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RESEARCH ARTICLE :

Influence of weed management practices on yield and economics of aerobic rice under different seeding methods

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SUMMARY : A field experiment was conducted during the *Kharif*, 2014 at College Farm, Professor Jayashankar Telangana State Agricultural University, Hyderabadto study the bio-efficacy of variousherbicides on weeds, yield and economics of direct seeded rice. The weed flora emerged during experimentation were: grasses like *Echinocloa colonam* L., *Cynodon dactylon* L., *Eleusine indica*, sedges like *Cyperus rotundus* L, and broad-leaved weeds like *Eclipta alba* L., *Commelina bengalensis* L., *Ipomoea purpurea, Alternanthera sessillis, Physalis minima, Bacopa monnieri, Cyanotis cristata, Corchorus, Phyllanthus niruri, Ageratum conyzoides*.Among seeding methods the highest gross returns (Rs.47280), net returns (Rs.17544) and B: C ratio (1.57) were obtained with line sowing than broadcasting.Among weed management practices highest gross returns (Rs.47770) were with T_6 treatment and highest net returns (Rs.15826) with T_5 treatment whereas highest BC ratio (1.56) with with T_3 and T_4 treatments was obtained which were superior to other treatments.

KEY WORDS :
Aerobic rice, Weed index, Yield, Economics

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BACKGROUND AND OBJECTIVES

Change in the method of crop establishment from traditionalmanual transplanting of seedlings to direct seedinghas occurred in many rice (*Oryza sativa* L.) growing countries in response to increasing production cost, especially for labour and water. Dry seeding with subsequent saturated soil conditions reduced the amount of water required during puddling and thus reduced overall water demand. Direct seeding of rice also aids in quick establishment,early harvest and thus early sowing of wheat (Singh *et al*., 2007).

The direct seeded rice culture is subjected to greaterweed competition than transplanted rice because bothweed and crop seeds emerge at the same time and competewith each other from the germination resulting in lessgrain yield. A weed-free period for the first 30-45 daysafter sowing (DAS) is required to avoid any loss in yield because the dry weight of weeds increases greatly

from 30DAS in dry direct-seeded rice. Uncontrolled weeds reducethe yield by 96% in dry direct-seeded rice, 61% in wet direct-seeded rice (Maity and Mukherjee, 2008).

Therefore, the major challenge for farmers is effective weed management, as failure to eliminate weeds may result in low or no yield. Manual removal of weeds is labour intensive, tedious, back breaking and does not ensure weed removal at critical stage of crop-weed competition due to non-availability of labours, and sometimes bad weather condition which does not allow labours to move in the field. Herbicides are more effective in controlling the weeds besides reducing the total energy requirement for rice cultivation. Pre emergence application of herbicides mainly control weeds in the earlier stages and weeds emerging at laterstages of rice growth are not controlled effectively. Hence, the present investigation was undertaken to study the alone and sequential application of herbicides on weed flora, yield, nutrient uptake by weeds and crop, and economics in direct seeded rice under different establishment methods.

RESOURCES AND METHODS

Field experiment was carried out during *Kharif*, 2014 at College Farm, Professor Jayashankar Telangana State Agricultural University, Hyderabad to evaluate the efficacy of sequential application of herbicides in different seeding methods in sandy loam soil. The experiment was conducted in factorial RBD with a plot size of 4 x 4m with three replications. Factor 1 includes seeding methods, broadcasting (S_1) and line sowing (S_2) Factor II includes weed management practices, T_1-Pretilachlor 50% EC as PE fb (metasulfuron methyl + clorimuron ethyl) 20% W.P. as PoE + cyhalofop butyl 10% EC as PoE at 15-20 DAS, T_2-Pretilachlor 50% EC as PE fb azimsulfuron 50% W.P + cyhalofop butyl 10% EC as PoE 15-20 DAS, T_3-Pretilachlor 50% EC as PE fb pyrazosulfuron 10% W.P + cyhalofop butyl 10% EC as PoE at 15-20 DAS, T_4-bispyribacsodium 10% EC as early PoE fb 2-4-D 80% W.P @ 0.5 kg.ai/ha at 40 DAS, T_5- T_1 followed by HW at 50 DAS, T_6- T_2 followed by HW at 50 DAS, T_7- T_3 followed by HW at 50 DAS, T_8- T_4 followed by HW at 50 DAS, T_9- HW at 20, 40 and 60 DAS, T_{10}-unweeded control. The recommended fertilizer dose was 100-60-40 kg of N, P_2O_5 and K_2O/ha, respectively.

OBSERVATIONS AND ANALYSIS

The results obtained from the experiment carried out on aerobic rice entitled 'effect of weed management practices on yield and economics of aerobic rice under different seeding methods' are presented below under different headings. Results obtained during the period of investigation on weed dynamics and their effect on yield and economics of aerobic rice are discussed and results are summarized in tables and illustrated through figures wherever appropriate and essential. The findings are discussed with possible reasons and correlated with other findings.

Table 1 : Weed index (%) of aerobic rice as influenced by weed management practices under different seeding methods

T	Weed management practices	Seeding methods		
		S_1	S_2	Mean
T_1	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Metsulfuron methyl + Chlorimuron ethyl 4 g. ai ha^{-1}as PoE + Cyhalofop butyl 75 g. ai ha^{-1} as PoE at 15-20 DAS.	21.1	26.7	23.9
T_2	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Azimsulfuron 35g.ai ha^{-1}+ Cyhalofop butyl75 g. ai ha^{-1} as PoE 15-20 DAS.	12.0	22.9	17.4
T_3	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Pyrazosulfuron ethyl 20 g.ai ha^{-1} + Cyhalofop butyl 75 g. ai ha^{-1} as PoE at 15-20 DAS.	22.0	20.2	21.1
T_4	Bispyribac sodium 25 g ai ha^{-1} as early PoE fb 2-4-D 0.5 kg.ai ha^{-1} at 40 DAS.	25.8	26.7	26.3
T_5	T_1 fb Hand weeding at 50 DAS.	11.1	10.4	10.7
T_6	T_2 fb Hand weeding at 50 DAS.	9.6	8.1	8.9
T_7	T_3 fb Hand weeding at 50 DAS.	14.8	10.9	12.8
T_8	T_4 fb Hand weeding at 50 DAS.	14.5	15.1	14.8
T_9	Hand weeding at 20, 40, 60 DAS	0.0	0.0	0.0
T_{10}	Unweeded (control)	67.9	74.1	71.0
	Mean	19.88	21.51	

Weed index (%) :

The weed index is the per cent reduction in crop yield due to presence of weeds in comparison with hand weeding. The lowest weed index was recorded with sequential application of herbicides along with one hand weeding than the sequential application of herbicides alone. Lower weed index was recorded with T_6 (8.9%) - (Pretilachlor as PE fb Azimsulfuron + Cyhalofop butyl as PoE 15- 20 DAS fb HW at 50 DAS)which was followed by T_5 and T_7 (10.7 and 12.8, respectively).

Grain yield :

Effect of seeding methods and weed management practices on grain yield of aerobic rice was analysed statistically and presented in this Table 2.

Among the seeding methods the more grain yield was recorded with line sowing (S_2) (3161) and was significantly superior over broadcasting (S_1) (2366) which might be due to less competition between crop and weeds and high yield attributes recorded with line sowing. Similar results were reported by Anwar *et al*. (2011) and Moorthy and Rao (1991).

Among weed management practices, hand weeding at 20, 40 and 60 DAS (T_9) was found to be superior over rest of the treatments. The highest grain yield was recorded with hand weeding thrice at 20, 40 and 60 DAS followed by sequential application of herbicides along with one hand weeding at 50 DAS *i.e.*T_6-(Pretilachlor 0.75 kg ai ha^{-1} as PE fb Azimsulfuron 35g.$aiha^{-1}$ + Cyhalofop butyl 75 g. $aiha^{-1}$ as PoE 15- 20 DAS fb HW at 50 DAS) (3218 kg ha^{-1}), however it was at par with T_7-(Pretilachlor 0.75 kg $aiha^{-1}$ as PE fb Pyrazosulfuron ethyl 20 g.$aiha^{-1}$ + Cyhalofop butyl 75 g.$aiha^{-1}$as PoE at15-20 DAS fb HW at 50 DAS) (3084 kg ha^{-1}), T_5-(Pretilachlor 0.75kg $aiha^{-1}$ as PE fb (Metasulfuron methyl+ Chlorimuron ethyl) 4 g.$aiha^{-1}$ as PoE + Cyhalofop butyl 75 g.$aiha^{-1}$ as PoE at 15-20 DAS fb HW at 50 DAS) (3150kg ha^{-1}) ,T_8-(Bispyribac sodium 25 g ai ha^{-1} as early PoE (10-12 DAS) fb 2-4-D 0.5 kg.ai ha^{-1} at 40 DAS fb HW at 50 DAS) (3003kg ha^{-1}), found better in increasing the yield significantly over sequential application of herbicides alone.

However, sequential application of herbicides along with one hand weeding found to be better than sequential application of herbicides alone suggesting integration of chemical and hand weeding for controlling weeds for

Table 2 : Grain and straw yield (kg ha^{-1}) of aerobic rice as influenced by weed management practices under different seeding methods

T	Weed management practices	Grain yield			Straw yield		
		S_1	S_2	Mean	S_1	S_2	Mean
T_1	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Metsulfuron methyl + Chlorimuron ethyl 4 g. ai ha^{-1}as PoE+Cyhalofop butyl 75 g. ai ha^{-1} as PoE at 15-20 DAS	2357	2978	2668	2963	3648	3305.6
T_2	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Azimsulfuron 35g.ai ha^{-1}+ Cyhalofop butyl75 g. ai ha^{-1} as PoE 15-20 DAS.	2630	3135	2883	3330	3860	3595.0
T_3	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Pyrazosulfuron ethyl 20 g.ai ha^{-1} + Cyhalofop butyl 75 g. ai ha^{-1} as PoE at 15-20 DAS.	2330	3245	2787	2893	3814	3353.9
T_4	Bispyribac sodium 25 g ai ha^{-1} as early PoE fb 2-4-D 0.5 kg.ai ha^{-1} at 40 DAS.	2217	2978	2598	2868	3584	3226.2
T_5	T_1 fb Hand weeding at 50 DAS.	2658	3643	3150	3349	4433	3891.3
T_6	T_2 fb Hand weeding at 50 DAS.	2701	3735	3218	3486	4525	4005.6
T_7	T_3 fb Hand weeding at 50 DAS.	2546	3622	3084	3431	4411	3921.0
T_8	T_4 fb Hand weeding at 50 DAS.	2557	3449	3003	3338	4240	3789.5
T_9	Hand weeding at 20, 40, 60 DAS	2989	4064	3526	3755	4803	4279.3
T_{10}	Unweeded (control)	958	1051	1005	1546	1637	1592.1
	Mean	2366.1	3161.1		3096.2	3895.7	
		S.E.±	C.D. (P=0.05)		S.E.±	C.D. (P=0.05)	
	F_1	44.73	128.09		48.84	139.87	
	F_2	100.0	286.4		109.22	312.7	
	$F_1 \times F_2$	141.4	405.0		154.46	NS	

NS=Non-significant

prolonged period to realize higher yields from aerobic rice as it results to be higher weed control efficiency during early growth stages of crop, there by minimizing competition between crop and weeds for nutrients there by crop plants able to utilize available nutrients more efficiently through out crop growth period, which in turn might positively influenced the yield components *viz.*, number of panicles m^{-2}, filled grains per $panicle^{-1}$ and test weight led to higher grain yield. Similar results were reported by Mishra and Singh (2008), Walia *et al*. (2008).

The grain yield was significantly influenced by the interaction of seeding methods and weed management practices. The significantly highest grain yield (3526 kg ha^{-1}) was obtained by hand weeding at 20, 40 and 60 DAS with the line sowing it might be due to the effective control of weeds under line sowing with hand weeding.

Straw yield (kg ha^{-1}) :

The data pertaining to straw yield were presented in Table 2 which revealed that the straw yield was significantly influenced by seeding methods and weed management practices. The pattern of increase of straw

Table 3 : Economics of aerobic rice as influenced by weed management practices under different seeding methods

T	Treatments	Seeding methods					
		Cost of production (Rs. ha^{-1})			Gross returns (Rs. ha^{-1})		
		S_1	S_2	Mean	S_1	S_2	Mean
T_1	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Metsulfuron methyl + Chlorimuron ethyl 4 g. ai ha^{-1}as PoE+Cyhalofop butyl 75 g. ai ha^{-1} as PoE at 15-20 DAS.	24912	26912	25912	35018	44149	39584
T_2	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Azimsulfuron 35g.ai ha^{-1}+ Cyhalofop butyl75 g. ai ha^{-1} as PoE 15-20 DAS.	26795	28795	27795	39098	46496	42797
T_3	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Pyrazosulfuron ethyl 20 g.ai ha^{-1} + Cyhalofop butyl 75 g. ai ha^{-1} as PoE at 15-20 DAS.	25245	27245	26245	34581	47946	41264
T_4	Bispyribac sodium 25 g ai ha^{-1} as early PoE fb 2-4-D 0.5 kg.ai ha^{-1} at 40 DAS.	23650	25650	24650	33019	44085	38552
T_5	T_1 fb Hand weeding at 50 DAS.	29912	31912	30912	39498	53978	46738
T_6	T_2 fb Hand weeding at 50 DAS.	31795	33795	32795	40220	55321	47770
T_7	T_3 fb Hand weeding at 50 DAS.	30245	32245	31245	38057	53670	45863
T_8	T_4 fb Hand weeding at 50 DAS.	28650	30650	29650	38113	51146	44630
T_9	Hand weeding at 20, 40, 60 DAS	35575	37575	36575	44405	60073	52239
T_{10}	Unweeded (control)	20575	22575	21575	14575	15931	15253
	Mean	27735.4	29735.4		35658	47280	

Table 4 : Economics of aerobic rice as influenced by weed management practices under different seeding methods

T	Weed management practices	Seeding methods					
		Net returns (Rs. ha^{-1})			B:C ratio (Rs. ha^{-1})		
		S_1	S_2	Mean	S_1	S_2	Mean
T_1	Pretilachlor 0.75 kg ai ha^{-1} as PE fb Metsulfuron methyl + chlorimuron ethyl 4 g. ai ha^{-1} as PoE+Cyhalofop butyl 75 g. ai ha^{-1} as PoE at 15-20 DAS.	10106	17237	13672	1.41	1.64	1.52
T_2	Pretilachlor 0.75 kg ai ha^{-1}as PE fb Azimsulfuron 35g.ai ha^{-1} + Cyhalofop butyl75 g. ai ha^{-1}as PoE 15-20 DAS.	12303	17701	15002	1.46	1.61	1.54
T_3	Pretilachlor 0.75 kg ai/ha as PE fb Pyrazosulfuron 20 g.ai ha^{-1}+ Cyhalofop butyl 75 g. ai ha^{-1}as PoE at 15-20 DAS.	9336	20701	15019	1.37	1.76	1.56
T_4	Bispyribac sodium 25 g ai ha^{-1} as early PoE fb 2-4-D 0.5 kg.ai ha^{-1}at 40 DAS.	9369	18435	13902	1.40	1.72	1.56
T_5	T_1 fb Hand weeding at 50 DAS.	9586	22066	15826	1.32	1.69	1.51
T_6	T_2 fb Hand weeding at 50 DAS.	8425	21526	14975	1.26	1.64	1.45
T_7	T_3 fb Hand weeding at 50 DAS.	7812	21425	14618	1.26	1.66	1.46
T_8	T_4 fb Hand weeding at 50 DAS.	9463	20496	14980	1.33	1.67	1.50
T_9	Hand weeding at 20, 40, 60 DAS	8830	22498	15664	1.25	1.60	1.42
T_{10}	Unweeded (control)	-6000	-6644	-6322	0.71	0.71	0.71
	Mean	7923	17544		1.28	1.57	

yield of rice followed almost similar trend as that of grain yield. Significantly, highest straw yield was recorded with line sowing (S_2) (3896 kg ha^{-1}) than the broadcasting (S_1) method (3096 kg ha^{-1}).

With regard to weed management practices tried, the highest straw yield was recorded with hand weeding thrice (T_9) (4279 kg ha^{-1}) which was significantly superior to rest of the weed management practices tried which might be due to luxurious growth of crop with increased stature of growth parameters *viz*., plant height, number of tillers and higher dry matter production and lesser crop weed competition at critical stages leading to higher straw yield. Similar results reported by Jayadeva *et al*. (2011) and Thimme Gowda *et al*. (2009).

The interaction effect of seeding methods and weed management practices on straw yield was not significant.

Economics :

The data on cost of cultivation, gross returns, net returns and B: C ratio was presented in Table 3 and 4. and depicted in figure revealed that among seeding methods the highest gross returns (Rs.47280), net returns (Rs.17544) and B:C(1.57) were obtained with line sowing than broadcasting.

Among weed management practices highest gross returns (Rs. 47770) were with T_6 treatment and highest net returns with T_5 treatment (Rs.15826)whereas highest BC ratio (1.56) was obtained with T_3 and T_4 treatments which were superior to other treatments.

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