E-ISSN: 2618-0618
P-ISSN: 2618-060X

NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 1341-1346
Received: 13-10-2025
Accepted: 17-11-2025

Vinay Kumar
ICAR-IARI (RS), Pusa, Samastipur, Bihar, India

Shashimala Kumari
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Mukesh Kumar
Department of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva - Bharati, West Bengal, India

Shashidhar Yadav
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Raushan Kumar
Department of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva - Bharati, West Bengal, India

Omprakash Kumar
Department of Agriculture, Doon (PG), College of Agriculture Science and Technology, Camp Road Selaqui, Dehradun, Uttarakhand, India

Corresponding Author:
Shashimala Kumari
Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar, India

Impact of crop establishment and different weed management practices on crop economics of direct seeded rice in north region of Bihar

Vinay Kumar, Shashimala Kumari, Mukesh Kumar, Shashidhar Yadav, Raushan Kumar and Omprakash Kumar

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12r.4662

Abstract
A field experiment was undertaken during *kharif* season of the year 2011-2012 at the Research Farm of Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), Bihar to study the effect of crop establishment methods and different weed management practices on growth, yield, economics, and uptake of N, P and K under direct seeded rice. The drum seeded in puddled condition obtained the significantly highest yield attributes, yield, profitability and uptake of N, P and K as compared to wet seeded and dry seeded rice. Rice established by drum seeded in puddled condition had improved the grain yield by 8.80% to 20.36%, and benefit cost ratio by 1.07 times to 1.16 times as compared to wet and dry seeded rice. Applications of pre-emergence pendimethalin and post-emergence bispyribac (W_6) showed maximum increment in yield attributes, *viz*. plant height (8.03%), no. of tillers (39.11%), plant dry matter production (32.16%), and crop growth rate (447.2%) over weedy check (W_8). Treatment, W_6 maintained the highest value of grain and straw yield i.e. 35.55 q ha^{-1} and 52.57 q ha^{-1}, respectively. On the basis of benefit cost ratio the weed management practices, W_3 (pre-emergence application of pretilachlor @ 0.75 kg ha^{-1}) maintained the highest benefit cost ratio (1.29) and lowest was recorded with hand weeding (W_7).

Keywords: Crop establishment, direct seeded rice, economics, weed management, yield etc.

Introduction
Rice is grown in both *kharif* and *Rabi* seasons under diverse ecological and climatic conditions apart from socio-economic diversities of the state. Direct seeded culture has become increasingly important in rice cultivation due to scarcity of farm labour and higher water requirement and higher production cost of transplanted rice (Azmi and Baki, 2007) [1]. Direct seeded rice needs only 34% of the total labour requirement and saves 27% of the total cost of the transplanted crop (Mishra and Singh, 2011) [8]. Direct seeding of rice also allows early establishment of the succeeding wheat crop. Sowing of pre-germinated rice seeds under puddled condition either manually or drum seeding method reduces the demand of water for puddling and reduces the emergence of weed flora by placing the seed, stems and stolons of weed into sub-surface. Dry seeding with subsequent saturated soil condition reduces the amount of water required during puddling and thus reduces overall water demand.
The direct seeded rice culture is subjected to greater weed competition than transplanted rice because both weed and crop seeds emerge at the same time and compete with each other from the germination resulting in less grain yield. Manual removal of weeds is labour intensive, tedious, back breaking and does not ensure weed removal at critical stage of crop-weed competition due to non-availability of labours. A very large number of herbicides are there which have been observed to have effective control of weeds in direct seeded rice. However, selecting a particular herbicide or its combination with mechanical weed management require thorough probe. While, selecting a weed control measure it is equally important to keep economic aspects under consideration. Hence, the present investigation is planned to study the Effect of crop establishment methods and weed management practices on crop performances, yield, nutrient uptake and economics of direct seeded rice.

Materials and Methods

The experiment was conducted during one *kharif* season (2011-12) at Research farm of Dr. Rajendra Prasad Central Agricultural University, Pusa, Bihar. The experiment site was situated on the southern bank of the river Budhi Gandak at 25.59º N and 84.40º E with an altitude of 52.30 m above the mean sea level. The soil was sandy loam in texture with alkaline pH (8.79), medium in organic carbon content (4.0 g kg^{-1}) and available N, P and K (90.31, 7.55 and 45.20 mg kg^{-1}), respectively. The average maximum and minimum temperature varied from 28.8-34.3 ºC and 16.3-27.2 ºC, respectively. The total rainfall and humidity recorded during cropping period was 662.3 mm, and 86-93%, respectively. These were touches the maximum value at 29th standard week. The experiment was laid out in strip plot design, replicated thrice within a plot and involved twenty four treatment combinations (Table 1). The seed rate of 55 kg ha^{-1} was used in all establishment methods. The crop was fertilized at the rate of 150 kg N, 60 kg P_2O_5 and 40 kg K_2O ha^{-1} in all the treatments. Nitrogen was applied through urea in three equal splits (sowing time, active tillering stage and panicle initiation stage); P_2O_5 and K_2O were applied as single basal dose in the form of diammonium phosphate (DAP) and muriate of potash (MOP) along with one third dose of nitrogen at the time of crop sowing. Total five irrigations were done when available soil moisture became 50% in direct seeded rice and only saturation levels were maintained. Herbicides were applied through knap-sac sprayer fitted with flat fan nozzle. Yield attributing characters, i.e. plant height, no. of tillers, plant dry matter production, crop growth rate, and harvest index were recorded at the time of harvesting. The height of randomly selected five tagged rice plants in net plot area was measured from the base of the plant to the tip of the upper most leaf. No. of tillers was counted in per square meter areas. For estimation of plant dry matter the plants enclosed in a quadrant of 0.50 m^2 placed randomly in the border area and was uprooted from each plot. The samples were washed, sun dried and then kept in oven at 65 ºC till constant weight reached. The dry matter production was converted into g m^{-2}. Crop growth rate (CGR) indicates the rate at which the crop is growing. It is expressed as g of dry matter produced per day m^{-2}. The harvest index was calculated by biological and economic yield as described by Singh and Stockopf (1971) [12]. Grain and straw yield were determined from the net plot area and was weighed in kg and converted into q ha^{-1}. The nutrient uptake by the crop was calculated by multiplying the nutrient content with dry matter yield. The nutrient content in grain and straw were determined as per the standard procedure (Tondon, 2005) [16]. Protein content in grain was calculated with multiplying the N content with 6.25. Economics of different treatments was calculated by taking into account the prevailing market price of inputs and produce. Gross returns were worked out for each treatment based on quality and market prices of the produce. The net returns were worked out by deducting the cost incurred from the gross returns of the particular treatment. Benefit cost (B: C) ratio was incurred by dividing the net return with cost of cultivation. Statistical analysis was performed using the SPSS statistical package.

Results and Discussion

Yield attributes

The highest yield attributes (Table 2), *viz*. plant height, no. of tillers, plant dry matter production, crop growth rate and harvest index were recorded in drum seeded puddled condition (E_3) which was followed by wet seeded-broadcasting of sprouted seeds under puddled condition (E_1) and dry seeded in rows at 20 cm apart (E_2). The improvement of yield attributes under the treatment of drum seeded in puddled condition, mainly due to lowest weed population (Singh, and Singh, 2010) [13]. Besides, the puddling virtually destroys the structure of soils completely dispersing their soil particles. Such a condition is favourable for rice growth as there is considerable reduction in the rate of percolation, which increases the period of submergence after each irrigation. The dispersal of soil particles and continued submergence or saturated regime under puddled conditions is unfavorable for the growth of weeds (De Datta, 1981) [4]. Applications of pre-emergence pendimethalin and post-emergence bispyribac (W_6) showed maximum increment in yield attributes, *viz*. plant height (8.03%), no. of tillers (39.11%), plant dry matter production (32.16%), and crop growth rate (447.2%) over weedy check (T_8). However, all other pre-emergence herbicidal applications (Butachlore, pretilachlor, pendimethalin) or bispyribac in combinations with butachlore or pretilachlor (W_1, W_2, W_3, W_4 and W_5) were superseded by two hand weeding so far as these characteristics were concerned due to lowest weed-crop competition during the crop growth. The highest harvest index was obtained with W_1. The results are close agreement with the works of Dwivedi *et al. (*1991) [5], Singh and Namdeo (2004) [14], and Singh *et al*. (2005) [11].

Yield

Yield data revealed that among the crop establishment methods (Table 2), rice establishment by drum seeded in puddled condition (E_1) produced significantly highest grain and straw yields of rice as compared to rest of the treatments (E_1 and E_2). The establishment method, E_3 has improved the grain and straw yield of rice by 8.80-20.36% and 5.12-11.11%, respectively as compared to establishment methods, E_1 and E_2 due to less weed population and higher yield attributes. Our results are in agreement with the findings of Bohra *et al*. (2006) [3], Bhagat *et al*. (2009) [2], Kumar *et al*. (2010) [7], and Singh and Singh (2010) [13].

With the applications of weed management practices (Table 2), *viz*. W_6, W_7, W_4, W_2, and W_3 were produced statistically similar effect on grain yield (average 34.84 q ha^{-1}) of rice and also statistically superior to rest of the weed management practices, namely W_1, W_5 and W_8. Likewise, weed management practices, *viz*. W_6, W_7 and W_4 were produced statistically similar effect on straw yield with an average value of 51.72%, and also significantly superior to rest of weed management practices, i.e. W_1, W_2, W_3, W_5 and W_8. The improvement in grain and straw yield can be attributed to marked improvement in yield attributes, dry matter accumulation, and better weed control efficiency. The minimum grain yield was recorded under weedy check which was attributed to more weed growth and poor yield attributes. The results are commensurate with the earlier findings of Tamilselvan and Budhar (2002) [15], Mohan *et al.* (2005) [9], and Jayadeva *et al*. (2009) [6].

Economics

Economic analysis of data (Table 2) showed that drum seeded in puddled condition (E_3) obtained the highest gross return, net return and benefit cost (B:C) ratio as compared to wet seeded (E_1) and dry seeded (E_2) rice. The treatment E_3 has enhanced the gross return by 1.04-1.08 times, whereas, net return and benefit cost ratio by 1.07-1.16 times when compared to treatment E_1 and E_2 due to better crop growth and yield.

When compared to different weed management practices, the

treatment combining pre-emergence application of pretilachlor followed by post-emergence application of bispyribac (W_4) had incurred the highest gross return which was closely followed by W_6 and W_7. Among the pre-emergence applications of pretilachlor herbicide gave the maximum gross return followed by pendimethalin and butachlor. Whereas, the minimum gross return was obtained with weedy check (W_8). Similarly, weed management practice, W_4 incurred the highest net return which was statistically at par with rest of the weed management practices except W_1, W_7 and W_8.

All the herbicidal weed management practices (W_1 to W_6) recorded higher B:C ratio i.e. 1.13-1.29 than two hand weeding (W_7) and weedy check (W_8) due to better growth and yield. Two hand weeding with B: C ratio of 0.58 was superior only to the control weedy check (0.67). Among the three pre-emergence applications, pretilachlor recorded the highest B: C ratio closely followed by butachlor and pendimethalin. Pre-emergence application of pretilachlor (W_3) also superseded all the three combinations of pre and post emergence applications, i.e. W3, W_2-butachlor + bispyribac, W_4 -pretilachlor + bispyribac and W_6-pendimethalin + bispyribac. The highest net return and benefit: cost ratio under W_3 treatments was owing to more grain yield and comparatively low cost of pretilachlor. All these findings with regard to economics of this investigation were in agreement with those reported by Mukherjee and Maity (2010) [10].

Nutrient uptake

Different crop establishment methods and weed management practices were produced the significant effect on cumulative uptake of N, P and K by crop and weed (Table 3). Drum seeded in puddled condition has recorded the highest uptake of N, P and K as compared to rest of the weed management practices might be due to highest grain and straw yield. Among the weed management practices, all the herbicidal treatments and hand weeding recorded the significantly higher N, P and K uptake which ranged between 88.61 kg ha^{-1} and 97.93 kg ha^{-1}, 23.95 kg ha^{-1}, and 27.13 kg ha^{-1} and 133.53 kg ha^{-1} and 149.81 kg ha^{-1}, respectively. This result is also in agreement with earlier results advocated by Kumar *et al.* (2010) [7].

Protein content

Protein content in grain was not significantly influenced with the adoption of crop establishment methods and weed management practices (Table 3). However, the highest protein content was obtained with E_3 (9.37%) and W_6 (9.39%) due to better weed control efficiency and crop growth.

On the basis of foregoing finding it can be concluded that drum seeded in puddled condition of rice with the application of Pendimethalin @ 1.0 kg ha^{-1} *fb* (pre-emergence) followed by bispyribac @ 25 g ha^{-1} (post-emergence) was found to be most effective in respect of weed control and yield attributes, yield and profitability of direct seeded rice.

Table 1: Abbreviations and description of crop establishment methods and weed management protocols under different treatments.

Establishment methods	
E_1	Wet seeded (broadcasting of sprouted seeds under puddled condition)
E_2	Dry seeded in rows at 20 cm apart
E_3	Drum seeded in puddled condition
Weed management	
W_1	Butachlor @ 1.5 kg ha^{-1} (pre-emergence)
W_2	Butachlor @ 1.5 kg ha^{-1} *fb* bispyribac @ 25 g ha^{-1}
W_3	Pretilachlor @ 0.75 kg ha^{-1} (pre-emergence)
W_4	Pretilachlor @ 0.75 kg ha^{-1} *fb* bispyribac @ 25 g ha^{-1}
W_5	Pendimethalin @ 1.0 kg ha^{-1} (pre-emergence)
W_6	Pendimethalin @ 1.0 kg ha^{-1} *fb* bispyribac @ 25 g ha^{-1}
W_7	Hand weeding at 20 & 40 DAS
W_8	Weedy check

Table 2: Effect of crop establishment methods and weed management practices on yield attributes of direct seeded rice at maturity/harvest.

Treatments	Plant height (cm)	No. of tillers (m^{-2})	Plant dry matter production (g m^{-2})	Crop growth rate (g day^{-1} m^{-2})	Harvest Index (%)
Establishment methods					
E_1	77.23	211.12	799.87	4.84	40.88
E_2	75.75	187.87	771.14	4.38	39.78
E_3	79.13	231.62	837.91	5.38	41.71
SEm±	0.43	0.48	20.35	0.29	1.28
CD (P=0.05)	1.71	1.90	N.S	NS	NS
Weed management					
W_1	77.47	202.00	754.30	3.32	41.86
W_2	78.26	218.00	830.40	5.44	41.40
W_3	78.03	212.33	809.66	4.88	41.55
W_4	78.53	224.66	840.96	5.57	40.80
W_5	77.23	202.33	784.43	4.29	41.20
W_6	78.93	230.00	851.73	5.91	40.34
W_7	78.80	227.00	842.65	5.60	40.65
W_8	73.06	165.33	644.44	1.08	38.36
SEm±	0.43	1.00	31.45	0.46	0.62
CD (P=0.05)	1.31	3.04	95.40	1.42	1.90

Table 3: Effect of crop establishment methods and weed management practices on yield and economics of direct seeded rice.

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B:C ratio
Establishment methods					
E_1	32.70	47.29	47968	24376	1.05
E_2	29.56	44.74	46133	22540	0.97
E_3	35.58	49.71	49738	26146	1.13
SEm±	0.91	0.90	638	638	0.02
CD (P=0.05)	3.57	3.55	2507	2508	0.10
Weed management					
W_1	31.63	43.93	45964	24536	1.14
W_2	34.36	48.64	50296	27092	1.16
W_3	33.60	47.26	49215	27727	1.29
W_4	35.35	51.29	52444	29181	1.24
W_5	32.26	46.04	47406	25168	1.13
W_6	35.55	52.57	52386	28373	1.18
W_7	35.36	51.62	51993	19159	0.58
W_8	22.80	36.63	33870	13596	0.67
SEm±	0.94	1.07	1401	1401	0.05
CD (P=0.05)	2.87	3.27	4250	4250	0.17

Table 4: Effect of crop establishment methods and weed management practices on total (crop + weed) uptake of NPK nutrients and protein content in grain under direct seeded rice.

Treatments	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Protein content in grain (%).
Establishment methods				
E_1	92.47	25.27	140.77	9.32
E_2	91.3	24.6	138.25	9.19
E_3	93.4	25.88	142.79	9.37
SEm±	1.52	0.33	3.11	0.06
CD (P=0.05)	2.99	0.67	6.21	NS
Weed management				
W_1	88.61	23.95	133.53	9.25
W_2	95.41	26.04	143.35	9.35
W_3	93.73	25.54	140.73	9.33
W_4	98.41	27.03	148.93	9.37
W_5	92.07	25.04	139.25	9.27
W_6	97.93	27.13	149.81	9.39
W_7	97.68	27.00	148.81	9.37
W_8	75.25	20.27	120.45	9.02
SEm±	3.05	0.70	4.17	0.08
CD (P=0.05)	4.29	1.15	6.67	NS

Acknowledgement

The support of Department of Agronomy and Department of Soil Science, Rajendra Agricultural University, Pusa, Samastipur, Bihar for providing land, laboratory for analysis and other basic infrastructure for this trail is duly acknowledged.

References

1. Azmi M, Baki B. Weed flora landscapes and innovative management in direct seeded culture. In: Science, technology and trade for peace and prosperity. Proceedings of the 26th International Rice Research Conference; 2006 Oct 9–12; New Delhi, India. p. 401-409.
2. Bhagat S, Malik RK, Ashok Y, Nandal DP. Herbicide efficacy in seeded rice with different methods under wet and dry conditions. Indian J Weed Sci. 2009;41(1-2):37-40.
3. Bohra JS, Verma KR, Singh RP, Singh JP, Singh Y. Crop establishment options in rice (*Oryza sativa*)–wheat (*Triticum aestivum*) system under irrigated conditions of Varanasi. In: Extended summaries of the Golden Jubilee National Symposium on Conservation Agriculture and Environment; 2006 Oct 26–28; Varanasi, India. Varanasi: Indian Society of Agronomy, BHU; 2006. p. 48-49.
4. De Datta SK. Principles and practices of rice production. New York: John Wiley and Sons; 1981. p. 618.
5. Dwivedi GK, Dwivedi M, Pal SS. Mode of application of micronutrients in rice–wheat crop sequence. J Indian Soc Soil Sci. 1991;38:458-463.
6. Jayadeva HM, Bhairappanavar ST, Somashekharappa PR, Rangaswamy BR. Efficacy of azimsulfuron for weed control in transplanted rice. Indian J Weed Sci. 2009;41(3-4):172-175.
7. Kumar J, Singh D, Puniya R, Pandey PC. Effect of weed management practices on nutrient uptake by direct seeded rice. Oryza. 2010;47(4):291-294.
8. Mishra JS, Singh VP. Cultivar competitiveness and weed control in zero-till dry seeded irrigated rice (*Oryza sativa*). Indian J Agric Sci. 2011;81(10):976-978.
9. Mohan KS, Muniyappa TV, Kumar HR. Effect of pre-emergence herbicides on growth and yield of direct seeded puddled rice (*Oryza sativa*). In: Extended summaries of the National Biennial Conference; 2005 Apr 6–9; Ludhiana, India. Ludhiana: Indian Society of Weed Science, PAU; 2005. p. 28-29.
10. Mukherjee PK, Maity SK. Weed control in transplanted and wet seeded rainy season rice (*Oryza sativa*). Indian J Agric Sci. 2011;81(2):134-139.
11. Singh G, Singh RG, Singh OP, Thakur T, Mehta RK, Kumar V, Singh PP. Effect of weed management practices

on direct seeded rice (*Oryza sativa*) under puddled lowlands. Indian J Agron. 2005;50(1):35-37.
12. Singh LD, Stoskopt NC. Harvest index in cereals. Agron J. 1971;63:224-226.
13. Singh M, Singh RP. Influence of crop establishment methods and weed management practices on yield and economics of direct-seeded rice (*Oryza sativa*). Indian J Agron. 2010;55(3):224-229.
14. Singh RK, Namdeo KN. Effect of fertility levels and herbicide on growth, yield and nutrient uptake of direct seeded rice. Indian J Agron. 2004;49(1):34-36.
15. Tamilselvan N, Budhar MN. Weed control in direct seeded puddled rice. Madras Agric J. 2002;88(10-12):745-746.
16. Tandon HLS. Methods of analysis of soils, plants, waters, fertilizers and organic manures. 2nd ed. New Delhi: Fertilizer Development and Consultation Organization; 2005. 204 p + xii.