Print ISSN : 0972-8813
e-ISSN : 2582-2780

[Vol. 23(3) September-December 2025]

Pantnagar Journal of Research

(Formerly International Journal of Basic and Applied Agricultural Research ISSN : 2349-8765)

G.B. Pant University of Agriculture & Technology

Pantnagar, U.S. Nagar; Uttarakhand, Website : gbpuat.res.in/PJR

PANTNAGAR JOURNAL OF RESEARCH

Vol. 23(3) September-December, 2025

CONTENTS

https://doi.org/10.67063/pjr.vol.23.issue.03.02

Impact of establishment methods and weed management practices on growth and yield attributes of rice (*Oryza sativa* L.)

HIMANSHU*, S.K. YADAV, D.K. SINGH and PRATIMA ARYA

Department of Agronomy, College of Agriculture, G.B. Pant University of Agriculture and Technology, Pantnagar (U.S. Nagar, Uttarakhand)
**Corresponding author's email id:himanshu22d@gmail.com*

ABSTRACT: A field experiment was conducted during *Kharif* 2024 at Pantnagar, Uttarakhand to assess the effect of various rice establishment methods and weed management strategies on weed ecology, crop growth, yield attributes, and the overall productivity of rice (*Oryza sativa* L.). The experiment followed a split-plot design with 3 establishment methods; transplanted rice (TPR), puddled direct seeding (WDSR) and un-puddled dry direct seeding (DDSR) in main plots and 4 weed management treatment; weedy check, mechanical weeding, chemical weeding and weed free in sub-plots. The findings revealed that DDSR recorded the highest weed density and biomass, which could be attributed to the lack of puddling and standing water conditions. In contrast, TPR was more effective in suppressing weed population, thereby achieving the lowest weed density, enhanced weed control efficiency (WCE) and superior yield performance. Among weed control methods, weed free was most effective, showing the lowest weed infestation and highest grain yield, followed by chemical weeding. TPR combined with weed free also recorded the highest net returns and B:C ratio (2.56). In contrast, weedy check plots showed maximum yield losses. The study concludes that TPR along with weed free treatment shows most efficient and profitable strategy.

Keywords: *Echinochloa colona,* Puddled Direct Seeding (WDSR), Transplanted rice (TPR), Un-puddled Dry Direct Seeding (DDSR), weed management, Weed control efficiency (WCE)

Rice is a major staple food crop globally, especially in Asia, where it provides a primary calorie source for over half the population. In India, rice plays a crucial role in food security and rural livelihoods, contributing significantly to the agricultural GDP. However, increasing pressure on natural resources such as water, labour and arable land demands more efficient and sustainable rice production methods.

The method of crop establishment greatly influencesthe rice growth and yield. Traditionally, puddled transplanted rice (TPR) has been the dominant method though it is resource-intensive. Alternatives like dry DSR and wet DSR are gaining popularity due to their potential to save water, reduce labour, and shorten crop duration. However, these methods differ in their effects on plant growth, tillering, nutrient uptake and yield-related traits. Growth parameters including plant height, tiller production, and dry matter accumulation serve as indicators of crop vigor, whereas yield attributes such as panicle density, grain filling, test weight, and grain yield represent the determinants of productivity. Among herbicidal options, penoxsulam, an acetolactate synthase (ALS) inhibitor, has been identified as a highly effective molecule for the management of annual grasses, sedges and broadleaf weed species. Similarly, pyrazosulfuron-ethyl has demonstrated efficacy against diverse and complex weed flora in rice ecosystems (Maiti *et al.,* 2003). These parameters influenced by establishment methods. This study was conducted to find out the effects of various methods of rice establishmenton growth and yield attributes of rice, with the objective of identifying the most suitable practice for achieving sustainable rice productivity.

MATERIALS AND METHODS

A field experiment was conducted during *Kharif* season of 2024 in the Rice Agronomy A2 Block at the N. E. Borlaug Crop Research Centre, G. B. Pant university of Agriculture and Technology, Pantnagar, Uttarakhand. The soil texture was silty loam in nature with pH 7.6, having 0.87% organic carbon, 225 kg/ha available N, 18.6 kg/ha available P and 208 kg/ha available K.The experiment was carried out in split-plot design with 12 treatment-combinations and 3 replications. Treatments consist 3 establishment methods *i.e.,* M_1-transplanting (TPR), M_2- puddled direct seeding (WDSR) and M_3- un-puddled dry direct seeding (DDSR) were in main plots and 4 weed management strategies *i.e.,* W_1- weedy check (control), W_2- mechanical weeding (conoweeder 2 times), W_3- chemical weeding (pre and post emergence herbicides) and W_4- weed free were in sub plots. In DDSR, Pendimethalin @ 1 kg a.i./ha (500 L water) was sprayed pre-emergence after seeding, while in WDSR, Pyrazosulfuron-ethyl @ 1 kg a.i./ha was used. For transplanted rice, Pretilachlor @ 0.75 kg a.i./ha was applied 5 DAT. As post-emergence (15 DAS/DAT), Penoxsulam + Cyhalofop-butyl @ 900 ml/ha was sprayed.To maintain a weed-free condition, manual hand weeding was carried out three times at 15, 25 and 35 DAS/DAT. The sown rice variety was Pant Dhan 24. In transplanted plot, manually transplanting was done at 20×20 cm, in puddled direct seeding, broadcasting of water-soaked pre-sprouted seeds was done at seed rate of 50 kg/ha and in case of un-puddle dry direct seeding, line sowing at 20 cm apart at seed rate of 50 kg/ha was done. A uniform pre-sowing irrigation was applied to all plots for seed bed preparation and water was applied as per need to maintain optimum soil condition. The fertilizer was applied as per the treatment, a full dose of phosphorus and potassium, as well as 50 % nitrogen, was applied as basal in all the rice established plots using urea (46% N), NPK fertilizer (12:32:16) and muriate of potash (60 % K_2O). In TPR, basal fertilizers are applied manually during final puddling before transplanting, while in case of WDSR, basal applied manually just before broadcasting the pre-sprouted seeds and DDSR, basal fertilizers are applied manually at the time of sowing. The remaining nitrogen was applied in two equal split doses, one at tillering and the other at panicle initiation. The data were analyzed using analysis of variance (ANOVA) for split plot design in OPSTAT software and the critical difference (CD) at the 5% level of significance was calculated and used to test significant differences between treatment means.

RESULTS AND DISCUSSION

Weed flora, weed dry weight and weed control efficiency

The major weed flora appear in the experimental fields were *Echinochloa colona, Eleusine indica, Cyperus iria, Cyperus difformis, Fimbristylis miliacea, Alternanthera sessilis,Commelina diffusa* and *Leptochloa chinensis*. At 60 DAS/DAT, significant differences were observed in weed species density and weed dry biomass across various methods of rice establishmentand weed management practices (Table 1). In general, *Echinochloa colona* was the most dominant weed among all the weed species.

At 60 DAS/DAT, DDSR recorded the highest infestation of major weeds, namely *Echinochloa colona*, *Eleusine indica* and *Alternanthera sessilis,* along with the maximum total weed dry weight. The lack of puddling and standing water in DDSR promoted weed seed germination and early growth leading to higher weed pressure compared to WDSR and TPR. In contrast TPR exhibited lower weed densities and dry weight of weed mainly due to continuous submergence and quicker canopy closure, which suppressed weed emergence. This resulted in a higher WCE (weed control efficiency) of 64.14% in TPR compared to 62.90% in DDSR. Continuous submergence in TPR effectively inhibited weed emergence and suppressed weed population by restricting weed seed germination. These findings are consistent with the observations reported by Subramanian *et al.* (2007) and Saha and Bharti (2010).

Among the weed management practices, the weedy check plots recorded the highest total weed density and maximum weed dry weight, resulting in the lowest weed control efficiency (0%), clearly emphasizing the importance of timely and effective weed management. Mechanical weeding reduced the total weed dry weight and achieved a WCE of 77.78%, indicating that two timely cono-weeder operations were effective in suppressing early and mid-season weed flushes. Chemical weeding performed even better, reducing total weed dry weight with a WCE of 85.83%, due to the combined action of pre- and post-emergence herbicides that efficiently controlled grasses, sedges and broadleaf weeds. The weed-free treatment, achieved through

Table 1. Influence of establishment methods and weed management practices on weed density, weed dry weight and WCE (weed-control efficiency) at 60 days after sowing/transplanting of rice

Treatment	*Echinochloa colona* (No. m^{-2})	*Eleusine indica* (No. m^{-2})	*Cyperus iria* (No. m^{-2})	*Fimbristylis miliacea* (No. m^{-2})	*Cyperus difformis* (No. m^{-2})	*Alternanthera sessilis* (No. m^{-2})	*Commelin adiffusa* (No. m^{-2})	*Leptochloa chinensis* (No. m^{-2})	Total weed dry weight (g m^{-2})	weed-control efficiency (%)
Establishment Methods										
TPR	3.59 (14.98)	2.69 (7.42)	3.54 (14.04)	2.11 (3.78)	2.85 (8.08)	2.85 (8.32)	2.15 (4.01)	2.10 (3.91)	5.98 (45.63)	64.14
WDSR	3.87 (16.98)	2.80 (8.06)	3.43 (13.12)	2.29 (4.64)	2.59 (6.67)	2.88 (8.35)	2.35 (4.93)	2.39 (4.98)	6.32 (48.17)	63.06
DDSR	4.22 (20.91)	2.98 (8.97)	3.19 (12.22)	2.68 (7.23)	2.52 (6.51)	3.18 (10.05)	2.71 (6.76)	2.47 (5.48)	6.78 (55.73)	62.9
SEm ±	0.08	0.08	0.06	0.1	0.05	0.09	0.06	0.07	0.12	0.99
CD (P=0.05)	0.33	NS	0.25	0.43	0.18	NS	0.25	0.28	0.51	3.87
Weed Management Practices										
Weedy check	6.93 (47.56)	4.56 (20.16)	6.10 (36.42)	3.49 (11.75)	4.35 (17.96)	4.62 (20.42)	3.33 (10.26)	3.25 (9.68)	11.68 (135.95)	0
Mech. weeding	3.57 (11.85)	2.60 (5.77)	2.87 (7.28)	2.28 (4.33)	2.40 (4.80)	2.74 (6.78)	2.43 (5.15)	2.33 (4.46)	5.58 (30.35)	77.78
Chem. weeding	2.80 (6.87)	2.20 (3.88)	2.54 (5.62)	1.90 (2.67)	2.00 (3.02)	2.51 (5.33)	2.01 (3.04)	1.92 (2.79)	4.54 (19.66)	85.83
Weed free	2.27 (4.21)	1.94 (2.78)	2.03 (3.17)	1.76 (2.11)	1.88 (2.58)	2.02 (3.11)	1.86 (2.48)	1.78 (2.25)	3.79 (13.41)	90.15
SEm ±	0.08	0.12	0.09	0.09	0.06	0.11	0.07	0.07	0.14	1.12
CD (P=0.05)	0.25	0.37	0.27	0.26	0.19	0.34	0.22	0.22	0.42	3.33

*Data were subjected to square root (“x+0.5) transformation; figures in parentheses are original values

three manual hand weeding, recorded the lowest weed dry weight and the highest WCE of 90.15%. Thus, although weed-free treatment remained superior, both mechanical and chemical weeding substantially reduced weed infestation compared to the weedy check. Netam (2013) observed the highest total weed density in dry direct-seeded rice followed by wet direct-seeded rice, while the lowest total weed density was recorded in transplanted rice. Mangaraj (2023) also has reported similar findings.

Yield attributes and yield

Transplanted rice (TPR) significantly outperformed other establishment methods in terms of yield attributes and productivity, as reflected in the data presented in Table 2. The highest panicles density (213/m^2), grain weight per panicle (2.76 g) and lowest spikelet sterility (10.69%) resulting in a maximum grain yield of 5263 kg/ha and straw yield of 5395 kg/ha. The harvest index was also highest in TPR (49.42%), reflecting efficient biomass partitioning towards grain. In contrast,WDSR recorded the lowest grain yield (4101kg/ha), mainly due to reduced panicle number (195/m^2) and grain weight (1.60 g), coupled with elevated spikelet sterility (12.65%). Although DDSR produced a moderate yield (4301 kg/ha), it showed the highest spikelet sterility (18.14%), which negatively affected overall productivity. Jain *et al.* (2018) reported that the transplanting method produced greater panicle length, higher panicle weight and more spikelets per panicle in comparison to the direct seeded rice method. Kumar (2015) reported that yield attributes including the number of effective and ineffective panicles/m^2, grains/panicle, 1000-grain weight, and overall yield were superior under manually transplanted rice compared to direct seeded rice. TPR increase in grain yield may be ascribed to lower weed infestation, which allowed greater nutrient absorption by the crop (Bhat *et al.,* 2011).

Among different weed management practices, weed free resulted in superior performance across all yield parameters. It recorded the highest panicle number (232/m^2), grain weight (2.15 g), and lowest spikelet sterility (11.48%), culminating in the maximum grain yield of 5497 kg/ha and straw yield of 5761 kg/ha.

Table 2: Influence of establishment methods and weed management practices on yield attributes, yields, harvest index and economics of rice

Treatment	No. of panicle (m^2)	Grain weight panicle (g)	Spikelet sterility (%)	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	Weed index (%)	Gross returns (Rs/ha)	Net returns (Rs/ha)	Benefit: Cost ratio
Establishment Methods										
TPR	213	2.76	10.69	5263	5395	49.42	15.94	144617	104148	2.53
WDSR	195	1.6	12.65	4101	4534	47.33	18.42	105299	70277	1.97
DDSR	200	1.73	18.14	4301	4619	48.42	17.3	111095	76523	2.17
SEm±	4	0.03	0.3	67	83	0.73	0.48	2144	1482	0.04
CD (P=0.05)	15	0.12	1.19	265	326	2.89	1.87	8420	5820	0.19
Weed Management Practices										
Weedy check	164	1.85	18.03	2880	3158	48	47.47	74910	43057	1.34
Mech. weeding	202	2.02	12.51	4783	5066	48.56	13.23	125752	90089	2.51
Chem. weeding	214	2.1	13.28	5060	5413	48.22	8.18	134252	96015	2.49
Weed free	232	2.15	11.48	5497	5761	48.78	0	146433	105436	2.56
SEm±	3	0.03	0.23	76	106	1.01	0.47	2149	1625	0.05
CD (P=0.05)	11	0.1	0.71	227	316	3.01	1.41	6387	4830	0.15

This was closely followed by chemical weeding, which achieved a grain yield of 5060 kg/ha. In contrast, the weedy check plot exhibited poor performance, with significantly lower panicle number (164/m^2), higher sterility (18.03%), and the lowest grain yield (2880 kg/ha). The weed index also reflected this trend, being highest in the weedy check (47.47%), indicating substantial yield loss due to weed competition, whereas the lowest weed index (0.47%) was observed in weed free, indicating its effectiveness in yield preservation.

Economics

The economic evaluation revealed that transplanted rice was the most profitable among the establishment methods, as reflected in the data presented in Table 2 with gross returns of Rs. 144617 ha^{-1}, net returns of Rs. 104148 ha^{-1}, and the highest benefit:cost ratio of 2.53. This was due to its superior yield and effective weed suppression. In contrast, WDSR and DDSR recorded lower net returns and B:C ratios of 1.97 and 2.17, respectively, as a result of yield penalties associated with greater weed competition and higher spikelet sterility. Mangaraj (2023) reported that transplanted rice achieved higher gross and net returns compared to direct-seeded rice.

Among weed management options, weed free was economically the most viable, achieving the highest gross returns (Rs. 146433 ha^{-1}), net returns (Rs. 105436 ha^{-1}), and B:C ratio (2.56). This was followed by chemical weeding (B:C ratio of 2.49). In contrast, the weedy check treatment produced the lowest economic returns, with a B:C ratio of only 1.34, highlighting the detrimental impact of unmanaged weed competition on crop profitability. Netam (2013) observed the lowest gross and net return under weedy check conditions and highest in weed free.

CONCLUSION

Among the different rice establishment methods, DDSR promoted higher tiller production and greater dry matter accumulation, while TPR resulted in taller plants, higher yield attributes, and ultimately higher grain yield. Among all the establishment methods, it was observed that TPR consistently reduced weed density more effectively than WDSR and DDSR. The weed flora was dominated by grasses especially *Echinochloa colona*, which was most prevalent in DDSR, whereas sedges were more common in TPR. Yield reductions were more pronounced in direct-seeded systems, underscoring the importance of efficient weed management. From an economic perspective, TPR under weed free conditions produced the highest net returns and benefit: cost ratio. However, chemical weeding also proved to be a more economical option than both the weedy check and mechanical weeding, making it a cost-effective alternative when continuous weed-free management is not feasible.

REFERENCES

Bhat, M. A., Hussain, A., Ganai, M. A. and Mushki, G. M. (2011). Effect of herbicides used alone and in combination on weeds and transplanted rice under temperate conditions of Kashmir. *Appl. Biol. Res.,*13(1): 75-78.

Jain, B.T., Sarial, A. K. And Harikesh.(2018). Comparison of yield potential of Basmati rice (*Oryza sativa*) through direct seeded rice, SRI and conventional technology. *Res. J. Agric. Sci.,* 9(2): 300-306.

Kumar, N. S. (2015). Crop establishment techniques on growth yield and economics of rice. *Am. Int. J. Res. Form. Appl. Nat. Sci.,* 12(2): 49-51.

Kumar, R., Kumar, M., Kumar, A. and Pandey, A. (2015). Productivity, profitability, nutrient uptake and soil health as influenced by establishment methods and nutrient management practices in transplanted rice (*Oryza sativa*) under hill ecosystem of North East India. *Indian J. Agric. Sci.,* 85 (5): 634-639.

Maiti, S., Haldar, P. and Banerjee, H. (2003). Management of weeds in boro rice withpyrazosulfuron-ethyl (PSE) under Gangetic Alluvial conditions of West Bengal. '*In: Proceedings of Biennial Conference*' at Pantnagar, Uttarakhand, during. March 12-14, 76p.

Mangaraj, A. (2023). Studies on weed dynamics in different rice establishment methods under rice-wheat system. Thesis, Doctor of Philosophy, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India, 192 p.

Netam, C. R. (2013). Effect of crop establishment methods and weed management practices on rice and weeds. Thesis, Doctor of Philosophy, G.B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India. 147p.

Saha, A. and Bharti, V. (2010). Effect of different crop establishment methods on growth, yield and economics of rice (*Oryza sativa* L.). *Environ. Ecol.,* 28(1): 519–522.

Subramanian, E., Ramachandra, B.S.N.M. and Balasubramanian, R. (2007). Studies on the effect of weed management practices on weed control in drum seeded wet rice. *Indian J. Weed Sci.,*37(3): 201–203.

Received: September 19, 2025
Accepted: December 16, 2025