Influence of weed management methods on weed characteristics, yield and economics of machine-transplanted rice

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ABSTRACT

A field experiment was conducted at Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu during late Samba (Oct-Feb) season of 2017-18 to assess the weed characteristics in relation to yield under machine-transplanted rice. The experiment included eight treatments viz T_1: Unweeded check, T_2: Pretilachlor [pre-emergence (PE)] followed by hand weeding 20 days after treatment (DAT), T_3: Pretilachlor (PE) followed by metsulfuron methyl + chlorimuron methyl [post-emergence (POE)] 20 DAT, T_4: Pretilachlor (PE) followed by weeding with power weeder 20 DAT, T_5: Pretilachlor (PE) followed by weeding with power weeder 20 and 35 DAT, T_6: Pretilachlor (PE) followed by weeding with power weeder 20, 30 and 40 DAT, T_7: Weeding with power weeder 20 and 35 DAT and T_8: Weeding with power weeder 20, 30 and 40 DAT. The field trial was designed in randomised complete block design and replicated three times. The results revealed that application of pretilachlor (PE) followed by either hand weeding on 20 DAT (T_2) or with power weeding twice (T_5) or thrice (T_6) or with chemical combinations of pre-emergence and post-emergence (T_3) registered lesser weed dry weight, lower weed density with higher weed control efficiency that led to higher grain yield, straw yield and B-C ratio in rice.

Keywords: Rice; weed density; weed dry weight; weed control efficiency; yield; economics

INTRODUCTION

Rice is a staple food for more than half of the world's population which ensures food security in many countries including India. India is the second largest rice producing country (104 MT), having the largest area of 43.5 Mha. The average productivity of rice in India is 2.4 tonne/ha (http://www.indiastat.com/). Transplanting method of rice cultivation is predominant in India over two to three decades. But in the recent past due to the scarcity of labour especially at the time of peak planting period in command areas, machine transplanting has become much popular in rice.

Under transplanted conditions the weed flora is much diverse and consists of grasses, sedges and broad-leaved weeds causing yield reduction up to 76 per cent (Singh et al 2004). Controlling the weeds within critical crop-weed competition period is essential to attain higher productivity. Various methods are practiced in rice to control the weeds. Every weed management practice has its own advantages and disadvantages. Hand weeding is very effective in eradicating all types of weed flora during critical period of crop-weed competition in inter- and intra-rows but it is labour-intensive which increases the cost of cultivation and reduces net returns. The undependable labour availability and escalating labour wages has led to use of chemicals for the control of weeds (Hasanuzzaman et al 2009). The information on effect of weed management practices inclusive of chemical, mechanical and cultural methods in combination of pre-emergence herbicide on weed characteristics in relation to yield under machine-transplanted conditions was lacking. Hence the present study was undertaken.

MATERIAL and METHODS

A field trial was carried out at wetland farms of Department of Farm Management, Tamil Nadu

Agricultural University, Coimbatore, Tamil Nadu during late Samba (Oct-Feb) season of 2017-18. The experimental site is located in the western agro-climatic zone of Tamil Nadu at 11° N latitude, 77° E longitude at an altitude of 426.72 m amsl. Soil of experimental site was clay loam in texture and low in available nitrogen (225.4 kg/ha), medium in available phosphorus (16.80 kg/ha) and high in available potassium (423.8 kg/ha).

The experiment was laid out in randomized complete block design with three replications. The experiment consisted of eight treatments viz T_1: Unweeded check, T_2: Pretilachlor [pre-emergence (PE)] followed by hand weeding 20 days after treatment (DAT), T_3: Pretilachlor (PE) followed by metsulfuron methyl + chlorimuron methyl [post-emergence (POE)] 20 DAT, T_4: Pretilachlor (PE) followed by weeding with power weeder 20 DAT, T_5: Pretilachlor (PE) followed by weeding with power weeder 20 and 35 DAT, T_6: Pretilachlor (PE) followed by weeding with power weeder 20, 30 and 40 DAT, T_7: Weeding with power weeder 20 and 35 DAT and T_8: Weeding with power weeder 20, 30 and 40 DAT. Short duration Rice CO 51 was used as test variety. Fourteen days old seedlings raised in trays were transplanted using 4 rows walk behind transplanter. The treatments were imposed in time with the pre-fixed combinations of pre-emergence herbicide with hand weeding, with power weeding and with post-emergence herbicide in appropriate recommended dose. Other package of practices like irrigation, fertilizer application etc were followed (Anon 2012).

The weed count was recorded species-wise using 0.5 x 0.5 m quadrat from four randomly fixed places in each plot and the weeds falling within the frames of the quadrat were accounted, recorded and the mean values were expressed in number/m^2 for weed density. In case of weed dry weight the weeds falling within the frames of the quadrates were collected, categorized into grasses, sedges and broad-leaved weeds, shade-dried and later dried in hot-air oven at 70 ± 5°C for 72 hour and expressed in kg/ha. The density and dry weight of weeds were recorded before and after imposing the treatments. Weed control efficiency (WCE) was calculated as follows:

$$WCE\,(\%) = \frac{\text{Total weed dry weight in unweeded control} - \text{Total weed dry weight in treated plot}}{\text{Total weed dry weight in unweeded control}} \times 100$$

Grains from each net plot were cleaned, sun-dried, weighed and adjusted to 14 per cent moisture content and the grain yield was expressed in kg/ha. The straw obtained from each net plot area was sun-dried and weighed. The straw yield was expressed in kg/ha. Harvesting index was worked out by counting the ratio of grain yield to biological yield (grain and straw yield).

Cost of cultivation and gross return for all the treatments were worked out on the basis of prevailing input cost and market price of the grain during the experimentation. The net income was calculated by deducting the cost of cultivation from the gross return. Benefit-cost ratio (B:C) was calculated from gross return and cost of cultivation of rice.

Data were subjected to statistical analysis as prescribed by Gomez and Gomez (2010).

RESULTS and DISCUSSION

Weed management practices had significant influence on total weed density and weed dry weight at different stages of rice crop (Table 1).

At 20 DAT significantly lower total weed density (14.50/m^2) and weed dry weight (7.11 g/m^2) were recorded when pretilachlor was applied as pre-emergence and hand weeding was made on 20 DAT (T_2) that was on par with T_4, T_6, T_3 and T_5. Significantly higher total weed density (57.70/m^2) and weed dry weight (48.46 g/m^2) were obtained in unweeded check (T_1). Similar trend was also obtained in case of 35 and 50 DAT. Lower weed density and weed dry weight in these treatments might be due to broad spectrum control of weeds at early stages by pre-emergence herbicide and at later stages with effective removal of weeds by manual weeding or incorporation of weeds by power weeding or post-emergence herbicide which

Table 1. Effect of weed management practices on weed characteristics in machine-transplanted rice

Treatment	20 DAT		35 DAT		50 DAT		Weed control efficiency (%)
	Weed density/m^2	Weed dry weight (g/m^2)	Weed density/m^2	Weed dry weight (g/m^2)	Weed density/m^2	Weed dry weight (g/m^2)	
T_1	7.63 (57.70)	7.00 (48.46)	11.39 (129.25)	10.08 (101.05)	14.06 (197.23)	12.75 (162.10)	-
T_2	3.87 (14.50)	2.76 (7.11)	2.90 (7.92)	1.95 (3.29)	4.71 (21.69)	3.12 (9.26)	75.53
T_3	4.15 (16.75)	2.91 (7.94)	5.38 (28.47)	3.36 (10.78)	5.87 (34.36)	3.94 (15.05)	69.10
T_4	4.10 (16.34)	2.79 (7.30)	6.52 (41.99)	3.80 (13.91)	7.86 (61.26)	5.18 (26.34)	59.37
T_5	4.31 (18.09)	2.95 (8.22)	6.16 (37.47)	3.72 (13.32)	6.74 (44.94)	4.24 (17.51)	66.75
T_6	4.11 (16.36)	2.85 (7.60)	3.46 (11.49)	2.30 (4.80)	5.07 (25.21)	3.43 (11.28)	73.10
T_7	7.30 (52.73)	6.96 (47.98)	7.55 (56.46)	5.21 (26.66)	8.48 (71.34)	5.92 (34.54)	53.57
T_8	7.29 (52.71)	6.99 (48.36)	6.99 (48.37)	4.77 (22.26)	7.76 (59.69)	5.15 (26.02)	59.61
SEd	0.24	0.18	0.28	0.23	0.37	0.33	-
$CD_{0.05}$	0.50	0.39	0.59	0.48	0.77	0.68	-

Data subjected to square root transformation; Figures in parentheses are original values with $\sqrt{x} + \sqrt{0.5}$

T_1: Unweeded check, T_2: Pretilachlor [pre-emergence (PE)] followed by hand weeding 20 days after treatment (DAT), T_3: Pretilachlor (PE) followed by metsulfuron methyl + chlorimuron methyl [post-emergence (POE)] 20 DAT, T_4: Pretilachlor (PE) followed by weeding with power weeder 20 DAT, T_5: Pretilachlor (PE) followed by weeding with power weeder 20 and 35 DAT, T_6: Pretilachlor (PE) followed by weeding with power weeder 20, 30 and 40 DAT, T_7: Weeding with power weeder 20 and 35 DAT and T_8: Weeding with power weeder 20, 30 and 40 DAT

reduced the density of weeds and ultimately the weed dry weight. These results are in line with the findings of Leela (2002), Negalur and Halepyati (2015) and Saiful Islam et al (2017).

Weed control efficiency (WCE) was computed on the basis of weed dry weight of the weed management treatments-imposed plots comparing with unweeded check at 50 DAT (Table 1). The crop expressed better responses for different weed management practices imposed. Among the treatments application of pretilachlor as pre-emergence followed by hand weeding 20 DAT recorded higher WCE (75.53%) than other treatments followed by pretilachlor applied as pre-emergence followed by power weeding at 20, 30 or 40 DAT (73.10%) or followed by metsulfuron methyl + chlorimuron methyl application 20 DAT (69.10%) or followed by power weeder used 20 and 35 DAT (66.75%). This might be due to lesser number of weeds and weed dry weight by efficient control through chemical, manual or power weeding. Similar results were earlier reported by Saha and Rao (2010) and Prakash et al (2013).

Grain yield and straw yield of rice differed significantly due to different weed management practices (Table 2). Higher grain yield (5678 kg/ha) was recorded in case of pretilachlor applied as pre-emergence followed by hand weeding 20 DAT (T_2) which was on par with pre-emergence herbicide application of pretilachlor followed by either with power weeding 20, 30 and 40 DAT (5254 kg/ha) or with power weeding 20 and 35 DAT (5237 kg/ha) or with post-emergence application of metsulfuron methyl + chlorimuron ethyl (5149 kg/ha). Higher straw yield was obtained in T_2 (8460 kg/ha) which was found to be on par with T_6 (8014 kg/ha). Lower grain yield (2890 kg/ha) and straw yield (4726 kg/ha) was recorded in unweeded check. Higher number of productive tillers, filled grains/panicle and panicle length were recorded in these treatments due to better weed control in critical crop-weed completion period that resulted in higher grain yield.

The efficient control of weeds in terms of weed density and dry weight together might have led to higher leaf area index (LAI) and production of more number

Table 2. Effect of weed management practices on yield of machine-transplanted rice

Treatment	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index
T1	2890	4726	0.38
T2	5678	8460	0.40
T3	5149	7516	0.41
T4	4912	7280	0.40
T5	5237	7553	0.41
T6	5254	8014	0.40
T7	4493	6422	0.41
T8	4839	6915	0.41
SEd	256	418	0.02
$CD_{0.05}$	535	872	NS

T_1: Unweeded check, T_2: Pretilachlor [pre-emergence (PE)] followed by hand weeding 20 days after treatment (DAT), T_3: Pretilachlor (PE) followed by metsulfuron methyl + chlorimuron methyl [post-emergence (POE)] 20 DAT, T_4: Pretilachlor (PE) followed by weeding with power weeder 20 DAT, T_5: Pretilachlor (PE) followed by weeding with power weeder 20 and 35

of tillers that in turn increased the straw yield. These results are in line with the findings of Kiran et al (2010).

Harvest index calculated was not significantly influenced by weed management practices applied. The ratio between grain and biological yields was also not influenced by the weed management practices. The economic analysis of different treatments revealed large variations in cost of cultivation, gross return, net return and B-C ratio in machine-transplanted rice (Table 3).

Pretilachlor applied as pre-emergence followed by hand weeding 20 DAT recorded higher cost of cultivation (Rs 48540/ha) along with higher gross return (Rs 85056/ha) and net return (Rs 36516/ha). Higher cost of cultivation was mainly due to more labour involved in hand weeding than chemical and power weeding treatments.

The higher gross return and net return were also obtained from the same treatment which was due to increased grain and straw yields than other treatments. These results are in line with Saiful Islam et al (2017) who reported that even though hand weeding recorded higher yield it involved higher weeding cost than others.

Table 3. Effect of weed management practices on economics of machine-transplanted rice

Treatment	Total cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B-C ratio
T_1	40540	44132	3592	1.09
T_2	48540	85056	36516	1.75
T_3	42380	76820	34440	1.81
T_4	45280	73504	28224	1.62
T_5	45980	77950	31970	1.70
T_6	46680	79076	32396	1.69
T_7	45980	66760	20780	1.45
T_8	45680	71898	26218	1.57

Data not analysed statistically

T_1: Unweeded check, T_2: Pretilachlor [pre-emergence (PE)] followed by hand weeding 20 days after treatment (DAT), T_3: Pretilachlor (PE) followed by metsulfuron methyl + chlorimuron methyl [post-emergence (POE)] 20 DAT, T_4: Pretilachlor (PE) followed by weeding with power weeder 20 DAT, T_5: Pretilachlor (PE) followed by weeding with power weeder 20 and 35 DAT, T_6: Pretilachlor (PE) followed by weeding with power weeder 20, 30 and 40 DAT, T_7: Weeding with power weeder 20 and 35 DAT and T_8: Weeding with power weeder 20, 30 and 40 DAT

Higher B-C ratio (1.81) was obtained from pre-emergence application of pretilachlor followed by post-emergence application of metsulfuron methyl + corimuron ethyl. This might be due to better performance of rice that resulted in increased productivity and decreased cost of cultivation owing to lesser cost of chemicals and lesser labour involvement and thus other mechanical methods in turn increased the gross returns and benefit-cost ratio. Lowest gross return (Rs 44132/ha), net return (Rs 3592/ha) and benefit-cost ratio (1.09) were recorded under unweeded check. This could be due to poor yield caused by weed competition which directly influenced the economic benefits. These results are in line with those of Hasanuzzaman et al (2009).

CONCLUSION

The results revealed that depending on the resources of the farmers the farmers can go for pretilachlor as pre-emergence followed by either hand weeding or metsulfuron methyl + chlorimuron ethyl (POE) 20 DAT as post-emergence or power weeding twice (20 and 35 DAT) or thrice (20, 30 and 40 DAT) for effective weed control, higher yields and economic returns in machine-transplanted rice.

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