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Short Communication

Performance of Florpyrauxifen-benzyl: A Novel Post-emergence Herbicide for Weed Control in Wet Direct-seeded Rice

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Abstract

A field experiment was conducted at CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, to evaluate the efficacy of different doses of florpyrauxifen-benzyl compared with bispyribac-Na in wet direct-seeded rice (WDSR) during kharif 2024. The study, laid out in a randomised block design with eight treatments, revealed that the major weeds were *Echinochloa colona*, *Eleusine indica*, *Digitaria sanguinalis*, *Panicum repens*, *Cyperus spp.*, *Commelina benghalensis*, and *Ageratum conyzoides*. Among treatments, florpyrauxifen-benzyl at 62.5 g/ha recorded the lowest weed density and dry weight, statistically at par with 39.06 and 37.5 g/ha. The weed-free plot produced the highest grain (4757 kg/ha) and straw yield (7158 kg/ha), closely followed by florpyrauxifen-benzyl at 37.5 and 39.06 g/ha. The results indicate that florpyrauxifen-benzyl at 37.5 and 39.06 g/ha effectively controls a broad spectrum of weeds and enhances the productivity of WDSR under mid-hill conditions of Himachal Pradesh.

Keywords: Florpyrauxifen-benzyl, Grain yield, Herbicide efficacy, Wet direct-seeded rice, Weed management

Rice (*Oryza sativa* L.) is one of the most important staple food crops globally, providing about 20% of the world's per capita energy and 15% of protein intake[1]. India ranks second in global rice production after China, contributing over 11% of total production. It leads in acreage with 47.8 million ha and records a production of 137.8 million tonnes and productivity of 2.9 t/ha during 2024[2]. In Himachal Pradesh, rice covers 69.87 thousand ha with 172.86 thousand tonnes production and 2474 kg/ha productivity[3].

Rice sustains millions of smallholder farmers and contributes significantly to food security, rural livelihoods, and national GDP. However, increasing labour and water scarcity, high input costs, and stagnant yields have prompted a shift from traditional puddled transplanted rice (PTR) to direct-seeded rice (DSR) systems. DSR offers advantages such as reduced labour, lower water use, earlier crop maturity, and enhanced profitability[4,5]. Among DSR systems, wet direct-seeded rice (WDSR) involves sowing pre-germinated seeds on puddled soil and serves as a promising alternative under labour- and water-limited conditions.

Despite its advantages, WDSR faces severe weed infestation due to the absence of continuous flooding, which otherwise suppresses weeds in PTR[6,7]. Weeds compete with rice for nutrients, moisture, and light, causing substantial yield losses[8]. In India, more than one-third of yield losses from biotic stresses are

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attributed to weeds[9]. Weed competition may reduce nutrient uptake by 24–50% and severely depress yields[4]. The predominant weed flora includes *Echinochloa spp.*, *Cyperus difformis*, *Fimbristylis miliacea*, and *Ischaemum rugosum*, which thrive under DSR conditions[10]. Manual weeding, though effective, is uneconomical due to labour scarcity[11], making herbicides an essential component of weed management[12]. Florpyrauxifen-benzyl, a novel synthetic auxin herbicide, offers broad-spectrum control with low use rates and excellent selectivity[13]. However, limited information is available regarding its efficacy in WDSR under mid-hill conditions. Therefore, the present study was undertaken to evaluate the effectiveness of different herbicides in wet direct-seeded rice.

A field experiment was conducted at the Experimental Farm of the Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalya, Palampur, during the *kharif* season of 2024. The Experimental Farm is situated at a latitude of 32°6′ N and a longitude of 76°3′ E, with an elevation of 1290.8 meters above mean sea level. The site lies in the North-West Himalayan region, representing the mid-hills sub-humid zone of Himachal Pradesh, characterised by a wet temperate climate. The soil of the experimental field was silty clay loam in texture and acidic in reaction (pH 5.12), with low available nitrogen (278.0 kg/ha), medium available phosphorus (24.6 kg/ha) and potassium (231.5 kg/ha). This agro-climatic zone extends from 651 to 1800 m above mean sea level and covers about 32 % of the geographical area and 37 % of the cultivated area of the state. The region receives an annual rainfall of 2000-2500, about 80 % of which occurs during the monsoon season (June-September). The temperature ranges between 16.4 and 20.9 °C during March - April and 27 to 30 °C during May- June, while the relative humidity varies from 46 to 84 %.

The experiment was laid out in a randomised block design with three replications. The rice variety' *HPR 1068*' was sown under wet direct-seeded conditions at a row spacing of 20 cm using a seed rate of 60 kg/ha on June 21, 2025. Each experimental plot measured 2.4 m x 4.8 m. The experiment consisted of eight treatments, all of which were post emergence herbicides. These included florpyrauxifen-benzyl at 25, 31.25, 37.50, 39.06 and 62.50 g/ha, bispyribac sodium at 25 g/ha, weed-free treatment and an untreated check. The crop was grown entirely under rainfed conditions. A recommended dose of fertiliser 60:30:30 (NPK/ha) was applied as a basal application through urea, single super phosphate (SSP) and murate of potash (MOP) as per the package of practices of the crop recommended for the region. All the post-emergence herbicides were applied 20 days after application of herbicides (DAA) using a knapsack sprayer fitted with a flat fan nozzle, utilising a spray volume of 500 L/ha.

Observations on weed count and weed dry weight were recorded at 60 DAA of herbicides. Data were collected from two randomly selected spots using a 0.50 m x 0.50 m quadrat, and their mean values were expressed as number/m² and g/m², respectively. Species-wise weed count was determined by counting, and then weed dry weight was measured by sun drying for two days, followed by oven drying at 70 ^{0}C for 48 hours. Due to wide variability in weed count and dry weight data, square root transformation ($\sqrt{x+1}$) was applied for statistical analysis as suggested by Gomez and Gomez[14].

During the field investigation on dry direct-seeded rice, the predominant weed flora comprised a diverse assemblage of grasses, sedges and broad-leaved species. The major grassy weeds observed were *E. colona*, *E. indica*, *D. sanguinalis* and *P. repens*, while the dominant sedge species included *Cyperus* spp. The broad-leaved weeds primarily consisted of *C. benghalensis* and *A. conyzoides*. These species caused significant early-stage competition for nutrients, light, and moisture, thereby necessitating effective chemical control measures.

A detailed analysis of Tables 1 and 2 revealed that weed control treatments exerted a significant influence on species-wise weed density and dry weight at 60

days after application (DAA) in wet direct-seeded rice. All doses of florpyrauxifen-benzyl (T_1–T_5) and bispyribac-Na (T_6) were effective in reducing weed populations compared with the untreated check (T_8). The lowest weed count and dry weight across all weed species were consistently recorded under the weed-free treatment (T_7), which maintained negligible infestation.

Among the herbicidal treatments, florpyrauxifen @ 31.25 g/ha (T_2), 37.50 g/ha (T_3), and 39.06 g/ha (T_4) showed superior performance, recording substantially reduced densities of *E. colona*, *E. indica*, *D. sanguinalis*, *P. repens*, *Cyperus* spp., *C. benghalensis* and *A. conyzoides*. These treatments also recorded lower dry weights for all weed species, indicating strong suppression of both grassy and broad-leaf weeds. In contrast, the untreated check (T_8) recorded the highest weed counts and dry weights, reflecting heavy weed infestation and the absence of chemical or manual control. Bispyribac-Na @ 25 g/ha (T_6) performed moderately well but remained inferior to the higher doses of florpyrauxifen.

The weed control treatments significantly enhanced the yield and yield attributes of wet direct-seeded rice (Table 3). Florpyrauxifen @ 37.50 g/ha (T_3) performed

Table 1. Effect of different weed control treatments on species-wise weed count (No./m²) at 60 DAA in wet direct-seeded rice

Sr. No.	Treatment	Dose (g/ha)	*Echinochloa colona*	*Eleusine indica*	*Digitaria sanguinalis*	*Panicum repens*	*Cyperus* spp.	*Commelina benghalensis*	*Ageratum conyzoides*
T_1	Florpyrauxifen benzyl	25	4.10 (16.00)	3.47 (12.0)	3.61 (12.0)	4.28 (17.33)	5.26 (26.67)	3.91 (16.0)	3.78 (13.33)
T_2	Florpyrauxifen benzyl	31.25	2.33 (5.33)	2.33 (5.33)	2.33 (5.33)	3.19 (9.33)	4.24 (17.33)	2.33 (5.33)	2.33 (5.33)
T_3	Florpyrauxifen benzyl	37.50	2.24 (4.00)	2.49 (5.33)	2.49 (5.33)	2.99 (8.00)	3.93 (14.67)	2.24 (4.00)	2.49 (5.33)
T_4	Florpyrauxifen benzyl	39.06	2.49 (5.33)	2.24 (4.00)	2.24 (4.00)	2.76 (6.67)	4.10 (16.00)	1.82 (2.67)	2.24 (4.00)
T_5	Florpyrauxifen benzyl	62.50	2.28 (5.33)	1.82 (2.67)	2.08 (4.00)	2.95 (8.00)	3.78 (13.33)	1.67 (2.67)	2.28 (5.33)
T_6	Bispyribac-Na	25	3.40 (10.67)	3.37 (10.67)	3.20 (9.33)	3.58 (12.00)	4.72 (21.33)	3.27 (10.67)	3.40 (10.67)
T_7	Weed free	-	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
T_8	Untreated check	-	6.18 (37.33)	4.82 (22.67)	6.80 (45.33)	6.37 (40.00)	5.74 (32.00)	6.81 (45.33)	5.50 (29.33)
	SEm±	-	0.40	0.34	0.36	0.29	0.22	0.48	0.35
	CD (P=0.05)	-	1.21	1.02	1.10	0.88	0.68	1.45	1.06

Where the values given in the parentheses are the means of the original values, Data subjected to √x+1 square root transformation.

best among the herbicidal treatments, with higher grains per panicle, panicle weight, and test weight, closely followed by Florpyrauxifen @ 31.25 and 39.06 g/ha (T_2 and T_4). The weed-free treatment (T_7) recorded the highest values for all parameters, including grains per panicle (94.72), panicle weight (3.19 g), test weight (26.00 g), and grain yield (4757 kg/ha). In contrast, the untreated check (T_8) consistently showed the lowest grains per panicle (57.92), panicle weight (2.03 g), test weight (24.24 g), and grain and straw yields, reflecting severe yield losses due to weed competition. The yield trend corresponded well with weed suppression efficiency, confirming that higher weed control resulted in improved resource availability and higher productivity[15]. The results are consistent with those reported by Wright *et al.*,[13] and Chauhan *et al.*,[6] who also found florpyrauxifen-benzyl highly effective in controlling diverse weed species in direct-seeded rice.

Table 2. Effect of different weed control treatments on species-wise weed dry weight (g/m^2) at 60 DAA in wet direct-seeded rice

Sr. No.	Treatment	Dose (g/ha)	*Echinochloa colona*	*Eleusine indica*	*Digitaria sanguinalis*	*Panicum repens*	*Cyperus* spp.	*Commelina benghalensis*	*Ageratum conyzoides*
T_1	Florpyrauxifen benzyl	25	2.28 (4.21)	1.63 (1.66)	1.86 (2.45)	1.98 (2.92)	2.53 (5.38)	1.61 (1.59)	1.60 (1.56)
T_2	Florpyrauxifen benzyl	31.25	1.79 (2.19)	1.30 (0.70)	1.35 (0.83)	1.56 (1.45)	2.03 (3.11)	1.27 (0.63)	1.22 (0.50)
T_3	Florpyrauxifen benzyl	37.50	1.73 (1.98)	1.24 (0.54)	1.41 (0.99)	1.51 (1.27)	1.94 (2.78)	1.21 (0.46)	1.26 (0.59)
T_4	Florpyrauxifen benzyl	39.06	1.62 (1.72)	1.21 (0.47)	1.37 (0.88)	1.55 (1.39)	2.00 (2.99)	1.29 (0.68)	1.21 (0.46)
T_5	Florpyrauxifen benzyl	62.50	1.65 (1.72)	1.22 (0.50)	1.45 (1.11)	1.52 (1.31)	1.96 (2.85)	1.27 (0.61)	1.31 (0.70)
T_6	Bispyribac-Na	25	2.23 (3.98)	1.53 (1.33)	1.87 (2.48)	1.88 (2.53)	2.38 (4.65)	1.52 (1.30)	1.56 (1.42)
T_7	Weed free	-	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)
T_8	Untreated check	-	4.47 (19.12)	2.86 (7.23)	3.56 (11.68)	3.51 (11.36)	4.70 (21.13)	2.86 (7.23)	2.90 (7.45)
	SEm±	-	0.13	0.05	0.04	0.06	0.07	0.07	0.06
	CD (P=0.05)	-	0.39	0.15	0.13	0.19	0.22	0.22	0.19

Where the values given in the parentheses are the means of the original values, Data subjected to √x+1 square root transformation.

Table 3. Effect of different weed control treatments on yield and yield attributes of wet direct seeded rice

Sr. No.	Treatment	Dose (g/ha)	No. of Grains/ Panicle	Panicle Weight (g)	1000 Grain Weight (g)	Grain Yield (kg/ha)	Straw Yield (kg/ha)
T_1	Florpyrauxifen - benzyl	25	84.32	2.77	24.87	4048	6467
T_2	Florpyrauxifen - benzyl	31.25	90.32	3.05	25.83	4628	7015
T_3	Florpyrauxifen - benzyl	37.50	91.12	3.12	25.96	4688	7052
T_4	Florpyrauxifen - benzyl	39.06	90.72	3.10	25.89	4672	7042
T_5	Florpyrauxifen - benzyl	62.50	89.52	2.91	25.80	4587	6903
T_6	Bispyribac-Na	25	85.92	2.74	25.20	4271	6574
T_7	Weed free	-	94.72	3.19	26.00	4757	7158
T_8	Untreated check	-	57.92	2.03	24.24	2282	3882
	SEm±	-	1.90	0.09	0.30	140.32	204.34
	CD(P=0.05)	-	5.77	0.27	0.92	425.66	619.85

CONCLUSION

The study demonstrated that effective weed management is essential for improving the productivity of wet direct-seeded rice under mid-hill conditions. Weed infestation by grasses, sedges, and broad-leaved weeds caused significant yield losses in untreated plots. Among the herbicidal treatments, florpyrauxifen-benzyl at 37.50 and 39.06 g/ha provided the most effective weed control, resulting in lower weed density and higher grain and straw yields. These doses performed similarly to the higher dose of 62.5 g/ha, indicating their efficiency at moderate application rates. Bispyribac-Na showed only moderate control. The weed-free treatment recorded the highest yields, highlighting the impact of weed competition. Overall, florpyrauxifen-benzyl at 37.50–39.06 g/ha proved to be an economical and effective option for managing weeds and enhancing productivity in wet direct-seeded rice.

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AUTHORS CONTRIBUTION

SB: conducted the experiment, data curation and wrote the original manuscript. GDS, SM and NKS: conceptualize the research programme, methodology, provided resources and edited the manuscript. S: Analyzed the data, figures and manuscript review.