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Short Research Article

Herbicidal Combination for Effective Management of Complex Weed Flora in Transplanted Rice (*Oryza sativa* L.)

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Abstract

Long term continuous use of similar herbicide is major culprit for weed shift and herbicide resistance. Therefore, a field experiment was conducted at Norman E. Borlaug Crop Research Centre of G.B. Pant University of Agriculture and Technology, Pantnagar during kharif 2012 to evaluate the performance of new broad spectrum herbicide molecules. Pre-emergence application of Pretilachlor 750 g ha^{-1} with no irrigation during initial one week along with post-emergence application of Bispyribac-Na 20 g ha^{-1} provided broad spectrum control of complex weed flora at 30 and 60 days after transplanting (DAT) resulted in significantly lower weed density and dry matter than rest of the weed control treatments. This treatment thus, provided higher weed control efficiency (98.7%) and yield (5729 kg ha^{-1}), than test treatment i.e., pre-emergence application of Pretilachlor alone. However, one conoweeding (15 DAT)+one hand weeding (45 DAT) recorded higher weed density and dry matter at both the stages. Alone post-emergence application of Bispyribac-Na and twice hand weedings produced at par yield with Pretilachlor 750 g ha^{-1} with no irrigation during initial one week along with application of Bispyribac-Na 20 g ha^{-1}. Among different doses of Penoxsulam, the increase in dose of Penoxsulam caused significant reduction in weed density and dry matter thus registered higher grain yield. Post-emergence application of Penoxsulam at 22.5 and 25 g ha^{-1} produced comparable yield with Bispyribac-Na. Conoweeding+one hand weeding was found least effective compared to rest of the treatments.

1. Introduction

Rice (*Oryza sativa* L.) is an important food crop of India cultivated in 43.9 mha area with a production of 106.5 Mt and an average productivity of 2.4 t ha^{-1} during 2013-14 (Economic Survey, 2014-15). With the introduction of short statured high yielding rice varieties with erect leaves, the weeds are becoming more problematic (Mishra et al., 2006). Heavy weed infestation, comprising grasses, broad-leaf weeds and sedges cause yield reduction of about 50% in transplanted rice **(**Mukherjee and Singh, 2005**),** mainly due to competition for nutrient, moisture, light and space. Uncontrolled weeds have caused yield reduction of 28 to 45% in transplanted rice (Manhas et al., 2012).

Thus, timely and effective management of weeds is pivotal to augment the productivity of rice. Manual and mechanical method of weed management are time consuming, cost intensive and tedious. In contrast, chemical control is effective, requires less time and labour thus widely practiced by the farmers. The most commonly used herbicides by the farmers are Pretilachlor and Butachlor applied as pre-emergence. However, continuous use of same group of herbicides over a period of time on a same piece of land leads to ecological imbalance in terms of weed shift and environmental pollution (Uma et al., 2014). Thus, integrated application of herbicides with other weed management practices or sequential application of pre and post-emergence herbicides may be effective in controlling wide range of weed species in transplanted rice (Sah et al., 2012). In many parts of Indian sub-continent, the water availability with the farmers is variable especially during initial post transplanting period till onset of monsoon. In order to prepare new rice fields for transplanting often irrigation to previously planted rice fields gets restricted. Hence, due to shortage of moisture the weed control efficiency is reduced. Thus, application of pre-emergence herbicide alone is not sufficient to control repeated flushes of weeds which necessitate adoption of integrated weed management practices utilizing both pre and post-emergence herbicides for effective management of complex weed flora in transplanted rice. This prompted us to take up the present investigation, with the objective to evaluate the efficacy of different herbicides alone or in combination with other methods of weed control for controlling weeds and their effect on yield and yield attributing characters of rice crop.

2. Materials and Methods

A field experiment was conducted during wet (rainy) season of 2012 on transplanted rice variety "Sarjoo 52" at Norman E. Borlaug Crop Research Centre of G.B.Pant University of Agriculture and Technology, Pantnagar. The soil of the experimental site was silty loam, high in organic carbon (0.86%), low in available nitrogen (226.2 kg ha^{-1}), medium in available phosphorus (22.8 kg ha^{-1}) and potassium (145.4 kg ha^{-1}) with a pH of 7.3. The experiment consisted of twelve treatments was laid out in randomized block design with three replications. The treatments T_1, T_2 and T_3 consisted of three doses of Penoxsulam (20, 22.5 and 25 g ha^{-1}, respectively), T_4-Bispyribac-Na 20 g ha^{-1}, T_5- Pretilachlor 750 g ha^{-1}, T_6- T_5+1 hand weeding (HW) at 45 days after transplanting (DAT), T_7-T_2+1 HW at 45 DAT, T_8-Pretilachlor 750 g ha^{-1}, with no irrigation up to one week, T_9-T_8+Bispyribac-Na 20 g ha^{-1}; T_{10}-Conoweeding at 15 DAT+1 HW at 45 DAT, T_{11}-Twice hand weeding (20 and 40 DAT) and T_{12}- Weedy check. To all the treatments irrigation was applied to saturation except Pretilachlor 750 g ha^{-1} with no irrigation upto one week (T_8) and Pretilachlor 750 g ha^{-1} with no irrigation upto one week+Bispyribac-Na 20 g ha^{-1} (T_9). In both of these treatments, irrigation was withheld upto initial one week after transplanting. Thereafter, irrigation application was common to all the plots. The transplanting was done on 6th July, 2012 at 20×10 cm^2 spacing using two seedlings per hill. Rice crop was fertilized with 120:60:40:20 kg ha^{-1} ($N:P_2O_5:K_2O:ZnSO_4$, respectively). Excluding half dose of N, all the fertilizers were applied as basal before puddling. Remaining N was applied in equal splits at active tillering and panicle initiation stages. Rice crop was harvested manually with the help of sickle at height of 10-15 cm from ground level on 3rd November, 2012. The data on total weed density and dry matter were recorded at 30 and 60 DAT by placing a quadrate of 0.25 m^2 randomly. Weed control efficiency (WCE) was worked out at 60 DAT to evaluate the comparative efficacy of different herbicides by

$$\text{WCE (\%)} = \frac{\text{WDC-WDT}}{\text{WDT}} \times 100$$

Where,
WDC=Weed dry weight in control (weedy plot), g m^{-2}
WDT=Weed dry weight in treated plot, g m^{-2}

using the formula suggested by Thakur (1994).

3. Results and Discussion

The predominant weeds found in the experimental field were *Echinochloa colona, E. crus-galli, Leptochloa chinensis* and *Ischaemum rugosum* among the grasses and *Ammania baccifera, Caesulia axillaris* and *Alternanthra sessilis* among the broad leaf weeds. *Cyperus difformis* was the only species found among the sedges. All the weed control treatments applied either alone or in combination significantly affected the density and dry matter of weeds at 30 and 60 days after transplanting (Table 1). Weed dry matter was better parameter to measure the competition than weed number as also reported by Channappagoudar et al. (2013). In general, the higher density and dry matter of weeds was observed at 60 DAT as compared to other stages. Among different weed control treatments, pre-emergence application of Pretilachlor 750 g ha^{-1} with no irrigation upto one week+Bispyribac-Na 20 g ha^{-1} (T_9) brought significant reduction in weed density and dry matter followed by post-emergence application of Bispyribac-Na 20 g ha^{-1} (T_4) while one conoweeding at 15 DAT+1 HW at 45 DAT (T_{10}) recorded higher density and dry matter of weeds at both the stages. The significant reduction in weed density and dry matter was observed with the increase in dose of Penoxsulam from 20 to 25 g ha^{-1}. Similar results were recorded by Khare et al. (2014) and Yadav et al. (2008). Among all the weed control treatments, pre-emergence application of Pretilachlor 750 g ha^{-1} with no irrigation upto one week+Bispyribac-Na 20 g ha^{-1} (T_9) provided broad spectrum control of weeds which resulted in significant reduction in weed density and dry matter over other treatments. This might be attributed to reduced crop-weed competition at initial stage by pre-emergence application of Pretilachlor and suppression of second flush of weeds by the post-emergence application of Bispyribac-Na. Similar findings were also reported by many workers (Uma et al., 2014; Walia et al., 2008; Singh et al., 2005). At 60 DAT, application of Pretilachlor 750 g ha^{-1} with no irrigation upto one week+Bispyribac-Na 20 g ha^{-1} (T_9) cause significant reduction in the weed count and dry matter and thus recorded maximum WCE followed by twice hand weeding at 20 and 40 DAT (T_{11}) and post-emergence application of Bispyribac-Na 20 g ha^{-1}(T_4) while minimum was observed with one conoweeding at 15 DAT+1 HW at 45 DAT (T_{10}). This might be due to suppression of weed competition due to combined application of pre and post-emergence herbicide resulting in minimum weed biomass production hence offering efficient and prolong WCE. These

Table 1: Effect of different weed control treatments on total weed density, dry matter and WCE

	Treatment	Total weed density (no. m^{-2})		Total weed dry matter (g m^{-2})		WCE (%)
		Days after transplanting (DAT)				
		30	60	30	60	60
T_1	Penoxsulam 20 g ha^{-1}, 20 DAT	4 (54.7)	4.7 (106.7)	2.4 (10.3)	4.1 (58.9)	64.5
T_2	Penoxsulam 22.5 g ha^{-1}, 20 DAT	3.8 (45.3)	4.3 (76)	2.3 (8.9)	3.8 (42.4)	74.5
T_3	Penoxsulam 25 g ha^{-1}, 20 DAT	3.2 (22.7)	3.5 (32)	1.6 (3.9)	3.2 (23.8)	85.7
T_4	Bispyribac-Na 20 g ha^{-1}, 14 DAT	3 (18.7)	3.3 (26.7)	1.4 (3.2)	2.7 (14)	91.6
T_5	Pretilachlor 750 g ha^{-1}, 3 DAT	4.3 (72)	4.5 (93.3)	2.8 (15.6)	4.1 (59.1)	64.4
T_6	T_5 + 1 HW (45 DAT)	4.3 (69.3)	3.5 (33.3)	2.8 (15.5)	2.8 (15.9)	90.5
T_7	T_2 +1 HW (45 DAT)	4 (54.7)	3.6 (34.7)	2.5 (10.8)	3 (20.3)	87.8
T_8	Pretilachlor 750 g ha^{-1} (3 DAT)+ no irrigation upto one week	4.4 (80)	4.7 (108)	3.0 (18.4)	4.2 (66.6)	59.9
T_9	T_8 + Bispy-ribac-Na 20 g ha^{-1} (14 DAT)	0.5 (1.3)	2.1 (8)	0.2 (0.3)	0.8 (2.2)	98.7
T_{10}	One cono-weeding (15 DAT) + 1 HW (45 DAT)	4.7 (104)	4.9 (140)	3.0 (19.7)	4.5 (88.2)	46.9
T_{11}	HW twice (20 and 40 DAT)	3.5 (33.3)	3.4 (29.3)	1.9 (5.4)	2.7 (13.4)	92
T_{12}	Weedy check	5.8 (316)	5.5 (256)	4.2 (67.7)	5.1 (166.2)	-
	SEm±	0.16	0.09	0.07	0.17	-
	LSD (*p*=0.05)	0.47	0.27	0.22	0.51	-

results are in conformity with the findings of Halder and Patra (2007).

Values in parentheses are original and transformed to log (x+1) for analysis. Among different treatments, Pretilachlor 750 g ha^{-1} with no irrigation upto one week+Bispyribac-Na 20 g ha^{-1} (T_9) recorded significantly higher grain and straw yield over pre-emergence application of Pretilachlor 750 g ha^{-1} alone (T_5), Pretilachlor 750 g ha^{-1} with no irrigation up to one week (T_8) and one conoweeding at 15 DAT+1 HW at 45 DAT (T_{10}) but remained at par with rest of the treatments.

Table 2: Effect of different weed control treatments on yield and yield attributing characters of rice crop

	Treatment	No. of panicles m^{-2}	No. of grains $panicle^{-1}$	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1	Penoxsulam 20 g ha^{-1}, 20 DAT	171	163.1	4896	7239
T_2	Penoxsulam 22.5 g ha^{-1}, 20 DAT	174	177.0	5156	7448
T_3	Penoxsulam 25 g ha^{-1}, 20 DAT	175	180.9	5260	7500
T_4	Bispyribac-Na 20 g ha^{-1}, 14 DAT	188	182.1	5625	7864
T_5	Pretilachlor 750 g ha^{-1}, 3 DAT	172	172.1	4843	6823
T_6	T_5+1 HW (45 DAT)	167	179.7	5390	7506
T_7	T_2+1 HW (45 DAT)	181	181.5	5364	7558
T_8	Pretilachlor 750 g ha^{-1} (3 DAT) + no irrigation upto one week	167	166.5	4635	6499
T_9	T_8+Bispyribac-Na 20 g ha^{-1} (14 DAT)	196	182.2	5729	8385
T_{10}	One conoweed-ing (15 DAT) + 1 HW (45 DAT)	165	152.5	4479	6741
T_{11}	HW twice (20 and 40 DAT)	185	180.5	5625	7760
T_{12}	Weedy check	117	134.2	2291	3958
	SEm±	7.7	6.4	239	415
	LSD (*p*=0.05)	22.6	18.8	701	1216

Application of Pretilachlor 750 g ha^{-1} with no irrigation up to one week (T_8) and one conoweeding at 15 DAT+1 HW at 45 DAT (T_{10}) recorded lower grain and straw yield, respectively (Table 2). The higher grain yield with Pretilachlor 750 g ha^{-1} with no irrigation upto one week+Bispyribac-Na 20 g ha^{-1} (T_9) might be attributed to season long effective control of all type of weeds due to sequential application of pre-emergence followed by post-emergence herbicide which resulted in more number of panicles m^{-2} and grains $panicle^{-1}$. Similar results was also reported by Uma et al. (2014). The higher straw yield might be attributed to more plant height and dry matter accumulation due to reduced crop-weed competition. The higher number of panicles m^{-2} and grains $panicle^{-1}$ were recorded with Pretilachlor 750 g ha^{-1} with no irrigation upto one week+Bispyribac-Na 20 g ha^{-1} (T_9) followed by post-emergence application of Bispyribac-Na 20 g ha^{-1}(T_4). Among the different doses of Penoxsulam, Penoxsulam 25 g ha^{-1} (T_3) applied as post-emergence recorded the higher grain yield followed by Penoxsulam 22.5 g ha^{-1} (T_2) owing to enhanced number of panicles m^{-2} and grains $panicle^{-1}$. These findings are in line with the results of several workers (Khare et al., 2014; Yadav et al., 2008; Mishra et al., 2007). Post-emergence application of Penoxsulam alone@ 22.5 and 25 g ha^{-1} was found statistically at par with post-emergence application of Bispyribac-Na (T_4). Integration of one hand weeding with Pretilachlor (T_6) or Penoxsulam (T_7) did not improve the grain yield significantly over their sole application.

4. Conclusion

The study suggested that for effective management of weeds in transplanted rice, pre-emergence application of Pretilachlor 750 g ha^{-1}+no irrigation upto one week with post-emergence application of Bispyribac-Na (T_9) can be advocated as it was found superior over rest of the treatments. However, post-emergence application of Bispyribac-Na alone (T_4) was also found effective in broad spectrum control of complex weed flora and resulted in higher grain yield.

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