0.16	2.60	2.46	2.53
W.C. x Crop variety	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2. Effect of weed control treatments and crop varieties in dry matter and seed production by *P. minor*

Treatment	*Dry matter of P. minor (q ha^{-1})*			*Seed output of P. minor (g m^{-2})*		
	2002-03	*2003-04*	*Mean*	*2002-03*	*2003-04*	*Mean*
Weed Control						
Isoproturon, 0.94 kg ha^{-1}	28.95	25.75	27.35	61.08	45.0	53.4
Clodinafop, 0.06 kg ha^{-1}	3.46	3.51	3.48	20.0	12.4	16.2
Trifluralin, 1.0 kg ha^{-1}	5.56	4.86	5.21	28.3	16.2	22.3
Weed free	2.65	1.96	2.30	10.6	8.4	9.5
Unweeded Control	32.68	34.02	33.35	61.9	50.5	56.2
CD at 5%	8.78	10.12	9.47	3.2	4.4	3.8
Crop variety						
Wheat PBW 343	17.91	16.51	17.21	39.7	30.3	35.0
Wheat WH 542	16.06	18.49	17.28	41.7	33.5	37.6
Barley PL 419	13.69	12.76	13.22	35.0	21.7	28.3
Barley PL 426	10.97	8.32	9.64	29.8	20.5	25.1
CD at 5%	6.12	7.16	6.66	4.1	3.5	3.8
W.C. x Crop variety	NS	NS	NS	NS	NS	NS

maximum grain yield (43.52 q ha^{-1}) and low seed output (16.2 g m^{-2}) of *P minor,* having an edge over trifluralin that recorded 42.03 q ha^{-1} grain yield and 22.3g m^{-2} seed output of *P. minor*. Both these herbicides proved effecive for the control of isoproturon- resistant *P. minor* as well as selective to both wheat and barley.

No significant interaction between weed control treatments and crop varieties in any of the observation confirmed independent importance of herbicides and crop varieties in managing isoproturon-ressitant *P. minor* in wheat.

CONCLUSION

Barley varieties (PL 419 and PL 426) exhibited better growth, LAI and higher light interception than wheat varieties (PBW 343 and WH 542) and caused significant reduction in dry matter and seed output of *P. minor*. Pre-emergent trifluralin 1.0 Kg ha^{-1}, post- emergent isoproturon 0.94 Kg ha^{-1} and clodinafop 0.06 Kg ha^{-1} provided 84.4, 17.8 and 89.5 per cent reduction in dry matter of isoproturon-resistant *P. minor*, respectively, against 33.35 q ha^{-1} under unweeded control. Clodinafop and trifluralin with crop grain yield of 43.52 q ha^{-1} and 42.03 q ha^{-1}, respectively, remained at par with weed free (45.73 q ha^{-1}) and significantly better than isoproturon (37.05 q ha^{-1}) and unweeded control (34.6 q ha^{-1})

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