Short communication

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Bio-efficacy of sequential application of herbicides on weed control, growth and yield of wet-seeded rice

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Due to shortage of labour and increased wages, transplanting is becoming difficult and farmers are resorting to wet-seeded rice in Krishna, Godavari zones of Andhra Pradesh, as it saves labour, time and energy, early crop maturity, ensures efficient water use and increased benefit cost ratio (Ravi Shankar *et al*. 2008). However, in wet-seeded rice, weeds are the major limiting factor in obtaining higher yields and uncontrolled weed growth may cause yield reduction to the extent of 64% (Rao *et al.* 2007). Use of pre-emergence herbicides such as butachlor, pretilachlor has been found effective in early stages but the second flush of weeds at later stages has become problematic. In such situations, sequential application of herbicides is the only alternative, in order to achieve broad spectrum and season long control during the critical period of the crop. The present experiment was under taken to evaluate the performance of various new herbicides alone and in sequential applications.

A field experiment was conducted during *Kharif* 2010-11 at Agricultural College Farm, Bapatla, Andhra Pradesh. The soil of the experimental plot was sandy clay loam in texture with low in available nitrogen, phosphorus and high in available potassium with a soil pH of 8.1. The experiment consisting of ten treatment was laid out in a randomized block design with three replications. The rice variety *'Jagitial Mashuri'* was sown in solid rows in the furrows opened by line marker at 25 cm interval. The pre emergence herbicides were applied uniformly at 3 days after sowing (DAS) by mixing the herbicide with dry sand at 50 kg/ha and broadcasted uniformly under thin film of water. Whereas, post-emergence herbicides were sprayed at 20 DAS with knapsack sprayer using a spray volume of 500 L/ha. All the recommended package of practices except weed control were adopted to raise the crop. The data on weed density and dry weight were subjected to square root transformation before statistical analysis to normalize their distribution.

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The experimental plot was largely infested with *Echinochloa colona, Cynodon dactylon, Paspalum conjugatum, Leptochloa chinensis* (grasses), *Cyperus rotundus, Scirpus articulatus* (sedges), *Eclipta alba, Ludwigia parviflora, Ammania baccifera, Bergia capensis* and *Euphorbia hirta* (broad-leafved weeds). All the weed control treatments significantly reduced the density and dry weight of weeds compared to unweeded check at 60 DAS (Table 1). Among the treatments, the lowest density, weeds dry weight and higher weed control efficiency of 86% was observed in the sequential treatment, with pre-emergence application of oxadiargyl 100 g/ha *fb* post-emergence application of penoxsulam 25 g/ha and was at par with other sequential treatments and hand weeding at 20 and 40 DAS but significantly superior to herbicides applied as one time. The lower weed growth in this treatment was mainly due to effective control of weeds in the early stage by pre-emergence herbicide and at later stages by post-emergence herbicides. Maximum weed growth was observed in unweeded check. In general, sequential treatments were found to be superior to alone application of herbicides.

All the herbicides under study were found to be selective to rice crop without any injury. All the weed management practices exhibited profound influence on growth (plant height, number of tillers and crop dry weight) and yield parameters (number of panicles per square metre, filled grains per panicle, except hundred seed weight), grain and straw yield (Table 1 and 2). Among the herbicide treatments, significantly the highest grain yield (5.19 t/ha) was observed in sequential application of oxadiargyl 100 g/ha *fb* penoxsulam 25 g/ha over single application of herbicides and was at par with sequential treatment and also with hand weeding. The increased yield in these treatments might be due to cumulative effect of lower weed density, dry weight, higher weed control efficiency and increased number of panicle bearing tillers per unit area, filled grains per panicle. The lowest grain yield (1.89 t/ha) was observed in weedy

Table 1. Effect of different treatments on weed and crop growth parameters

Treatment	Dose (g/ha)	Time of application (DAS)	Weed density (no./m^2) at 60 DAS	Weed dry weight (g/m^2) at 60 DAS	WCE at 60 DAS (%)	Plant height at 60 DAS (cm)	No. of tillers/m^2 at 60 DAS	Crop dry weight at 60 DAS (t/ha)
Oxadiargyl	-	3	6.4 (40.5)	10.9 (118.3)	61	65	386	1.43
Pyrazosulfuron-ethyl	20	3	7.1 (49.9)	11.8 (138.7)	55	64	372	1.35
Penoxsulam	25	20	6.8 (45.7)	11.3 (127.2)	58	64	379	1.41
Azimsulfuron	35	20	7.5 (55.8)	12.1 (145.9)	52	63	358	1.28
Oxadiargyl *fb* penoxsulam	100 *fb* 25	3 *fb* 20	4.2 (17.1)	6.6 (43.1)	86	71	479	1.86
Oxadiargyl *fb* azimsulfuron	120 *fb* 35	3 *fb* 20	4.5 (19.8)	6.8 (45.7)	85	69	451	1.80
Pyrazosulfuron-ethyl *fb* penoxsulam	20 *fb* 25	3 *fb* 20	4.8 (22.5)	7.4 (54.3)	82	68	434	1.75
Pyrazosulfuron-ethyl *fb* azimsulfuron	20 *fb* 355	3 *fb* 20	5.0 (24.8)	7.6 (57.3)	81	68	426	1.70
Weedy check	-	-	10.6 (111.9)	17.5 (305.8)	-	56	248	0.96
Hand weeding	-	20 & 40	4.2 (17.1)	6.0 (35.5)	88	74	545	1.89
LSD (P=0.05)			1.1	2.2	16	12	59	0.24

The data shown on weed density and dry matter follows square root ($\sqrt{x+0.5}$) transformation. The figures in parentheses are original values.

Table 2. Effect of different treatments on yield attributes, yield and economics of wet seeded rice

Treatment	Dose (g/ha)	Time of application (DAS)	No. of panicles/ m^2	No. of filled grain/ panicle	100 seed weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Net return (x10^3 `/ha)	Benefit cost ratio (`/ha)
Oxadiargyl	-	3	372	95	14.0	3.86	4.92	45.49	2.9
Pyrazosulfuron-ethyl	20	3	361	94	13.9	3.56	4.60	42.06	2.7
Penoxsulam	25	20	366	92	13.8	3.63	4.69	42.84	2.7
Azimsulfuron	35	20	339	92	13.8	3.39	4.41	40.11	2.5
Oxadiargyl *fb* penoxsulam	100 *fb* 25	3 *fb* 20	441	109	14.5	5.18	5.72	60.21	3.6
Oxadiargyl *fb* azimsulfuron	120 *fb* 35	3 *fb* 20	435	104	14.4	5.04	5.71	58.69	3.4
Pyrazosulfuron-ethyl *fb* penoxsulam	20 *fb* 25	3 *fb* 20	419	103	14.2	4.97	5.67	57.91	3.5
Pyrazosulfuron-ethyl *fb* azimsulfuron	20 *fb* 355	3 *fb* 20	423	102	14.2	4.91	5.50	57.91	3.4
Weedy check	-	-	339	78	13.4	1.89	3.92	23.73	1.6
Hand weeding	-	20 & 40	521	114	14.5	5.23	5.80	60.75	2.4
LSD (P = 0.05)			56	13	NS	0.86	0.87	-	-

Note: Sale price of: paddy ` 10.5 /kg, Straw: ` 1/kg,

check with an yield loss of 64% as compared to hand weeding because of severe weed competition, which effected crop growth and ultimately yield. The results are similar to those reported by Kumar and Kumar (2003). Regarding economics, the same treatment recorded higher net returns (` 60, 213/ha) and benefit cost ratio of 3.6. The next best treatment was pyrazosulfuron-ethyl 20 g/ha *fb* penoxsulam 25 g/ha. Thus, it can be summarized that in wet-seeded rice, pre-emergence application of oxadiargyl g/ha *fb* penoxsulam 25 g/ha was found to be effective and economical.

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