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Short communication

Bioefficacy of herbicides for weed management in transplanted rice

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In India, rice is cultivated in an area of 44.07 m/ha annually with a production of 103.4 m tonnes with an average productivity only 2.3 t/ha (FAO, 2012). Weed problem is most important that contribute heavily for the loss of rice yields and deteriorate the quality of crop produce and hence reduce the market value (Arif *et al*. 2006). Weeds compete with rice for moisture, nutrient, light, temperature, space and can cause yield reduction up to 28 to 45% in transplanted rice (Singh *et al*. 2007, Manhas *et al*. 2012). Pretilachlor 50% EC is a selective systemic anilide group of herbicide which was tested as pre-emergence herbicide in this experiment for weed management in transplanted rice as a broad spectrum.

The field experiment was conducted at Norman E. Borlaug, Crop Research Centre of GBPUA&T, Pantnagar, during *Kharif* 2014 to evaluate the bio-efficacy of pretilachlor against the weeds in transplanted rice. Rice variety '*Pant Dhan 18'* was transplanted on 2nd July 2014 at spacing of 20 x 10 cm with 35 kg/ha seed rate. Herbicides were applied using knapsack sprayer fitted with flat fan nozzle fitted with boom (3) with a spray volume of 500 l/ha of water.

The data on weed density and weed dry matter were recorded with the help of quadrate of 0.25 m^2. The dry weight of weeds was recorded after air drying and then placing weeds in oven for 3 days up to 65-70 ^{0}C temperature and was expressed in g/m^2. Weed control efficiency (WCE) was calculated by using the formula suggested by Mani *et al.* (1973) and expressed in percentage.

Data recorded were statistically analyzed. There was great difference among the density of weeds within different treatments. So, to reduce the variation in analyzed data, square root transformation had been used.

Effect on weed flora and density

The dominant weed species identified at 60 DAT comprised of *Echinochloa colona, Echinochloa crus-galli, Leptochloa chinensis, Ischaemum rugosum* as grassy, *Caesulia axillaris* as broad-leaf, whereas, *Cyperus difformis* and *Fimbristylis miliaceae* as sedges which account 18.6, 14.2, 7.1, 12.0, 0.4, 30.6 and 13.1%, respectively in the weedy check plot.

At 30 DAT among grassy weeds, complete elimination of *L. chinensis* and *I. rugosum* was obtained with the application of all herbicidal treatments, whereas, population of *E. crus-galli* was completely controlled with pre-emergence application of all the doses of pretilachlor, either sponsor sample (SS) or market sample (MS). Among non-grassy weeds, pretilachlor (SS) applied at 750 to 1500 g/ha and MS at 750 g/ha proved to be very effective in controlling *C. difformis* and *F. miliaceae*. Butachlor applied at 1250 g/ha and pretilachlor (SS) at 500 g/ha were not found much effective in controlling the population of most of the weeds (Table 1).

At 60 DAT, twice hand weeding showed complete control over the density of all grassy and non-grassy weeds except *I. rugosum*. Among the grassy weeds, complete control of *I. rugosum* was observed under all herbicidal treatments, *L. chinensis* was controlled with the application of all doses of pretilachlor (either SS or MS) except at its lower dose (500 g/ha). Among non-grassy weed, complete reduction of *F. miliaceae* was observed with the application of pretilachlor (SS) at 1500 g/ha and pretilachlor (MS) at 750 g/ha (Table 2).

Statistical analysis of data revealed that among the different doses of pretilachlor (SS) and (MS), lowest total dry matter of weeds (1.5 and 4.1 g/m^2) and maximum weed control efficiency (98.0 and 88.8%) was obtained with the application of pretilachlor (SS) at 1500 g/ha at all the crop growth stages *i.e.*, 30 and 60 DAT, respectively, followed by the application of pretilachlor (SS) at 1000 g/ha (Table 1 and 2). This finding is in close conformity with Dharumarajan *et al.* 2009 who also reported the minimum total dry weight of weeds with the application of pretilachlor at 1000 g/ha. However, it was at par with its respective lower dose applied at 750 g/ha.

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Table 1. Effect of herbicides on weed density, total dry weight and WCE at 30 days after transplanting

Treatment	Dose (g/ha)	Weed density (no./m^2)							Total dry weight (g/m^2)	WCE (%)
		Grassy weeds				Non-grassy weeds				
		E. colona	*E. crus-galli*	*L. chinensis*	*I. rugosum*	*C. axillaris*	*C. difformis*	*F. miliaceae*		
Pretilachlor (SS)	500	4.9(24.0)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.5(5.3)	1.9(2.7)	2.2(4.0)	3.7(12.9)	83.2
Pretilachlor (SS)	750	3.9(14.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.4(4.7)	1.0(0.0)	1.0(0.0)	2.8(6.8)	91.2
Pretilachlor (SS)	1000	3.4(10.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.2(4.0)	1.0(0.0)	1.0(0.0)	2.7(6.3)	91.8
Pretilachlor (SS)	1500	3.4(10.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.2(4.0)	1.0(0.0)	1.0(0.0)	1.5(1.5)	98.0
Pretilachlor (MS)	750	4.4(18.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.2(4.0)	1.0(0.0)	1.0(0.0)	2.9(7.5)	90.2
Butachlor	1250	3.8(13.3)	2.8(6.7)	1.0(0.0)	1.0(0.0)	2.8(6.7)	1.7(2.0)	1.5(1.3)	3.2(10.5)	86.3
Hand weeding (2)	30 and 60 DAT	4.4(18.7)	1.0(0.0)	1.5(1.3)	1.3(0.7)	1.7(2.0)	2.8(6.7)	1.9(2.7)	1.3(0.7)	99.1
Weedy check	-	7.4(53.3)	3.2(9.3)	2.5(5.3)	1.9(2.7)	2.5(5.3)	3.6(12.0)	6.4(40.0)	8.8(76.9)	-
LSD (P=0.05)	-	0.6	0.3	0.3	0.2	0.3	0.4	0.5	0.8	-

SS- Sponsor sample, MS- Market sample, DAT- Days after transplanting, WCE- Weed control efficiency, Value in parentheses was original and transformed to log" X+1 for analysis

Table 2. Effect of herbicides on weed density, total dry weight and weed control efficiency (WCE) at 60 days after transplanting

Treatment	Dose (g/ha)	Weed density (no./m^2)							Total dry weight (g/m^2)	WCE (%)
		Grassy weeds				Non-grassy weeds				
		E. colona	*E. crus-galli*	*L. chinensis*	*I. rugosum*	*C. axillaris*	*C. difformis*	*F. miliaceae*		
Pretilachlor (SS)	500	4.4(18.7)	2.8(6.7)	2.1(3.3)	1.0(0.0)	2.8(6.7)	3.2(9.3)	2.2(4.0)	6.8(44.6)	68.9
Pretilachlor (SS)	750	3.4(10.7)	2.2(4.0)	1.0(0.0)	1.0(0.0)	2.4(4.7)	2.8(6.7)	1.5(1.3)	5.2(26.0)	81.9
Pretilachlor (SS)	1000	2.8(6.7)	1.4(1.3)	1.0(0.0)	1.0(0.0)	2.4(4.7)	2.5(5.3)	1.5(1.3)	4.4(19.2)	86.6
Pretilachlor (SS)	1500	2.8(6.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.8(6.7)	2.2(4.0)	1.0(0.0)	4.1(16.1)	88.8
Pretilachlor (MS)	750	3.9(14.7)	2.8(6.7)	1.0(0.0)	1.0(0.0)	2.4(4.7)	2.4(4.7)	1.0(0.0)	5.7(32.3)	77.5
Butachlor	1250	3.8(13.3)	1.9(2.7)	2.4(4.7)	1.0(0.0)	2.5(5.3)	2.2(4.0)	2.4(4.7)	6.4(40.4)	71.9
Hand weeding (2)	30&60 DAT	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.4(4.7)	1.0(0.0)	1.0(0.0)	1.0(0.0)	2.2(4.0)	97.2
Weedy check		4.9(22.7)	4.3(17.3)	3.1(8.7)	3.9(14.7)	2.5(5.3)	6.1(37.3)	4.1(16.0)	11.9(143.8)	-
LSD (P=0.05)		0.5	0.5	0.3	0.2	0.4	0.7	0.5	1.3	-

SS- Sponsor sample, MS- Market sample, DAT- Days after transplanting, WCE- Weed control efficiency, Values in parentheses were original and transformed to square root $(\sqrt{x+1})$ for analysis.

Among the different doses of pretilachlor (SS), applications at 1500 as well as 1000 g/ha were found comparable and superior to rest of the doses in controlling the total weed density at both the stages. Whereas, lower dose of pretilachlor (SS) applied at 500 g/ha was found inferior for the same. Sponsor as well as market sample of pretilachlor applied at 750 g/ha were found comparable with each other in minimizing the total weed density (Fig. 1).

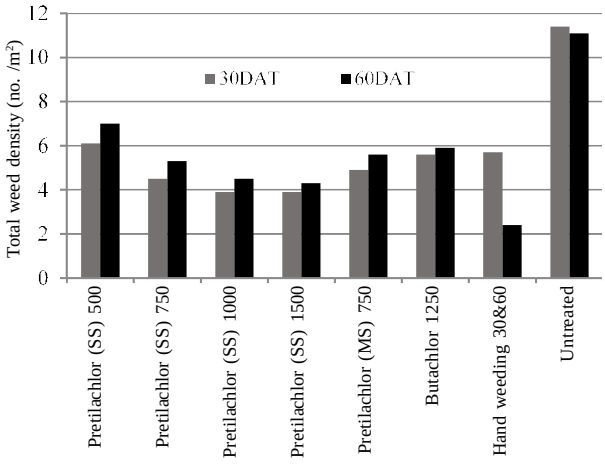

Fig. 1. Effect of treatments on total weed density at 30 and 60 DAT

Yield and yield attributing characters

All the treatments found significant towards yield of transplanted rice while had no significant effect on number of panicles (no./m^2) and 1000 grain weight (g). However, grain yield under all the herbicidal treatments was significantly superior to the uncontrolled one. Weeds in weedy plot resulted 38.5% reduction in grain yield as compared to butachlor (1250 g/ha). Reduction of 37.5% of grain yield was recorded in uncontrolled plot in comparison to highest dose of pretilachlor (SS) at 1500 g/ha. This reduction in yield was mainly due to highest infestation of weeds. Similar findings have also been reported by Bahar and Rashid (2013).

Among the different herbicidal treatments, maximum net return (` 84790) and benefit: cost ratio (2.63) was gained by the application of pretilachlor at

Table 3. Effect of herbicides on growth yield, yield attributes and economics of rice crop

Treatment	Dose (g/ha)	Panicles (no./m^2)	1000-grain weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Yield increase % over weedy check	Cost of cultivation (x10^3 `/ha)	Gross return (x10^3 `/ha)	Net return (x10^3 `/ha)	B:C Ratio
Pretilachlor (SS)	500	256	26.7	5.5	9.9	52.1	32.05	109.45	77.40	2.41
Pretilachlor (SS)	750	258	27.4	5.9	10.5	62.0	32.20	116.99	84.79	2.63
Pretilachlor (SS)	1000	261	27.2	5.9	10.6	62.2	32.60	117.34	84.74	2.60
Pretilachlor (SS)	1500	272	27.5	5.8	10.4	60.0	33.15	115.28	82.13	2.48
Pretilachlor (MS)	750	262	27.0	5.6	10.2	54.9	32.32	111.86	79.53	2.46
Butachlor	1250	258	27.4	5.9	10.0	62.5	32.25	115.24	82.99	2.57
Hand weeding (2)	30 and 60 DAT	273	27.5	5.9	10.7	62.0	34.00	117.69	83.69	2.46
Weedy check	-	218	24.9	3.6	6.7	-	31.00	72.41	41.41	1.34
LSD (P= 0.05)	-	NS	NS	387.3	862.1	-				

SS- Sponsor sample, MS- Market sample, DAT- days after transplanting, NS- non significant

750 g/ha due to increased grain yield and lesser cost of the herbicides.

It may be concluded that application of pretilachlor applied at 750 g/ha may be recommended for achieving higher grain yield, net return and B:C ratio.

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SUMMARY

A field trial was conducted to evaluate different doses of herbicides for weed control in transplanted rice during *Kharif* season 2014 at Pantnagar. Experiment was laid out in a randomized block design with three replications. Results showed that all the herbicides were effective in reducing the total density of weeds at all the growth stages and enhancing the rice yield. Application of pretilachlor (SS) 1000 and 1500 g/ha applied as pre-emergence proved to be most effective followed by its lower doses applied at 750 g/ha in decreasing the density of weeds (30 and 60 DAT) than the other treatments. None of the herbicides found phytotoxic to rice crop.

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