Plant Archives Vol. 26, Supplement 2, 2026 pp. 605-612 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-2.068

OPTIMIZING MOISTURE REGIMES AND WEED CONTROL FOR SUSTAINABLE AND PROFITABLE DRUM-SEEDED RICE PRODUCTION

Digvijay Singh*[1,2], Anil Kumar Singh[1], Shivam Pathak[2], Harshita Singh[3], Vaibhav Pandey[4], Deepak Kumar Dwivedi[5], Om Prakash[6] and Basant Tamang[5]

[1]Department of Agronomy, College of Agriculture, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, Uttar Pradesh-224229, India
[2]Department of Agronomy, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar-848125, India
[3]Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-21100, India
[4]Department of Agronomy, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh–208002, India
[5]SNRM, CPGS-AS, Central Agricultural University (Imphal), Umiam (Barapani), Ri Bhoi, Meghalaya 793103, India
[6]Krishi Vigyan Kendra, Mamit, Lengpui, Mizoram-796421, India
*Corresponding author E-mail: dvrs0411@gmail.com
(Date of Receiving : 12-05-2026; Date of Revision : 30-06-2026; Date of Acceptance : 17-07-2026)

ABSTRACT

A field experiment was conducted during the *kharif* season of 2021 at the Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (Uttar Pradesh), to optimize Moisture Regimes and Weed Control for Sustainable and Profitable Drum-Seeded Rice Production. The experiment was laid out in a split-plot design, replicated thrice, with three moisture regimes i.e 6 cm irrigation at 1, 4 and 7 days after the disappearance of ponded water (DADPW) in the main plots and five weed management practices i.e weed free, rice-straw mulch @ 3 t ha^{-1}, pretilachlor (PE) @ 0.75 kg a.i. ha^{-1} followed by bispyribac-sodium 10% SC @ 200 mL ha^{-1} (PoE), two hand weedings (20–25 and 40–45 DAS) and a weedy check in the sub-plots, using the variety NDR 2065. Among the main-plot treatments, irrigation of 6 cm at 1 DADPW recorded the highest grain yield (47.5 q ha^{-1}), at par with 6 cm at 4 DADPW (45.7 q ha^{-1}), together with the maximum tillers, dry-matter accumulation, leaf-area index and water-use efficiency (3.1 kg ha^{-1} mm), the lowest values being under 6 cm at 7 DADPW. Among the sub-plot treatments, the weed-free plots gave the highest grain yield (50.1 q ha^{-1}), closely followed by two hand weedings (48.2 q ha^{-1}) and pretilachlor followed by bispyribac-sodium (46.9 q ha^{-1}; weed-control efficiency 91.4%, weed index 6.4%), whereas the weedy check recorded the lowest (33.8 q ha^{-1}). The interaction of 6 cm at 1 DADPW with pretilachlor followed by bispyribac-sodium (I_1W_3) recorded the highest net return (Rs. 80,783 ha^{-1}) and benefit–cost ratio (1.94), and is recommended for profitable, water-efficient drum-seeded rice.
***Keywords* :** Drum-seeded rice, Moisture regimes, Weed management, Bispyribac-sodium, Water-use efficiency.

Introduction

Rice (*Oryza sativa* L.) is the world's most important cereal crop and the staple food of more than two-thirds of the Indian population, contributing over 40% of the national food-grain output. Around 90% of the world's rice is produced and consumed in Asia, where it forms the principal source of dietary energy. With the human population continuing to rise, rice demand in India is projected to reach about 150 million tonnes by 2030, which must be met from a shrinking base of land and water resources. Rice is a highly water-demanding crop, and irrigation accounts for the largest single use of available fresh water. Continuous submergence, though traditionally practised, is increasingly unsustainable as competition for water from domestic and industrial sectors intensifies and rainfall becomes more erratic under a changing climate (Tong *et al.*, 2022; Zhao *et al.*, 2022). Consequently, water-saving establishment methods such as direct- and drum-seeding, together with intermittent irrigation based on the disappearance of ponded water, are being promoted to raise water productivity without compromising yield (Djaman *et al.*, 2018).

Drum-seeding of pre-germinated rice in puddled soil is a labour- and water-saving alternative to conventional transplanting that shortens crop duration and lowers the cost of establishment (Bista, 2018; Pandey and Velasco, 2002). However, its principal limitation is severe weed competition: because crop and weed seedlings emerge simultaneously, heterogeneous weed flora becomes the most important biological constraint, and unchecked weed growth can reduce grain yield by 30–48% or more in direct-seeded systems (Mahajan *et al.*, 2013). No single herbicide effectively controls grasses, sedges and broad-leaved weeds together as either a pre- or a post-emergence treatment; hence sequential or combined applications of pre- and post-emergence herbicides, or their integration with manual weeding, are generally required for season-long weed control (Singh *et al.*, 2017).

Materials and Methods

The experiment was conducted during the *kharif* season of 2021 at the Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar (Kumarganj), Ayodhya, Uttar Pradesh, situated at 26°47′ N latitude and 82°12′ E longitude at an altitude of 113 m above mean sea level, in the subtropical zone of eastern Uttar Pradesh. The soil of the experimental field was silt loam in texture (sand 27.2%, silt 51.9%, clay 20.9%), slightly alkaline in reaction (pH 9.2; EC 0.94 dS m^{-1}), low in organic carbon (0.29%) and available nitrogen (112.4 kg ha^{-1}), and medium in available phosphorus (14.8 kg ha^{-1}) and potassium (248.8 kg ha^{-1}). Soil properties were determined by standard methods mechanical composition by the hydrometer method (Bouyoucos, 1936), organic carbon by Walkley and Black (1934), available N by the alkaline potassium permanganate method (Subbiah and Asija, 1956), available P by Olsen's method (Olsen *et al.*, 1954) and available K by the neutral ammonium acetate method (Hanway and Heidel, 1952).

The experiment was laid out in a split-plot design with three replications. Three moisture regimes in 6 cm irrigation applied at 1 (I_1), 4 (I_2) and 7 (I_3) days after the disappearance of ponded water (DADPW) were assigned to the main plots, while five weed-management practices were allotted to the sub-plots: weed-free (W_1); organic mulch of rice straw at 3 t ha^{-1} (W_2); pre-emergence pretilachlor 50% EC at 0.75 kg a.i. ha^{-1} followed by post-emergence bispyribac-sodium 10% SC at 200 mL ha^{-1} (W_3); two hand weedings at 20–25 and 40–45 DAS (W_4); and a weedy check (W_5). The resulting 15 treatment combinations were accommodated in 45 plots, with gross and net plot sizes of 21.6 m² (3.6 × 6.0 m) and 14.0 m² (2.8 × 5.0 m), respectively, at a spacing of 20 cm.

The medium-duration variety NDR 2065 was sown with a manually operated eight-row drum seeder using pre-germinated seed on 29 June 2021. A thin film of water was maintained at sowing, followed by alternate irrigation and drainage for 8–10 days to aid germination and establishment; thereafter the crop was irrigated to the depth and interval prescribed by the moisture-regime treatments, and irrigation was withheld 15 days before harvest. Pretilachlor was applied within 48 h of sowing and bispyribac-sodium at 14 DAS. The fertilization dose was applied @ 120: 60: 40 kg N_2: P_2O_5 : K_2O ha^{-1}; half of the nitrogen and the full dose of phosphorus and potassium were applied basally through urea, DAP and MOP, and the remaining nitrogen was top-dressed in two equal splits at tillering and panicle initiation. Farmyard manure was applied as per treatment. The crop was harvested at physiological maturity on 8 November 2021.

Observations on plant height, number of tillers m^{-2}, dry-matter accumulation, leaf-area index and weed parameters were recorded at 30, 60, 90 DAS and at harvest on the tagged plants of each plot. Weed density (species-wise) and weed dry weight were recorded from a 1 m × 1 m quadrat, and counts were subjected to square-root ($\sqrt{x}$ + 0.5) transformation before analysis. Weed-control efficiency (WCE) and weed index (WI) were computed as:

Weed indices were calculated using the following formulae:

Weed Control Efficiency (WCE) = DWC –DWT/DWC x 100 DWC

where, DWC and DWT are dry weight of weed from unwedded and weeded plots, respectively.

Weed Index (W I) = a-b/ a x 100

where 'a' and 'b' are grain yields from the best treatments and treatment for which WI is to be computed.

The data were statistically analyzed by Gomez and Gomez (1978).

Results and Discussion

Growth parameters

Plant height, an important growth character, was significantly influenced by the moisture regimes at 60, 90 DAS and at harvest, significantly the tallest plants (104.4 cm) were registered under 6 cm at 1 DADPW (I_1), which was at par with 6 cm at 4 DADPW (102.1 cm) and significantly highest to 6 cm at 7 DADPW (92.9 cm). A similar trend was apparent for dry-matter accumulation, number of tillers and leaf-area index, all of which remained non-significant at 30 DAS but were significantly the highest under I_1 at the subsequent stages, I_1 recording an increment of 27.4% in dry matter, 19.7% in tiller number and 13.2% in leaf-area index over I_3. This improvement under the shorter irrigation interval can be attributed to the maintenance of adequate soil moisture during the vegetative phase, which promoted better germination, root and tiller production and canopy expansion. Similar results have been reported by (Djaman *et al.,* 2018).

Among the weed management practices, plant height varied between 92.5 cm and 105.3 cm, with significantly the tallest plants (105.3 cm) registered in the weed-free treatment (W_1), closely followed by two hand weedings (103.2 cm) and the sequential application of pretilachlor (PE) *fb* bispyribac-sodium (PoE) (100.7 cm), and these were at par with the weed-free check. The weed management practices had a similar impact on the other growth parameters. The weed-free treatment recorded significantly the highest number of tillers (300.0 m^{-2}), dry-matter accumulation (1244.1 g m^{-2}) and leaf-area index (5.07 at 90 DAS), being in each case at par with two hand weedings and the herbicide sequence. The percentage increase in tiller number under W_1 and W_4 over the weedy check (W_5) was 22.2 and 20.6%, respectively, while the corresponding increase in dry-matter accumulation was 44.9 and 39.5% and in leaf-area index 31.0 and 28.7%, respectively. Due to severe competition for both above and below-ground resources on account of higher weed infestation, the weedy check depicted significantly the lowest values for all growth parameters. Sequential application of pre- and post-emergence herbicides had a favourable effect on crop growth parameters (Mohapatra *et al.*, 2016).

Yield indices and yield parameter

The favourable effect of the shorter irrigation interval was reflected in the number of tillers and panicles m^{-2}. On an average, 6 cm at 1 DADPW (I_1) recorded significantly the highest number of panicles m^{-2} (277.9), with an increase of 19.8% over 6 cm at 7 DADPW (I_3). Among the weed management practices, apart from the weed-free treatment, two hand weedings and the pretilachlor *fb* bispyribac-sodium sequence produced statistically similar values for the number of panicles m^{-2}; an increment of 22.5 and 19.0% in panicles m^{-2} was registered in W_1 and W_3 over the weedy check, respectively, while all the other treatments produced significantly lower values. Panicle length was significantly affected by both factors, being the longest under I_1 (21.4 cm; a superiority of 17.6% over I_3) and under the weed-free treatment (21.9 cm), which was at par with two hand weedings and the herbicide sequence.

The number of grains panicle^{-1} was non-significant among the moisture regimes, though numerically about 6.6% higher in I_1 than in I_3, but was significantly affected by the weed management practices; the weed-free treatment and the pretilachlor *fb* bispyribac-sodium sequence were statistically at par, there being a gain of 20.1 and 15.7% in the number of grains panicle^{-1} in the weed-free treatment and the herbicide sequence over the weedy check, respectively. The 1000-grain (test) weight remained unaffected by both the irrigation regimes and the weed management practices. Our results align with the findings of (Mohapatra *et al.*, 2016) and (Singh *et al.*, 2017), who reported an increment in the rice seed yield on account of sequential application of pre- and post-emergence herbicides.

The grain yield, straw yield and biological yield were significantly affected by the irrigation levels and weed management practices. The study showed an increase of about 28.0% and 27.1% in grain and straw yield, respectively, in I_1 over I_3, the highest grain yield (47.5 q ha^{-1}) being recorded under I_1, which was at par with I_2 (45.7 q ha^{-1}). (Rejesus *et al.,* 2011) and (Djaman *et al.* 2018) reported an increase in rice yield under intermittent irrigation and alternate wetting and drying, attributed to an increase in the proportion of productive tillers and a change in shoot and root activity. Under the weed management practices, grain yield varied from 33.8 q ha^{-1} in the weedy check to 50.1 q ha^{-1} in the weed-free treatment. In general, all the herbicide and manual treatments registered significantly higher grain yield over the weedy check. The pretilachlor (PE) *fb* bispyribac-sodium (PoE) sequence, though remaining at par with the weed-free treatment and two hand weedings, registered a significantly higher grain yield of 46.9 q ha^{-1}, with a superiority of about 38.8% over the weedy check;

being a season-long weed-control approach, it was at par with the weed-free check. The weed-free treatment, followed by two hand weedings and the herbicide sequence, recorded significantly higher straw yield with a superiority of 42.6, 37.4 and 34.0%, respectively, over the weedy check. The harvest index was non-significant, ranging from 39.35% to 40.30%. Several studies have reported a significant increase in grain yield under sequential application of herbicides in rice (Singh *et al.*, 2017).

Effect on weed flora

The most common weeds in the experimental field were *Echinochloa colona* (L.) Link and *Echinochloa crus-galli* (L.) P. Beauv. among the grasses, *Cyperus rotundus* L. among the sedges and *Phyllanthus niruri* L. among the broad-leaved weeds, along with a small proportion of other associated weeds. Weed dry weight recorded at harvest was significantly affected by the moisture regimes at 90 DAS and at harvest, though non-significant at 30 and 60 DAS. On an average there was an increase of about 19.6% in weed dry weight under 6 cm at 7 DADPW (I_3) over 6 cm at 1 DADPW (I_1); the exposure of the soil surface provides better aeration that favours weed seeds to germinate under the longer irrigation interval (Patel, 2000; Murugan *et al.*, 2019). Among the weed management practices, the weedy check had significantly the highest weed dry weight, whereas the pretilachlor (PE) *fb* bispyribac-sodium (PoE) sequence recorded the lowest values; on an average this treatment resulted in a 91.3% reduction in weed dry weight over the weedy check, while two hand weedings resulted in a 93.7% reduction, and the two were at par with each other.

Similarly, significantly the highest total weed density (85.4 m^{-2}) was recorded under I_3 and the lowest (71.4 m^{-2}) under I_1, there being an increase of 19.6% in weed density in I_3 over I_1. Similarly, the weed management practices significantly influenced the weed population. The maximum number of weeds (253.7 m^{-2}) was recorded in the weedy check and the lowest in the treatment resorting to the sequential application of pretilachlor *fb* bispyribac-sodium (22.0 m^{-2}); a discernible amount of 91.3% reduction in weed population was reflected by this treatment over the weedy check. Furthermore, two hand weedings recorded significantly the highest weed-control efficiency (93.7%), closely followed by and at par with the pretilachlor *fb* bispyribac-sodium sequence (91.4%), while the weed index representing the reduction in yield over the weed-free plot was just 6.4% under the herbicide sequence and 3.8% under two hand weedings, the lowest among the operative treatments, compared with 32.5% in the weedy check. These results are consistent with the findings of Jehangir *et al.* (2024), who reported better weed control while resorting to sequential application of herbicides.

Interaction between moisture regimes and weed management practices

The interaction between the moisture regimes and the weed management practices was significant only for a few weed-density parameters, while it remained non-significant for the growth attributes, yield attributes, yield, water-use efficiency and the density of the major weed species. A significant interaction was recorded for the density of *Cyperus rotundus* at 30 DAS and for the density of other weeds at 30 and 60 DAS. In each case, significantly the lowest weed density was registered under the weed-free treatment, most notably in combination with 6 cm at 1 DADPW (I_1W_1; 1.88 and 0.94 plants m^{-2} for *C. rotundus* and other weeds at 30 DAS, respectively, and complete suppression under the weed-free plots at 60 DAS). Conversely, significantly the highest density was recorded under the weedy check in combination with the longer irrigation intervals in 6 cm at 4 DADPW (I_2W_5) for *C. rotundus* at 30 DAS and 6 cm at 7 DADPW (I_3W_5) for other weeds at both 30 and 60 DAS. This indicates that the suppression of the perennial sedge and the minor weed flora was most effective when the shortest irrigation interval, which favoured a vigorous and competitive crop stand, was coupled with complete weed removal. For the remaining growth, yield and productivity parameters, the absence of a significant interaction indicates that the moisture regimes and the weed management practices acted largely independently of each other (Jehangir *et al.*, 2021).

Water use efficiency

Water-use efficiency (WUE) was significantly affected by both factors. Among the moisture regimes, significantly the highest WUE (3.1 kg ha^{-1} mm) was recorded under 6 cm at 1 DADPW (I_1) and the lowest (2.4 kg ha^{-1} mm) under 6 cm at 7 DADPW (I_3), the superiority of I_1 arising from its higher grain yield relative to the water consumed. Among the weed management practices, the maximum WUE (3.2 kg ha^{-1} mm) was recorded under the weed-free treatment and the minimum (2.2 kg ha^{-1} mm) under the weedy check, the pretilachlor *fb* bispyribac-sodium sequence (3.0 kg ha^{-1} mm) and two hand weedings (3.1 kg ha^{-1} mm) performing almost as well as the weed-free plots. This improvement reflects the higher productivity obtained per unit of water when crop–weed competition was minimised (Lampayan *et al.*, 2015; Tong *et al.*, 2022).

Economics

The economics of drum-seeded rice was significantly influenced by both the moisture regimes and the weed management practices. Among the moisture regimes, the cost of cultivation was significantly the highest under 6 cm at 7 DADPW (Rs.. 55,062 ha^{-1}) and the lowest under 6 cm at 1 DADPW (Rs. 50,238 ha^{-1}). On account of its higher yields, 6 cm at 1 DADPW (I_1) recorded significantly the highest gross return (Rs. 1,13,408 ha^{-1}), at par with 6 cm at 4 DADPW (Rs. 1,09,064 ha^{-1}), along with significantly the highest net return (Rs. 63,170 ha^{-1}) and benefit–cost ratio (1.30), the lowest values being under 6 cm at 7 DADPW (Rs. 33,607 ha^{-1} and 0.63).

Among the weed management practices, the cost of cultivation was significantly the highest under the weed-free treatment (Rs. 68,217 ha^{-1}) and the lowest under the weedy check (Rs. 40,677 ha^{-1}). The gross return was significantly the highest under the weed-free treatment (Rs. 1,19,544 ha^{-1}), at par with two hand weedings (Rs. 1,14,943 ha^{-1}). However, in terms of net return, the pretilachlor (PE) *fb* bispyribac-sodium (PoE) sequence recorded significantly the highest value (Rs. 67,970 ha^{-1}), being about 22 and 32% higher than two hand weedings (Rs. 55,906 ha^{-1}) and the weed-free treatment (Rs. 51,327 ha^{-1}), respectively, owing to its lower weed-management cost. Consequently, it also recorded significantly the highest benefit–cost ratio (1.56). These results are in agreement with the findings of Singh *et al.* (2017). Thus, 6 cm at 1 DADPW along with pretilachlor *fb* bispyribac-sodium was found to be the most profitable and resource-efficient option for drum-seeded rice.

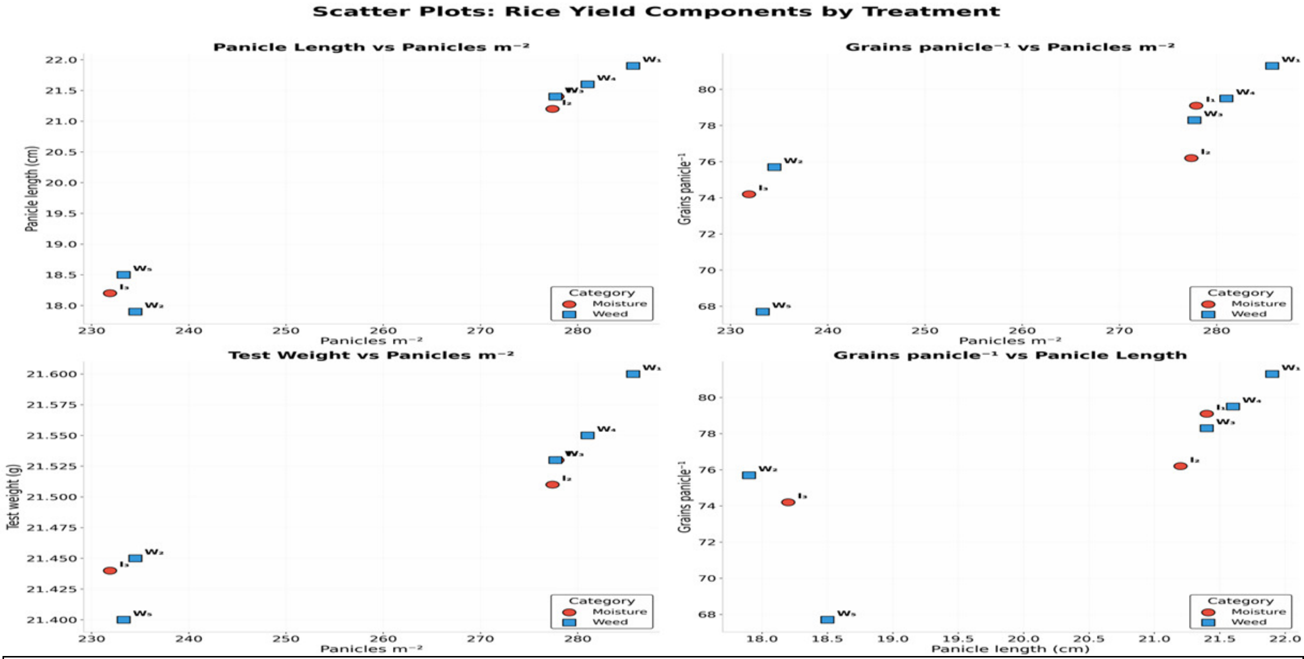
Conclusion

Among the moisture regimes, irrigation of 6 cm at 1 DADPW was the most suitable schedule for drum-seeded rice, recording the lowest weed density and weed dry weight and the highest weed-control efficiency, growth, yield and water-use efficiency, and being at par with 6 cm at 4 DADPW. Among the weed management practices, the weed-free treatment recorded the highest growth and yield, closely followed by two hand weedings and by the sequential application of pretilachlor (PE) *followed by* bispyribac-sodium (PoE), the last providing effective, season-long weed control at a low weed index. Economically, 6 cm at 1 DADPW combined with pretilachlor *followed by* bispyribac-sodium (I_1W_3) recorded the highest net return (Rs. 80,783 ha^{-1}) and benefit–cost ratio (1.94), and is therefore recommended for profitable and water-efficient drum-seeded rice.

Table 1: Effect of moisture regimes and weed management practices on weed dynamics and growth attributes at harvest in drum-seeded rice

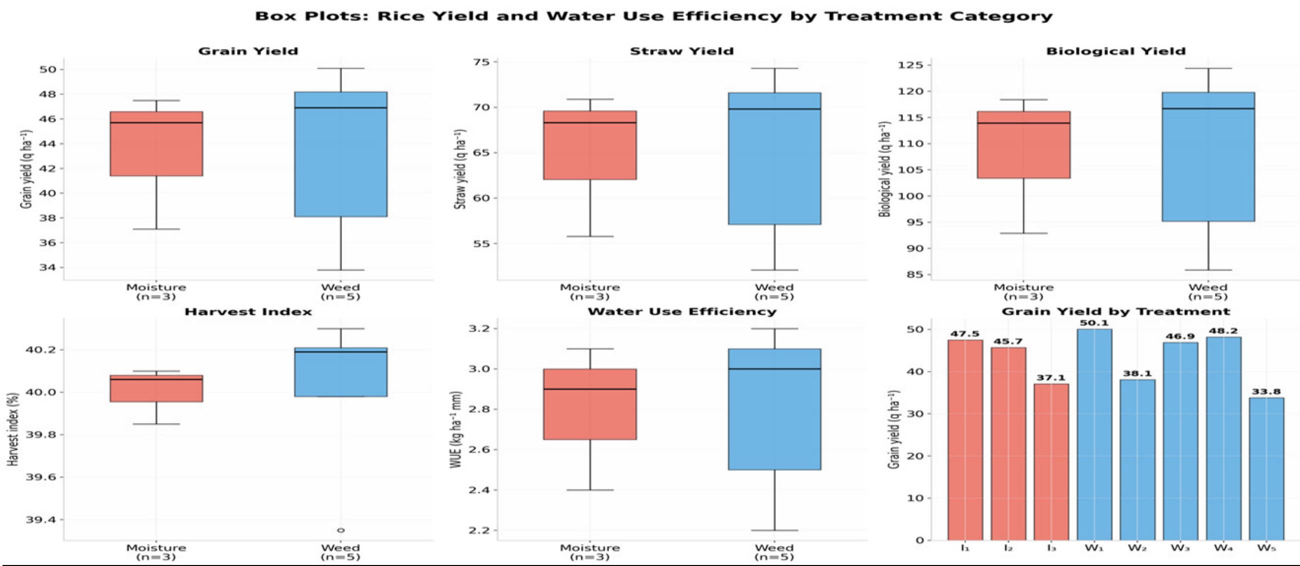
Treatments	Total weed density (No. m^{-2})	Weed dry weight (g m^{-2})	WCE (%)	Weed index (%)	Plant height at harvest (cm)	Tillers m^{-2} at harvest	Dry-matter accumulation at harvest (g m^{-2})	Leaf-area index at 90 DAS
Moisture regimes								
I_1: 6 cm at 1 DADPW	6.73 (71.40) *	4.67 (32.84)	70.00	13.33	104.4	292.2	1183.6	4.98
I_2: 6 cm at 4 DADPW	6.96 (76.20)	4.80 (35.05)	69.40	13.34	102.1	292.0	1139.8	4.75
I_3: 6 cm at 7 DADPW	7.45 (85.40)	5.12 (39.28)	68.83	13.33	92.9	244.2	928.8	4.40
SEm±	0.15	0.09	2.00	0.48	2.39	5.75	21.36	0.11
CD ($p \leq 0.05$)	0.53	0.34	NS	NS	8.26	19.90	73.93	0.39
Weed management practices								
W_1: Weed free	0.71 (0.00)	0.71 (0.00)	100.00	0.00	105.3	300.0	1244.1	5.07
W_2: Organic mulch (rice straw @ 3 t ha^{-1})	9.84 (96.67)	6.69 (44.47)	61.95	23.95	97.3	246.9	952.3	4.71
W_3: Pretilachlor (PE) fb bispyribac-sodium (PoE)	4.73 (22.00)	3.25 (10.12)	91.36	6.39	100.7	292.1	1166.7	4.92
W_4: Two hand weedings (20–25 & 40–45 DAS)	4.04 (16.00)	2.79 (7.36)	93.74	3.79	103.2	296.1	1198.4	4.98
W_5: Weedy check	15.91 (253.67)	10.87 (116.69)	0.00	32.53	92.5	245.5	858.8	3.87
SEm±	0.17	0.09	1.93	0.39	2.51	5.56	22.01	0.12
CD ($p \leq 0.05$)	0.50	0.28	5.63	1.15	7.33	16.23	64.24	0.34

* The value in the bracket is under parenthesis.



Scatter plots showing bivariate relationships among rice yield components under three moisture regimes (I_1–I_3: irrigation at 6 cm depth applied at 1, 4, and 7 days after disappearance of ponded water, respectively; n = 3) and five weed management practices (W_1: weed-free; W_2: organic mulch @ 3 t ha^{-1}; W_3: pretilachlor fb bispyribac-sodium; W_4: two hand weedings at 20–25 and 40–45 DAS; W_5: weedy check; n = 5). Panels show: (A) panicle length vs panicles m^{-2}, (B) grains panicle^{-1} vs panicles m^{-2}, (C) test weight vs panicles m^{-2}, and (D) grains panicle^{-1} vs panicle length. Red circles (●) denote moisture regime treatments and blue squares (■) denote weed management treatments. Each point is labelled with its treatment code."

Fig. 1 : Effect of moisture regimes and weed management practices on yield attributes of drum-seeded rice.



Box plots of rice yield parameters and water use efficiency (WUE) under three moisture regimes (I_1–I_3) and five weed management practices (W_1–W_5). (A) Grain yield, (B) straw yield, (C) biological yield, (D) harvest index, (E) WUE, (F) treatment-wise grain yield comparison. Boxes show the median (bold line) and interquartile range (Q1–Q3); whiskers show the full range. Red = moisture regimes; blue = weed management practices. I_1, I_2, I_3 = irrigation at 1, 4 and 7 days after disappearance of ponded water (DADPW), respectively; W_1–W_5 = weed free, organic mulch (rice straw @ 3 t ha^{-1}), pretilachlor (PE) fb bispyribac-sodium (PoE), two hand weeding, and weedy check, respectively

Fig. 2 : Effect of moisture regimes and weed management practices on yield and water-use efficiency (WUE) of drum-seeded rice.

Table 2: Economics of drum-seeded rice as influenced by moisture regimes and weed management practices (treatment combinations).

Treatments	Cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B: C ratio
Moisture regimes				
I_1: 6 cm at 1 DADPW	50238	113408	63170	1.296
I_2: 6 cm at 4 DADPW	52650	109064	56414	1.105
I_3: 6 cm at 7 DADPW	55062	88669	33607	0.629
SEm±	794	1630	1172	0.028
CD ($p \leq 0.05$)	3200	6573	4725	0.114
Weed management practices				
W_1: Weed free	68217	119544	51327	0.754
W_2: Organic mulch (rice straw @ 3 t ha^{-1})	51309	90854	39545	0.778
W_3: Pretilachlor (PE) fb bispyribac-sodium (PoE)	44011	111981	67970	1.559
W_4: Two hand weedings (20–25 & 40–45 DAS)	59037	114943	55906	0.949
W_5: Weedy check	40677	81247	40570	1.01
SEm±	1275	2226	1151	0.033
CD ($p \leq 0.05$)	3745	6536	3380	0.096

References

Bista, B. (2018). Direct seeded rice: a new technology for enhanced resource-use efficiency. *International Journal of Applied Sciences and Biotechnology*, **6**(3), 181–198.

Bouyoucos, G.J. (1936). Directions for making mechanical analysis of soils by the hydrometer method. *Soil Science*, **42**(3), 225–229.

Djaman, K., Valere, I.D., Mel, C., Diop, L., Sow, A., El-Namaky, R., Manneh, B., Saito, K., Futakuchi, K. and Irmak, S. (2018). Effects of alternate wetting and drying irrigation regime and nitrogen fertiliser on yield and nitrogen use efficiency of irrigated rice in the Sahel. *Water*, **10**, 711.

Gomez, K.A. and Gomez, A.A. (1984). *Statistical Procedures for Agricultural Research*, 2nd edn. John Wiley & Sons, New York.

Hanway, J.J. and Heidel, H. (1952). Soil analysis methods as used in Iowa State College Soil Testing Laboratory. *Iowa Agriculture*, **57**, 1–31.

Jehangir, I.A., Hussain, A., Sofi, N.R., Wani, S.H., Ali, O.M., Abdel Latef, A.A.H., Raja, W. and Bhat, M.A. (2021). Crop establishment methods and weed management practices affect grain yield and weed dynamics in temperate rice. *Agronomy*, **11**, 2137.

Jehangir, I.A., Raja, W., Hussain, A., Al-Shuraym, L.A., Sayed, S.M., Lone, A.H., Shah, Z.A. and Dar, E.A. (2024). Herbicide effectiveness and crop yield responses in direct seeded rice: insights into sustainable weed management. *Advances in Weed Science*, **42**, e020240004.

Lampayan, R.M., Rejesus, R.M., Singleton, G.R. and Bouman, B.A.M. (2015). Adoption and economics of alternate wetting and drying water management for irrigated lowland rice. *Field Crops Research*, **170**, 95–108.

Mahajan, G., Chauhan, B.S. and Gill, M.S. (2013). Dry-seeded rice culture in Punjab State of India: lessons learned from farmers. *Field Crops Research*, **144**, 89–99.

Mohapatra, S., Mohanty, A.K., Tripathy, S.K., Lenka, S., Panigrahy, N. and Nayak, B.R. (2016). Integrated weed management under modified water regimes in System of Rice Intensification. *Indian Journal of Weed Science*, **48**(1), 17–20.

Murugan, G., Bhagavathi, M.S., Stalin, P., Gobi, R. and Balasubramanian, A. (2019). Effect of irrigation practices on weeds and its impact on yield in different rice establishing methods. *Journal of Pharmacognosy and Phytochemistry*, **8**(3), 2199–2201.

Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. (1954). *Estimation of Available Phosphorus in Soils by Extraction with Sodium Bicarbonate*. USDA Circular No. 939. US Government Printing Office, Washington, D.C.

Pandey, S. and Velasco, L. (2002). Economics of direct seeding in Asia: patterns of adoption and research priorities. In: *Direct Seeding: Research Strategies and Opportunities* (Eds. Pandey, S., Mortimer, M., Wade, L., Tuong, T.P., Lopez, K. and Hardy, B.). International Rice Research Institute, Los Baños, Philippines.

Patel, J.R. (2000). Effect of water regimes, variety and blue green algae on rice. *Indian Journal of Agronomy*, ***45***(1), 103–106.

Rejesus, R., Palis, F., Rodriguez, D.G.P., Lampayan, R.M. and Bouman, B.A.M. (2011). Impact of the alternate wetting and drying (AWD) water-saving irrigation technique: evidence from rice producers in the Philippines. *Food Policy*, **36**, 280–288.

Singh, A., Nandal, D.P. and Punia, S.S. (2017). Performance of sequential herbicides to control weeds in direct seeded rice. *Journal of Applied and Natural Science*, **9**(3), 1324–1328.

Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for the estimation of available nitrogen in soils. *Current Science*, **25**, 259–260.

Tong, L., Ulubaşoğlu, M., Ali, M. and Guven, C. (2022). Growing more rice with less water: the System of Rice Intensification and water productivity in Vietnam. *Australian Journal of Agricultural and Resource Economics*, **66**, 581–611.

Walkley, A. and Black, I.A. (1934). An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. *Soil Science*, **37**, 29–38.

Zhao, W., Chou, J., Li, J., Xu, Y., Li, Y. and Hao, Y. (2022). Impacts of extreme climate events on future rice yields in global major rice-producing regions. *International Journal of Environmental Research and Public Health*, **19**, 4437.