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Effect of Rice Establishment Methods and Nutrient Management Practices on Growth, Yield and Economics of Rice (*Oryza sativa* L.)

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ABSTRACT

A field experiment was conducted at Rice Research Farm of Birsa Agricultural University, Ranchi, Jharkhand, during Kharif seasons of 2018 and 2019 to find out the effect of rice establishment methods and nutrient management practices on growth, yield and economics of rice. The experiment was laid out in split plot design replicated thrice with rice variety Naveen as test crop. The treatments comprised of three different rice establishment methods *viz.,* normal transplanting, wet direct seeding using drum seeder and aerobic rice assigned to main plots and five nutrient management practices *viz.,* RDF(80:40:20 kg NPK/ha), 75% RDF + 25% N through FYM (60:30:15 kg NPK/ha + 20 kg N through FYM), RDF + 25% N through FYM (80:40:20 kg NPK/ha + 20 kg N through FYM) , LCC based nitrogen application and control (No fertilizer) assigned to sub plots. The soil was clay loam in texture and slightly acidic in reaction (6.2) having 4.3 g/kg organic carbon, 230.00 kg/ha available soil nitrogen, 36.80 kg/ha available phosphorous, 161.20 kg/ha of available potassium. Results revealed that wet direct seeding of rice using drum seeder recorded maximum grain (42.19 q/ha) and straw yield (65.22 q/ha) which was comparable with transplanting method but were significantly superior to aerobic rice. Among the nutrient management practices, application of RDF + 25% N through FYM produced maximum grain (46.33 q/ha) and straw yield (71.53 q/ha) which was significantly better than rest of the treatments except LCC based N application. Among the different establishment methods, wet direct seeding of rice using drum seeder recorded maximum net return (58337 ₹/ha) which was significantly higher than other establishment methods. The B:C ratio was also maximum with wet direct seeding using drum seeder (2.00) which was statistically at par with aerobic rice (1.93). Among the nutrient management practices, LCC based N application gave the highest net return (64030 ₹/ha) and B:C ratio (2.28).

Key words : *Aerobic rice, Drum seeding of rice, Leaf colour chart, Recommended dose of fertilizer.*

Introduction

To feed the burgeoning Indian population which is increasing at population growth rate of 1.5%, the projected rice demand of the nation will be 125 million tons by 2025 AD. As possibility of expanding the area under rice cultivation is limited in the near future. Therefore, technological intervention can play a major role in enhancing productivity of rice. In the current scenario, the increasing scarcity of water is forcing farmers to adopt less water demanding technologies.

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The major operations followed in normal transplanting such as nursery preparation and management, pulling of nursery, transporting and distribution of seedlings in main field consumes 30-40 % of total cost of cultivation (Rani and Jayakiran, 2003). The lowering of cost:benefit ratio and productivity per unit area per unit time and rising cost of inputs has shaken the trust of the farmers in transplanting system (Sanjay *et al*., 2006). Direct seeding in rice is becoming a popular alternative to transplanting system as it reduces labor requirement, cost of cultivation, shortens the duration of crop by 7-10 days and gives comparable grain yield as of transplanting (Sharma *et al*., 2005). The use of drum seeder, not only simplified the direct seeding operation but also gave monetary saving. Drum seeding also offers other advantages like reduction in total crop duration by 10-12 days, possibility of better weed management and ease in fertilizer application under row seeding which is not possible under random transplanting (Sanjay *et al*., 2006).

Nutrient management is also an important factor for soil and crop management system in rice**.** Precision nitrogen application based on plant need and location specific applications improves the fertilizer use efficiency in rice and optimizes the use of nitrogen by matching nitrogen supply according to crop demand. The leaf color intensity is directly related with the leaf chlorophyll content governed by nitrogen status of leaf as there has been close relationship between chlorophyll content of leaf and nitrogen content in leaf (Alam *et al.,* 2005). Therefore, supplying of nutrients at critical growth stages along with considering the ability of soil to supply nutrients led to profitable crop production**.**

Materials and Methods

A field investigation was carried out for two consecutive years during *kharif* season of 2018 and 2019 at Rice Research Farm of Birsa Agricultural University, Kanke, Ranchi. The soil was clay loam with 37.1% sand, 29.7% silt and 33.2% clay textural composition and slightly acidic (6.2) in reaction having 4.3 g/kg organic carbon, 230.00 kg/ha available soil nitrogen, 36.80 kg/ha available phosphorous, 161,20 kg/ha of available potassium content. The experiment was laid out in split plot design replicated thrice with rice variety Naveen as test crop. The treatments comprised of three different rice establishment methods *viz.,* normal transplanting, wet direct seeding of sprouted seeds in puddle field using drum seeder and aerobic rice assigned to main plots and five nutrient management practices *viz.,* RDF(80:40:20 Kg NPK/ha), 75% RDF + 25% N through FYM, RDF + 25% N through FYM, LCC based nitrogen application and control (no fertilizer) assigned to sub plots. Prior to sowing or transplanting of rice crop, farm yard manure was applied as per treatment and thoroughly mixed into the top 15 cm soil with the help of spade. Full dose of phosphorus and potassium and 25% of nitrogen was applied as basal in wet-direct seeded and aerobic rice while 50% of nitrogen with full dose of phosphorus and potassium was applied as basal in transplanted rice plots through urea, diammonium phosphate and murate of potash as per treatment dose. The remaining quantity of nitrogen was top dressed in two splits: at tillering (50% in aerobic and wet-direct seeded treatments and 25% in transplanted rice) and at panicle initiation stage 25%N was applied in all establishment methods. In LCC based nitrogen application, full recommended dose of phosphorus, potassium and half of the recommended dose of nitrogen (40 kg/ha) was applied as basal and remaining nitrogen was top dressed at the rate of 13.33 kg N/ha applied thrice on 23rd, 45th and 61st days after sowing or transplanting when color of 6 out of 10 leaves fall below a threshold level of shade 4 on the leaf color chart.

Results and Discussion

Growth parameters

The rice established through wet direct seeding using drum seeder recorded comparable growth parameters viz. total tillers/m^2, leaf area index and dry matter accumulation as of transplanting method. However, both of these treatments establishes significant superiority over aerobic rice in respect of tiller number/m^2 and dry matter accumulation. The rice established through wet direct seeding through drum seeder recorded significantly higher leaf area index at 90 days after sowing over aerobic rice. While, the normal transplanting failed to exert significant variation in leaf area index with aerobic rice and remained statistically at par between themselves. This might be due to profuse tillering due to better availability of space, nutrients and light (Kumar *et al.,* 2018).

Among nutrient management practices, applica-

tion of RDF + 25% N through FYM and LCC based N application being similar between themselves in respect of tillers/m^2, leaf area index and dry matter accumulation but, both of the nutrient management practices showed their significant superiority over application of RDF and 75% RDF+ 25% N through FYM as well as control in respect of tiller number/m^2, leaf area index at 90 DA/DAT and dry matter accumulation at maturity. The inorganic nitrogen nourished the plant at initial stage and boosted the growth, while the incorporated FYM released the nutrients slowly and made available upto reproductive stages of crop (Dahiphale *et al*., 2003) thereby improved the growth attributes of rice.

The yield attributes viz. Panicle/m^2, fertile grains/panicle and 1000 grain weight was recorded highest with wet direct seeding using drum seeder which was significantly higher than aerobic rice and normal transplanting in respect of fertile grains/panicle. While, in case of panicles/m^2 the rice establishment through wet direct seeding and normal transplanting recorded significantly higher number of panicles/m^2 than aerobic rice but, both of former establishment methods i.e. wet direct seeding and normal transplanting were statistically similar in respect of panicles/m^2. The 1000 grain weight were not significantly influenced by establishment method and all of the establishment method were comparable in respect of 1000 grain weight. The beneficial effects of puddling in drum seeding as well as in transplanting together with uniform stand establishment, ideal rhizosphere environment and weed free condition might have contributed to higher uptake of nutrient which resulted in the more production of source and efficient photosynthates translocation into the larger sink as indicated by higher yield attributes.

The nutrient management through RDF + 25% N through FYM recorded highest yield attributes viz. panicles/m^2 and fertile grains/panicle which was comparable with LCC based N application. However, both of the nutrient application were significantly superior to rest of the nutrient management practices viz. RDF and 75% RDF + 25% N through FYM as well as control. Although application of RDF +25% N through FYM recorded the highest 1000 grain weight but, it failed to exert significant difference with other nutrient management practices and control. Integration of FYM along with inorganic sources resulted in slow release of nutrient and its increased availability resulted in enhanced photosynthates production of and its translocation from source to sink thereby improved the yield attributing characters (Ramamoorthy *et al*., 2000).

Yield

The grain and straw yield of rice was found highest with rice established through wet direct seeding us-

Table 1. Growth and yield attributes on rice as influenced by establishment methods and nutrient management practices (Pooled data of two years)

Treatment	Growth attributes			Yield attributes		
	Tillers/m^2	Dry matter accumulation (g/m^2)	Leaf area index at 90 DAS/T	Panicles/m^2	Fertile Grain/panicle	1000 grain weight(g)
Establishment Methods						
Normal Transplanting	257	1249	3.48	248	103	24.22
Wet direct seeding using drum seeder	267	1292	3.58	251	109	24.26
Aerobic rice	227	1150	3.29	219	101	24.05
SEm±	6.21	11.80	0.05	4.04	1.09	0.05
CD(P=0.05)	24.40	46.34	0.18	15.88	4.28	NS
Nutrient management practices						
RDF (80:40:20 kg NPK/ha)	259	1338	3.51	251	105	24.15
75% RDF + 25% N through FYM	254	1333	3.52	241	98	24.21
RDF + 25% N through FYM	284	1407	3.77	277	118	24.36
LCC based Nitrogen application	283	1404	3.75	273	118	24.23
Control (No fertilizer)	172	670	2.71	154	83	23.95
SEm±	8.14	22.03	0.08	6.58	1.77	0.26
CD(P=0.05)	23.77	64.29	0.22	19.22	5.15	NS
CV%	9.76	5.37	6.62	8.25	5.07	3.20

ing drum seeder which was significantly higher than aerobic rice. Similarly, the grain and straw yield recorded with normal transplanting was significantly higher than aerobic rice. However, rice established through wet direct seeding through drum seeder and normal transplanting were comparatively similar in respect of grain and straw yield. The comparatively low paddy yields in aerobic rice as compared to transplanting could have been due to exposure of seeds to pest destruction and weed competition (Dingkuhn *et al*., 1991) whereas, wet direct seeding using drum seeder recorded significantly higher paddy yield because of early vigrous, plant growth, less initial weed, optimum planting distance which ensure air circulation, water and light which are important factors for photosynthesis. This is in agreement with findings of Gangwar *et al.* (2009). The rice establishment methods failed to exert significant statistical differences in harvest index although, the rice establishment through wet direct seeding using drum seeder recorded the higher harvest index while, the lowest harvest index was found with aerobic rice. The higher grain and straw yield under wet direct seeding using drum seeder was also reported by Bhardwaj *et al.* (2016).

Among various nutrient management practices, application of RDF + 25% N through FYM and LCC based N application being statistically similar between themselves in respect of grain yield but, both of these treatments recorded significantly higher grain yield than other nutrient management practices as well as control. The straw yield was found highest with application of RDF + 25% N through FYM which was statically similar to LCC based nitrogen application. However, the former viz. RDF + 25% N through FYM showed its significant superiority over the other nutrient management practices in respect of straw yield. The nutrient management practices were unable to exert significant statistical variation in harvest index and remained comparable among themselves as well as no fertilizer treatments.

Economics

Among the rice establishment methods, the net return with wet direct seeding using drum seeder was significantly higher than other establishment methods. Although the benefit: cost ratio was also found highest under drum seeded rice but, it failed to exert significant statistical variation with aerobic rice and remained comparable between themselves. However, rice established through drum seeder and aerobic rice resulted in significantly higher benefit: cost ratio than normal transplanting. The higher net return under drum seeded and transplanted rice was due to higher grain and straw yield of the rice crop. This confirms the findings of Bhardwaj *et al.*, 2018.

Table 2. Yield and economics of rice as influenced by establishment methods and nutrient management practices (Pooled data of two years)

Treatment	Yield (kg/ha)			Economics (‘/ha)	
	Grain	Straw	Harvest index (%)	Net return (‘/ha)	B:C
Establishment Methods					
Normal Transplanting	3949	6189	38.80	47845	1.39
Wet direct seeding using drum seeder	4219	6522	39.26	58337	2.00
Aerobic rice	3265	5240	37.97	44987	1.93
SEm±	113	133	0.74	2208	0.09
CD(P=0.05)	443	521	NS	8670	0.34
Nutrient management practices					
RDF (80:40:20 kg NPK/ha)	4132	6632	38.37	57446	2.09
75% RDF + 25% N through FYM	3898	6139	38.80	51126	1.77
RDF + 25% N through FYM	4633	7153	39.29	64258	2.10
LCC based Nitrogen application	4510	6872	39.60	64030	2.28
Control (No fertilizer)	1880	3122	37.31	15088	0.64
SEm±	100	158	0.86	2017	0.06
CD(P=0.05)	293	461	NS	5886	0.18
CV%	790	792	6.68	12.01	12.17

The different mode of nutrient application caused significant variation in net return as application of RDF + 25% N through FYM recorded the highest net return which was significantly higher than the other nutrient management practices except the LCC based nitrogen application whereas, the benefit:cost ratio under LCC based nitrogen application was found significantly higher than all other nutrient management practices.

Conclusion

On the basis of two years of experimentation, it can be concluded that wet direct seeding of rice using drum seeder produced comparable yield as with normal transplanting method. Application of RDF(80:40:20 kg NPK/ha) + 25% N through FYM or LCC based N application were the most suitable nutrient management practices under different rice establishment methods.

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