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Effect of different establishment methods on the productivity of rice- rice system

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Abstract
A field experiment was conducted in Instructional Farm of College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar during 2016-17, to study the Productivity and resource use efficiency of rice-rice system under different establishment methods. The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.2), low in organic carbon (4.1 kg/ha), low in available nitrogen (160 kg/ha), low in available phosphorus (4.5 kg/ha) and medium in potassium (253.3 kg/ha).The experiment was laid out in Randomized Block Design with nine treatment and three replications. Three establishment methods (DSR, NPTR and PTR) were assigned to nine treatments in different combination. Rice varieties Swarna sub 1 and Lalat were grown in *kharif* and *Rabi*, respectively for this experiment. The investigation revealed that in *kharif*, maximum grain yield (4.8 t/ha), straw yield (5.43 t/ha) and harvest index (0.47) was recorded under PTR method of establishment. However in *Rabi*, maximum grain yield (6.65 t/ha) was recorded under NPTR-PTR method of establishment which was 30.5% higher than DSR-DSR method. Thus NPTR-PTR method of establishment was found to be the best method as far as productivity and resource use efficiency is concerned.

Keywords: Establishment, productivity of rice- rice

Introduction
Rice, "The Crop of the Millennium" provides 21% of global per capita energy and 15% of per capita protein. Rice eaters and growers constitute the bulk of the world's poor. According to the UNDP Human Development Report for 1997, approximately 70% of the world's poor (1.3 billion) live in Asia, where rice is the staple food. An estimated 450 million people in the region depend on rainfed rice as their major source of livelihood (IRRI, 1997) [1]. Rice is the most important food crop of India producing 104.32 MT of rice (Directorate of Economics & Statistics, 2015-16). Out of the 43.3 million ha of rice area in India. *Kharif* and *Rabi* rice accounts for 89% and 11% of total rice area and 85% and 15% of total rice production, respectively. Rainfed lowlands constitutes about 17.4 million ha, of which 14.6 million ha are in eastern India (Singh *et al*, 2015) [6].

Environmental stress constrains rice production affecting about 30% of the 700 million poor in Asia alone who live in rainfed rice-growing areas. These is caused by extreme climatic event like drought, flood or rise in sea levels (Dar *et al*., 2014) [8]. The productivity and sustainability of rice-based systems are threatened because of (1) inefficient use of inputs (fertilizer, water, labour); (2) increasing scarcity of resources, especially water and labour; (3) changing climate; (4) the emerging energy crisis and rising fuel prices; (5) the rising cost of cultivation; and (6) emerging socioeconomic changes such as urbanization, migration of labour, preference of non-agricultural work, concerns about farm-related pollution (Ladha *et al.*, 2009) [2,9].

Rice is primarily grown by transplanting of seedlings in puddled field which is very cumbersome and labour intensive as it requires around 30 man days/ha (Prasad, 2004). It requires nursery raising, it's uprooting and supply for transplanting in the field and continuous ponding of water for the first 15 days. This leads to nutrient losses through leaching besides causing high evaporation loss during the hot summer months. Flooded rice culture with puddling and transplanting is considered one of the major sources of methane (CH_4) emissions and accounts for 10-20% (50-100 Tg/ year) of total global annual CH_4 emission (Reiner and Aulakh, 2000) [4]. Therefore, it is imperative to identify alternative methods of rice establishment to overcome these limitations.

In the conventional puddled transplanting system (PTR), large quantity of irrigation water is used for puddling which destroys soil aggregates and results in formation of hard pan, creating
In DSR as compared to PTR fits this crop well in different cropping systems.

Materials and Methods

A field experiment was conducted in Instructional Farm of College of Agriculture, Odisha University of Agriculture and Technology, Bhubaneswar during 2016-17, to study the "Productivity of rice-rice system under different establishment methods". The soil of the experimental site was sandy loam in texture, acidic in reaction (pH 5.2), low in organic carbon (4.1 kg/ha), low in available nitrogen (160 kg/ha), low in available phosphorus (4.5 kg/ha) and medium in potassium (253.3 kg/ha).The experiment was laid out in Randomized Block Design with nine treatment and three replications. Three establishment methods (DSR, NPTR and PTR) were assigned to nine treatments in different combinations. Rice varieties Swarna sub and Lalat were grown in *kharif* and *rabi*, respectively for this experiment.

Result and Discussion

Yield is a function of the yield attributes of a plant. The major yield contributing characters are number of panicle bearing effective tillers, number of grains per panicle, percent filled grains per panicle and test weight. Usually, there exists a positive relation these parameters with yield. But, this is not always true as negative correlation may also exist beyond certain level. In the present investigation, yield attributing characters viz. number of panicle, number of grains per panicle, percent filled grains per panicle and test weight were markedly influenced by different establishment methods. However, for all the yield attributing characters, the differences were significant. Number of effective tillers per unit area is the primary attribute for obtaining good yield in rice as yield is function of number of ear bearing tillers per unit area. Among all the treatments highest number of effective tillers was recorded in NPTR-PTR method (382/m^2) which was 26.9% higher than DSR-DSR method (279/m^2) which recorded the lowest effective tillers/m^2. The reason for more number of effective tillers might be due to higher LAI resulting in increased photosynthetic ability and dry matter accumulation and reduced tiller mortality there by increasing the proportion of effective tillers to total tillers. The results are in accordance with the findings of Sidhu *et al*., (2014).The maximum panicle length (27.7 cm) was recorded under NPTR-PTR method which was 7.5% higher than the shortest panicle length was recorded under DSR-DSR method of establishment (25.6 cm). The increase in panicle length might be due to better growth and dry matter accumulation ensuring better photosynthetic efficiency there by increasing the source strength to accumulate photosynthates which in turn increased the sink size i.e. panicle length. The total number of grains per panicle (filled grains) is an important parameter which contributes towards grain yield. The average of filled grains produced per panicle and sterility ranged between 93 to 113 and 13.0 to 16.3%, respectively. Maximum number of grains per panicle was recorded under NPTR-PTR method (113), which was 17.6% higher than the DSR-DSR method (93) which recorded the lowest number of grains per panicle. Minimum sterility was also noticed with NPTR-PTR method (13%) and it was percent was highest under NPTR-NPTR method of establishment (16.3%). The NPTR-PTR method produced better growth which resulted in higher photosynthates accumulation and translocation of these photosynthates to the reproductive part thereby increasing the number of filled grains per panicle. Moreover the increase in panicle length also helped in accommodating higher number of grains per panicle. The results are in conformity with the findings of Sekhar *et al*., (2014) [10].Grain weight, an important yield determining attribute, is a genetic character least influenced by environment (Ashraf *et al.*, 1999). However favourable environment at grain filling stage ensures higher grain weight. The test weight reportedly varied from 22.3 g to 25.5 g. The highest test weight (25.5 g) was recorded under NPTR-PTR method which was 12.5% higher than DSR-DSR method (22.3g) which recorded the lowest test weight. The increase in test weight in NPTR-PTR method might be because it was photosynthetically active for a large period and translocated the photosynthates more efficiently to the grains resulting in well filled grains. Moreover being the transplanted rice, there was less weed competition and nutrient leaching; the uniform spacing must have favoured better nutrient absorption and utilization. This corroborated the earlier findings of Kumhar *et al*., (2014) [11]. Grain yield is a function of interplay of various yield components such as a number of productive tillers per unit area, grains per panicle and grain weight. It is also a cumulative effect of several growth regulating factors consisting mainly of genetic, environmental and management aspects dovetailed one into other to meet the optimum need of the crop at different stages of growth. The grain yield varied significantly under different establishment methods. Maximum grain yield (6.65 t/ha) was recorded under NPTR-PTR method which was 30.5% higher the yield recorded under DSR-DSR method of establishment (4.62 t/ha) recording the lowest grain yield and 13.1% higher than PTR-PTR method (5.78 t/ha) recording second highest yield. The highest system yield was recorded under the NPTR-PTR method of establishment (11.45 t/ha) which was 27.2% higher than the DSR-DSR method (8.33 t/ha) which recorded the lowest system yield in the rice-rice system under different establishment methods. This could be possibly due to better growth and photosynthates produced more number of effective tillers, total grains, filled grains per panicle, test weight and lower sterility. There was also heavy infestation of weeds in DSR method of establishment which compete with crop for nutrient and water and declined the yield of rice (Fukai, 2002).

Table 1: Effect of establishment methods on yield attributes

Establishment method	Effective tillers/m^2	Panicle length (cm)	Total Grains/ panicle	Filled grains/ panicle	Sterility (%)	Test Wt (g)
Kharif						
DSR	299	22.3	138	120	12.5	19.3
NPTR	308	22.4	139	126	9.6	19.4
PTR	316	23.2	144	126	12.1	20.1
Rabi						
DSR-DSR	279	25.6	109	93	15.2	22.3
NPTR-DSR	324	25.7	110	95	13.6	22.9
PTR-DSR	338	26.2	114	97	15.0	23.6
DSR-NPTR	336	25.9	111	95	14.2	23.3
NPTR-NPTR	355	27.0	124	104	16.3	25.3
PTR-NPTR	341	26.7	116	98	15.2	24.6
DSR-PTR	350	26.8	117	100	14.3	25.0
NPTR-PTR	382	27.7	130	113	13.0	25.5
PTR-PTR	367	27.5	125	106	14.6	25.4
SE m±	4.98	0.34	1.88	2.05	0.50	0.37
CD(0.05)	14.92	1.03	5.64	6.16	1.51	1.12

Table 2: Effect of establishment methods on yield

Establishment method	Grain Yield (t/ha)	Straw Yield (t/ha)	HI	System Yield (t/ha)
Kharif				
DSR	3.71	4.32	0.46	--
NPTR	4.57	4.98	0.48	--
PTR	4.8	5.43	0.47	--
Rabi				
DSR-DSR	4.62	5.8	0.44	8.33
NPTR-DSR	5.12	5.99	0.46	8.83
PTR-DSR	5.65	5.92	0.49	9.36
DSR-NPTR	5.51	6.25	0.47	10.08
NPTR-NPTR	5.72	6.11	0.48	10.29
PTR-NPTR	5.66	6.02	0.48	10.23
DSR-PTR	5.68	6.45	0.47	10.48
NPTR-PTR	6.65	6.04	0.52	11.45
PTR-PTR	5.78	6.65	0.47	10.58
SE m±	0.16	0.14	0.03	0.37
CD(0.05)	0.48	0.41	NS	1.12

Conclusion

The NPTR-PTR method of establishment produced highest grain yield (6.65 t/ha) with straw yield (6.04 t/ha), 382 effective tillers, 113 filled grains per panicle and 25.5 g /1000 grain weight. Maximum harvest index was noticed in NPTR-PTR method (0.52) which was 15.3% higher than DSR-DSR method which recorded the lowest harvest index (0.44). The highest system yield (11.45 t/ha) was also recorded under NPTR-PTR method of establishment in the rice-rice system among different establishment methods.

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