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Weed management effect on growth and yield of wet direct-seeded rice in Cauvery command area of Karnataka

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ABSTRACT

Field experiment was conducted during rainy seasons of 2014 and 2015 to study the effect on weed management practices in wet direct-seeded rice (*Oryza sativa* L.) in Cauvery command area of Karnataka under irrigated condition with eight treatments replicated thrice. Pre-emergence application of bensulfuron-methyl + pretilachlor GR (Londax Power) at 660 g/ha *fb* bispyribac-sodium (Nominee Gold) at 25 g/ha at 20 days after sowing (DAS) significantly reduced weed growth and recorded the higher seed yield (4.80 t/ha), net monetary returns (` 25631/ha) and B:C ratio (1.62) and it was at par with other sequential treatments, *viz*. pre-emergence application of pendimethalin at 1.0 kg/ha (Stomp) *fb* post-emergence application of bispyribac-sodium, pre-emergence application of bensulfuron-methyl + pretilachlor, application of pendimethalin as pre-emergence *fb* 1 HW. Uncontrolled weed growth caused 55.2% reduction in seed yield of wet seeded rice.

Key words: Direct-seeded rice, Economics, Pre- and post-emergence herbicides, Sequential application

Rice is the world's most important crop and is a staple food for more than half of the world's population. About 90% of the world's rice is grown and produced in Asia. India is the second largest rice producing country in the world with an area of 43.4 Mha and produced 104.3 Mt of rice with a productivity of 2404 kg/ha (Anonoymus 2016). In many parts of the country traditional transplanting of rice seedlings in the puddled field is a major practice. However, in recent years, traditional transplanted rice is being replaced by the direct seeding of rice because of its lower labour, seeds and water requirement with 10-12 days early maturity. Though direct-seeded rice (DSR) yields comparable with transplanted crop, increased weed infestation is major drawback of this system.

Success of DSR is mainly depends on effective weed control with all the possible means. The yield loss in DSR is as high as 50-60% due to simultaneous germination of both crop and weeds seeds (Pinjari *et al*. 2016). Though the hand weeding has been found effective, but it is very expensive. Moreover, heavy demand of labour during peak period and its scarcity necessitates the use of alternate weed control measures. Chemical weed control by using pre-emergence herbicides being cost effective and less labour dependent is recommended to overcome this constraint under DSR. Broad spectrum of weed flora may not be controlled by spraying pre-emergence herbicides alone, as flushes of weeds come up at different growth stages. Hence, use of sequential application of pre- *fb* post-emergence herbicides or pre-emergence herbicides *fb* manual weeding could be more convenient in containing the weed menace. By keeping above information in view, the present investigation was carried out to study the effect of weed management practices on wet direct seeded rice in Cauvery command area of Karnataka.

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MATERIALS AND METHODS

The experiment was conducted during rainy seasons of 2014 and 2015, at Zonal Agricultural Research Station, V.C. Farm, Mandya. The soil of experimental site was red sandy loams with bulk density and particle density of 1.15 g/cc and 2.65 g/cc, respectively. The soil pH was 6.5 (neutral in reaction). It was low in available nitrogen and phosphorus and high in potassium. Eight treatments, *viz.* bensulfuron-methyl + pretilachlor 660 g/ha (pre-emergence; PE) + one HW, pendimethalin 1.0 kg/ha (PE) + one HW, bensulfuron-methyl + pretilachlor 660 g/ha (PE) *fb* bispyribac-sodium 25 g/ha (post-emergence; PoE), pendimethalin 1.0 kg/ha (PE) *fb* bispyribac-sodium 25 g/ha (PoE) and bispyribac-sodium 25 g/ha (early PoE) were take. These weed control treatments were compared with hand weeding thrice at 20, 40 and 60 DAS, weedy and weed free check. These eight treatments were laid out in complete randomized block design with three replications.

Pre-germinated seeds of medium duration rice variety '*MTU 1001*' were broadcasted on well puddled and leveled field in June 2014 and 2015 with a seed rate of 62.5 kg/ha. The crop was fertilized with 100:50:50 kg N:P_2O_5:K_2O/ha and 50% nitrogen, entire dose of phosphorous and potassium was applied as basal in addition to zinc sulphate 25 kg/ha. The remaining 50% of the nitrogen was top dressed at two equal splits at tillering and panicle initiation stage. Pre-emergence herbicides were mixed with sand 100 kg/ha and applied uniformly in the field on 5 DAS. A thin film of water was maintained at the time of pre-emergence herbicide application. The post-emergence herbicides were sprayed at 3-4 leaf stage of weeds by using knapsack sprayer fitted with deflector nozzle mixed with water 750 liter/ha. Hand weeding was carried out as per the treatment schedule. All other agronomic and plant protection measures were adopted as per the recommended packages of UAS, Bangalore.

The data on weed density and weed dry weight (at 60 DAS) were recorded with the help of quadrate (0.5 x 0.5 m). The normality of distribution was not seen in case of observation on weeds hence, the values were subjected to square root transformation ($\sqrt{x+0.5}$) prior to statistical analysis to normalize their distribution. Data on plant height (at harvest) and yield attributes like number of productive tillers, grain weight/panicle, 100 seed weight and grain yield were recorded. The weed control efficiency was worked out on the basis of weed dry matter production using the formula suggested by Mani *et al.* (1973) and weed index was calculated by using the formula suggested by Gill and Vijayakumar (1966).

All the data obtained in the study were statistically analyzed using F-test, the procedure given by Gomez and Gomez (1984), critical difference values at p=0.05 were used to determine the significance of differences between means.

RESULTS AND DISCUSSION

Weed flora

The important weeds observed in the experimental fields were; *Echinochloa colona, Cynodon dactylon, Paspalum conjugatum* and *Leptochloa chinensis* among grasses; *Eclipta alba, Ludwigia parviflora, Ammania baccifera, Euphorbia hirta* and *Bergia capensis* among broad-leaved weeds (BLW) and *Cyperus rotundus, Cyperus iria* and *Scripus* spp. among sedges.

Effect on weeds

All the weed control treatments significantly reduced the density and dry weight of grasses, BLW, sedges and total weeds as compared to unweeded check (**Table 1 and 2**). Among the weed control treatments, hand weeding thrice at 20, 40 and 60 DAS recorded significantly lower weed density (11.62, 7.63, 4.35 and 23.60/m^2 of grasses, BLW, sedges and total weeds, respectively) and weed dry matter production (3.66, 2.04, 0.50 and 6.20 g/m^2 of grasses, BLW, sedges and total weeds, respectively) as compared to other treatments. However, it was at par with pre-emergence application of bensulfuron-methyl + pretilachlor 660 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha (18.36, 12.52, 7.11 and 37.99/m^2 density of grasses, BLW, sedges and total weeds, respectively) and (4.80, 2.69, 0.66 and 8.15 g/m^2 dry weight of grasses, BLW, sedges and total weeds, respectively). While, the lowest weed density and dry weight of weeds were observed in weed free check and the highest was recorded in weedy check. These results were in conformity with the findings of Walia *et al.* (2012) who reported that sequential application of bispyribac-sodium after pre-emergence herbicide found effective in control of weeds in direct-seeded rice. The crop yield was directly proportional to weed control efficiency. The weed control efficiency at 60

Table 1. Density of weeds (no. /m^2) as influenced by weed management practices in wet direct-seeded rice at 60 DAS (pooled data of two years)

Treatment	Grasses	BLW	Sedges	Total
Bensulfuron-methyl + pretilachlor 660 g/ha (PE) *fb* one HW	4.60(20.72)	4.00(15.51)	3.09(9.04)	6.76(45.26)
Pendimethalin 1 kg/ha (PE) v one HW	5.33(27.91)	4.49(19.68)	3.47(11.55)	7.72(59.14)
Bensulfuron-methyl + pretilachlor 660 g/ha (PE) *fb* bispyribac-sodium 25 g/ha (PoE)	4.34(18.36)	3.61(12.52)	2.76(7.11)	6.20(37.99)
Pendimethalin 1 kg/ha (PE) *fb* bispyribac-sodium 25 g/ha (PoE)	5.04(24.90)	3.96(15.22)	3.21(9.79)	7.10(49.91)
Bispyribac-sodium 25 g/ha (early PoE)	6.01(35.72)	4.96(24.13)	3.91(14.82)	8.67(74.67)
Hand weeding thrice at 20, 40 and 60 DAS	3.47(11.62)	2.85(7.63)	2.20(4.35)	4.90(23.60)
Weed free check	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)
Weedy check	8.15(65.93)	6.64(43.61)	5.16(26.14)	11.67(135.7)
LSD (p=0.05)	0.33	0.23	0.12	0.27

Square root ($\sqrt{x+0.5}$) transformed values. Values in the parentheses are original values; PE - pre-emergence; PoE - post-emergence

DAS was maximum in hand weeding thrice at 20, 40 and 60 DAS (87.2%) and pre-emergence application of bensulfuron-methyl + pretilachlor 660 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha was the best treatment among the herbicides in terms of higher WCE (83.1%). These results were in agreement with Walia *et al.* (2012) and Naseeruddin and Subramanyam (2013). Among the herbicides tested, pendimethalin found toxic and hinders germination of rice seeds lead to reduced plant population. A similar phytotoxic effect caused by pendimethalin on rice crop was observed by Rana *et al.* (2016). While, application of pre-emergence herbicide *fb* one hand weeding failed to control the all types of weeds due to emergence of second flush weeds.

Effect on crop

All the herbicide treatments produced significantly higher seed yield (3.19-4.80 t/ha) compared to weedy check (2.34 t/ha). Unweeded check registered 55.2% reduction in seed yield compared to weed free check owing to sever competition offered by uncontrolled weeds for nutrients, soil moisture, space and light. Among the weed control treatments, significantly higher seed yield (5.22 t/ha) was obtained with season long weed free check as compared to weedy check (**Table 3**). However, it was at par with pre-emergence application of bensulfuron methyl + pretilachlor 660 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha (4.80 t/ha) and hand weeding thrice at 20, 40 and 60 DAS (5.14 t/ha). The superior performance of these treatments were mainly attributed to enhanced yield parameters, *viz.* number of productive tillers/plant, grain weight/panicle and 100 seed weight. These increased yield parameters in turn due to growth parameters, *viz.* plant height and total dry matter production, was due to effective control of weeds during critical period of paddy growth. These results were in conformity with earlier findings of Brar and Bullar (2012), Singh and Singh (2014), Kaur and Singh (2015) and Pinjari *et al.* (2016). Pre-emergence application of bensulfuron-methyl 0.6% + pretilachlor 6% GR 10 kg/ha or pendimethalin *fb* one hand weeding failed to enhance

Table 2. Dry weight of weeds (g/m^2) and weed control efficiency as influenced by weed management practices in wet direct seeded rice at 60 DAS (pooled data of two years)

Treatment	Grasses	BLW	Sedges	Total	WCE (%)
Bensulfuron-methyl + pretilachlor 660 g/ha (PE) *fb* 1 HW	2.62(6.40)	2.02(3.57)	1.18(0.88)	3.37(10.85)	77.5
Pendimethalin 1 kg/ha (PE) *fb* one HW	2.82(7.46)	2.16(4.17)	1.23(1.02)	3.63(12.65)	73.8
Bensulfuron-methyl + pretilachlor 660 g/ha (PE) *fb* bispyribac-sodium 25 g/ha (PoE)	2.30(4.80)	1.78(2.69)	1.08(0.66)	2.94(8.15)	83.1
Pendimethalin 1 kg/ha (PE) *fb* bispyribac-sodium 25 g/ha (PoE)	2.61(6.34)	2.01(3.54)	1.17(0.87)	3.35(10.75)	77.7
Bispyribac-sodium 25 g/ha (early PoE)	3.70(13.17)	2.81(7.38)	1.52(1.80)	4.78(22.35)	53.7
Hand weeding thrice at 20, 40 and 60 DAS	2.04(3.66)	1.59(2.04)	1.00(0.50)	2.59(6.20)	87.2
Weed free check	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	100.0
Weedy check	5.40(28.70)	4.15(16.71)	1.84(2.87)	6.98(48.28)	0.0
LSD (p=0.05)	0.12	0.23	0.18	0.15	-

Square root ($\sqrt{x+0.5}$) transformed values. Values in the parentheses are original values

Table 3. Growth and yield of wet direct seeded rice as influenced by weed management practices (pooled data of two years)

Treatment	Plant height at harvest (cm)	No. of productive tillers per hill at harvest	Grain weight/ panicle (g)	100-seed weight (g)	Per cent choppiness	Grain yield (t/ha)	Weed index (%)	Net returns (x10^3 `/ha)	B:C ratio
Bensulfuron-methyl + pretilachlor 660 g/ha (PE) *fb* 1 HW	55.3	12.0	2.06	1.29	19.7	3.67	29.7	12.37	1.32
Pendimethalin 1 kg/ha (PE) *fb* one HW	53.6	10.7	1.78	0.99	22.2	3.49	33.1	9.99	1.26
Bensulfuron-methyl + pretilachlor 660 g/ha (PE) *fb* bispyribac-sodium 25 g/ha (PoE)	58.3	13.3	2.34	1.54	15.5	4.80	8.0	27.63	1.65
Pendimethalin 1 kg/ha (PE) *fb* bispyribac-sodium 25 g/ha (PoE)	51.8	11.0	1.95	1.15	24.8	3.87	25.8	12.71	1.31
Bispyribac-sodium 25 g/ha (early PoE)	50.3	10.2	1.56	1.11	28.4	3.19	39.0	5.24	1.13
Hand weeding thrice at 20, 40 and 60 DAS	62.0	13.2	2.57	1.78	11.9	5.14	1.5	25.72	1.49
Weed free check	63.6	14.6	2.60	1.79	10.9	5.22	0.0	23.34	1.50
Weedy check	43.3	8.8	1.49	1.08	54.7	2.34	55.2	-3.98	0.89
LSD (p=0.05)	5.9	2.9	0.26	0.15	3.9	0.47	-	-	-

the paddy grain yield significantly owing to severe weed competition. The treatments, which received pre-emergence application of pendimethalin also failed to enhance the paddy grain yield significantly because of its toxicity.

Economics

The highest net returns (` 27,631/ha) and B:C ratio (1.65) were recorded in pre-emergence application of bensulfuron-methyl + pretilachlor 660 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha. The increased monetary benefits in this treatment were mainly attributed to higher grain yield and reduced labour cost. While, the lowest net returns (` -3976/ha) and B:C ratio (0.89) was observed in weedy check (**Table 3**). Similar results of higher net returns and B:C ratio in direct-seeded rice due to sequential application of herbicides were also reported by Pinjari *et al.* (2016) and Ghosh *et al.* (2016).

On the basis of pooled data of two years, it was concluded that pre-emergence application of bensulfuron-methyl + pretilachlor 660 g/ha *fb* post-emergence application of bispyribac-sodium 25 g/ha found most effective and economical in controlling the weeds in direct seeded wet sown rice in Cauvery Command Area of Karnataka.

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