Short communication

Indian Journal of Weed Science **47**(4): 414–416, 2015

Herbicide combinations for control of complex weed flora in transplanted rice

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Received: 18 October 2015; Revised: 2 December 2015

Key words: Herbicide, Transplanted rice, Weed control, Weed flora

Rice (*Oryza sativa* L.) is the staple food of more than 60% of the world population. In India, rice occupies an area of 43.95 mha with production and productivity of 106.65 mt and 2.4 t/ha, respectively (Ministry of Agriculture 2015). Because of growing population, the demand of rice is expected to increase in the coming decades. India should add 1.7 million tonnes of additional rice every year to ensure national food security (Das and Chandra 2013). Though, India has the largest area under rice in the world but its productivity is very low. This might be due to several constraints. Among them weeds pose a major threat. Weeds compete with the crop for light, nutrients, moisture, etc. Weeds also harbor insect pests that cause decrease in yield and quality of produce. Rice grain production in our country is reported to suffer a loss of 15 mt annually due to weed competition. Uncontrolled weed growth causes 33-45% reduction in grain yield of transplanted rice (Singh *et al.* 2007, Manhas *et al.* 2012).

At present, use of a single herbicide is not convenient and effective in eliminating the weed menace in transplanted rice. Studies have shown that combination of herbicides may be a better option rather than alone application because it offers even broader spectrum of weed control, saves time and reduces the cost of cultivation. This situation warrants for initiating research efforts to evaluate and identify suitable herbicide combinations to widen the weed control spectrum. Therefore, keeping the above facts in mind, the present investigation was carried out to study the herbicide combinations for control of complex weed flora in transplanted rice (*Oryza sativa* L.).

A field experiment was conducted at G.B. Pant University of Agriculture and Technology, Pantnagar during *Kharif*, 2014. The soil of the experimental site was silty loam having pH of 7.38, containing high organic carbon (0.89%), low available nitrogen (244.6 kg/ha), medium available phosphorus (22.4 kg/ha) and potassium (215.6 kg/ha), respectively. The experiment was laid out in randomized block design and replicated thrice with twelve treatments, *viz.* post-emergence application of bispyribac-sodium 25 g/ha, penoxsulam 24% SC 22.5 g/ha, bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha, bispyribac-sodium 25 g/ha + readymix of chlorimuron-ethyl and metsulfuron-methyl 4 g/ha, pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of ethoxysulfuron 18.75 g/ha, pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of readymix of chlorimuron-ethyl and metsulfuron-methyl 4 g/ha, pre-emergence application of pyrazosulfuron 20 g/ha *fb* post-emergence application of readymix of chlorimuron-ethyl and metsulfuron-methyl 4 g/ha, post-emergence application of readymix of penoxsulam + cyahalofop-butyl 6% OD 135 g/ha, post-emergence application of readymix of triafamone + ethoxysulfuron 60 g/ha, pre-emergence application of pendimethalin 750 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha, hand weeding at 25 and 45 DAT and weedy check. Rice variety '*Narendra 359*' was transplanted on 27th June 2014 at spacing of 20 x 10 cm. All the plots (5 x 3 m) were fertilized with 120 kg N, 60 kg P, 40 kg K/ha through NPK mixture, urea, murate of potash and 20 kg ZnSO4/ha. 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 stage [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 on 17th October 2014.

Species-wise weed density and biomass were recorded at 30, 60, 90 DAT and at harvest by placing a quadrate of 50 x 50 cm from the marked sampling area 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 (Rs. 1360/100 kg) for 2014-15. The significant differences between treatments were compared by critical difference at 5% level of probability. The data on weed density and biomass were subjected to square root transformation for comparison.

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Weed flora

The dominant weed flora of the experimental field consisted of *Echinochloa colona*, *Echinochloa crusgalli*, *Panicum maximum*, *Leptochloa chinensis* and *Ischaemum rugosum* among grasses, *Caesulia axillaris*, *Ammania baccifera* and *Alternanthera sessilis* among broad-leaved weeds and *Cyperus iria* and *Cyprus difformis* among sedges.

Effect on weeds

All the weed control treatments significantly reduced the density of weeds (Table 1) but their efficiency in controlling different types of weeds varied significantly. Grassy and broad-leaf weeds were found predominanted at 60 DAT. Pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of ethoxysulfuron 18.75 g/ha resulted in the lowest total weed density. Similar results were also reported by Hossain *et al.* (2014). The better performance of this treatment might be attributed to the effective control of grasses and broad-leaf weeds by pretilachlor and control of broad leaf weeds and sedges by ethoxysulfuron. This was statistically similar to post-emergence application of readymix of penoxsulam + cyhalofop-butyl 135 g/ha, pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of readymix of chlorimuron-ethyl + metsulfuron-methyl 4 g/ha and post-emergence application of bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha.

Different weed control treatments significantly reduced the biomass of different weed species over the weedy check (Table 1). Post-emergence application of readymix of penoxsulam + cyhalofop-butyl 135 g/ha recorded complete reduction in biomass of grassy weeds. The effective control of grasses in this treatment might be attributed to the combined broad spectrum activity of penoxsulam and cyhalofop-butyl which controls grasses effectively. Besides this treatment, pre-emergence application of pendimethalin 1000 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha also recorded low dry matter of grassy weeds. The lowest dry matter of broad-leaf weeds was recorded with post-emergence application of bispyribac-sodium 25 g/ha + ethoxysulfuron 18.75 g/ha, post-emergence application of readymix of penoxsulam + cyhalofop-butyl 135g/ha and post-emergence application of readymix mixture of triafamone + ethoxysulfuron 60 g/ha. The broad spectrum effect of bispyribac-sodium, penoxsulam and triafamone and effective control of broad-leaf weeds by ethoxysulfuron might be the reason for reduced weed biomass in these treatments. These were at par with pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of ethoxysulfuron 18.75 g/ha, pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of readymix of chlorimuron-ethyl + metsulfuron methyl 4 g/ha and pre-emergence application of pendimethalin 1000 g/ ha *fb* post-emergence application of bispyribac-sodium 25 g/ha. The sedges were not much problem and the dry matter of sedges was completely reduced in most of the treatments where combinations of herbicides were used. The total weed dry matter at 60 DAT however, was found to be lowest with pre-emergence application of pendimethalin 1000 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha, owing to the control of weeds in early stages by pendimethalin and in later stages by bispyribac-sodium. This treatment, therefore, recorded the highest weed control efficiency (97.7%) (Table 1). These results were in conformity with the findings of Walia *et al.* (2012) for direct seeded rice. Significant reduction in total dry matter over weedy check with bispyribac–sodium at 60 DAT was also reported by Kumar *et al.* (2013). The low weed dry matter and high weed control efficiency of the above treatment was at par with pre-emergence application of pretilachlor 750 g/ha *fb* post-emergence application of ethoxysulfuron 18.75 g/ha, post-emergence application of readymix of penoxsulam + cyhalofop-butyl 135 g/ha and twice hand weeding at 25 and 45 DAT. Among the herbicidal treatments, the lowest weed control effieiency was recorded with alone post-emergence application of bispyribac-sodium 25 g/ha. The better performance of treatments with herbicide combinations indicates their superiority over alone application. The highest weed density and dry matter were recorded in weedy check. This suggests that without proper management of weeds in transplanted rice, the weed growth will be at its peak and hamper crop growth.

The highest grain yield (6.42 t/ha) was recorded with pre-emergence application of pendimethalin 1000 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha (Table 1). Similar results have been also reported by Walia *et al.* (2012) for direct-seeded rice. This was at par with post-emergence application of readymix of penoxsulam + cyhalofop-butyl 135 g/ha (6.32 t/ha) and twice hand weeding at 25 and 45 DAT (6.28 t/ha). The higher grain yield may be attributed to the reduced weed competition and thereby increased crop growth due to control of weeds at initial stage by pre-emergence application of pendimethalin which controls grasses and broad leaved weeds effectively and subsequent control by bispyribac-sodium, which offers broad spectrum weed control (Parthipan *et al.* 2013), thus offering broad spectrum control of weed for the

Table 1. Effect of weed management practices on weed density, weed dry weight at 60 DAT and grain yield of transplanted rice

Treatment	Dose (g/ha)	Weed density (no./m^2)				Weed dry matter (g/m^2)				Grain yield (t/ha)
		Grasses	Broad-leaf weeds	Sedges	Total weed density	Grasses	Broad-leaf weeds	Sedges	Total weed dry matter	
Bispyribac-sodium	25	3.4 (10.7)	6.9 (47.3)	3.2 (9.3)	8.3 (67.3)	2.9 (7.67)	2.7 (6.3)	3.2 (9.0)	4.9 (23.0)	4.42
Penoxsulam	22.5	3.8 (13.3)	6.3 (38.7)	1.9 (2.7)	7.5 (54.6)	2.6 (5.9)	2.23 (4.0)	1.7 (2.0)	3.6 (11.9)	5.42
Bispyribac-sodium + ethoxysulfuron	25 + 18.75	3.9 (14.0)	2.2 (4.0)	1.0 (0.0)	4.4 (18.0)	3.4 (10.2)	1.2 (0.4)	1.0 (0.0)	3.4 (10.6)	5.56
Bispyribac-sodium + chlorimuron-ethyl + metsulfuron-methyl	20 + 4	4.0 (14.7)	4.8 (22.0)	1.0 (0.0)	6.1 (36.7)	4.0 (15.3)	1.7 (1.8)	1.0 (0.0)	4.2 (17.1)	5.05
Pretilachlor *fb* ethoxysulfuron	750 *fb* 18.75	2.8 (7.3)	2.7 (6.7)	1.0 (0.0)	3.8 (14.0)	2.7 (7.9)	1.3 (0.7)	1.0 (0.0)	2.9 (8.0)	5.90
Pretilachlor *fb* chlorimuron-ethyl + Metsulfuron methyl	750 *fb* 4	3.6 (12.0)	2.8 (7.3)	1.0 (0.0)	4.5 (19.3)	4.2 (16.5)	1.4 (0.9)	1.0 (0.0)	4.3 (17.5)	5.46
Pyrazosulfuron *fb* chlorimuron-ethyl + metsulfuron-methyl	20 *fb* 4	4.9 (22.7)	5.4 (28.0)	1.0 (0.0)	7.2 (50.7)	4.2 (16.9)	1.5 (1.2)	1.0 (0.0)	4.3 (18.1)	4.85
Penoxsulam + cyhalofop-butyl (RM)	135	1.0 (0.0)	3.5 (11.3)	2.5 (5.3)	4.2 (16.7	1.0 (0.0)	1.2 (0.5)	2.6 (5.7)	2.7 (6.2)	6.32
Triafamone + ethoxysulfuron (RM)	60	3.5 (11.3)	4.8 (22.0)	1.0 (0.0)	5.9 (33.3)	3.4 (10.9)	1.2 (0.5)	1.0 (0.0)	3.5 (11.3)	5.97
Pendimethalin *fb* bispyribac-sodium	1000 *fb* 25	3.0 (8.0)	3.8 (13.3)	2.0 (3.3)	5.0 (24.7)	1.8 (2.2)	1.4 (0.9)	1.7 (2.1)	2.5 (5.2)	6.42
Hand weeding at 25 and 45 DAT	-	3.2 (9.3)	7.1 (49.3)	1.5 (1.3)	7.8 (60.0)	2.0 (3.2)	2.1 (3.6)	1.6 (1.7)	3.1 (8.5)	6.28
Weedy check	-	9.1 (81.3)	12.2 (150)	5.8 (33.3)	16.3 (265)	14.2 (201)	3.4 (10.8)	3.7 (13.0)	15.0 (225)	3.60
LSD (P= 0.05)		0.7	1.0	0.6	1.0	0.7	0.2	0.4	0.7	0.21

Original values are given in parenthesis; RM= Readymix; DAT= Days after transplanting

whole crop period. The lowest grain yield was recorded in weedy check. Lower grain yield in weedy check might be due to severe crop weed competition, as evident from higher weed density and dry matter (Table 1). Similar results were also reported by Prakash *et al.* (2011), Bhat *et al.* (2013).

SUMMARY

Among the weed control treatments, herbicidal combinations of pre-emergence application of pendimethalin 1000 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha and post-emergence application of readymix of penoxsulam + cyhalofop-butyl 135 g/ha were found most effective in controlling weed infestation with the highest weed control efficiency and grain yield.

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