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Effect of Weed Management Practices on Growth and Economics of Transplanted Rice under Sodic Soil

C. Nivetha*, G. Srinivasan and P.M. Shanmugam

Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Trichy, Tamil Nadu, India
**Corresponding author*

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A B S T R A C T

Field experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tamil Nadu Agricultural University, Tiruchirapalli, Tamil Nadu during *rabi* 2016-2017 to evaluate the weed management practices in transplanted rice under sodic soil. The experiment consisted of 12 treatments laid out in Randomized Complete Block Design with three replications consisting of three pre-emergence herbicides integrated with post emergence herbicides and one hand weeding at 40 DAT, two early post emergence herbicides and one post emergence herbicide, hand weeding twice at 20 and 40 DAT, compared with weed free and unweeded check. The weed flora of the experimental site consisted of *Cynodon dactylon, Echinochloa colona and Panicum repens* in grasses, *Cyperus rotundus* and *Cyperus difformis* in sedges and *Ammannia baccifera, Ipomoea aquatica and Marsilea quadrifolia* in broad leaved weeds. Grasses were found to be predominant category followed by sedges and broad leaved weeds. The results revealed that pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *followed by* hand weeding on 40 DAT recorded significantly higher grain and straw yield (4987 kg $ha^{-1}$and 6841 kg ha^{-1}) which remained at par with weed free check (4798 and 6741 kg ha^{-1}). In terms of economics, highest net returns (Rs. 47765 ha^{-1}) and B: C ratio (2.49) was realized compared to that weed free check (Rs. 42640 ha^{-1}) and B: C ratio (2.25).

Introduction

Rice is cultivated in a very wide range of ecosystems from irrigated to shallow lowlands, mid-deep lowlands and deep water to uplands. Transplanting is the major method of rice cultivation in India. Weeds are a major impediment to rice production through their ability to compete for resources and their impact on product quality. Out of losses due to various biotic stresses, weeds are known to account for nearly one third. Transplanted rice is particularly infested by heterogeneous types of weed flora under lowland ecosystem, which reduces yield up to 48 per cent with an annual loss of 15 million tonnes due to weed competition. Prevention of weed competition and provision of weed free environment at critical period of rice growth is necessary for successful rice production (Murali and Gowthami, 2017). Weed competition is one of the prime yield limiting constraints in rice resulting in yield reduction of 28-45 per cent (Maheshwari *et al.,* 2015). Manual weeding although effective and most common practice of weed control in transplanted rice, raising

cost of labour and their non-availability in time lead to the search for alternative methods. Herbicides offer the most effective, economical and practical way of weed management (Sureshkumar and Durairaj, 2016). So, there is a need to evaluate the effect of new herbicides on growth and economics of transplanted rice under sodic soil condition in order to gain profitability and for providing wider options to farmers.

Materials and Methods

An experiment was conducted at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli during *rabi* 2016-2017. The soil of the experimental field was sandy clay loam in texture with pH of 8.8.

The experiment was laid out in randomized complete block design with twelve treatments were T_1- pre emergence application of butachlor at 1.5 kg a.i. ha^{-1} on 3 days after transplanting (DAT) *followed by* (*fb*) hand weeding on 40 DAT, T_2- pre emergence application of pyrazosulfuron ethyl at 25 g a.i. ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT, T_3- pre emergence application of pyrazosulfuron ethyl at 25 g a.i. ha^{-1} on 3 DAT *fb* early post emergence application of bispyribac sodium at 25 g a.i. ha^{-1} on 8-12 DAT, T_4- pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT, T_5- pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* early post emergence application of bispyribac sodium at 25 g a.i. ha^{-1} on 8-12 DAT, T_6- pre emergence application of pyrazosulfuron ethyl at 25 g a.i. ha^{-1} on 3 DAT *fb* post emergence application of 2,4-D sodium salt at 80 g a.i. ha^{-1}on 25-30 DAT, T_7- pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* post emergence application of 2,4-D sodium salt at 80 g a.i. ha^{-1} on 25-30 DAT, T_8- early post emergence application of bispyribac sodium at 25 g a.i. ha^{-1} on 8-12 DAT *fb* post emergence application of 2,4-D sodium salt at 80 g a.i. ha^{-1} on 25-30 DAT, T_9- early post emergence application of oxadiargyl at 80 g a.i. ha^{-1} on 8-12 DAT *fb* post emergence application of 2,4-D sodium salt at 80 g a.i. ha^{-1}on 25-30 DAT, T_{10}- hand weeding twice at 20 *fb* 40 DAT, T_{11}- unweeded check, T_{12}- weed free check and replicated thrice.

The pre emergence herbicides were applied at 3 DAT as sand mix application and the early post emergence application were applied at 8-12 DAT and post emergence application were applied at 30 DAT through knap sack sprayer using a spray volume of 500 L ha^{-1}.

The data on weed density and dry weight were recorded at 20, 40 and 60 DAT and were subjected to square root x+0.5 transformation before statistical analysis to normalize their distribution.

The growth and yield attributes like number of productive tillers per square metre, number of filled grains per panicle, test weight were recorded at the time of harvesting and threshing were recorded at the time of maturity. Economics of different treatments was calculated taking into account of the prevailing market prices of inputs and output.

Results and Discussion

The weed flora consisted of *Cynodon dactylon*, *Echinochloa colona* and *Panicum repens in* grasses, *Cyperus rotundus* and *Cyperus difformis* in sedges and *Ammannia baccifera*, *Ipomoea aquatica* and *Marsilea quadrifolia* in broad leaved weeds. Grasses were found to be the predominant category followed by sedges and broad leaved weeds.

Table.1 Effect of different weed management practices on weed density, weed dry weight and weed control efficiency of transplanted rice under sodic soil

Treatments	Weed density (no. m^{-2})		Weed dry weight (g. m^{-2})		Weed control efficiency (%)	
	40 DAT	60 DAT	40 DAT	60 DAT	40 DAT	60 DAT
T_1- PE Butachlor *fb* HW on 40 DAT	4.88 (23.3)	4.30 (18.0)	2.32 (4.9)	3.30 (10.4)	82.0	77.9
T_2- PE PSE *fb* HW on 40 DAT	5.90 (34.3)	4.95 (24.0)	2.39 (5.2)	3.08 (9.0)	73.5	70.5
T_3- PE PSE *fb* EPOE Bispyribac	5.64 (31.3)	5.36 (28.7)	2.39 (5.20)	2.96 (8.3)	75.8	64.8
T_4- PE Bensulf + Pretila *fb* HW on 40 DAT	2.59 (6.3)	3.19 (9.7)	1.85 (3.0)	2.16 (4.2)	95.1	88.1
T_5- PE Bensulf + Pretila *fb* EPOE Bispyribac	6.72 (44.7)	5.70 (32.0)	2.57 (6.1)	2.61 (6.3)	65.5	60.7
T_6 - PE PSE *fb* POE 2,4-D Na salt	5.99 (35.3)	5.21 (26.7)	2.44 (5.5)	4.47 (19.5)	72.7	67.2
T_7- PE Bensulf + Pretila *fb* POE 2,4 -D Na salt	3.53 (12.0)	3.76 (13.7)	1.66 (2.3)	2.50 (5.8)	90.7	83.2
T_8 - EPOE Bispyribac *fb* POE 2,4 -D Na salt	4.81 (22.7)	3.88 (14.7)	2.23 (4.5)	2.80 (7.3)	82.5	82.0
T_9 -EPOE Oxadiargyl *fb* POE 2,4 -D Na salt	7.84 (61.0)	6.54 (42.3)	3.14 (9.3)	4.88 (23.4)	52.8	48.0
T_{10} -Hand weeding at 20 and 40 DAT	3.24 (10.0)	3.49 (11.7)	1.69 (2.4)	2.22 (4.5)	92.3	85.7
T_{11} - Unweeded check	11.39 (129.3)	9.04 (81.3)	4.14 (16.7)	5.84 (33.6)	-	-
T_{12} - Weed free check	3.26 (10.7)	3.13 (9.3)	1.31 (1.3)	1.30 (1.5)	-	-
SE d	0.30	0.26	0.16	0.18	-	-
CD (P = 0.05)	0.62	0.53	0.33	0.38	-	-

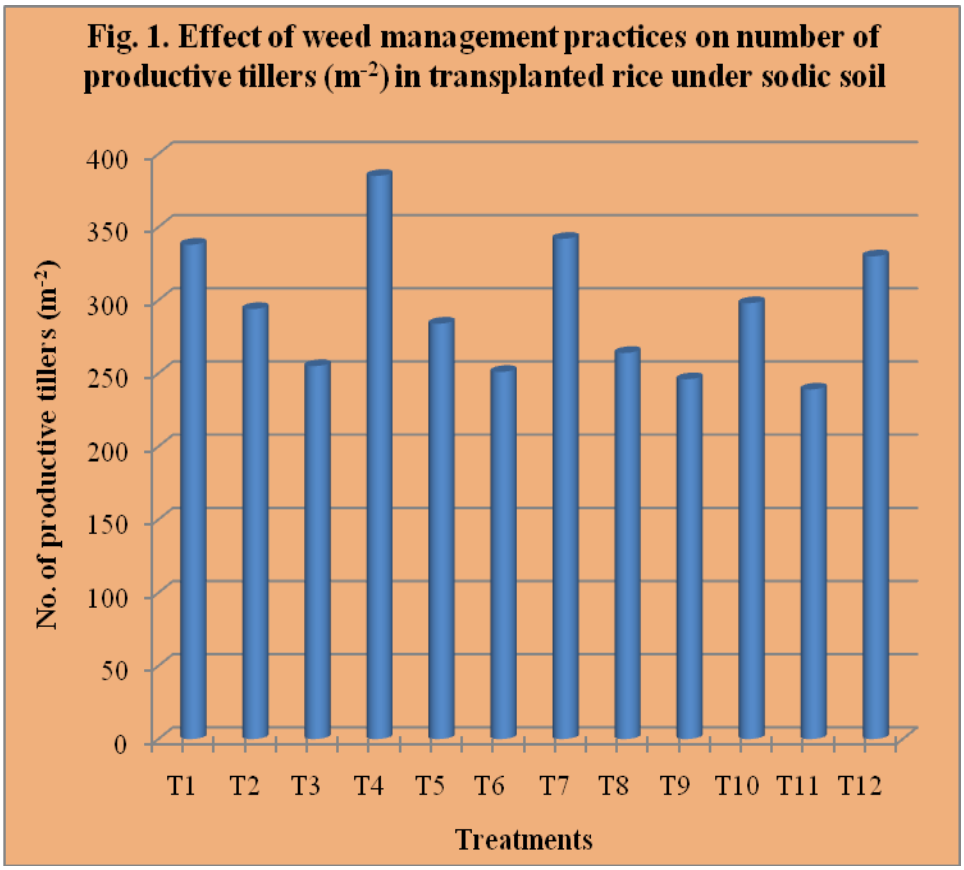
The data were transformed to $\sqrt{x + 0.5}$. The figures in the parenthesis are original values.

Table.2 Effect of different weed management practices on yield contributing characters of transplanted rice under sodic soil

Treatments	No. of productive tillers (m^{-2})	No. of grains panicle^{-1}	Grain yield (kg ha^{-1})
T_1- PE Butachlor *fb* HW on 40 DAT	338	188	4215
T_2- PE PSE *fb* HW on 40 DAT	294	157	4502
T_3- PE PSE *fb* EPOE Bispyribac	255	173	4299
T_4- PE Bensulf + Pretila *fb* HW on 40 DAT	385	182	4987
T_5- PE Bensulf + Pretila *fb* EPOE Bispyribac	284	180	4199
T_6 - PE PSE *fb* POE 2,4-D Na salt	251	155	4088
T_7- PE Bensulf + Pretila *fb* POE 2,4 -D Na salt	342	163	4532
T_8 - EPOE Bispyribac *fb* POE 2,4 -D Na salt	264	156	3435
T_9 -EPOE Oxadiargyl *fb* POE 2,4 -D Na salt	246	192	4046
T_{10} -Hand weeding at 20 and 40 DAT	298	188	4405
T_{11} - Unweeded check	239	112	2943
T_{12} - Weed free check	330	158	4798
SE d	25	10	209
CD (P = 0.05)	53	22	433

Table.3 Economics of weed management

Treatments	Total variable cost(₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
T_1- PE Butachlor *fb* HW on 40 DAT	31219	67440	36221	2.16
T_2- PE PSE *fb* HW on 40 DAT	32399	72032	39633	2.22
T_3- PE PSE *fb* EPOE Bispyribac	34133	68784	34651	2.02
T_4- PE Bensulf + Pretila *fb* HW on 40 DAT	32027	79792	47765	2.49
T_5- PE Bensulf + Pretila*fb* EPOE Bispyribac	36048	67184	31136	1.86
T_6 - PE PSE *fb* POE 2,4-D Na salt	31138	65408	34270	2.10
T_7- PE Bensulf + Pretila *fb* POE 2,4 -D Na salt	35088	72512	37424	2.07
T_8 - EPOE Bispyribac *fb* POE 2,4 -D Na salt	30418	54960	24542	1.81
T_9 -EPOE Oxadiargyl *fb* POE 2,4 -D Na salt	31048	64736	33688	2.09
T_{10} -Hand weeding at 20 and 40 DAT	36418	70480	34062	1.94
T_{11} - Unweeded check	28803	47088	18285	1.63
T_{12} - Weed free check	34128	76768	42640	2.25



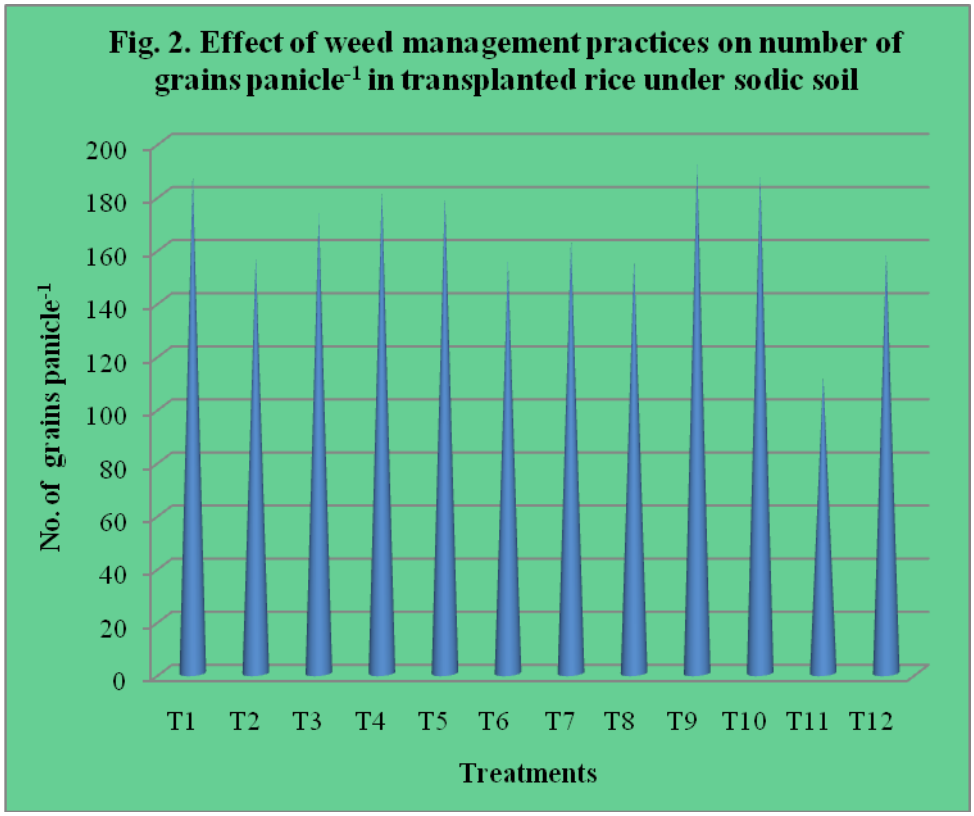


Fig. 2. Effect of weed management practices on number of grains panicle-1 in transplanted rice under sodic soil
No. of grains panicle-1
200
180
160
140
120
100
80
60
40
20
0
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12
Treatments

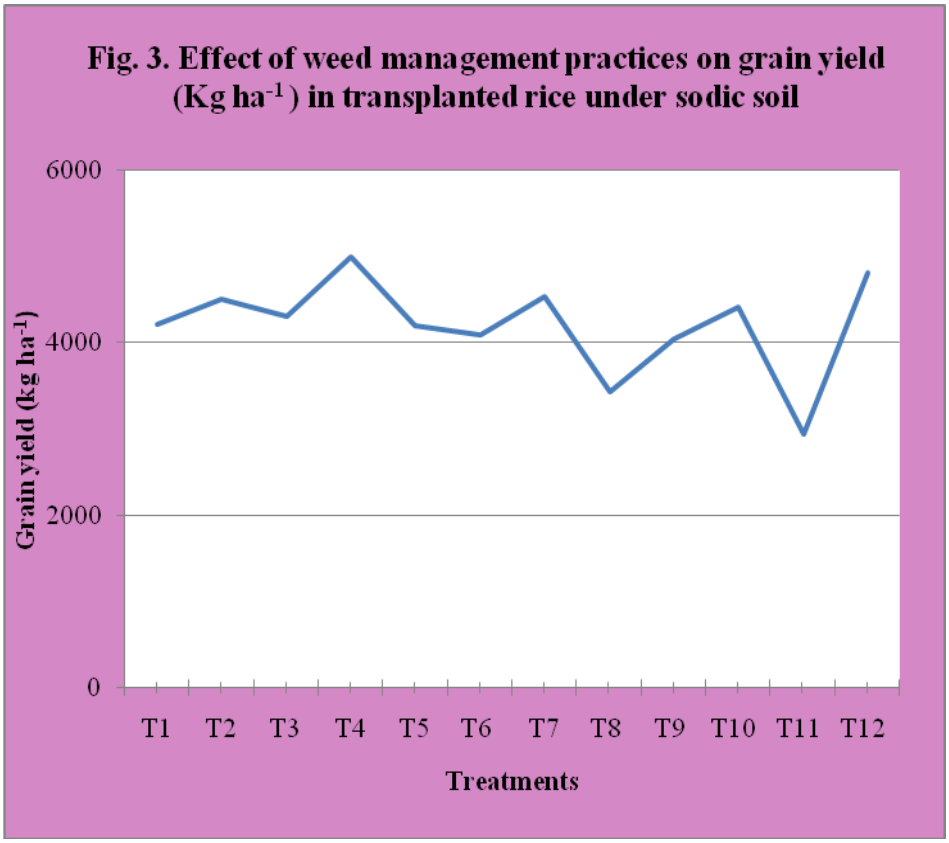
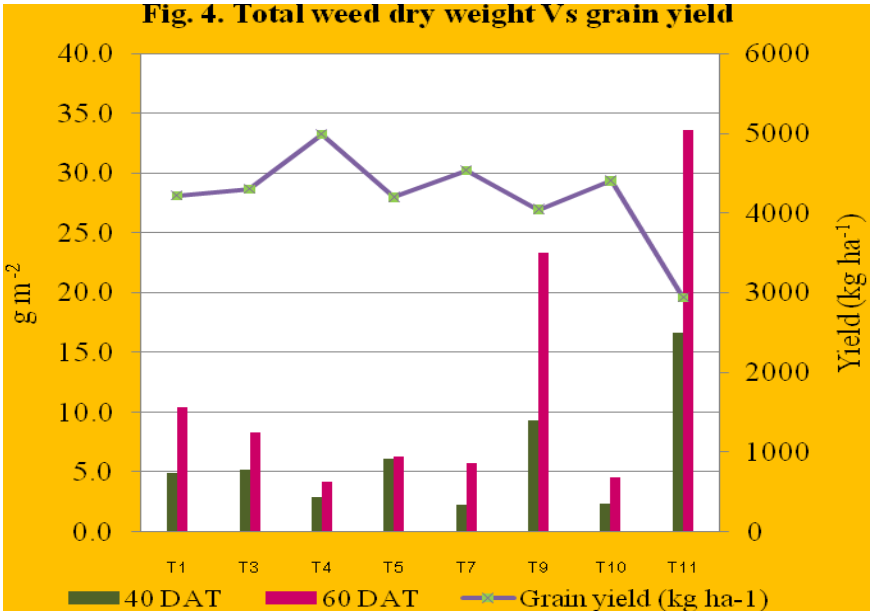


Fig. 3. Effect of weed management practices on grain yield (Kg ha-1) in transplanted rice under sodic soil
Grain yield (kg ha-1)
6000
4000
2000
0
T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12
Treatments



Effect on weed dry weight

The data presented in Table 1 on density and dry weight of weeds revealed that all the weed control treatments reduced the weed dry weight significantly from that of unweeded treatment. Among the weed control treatments, the lowest weed density and weed dry weight were registered in pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT (T_4) at 40 and 60 DAT. It was comparable with weed free check (T_{12}). The highest weed density and dry weight recorded with unweeded check (T_{11}) for all the stages (Fig. 4). Higher weed control efficiency was registered with bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT (T_4).

Effect on yield

A perusal of the data in Table 2, further revealed that among the herbicide treatments, number of productive tillers m^{-2} (385) (Fig. 1) and the highest grain yield (4987 kg ha^{-1}) were obtained with pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT (T_4)and it was on par with weed free check (T_{12}) (4798 kg ha^{-1}) with the weed control efficiency (95.1 %) on 40 DAT. The minimum grain yield and straw yield were observed in weedy check with a yield loss of 40.9% and 35.9%, respectively as compared to T_4 (Fig. 3). An increase in yield of 69.4% over weedy check was observed in case of T_4. Abdhullah (2011), Uma *et al.*, (2014) and Charan Teja (2015) also recorded the highest grain yield with bensulfuron methyl + pretilachlor. This was due to lesser weed competition and better uptake of nutrients by the crop. Yield attributes and grain yield was the lowest in unweeded check (T_{11}). This might be due to interception of light by tall growing *Echinochloa spp.* resulting in poor phytosynthesis and photo-chemical energy supply which ultimately affected the translocation of photosynthates to the developing grains in rice (Murty and Murty, 1982). This has reflected in the lesser number of filled grains with lesser percentage in the unweeded check (T_{11}). Early post emergence application of oxadiargyl at 80 g a.i. ha^{-1} on 8-12 DAT *fb* post emergence application of 2,4-D sodium salt (T_9) and pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT (T_4) registered more grains $panicle^{-1}$(Fig. 2).

Effect on economics

The data in Table 3 indicated that hand weeding is expensive due to high labour cost but use of herbicides was cheaper in cost and effective in

controlling the weeds and reducing total energy required for rice cultivation. Similar findings were reported by Srinivasan and Chaudhary (1993).

The highest gross returns (Rs. 89,597 ha^{-1}) were observed with T_{11}. While the lowest gross returns (Rs. 55,839ha^{-1}) as observed with weedy check. The gross returns followed similar trend as that of grain yield. The highest benefit cost ratio (1.91) was observed with T_{11} and was followed by T_{10} which showed almost the same ratio. All herbicide treatments registered higher benefit cost ratio over weedy check which recorded markedly higher than that observed with hand weeding at 20 and 40 DAT (1.65). The highest benefit cost ratio (BCR) obtained by T_{11} might be due to higher grain yield in this treatment compared to other treatments. The lower BCR in hand weeding treatment was mainly because of higher labour cost involved in hand weeding. Therefore, the higher cost involved in manual weeding was not compensated by the additional grain yield obtained in hand weeding resulting in lower BCR (1.65).

From this study, it could be concluded that under transplanted rice in sodic soil, pre emergence application of bensulfuron methyl + pretilachlor at 60 + 600 g a.i. ha^{-1} on 3 DAT *fb* hand weeding on 40 DAT (T_4) resulted in increased yield attributes and nutrient uptake by rice. This has reflected in increased grain and straw yield. The same treatment has shown broad spectrum of weed control, higher net return and BCR. This was followed by weed free check (T_{12}).

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