Short communication

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Integrated weed management in transplanted rice

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Rice (*Oryza sativa* L.) is the principal crop of India cultivated in an area of 44 million ha annually with a production of 103 mt, with an average productivity of 2.3 t/ha (Parthipan *et al.* 2013). Out of 44 mha of rice grown in India, about 57% (25 mha) is grown under irrigated condition (Government of India 2010). A major hindrance in successful cultivation of transplanted rice is heavy infestation of weeds causing drastic reduction in yield. Uncontrolled weeds growth caused 33-45% reduction in rice grain yield (Singh *et al.* 2007, Manhas *et al.* 2012). Therefore, proper weed management is essential for enhancing rice production. Removal of weeds during the critical period of crop-weed competition is essential to minimize crop-weed competition and maximize yield. Sometime, after transplanting the crop faces the moisture stress situation as farmers are unable to maintain the water in the field which leads to heavy infestation of weeds. In this type of situation no single weed management practice. Integration of different methods of weed management resulted in effective control of weeds and enhanced the productivity of transplanted rice (Brar and Walia 2001).Therefore, the present study was undertaken to assess the effect of different weed control treatments either applied alone or in combination on weed infestation and grain yield of transplanted rice.

A field experiment was conducted at G.B.Pant University of Agriculture and Technology, Pantnagar during 2012. The soil of the experimental site was silty loam having a pH of 7.3 and EC 1.16 (mS/cm). The organic carbon and available N, P and K were 0.86%, 226.2 kg/ha, 22.8 kg/ha, 145.4 kg/ha, respectively. The experiment was laid out in a randomized block design and replicated thrice with twelve treatments (Table 1). Rice variety '*Sarjoo 52*' was transplanted on 6th July 2012 at spacing of 20 x 10 cm. All the plots (5 x 3m) were fertilized with 120 kg N, 60 kg P, 40 kg K /ha through NPK mixture, urea, murate of potash and 20 kg $ZnSO_4$ per hectare. Full dose of P and K and half dose of N were applied uniformly as basal at the time of transplanting. Remaining half dose of N was top dressed in two equal splits *i.e.* one-fourth at active tillering [30-35 days after transplanting (DAT)] and one-fourth at panicle initiation (60-65 DAT) stage of the crop. After treatment execution, the water application was uniform for all the treatments to keep the soil near saturation. Rice crop was harvested manually with help of sickle at height of 10-15 cm from ground level on 3 November 2012. Species-wise weed density and biomass were recorded at 60 DAT by placing a quadrate of 50 x 50 cm from the marked sampling area of 1.0 m^2 in each plot. The cost of cultivation was calculated by taking into account the prevailing market price of inputs and operational cost from the farmer's field. The returns were calculated by using minimum support price of rice (` 1250/100 kg) for 2011-12. The significant differences between treatments were compared by critical difference at 5% level of probability.

All the weed control treatments significantly reduced the weed density compared to weedy check (Table 1). Grassy and broad-leaf weeds were found pre-dominant at 60 DAT. Pre-emergence application of pretilachlor 750 g/ha without water stagnation in field up to one week along with post-emergence application of bispyribac-Na 20 g/ha were found to be very effective in reducing the weed density as compared to other treatments. The better performance of these herbicides could be attributed to its effectiveness against *Echinochloa* sp. which was dominant weed species among the diverse weed flora. This treatment was also found superior over rest of the treatments as it provided complete control of grassy and non-grassy weeds. Water stress for one week led to uniform emergence of weeds which were then controlled by post-emergence application of bispyribac-Na in this treatment

Different weed control treatments significantly reduced the biomass of different weed species over the weedy check (Table 2). Pre-emergence application of pretilachlor 750 g/ha without water stagnation

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in field up to one week *fb* post-emergence application of bispyribac-Na 20 g/ha caused significant reduction in biomass of grassy weeds, *viz. E. colona, E. crus-galli, L. chinensis* and *I. rugosum* than other integrated treatments. The better performance of this treatment could be attributed to the reduced weed competition in the initial stage and suppression of late emerged weeds by sequential application of bispyribac-Na. Among the treatments where herbicides were applied alone, bispyribac-Na 20 g/ha was found superior than other herbicides in reducing the biomass of different weed species.

Table 1.Effect of different weed control treatments on weed density at 60 days after transplanting (DAT)

Treatment	Dose (g/ha)	Weed density (no./m^2)							
		Grasses				Broad-leaved weeds			Sedges
		E. colona	*E. crusgalli*	*L. chinensis*	*I. rugosum*	*C. axillaris*	*A. baccifera*	*A. sessilis*	*C. difformis*
Penoxsulam	20.0	3.1(21.3)	2.4 (10.7)	3.0(18.7)	2.8(16.0)	2.3(9.3)	3.2(22.7)	2.2(8.0)	0.0(0.0)
Penoxsulam	22.5	2.7(13.3)	1.6(4.0)	2.7(13.3)	2.6(12.0)	2.0(6.7)	3.0(20.0)	2.0(6.7)	0.0(0.0)
Penoxsulam	25.0	1.8(5.3)	0.0(0.0)	1.6(4.0)	2.0(6.7)	0.5(1.3)	2.6(12.0)	1.1(2.7)	0.0(0.0)
Bispyribac-Na	20.0	1.6(4.0)	0.0(0.0)	1.6(4.0)	1.8(5.3)	0.0(0.0)	2.6(12.0)	0.5(1.3)	0.0(0.0)
Pretilachlor	750	3.0(20.0)	2.4(10.7)	1.1(2.7)	2.6(12.0)	2.8(16.0)	3.2(24.0)	2.2(8.0)	0.0(0.0)
Pretilachlor *fb* 1 HW (at 45 DAT)	750	2.2(8.0)	0.0(0.0)	0.5(1.3)	1.6(4.0)	1.6(4.0)	2.7(14.7)	0.5(1.3)	0.0(0.0)
Penoxsulam *fb* 1 HW (at 45 DAT)	22.5	2.0(6.7)	0.5(1.3)	1.1(2.7)	1.8(5.3)	1.1(2.7)	2.7(13.3)	1.1(2.7)	0.0(0.0)
Pretilachlor + without water stagnation in field upto one week	750	3.1(21.3)	2.6(12.0)	2.0(6.7)	2.7(13.3)	3.0(18.7)	3.3(26.7)	2.3(9.3)	0.0(0.0)
Pretilachlor + without water stagnation in field upto one week *fb* bispyribac-Na	750 *fb* 20.0	0.5(1.3)	0.0(0.0)	0.5(1.3)	0.0(0.0)	0.0(0.0)	1.8(5.3)	0.0(0.0)	0.0(0.0)
One mechanical weeding using conoweeder *fb* 1 HW at 45 DAT	15 *fb* 45 DAT	3.2(22.7)	2.7(14.7)	2.9(17.3)	2.7(14.7)	3.1(21.3)	3.5(33.3)	2.3(9.3)	2.0(6.7)
Hand weeding (HW) twice at 20 and 40 DAT	20 and 40 DAT	1.1(2.7)	0.5(1.3)	1.8(5.3)	1.1(2.7)	1.6(4.0)	2.0(6.7)	0.5(1.3)	1.8(5.3)
Untreated (weedy check)	-	3.7(41.3)	3.2(22.7)	3.3(25.3)	3.4(29.3)	3.9(46.7)	3.9(48.0)	2.7(13.3)	3.4(29.3)
LSD (P=0.05)	-	0.68	0.68	0.89	0.54	0.7	0.28	1.04	0.24

Table 2. Effect of different weed control treatments on weed biomass at 60 DAT

Treatment	Dose (g / ha)	Weed biomass (g / m^2)							
		Grasses				Broad-leaved weeds			Sedges
		E. colona	*E. crusgalli*	*L. chinensis*	*I. rugosum*	*C. axillaris*	*A. baccifera*	*A. sessilis*	*C. difformis*
Penoxsulam	20.0	2.6(12.8)*	1.6(4.2)	2.8(15.8)	3.1(20.1)	1.2(2.5)	0.8(1.2)	1.2(2.2)	0.0(0.0)
Penoxsulam	22.5	2.2(8.3)	0.9(1.5)	2.5(11.4)	2.8(16.3)	1.0(1.9)	0.7(1.1)	1.0(1.9)	0.0(0.0)
Penoxsulam	25.0	1.6(4.2)	0.0(0.0)	1.8(4.8)	2.6(12.6)	0.3(0.4)	0.6(0.8)	0.6(0.9)	0.0(0.0)
Bispyribac-Na	20.0	1.2(2.3)	0.0(0.0)	1.3(3.1)	2.1(7.8)	0.0(0.0)	0.3(0.4)	0.2(0.3)	0.0(0.0)
Pretilachlor	750	2.8(15.8)	1.8(5.2)	1.4(4.6)	3.1(21.1)	2.0(6.1)	1.0(1.7)	1.7(4.6)	0.0(0.0)
Pretilachlor *fb* 1 HW (at 45 DAT)	750	1.5(3.7)	0.0(0.0)	0.6(1.7)	2.2(8.1)	0.8(1.3)	0.4(0.5)	0.3(0.4)	0.0(0.0)
Penoxsulam *fb* 1 HW (at 45 DAT)	22.5	1.6(3.9)	0.3(0.5)	1.1(2.9)	2.4(11.0)	0.5(0.7)	0.4(0.6)	0.5(0.8)	0.0(0.0)
Pretilachlor + without water stagnation in field upto one week	750	2.9(16.6)	1.8(5.3)	2.4(10.9)	3.1(22.2)	1.9(6.0)	1.0(1.6)	1.6(4.1)	0.0(0.0)
Pretilachlor + without water stagnation in field upto one week *fb* bispyribac-Na	750 *fb* 20.0	0.4(0.8)	0.0(0.0)	0.5(1.2)	0.0(0.0)	0.0(0.0)	0.1(0.2)	0.0(0.0)	0.0(0.0)
One mechanical weeding using conoweeder *fb* 1 HW at 45 DAT	15 *fb* 45 DAT	2.9(18.0)	2.0(6.4)	3.0(19.9)	3.3(26.3)	2.0(6.7)	1.0(1.8)	1.6(4.2)	1.7(4.9)
Hand weeding (HW) twice at 20 and 40 DAT	20 and 40 DAT	0.7(1.3)	0.2(0.3)	1.6(4.0)	1.2(3.5)	0.6(0.8)	0.2(0.3)	0.2(0.3)	1.3(2.8)
Untreated (weedy check)	-	3.6(36.8)	2.3(9.1)	3.5(30.6)	3.9(46.8)	2.7(13.4)	1.3(2.8)	1.8(5.2)	3.1(21.4)
LSD (P=0.05)	-	0.52	0.35	0.97	0.61	0.36	0.08	0.51	0.23

*Original values are given in parentheses

Table 3. Cost of cultivation, gross return, net return and B:C ratio of transplanted rice

Treatment	Dose (g/ha)	Cost of cultivation ($x10^3$ `/ha)	Gross returns ($x10^3$ `/ha)	Net returns ($x10^3$ `/ha)	B: C ratio
Penoxsulam	20.0	29.53	61.20	31.67	1.09
Penoxsulam	22.5	29.78	64.45	34.67	1.16
Penoxsulam	25.0	30.00	65.75	35.75	1.19
Bispyribac-Na	20.0	29.30	70.31	41.01	1.39
Pretilachlor	750	28.48	60.54	32.06	1.12
Pretilachlor *fb* 1 HW (at 45 DAT)	750	30.72	67.37	36.65	1.19
Penoxsulam*fb* 1 HW (at 45 DAT)	22.5	32.03	67.05	35.02	1.09
Pretilachlor + without water stagnation in field upto one week	750	28.48	57.94	29.46	1.03
Pretilachlor + without water stagnation in field upto one week *fb*bispyribac-Na	750 *fb* 20.0	30.25	71.61	41.36	1.36
One mechanical weeding using conoweeder *fb* 1 HW at 45 DAT	15 *fb* 45 DAT	30.98	55.99	25.01	0.80
Hand weeding (HW) twice at 20 and 40 DAT	20 and 40 DAT	34.28	70.31	36.03	1.05
Untreated (weedy check)	-	27.53	28.64	1.11	0.04

B:C- Benefit cost ratio

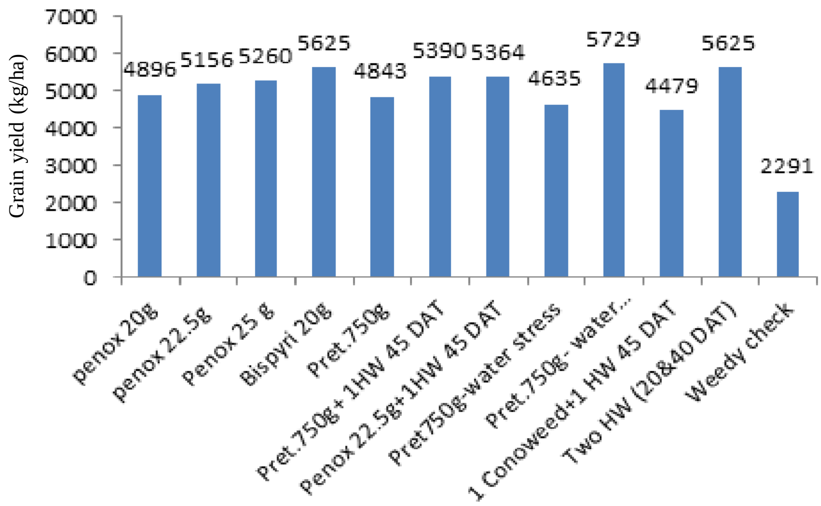

Fig . 1. Effect of different weed control treatments on grain yield

All the weed control treatments registered significantly higher rice grain yield over the weedy check (Fig. 1). Pre-emergence application of pretilachlor750 g/ha without water stagnation in field upto one week along with post-emergence application of bispyribac-Na 20 g/ha recorded the highest grain yield (5.73 t/ha) however it was at par with post-emergence application of bispyribac-Na 20 g/ha alone and hand weeding twice at 20 and 40 DAT. Unweeded control recorded the lowest rice grain yield (2.29 t/ha) with a yield loss of 150% in comparison to the most promising treatment. The possible reason for better performance of pre-emergence application of pretilachlor 750 g/ha without water stagnation in field up to one week *fb* post-emergence application of bispyribac-Na 20 g/ha in terms of grain yield could be attributed to better weed suppression.

The total production cost varied due to differences in cost of weed control treatments. Twice hand weeding (20 and 40 DAT) incurred maximum cost of production among all the treatments (Table 3). Among other treatments, maximum gross return and net profit was recorded with pre-emergence application of pretilachlor 750 g/ha without water stagnation in field up to one week *fb* post-emergence application of bispyribac-Na 20 g/ha followed by post-emergence application of bispyribac -Na 20 g/ha alone while minimum was recorded in one mechanical weeding using cono weeder (15 DAT) *fb* one hand weeding at 45 DAT, as it recorded less rice grain and straw yield. The benefit cost ratio was found to be highest with post-emergence application of bispyribac-Na 20 g/ha alone which was comparable to pre-emergence application of pretilachlor 750 g/ha without water stagnation in field upto one week *fb* post-emergence application of bispyribac-Na 20 g/ha.

It may be concluded that pre-emergence application of pretilachlor 750 g/ha without water stagnation in field upto one week *fb* post-emergence application of bispyribac-Na 20 g/ha is the most effective treatment for managing broad spectrum weed species complex and attain higher rice grain yield and economic returns.

SUMMARY

The present study was conducted to quantify the effect of different weed control treatments alone or in combination with each other on weed growth and grain yield of transplanted rice during *Kharif* season of 2012 at G.B. Pant university of Agriculture and technology, Pantnagar, Uttarakhand. Different weed species responded variably to tested weed control treatments. The dominant weeds in experimental plots were *Echinochloa colona, E. crusgalli, Leptochloa chinensis, Ischeamum rugosum* among grasses and *Ammania baccifera, Alternanthra sessilis* and *Ceasulia axillaris* among broad-leaf weeds and *Cyperus difformis* was the only sedge. Pre-emergence application of pretilachlor 750 g/ha without water stagnation in the field up to one week *fb* post-emergence application of bispyribac-Na 20 g/ha was found superior to rest of the treatments.

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