



RESEARCH ARTICLE

Synergistic effects of new generation herbicides and cultural practices on the performance and economics of direct-seeded rice

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Received: 30 January 2026; Accepted: 18 May 2026; Available online: Version 1.0: 22 July 2026

Cite this article: Jothilakshmi B, Suresh KSM, Baradhan G, Sathiya NG, Sivanantha J, Madhusree S, Soundhar RS. Synergistic effects of new generation herbicides and cultural practices on the performance and economics of direct-seeded rice. *Plant Science Today*. 2026; 13(sp5): 1-5.

<https://doi.org/10.14719/pst.13740>

Abstract

Weed infestation is a major production constraint in direct-seeded rice (DSR), causing severe yield losses due to intense crop weed competition. A field study was conducted at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar, Tamil Nadu during the kharif seasons of 2022 and 2023 to assess the efficacy of new generation herbicides and cultural practices on weed suppression, crop performance and economic returns in DSR. The study employed a randomised block design with 3 replications, comprising treatments of bensulfuron methyl + pretilachlor (PE), triafamone + ethoxysulfuron (EPoE) and bispyribac sodium (PoE), each combined with manual or cono weeding, along with an unweeded control. Results indicated that bensulfuron methyl 0.6 % + pretilachlor 6 % granules (GR) (PE) at 10 kg ha⁻¹ on 7 days after sowing (DAS) followed by manual weeding on 40 DAS (T₄) achieved the most effective weed control, with weed control efficiencies of 77.95 % and 81.68 % and grain yields of 4.86 and 5.30 t ha⁻¹ in both seasons. While the treatment of bensulfuron methyl 0.6 % + pretilachlor 6 % GR (PE) at 10 kg ha⁻¹ on 7 DAS followed by manual weeding on 40 DAS (T₄) maximised productivity, T₅ (bensulfuron methyl 0.6 % + pretilachlor 6 % GR (PE) at 10 kg ha⁻¹ on 7 DAS followed by cono weeding on 40 DAS) recorded the highest benefit-cost ratio, indicating better economic efficiency. The study clearly demonstrates that the integration of pre-emergence herbicides with cono weeding provides an efficient and economically viable weed management strategy for DSR under labour- and water-constrained conditions.

Keywords: cono weeding; direct-seeded rice; economic viability; herbicides; integrated weed management

Introduction

Rice is the most widely cultivated cereal and the primary source of nutrition for over half of the global population. In India, rice is grown on about 50 million hectares, producing 145 million tonnes with an average productivity of 4.35 t ha⁻¹ (1). Puddled transplanted rice (PTR) remains the predominant method of rice cultivation, but its long-term sustainability is under critical scrutiny due to excessive water use, soil degradation, green house gases and high labour demand (2). In response, direct-seeded rice (DSR) is gaining recognition as a sustainable, resource efficient alternative, particularly in regions facing water scarcity and labour shortages. Direct-seeded rice offers a water-saving advantage by reducing the dependency on continuous ponding, leading to 15–20 % less water than PTR. It also lowers labour requirements, enhances operational efficiency, facilitates planting, reduces methane emissions and serves as a more cost-effective, environmentally sustainable alternative to the conventional PTR system (3–5). However, weed proliferation is more pronounced in DSR than in transplanted systems due to the absence of a standing water layer that naturally

suppresses weed emergence (6). Early weed flush under DSR occurs within the first two weeks after sowing, emphasising the importance of early-stage weed control. Without proper management, severe weed infestations can lead to significant yield reductions or even complete crop failure (7). Effective weed management is therefore essential for optimising the benefits of DSR. Labour shortages and the rising costs of manual weeding have made herbicides an integral component of DSR cultivation (8). At the same time, economic sustainability remains a critical consideration, especially for farmers in resource-limited areas. Addressing these challenges requires integrated strategies that balance input use with profitability. The combination of pre-emergence herbicide application and manual weeding reduces dependence on chemical control measures; however, this approach results in higher labour expenses. Alternatively, cono weeding, a labour saving technique, provides an alternative approach by improving weed control efficiency with reduced labour input (9). Therefore, the present study was undertaken to evaluate weed management practices that are both effective and economically sustainable for DSR cultivation.

Materials and Methods

The field experiment was conducted at the Experimental Farm, Department of Agronomy, Annamalai University, Annamalai Nagar [11° 24' N, 79° 44' E, +5.79 m mean sea level (MSL)] during the kharif season of 2022 and 2023 to evaluate the performance of new generation herbicides and cultural practices on weed dynamics, crop performance and economic efficiency in DSR. The region is characterised by a moderately warm climate, with relatively high temperatures during the summer months. The experimental soil was clay loam in texture, with a pH of 7.5, organic carbon content of 0.48 %, low available nitrogen (248 kg ha⁻¹), medium available phosphorus (21.7 kg ha⁻¹) and high available potassium (292 kg ha⁻¹).

The experiment was replicated three times using a randomised block design with 9 treatments comprising different weed management practices. The treatments were included unweeded control (T₁), twice manual weeding on 20 and 40 days after sowing (DAS) (T₂), twice cono weeding on 20 and 40 DAS (T₃), bensulfuron methyl 0.6 % + pretilachlor 6 % granules (GR) (PE) at 10 kg ha⁻¹ on 7 DAS followed by manual weeding on 40 DAS (T₄), bensulfuron methyl 0.6 % + pretilachlor 6 % GR (PE) at 10 kg ha⁻¹ on 7 DAS followed by cono weeding on 40 DAS (T₅), triafamone 20 % + ethoxysulfuron 10 % WG (EPoE) at 225 g ha⁻¹ on 12 DAS followed by manual weeding on 40 DAS (T₆), triafamone 20 % + ethoxysulfuron 10 % WG (EPoE) at 225 g ha⁻¹ on 12 DAS followed by cono weeding on 40 DAS (T₇), bispyribac sodium 10 % SC (PoE) at 200 mL ha⁻¹ on 20 DAS followed by manual weeding on 40 DAS (T₈), bispyribac sodium 10 % SC (PoE) at 200 mL ha⁻¹ on 20 DAS followed by cono weeding on 40 DAS (T₉).

The rice variety “ADT 43” was sown at 40 kg ha⁻¹ with a spacing of 25 × 10 cm in the gross plot of 20 m². The recommended fertiliser dose of 120:40:40 kg N:P:K ha⁻¹ were applied following standard agronomic practices. Herbicide application was carried out as per the treatment plan, manual and cono weeding was performed on 20 and 40 DAS according to the respective treatments. Herbicides were applied as per the treatment schedule using 500 L of water per hectare and applied using a knapsack sprayer fitted with flat fan nozzle.

Biometric observations on weed, crop growth and yield attributes were recorded and the mean values were taken. The data on weed biomass and density showed high variation and were subjected to $\sqrt{x+0.5}$ transformation before analysis. Weed control efficiency was calculated by using the formula suggested by Mani et al. (10). The experimental data on weeds and crops were statistically analysed as per the procedure to find out the treatment difference by Gomez and Gomez (11). Results from both years were recorded and treatment differences were tested using analysis of variance (ANOVA).

Results and Discussion

Weed flora

The experimental field was predominantly infested with grassy weeds such as *Echinochloa colona*, *Echinochloa crus-galli* and *Leptochloa chinensis*; followed by sedges, namely *Cyperus difformis* and *Cyperus rotundus*; and the broad-leaved weed of *Eclipta alba*, collectively representing a weed flora composition characteristic of the DSR ecosystem.

Effect on weed density, weed dry matter and weed control efficiency

The weed density and weed dry matter were significantly influenced by different weed management practices during both kharif 2022 and 2023 (Table 1). Among the treatments, the application of bensulfuron methyl 0.6 % + pretilachlor 6 % GR (PE) at 10 kg ha⁻¹ at 7 DAS followed by manual weeding at 40 DAS (T₄) recorded the lowest weed density (68.24 and 53.31 m⁻²) and weed dry matter (40.19 and 27.32 g m⁻²) with the highest weed control efficiency of 77.95 % and 81.68 % in both seasons. On average, T₄ reduced weed density by 79.82 % compared to the unweeded control, with consistent performance across seasons. Bensulfuron methyl + pretilachlor followed by cono weeding (T₅) was the subsequently most effective treatment and was statistically comparable to triafamone + ethoxysulfuron followed by manual weeding (T₆). The superior weed suppression under T₄ was due to the combined action of bensulfuron methyl and pretilachlor. Bensulfuron methyl, a sulfonylurea herbicide, inhibits acetolactate synthase (ALS), resulting in disruption of amino acid synthesis and subsequent inhibition of weed growth through absorption by young shoots and secondary roots. Pretilachlor complements this action by inhibiting weed seed germination and seedling establishment through interference with cell division and protein synthesis (12). The broad-spectrum activity of this herbicide combination against grasses, sedges and broad-leaved weeds effectively reduced weed density and dry matter accumulation, which consequently enhanced weed control efficiency. Similar findings on improved weed suppression and reduced weed biomass due to integrated herbicide action have also been reported earlier (13, 14). In contrast, significantly higher weed density and dry matter accumulation were observed under the unweeded control (T₁) due to the uninterrupted growth of weeds throughout the crop cultivation period, leading to an overall increase in their abundance (15).

Effect on crop growth, yield attributes and yield

The weed management practices significantly influenced crop growth and yield parameters (Table 2). Among the treatments, T₄ recorded significantly higher plant height (99.42 and 105.14 cm), number of tillers (11.18 and 12.56 hill⁻¹) and dry matter accumulation (10.43 and 11.94 t ha⁻¹) during 2022 and 2023 respectively. The superiority of T₄ was attributed to effective weed suppression during early and later stages, reducing competition for essential resources and thereby improving nutrient uptake, photosynthetic efficiency and assimilate production, ultimately enhancing vegetative growth (16, 17). The reduction in growth parameters under the unweeded control (T₁) was primarily due to severe weed interference during the initial growth phases of the crop, which significantly restricted the availability of vital resources such as nutrients, moisture, light and rooting space. This, in turn, hindered the overall vegetative growth and biomass development of the crop (18). Treatment T₄ recorded the highest number of productive tillers (329.54 and 362.13 m²) and filled grains per panicle (98.97 and 108.76) during both seasons. The enhanced yield attributes under T₄ may be attributed to improved source-sink relationships resulting from better crop establishment and sustained weed-free conditions (19, 20). Similar improvements were also observed under T₅ and T₆, indicating the effectiveness of combining chemical and cultural weed control measures. Yield attributes were adversely affected under unweeded control (T₁) due to severe weed infestation, which restricted the availability of nutrients and essential resources to the crop (21). Grain yield was

Table 1. Efficacy of new generation herbicides in combination with cultural practices on weed density, weed dry matter and weed control efficiency at 60 days after sowing in direct-seeded rice

Treatments	Total grass population (No. m ⁻²)			Total sedges population (No. m ⁻²)			Total broad leaved weeds population (No. m ⁻²)			Total weed density (No. m ⁻²)			Total weed dry matter (g m ⁻²)			Weed control efficiency (%)		
	2022	2023		2022	2023		2022	2023		2022	2023		2022	2023		2022	2023	
T ₁	11.39 (129.30)	10.94 (119.08)		12.65 (159.50)	12.36 (152.30)		4.61 (20.71)	4.48 (19.54)		17.61 (309.51)	17.07 (290.92)		13.41 (179.43)	13.07 (170.29)		-	-	
T ₂	7.04 (49.04)	6.56 (42.50)		7.84 (61.01)	7.32 (53.08)		2.92 (8.05)	2.73 (6.94)		10.89 (118.09)	10.15 (102.52)		8.13 (65.52)	7.54 (56.38)		61.84	64.76	
T ₃	8.53 (72.33)	8.22 (67.00)		9.24 (84.83)	8.89 (78.62)		4.20 (17.15)	3.71 (13.30)		13.22 (174.32)	12.63 (158.92)		9.77 (94.91)	9.34 (86.75)		43.68	45.37	
T ₄	5.31 (27.67)	4.71 (21.70)		6.04 (36.03)	5.35 (28.09)		2.24 (4.54)	2.00 (3.52)		8.29 (68.24)	7.34 (53.31)		6.38 (40.19)	5.27 (27.32)		77.95	81.68	
T ₅	5.73 (32.29)	5.19 (26.46)		6.53 (42.09)	5.92 (34.52)		2.46 (5.56)	2.22 (4.44)		8.97 (79.94)	8.12 (65.42)		6.80 (45.77)	5.87 (33.93)		74.17	77.51	
T ₆	5.92 (34.60)	5.46 (29.32)		6.73 (44.75)	6.20 (37.94)		2.57 (6.09)	2.32 (4.86)		9.27 (85.41)	8.52 (72.12)		7.10 (49.95)	6.14 (37.14)		72.39	75.21	
T ₇	6.51 (41.94)	6.04 (36.00)		7.37 (53.81)	6.82 (46.02)		2.78 (7.25)	2.52 (5.84)		10.17 (103.00)	9.40 (87.86)		7.65 (58.09)	6.94 (47.62)		66.72	69.80	
T ₈	7.57 (56.75)	7.12 (50.20)		8.31 (68.55)	7.82 (60.71)		3.19 (9.65)	2.92 (8.03)		11.64 (134.95)	10.93 (118.94)		8.67 (74.75)	8.14 (65.73)		56.40	59.12	
T ₉	8.04 (64.09)	7.56 (56.68)		8.85 (77.86)	8.37 (69.57)		3.40 (11.04)	3.10 (9.13)		12.39 (152.98)	11.66 (135.38)		9.38 (87.49)	8.74 (75.96)		50.57	53.46	
SEm±	0.11	0.10		0.12	0.11		0.05	0.05		0.16	0.16		0.12	0.12		-	-	
CD (p = 0.05)	0.32	0.31		0.35	0.34		0.15	0.14		0.50	0.47		0.37	0.35		-	-	

Data in the parenthesis indicates the original values, outside are square root transformed values. **SEm±** : Standard error of the mean; **CD**: critical difference

Table 2. Efficacy of new generation herbicides in combination with cultural practices on growth attributes, yield attributes and yield of direct-seeded rice

Treatments	Plant height (cm)		Number of tillers hill ⁻¹		Dry matter production (t ha ⁻¹)		No. of productive tillers m ⁻²		No. of filled grains panicle ⁻¹		Grain yield (t ha ⁻¹)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
T ₁	69.45	72.99	5.91	6.72	4.54	5.19	222.28	249.75	58.86	66.14	1.94	2.14
T ₂	85.95	90.34	8.76	9.95	8.44	9.48	275.12	312.64	77.90	89.66	3.74	4.21
T ₃	73.15	77.65	6.80	7.55	7.19	8.06	238.64	265.16	64.64	72.93	3.13	3.55
T ₄	99.42	105.14	11.18	12.56	10.43	11.94	329.54	362.13	98.97	108.76	4.86	5.30
T ₅	95.08	101.19	10.54	11.84	9.67	10.85	316.55	347.86	93.40	102.64	4.54	4.95
T ₆	93.06	98.35	10.38	11.53	9.39	10.66	313.69	340.97	90.95	99.95	4.41	4.82
T ₇	88.47	94.37	9.53	10.71	8.70	10.10	292.22	328.34	84.43	94.86	4.04	4.51
T ₈	80.57	86.04	8.06	9.16	7.92	8.97	266.90	296.56	73.65	84.06	3.58	3.97
T ₉	76.58	81.93	7.59	8.63	7.65	8.53	243.97	280.43	69.09	78.26	3.35	3.77
SEm±	1.11	1.18	0.12	0.13	0.11	0.13	3.63	4.05	1.04	1.17	0.05	0.06
CD (p = 0.05)	3.34	3.56	0.35	0.40	0.34	0.39	10.98	12.15	3.15	3.50	0.16	0.18

significantly higher under T₄, recording 4.86 and 5.30 t ha⁻¹ during both years, which can be attributed to the combined effect of pre-emergence herbicide application and hand weeding that effectively suppressed early- and late-emerging weeds, reduced crop-weed competition and resulted in higher biomass accumulation and productive tiller formation, thereby leading to significantly higher grain yields (22). Yield reduction under the unweeded control (T₁) was primarily due to intense interference imposed by a variety of weeds, leading to poor growth and reduced yield formation (14).

Economics

The economic evaluation of different weed management practices was carried out in DSR (Table 3). Bensulfuron methyl + pretilachlor followed by cono weeding (T₅) recorded the highest benefit-cost ratio (B:C ratio) of 2.39 and 2.62 across both years. Although T₄ resulted in higher gross and net returns due to superior yield performance, the increased cost of cultivation associated with manual weeding resulted in a comparatively lower B:C ratio (23). The economic superiority of T₅ highlights the advantage of integrating herbicide application with labour-saving mechanical weed control, which effectively reduced dependence on manual labour and lowered production costs without compromising yield. This combination enhanced overall profitability and proved particularly suitable for labour-scarce and resource-constrained farming systems (24, 25). The consistency of higher B:C ratios across both years further confirms the economic viability and practical feasibility of integrated weed management strategies in DSR.

Conclusion

Based on the findings, the application of bensulfuron methyl 0.6 % + pretilachlor 6 % GR (PE) at 10 kg ha⁻¹ on 7 days after sowing (DAS), followed by cono weeding on 40 DAS (T₅), proved to be the most economically viable option, providing effective weed suppression along with a higher benefit-cost ratio. Although manual weeding after herbicide application resulted in marginally higher yield, the increased labour cost reduced profitability. Therefore, integration of pre-emergence herbicides with labour-saving practices such as cono weeding can be recommended as a practical and sustainable weed management strategy for direct-seeded rice (DSR) under labour-scarce conditions. Future research should focus on evaluating the long term effects of these practices on soil health, herbicide resistance development and overall system sustainability.

Acknowledgements

The authors would like to express my sincere gratitude to Annamalai University, Chidambaram, Tamil Nadu, for providing the facilities, resources and literature necessary for conducting my research and completing this article.

Authors' contributions

BJ contributed to conceptualisation, data curation and writing the original draft. SMSK was responsible for conceptualisation, supervision, funding acquisition and review and editing of the manuscript. GB was involved in writing the original draft, methodology and validation. GSN participated in writing the original draft and editing. JS provided resources, visualisation, methodology and review and editing of the manuscript. SM was involved in review and editing. SSR was responsible for drafting and interpretation of the methodology and results. All authors have read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used ChatGPT in order to improve language and readability. After using this tool/service, the authors reviewed and edited the content as needed and takes full responsibility for the content of the publication.

References

1. USDA. World agricultural production. Washington, DC: Foreign Agricultural Service; 2024–2025.
2. Kaur T, Kaur S, Singh G, Singh M, Singh J, Kaur P, et al. Weed control in direct-seeded rice with ready mix of penoxsulam + pendimethalin. *Indian J Weed Sci.* 2025;57(2):155–9. <https://doi.org/10.5958/0974-8164.2025.00026.6>
3. Saleem MU, Iqbal N, Iqbal S, Khalid UB, Iram A, Akhter M, et al. Reduced water use and labor cost and increased productivity of direct-seeded basmati rice in Punjab, Pakistan. *Sarhad J Agric.* 2020;36(2):603–11. <https://doi.org/10.17582/journal.sja/2020/36.2.603.611>
4. Sen S, Kaur R, Das TK. Weed management in dry direct-seeded rice: Assessing the impacts on weeds and crop. *Indian J Weed Sci.* 2020;52(2):169–74. <https://doi.org/10.5958/0974-8164.2020.00030.1>
5. Verma B, Bhan M, Jha AK, Agrawal KK, Kewat ML, Porwal M. Weed management in direct-seeded rice (*Oryza sativa*) in central India. *Indian J Agron.* 2023;68(2):211–4. <https://doi.org/10.59797/ija.v68i2.362>
6. Tirkey S, Rawat A, Verma B, Dangi RS, Tomar DS. Evaluation of bentazone as post-emergence against weed flora of direct-seeded rice (*Oryza sativa* L.). *J Sci Res Rep.* 2024;30(8):884–91. <https://doi.org/10.9734/jsrr/2024/v30i82308>
7. Singh SK, Kumar HJ, Maurya S, Kumar A, Yadav S, Sah D. Direct-seeded rice: potential benefits, constraints and prospective. *J Sci Res Rep.* 2024;30(7):272–80. <https://doi.org/10.9734/jsrr/2024/v30i72143>

Table 3. Efficacy of new generation herbicides in combination with cultural practices on economics of direct-seeded rice

Treatments	Gross income (Rs. ha ⁻¹)		Net income (Rs. ha ⁻¹)		B:C ratio	
	2022	2023	2022	2023	2022	2023
T ₁	46917	51816	6043	10942	1.15	1.27
T ₂	89425	100935	36551	48061	1.69	1.91
T ₃	75316	85357	29642	39683	1.65	1.87
T ₄	115470	126483	66721	77734	2.37	2.59
T ₅	107833	118148	62684	72999	2.39	2.62
T ₆	105025	115296	55751	66022	2.13	2.34
T ₇	96264	108037	50590	62363	2.11	2.37
T ₈	85491	95381	37817	47707	1.79	2.00
T ₉	80608	90443	36534	46369	1.83	2.05

8. Ameena M. Growth, nutrient uptake and yield of direct-seeded rice as influenced by weed management practices. *Indian J Agron.* 2024;69(3):233–40. <https://doi.org/10.59797/ija.v69i3.5515>
9. Nivetha K, Anandan P, Natarajan S, Pooja K. Performance and efficacy of non-chemical weed management in drum-seeded rice cultivation under the Cauvery Delta Zone. *Int J Res Agron.* 2025;8(8):880–5. <https://doi.org/10.33545/2618060X.2025.v8.i8m.3658>
10. Mani VS, Malla ML, Gautam KC, Das B. Weed killing chemicals in potato cultivation. *Indian Farming.* 1973;23:17–8.
11. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. Manila (Philippines): International Rice Research Institute; New York (NY): John Wiley & Sons; 1984.
12. Karthika R, Subramanian E, Ragavan T, Kumutha K. Studies on crop-weed competition and weed management in direct-seeded rice under puddled and unpuddled conditions. *Int J Chem Stud.* 2019;7(3):2769–73.
13. Mir MS, Singh P, Bhat TA, Kanth RH, Nazir A, Al-Ashkar I, et al. Influence of sowing time and weed management practices on the performance and weed dynamics of direct drum-seeded rice. *ACS Omega.* 2023;8(29):25861–76. <https://doi.org/10.1021/acsomega.3c01361>
14. Palani R, Ramesh T, Rathika S, Balasubramaniam P. Evaluation of weed management techniques in drip-irrigated aerobic rice. *Int J Curr Microbiol Appl Sci.* 2020;9(12):2463–71. <https://doi.org/10.20546/ijcmas.2020.912.291>
15. Yogananda SB, Thimmegowda P, Shruthi GK. Weed management in wet (drum)-seeded rice under the Southern Dry Zone of Karnataka. *Indian J Weed Sci.* 2021;53(2):117–22. <https://doi.org/10.5958/0974-8164.2021.00022.8>
16. Manisankar G, Ramesh T, Rathika S. Effect of different weed management practices on nutrient removal, nutrient uptake and grain yield of transplanted rice (*Oryza sativa* L.) under sodic soil ecosystem. *Int J Curr Microbiol Appl Sci.* 2021;10(5):378–89. <https://doi.org/10.20546/ijcmas.2021.1005.045>
17. Suganya R. Effect of chemical weed management on growth, yield and economics of drum-seeded rice (*Oryza sativa*). *Indian J Agron.* 2024;69(3):247–51. <https://doi.org/10.59797/ija.v69i3.5517>
18. Kalaisudarson S, Srinivasaperumal AP. Study of effect of new herbicides on weed management in transplanted rice. *Plant Arch.* 2019;19(1):621–4.
19. Bhagavathi MS, Ajithkumar M, Sandhiya R. Management of jungle rice (*Echinochloa colona*) through herbicides in transplanted rice. *Indian J Weed Sci.* 2024;56(1):19–23. <https://doi.org/10.5958/0974-8164.2024.00004.2>
20. Reddy MS, Ameena M. Influence of weed management practices on weed flora, crop yield and nutrient uptake in direct-seeded rainfed lowland rice. *J Crop Weed.* 2021;17(2):206–10. <https://doi.org/10.22271/09746315.2021.v17.i2.1472>
21. Iqbal N, Saleem MU, Awan TH, Khalid UB, Iqbal S, Iram A, et al. Effective weed management in dry direct-seeded rice for sustainable productivity. *Appl Sci Bus Econ.* 2017;4:1–8.
22. Sai MV, Murugan G, Chakravarthy GA, Vamshi M. Performance of various weed management approaches on weed dynamics, yield attributes and yield of puddled rice under different planting techniques. *Agric Sci Digest.* 2024;45(1):42–7. <https://doi.org/10.18805/ag.D-5844>
23. Nagarjun P, Dhanapal GN, Sanjay MT, Yogananda SB, Muthuraju R. Energy budgeting and economics of weed management in dry direct-seeded rice. *Indian J Weed Sci.* 2019;51(1):1–5. <https://doi.org/10.5958/0974-8164.2019.00001.7>
24. Satapathy BS, Duary B, Saha S, Munda S, Chatterjee D. Impact of sowing methods and weed control practices on yield and economics of wet direct-seeded rice. *Oryza.* 2021;58(3):375–83. <https://doi.org/10.35709/ory.2021.58.3.4>
25. Sivakumar C, Krishnaveni A, Pandiyan M. Weed management practices in direct-seeded rice ecosystem in north western zone of Tamil Nadu. *Environ Conserv J.* 2019;20(3):145–51. <https://doi.org/10.36953/ECJ.2019.20319>

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

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Publisher information: Plant Science Today is published by HORIZON e-Publishing Group with support from Empirion Publishers Private Limited, Thiruvananthapuram, India.