



Effect of Chemical and Non-Chemical Weed Management Practices in Direct Seeded Rice

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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

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at 30 DAS *fb* Hand weeding at 45 DAS (T₅) 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

Table 1. Treatment details

T ₁	PE Pyrazosulfuron ethyl 10% WP @ 20 g ha ⁻¹ on 3 DAS <i>fb</i> 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 <i>fb</i> 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 <i>fb</i> PoE Bispyribac sodium 10% SC @ 25 g ha ⁻¹ on 20 DAS <i>fb</i> Power weeder at 30 DAS
T ₄	PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha ⁻¹ on 3 DAS <i>fb</i> PoE Bispyribac sodium 10% SC @ 25 g ha ⁻¹ on 20 DAS <i>fb</i> Power weeder at 30 DAS
T ₅	PE Pyrazosulfuron ethyl 10% WP @ 20 g ha ⁻¹ on 3 DAS <i>fb</i> PoE Bispyribac sodium 10% SC @ 25 g ha ⁻¹ on 20 DAS <i>fb</i> Power weeder at 30 DAS <i>fb</i> Hand weeding at 45 DAS
T ₆	PE Pyrazosulfuron ethyl 70% WDG @ 21 g ha ⁻¹ on 3 DAS <i>fb</i> PoE Bispyribac sodium 10% SC @ 25 g ha ⁻¹ on 20 DAS <i>fb</i> Power weeder at 30 DAS <i>fb</i> 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

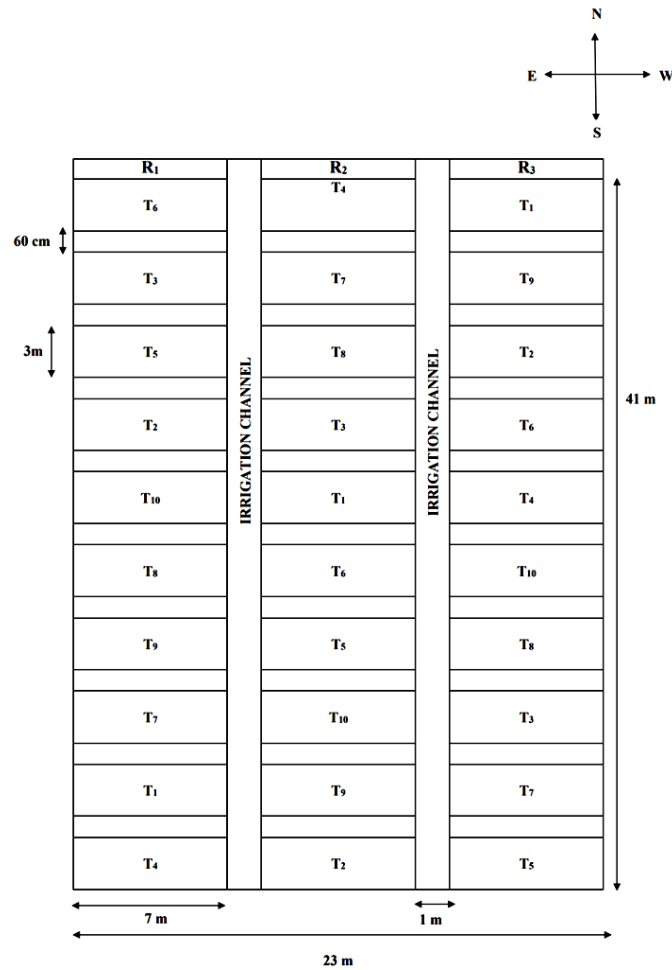


Fig. 1. Layout of the field

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 (Table 1). 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).

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.

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 (T₉) 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 (T₉) 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

(T₉) 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 (T₁₀).

3.4 Yield and Yield Attributes (Table 4)

Significantly higher panicle length of 27.0 cm was recorded in weed free (T₉) 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 (T₅) 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 (T₅) 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 (T₅) 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].

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 $\sqrt{x+0.5}$ 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

Treatments	Plant Height (cm)		No of tillers m ⁻²	Dry matter production (kg ha ⁻¹)
	60 DAS	Harvest	60 DAS	60 DAS
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

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 (kg ha ⁻¹)	Straw Yield (kg ha ⁻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

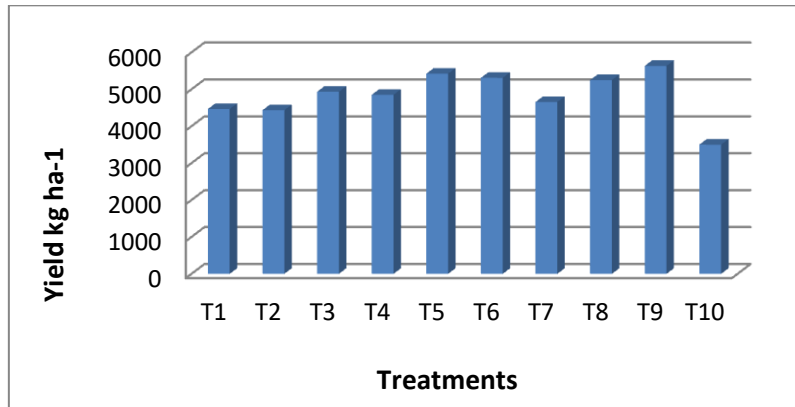


Fig. 2. Effect of different weed management practices on Yield (kg ha⁻¹)



Fig. 3. Drum seed sowing



Fig. 4. T₅ - 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. T₁₀ – Weedy Check (Control)

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

With regard to yield, weed free (T₉) 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 (T₅) 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.

3.5 Economics of Weed Management (Table 5)

Weed free (T₉) 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 (T₅) 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 (T₅) 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.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Annual report 2021-22, Department of Agriculture, 2021, Cooperation & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India. Krishi Bhavan.
2. India stat; 2021-2022. Available: <https://www.indiastat.com/Home/DataSearch?Keyword=Rice%20Production>
3. Chauhan B. Weed ecology and weed management strategies for dry-seeded rice

- in Asia. Weed Technology. 2012;26(1): 1-13.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd Edn. John Wiley and Sons, New York. 2010;704.
 5. Barlette MS. The use of transformation. Biometrics. 1947;3:1-2.
 6. Ramesha YM, Umesh MR, Anand SR, Bhanuvally M, Gaddi AK. Herbicide sequence for weed management in direct seeded rice. Journal of Applied and Natural Science. 2017;9(3):1866-70.
 7. Angiras NN, Kumar S. Efficacy of pyrazosulfuron-ethyl against weeds in rice nursery under mid hill conditions of Himachal Pradesh. Indian Journal of Weed Science. 2005;37(3 and 4):202-4.
 8. Acharya SS, Bhattacharya SP. Comparative efficacy of pyrazosulfuron ethyl and bentazon with acetamides for weed control in transplanted bororice (*Oryza sativa* L.) in the lower gangetic plain zone of West Bengal, India. International journal of Bio-resource and Stress Management. 2013;4(4):506-509.
 9. Rao RS, Kumar JH, Venkataramulu M, Reddy PR. Evaluation of different herbicides in direct seeded rice (*Oryza sativa* L.). International Journal of Current Microbiology and Applied Sciences. 2019; 8(12):790-8.
 10. Yadav DB, Yadav A, Punia SS. Evaluation of bispyribac-sodium for weed control in transplanted rice. Indian Journal of Weed Science. 2009;41(1 and 2): 23-7.
 11. Kumar A, Vivek, RK, Kumar R, Ghasal PC, Chaudhary K, Singh V, Kumar S. Effect of pyrazosulfuron and azimsulfuron in combination with other herbicides on weeds species, growth and yield of transplanted rice in typic ustochrept Soil. Journal of Pharmacognosy and Phytochemistry. 2017;6(4):1550-1556.
 12. Kiran YD, Subramanyam D, Sumathi V. Growth and yield of transplanted rice (*Oryza sativa*) as influenced by sequential application of herbicides. Indian Journal of Weed science. 2010;226-228.
 13. Saito K. Weed pressure level and the correlation between weed competitiveness and rice yield without weed competition: An analysis of empirical data. Field Crops Research. 2010;117(1):1-8.
 14. Khaliq A, Matloob A. Weed-crop competition period in three fine rice cultivars under direct-seeded rice culture. Pakistan Journal of Weed Science Research. 2011;17(3).
 15. Rao AN, Johnson DE, Sivaprasad B, Ladha JK, Mortimer AM. Weed management in direct-seeded rice. Advances in agronomy. 2007;93:153-255.
 16. Sivakumar C, Krishnaveni A, Pandiyan M. Weed management practices in direct seeded rice ecosystem in north western zone of Tamil Nadu. Environment Conservation Journal. 2019;20(3):145-51.
 17. Patil HM, Kusalkar DV, Patil SD, Bhoite KD. Studies on effective herbicidal weed management practice in direct seeded rice under western Ghat zone. Journal of Pharmacognosy and Phytochemistry. 2020;9(2):2009-13.
 18. Raghavendra BM, Susheela R, Rao VP, Madhavi M. Efficacy of different weed management practices on growth and yield of direct wet seeded rice sown through drum seeder. The Bioscan. 2015;10(1):97-101.
 19. Kishore Kumar P. Effect of different wet seeding methods and weed management practices on grain yield of unpuddled rice (*Oryza sativa* L.) in Tamirabarani Command Area. International Journal of Agriculture Sciences, ISSN. 2018;0975-3710.
 20. Kokilam MV, Rathika S, Ramesh T, Baskar M. Weed dynamics and productivity of direct wet seeded rice under different weed management practices. Indian Journal of Agricultural Research. 2023; 57(3):347-51.

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