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Sequential application of herbicides for weed management in rainfed lowland rice

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ABSTRACT

A field experiment was conducted during rainy season of *(Kharif)* 2018 at Tirupati, Andhra Pradesh to find out the effect of sequential application of pre- and post-emergence herbicides on weed growth and yield of rainfed lowland rice. The present study has revealed that pre-emergence application of pendimethalin 1000 g/ha *fb* florpyrauxifen-benzyl 25 g/ha or halosulfuron-methyl 65.7 g/ha applied at 20 DAS resulted in the highest grain yield and economic returns as well as broad-spectrum weed control in rainfed lowland rice.

Rice (*Oryza sativa* L.) is an important food crop of India contributing 45% of the total food grain production. Transplanting in puddled soils with continuous land submergence is the most common method of rice crop establishment. Puddling causes clogging of macropores, breakage of soil aggregates and formation of subsurface shallow hardpans along with effective weed control due to standing water in the field. But, this technique is very laborious, cumbersome, expensive and time consuming. In this context, to overcome the problems associated with traditional rice cultivation, direct seeding of rice seems to be the viable alternative. Weeds are the major yield-limiting constraint in direct-seeded rice due to simultaneous germination of weeds and crop. The risk of yield loss from weeds in direct-seeded rice is greater than transplanted rice. Singh *et al.* (2005) reported that uncontrolled weed growth in direct-seeded rice, wet-seeded rice and transplanted rice reduced the grain yield by 75.8, 70.6 and 62.6%, respectively. Pre-emergence application of pendimethalin is recommended to control weeds in direct-seeded rice, but it does not control *Cyperus rotundus* and some of the broad-leaved weeds. Heavy weed infestation in direct-seeded rice from sowing to harvesting of rice crop leads to severe competition offered by weeds and sometimes complete crop failure. Hence, there is a need to evaluate sequential application of pre- and post-emergence herbicides for broad-spectrum weed control in direct-seeded rice with special reference to perennial sedge, *Cyperus rotundus*. Hence, the present investigation was carried out to evaluate the relative efficacy of some of the newly developed post-emergence herbicides for control of weeds in direct-seeded rice.

The field experiment was conducted duringrainy season of *(Kharif)* 2018 at wetland farm of S.V. Agricultural College, Acharya N. G. Ranga Agricultural University, Tirupati, Andhra Pradesh in rainfed lowland rice. The soil was sandy clay loam in texture having low organic carbon, slightly alkaline in reaction with low available nitrogen and medium in available phosphorus and potassium. The rice variety '*MTU-1010*'is a semi dwarf variety suitable for both aerobic and lowland conditions and matures within 120 days. It was sown at a spacing of 20 x 10 cm on 13August, 2018 with seed rate of 35 kg/ha by giving pre-sowing irrigation and it was grown under aerobic condition upto 40 DAS and then converted to lowland submergence for better growth and development. The crop was harvested on 14 November, 2018.The experiment was laidout in a randomized block design with twelve treatments and replicated thrice. The weed management practices consisted of sequential application of pre-emergence (PE) herbicides oxadiagryl, pendimethalin and pretilachlor 100, 1000 and 750 g/ha, each followed by post-emergence (PoE) application of penoxsulam + cyhalofop-p-butyl, florpyrauxifen-benzyl and halosulfuron-methyl each 130, 25, 67.5 g/ha; pre-emergence application of pendimethalin 1000 g/ha *fb* bispyribac-sodium 25 g/ha, two hand weeding at 20 and 40 DAS and

unweeded check (**Table 1**). Uniform dose of 120 kg N, 60 kg P_2O_5 and 60 kg K_2O/ha was applied in the form of urea, single super phosphate and muriate of potash, respectively. Iron sulphate and zinc sulphate were applied at 50 and 25 kg/ha, respectively to overcome the deficiencies of iron and zinc in direct seeded rice as basal. Nitrogen was applied in three splits. One third dose of nitrogen along with entire dose of phosphorous and potassium was applied as basal. The remaining quantity of nitrogen was applied in two equal splits as top dressing at active tillering and at panicle initiation stage. The rest of the packages of practices were adopted as per recommendations of the Acharya N.G. Ranga Agricultural University. The required quantities of pre-and post-emergence herbicides were applied uniformly at one and 20 DAS, respectively, by using spray fluid at 500 L/ha with the help of battery operated knapsack sprayer fitted with flat fan nozzle. Weed density and dry weight were recorded randomly with the help of 0.25 m^2 quadrate. The data on weed density and dry weight were transformed to square root ($\sqrt{x+0.5}$) transformation to normalize their distribution. The yield attributing characters, *viz.* panicles/m^2, panicle length, total grains/panicle, filled grains/panicle, test weight, grain and straw yields were recorded at harvest.

The major weeds found in the experimental plots were *Cyperus rotundus* (55%), *Digitaria sanguinalis* (12%), *Commelina benghalensis* (7%), *Boerhavia erecta*. (5%), *Trichodesma indicum* (5%), *Dactyloctenium aegyptium* (3%), *Digera arvensis* (3%), *Cleome viscosa* (2%) and others (8%) in unweeded check plot. All the weed management practices significantly influenced the weed growth and yield of rainfed lowland rice (**Table 1**). The lowest density and dry weight of total weeds was recorded with pre-emergence application of pendimethalin 1000 g/ha *fb* florpyrauxifen-benzyl 25 g/ha, which was comparable with PRE application of pendimethalin 1000 g/ha *fb* halosulfuron-methyl 67.5 g/ha. The reduced density and dry weight of weeds in these weed management practices might be due to broad-spectrum and season long weed control because of sequential application of pre-and post-emergence herbicides.

Pre-emergence application of pendimethalin 1000 g/ha effectively controlled the weeds at early stages of crop growth and post-emergence application of florpyrauxifen-benzyl 25 g/ha effectively controlled the late coming weeds, including perennial sedge, *Cyperus rotundus* by disrupting the plant growth regulation process similar to synthetic auxin group of herbicides. The findings of the present study were in accordance with those of Epp *et al.* (2016) in rice and Gosh *et al.* (2017) in sugarcane. All the post-emergence herbicides did not showed any phytotoxicity to rice crop. Among the sequential application of herbicides tried, PE application of oxadiagryl 100 g/ha *fb* penoxsulam + cyhalofop-p-butyl 130 g/ha resulted in higher density and dry weight of total weeds, which was comparable with pre-emergence application of pretilachlor 750 g/ha *fb* penoxsulam + cyhalofop-p-butyl 130 g/ha. Post-emergence application of penoxsulam + cyhalofop-p-butyl 130 g/ha failed to control predominant weed *i.e*. *Cyperus rotundus* associated with direct-seeded rice compared to rest of the PoE herbicides. The highest density and dry weight of total weeds was observed with unweeded

Table 1. Effect of sequential application of pre- and post-emergence herbicides on weed growth, yield and economics of rainfed lowland rice

Treatment	Dose g/ha	Time of application (DAS)	Weed density (no/m^2)	Weed dry weight (g/m^2)	Panicles / m^2	Filled grains/ panicle	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Net returns (x10^3 `/ha)	B:C ratio
Oxadiargyl *fb* penoxsulam + cyhalofop-p-butyl	100+130	1 and 20	10.2(103)	18.0(324)	104	60.67	17.30	1.75	2.68	3.17	1.11
Pendimethalin *fb* penoxsulam + cyhalofop-p-butyl	1000+130	1 and 20	9.3(87)	16.4(269)	113	65.67	17.70	1.93	2.82	5.92	1.20
Pretilachlor *fb* penoxsulam + cyhalofop-p-butyl	750+130	1 and 20	9.9(97)	16.9(284)	113	65.67	17.70	1.84	2.72	4.93	1.17
Oxadiargyl *fb* florpyrauxifen-benzyl	100+25	1 and 20	5.4(29)	10.9(119)	166	73.33	19.43	2.36	3.36	15.88	1.57
Pendimethalin *fb* florpyrauxifen-benzyl	1000+25	1 and 20	4.7(21)	9.8(94)	201	82.33	21.20	3.52	4.64	36.47	2.30
Pretilachlor *fb* florpyrauxifen-benzyl	750+25	1 and 20	5.3(28)	10.8(116)	152	72.67	19.00	2.10	3.01	11.21	1.41
Oxadiargyl *fb* halosulfuron-methyl	100+67.5	1 and 20	5.2(26)	10.5(109)	181	75.00	19.70	2.67	3.69	17.35	1.55
Pendimethalin *fb* halosulfuron-methyl	1000+67.5	1 and 20	4.6(21)	10.0(99)	197	82.00	21.17	3.43	4.56	30.76	1.96
Pretilachlor *fb* halosulfuron-methyl	750+67.5	1 and 20	5.2(27)	10.6(112)	196	81.33	20.63	3.28	4.43	28.66	1.91
Pendimethalin *fb* bispyribac-sodium	1000+25	1 and 20	8.0(64)	12.9(167)	149	71.33	18.07	2.05	2.98	9.26	1.32
Two hand weedings	-	20 and 40	7.5(56)	162.7(13)	184	76.67	20.00	2.82	3.88	20.89	1.67
Unweeded control	-	-	12.3(150)	22.0(484)	78	53.00	16.80	0.92	1.58	-8.37	0.67
LSD (p=0.05)	-	-	0.49	1.04	12.3	5.21	1.29	0.29	0.34	4.96	0.15

Figures in parentheses are original values; *fb:* followed by

check, which was significantly higher than rest of the weed management practices due to favorable conditions available for establishment of all the categories of weeds.

Different weed management practices imposed in rainfed lowland rice exerted significant influence on panicles/m^2, number of filled grains/panicle and 1000-grain weight. The highest stature of all the yield parameters were recorded with PE application of pendimethalin 1000 g/ha *fb* florpyrauxifen-benzyl 25 g/ha applied at 20 DAS, which were comparable with PE application of pendimethalin 1000 g/ha *fb* halosulfuron-methyl 67.5 g/ha. The increase in growth and yield attributes might be attributed due to reduction in competition offered by weeds on crop plants for growth resources. The highest grain (3.52 t/ha) and straw yield (4.64 t/ha) of rice was obtained with pre-emergence application of pendimethalin 1000 g/ha *fb* florpyrauxifen-benzyl 25 g/ha, which was comparable with pre-emergence application of pendimethalin 1000 g/ha *fb* halosulfuron-methyl 67.5 g/ha and both the weed management practices were significantly higher than rest of the weed management practices due to increased stature of yield components, *viz.* number of productive tillers/ m^2, number of filled grains/panicle and test weight as result of maintenance of weed free environment. The combined effect of all the yield components in these weed management practices resulted in enhanced grain and straw yield of rainfed lowland rice. The findings of the present study are in accordance with those of Pattar *et al*. (2005) in direct-seeded rice. Among the sequential application of pre-and post-emergence herbicides, the lowest values of the above said yield components and yield were recorded with pre-emergence application of oxadiagryl 100 g/ha *fb* penoxsulam + cyhalofop-p-butyl 130/ha. Decrease in grain and straw yield of rainfed lowland rice in unweeded check plots was 73.8 and 66.1% respectively, compared to best weed management practice of pre-emergence application of pendimethalin 1000 g/ha *fb* florpyrauxifen-benzyl 25 g/ha. Singh *et al*. (2005) also reported that uncontrolled weed growth in direct-seeded rice resulted in reduction in grain yield by 75.8%. The highest net returns (` 36468/ha) and benefit-cost ratio (2.30) were obtained with pre-emergence application of pendimethalin 1000 g/ha *fb* florpyrauxifen-benzyl 25 g/ha, due to increased yield and reduced cost of weed management practice.

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