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EVALUATION OF WEED INFESTATION AND CULTIVAR COMPETITIVENESS IN DIRECT-SEEDED RICE

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ABSTRACT

Dry direct-seeded rice (DSR) offers a promising alternative to conventional transplanting, particularly in regions facing labour shortages, rising production costs, and water scarcity. However, weed infestation remains a major challenge in DSR due to the simultaneous emergence of weeds and rice seedlings, leading to severe crop-weed competition and yield losses. Results indicated that effective weed control through herbicide application, combined with the use of competitive cultivars, significantly reduced weed biomass and improved crop performance. The findings highlight the importance of integrated weed management strategies combining chemical control with cultivar selection to enhance productivity and profitability in DSR systems.
Keywords **:** DSR, Weed Competition, Integrated, Yield and Profitability.

Introduction

Direct-seeded rice (DSR) involves sowing seeds directly into the field without nursery raising or transplanting, offering advantages such as reduced labour, time, and cost (Farooq et al., 2011). Within DSR, dry seeding—the placement of dry seeds in dry soil is increasingly adopted due to its adaptability in resource-scarce environments. However, weed infestation remains a major constraint in DSR systems, as weeds emerge simultaneously with the crop, leading to intense crop-weed competition and yield losses ranging from 15–20%, and up to 50% or complete crop failure in severe cases (Hasanuzzaman et al., 2009; Jayadeva et al., 2011; Raj and Syriac, 2017).

Effective weed management is crucial for the success of DSR, especially under rainfed conditions where rainfall is a limiting factor for crop growth (Taimiyu et al., 2015) and agriculture is increasingly impacted by climate variability (Maraseni et al., 2009). While herbicide application provides initial control, integrating weed-competitive rice cultivars can enhance long-term weed suppression and reduce reliance on herbicides, thereby supporting environmentally sustainable weed management (Chauhan, 2012). In this context, the present study was conducted to evaluate the weed competitiveness of rice cultivars under varying weed management practices in DSR. The goal was to identify cultivars and treatment combinations that enhance weed suppression, improve yield, and increase profitability under dry direct-seeded conditions.

Materials and Methods

A field experiment was conducted during the Kharif season of 2023–2024 at the Research Farm of ICAR–Directorate of Weed Research, Adhartal, Jabalpur, Madhya Pradesh (23°09′N, 79°58′E; 412 m above mean sea level). The objective was to assess the weed competitiveness of rice cultivars for effective weed management under dry direct-seeded rice (DSR) conditions. The experiment was arranged in a split-plot design with three replications, where weed management treatments were allocated to the main plots and rice cultivars to the sub-plots.

The main plot treatments included three levels of weed pressure: weedy check (high weed pressure), Pendimethalin @ 678 g/ha as pre-emergence (medium weed pressure) and Pendimethalin @ 678 g/ha as pre-emergence followed by cyhalofop-butyl + Penoxsulam @ 135 @ g/ha as post-emergence (low weed pressure). The sub-plots comprised ten rice cultivars of varying maturing durations. Early maturing cultivars included Sadabhar and Purna; medium duration cultivars were CR Dhan 206, CR Dhan 205, JR 206 (check), IR 64 Drt-1, Tej Gold and Abhishek while Kranti (check) and Arize 6129 Gold represented the late-maturing group. Among these, Arize 6126 Gold and Tej Gold were hybrid cultivars.

Fertilizer application was carried out as per cultivar requirement. A nitrogen dose of 120 kg/ha was applied to high-yielding varieties and 150 kg/ha to hybrid cultivars, while phosphorus was applied uniformly at 60 kg/ha through DAP. The entire dose of phosphorus was applied as a basal at sowing. Nitrogen was applied in three equal splits at 25, 45 and 60 days after sowing (DAS) for long-duration cultivars, except for Kranti, where the final split was given at 70 DAS. For short-duration cultivars (Purna and Sadabhar), nitrogen was split at 25, 42 and 55 DAS. Potassium @ 20 kg/ha, through muriate of potash was applied along with the final top dressing of nitrogen.

Seeding was done manually on 4 July 2023 and 24 June 2024, using 25 kg/ha seed rate for hybrids and 50 kg/ha for other cultivars, maintaining 20 cm row spacing. Each plot measured 5 m × 3 m. Herbicides were applied with a knapsack sprayer (flat-fan nozzle) using 500 L/ha water for pre-emergence and 400 L/ha for post-emergence applications.

Observation on weed density and biomass were recorded at 60 and 90 DAS by placing a 25 cm x 25 cm quadrat randomly in the net plot are. Weeds within the quadrat were uprooted and cut near the root-shoot junction, separated into monocot and dicot groups, oven-dried at 60^0C and weighed. Weed biomass was expressed as g/m^2. Square root transformation ($\sqrt{x}$ + 0.5) was applied to weed density and dry weight data prior to statistical analysis (Shapir-o-test). Weed control efficiency was calculated by using standard formula mention in Mani *et al* 1973. Weed control efficiency was calculated based on weed dry weight under different treatments. Economic parameter such as gross return and benefit-cost (B:C) ratio were computed based on the total investment and market value of grain and straw yield. Data on various growth and yield attributes were statistically analysed following standard procedures to assess treatment effects.

Result and Discussion

Weed flora and weed control efficiency

In high weed pressure, weeds were dominated by broadleaf weed *Alternanthera paronychioides,* the sedge *Cyperus iria*, and the grasses *Dinebra retroflexa* and *Echinochloa colona*. However, in medium weed pressure, complete dominance of *Cyperus iria* and in low weed pressure complete dominance of *Ludwigia parviflora* and *Phyllanthus maderaspatensis* were recorded in the year 2024. Data on weed dry weight also revealed that 48.3 and 60.3% more weed dry weight was recorded at 60 and 90 days after sowing (DAS) under high weed pressure in 2024 compared to 2023, respectively. Similarly, under medium weed pressure 62.9 and 67.2% more dry weight was recorded at 60 and 90 DAS in 2024 compared to 2023, respectively, reported by Kumar and Ladha 2011

Among the weed control treatments, the sequential application of pendimethalin at 678 g/ha (pre-emergence) followed by cyhalofop-butyl + penoxsulam at 135 g/ha under low weed pressure conditions recorded the lowest weed dry weight (27.7 g/m² at 60 DAS and 64.5 g/m² at 90 DAS). This was followed by the application of pendimethalin alone under medium weed pressure. Among the rice cultivars, 'Purna' recorded the highest weed control efficiency 91.1% at 60 DAS and 90.5% at 90 DAS in the year 2024. In contrast, the weedy check plots under high weed pressure exhibited the highest weed dry weight and the lowest weed control efficiency, emphasizing the effectiveness of chemical weed management (Table 1 and Table 2). Pendimethalin *fb* cyhalofop-butyl + penoxsulam in term of weed biomass reduction and supporting yield attribution characters. This is because the combination Pendimethalin *fb* cyhalofop-butyl + penoxsulam can achieve broad spectrum control of grasses, sedges and broadleaf weeds also reported by Singh et al 2016.

Effect on rice yield and economic

The highest grain yield (3.39 t/ha) was obtained under the sequential application of pre-emergence pendimethalin and post-emergence cyhalofop-butyl + penoxsulam under low weed pressure conditions in 2024. This was followed by a grain yield of 2.31 t/ha under medium weed pressure. The respective yields were 44.2% and 26.7% higher than those recorded in the previous year (2023) (Table 3). In contrast, under high weed pressure conditions, the lowest grain yield of 0.34 t/ha was observed in 2024, which was 67.01% lower than that of 2023, thereby emphasizing the adverse impact of severe weed infestation (Sen et al 2018).

Among the cultivars, the highest grain yield in 2024 was recorded in ‘Purna’ (3.31 t/ha), followed by ‘Abhishek’ (2.79 t/ha), ‘IR64-Drt-1’ (2.48 t/ha), and ‘Sadabahar’ (2.15 t/ha). However, these yields were 22.6%, 10.57%, 22.2%, and 9.28% lower, respectively, compared to the previous year. The reduced yield in ‘Purna’ was primarily attributed to lodging at maturity, caused by strong winds during the grain-filling stage which hampered photosynthetic activity due to canopy shading Matsue et al 1991 and Farooq et al 2011. Additionally, growing the same varieties in the same plots for two consecutive years led to a shift in the weed flora, promoting the growth of more aggressive and competitive weed species in the second year. This resulted in intensified weed-crop competition, particularly during the early growth stages (Ziska et al 2015). Despite these challenges, favourable rainfall during September (321.4 mm) and October (14.4 mm) in 2024 contributed to a relatively higher grain yield in ‘CR Dhan 205’ (2.06 t/ha) compared to the previous year as rainfall during critical growth stages has a positive and significant impact on yield (Taimiyu et al 2015) represented in Table 3 .

In terms of economics, the highest net monetary return was recorded under low weed pressure (Rs. 45,293/ha), followed by medium (Rs. 22,600/ha), while the high weed pressure plots resulted in a negative return (–Rs. 34,564/ha) during 2024. This negative return under uncontrolled conditions highlights the critical importance of effective weed management for profitability (Mahajan *et al*., 2009). Net returns under low and medium weed pressure conditions were also higher compared to the previous year. Among the cultivars, ‘Purna’ recorded the highest net monetary return (Rs. 51,961/ha) and benefit-cost ratio (B:C ratio) of 2.16 in year 2024. This can be attributed to its high weed competitiveness, enabling early suppression of weeds and improved crop growth and yield (Chauhan 2012 and Sen *et al*., 2018).

Table 1 : Effect of different weed pressures and cultivars on total weed dry weight at different days after sowing.

Cultivar	Weed dry weight (g/m^2)			
	60 DAS		90 DAS	
	2023	2024	2023	2024
Main plot factor (Weed pressure)				
High weed pressure	8.47 (80.48)	12.45(155.78)	11.42 (133.78)	18.20 (337.38)
Medium weed pressure	4.38 (19.89)	7.23(53.60)	6.45 (42.59)	11.31(130.02)
Low weed pressure	4.04 (17.01)	5.25(27.7)	5.87 (35.10)	7.94(64.5)
SEm±	0.02	0.05	0.03	0.13
CD (P=0.05)	0.06	0.21	0.15	0.49
Sub-plot factor (Rice cultivar)				
CR Dhan 206	4.92 (29.13)	8.39(78.3)	7.26 (58.81)	13.50(203.2)
CR Dhan 205	5.72 (39.47)	8.24(76.1)	8.01 (70.29)	13.86(217.1)
JR 206	7.29 (62.87)	10.15(114.5)	9.86 (104.46)	14.80(240.0)
IR64-Drt1	5.83 (38.17)	8.50(81.8)	7.75 (67.15)	12.52(176.1)
Tej Gold	7.17 (58.97)	8.32(77.8)	9.58 (97.58)	11.08(156.8)
Kranti	5.10 (32.45)	7.90(73.3)	6.79 (48.37)	11.64(151.9)
Arize 6129 Gold	6.41 (50.88)	8.35(79.7)	9.40 (98.77)	11.98(159.6)
Sadabahar	5.60 (39.54)	8.14(78.5)	7.96 (71.41)	12.86(186.5)
Abhishek	4.70 (26.71)	8.38(78.5)	7.19 (58.44)	13.00(188.0)
Purna	3.44 (14.80)	6.42(51.2)	4.99 (27.43)	8.61(90.4)
SEm±	0.04	0.09	0.07	0.23
CD (P=0.05)	0.12	0.25	0.27	0.65

HWP- Weedy check

MWP- Pendimethalin @ 678 g/ha as pre-emergence

LWP- Pendimethalin @ 678 g/ha as pre-emergence followed by cyhalofop-butyl + Penoxsulam @ 135 @ g/ha as post-emergence

Table 2: Weed control efficiency (%) at different days after sowing (DAS) of different cultivars under medium and low weed pressure while considering dry weight of weeds in high weed pressure of corresponding cultivar.

Cultivar	Medium weed pressure				Low weed pressure			
	60 DAS		90 DAS		60 DAS		90 DAS	
	2023	2024	2023	2024	2023	2024	2023	2024
CRDhan 206	79.1	60.8	66.8	62.4	82.9	80.9	80.8	79.8
CRDhan 205	79.9	62.2	57.2	61.1	83.6	82.5	70.1	79.7
JR 206	78.1	61.0	60.0	55.8	81.2	80.6	72.0	78.3
IR64-Drt1	72.7	64.3	73.5	65.8	75.7	82.3	76.7	79.7
Tej Gold	72.4	64.0	63.0	59.7	76.8	81.5	66.4	78.9
Kranti	76.9	71.2	57.1	56.9	80.1	80.0	65.7	81.7
Arize 6129 Gold	77.3	70.7	72.9	58.5	80.3	82.1	76.6	80.4
Sadabahar	74.9	64.5	74.9	63.2	79.1	81.3	77.7	79.9
Abhishek	66.3	67.3	76.2	64.8	69.7	83.8	78.0	81.9
Purna	80.1	78.0	71.7	69.2	86.0	91.1	77.7	90.5

HWP- Weedy check
MWP- Pendimethalin @ 678 g/ha as pre-emergence
LWP- Pendimethalin @ 678 g/ha as pre-emergence followed by cyhalofop-butyl + Penoxsulam @ 135 @ g/ha as post-emergence

Table 3 : Effect of weed pressure and rice cultivar on grain yield, straw yield net return and B: C ratio.

	Grain yield (t/ha)		Straw yield (t/ha)		Net returns (Rs./ha)		B:C	
	2023	2024	2023	2024	2023	2024	2023	2024
Main plot factor (Weed pressure)								
High weed pressure	0.97	0.34	3.39	0.63	-9815	-34561	0.79	0.22
Mediumweed pressure	1.87	2.31	4.88	4.33	13946	22619	1.32	1.49
Low weed pressure	2.35	3.39	5.01	5.13	21926	45317	1.46	1.92
SEm±	0.02	0.03	0.03	0.04				
CD (P=0.05)	0.09	0.12	0.10	0.12				
Sub-plot factor (Rice cultivar)								
CR Dhan 206	1.01	1.41	4.31	3.18	-5692	-1367	0.86	0.94
CR Dhan 205	0.75	2.06	3.27	2.98	-15413	11853	0.65	1.23
JR 206	0.83	1.65	2.87	2.82	-15166	2593	0.66	1.03
IR64-Drt1	3.19	2.48	5.19	3.22	43404	19996	1.90	1.38
Tej Gold	0.48	1.32	2.97	2.67	-27784	-10454	0.44	0.77
Kranti	1.25	0.82	6.00	3.78	6528	-11596	1.13	0.72
Arize6129	1.00	1.79	3.07	2.76	-16550	-557	0.66	0.96
Sadabahar	2.37	2.15	5.06	2.99	26921	14066	1.58	1.28
Abhishek	3.12	2.79	4.90	3.47	42979	30171	1.94	1.63
Purna	4.28	3.31	7.38	6.10	78311	51877	2.75	2.14
SEm±	0.06	0.06	0.07	0.08				
CD (P=0.05)	0.18	0.20	0.21	0.26				
Int. (AXB)								
SEm±	0.11	0.13	0.12	0.13				
CD (P=0.05)	0.31	0.40	0.37	0.40				

HWP- Weedy check
MWP- Pendimethalin @ 678 g/ha as pre-emergence
LWP- Pendimethalin @ 678 g/ha as pre-emergence followed by cyhalofop-butyl + Penoxsulam @ 135 @ g/ha as post-emergence

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