



Weed Dynamics as Influenced by Planting Methods, Water Management and Weed Management of Dry Seeded Rice

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(Received: 20 April 2025; Revised: 04 June 2025; Accepted: 29 June 2025; Published online: 22 July 2025)

(Published by Research Trend)

DOI: <https://doi.org/10.65041/BiologicalForum.2025.17.7.34>

ABSTRACT: Field experiments were conducted on rice (*Oryza sativa* L.) to evaluation of weed dynamics as influenced by planting methods, water management and weed management of dry seeded rice, at irrigation plot (UGC, SAP project), Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) for 2 years. The experiment was conducted in split plot design with four replications and 20 treatment combination. Significant reduction in weed density and weed index and maximum grain and straw yield was recorded in furrow irrigated raised bed system of planting. Among the water management, alternate wetting and drying recorded significantly lower weed density and weed index during both the years. Whereas saturation to field capacity accounted maximum grain and straw yield. Among herbicide treatment the flufenacet 120 g a.i./ha *fb* pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds recorded significantly lower weed density and weed index and maximum grain and straw yield, during both the years of experimentation. The interactive effect of planting methods with weed management and water management with weed management also found significant in case of yields during both the years of study.

Keywords: Dry seeded rice, weed index, AWD, FIRB.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important food crop for the majority of the world's population, notably in Asia, where it accounts for greater than 90% of worldwide rice production and consumption. In India, rice occupies 43.90 million hectares with a production of 114.45 million tonnes and productivity of 2.61 t/ha (Directorate of Economics and Statistics 2022) Uttar Pradesh is the largest rice growing state only after West Bengal in the country, where it is raised over an area of about 5.68 m ha with the production of 15.52 Mt and productivity of 2.73 t/ha, respectively (Directorate of Economics and Statistics, 2022). To meet ever-increasing rice demand with shrinking natural resources in a sustainable way is a great challenge. The water crisis is another challenge in rice production. Due to these reasons, there is a need to shift from the conventionally flooded transplantation to direct seeding. Dry seeding of rice not only saves the labour cost for nursery raising and transplanting of rice but also harvest the early shower of monsoon. Dry seeding of rice avoids need for ponding water vis-à-vis transplanting, thus requires ~36% less water (Mohammad *et al.* 2018).

The importance of water management for controlling weeds in rice is well-known but in the absence of standing water, weed become a major issue to hinder the yield. The types and the degree of weed infestation in rice fields are often determined by the type of rice culture, stand establishment technique, moisture regime, land preparation, and cultural practices (Matloob *et al.*, 2014). The importance of water management for controlling weeds in rice is well-known but in the absence of standing water weed become a major issue to reduce the yield. Right herbicides and timely application of it, is a most practical and cost-efficient measure for weed control in DSR. Numerous herbicides have been evaluated for managing weed flora in dry direct-seeded rice (DSR) across the central region of the country. However, their effective utilization requires a region-specific strategy to address the diverse weed spectrum. Accordingly, the present study was undertaken to evaluate the efficacy of selected post-emergence herbicides in DSR (Bijamnia *et al.*, 2022). Hence, it is necessary to evaluate different pre- and post-emergence herbicides that are formulated from time to time to provide wider options to farmers for weed control in dry seeded rice.

MATERIALS AND METHODS

The experiment was conducted in the Irrigation Plots (UGC, SAP project), Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh) situated at 25°18'N latitude, 88°03'E latitude and at an altitude of 75.7 meters above the mean sea level for 2 years. All the plots were surrounded by cemented waterproof brick walls to prevent lateral water seepage and nutrient diffusion between plots. Soils at experiment site was classified as sandy clay-loam, neutral, low in organic carbon, available nitrogen, medium available phosphorus and available potassium. The experiment was laid out in a Split-plot design with a plot size of 16 m² for each treatment. The main plot comprises (2 planting method) viz., Conventional method (flatbed), Farrow irrigated raised bed system (FIRB), (2 water management practices) viz., alternate wetting and drying (AWD) and saturation to field capacity and in subplot 5 weed management practices viz. weedy check (W₀), two hand weeding at 20 and 40 DAS (W₁), pendimethalin 1 kg/ha (PE) fb bispyribac sodium 25 g/ha at 4-6 leaf stage of weeds (W₂), oxadiargyl 90 g/ha (PE) fb penoxsulam 22.5 g/ha at 4-6 leaf stage of weeds (W₃), flufenacet 120 g/ha (PE) fb pyrazosulfuron 20 g/ha + bispyribac sodium 25 g/ha at 4-6 leaf stage of weeds (W₄) were allocated during both the years of experimentation. The bed was prepared at the width of 42 cm and furrow of 20 cm manually to maintain same no of row as 20 cm row spacing in flatbed. Irrigation was given as per treatments. No standing water was kept throughout growth season. For weed free treatment, hand weeding at 20 and 45 DAS was done to maintain weed free condition. The pre-emergence herbicides were applied just after sowing whereas the post-emergence herbicides were applied at 3-4 leaf stage of weeds (15-20 DAS). The Spray volume used for spraying herbicides was 400 L ha⁻¹ for both pre-emergence and post-emergence herbicides. The weed sample were collected by placing a quadrat (0.50 x 0.50 m) randomly at two places in each plot. The observations were taken at different stages viz., at 20, 40, 60, 80 DAS and at harvest.

RESULT AND DISCUSSION

A. Weed density

Major weed species present in experimental field were, *Echinochloa colona*, *E. crus-galli*, *Cynodon dactylon* among grasses; *Cyperus iria*, *C. difformis*, *Fmbristylis miliacea* among sedges and *Ammania baccifera*, *Caesulia axillaris*, *Commelina benghalensis*, *Eclipta alba* and *Ludwigia parviflora* among broad-leaved.

The minimum density of total weeds (Table 1) were observed under furrow irrigated raised bed system planted dry seeded rice, and it was found significantly lower throughout the crop growth over conventional planting during both years of study. Among the water

management treatment, the significantly lower weed density was recorded in alternate wetting and drying treatment and it was superior to saturation to field capacity treatment at 20, 40, 60, 80 DAS and harvest.

Amongst herbicide treatment, the minimum weed density was found under W₄ (flufenacet 120 g a.i./ha fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds) and this was found significantly superior to rest of treatments during both years of experimentation. The W₀ (weedy check) had accounted significantly lowest total weed population during each year of study. Similar finding was reported by Rana *et al.* (2016). Flufenacet disrupts the synthesis of long-chain fatty acids required for cell membrane and cuticle formation in germinating weed seedlings. pyrazosulfuron and bispyribac sodium is a systemic herbicide, it inhibits the synthesis of branched-chain amino acid.

It effectively suppresses various weeds by interfering with the enzyme acetolactate synthase (ALS), which is responsible for growth (Bhattacharya *et al.*, 2022).

Interaction effect of planting methods and weed management on total weed density of dry seeded rice

The combination of planting methods and weed management significantly influences total weed density of dry seeded rice (Table 2). At 40 DAS, significantly lowest total weed density was recorded in combination of furrow irrigated raised bed planting with flufenacet 120 g a.i./ha (PE) fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds during both the years of experimentation and found at par with combination of conventional planting with furrow irrigated raised bed planting with flufenacet 120 g a.i./ha (PE) fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds during second year of study.

Interaction effect of water management and weed management on total weed density of dry seeded rice

The combination of water management and weed management significantly influences total weed density of dry seeded rice (Table 3). At 40 DAS, significantly lowest total weed density was recorded in combination of alternate wetting and drying with flufenacet 120 g a.i./ha (PE) fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds during both the years of experimentation. It found at par with combination of conventional planting with alternate wetting and drying with flufenacet 120 g a.i./ha (PE) fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds during second year of study.

B. Weed index

The minimum weed index (Table 4) was recorded in furrow irrigated raised bed system planted crop during both the years. Alternate wetting and drying recorded minimum weed index than saturation to field capacity treatment during both the years.

Table 1: Effect of planting methods water management practices and weeds management on density (per m²) of total weeds in dry seeded rice.

Treatments		20 DAS		40 DAS		60 DAS		80 DAS		At harvest	
		2016	2017	2016	2017	2016	2017	2016	2017	2016	2017
Planting methods											
D ₀	Conventional method	9.01 (100.24)	8.59 (91.10)	10.78 (143.72)	10.45 (135.69)	14.99 (227.14)	14.04 (201.16)	15.83 (253.60)	15.04 (230.47)	14.91 (225.41)	13.85 (195.83)
D ₂	Furrow irrigated raised bed (FIRB)	8.86 (96.88)	8.34 (85.67)	10.57 (138.38)	10.11 (126.38)	14.63 (216.19)	13.48 (185.13)	15.49 (242.82)	14.41 (211.71)	14.64 (217.35)	13.15 (176.84)
	SEm±	0.08	0.06	0.06	0.08	0.08	0.10	0.08	0.11	0.07	0.10
	CD 5%	0.26	0.18	0.18	0.25	0.26	0.31	0.26	0.36	0.21	0.31
Water management											
I ₀	Alternate wetting and drying	8.81 (95.65)	8.61 (91.60)	10.58 (138.16)	10.46 (135.84)	14.61 (215.56)	14.02 (200.44)	15.42 (240.73)	15.05 (230.80)	14.57 (215.19)	13.86 (196.38)
I ₁	Saturation to field capacity	9.07 (101.47)	8.32 (85.18)	10.78 (143.74)	10.10 (126.22)	15.01 (227.77)	13.50 (185.84)	15.90 (255.68)	14.40 (211.38)	14.98 (227.57)	13.14 (176.29)
	SEm±	0.08	0.06	0.06	0.08	0.08	0.10	0.08	0.11	0.07	0.10
	CD 5%	0.26	0.18	0.18	0.25	0.26	0.31	0.26	0.36	0.21	0.31
Weed management											
W ₀	Weedy check	13.78 (189.66)	13.17 (173.10)	16.21 (262.46)	15.84 (250.80)	18.02 (324.53)	17.65 (311.44)	19.21 (368.70)	18.75 (351.67)	18.39 (337.81)	17.45 (304.44)
W ₁	Two hand weedings at 20 and 40 DAS	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	13.49 (181.79)	12.09 (145.99)	14.23 (202.20)	12.99 (168.62)	13.25 (175.34)	11.82 (139.46)
W ₂	Pendimethalin 1 kg a.i./ha (PE)/bispiribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	10.38 (107.36)	9.81 (95.90)	12.45 (154.71)	12.10 (146.16)	14.49 (209.79)	13.62 (185.24)	15.33 (234.59)	14.64 (214.22)	14.42 (207.58)	13.34 (177.76)
W ₃	Oxadiargyl 90 g a.i./ha (PE) /b penoxsulam 22.5g ha ⁻¹ at 4-6 leaf stage of weeds	10.14 (102.53)	9.56 (90.93)	12.20 (148.37)	11.66 (135.65)	14.30 (204.14)	13.03 (169.53)	15.06 (226.50)	13.98 (195.25)	14.17 (200.33)	12.79 (163.42)
W ₄	Flufenacet 120 g a.i./ha (PE) /b pyrazosulfuron 20 g a.i./ha + bispiribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	9.68 (93.25)	9.08 (81.99)	11.82 (139.22)	11.09 (122.55)	13.73 (188.08)	12.40 (153.52)	14.47 (209.03)	13.26 (175.69)	13.65 (185.85)	12.11 (146.59)
	SEm±	0.06	0.05	0.04	0.06	0.08	0.08	0.07	0.08	0.07	0.08
	CD 5%	0.16	0.13	0.11	0.17	0.24	0.24	0.22	0.24	0.20	0.24

Table 2: Interaction effect of planting methods and weed management on density (per m²) of total weeds in dry seeded rice at 40 DAS during 2016 and 2017.

Weed management		Planting method			
		2016		2017	
		D ₁ (Conventional planting)	D ₂ (Furrow irrigated raised bed planting)	D ₁ (Conventional planting)	D ₂ (Furrow irrigated raised bed planting)
W ₀ -	Weedy check	16.32	16.11	16.17	15.52
W ₁ -	Two hand weedings at 20 and 40 DAS	0.71	0.71	0.71	0.71
W ₂ -	Pendimethalin 1 kg a.i./ha (PE) <i>fb</i> bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	12.63	12.28	12.38	11.82
W ₃ -	Oxadiargyl 90 g a.i./ha (PE) <i>fb</i> penoxsulam 22.5g ha ⁻¹ at 4-6 leafstage of weeds	12.32	12.08	11.84	11.48
W ₄ -	Flufenacet 120 g a.i./ha (PE) <i>fb</i> pyrazosulfuron 20 g a.i./ha +bispyribac sodium 25 g a.i./ha at 4-6 leaf Stage of weeds	11.95	11.68	11.17	11.01
		SEm±	CD at 5%	SEm±	CD at 5%
	W at same levels of D	0.06	0.16	0.08	0.24
	D at same or different levels of W	0.12	0.74	0.17	1.00

Table 3: Interaction effect of Water management and weed management on density (per m²) of total weeds in dry seeded rice at 40 DAS during 2016 and 2017.

Weed management		Irrigation method			
		2016		2017	
		I ₀ (Alternate wetting and drying)	I ₁ (Saturation to field capacity)	I ₀ (Alternate wetting and drying)	I ₁ (Saturation to field capacity)
W ₀ -	Weedy check	16.39	16.04	16.14	15.55
W ₁ -	Two hand weedings at 20 and 40 DAS	0.71	0.71	0.71	0.71
W ₂ -	Pendimethalin 1 kg a.i./ha (PE) <i>fb</i> bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	12.57	12.34	12.36	11.84
W ₃ -	Oxadiargyl 90 g a.i./ha (PE) <i>fb</i> penoxsulam 22.5g ha ⁻¹ at 4-6 leafstage of weeds	12.37	12.02	11.89	11.43
W ₄ -	Flufenacet 120 g a.i./ha (PE) <i>fb</i> pyrazosulfuron 20 g a.i./ha +bispyribac sodium 25 g a.i./ha at 4-6 leaf Stage of weeds	11.87	11.77	11.23	10.95
		SEm±	CD at 5%	SEm±	CD at 5%
	W at same levels of I	0.06	0.16	0.08	0.24
	I at same or different levels of W	0.12	0.74	0.17	1.00

Table 4: Effect of planting methods, water management practices and weed management on Weed index, Grain Yields and Straw yield of dry seed rice.

Treatments		Weed index (%)		Grain yield (kg/ha)		Straw yield (kg/ha)	
		2016	2017	2016	2017	2016	2017
	Planting method						
D₁	Conventional method	12.54	11.97	3934.19	3848.98	5939.14	5699.31
D₂	Furrow irrigated raised bed (FIRB)	10.67	11.16	4157.98	4051.72	6249.10	5978.73
	SEm±			48.13	55.46	40.24	66.14
	CD 5%			153.97	177.42	128.74	211.58
	Water management						
I₀	Alternate wetting and drying	12.13	12.23	3964.22	3817.11	5972.00	5700.13
I₁	Saturation to field capacity	11.08	11.60	4127.95	4083.59	6216.23	5977.92
	SEm±			48.13	55.46	40.24	66.14
	CD 5%			153.97	177.42	128.74	211.58
	Weed management						
W₀	Weedy check	45.51	46.33	2497.58	2400.85	4260.47	3983.89
W₁	Two hand weedings at 20 and 40 DAS	0.00	0.00	4575.92	4466.21	6741.94	6506.38
W₂	Pendimethalin 1 kg a.i./ha (PE) <i>fb</i> bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds	5.89	4.41	4306.99	4266.94	6295.65	6060.33
W₃	Oxadiazyl 90 g a.i./ha (PE) <i>fb</i> penoxsulam 22.5g ha ⁻¹ at 4-6 leafstage of weeds	5.69	5.37	4317.26	4228.58	6452.50	6174.61
W₄	Flufenacet 120 g a.i./ha (PE) <i>fb</i> pyrazosulfuron 20 g a.i./ha +bispyribac sodium 25 g a.i./ha at 4-6 leaf Stage of weeds	0.93	1.71	4532.70	4389.15	6720.02	6469.90
	SEm±			39.36	41.80	38.39	47.14
	CD 5%			111.91	118.85	109.16	134.04

Amongst weed management treatment, minimum weed index was recorded under W₄ (flufenacet 120 g a.i./ha (PE) fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds) whereas, maximum weed index was recorded under weedy check during both the years of investigation.

C. Grain and straw yield

In general, data envisage (Table 4) that higher grain and straw yield recorded during first year of experimentation as compared to the second year. Furrow irrigated raised bed planting recorded significantly higher grain and straw yield than conventional planted dry seeded rice during both the years of investigation. This might be due to border effect of plants and also proliferate root growth on ridges. Saturation to field capacity treatment recorded significantly maximum grain and straw yield as compared to alternate wetting and drying during both the years of study this might be due to higher available moisture throughout growth period.

The data of weed management treatments indicated that the grain and straw yield was significantly varied due to variables. The herbicide flufenacet 120 g a.i./ha fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds exhibited maximum grain straw yield during both the years of experimentation. Weedy check recorded significantly minimum grain straw yield among all weed management treatments during both the years of experiment. This was corroborated by Singh *et al.* (2007); Chauhan *et al.* (2012).

CONCLUSIONS

On the basis of result it can be concluded that furrow irrigated raised bed planting and saturation to field capacity treatment with flufenacet 120 g a.i./ha fb pyrazosulfuron 20 g a.i./ha + bispyribac sodium 25 g a.i./ha at 4-6 leaf stage of weeds was found to be most effective in minimizing weed density, higher weed index and enhance yield during both the year of experimentation.

FUTURE SCOPE

Further research should extend these findings across seasons and locations to validate the agronomic and environmental robustness of the identified management practices. Monitoring herbicide resistance and advancing integrated weed-management strategies remain critical for sustaining long-term efficacy. The application of precision-agriculture tools—such as sensor-based irrigation offers promising avenues for

optimizing resource use. Additionally, evaluating economic returns, environmental impacts, and varietal interactions will help refine and tailor recommendations for diverse dry-seeded rice ecosystems.

Acknowledgements. The author gratefully acknowledges the Department of Agronomy, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi (Uttar Pradesh), and her late guide, Dr. Ramesh K. Singh, for their guidance and support. Sincere thanks are also extended to the UGC for providing the financial assistance necessary to carry out this research work.

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How to cite this article: Neelam Bisen Pawar and U. P. Singh (2025). Weed Dynamics as Influenced by Planting Methods, Water Management and Weed Management of Dry Seeded Rice. *Biological Forum*, 17(7): 227-232.