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Performance of Pre- and Post-emergence Herbicides on Weed Flora and Yield of Transplanted Rice (*Oryza sativa*)

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The productivity of rice (*Oryza sativa* L.) in India is declining due to an array of biotic and abiotic factors. Weed competition is one of the important biotic constraints in rice production. Weeds can cause a reduction of 28-45% of grain yield in transplanted rice (Singh *et al.,* 2003). The use of herbicides offers scope for economical control of weeds right from the beginning, giving rice crop an advantage of good start and competitive superiority. Pre-emergence herbicides such as butachlor, pretilachlor and anilofos are being frequently used for the effective management of weeds in transplanted rice. Continuous application of these voluminous herbicides year after year may lead to shift in weed flora from grassy to non-grassy weeds and sedges and development of herbicide resistance in weeds (Rajkhowa *et al.,* 2006). Recent trend of herbicide use is to find out an alternative and effective weed control measure by using low dose high efficiency herbicides, which will not only reduce the total volume of herbicide per unit area, but also make the application easier and economical to the farmer. Of late, some of the promising low dose high efficacy pre- and post-emergence herbicides are available for control of wide spectrum of weed flora in lowland rice (Moorthy, 2002). The sequential application of pre- and post-emergence herbicides, especially with those of low dose high efficiency herbicides in relation to weed dynamics has not been investigated adequately in transplanted rice. In cognizance of the above, the present study was undertaken to test the relative efficacy of pre- and post-emergence herbicides on weed flora in transplanted rice.

A field experiment was conducted during **rabi** 2009 at wetland farm of S. V. Agricultural College, Acharya N. G. Ranga Agricultural University, Tirupati, Andhra Pradesh in transplanted rice. The soil was sandy clay loam in texture having low organic carbon (0.23%) and available nitrogen (178 kg/ha), medium in available phosphorus (25 kg/ha) and potassium (183 kg/ha), slightly alkaline in reaction (pH 7.8) and EC of 0.22 dS/m. The experiment was laid out in a randomized block design with 12 treatments and replicated thrice. The experiment consisted of pre-emergence application of pretilachlor 1 kg/ha, oxadiargyl 75 g/ha, pyrazosulfuron 35 g/ha alone and sequential application of pre- and post-emergence herbicides viz., pretilachlor 1 kg/ha+penoxsulam 25 g/ha, oxadiargyl 75 g/ha+penoxuslam 25 g/ha, pyrazosulfuron 35 g/ha+penoxsulam 25 g/ha, pretilachlor 1 kg/ha+bispyribac 30 g/ha, oxadiargyl 75 g/ha+bispyribac 30 g/ha, pyrazosulfuron 35 g/ha+bispyribac 30 g/ha along with post-emergence application of cyhalofop-p-butyl 125 g/ha, two hand weedings at 20 and 40 DAT and unweeded check. The required quantities of pre- and post-emergence herbicides were applied uniformly at 4 and 20 DAT, respectively, by knap sack sprayer fitted with flat fan nozzle using 600 l/ha of water as per the treatments. Twenty-eight days old seedlings of rice cultivar NLR-34449 were transplanted on 18 December, 2009 and harvested on 8 April, 2010. The crop was raised according to package of practices of Acharya N. G. Ranga Agricultural University. Density of weeds viz., grasses, sedges and broad-leaved weeds was recorded species-wise in a 0.25 m^2 quadrat at harvest. Dry weight of these weeds was recorded from 0.25 m^2 area by destructive sampling. Weed control efficiency (WCE) was calculated based on weed dry weight. The data on weed density and dry weight for all the categories were computed using square root ($\sqrt{x+0.5}$) transformation.

Effect on Weeds

The major weed species found in the experimental plots were *Echinochloa colonum* (L.) Link., *Digitaria sanguinalis* (L.) Scop., *Cyperus rotundus* L., *Cyperus difformis* L., *Cyperus iria* L., *Eclipta alba* (L.) Hassk. and *Ammania baccifera* L. All the herbicide treatments reduced the population and biomass of weeds substantially over unweeded check. The lowest density and dry weight of grasses and broad-leaved weeds was recorded with oxadiargyl 75 g/ha fb bispyribac 30 g/ha, which was comparable with oxadiargyl 75 g/ha fb penoxsulam 25 g/ha and HW

twice. However, the lowest density and dry weight of sedges were registered with HW twice followed by pyrazosulfuron 35 g/ha fb bispyribac 30 g/ha (Table 1). This might be due to effective management of all categories of weeds during early stages of crop growth by pre-emergence herbicide oxadiargyl 75 g/ha and at late stages by post-emergence herbicide bispyribac 30 g/ha. The findings of the present study are in accordance with those of Yadav *et al.* (2009). Hand weeding twice completely removed all the categories of weeds including sedges. Pyrazosulfuron 35 g/ha was very effective in reducing the density and dry weight of sedges than rest of the pre-emergence herbicides tried (Halder, 2000).

Table 1. Effect of sequential application of pre- and post-emergence herbicides on density and dry weight of weeds in transplanted rice

Treatments	Weed density (No./m^2)			Weed dry weight (g/m^2)		
	Grasses	Sedges	BLW	Grasses	Sedges	BLW
T_1 : Pretilachlor 1 kg/ha	16.33	98.00	7.00	28.32	45.67	4.21
	(4.10)	(9.92)	(2.73)	(5.37)	(6.79)	(2.17)
T_2 : Oxadiargyl 75 g/ha	10.66	85.66	10.66	22.68	31.27	6.95
	(3.34)	(9.28)	(3.34)	(4.81)	(5.64)	(2.73)
T_3 : Pyrazosulfuron-ethyl 35 g/ha	18.00	50.33	12.33	36.66	27.64	8.00
	(4.30)	(7.13)	(3.58)	(6.10)	(5.21)	(2.91)
T_4 : Pretilachlor 1 kg/ha fb penoxsulam 25 g/ha	5.33	48.33	6.00	12.54	20.74	3.92
	(2.41)	(6.99)	(2.54)	(3.61)	(4.61)	(2.10)
T_5 : Oxadiargyl 75 g/ha fb penoxsulam 25 g/ha	2.33	30.66	5.00	6.04	14.69	2.69
	(1.68)	(5.58)	(2.34)	(2.56)	(3.90)	(1.78)
T_6 : Pyrazosulfuron-ethyl 35 g/ha fb penoxsulam 25 g/ha	15.33	20.66	12.00	32.48	10.98	7.82
	(3.97)	(4.60)	(3.53)	(5.74)	(3.39)	(2.88)
T_7 : Pretilachlor 1 kg/ha fb bispyribac-sodium 30 g/ha	1.33	32.66	5.66	8.67	14.98	3.84
	(1.34)	(5.76)	(2.48)	(3.03)	(3.93)	(2.08)
T_8 : Oxadiargyl 75 g/ha fb bispyribac-sodium 30 g/ha	0.66	26.00	5.00	4.52	12.60	3.01
	(1.05)	(5.15)	(2.34)	(2.24)	(3.62)	(1.87)
T_9 : Pyrazosulfuron-ethyl 35 g/ha fb bispyribac-sodium 30 g/ha	7.00	18.33	11.66	11.78	8.52	5.12
	(2.72)	(4.34)	(3.48)	(3.50)	(3.00)	(2.37)
T_{10} : Cyhalofop-butyl 125 g/ha	6.33	105.00	38.66	12.52	46.84	25.12
	(2.61)	(10.27)	(6.26)	(3.61)	(6.88)	(5.06)
T_{11} : HW twice at 20 and 40 DAT	7.00	15.66	4.33	8.00	7.97	2.78
	(2.73)	(4.02)	(2.20)	(2.92)	(2.91)	(1.81)
T_{12} : Unweeded check (Control)	36.66	121.00	72.00	69.90	54.63	47.02
	(6.01)	(11.02)	(8.51)	(8.39)	(7.42)	(6.89)
LSD (P=0.05)	0.71	0.17	0.31	0.38	0.16	0.18

fb : followed by. Figures in parentheses indicate square root transformed ($\sqrt{x+0.5}$) values.

Effect on Yield Attributes and Yield of Crop

The highest number of filled grains/panicle, higher 1000-grain weight and grain yield of rice were recorded with HW twice at 20 and 40 DAT, which were at par with oxadiargyl 75 g/ha fb bispyribac 30 g/ha. This might be due to increased production and translocation of photosynthates to grains, owing to adequate availability of growth resources, as a result of less competition offered by weeds (Table 2). Timely and effective control of weeds with integrated use of pre- and post-emergence herbicides resulted in increased yield components, which ultimately reflected on grain yield. These results are in conformity with those of Walia *et al.* (2008) and Yadav *et al.* (2009). The reduction in grain yield due to unchecked weed growth was 27.8 and 26.0% compared to HW twice and oxadiargyl 75 g/ha fb bispyribac 30 g/ha, respectively. Among the different sequential applications of herbicides tried, the highest grain yield was recorded with oxadiargyl 75 g/ha fb bispyribac 30 g/ha, which was comparable with oxadiargyl 75 g/ha fb penoxsulam 25 g/ha. The lowest grain yield was obtained with pyrazosulfuron 35 g/ha fb bispyribasc 30 g/ha. The highest benefit : cost ratio was

Table 2. Effect of sequential application of pre-and post-emergence herbicides on density and dry weight of weeds in transplanted rice

Treatments	No. of filled grains/ panicle	1000-grain weight (g)	Grain yield (kg/ha)	Straw yield (kg/ha)	Benefit : cost ratio
T_1 : Pretilachlor 1 kg/ha	103.6	13.87	5325	6650	2.64
T_2 : Oxadiargyl 75 g/ha	109.0	14.08	5553	6801	2.81
T_3 : Pyrazosulfuron-ethyl 35 g/ha	105.3	14.22	5495	6768	2.74
T_4 : Pretilachlor 1 kg/ha fb penoxsulam 25 g/ha	114.0	14.33	5822	6928	2.63
T_5 : Oxadiargyl 75 g/ha fb penoxsulam 25 g/ha	116.6	14.82	6548	7324	3.00
T_6 : Pyrazosulfuron-ethyl 35 g/ha fb penoxsulam 25 g/ha	112.3	14.47	5698	6858	2.59
T_7 : Pretilachlor 1 kg/ha fb bispyribac-sodium 30 g/ha	115.6	14.70	6264	7064	2.71
T_8 : Oxadiargyl 75 g/ha fb bispyribac-sodium 30 g/ha	118.6	14.96	6758	7442	3.06
T_9 : Pyrazosulfuron-ethyl 35 g/ha fb bispyribac-sodium 30 g/ha	115.0	14.62	5947	6837	2.67
T_{10} : Cyhalofop-butyl 125 g/ha	101.3	13.70	5126	6563	2.41
T_{11} : Two HW at 20 and 40 DAT	120.6	15.05	6812	7550	3.04
T_{12} : Unweeded check (Control)	99.6	13.42	4552	6362	2.39
LSD (P = 0.05)	4.22	NS	399	506	0.24

NS : Not Significant.

obtained with oxadiargyl 75 g/ha fb bispyribac 30 g/ha, which was at par with HW twice and oxadiargyl 75 g/ha fb penoxsulam 25 g/ha, due to reduced cost of weeding and increased grain and straw yields in sequential application of herbicides.

Performance of pre- and post-emergence herbicides on weed control and yield of transplanted rice was evaluated at S. V. Agricultural College, Tirupati. Pre-emergence application of oxadiargyl 75 g/ha fb bispyribac-sodium 30 g/ha was applied at 20 DAT being at par with HW twice at 20 and 40 DAT in achieving higher grain yield. Unchecked weed growth in transplanted rice reduced the grain yield by 27.8 and 26.0% compared to HW twice and oxadiargyl 75 g/ha fb bispyribac-sodium 30 g/ha, respectively. Pyrazosulfuron-ethyl 35 g/ha was very effective in reducing the density and dry weight of sedges than rest of the pre-emergence herbicides tried.

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