Original Research Article

Effect of different establishment methods and nutrient management practices on growth, yield and economics of rice (*Oryza sativa* L.)

Abstract

The field experiment was conducted during 2018 *Kharif* at Zonal Agricultural Research Station, Vishwesharaiah Canal Farm, Mandya to study the Effect of different establishment methods and nutrient management practices on growth, yield and economics of rice (*Oryza sativa* L.). The experiment laid out in a split plot design with three replications. The treatments comprised of three rice establishment methods *viz*., semi dry, drum seeding & transplanting and five nutrient management practices. Among establishment methods, growth and yield parameters such as LAI at 60 DAS, plant height, dry matter production at harvest, panicles m^{-2}, panicle weight, test weight, grain and straw yields recorded were statistically analyzed at par with each other. Further between nutrient management practices, application of 150% RDIF recorded significantly higher LAI at 60 DAS, plant height, dry matter production at harvest, panicles m^{-2}, panicle weight, test weight, grain and straw yields as compared to rest of the nutrient management practices. Further semi dry and drum seeding of rice recorded higher B:C ratio (2.15) over transplanting of rice (2.10). Similarly, 150% RDIF recorded higher B:C ratio (2.37), but was closely followed by 100% RDIF (2.22).

Keywords: Drum seeding, LCC, methods of establishment, nutrient management, rice, semi dry rice, transplanting

Introduction

Rice is one among the most important cereal crop in the world. It is a staple food for more than half of the world's population and plays a role in attenuate poverty and malnutrition. World’s 90 percentage of paddy is produced and consumed in Asia. The second largest producer and consumer of paddy in the world are in India.

The world’s population is expected to increase 8.1 billion by 2025. Hence, an increase of 2% to 3% of rice production has to be maintained per year with the available land and key resources in order to maintain self-sufficiency in rice production. The rice production might be increased due to the adoption of high yielding cultivars, use of chemical fertilizers and increase in irrigated area from past few decades. However, stagnant rate in the increasing rice yield is noticed at present is mainly due to degradation of rice soils, apart from inadequate or imbalanced supply of primary nutrients to rice crop. To enhance the rice yield, the sustainable technologies are playing major role, which may include cost minimization by saving resources and adoption of low cost or non-monetary inputs. Hence, crop husbandry practices such as judicious application of fertilizer and establishment methods are of prime most important in rice crop production.

Again, traditional method of establishing through transplanting is becoming difficult due to acute shortage of labour, especially during the peak periods of operation apart from higher labour wages to the tune of 30-40% of total cost of cultivation (Rani and Jayakiran, 2003). Hence an alternative to transplanting, direct seeding of rice can be practiced to overcome the above problems with an additional advantage of reduced crop duration and comparable grain yield (Sharma *et al*., 2005).Therefore, there is a need to evaluate crop establishment methods together with optimal nutrient dose to realize the production potential.

Material and Methods

The field experiment was conducted during 2018 *Kharif* at Zonal Agricultural Research Station, Vishwesharaiah Canal Farm, Mandya to study the Effect of different establishment methods and nutrient management on growth and yield of rice (*Oryza sativa* L.). Its geographical location situated at coordinates, 12° 57' N Latitude and 76° 82' E Longitude, with an Altitude of 757.10 m above mean sea level. The experimental soil was red sandy loam in texture with an average particle content of 53.45 per cent coarse sand, 14.78 per cent fine sand, 16.58 per cent silt and 15.19 per cent clay. The soil was neutral in reaction (pH 6.97), organic carbon content was medium (0.66%) with the electrical conductivity of 0.25 dSm^{-1}. The soil was low in available nitrogen (225.79 kg ha^{-1}) and high in available phosphorus (69.25kg ha^{-1}) and medium in available potassium (276.26 kg ha^{-1}).

The experiment laid out in a split plot design with three replications. The treatments comprised of three establishment methods *viz.*,Semi dry rice (Dry direct seeding), drum seeded rice (wet direct seeding of sprouted rice by using drum seeder in puddled soil) and transplanted rice (Transplanting 21 days aged seedlings) and five nutrient management practices *viz.*,100% Recommended dose of inorganic fertilizers (120:60:40 kg N: P_2O_5: K_2O ha^{-1}) as per National recommendation, 75% Recommended dose of inorganic fertilizers as per National recommendation + 25% N equivalent FYM, 150% Recommended dose of inorganic fertilizers as per National recommendation, LCC based nitrogen application and Nutrient management as per

University of Agricultural Sciences, Bangalore (UASB) package of practice (100:50:50 kg N: P_2O_5: K_2O ha^{-1}). Different establishment methods were placed in main plots while nutrient management practices were allocated to the subplots.

The variety used was MTU 1001. Spacing for semi dry rice was 25 X 10 cm, whereas for drum seeding and transplanting method was 20 X 10 cm. The full dose of phosphorus and potassium were applied as basal dose as per treatment. Whereas, half of the recommended dose of nitrogen was applied as basal and remaining as top dress in two equal splits at 50 and 75 DAS as per treatment. In LCC based nitrogen management first dose of nitrogen was supplied at 21 DAS in direct seeded rice and 14 DAT in transplanted rice, thereafter 25 kg N ha^{-1} was applied when 6 out of 10 readings recorded below LCC scale in once in a week up to heading.

Result and Discussion:

Leaf area index (LAI)

At 60 DAS, statistically on par LAI recorded among methods of establishment (2.53 to 2.91). Between nutrient management practices, application of 150% RDIF recorded significantly higher LAI (3.21) over rest of the nutrient management practices (2.32 to 2.33), but was statistically on par with 100% RDIF (2.81) and nutrient management as per UASB recommendation (2.71). The interaction effect between establishment methods and nutrient management practices was non-significant with respect to LAI at 60 DAS (Table 1).

Plant height (cm)

At harvest, statistically on par plant height was recorded among establishment methods. However, drum seeded rice recorded taller plants (83.37 cm) compared to rest of the establishment methods (81.78 to 82.13 cm). Among nutrient management practices, application of 150% RDIF recorded significantly higher plant height (87.30 cm) over rest of the nutrient management treatments (79.17 to 82.01 cm), but was on par with 100% RDIF (83.87 cm).While, interaction effect of establishment methods and nutrient management practices was non-significant(Table 1).

Dry matter production hill^{-1} (g)

At harvest, the total dry matter production was higher in semi dry rice (180.67 g hill^{-1}) followed statistically by drum seeded rice (167.13 g) and were superior over transplanted rice (143.20 g). Among nutrient management practices 150% RDIF recorded higher total dry matter production hill^{-1} (182.78 g) followed statistically by 100% RDIF (175.89 g) and was superior over rest of the treatments (147.11 to 155.67 g). There was no significant difference between interaction effects (Table 1).

Panicles per meter square

Number of panicles was non-significant among establishment methods (311.60 to 337.78 m^{-2}) among nutrient management practices 150% RDIF recorded higher number of panicles (347.81 m^{-2}) followed statistically on par with 100% RDIF (334.01) and LCC based N application (326.99), but was significantly superior over other treatments (303.37 to 309.95). The interaction between establishment methods and nutrient management practices was statistically non significant (Table 1).

Panicle weight (g)

Similarly, there was no significant difference among establishment methods for panicle weight at harvest (2.24 to 2.31 g). Among nutrient management practices, 150% RDIF recorded significantly higher panicle weight (2.82 g) as compared to rest of the treatments (2.06 to 2.31 g) (Table 1). Further, between interactions, transplanted rice and 150% RDIF recorded significantly higher panicle weight (3.59 g) over rest of the interactions.

Test weight (g)

The test weight of rice was not influenced significantly among establishment methods (25.62 to 26.46 g), nutrient management practices (25.27 to 26.79 g) and their interaction (Table 1).

Among establishment methods, the growth parameters viz., plant height (at harvest), tillers m^{-2} (at harvest), LAI (at 60 DAS) and total dry matter production (at harvest) and yield parameters viz., number of panicle m^{-2}, panicle weight and test weight were statistically at par mainly due to plasticity of rice plant to adjust varied planting methods. The soil aerobic and anaerobic conditions created due to puddling and water stagnation leads to formation of aerenchyma cells in the plant. The results are in conformity with Sandhya *et al.* (2014) and Prakhar *et al.* (2018). Between nutrient management practices, application of 150% RDIF recorded significantly higher plant height (at harvest), tillers m^{-2} (at harvest), LAI (at 60 DAS) and total dry matter production (at harvest) as compared to rest of the nutrient management practices. The reason behind this was addition of 50% more recommended dose of fertilizer which resulted in higher readily available soil nutrients and there by higher nutrient uptake at harvest which inturn resulted in enhanced photosynthesis and growth attributes in the treatments. The results are in conformity with Santosh *et al.* (2013); Malo *et al.* (2018) and Patel *et al.* (2015).

Grain and straw yield (kg ha^{-1})

Establishment of paddy through transplanting recorded higher grain and straw yield (6242 and 7000 kg ha^{-1}, respectively), however it was statistically comparable with drum seeding and semidry rice due to production of comparable growth and yield parameters (Table 2).

The comparable yield levels obtained either with transplanting or drum seeded rice or semi dry method of rice establishment with varying land preparation, planting and submergence were able to produce similar yield parameters like number of panicles m-2 , panicle weight and test weight and as seen in this experiment (Table 4.4, 4.5 and 4.6) showed the adoptability of rice plant to changes in its habitats and planting patterns. Added to this, the plasticity of rice to adjust varied aerobic and anaerobic soil condition for nutrient uptake for the production of similar levels of growth and yield parameters. The results are in conformity with Sandhya *et al.* (2014).

Among nutrient management practices, application of 150% RDIF recorded significantly higher grain and straw yield (6687 and 8451 kg ha^{-1} , respectively) as compared to rest of the nutrient management practices (5418 to 5996 and 6093 to 6868 kg ha^{-1}, respectively) (Table 2). This could be attributed to the additional application of 60 to 80 kg N ha^{-1}, 30 to 40 kg P_2O_5 ha^{-1}, 10 to 20 kg K_2O ha^{-1} in the treatment makes the adequate available of soil nutrients for uptake of rice plant throughout the crop growth stages, which in turn resulted in higher and optimum photosynthetic activity in the plant for the production of growth parameters such as plant height, LAI and dry matter production. The overall effect contributed for production of more sink in rice such as panicle and test weight and thereby superior grain and straw yield production with 150% RDIF. The results are in conformity work of Priyanka *et al*., (2013) for phosphorous usage and Murthy *et al.* (2015) for other elements.

The interaction effect between establishment methods and nutrient management practices for grain and straw yield was statistically at par (Table 2).

Cost of cultivation (Rs. ha^{-1})

Among establishment methods, semi dry rice recorded lower total cost of cultivation (44,174 Rs. ha^{-1}) as compared to drum seeding and transplanting (46,568 and 51,044 Rs. ha^{-1}, respectively) as due to no nursery preparation, puddling and transplanting. These results recorded are in line with Bhardwaj *et al.* (2018).

Among nutrient management practices, nutrient management as per UASB recommendation resulted in lower total cost of cultivation (45,542 Rs. ha^{-1}) as compared to rest of the nutrient management practices (45,706 to 50,048 Rs. ha^{-1}) as due less cost invested on fertilizers.Similar results were reported by Paramasivan *et al*. (2016).

Net return (Rs. ha^{-1})

Between establishment methods, transplanted rice recorded higher net returns (55,822 Rs. ha^{-1}) followed by drum seeding (53434 Rs. ha^{-1}) and lower was with semi dry rice (50840 Rs. ha^{-1}) as mainly related to higher grain and straw yield in the former establishment. The similar type of return in rice transplanting is reported by Bhardwaj et *al.* (2018).

While, nutrient management with 150% RDIF recorded higher net returns (66,541 Rs. ha^{-1}) followed by 100% RDIF (56,221 Rs. ha^{-1}) and lower was with nutrient management as per UASB recommendation as interrelated to significantly higher grain and straw yields in the former treatment (Paramasivan *et al*., 2016)

B: C ratio

Between, rice establishment methods, semi dry and drum seeding gave higher B:C ratio (2.15) over transplanting (2.10), as allied to low cost on establishment (Vinay *et al.,* 2018).

Among nutrient management practices, 150% RDIF resulted in higher B:C ratio (2.37) followed by 100% RDIF (2.22) was owing to higher grain and straw yield (Sangeeta *et al.*, 2019).

Conclusion

From this study it can be inferred that, rice establishment with drum seeding (wet direct seeding) and semi dry (dry direct sowing) methods can be effectively promoted to replace the traditional manual transplanting to save soil, water and cost on production without compromising yield and economics. Further, no doubts on rice for responding higher dose of inorganic fertilizer nutrient (150% RDIF) management, but the benefit to cost ratio is meager and not attractive.

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Table 1: Effect of establishment methods and nutrient management practices on growth and yield parameters of rice

Treatments		LAI at 60 DAS	Plant height at harvest (cm)	Dry matter production hill^{-1} at harvest (g)	Panicles m^{-2} (No.s)	Panicle weight (g)	Test weight (g)
	Main plot: Establishment methods (M)						
M$_1$	Semi dry rice	2.91	82.13	180.67	311.60	2.24	25.62
M$_2$	Drum seeded rice	2.53	83.37	167.13	323.90	2.28	26.01
M$_3$	Transplanted rice	2.58	81.78	143.20	337.78	2.31	26.46
S.Em±		0.15	0.97	2.15	9.64	0.12	0.44
CD(p=0.05)		NS	NS	8.42	NS	NS	NS
	Sub plot: Nutrient management practices (S)						
S$_1$	100% RDIF	2.81	83.87	175.89	334.01	2.31	26.31
S$_2$	75% RDIF+ 25% N equivalent FYM	2.32	82.01	155.67	309.95	2.06	25.27
S$_3$	150% RDIF	3.21	87.30	182.78	347.81	2.82	26.79
S$_4$	LCC based N application	2.33	79.79	156.89	326.99	2.11	26.08
S$_5$	Nutrient management as per UASB recommendation	2.71	79.17	147.11	303.37	2.09	25.70
S.Em±		0.20	1.28	7.94	10.73	0.10	0.36
CD(p=0.05)		0.57	3.73	23.17	31.32	0.30	NS
	Interaction						
S.Em±		0.34	2.20	12.49	19.22	0.20	0.71
CD(p=0.05)		NS	NS	NS	NS	0.52	NS

Note: RDIF = Recommended dose of inorganic fertilizers; LAI = Leaf area index; N = Nitrogen; LCC= leaf colour chart; NS = Non significant @ 5%, FYM = Farm yard manure

Table 2: Effect of establishment methods and nutrient management practices on yield and economics of rice

Treatments		Grain yield ($kg ha^{-1}$)	Straw yield ($kg ha^{-1}$)	Total Cost of cultivation (Rs ha^{-1})	Net Return (Rs ha^{-1})	B:C ratio
Main plot: Establishment methods (M)						
M_1	Semi dry rice	5521	6682	44174	50840	2.15
M_2	Drum seeded rice	5815	6964	46568	53434	2.15
M_3	Transplanted rice	6242	7000	51044	55822	2.10
S.Em±		248	434			
CD(p=0.05)		NS	NS			
Sub plot: Nutrient management practices (S)						
S_1	100% RDIF	5966	6864	46108	56221	2.22
S_2	75% RDIF+ 25% N equivalent FYM	5460	6134	50048	43444	1.87
S_3	150% RDIF	6687	8451	48906	66541	2.37
S_4	LCC based N application	5764	6868	45706	53381	2.17
S_5	Nutrient management as per UAS (B) POP	5418	6093	45542	47241	2.03
S.Em±		186	242	NA	NA	NA
CD(p=0.05)		542	706	-	-	-
Interaction						
S.Em±		380	537	-	-	-
CD(p=0.05)		NS	NS	-	-	-

Note: NA = Not analyzed statistically