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Research Communication

Effect of irrigation scheduling and nitrogen application on productivity and profitability of direct seeded rice (*Oryza sativa*)

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ABSTRACT

A field experiment was conducted during the rainy (*kharif*), season of 2015, to study the effect of irrigation scheduling and split application of nitrogen on productivity and profitability of direct-seeded rice (DSR) (*Oryza sativa* L.). The experiment was laid out in split-plot design with 12 treatment combinations including 4 irrigation schedules, viz, 0 kPa; 10 kPa, 20 kPa and 10 kPa during entire stage except 40 kPa at tillering to flowering stages in main plot and 3 N (120 kg/ha) application methods, viz. control (N_0), half recommended dose of nitrogen (RDN) as basal + one-fourth RDN at week 2 + one-fourth RDN at week 5, and one-fourth RDN as basal + one-fourth RDN at week 2 + one-fourth RDN at week + one-fourth RDN at week 9 after sowing in subplot were taken with 3 replications. Irrigation scheduling at 0 kPa resulted in the highest yield attributes, grain and straw yields and net returns of DSR, which was remained at par with 10 kPa. Four times split application of N as one-fourth RDN as basal + one-fourth RDN at 2 week + one-fourth RDN at week 5 + one-fourth RDN at week 9 recorded significantly high grain and straw yields and net returns over half RDN as basal + one-fourth RDN at week 2 + one-fourth RDN at week 5 and control. Thus, irrigation threshold of 10 kPa with 4 times split application of RDN can be applied to DSR to get higher yield and net returns.

Key words: Direct seeded rice, Irrigation thresholds, Split N application

Direct-seeded rice (DSR) is one of the resource-conservation technologies which requires less water and labour over transplanted puddled rice (TPR) (Chauhan *et al*., 2012). Here, sowing of rice is done under aerobic environment which avoids the puddling and maintains continuous moist soil conditions and thus reduces the overall water demand. Crop competition from weeds, deficiency of iron and nematodes are the major limitation for successful DSR production (Kreye *et al*., 2009). DSR could be a best alternative to TPR in terms of saving of irrigation water, labour and energy as puddling and transplanting operations are completely avoided without any significant yield reduction (Yadav *et al*., 2011). Nitrogen-use efficiency (NUE) in rice is very low ~33%, as applied N is lost from the soil–plant system via denitrification, leaching, surface runoff and volatilization. Since NUE is a function of available water, temporal variability in soil moisture directly translates into temporal variability of crop response to N (Cassman *et al.,* 1996). The moisture regime in DSR is different as compared to puddled rice. Keeping this in view, the present study was undertaken to study the effect of water and nitrogen-management practices on yield and economics of DSR.

A field experiment was conducted during the rainy (*kharif*) season of 2015 at the research farm of ICAR-Indian Agricultural Research Institute, New Delhi (28º40' N, 77º12’ E, 228.6 m above the mean sea-level). The soil of the experimental field was sandy clay loam in texture, having good water-holding capacity. The soil was low in organic C (0.43%) and available N (167 kg/ha), medium in available P (13.9 kg/ha) and high in available K (275 kg/ha), with a *p*H 7.9. The total rainfall was 748.5 mm during the growing period of rice. The experiment was laid out in split-plot design, having 4 irrigation schedules (0 kPa, 10 kPa, 20 kPa and 10 kPa during entire stage except 40 kPa) at tillering to flowering stages) in main plot and 3 N application methods, viz, 120 kg/ha [control (N_0), half RDN basal + one-fourth at week 2 + one-fourth at week 5 and one-fourth RDN basal + one-fourth at week 2 + one-fourth at 5 week + one-fourth at week 9 after sowing)] in

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sub-plot with 3 replications. Rice variety 'Pusa Basmati 1509' was sown using a seed rate of 30 kg/ha at 22.5 cm row- to -row spacing on 27 June 2015. The sowing was done with the help of multi-row crop planter. The recommended dose of 60 kg P_2O_5/ha through single super phosphate and 60 kg K_2O/ha through muriate of potash were applied at the time of sowing. A pre-emergence application of pendimethalin @ 0.75 kg/ha followed by post- emergence application of bispyribac @ 0.025 kg/ha was done for effective weed management. The nitrogen and irrigations scheduling was done as per the treatments. Tensiometers were installed up to the 15 cm soil depth of effective root zone of rice. The observations on plant growth, yield attributes, yield and economics were recorded as per the standard procedures.

The result showed that yield-attributing parameters, viz. numbers of effective tillers, panicle length, grains/panicle and 1,000-grain weight, were significantly influenced by irrigation scheduling (Table 1). The yield-attributing parameters were maximum with irrigation scheduling at 0 kPa (saturated condition) which found at par with 10 kPa. The split application of N as one-fourth basal + one-fourth at week 2 + one-fourth at week 5 + one-fourth at week 9 gave the highest effective tillers/m^2, panicle length, grains/panicle, panicle weight and 1,000-grain weight compared to half basal + one-fourth at week 2 + one-fourth at week 5 and control. This could be attributed to the adequate and partitioned supply of N and increased accumulation of photosynthates from source to sink (Sinha and Talati, 2000). The highest grain, straw and biological yield were observed with irrigation scheduling at 0 kPa which remained at par with 10 kPa (Table 1). Irrigation scheduling at higher thresholds at 20 kPa and 10 kPa throughout the growing season except 40 kPa at tillering to flowering showed a decline in yield. However, the treatments 10 kPa throughout the growing season except 40 kPa during tillering to flowering was found comparable with 20 KPa during the experimentation period. Similar findings were also reported by Mahajan *et al.* (2006). The split application of RDN as one-fourth basal + one-fourth at week 2 + one-fourth at week 5 + one-fourth at week 9 gave higher grain yield than half basal + one-fourth at week 2 + one-fourth at week 5. Better partitioning of photosynthates in vegetative organs to grain possibly caused a significant variation in yield (Jat *et al*., 2014). The highest cost of cultivation was recorded in the treatments with irrigation scheduling at 0 kPa (₹39.7 × 10³/ha) followed by 10 kPa and 20 kPa. The lowest cost of cultivation (₹32.5 × 10³/ha) was recorded with 10 kPa throughout the growing season except 40 kPa during tillering to flowering stage. Likewise, the maximum gross return ₹84.8 × 10³/ha and ₹82.1 × 10³/ha was recorded with irrigation scheduling at 0 kPa and 10 kPa respectively, followed by 20 kPa. The maximum net return (₹45.1 × 10³/ha) was obtained with irrigation scheduling at 10 kPa which remained at par with 0 kPa. Similarly, the highest cost of cultivation was recorded with split application of RDN as one-fourth basal + one-fourth at week 2 + one-fourth at week 5 + one-fourth at week 9 (36.6 ×₹10³/ha). However, this treatment gave the highest values of gross and net returns (₹52.2 × 10³/ha) followed by half basal + one-fourth at week 2 + one-fourth at week 5.

Table 1. Effect of irrigation scheduling and N application on yield attributes of direct seeded rice

Treatment	Effective Tillers/m^2	Panicle length (cm)	Filled grains/ panicle	1,000-grain weight(g)	Grain yield (t/ha)	Straw yield (t/ha)	Cost of cultivation (×10³₹/ha)	Net returns (×10³₹/ha)
Irrigation scheduling								
0 kPa	333	27.7	136	23.0	4.83	7.38	39.7	45.0
10 kPa	322	27.6	134	22.8	4.68	7.08	37.0	45.1
20 kPa	319	26.4	132	22.3	4.24	6.52	35.3	39.2
40 kPa*	307	25.4	131	21.6	3.96	6.27	32.5	37.4
SEm±	4.56	0.19	0.98	0.19	0.13	0.24	-	1.59
CD (P=0.05)	15.8	0.68	3.39	0.68	0.46	NS	-	5.51
Nitrogen application								
Control (N_0)	257	24.9	128	20.5	3.60	5.80	35.7	28.1
N_1**	343	27.4	136	23.0	4.62	6.94	36.1	44.8
N_2***	361	28.1	136	23.8	5.06	7.70	36.6	52.1
SEm±	3.33	0.09	0.41	0.09	0.06	0.11	-	0.83
CD (P=0.05)	9.99	0.27	1.23	0.28	0.18	0.34	-	2.49

*10 kPa throughout the growing season except 40 kPa during tillering to flowering;
**half basal + one-fourth at week 2 + one-fourth at week 5
***one-fourth basal + one-fourth at week 2 + one fourth at week 5 + one-fourth at week 9

Thus, irrigation threshold of 10 kPa could be an alternative of 0 kPa without any reduction in yield of DSR. Likewise, split application of 120 kg N/ha as one-fourth basal + one-fourth at week 2 + one-fourth at week 5 + one-fourth at week 9 can be recommended to obtain higher grain yield and net return in DSR.

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