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Effect of Different Crop Establishment Methods on Yield and Yield of Wet Season Rice

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Abstract A field experiment was conducted during *kharif,* 2012 and 2013 to study the effect of different crop establishment methods on plant growth and yield parameters of *kharif* rice. Among the four crop establishment methods, raising rice crop by system of rice Intensification (SRI) resulted in significantly more number of vegetative tillers m^{-2} (602.3 and 595.7), panicles (574 m^{-2} and 566 m^{-2}), filled spikelets $panicle^{-1}$ (160.3 and 165.7) and higher grain yield (6.5 t ha^{-1} and 6.6 t ha^{-1}) during *kharif* 2012 and 2013 respectively.

Keywords SRI, Vegetative tillers m^{-2}, Plant height, Panicles m^{-2}, Filled spikelets $panicle^{-1}$.

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Introduction

Rice (*Oryza sativa* L.) is the most important staple food crop for more than half of the world's population, including regions of high population density and rapid growth. It provides about 21% of the total calorie intake of the world population. Transplanting is the most dominant and traditional method of establishment in irrigated low land rice. The area under transplanted rice in world is decreasing due to scarcity of water and labor. So, there is need to search for alternate crop establishment methods to increase the productivity of rice [1] Pandey and Velasco [2] stated that transplanted rice practiced in areas where low wages for labor and adequate water is available whereas, direct seeded rice can be practiced in areas with high wages and low water availability. Direct seeding reduces labor requirement, shortens the crop duration by 7-10 days and can produce as much grain yield as that of transplanted crop. Direct seeding of rice allows early establishment of the succeeding crop and higher profit in areas with assured water supply by utilizing short duration modern varieties and cost efficient herbicides [3]. However, this has been accompanied by increase in weed problems and a shift in dominant grassy weeds. The innovative systems of rice cultivation such as System of Rice Cultivation (SRI) is being evolved to increase the productivity of irrigated rice.

Rice is the major crop in the tribal dominated district of Keonjhar, Orissa covering an area of 2.97 lakh ha out of which medium land *kharif* rice covers an area of 1.73 lakh ha [4]. The average yield of *kharif*

Table 1. Results on plant growth parameters in different crop establishment methods. (pooled data of 2012-13).

Treatments	Plants (no. m^{-2})		Plant height (cm)		Vegetative tillers m^{-2}	
	2012	2013	2012	2013	2012	2013
T_1 SRI	16.0	16.0	96.8	97.2	602.3	595.7
T_2 Pre-germinated paddy seeder	66.3	68.3	94.5	95.0	520.3	524.7
T_3 Broadcasting	172.0	178.0	91.6	92.0	426.0	425.7
T_4 Convectional random transplanting	122.3	131.3	94.0	94.4	441.0	439.3
CD (0.05)	NS	NS	NS	NS	22.26	25.20

paddy in the district is 2.02 t ha^{-1}, which is very low. The low yield is mainly due to improper plant population per unit area in the existing method of manual random transplanting in low land and broadcasting of dry seeds in upland and medium land in the district. The socio-economic condition of the farmers of the district is primarily dependent on the prduction and productivity of rice. In this context, the various method of crop establishment of the rice being suggested to the farmers such as SRI method of cultivation and sowing of pre-germinated seeds by drum seeder for higher production and productivity need to be evaluated in the district. Considering the above points, the present investigation was carried out to find out an appropriate crop establishment method which may increase the yield of *kharif* rice.

Materials and Methods

The experiment was conducted comprising of four treatments with six replications in a randomized block design (RBD) with details of treatments as given below. T_1 : System of rice Intensification (SRI), T_2: Direct sowing of pre-germinated rice with four row drum seeder, T_3 : Direct sowing of dry seeds by manual broadcasting method, T_4 : Conventional method of manual random transplanting.

The soil of the experimental plot was clay loam in texture having pH 6.5, organic carbon 0.42% available phosphorus 21.0 kg ha^{-1}, available potassium 225.0 kg ha^{-1} and available nitrogen 106 kg ha^{-1}. A high yielding rice variety MTU 7027 (Swarna) was used in the experiment and the recommended package of practices were followed. The recommended dose of fertilizer was @ 80:40:40 $N:P_2O_5:K_2O$ kg ha^{-1} were applied. Full dose of phosphorus and potassium and 50% of nitrogen were applied as basal and remaining nitrogen was top dressed twice i.e. 25% at active tillering stage and rest 25% at panicle initiation stage. In the SRI method, 10 days old seedlings were transplanted with a spacing of 25 cm × 25 cm. Weeding was done at 15, 25 and 35 days after transplanting in System of rice Intensification (SRI) and 15, 25 and 35 days after sowing in Direct sowing of pre-germinated rice seeds with four row drum seeder by using the manual operated Cono weeder. In other two treatments manual weeding was done at initiation of tillering and at active tillering stage. The observations on various plant growth parameters such as plant height, number of vegetative tillers m^{-2} and yield parameters such as panicles m^{-2}. 1000 seed weight (g), number of spikelets $panicle^{-1}$ and yield (t ha^{-1}) were recorded to study the efficacy of the different crop establishment methods.

Results and Discussion

The performance of the four different crop establishment methods for *kharif* rice during 2012 and 2013 with reference to the various plant growth parameters and the number of plants established in various treatments have been presented in Table 1. The results indicated that highest and lowest number of plants as 172 m^{-2} and 16 m^{-2} were found to the established in treatments direct sowing of dry seeds by manual broadcasting method and system of rice intensification (SRI) respectively during *kharif* 2012. In treatments T_2 and T_3 the number of plants were recorded 66.33 m^{-2} and 16.0 m^{-2} respectively. In treatments T_2 and T_4 the number of plant established were found to be 68.33 m^{-2} and 131.33 m^{-2} respectively. In treatment T_1 one plant of 10 days old seedling were transplanted

Table 2. Results on yield parameters in different crop establishment methods. (pooled data of 2012-13).

Treatments	Panicles m^{-2}		1000 grain weight (g)		Filled spikelets $panicle^{-1}$	
	2012	2013	2012	2013	2012	2013
T_1 : SRI	574.0	566.3	20.5	19.5	160.3	165.7
T_2 : Pre-germinated paddy seeder	469.0	474.7	19.2	19.2	134.0	141.3
T_3 : Broadcasting	380.7	392.0	19.1	18.7	98.3	104.0
T_4 : Convectional random transplanting	404.0	410.7	19.4	19.3	113.3	115.3
CD (0.05)	20.4	32.3	NS	NS	14.3	21.4

per hill while in treatment T_4 three–four seedlings per hill were randomly planted. In treatments T_2, pre-germinated seeds were sown in line with the drum seeder while in treatment T_3, dry seeds were sown manually in a random manner while resulted in higher no. of plants. The highest number of vegetative tillers m^{-2} were recorded as 602.33 and 595.67 during *kharif* 2012 and *kharif* 2013 respectively with the treatment of SRI. At Banglore, Hugar et al. [5]. reported that SRI method resulted in significantly higher yield attributes viz., panicle length (23.5 cm), number of seed per panicle (94.5), 1000 grain weight (27.5g), grain yield (6140 kg ha^{-1}) and straw yield (9306 kg ha^{-1}) compared to aerobic and conventional method. The results are in conformity with the earlier findings of [6-8], whereas the lowest number of vegetative tillers m^{-2} were found as 426 and 425.67 during *kharif* 2012 and *kharif* 2013 respectively in T_3. The number of vegetative tillers m^{-2} in case of T_2 was significantly higher than T_3 and T_4 in both the years. The highest number of vegetative tillers m^{-2} in case of T_1 may be attributed to higher spacing in between the hills, planting of younger (10 days old) seedlings, better aeration, light distribution and water management. The lowest number of vegetative tillers m^{-2} in case of T_2 as compared to T_1 may be due to the fact that although the row to row spacing was maintained at 20 cm, the seed to seed spacing was not uniform. The lowest number of vegetative tillers m^{-2} in case of T_3 and T_4 may be due to more than optimum plant population m^{-2}. The observation on plant height was found to be non significant in both the years under the study. The highest and lowest plant height as 97.77 cm and 91.60 cm were observed in case of treatments T_1 and T_3 respectively during *kharif* 2012. During *kharif* 2013 the highest plant height was recorded in case of treatment T_1 (97.23 cm), while the lowest plant height as 92.00 cm was recorded in case of T_3.

The performance of the four different crop establishment methods for *kharif* rice 2012 and 2013 with reference to the various yield parameters have been presented in Table 2. The yield parameters including panicles m^{-2}, 1000 grain weight (g), filled spikelets $panicle^{-1}$ and grain yield (t ha^{-1}). The results indicated that the highest number of panicles m^{-2} were recorded in case of T_1 as 574 and 566.3 during *kharif*, 2012 and 2013 respectively, whereas the lowest number of panicles m^{-2} were recorded in case of T_3 as 380.7 and 392.0 during *kharif*, 2012 and 2013 respectively. The number of panicles m^{-2} in case of T_2 was significantly higher than those in case of T_3 and T_4 during both the years under observation. The highest number of panicles m^{-2} in case of T_1 may be attributed higher spacing in between the hills, planting of younger (10 days old) seedlings, better aeration and water management. Furthermore the operation of the cono weeder in T_1 facilitated in creating a favourable micro environment at the root zone for luxurious root growth resulting in more number of tillers and panicles at later stage. The lower number of panicles m^{-2} in case of T_2 as compared to T_1 May be due to the fact that although the row to row spacing was maintained as 20 cm, the seed to seed was not uniform. The operation of cono weeder in T_2 of course facilitated aeration at root zone which resulted in more number of panicles m^{-2} as compared to T_3 and T_4. The lower number of panicles m^{-2} in case of T_3 may be attributed to more than optimum plant population m^{-2}. The results on 1000 grain weight indicated that there was no significant difference among the treatments, which may be due to the varietal characteristic of the MTU 7027 under observation.

The result on filled spikelets $panicle^{-1}$ showed significant difference among the treatments, in case of T_1, the number of filled spikelets $panicle^{-1}$ was observed to be highest as 160.3 and 165.7 during *kharif*

Table 3. Results on yield and harvest index in different crop establishment methods (pooled data of 2012-13).

Treatments	Seed yield (t/ha)		Straw yield (t/ha)		Harvest index (%)	
	2012	2013	2012	2013	2012	2013
T_1 : SRI	6.5	6.6	7.5	7.9	46.2	45.6
T_2 : Pre-germinated paddy seeder	5.7	5.5	6.9	6.9	45.2	44.3
T_3 : Broadcasting	4.3	4.5	5.3	5.7	44.7	44.3
T_4 : Convectional random transplanting	5.1	5.0	6.2	6.2	45.3	44.6
CD (0.05)	0.52	0.59	0.71	0.74	0.92	0.88

seasons of 2012 and 2013 respectively while it was lowest in case of T_3 as 98.3 and 104 during the same period. The filled spikelets panicle^{-1} in case of T_2 was significantly higher than the treatments of T_4 and T_3. This may be due to the fact that the number of effective panicles m^{-2} were higher in case of T_1 and T_2 as compared to T_4 and T_3. The row to row and plant spacing in case of T_1 was maintained as 25 cm × 25 cm while the row to row spacing of 20 cm was maintained in case of T_2. In case of T_3 and T_4, the number of hill m^{-2} and number of plants m^{-2} were much higher and no-uniform, while accounted for lower number of effective tillers as well as lower number of filled spikelets per panicle subsequently. The results on grain yield among the treatments were found to be statistically significant. Higher grain yield of 6.4 and 6.6 t ha^{-1} were observed in case of T_1 while lowest grain yield of 4.3 and 4.5 t ha^{-1} were observed in case of T_3 during *kharif* seasons of 2012 and 2013 respectively (Table 3). The grain yield in case of T_2 was significantly higher than the treatments of T_4 and T_3. The grain yield recorded in case of T_4 was found to be significantly higher than the T_3 which may be due to proper plant population followed by more number of effective tillers. These results are in conformity with the findings of Ram et al. [9]. The higher grain yield in case of the treatment T_1 and T_2 may be due to higher number of effective tillers m^{-2} and filled spikelets panicle^{-1} as compared to T_4 and T_5. In case of SRI method and sowing of pre-germinated seeds by drum seeder were recorded all the three yield parameters indicated better performance, which may be attributed to proper spacing, better aeration and nutrient absorption, higher rate of light absorption and increased rate of photosynthetic activity. The results on plant stand and plant growth parameters presented in Table 1 indicated similar trend in the treatments under observation. These findings were in agreement with those of Halder et al. [10].

Conclusion

Considering the various plant growth parameters and yield attributes, the performance of SRI method of rice cultivation was found to be most appropriate followed by the sowing of pre-germinated paddy seeds by the manually operated drum seeder. Although the system followed in case of SRI method is relatively new for the farmers, but the results are quite encouraging for adopting in near future.

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