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

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A B S T R A C T

Field experiment was conducted at Agronomy Department Farm, College of Agriculture, Dapoli. Dist. Ratnagiri during Kharif seasons 2017 and 2018 to study the "Effect of establishment methods and nutrient management on yield and economics of Kharif rice (*Oryza Sativa* L.)". The field experiment was laid out in a strip plot design comprising of twelve treatment combinations replicated thrice. The horizontal strips comprised four rice establishment methods viz., sowing of dry seeds by drum seeder at onset of monsoon (M_1), SRI (System of Rice Intensification) method (M_2), Transplanting by hand operated transplanter (M_3) and Conventional transplanting (M_4). The vertical strips consisted three nutrient management treatments viz., 100% RDN through organics (N_1), 100% RDF through inorganics (N_2) and application of 50% RDN through organics + 50% RDF through inorganics (N_3). The highest grain and straw yield from Kharif rice were obtained when rice crop was established by conventional transplanting method with application of 100% RDF (M_4N_2) or transplanting by SRI method (M_2N_2) as compared to remaining treatment combinations during pooled analysis. The highest net returns and benefit cost ratio was observed in transplanting by hand operated transplanter and application of 100% RDF or INM during both years and pooled mean.

Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop of the world and India, feeding more than half of the world's population every day. Rice provides 20 per cent of the world's dietary energy supply, while wheat supplies 19 per cent and maize 5 per cent (FAO, International year of rice, 2004). In Asia, it has a special significance, where about 90% of the rice is produced and consumed as a staple food. It is a predominant crop in lowland ecosystem. Globally it is cultivated in an area of 161.28 million hectares with an annual production of 715.75 million tonnes (Anonymous, 2016a) [1]. Among the various rice growing countries of the world, India has the largest area under rice

and in case of production it stands next to China. In India, rice is the most important and extensively grown food grain crop, occupying an area of 44.11 million hectares with production of 105.48 million tonnes. However, productivity of India (2.39 tonnes ha^{-1}) is lower than the world average yields (4.4 tonnes ha^{-1}) and is much behind than the rice productivity of Egypt, Japan and China (Anonymous, 2016 b) [2]. Rice is also an important cereal food crop of Maharashtra State, which contributes 3.6 per cent of area and 2.8 per cent of production of rice at national level. Total area, production and productivity of rice were 14.71 lakh hectares, 25.17 lakh tonnes and 1.71 tonnes ha^{-1}, respectively. Rice is the main food crop grown in Konkan region, which occupies an area of 3.79 lakh hectares with production 9.94 lakh tonnes and productivity of 2.61 tonnes ha^{-1} (Anonymous, 2016c) [3]. Rice is grown either by direct seeding or by transplanting. In Konkan, rice is mostly grown by transplanting method. Method of crop establishment influences the performance of rice through its effect on growth and development. Although, transplanting has been reported to be the best establishment method (Jana *et al.*, 1981 and Singh *et al.*, 1997) but due to high water and labour requirement, some alternatives like dry and wet direct seeding are being explored to ensure optimum yield at a lower cost. The results revealed that both transplanted and direct seeded method needed nearly equal investment on cultivation, but transplanted rice required more initial expenditure as compared to direct seeded rice. Weed infestation and weed competition are more in direct seeded rice as compared to transplanted rice, because the land is exposed till the initial seedling establishment in direct seeded rice.

Nutrient management provides an approach for feeding the plants with nutrients as and when required. Integrated use of organic manures and chemical fertilizers has advantages over use of only organic manures or chemical fertilizers (Kumar *et al.,* 2009). Since sourcing of organic manure is difficult and the crop response to them during initial stages is not as spectacular, compared to the chemical fertilizers (Deka *et al.,* 1996), an integrated approach of plant nutrition involving the judicious mix of organic, chemical and microbial sources could be helpful to sustain optimum yield and to restore the residual soil fertility. Keeping this in view, the present study was undertaken to investigate the effect of establishment methods and nutrient management on yield and economics of kharif rice.

Materials and Methods

The field experiment was conducted on plot Nos. 22 and 23 of 'B' block of Agronomy Department Farm, College of Agriculture, Dapoli. Dist. Ratnagiri during Kharif 2017 and 2018. The soil of the experimental plot was uniform, levelled and well drained. It was sandy clay loam in texture, low in available nitrogen (214.42 kg ha^{-1}), phosphorus (9.62 kg ha^{-1}) and medium in potassium (207.31 kg ha^{-1}), moderately high in organic carbon (0.95%) and slightly acidic in reaction (5.86). The sowing of dry seeds by drum seeder was done at onset of monsoon as per the treatments. The nursery for conventional transplanting, transplanting by hand operated transplanter and SRI method was done on the same day of sowing of dry seeds by drum seeder. In 100 % RDF and 50% RDF dose of integration, 40% N and all P and K was applied as basal dose and remaining 60% N was applied in two splits i.e. 40% at maximum tillering and 20% at panicle initiation stages. In 100% RDN through organics and 50% RDN of integration, full doses were applied as basal as per the treatments. The other usual common packages of practices were followed time to time and periodical growth observations were recorded at an interval of

30 days. Crop was harvested at physiological maturity and data on yield attributes and yield were recorded.

Results and Discussion

Effect of establishment methods on yield and economics of

Kharif rice

The highest grain and straw yield were recorded when the rice established by conventional transplanting as compared to other establishment methods during individual years as well as in pooled data.

Among transplanting methods conventional transplanting remained at par with SRI and produced higher grain yield than rice planted by hand operated transplanter during individual years. Further, SRI method produced statistically identical grain yield to that of hand operated transplanter during both the years of study.

Submerged conditions in transplanted rice facilitate efficient weed management and balanced nutrition that might have encouraged higher growth, tillers and panicles production and contributing to higher dry matter production and grain yield. However, the net returns and B:C ratio differed with the different crop establishment methods with transplating by hand operated transplanter recording the highest net returns and B:C ratio followed by CT, SRI and DSR.

The economics clearly indicated that though the grain and straw yield of rice was significantly higher due to conventional transplanting and SRI, higher yields did not compensate the expenditure incurred for transplanting of seedlings in both the methods. These findings corroborate earlier reports by Subbulaxmi *et al.,* (2008) and Geethalaxmi *et al.,* (2011).

Effect of nutrient management on yield and economics of *Kharif* rice

Data pertaining to the grain, straw yields (q ha^{-1}), net returns and B:C ratio as influenced by different treatments are presented in Table 1 and 2 indicated that, application of 100% RDF through inorganic (N_2) and Integrated nutrient management (N_3) recorded significantly higher grain and straw yield over organic treatment (N_1) during individual years as well as in pooled data.

However, application of 100% RDF recorded higher net returns and B:C ratio. The increase in grain yield was might be due to application of mineral N, P and K that significantly increased growth and yield attributes which in turn, increased the rice yield compared to added levels of N and other nutrients in organic form. The similar findings were also reported by Dash *et al.,* (2011), Sujatha (2013), Meena *et al.*,(2014), Patel (2014), and Marskole (2017).

Effect of establishment methods and nutrient management on yield of rice

Among the interactions the highest grain and straw yield (46.46 and 65.26 q ha^{-1}) were recorded with conventional transplanting method coupled with 100% RDF or INM and the lowest yield (35.21 and 51.40 q ha^{-1}) in drum seeded rice with 100% RDN through organic (N_1), respectively (Table 3). This can be ascribed to balanced nutrition of essential nutrients due to better physical, chemical and biological properties maintained under INM followed for transplanted rice. These findings corroborate the reports of Mohanty *et al.,* (2014) and Moharana (2015) (Table 4).

Table.1 Grain and straw yield (q ha^{-1}) of rice as influenced by different treatments during *Kharif* 2017, 2018 and in pooled data

Treatments	Grain yield (q ha^{-1})			Straw yield (q ha^{-1})		
	2017	2018	Pooled	2017	2018	Pooled
Establishment methods						
M1: Sowing of dry seeds by drum seeder	35.82	34.93	35.37	53.35	50.59	**51.97**
M2: SRI method	43.10	41.60	42.35	60.14	58.04	**59.09**
M3: Transplanting by hand operated transplanter	42.30	40.07	41.18	56.34	53.03	**54.68**
M4: Conventional transplanting	43.97	42.87	43.42	62.89	61.58	**62.23**
S.Em. ±	0.39	0.38	0.22	0.83	0.48	**0.45**
C.D. at 5%	1.35	1.32	0.75	2.86	1.65	**1.55**
Nutrient management treatments						
N1: 100% RDN through organic	38.63	37.93	38.28	55.51	52.63	**54.07**
N2: 100% RDF through inorganic	43.15	41.32	42.20	59.71	57.93	**58.82**
N3: 50% RDN through organic+50% RDF	42.11	40.36	41.23	59.32	56.87	**58.09**
S.Em. ±	0.30	0.41	0.34	0.81	0.28	**0.43**
C.D. at 5%	1.18	1.60	1.32	3.16	1.12	**1.69**
Interaction effect						
S.Em. ±	1.27	0.98	1.09	1.90	1.75	**1.60**
C.D. at 5%	3.90	NS	3.36	NS	NS	**4.93**
General mean	**41.30**	**39.87**	**40.58**	**58.18**	**55.81**	**56.99**

Table.2 Net returns (Rs. ha^{-1}) and benefit to cost ratio from rice as influenced by different treatments during *Kharif* 2017, 2018 and in pooled data

Treatments	Net returns (Rs. ha^{-1})			B: C ratio		
	2017	2018	Pooled	2017	2018	Pooled
Establishment methods						
M1: Sowing of dry seeds by drum seeder	16295	14434	15365	1.31	1.28	**1.30**
M2: SRI method	17921	15309	16615	1.27	1.24	**1.25**
M3: Transplanting by hand operated transplanter	22746	18601	20673	1.38	1.32	**1.35**
M4: Conventional transplanting	19800	18001	18900	1.29	1.27	**1.28**
S.Em. ±	592	602	353	0.01	0.01	**0.01**
C.D. at 5%	2049	2083	1220	0.03	0.03	**0.02**
Nutrient management treatments						
N1: 100% RDN through organic	9185	7299	8242	1.10	1.08	**1.09**
N2: 100% RDF through inorganic	33680	30708	32194	1.63	1.58	**1.61**
N3: 50% RDN through organic+50% RDF	14705	11752	13229	1.21	1.17	**1.19**
S.Em. ±	269	456	285	0.01	0.01	**0.01**
C.D. at 5%	1055	1791	1119	0.03	0.04	**0.03**
Interaction effect						
S.Em. ±	1529	1330	1311	0.03	0.03	**0.03**
C.D. at 5%	NS	NS	NS	NS	NS	**NS**
General mean	**19190**	**16586**	**17888**	**1.31**	**1.28**	**1.30**

Table.3 Interaction effects between of establishment methods and nutrient management on grain yield (q ha^{-1}) of rice during *Kharif* 2017 and pooled mean

	Grain yield (q ha^{-1})							
	2017				Pooled mean			
	M_1	M_2	M_3	M_4	M_1	M_2	M_3	M_4
N_1	35.21	39.32	39.37	40.62	34.85	39.23	38.33	40.72
N_2	36.79	45.50	43.86	46.46	36.24	44.28	42.73	45.69
N_3	35.45	44.49	43.67	44.82	35.04	43.54	42.50	43.86
S.Em. ±.	1.27				1.09			
C.D. at 5%	3.90				3.36			

Table.4 Interaction effect of establishment methods and nutrient management treatments on straw yield (q ha^{-1}) of rice in pooled analysis

	Straw yield (q ha^{-1})				
	Pooled mean				
	M_1	M_2	M_3	M_4	
N_1	51.40	55.85	51.74	57.30	
N_2	53.03	60.69	56.30	65.26	
N_3	51.48	60.74	56.00	64.15	
S.Em.±	1.60				
C.D. at 5%	4.93				

From the results of the present investigation, it can be concluded that highest grain and straw yield from *Kharif* rice was obtained when rice crop was established by conventional transplanting method and highest net returns ad benefit to cost ratio was recorded under transplanting by hand operated transplanter with application of 100% RDF or INM.

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