EFFECT OF CHEMICAL AND NON-CHEMICAL WEED MANAGEMENT PRACTICES IN DIRECT SEEDED RICE

ABSTRACT

A field experiment was conducted at Regional Research Station, Tamil Nadu Agricultural University, Paiyur, Tamil Nadu, India during the Summer of 2022 to study the effect of herbicide combination and non-chemical weed management techniques in puddled direct seeded rice. The experiment was laidout in a randomized block design with ten treatments and three replications. The treatments include Pre emergence (PE) Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1}, Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1}, Post emergence (PoE) Bispyribac sodium 10% SC @ 25 g ha^{-1}, Power weeder, Hand weeding (HW), Weed free and Weedy check. The results revealed that, among different weed control treatments, PE application of Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* (PoE) Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS (T_5) recorded higher grain yield of 5422 kg ha^{-1} and B: C ratio of 2.35. The higher weed control efficiency of 83.52 % and 55.47 % was recorded at 30 and 60 DAS.Hence,it can be concluded that combination of PE (Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS) and POE (Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS) herbicides along with non-chemical weed management technique (power weeder at 30 DAS and HW at 45 DAS) was found to be effective for weed control in direct seeded puddled lowland rice to deal with the issues of labour shortage and weed infestation faced by farmers.

Keywords: *Bispyribac sodium, Direct seeded rice, Drum seeder, Grain yield, Hand weeding, Power weeder, Pyrazosulfuron ethyl.*

1. INTRODUCTION

India's economy relies greatly on agriculture, which contributed 18.6 percent of the Gross Value Added (GVA) for the country in 2018-19 (1). Moreover, half of the world's population relies on rice as their primary source of food. Rice is the primary crop in India and is grown in almost every state. It plays a vital role in the country's food security and is the backbone of millions of rural households' livelihoods. "Rice is life" is especially applicable in India due to its significance. Rice cultivation in India spans 45.76 million hectares and yields a total of 124.36 million tonnes with an average yield of 2717 kg per hectare. In Tamil Nadu, the total area of rice cultivation is 2.03 million hectares, producing

3379 kg per hectare, and a total production of 6.88 million tonnes. (2). Direct seeded rice (DSR) is a popular method of crop establishment due to its low input requirements. This traditional approach offers many benefits, such as saving on labour, reducing water and labour needs, and achieving early crop maturity. It is also cost-effective, improves soil conditions for future crops, reduces methane emissions, and can complement various cropping systems. In this crop system, the main obstacle to achieving success is managing weed growth. Weeds tend to sprout alongside rice at the same time, unlike transplanted situations where standing water is present during the early stages of rice growth (3). This leads to competition between the weeds and the crop for essential resources such as moisture, nutrients, light, and space. To control weeds, farmers traditionally resort to hand weeding, which is a costly and time-consuming technique that requires a lot of labour. Using herbicides in Direct Seeded Rice (DSR) can lower production costs and effectively control weed growth. A study was conducted to evaluate both chemical and non-chemical methods of weed management to reduce weed species in direct seeded rice.

2. MATERIALS AND METHODS

A field experiment was conducted at the Regional Research Station in Paiyur during the 2022 summer season. The station is situated at 12°37'N latitude, 78°21'E longitude, and 490 meters above mean sea level. The soil at the site was sandy loam with 0.35% organic carbon, a pH of 8.1, and 0.317 dS m^{-1}. The available N, P, and K content in the soil was recorded as 112, 14.78, and 328.98 kg ha^{-1}, respectively. The experiment was framed with ten treatments and three replications, following a randomized block design (Fig1). The treatment details were mentioned in Table 1. The ADT 56 variety was used for the study, and an eight-row drum seeder was employed for the seed sowing. (Fig.3).

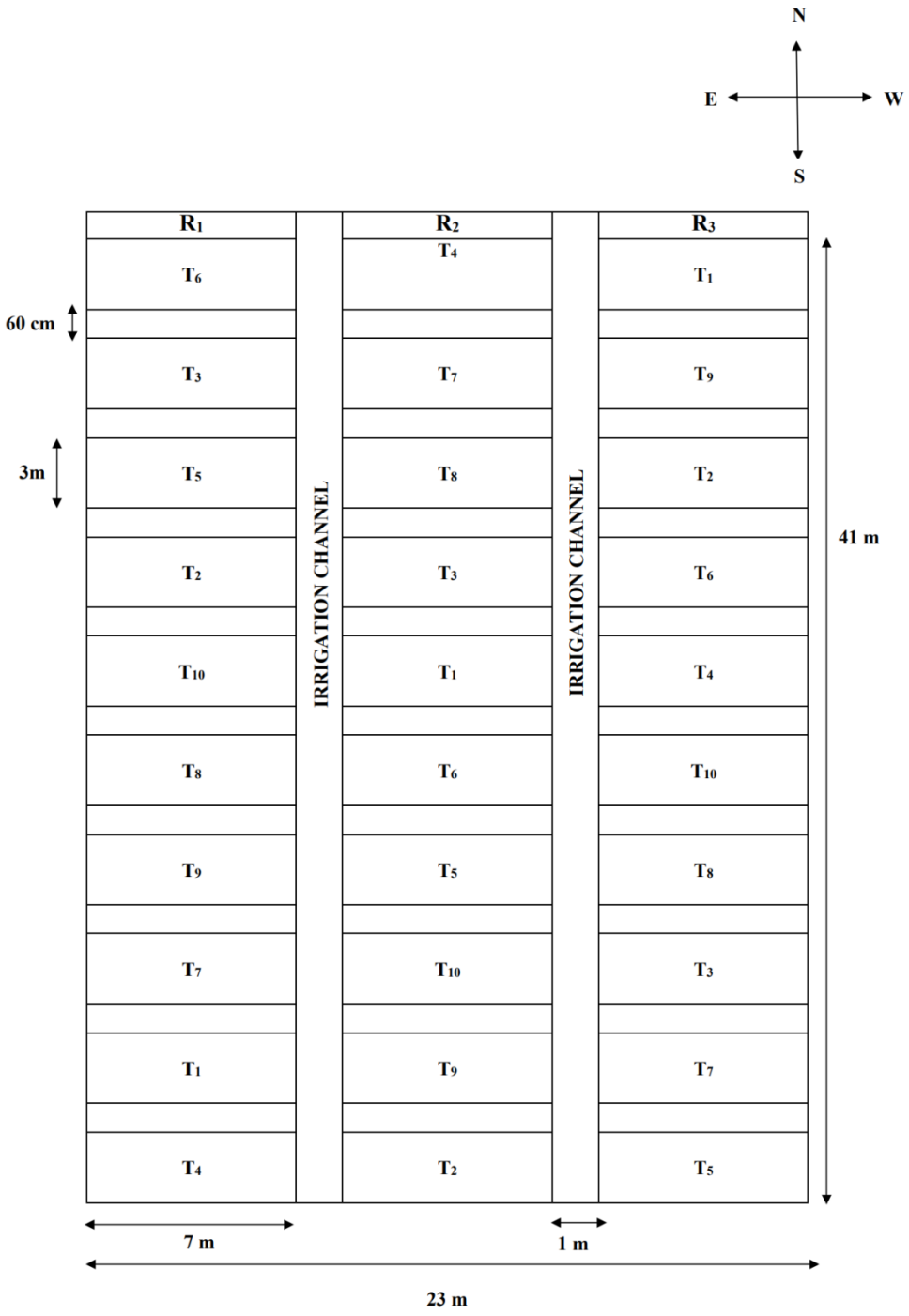

Fig 1. Layout of the field

For optimal crop growth, it is recommended to apply fertilizer at a ratio of 120:40:40 kg of N, P and K per hectare. Urea (46% N), Single superphosphate (16% P), and Muriate of potash (60% K) was used. The full dose of phosphorus was applied at the time of sowing, while nitrogen and potassium were applied in four equal amounts at different stages: basal, active tillering, panicle initiation, and flowering.

Using the approach recommended by (4), statistical analysis was done on all the data relevant to crops and weeds. According to Bartlette (5), the initial values for weeds were changed using the $\sqrt{(X+2)}$ transformation and statistically analyzed. Wherever statistical significance was found, a critical difference (CD) at a 0.05 percent level of probability was calculated for comparison. Non-significant difference was denoted as NS.

Table 1. Treatment details

T_1	PE Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* PoE Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS
T_2	PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} on 3 DAS *fb* PoE Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS
T_3	PE Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* PoE Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS
T_4	PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} on 3 DAS *fb* PoE Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS
T_5	PE Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* PoE Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS
T_6	PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha^{-1} on 3 DAS *fb* PoE Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding on 45 DAS
T_7	Power weeder at 15, 25, and 35 DAS
T_8	Hand Weeding at 15 and 30 DAS
T_9	Weed free
T_{10}	Weedy check

PE -Pre- emergence; PoE- Post emergence; DAS- Days after sowing

3. RESULTS AND DISCUSSION

3.1 Weed spectrum of the experimental field

The dominant weed flora of the experimental fields was *Echinochola colona* (L.), *Echinochloa crusgalli* (L.) among the grasses, *Cyperus difformis* (L.), *Cyperus rotundus* (L.) among the sedges and *Ammania baccifera* (L.), *Bergia capensis* (L.), *Marsilia quadrifolia* (L.), *Eclipta alba* (L.) Hassk. among the broad-leaved weeds.

3.2 Weed density and Weed control Efficiency (WCE)

The weed density on 30 and 60 DAS, as stated in Table 2, consisted mainly of grasses, sedges, and broad-leaved weeds.

The application of pre-emergence herbicide Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS fb Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS fb Power weeder at 30 DAS fb Hand weeding at 45 DAS (T5) resulted in a significant reduction of weed density, with the lowest recorded at 30 and 60 DAS at 11.0 m^{-2} and 36 m^{-2}, respectively. On the other hand, the control (weedy check) showed a higher weed density of 178.3 m^{-2} and 90.6 m^{-2} at 30 and 60 DAS. The weed control efficiency was 83.5% at 30 DAS and 55.4 % at 60 DAS, which is consistent with the findings of Ramesha Y.M *et al.* (6). The study showed that Pyrazosulfuron-ethyl application at a rate of 15 g ha^{-1} successfully reduced weed biomass and density without causing any harm to the rice plant (7); (8).

3.3 Growth characters (Table 3)

The plant height was significantly higher in the weed free (T_9) with 69.5 cm and 113 cm at 60 DAS and harvest stage. This was on par with pre-emergence herbicide Pyrazosulfuron ethyl 10% WP at 20 g ha^{-1} on 3 DAS, followed by Bispyribac sodium 10% SC at 25 g ha^{-1} on 20 DAS, Power weeder at 30 DAS, and Hand weeding at 45 DAS which recorded 68.3 cm and 111 cm at 60 DAS and harvest stage respectively. The control (Weedy check) had the lowest plant height, measuring 32.8 cm and 84.5 cm at 60 DAS and during harvest stage.

Significantly higher number of tillers m^{-2} was recorded in weed free (T_9) at 60 DAS (325 number of tillers m^{-2}) which was on par with application of pre-emergence herbicide Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS (319 number of tillers m^{-2}) at 60 DAS. The lower number of tiller m^{-2} was recorded in control (Weedy check) of 164 number of tillers m^{-2} at 60 DAS. The outcomes were consistent with Rao *et al*. (9), the application of PE Pyrazosulfuron ethyl 200 g ha^{-1} + POE Bispyribac sodium 250 ml ha^{-1} resulted in maximum plant height of 98.6 cm, 32.0 m^{-2} of hills, and 308.0 m^{-2} of tillers.

Dry matter production (DMP) was significantly higher (3834 kg ha^{-1}) at 60 DAS with weed free (T_9) which was on par with Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand

weeding at 45 DAS recorded 3651 kg ha^{-1} whereas lowest dry matter production of 2133 kg ha^{-1} was recorded under Weedy check (T_{10})

Table 2. Effect of different weed management practices on Weed density (No m^{-2}) and Weed control efficiency (WCE) (%)

Treatments	Weed density at 30 DAS				WCE (%) at 30 DAS	Weed density at 60 DAS				WCE (%) at 60 DAS
	Grasses	Sedges	BLW	Total		Grasses	Sedges	BLW	Total	
T_1	2.34 (5)	2.34 (5)	2.47 (5.67)	4.01 (15.67)	82.44	6.54 (42.33)	6.04 (36.00)	5.49 (29.67)	10.42 (108)	26.54
T_2	3.29 (10.33)	3.85 (14.33)	3.44 (11.33)	6.04 (36)	76.64	6.72 (44.67)	6.44 (41)	6.04 (36)	11.05 (121.67)	24.18
T_3	2.02 (3.67)	2.41 (5.33)	2.61 (6.33)	3.97 (15.33)	81.92	5.21 (26.67)	4.85 (23)	4.49 (19.67)	8.39 (69.33)	37.07
T_4	3.44 (11.33)	4.10 (16.33)	3.67 (13)	6.41 (40.67)	75.51	6.01 (35.67)	5.05 (25)	4.88 (23.33)	9.19 (84)	32.86
T_5	1.56 (2.00)	1.93 (3.33)	2.48 (5.67)	3.39 (11)	83.52	3.67 (13)	3.53 (12)	3.39 (11)	6.04 (36)	55.47
T_6	3.39 (11)	4.26 (17.67)	3.80 (14)	6.57 (42.67)	74.78	3.94 (15.00)	3.63 (12.67)	3.44 (11.33)	6.28 (39)	48.46
T_7	3.72 (13.33)	4.67 (21.33)	3.52 (17)	7.22 (51.67)	66.12	5.90 (34)	5.21 (26.67)	5.37 (28.33)	9.48 (89.33)	29.09
T_8	2.73 (7)	2.73 (7)	3.08 (9)	4.85 (23)	80.25	4.41 (19)	4.26 (17.67)	3.58 (12.33)	7.04 (49)	44.91
T_9	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	100.00	0.71 (0)	0.71 (0)	0.71 (0)	0.71 (0)	100.00
T_{10}	8.43 (71)	6.19 (38)	6.29 (39.33)	12.19 (148.33)	0.00	32.53 (117.33)	10.90 (119)	8.99 (81)	17.80 (317.33)	0.00
SE (d)	**0.28**	**0.20**	**0.23**	**0.22**	-	**0.23**	**0.25**	**0.29**	**0.33**	-
CD(P=0.05)	**0.59**	**0.43**	**0.49**	**0.48**	-	**0.49**	**0.54**	**0.61**	**0.71**	-

***Figures in parenthesis are original values (Analysis by √x+0.5 transformation**

Table 3. Effect of different weed management practices on growth characters of direct seeded puddled lowland rice

Treatments	Plant Height (cm)		No of tillers m^{-2}	Dry matter production (kg ha^{-1})
	60 DAS	Harvest	60 DAS	60 DAS
T_1	45.37	95.93	265.00	3124.33
T_2	44.30	91.50	257.67	3075.00
T_3	57.27	103.50	286.67	3344.33
T_4	53.33	101.63	275.67	3185.33
T_5	68.33	111.00	319.00	3651.67
T_6	67.87	109.00	299.33	3553.33
T_7	49.97	99.27	272.67	3135.00
T_8	61.57	108.67	297.33	3431.67
T_9	69.53	113.00	325.00	3834.33
T_{10}	32.80	84.57	164.33	2133.33
SE (d)	**2.56**	**3.51**	**13.91**	**147.15**
CD(P=0.05)	**5.38**	**7.37**	**29.22**	**309.14**

3.4 Yield and Yield Attributes (Table 4)

Significantly higher panicle length of 27.0 cm was recorded in weed free (T_9) which was on par with application of pre-emergence herbicide Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS(T_5) which recorded 26.1 cm whereas lower panicle length of 9.85 cm was recorded in control (weedy check). Weed free recorded significantly higher number of productive tillers (485 m^{-2}) which was on par with application of pre-emergence herbicide Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS (T_5) which recorded 484 m^{-2}. The lower number of productive tillers 225 m^{-2} was recorded in control (weedy check). Similar results also reported by Yadav *et al*. (10). Among the herbicides, Pyrazosulfuron *fb* Bispyribac Sodium (150 g a.i ha^{-1} PE *fb* 25 g a.i ha^{-1} (POE) recorded the highest panicle length, filled grain, unfilled grain, and test weight of grain (11). The adoption of different weed management practices did not have a significant impact on the thousand grain weight. (12)

Rice is still a weak weed competitor (13) and is especially susceptible to yield loss by weeds in the early stages of development (14). When rice is sown directly, these yield

losses frequently become much more severe (15).With regards to yield components, Weed free recorded significantly higher number of filled grains (136 panicle^{-1}) and lower number of ill-filled grains (9 panicle^{-1}) which was on par with application of pre-emergence herbicide Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS (T_5) which recorded 136.3 filled grains panicle^{-1} and number of ill-filled grains was 11 panicle^{-1}.The lower number of filled grains 98.3 panicle^{-1} and highest number of ill-filled grains 29.6 panicle^{-1} were recorded in control (weedy check). The outcomes agree with the findings of Sivakumar *et al.* (16).

With regard to yield, weed free (T_9) recorded higher grain and straw yield (5633 kg ha^{-1} and 7433 kg ha^{-1}) which was on par with application of pre-emergence herbicide Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS(T_5) which recorded the grain and straw yield of 5422 kg ha^{-1} and 7222 kg ha^{-1} respectively. The lower grain and straw yield of 3500 kg ha^{-1} and 5525 kg ha^{-1} were recorded in control (weedy check). This was in conformity with Patil *et al*. (17); Raghavendra *et al*. (18). Adoption of various weed management techniques had no significant effect on the harvest index.

Table 4. Effect of different weed management practices on Yield and Yield attributes of direct seeded puddled lowland rice

Treatments	No of productive tillers m^{-2}	Panicle length (cm)	No of filled grains panicle^{-1}	No of infilled grains panicle^{-1}	1000 grain weight (g)	Grain Yield (kgha^{-1})	Straw Yield (kgha^{-1})	Harvest Index
T_1	430.00	15.03	108.67	23.00	14.27	4465	6265	0.42
T_2	420.33	14.13	107.33	26.00	14.23	4433	6433	0.41
T_3	459.33	19.13	116.33	18.67	14.43	4933	6733	0.43
T_4	448.67	17.63	114.00	20.33	14.37	4850	6650	0.42
T_5	484.33	26.17	136.00	11.00	15.67	5422	7222	0.43
T_6	474.33	23.90	131.33	12.33	15.10	5310	7110	0.43
T_7	438.33	15.87	110.00	22.00	14.30	4654	6454	0.42
T_8	462.33	20.73	120.33	17.00	14.47	5250	7050	0.43
T_9	485.33	27.07	136.33	9.00	15.70	5633	7433	0.43
T_{10}	225.67	9.85	98.33	29.67	13.83	3500	5525	0.41
SE (d)	**24.25**	**1.07**	**4.03**	**1.82**	**0.63**	**167.91**	**223.95**	**0.02**
CD (P=0.05)	**50.95**	**2.25**	**8.47**	**3.84**	**NS**	**352.78**	**470.51**	**NS**

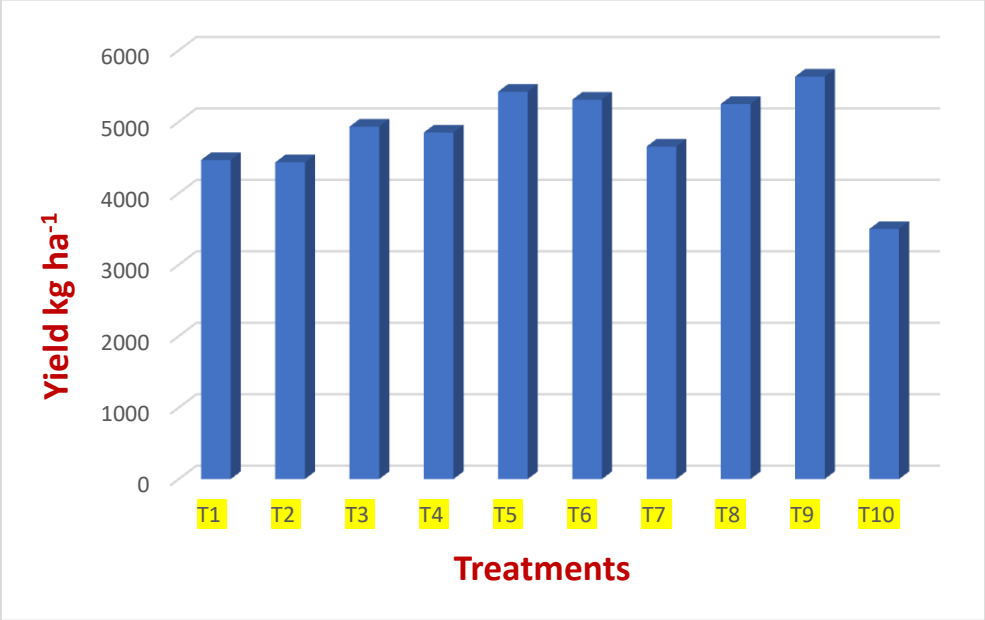

Figure 2. Effect of different weed management practices on Yield (kg ha^{-1})

3.5 Economics of weed management (Table 5)

Weed free (T_9) recorded significantly higher gross income of Rs. 153774, net income of Rs.84216 with B:C ratio of 2.21 which was on par with application of Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS (T_5) which recorded the gross income of Rs. 148183, net income of Rs. 84125 with B:C ratio of 2.35. The lower gross income of Rs. 97812.5 and net income of Rs. 49558 were recorded in control (weedy check). Regarding the economics, (19) highest benefit cost ratio was found with application of pyrazosulfuron ethyl at 20 g a.i ha^{-1} on 8 DAS *fb* POE bispyribac sodium at 25 g a.i ha^{-1} on 30 DAS in drum seeded rice since good weed control was obtained with minimum labour. Also, the results are in line with Kokilam *et al*. (20).

4. CONCLUSION

As a consequence of comparing the various weed management methods, the results showed that the application of pre-emergence herbicide Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* PoE Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS (T_5) recorded maximum yield of 5422 kg ha^{-1} with B:C ratio 2.35 (Fig.4).Hence this treatment should be considered for weed control in direct-seeded

puddled lowland rice to deal with the issues of labour shortage and weed infestation faced by farmers.

Table 5. Effect of different weed management practices on Economics of direct seeded puddled lowland rice

Treatments	Cost of cultivation (Rs ha^{-1})	Gross income (Rs ha^{-1})	Net income (Rs ha^{-1})	B: C ratio
T_1	55058	122822	67764	2.23
T_2	54808	122474	67666	2.23
T_3	58058	135224	77166	2.33
T_4	57808	133025	75217	2.30
T_5	63058	148183	84125	2.35
T_6	64558	145215	81657	2.25
T_7	58558	127831	69273	2.18
T_8	65558	143625	78067	2.19
T_9	69558	153774	84216	2.21
T_{10}	49558	97812	48254	1.97

Figure 3. Drum seed sowing

Figure 4. **T_5 - Pyrazosulfuron ethyl 10% WP @ 20 g ha^{-1} on 3 DAS *fb* Bispyribac sodium 10% SC @ 25 g ha^{-1} on 20 DAS *fb* Power weeder at 30 DAS *fb* Hand weeding at 45 DAS**

Fig 5. T_{10} – Weedy Check (Control)

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