Effect of Different Planting Techniques on Yield Attributes and Yield of Rice (*Oryza sativa* L.) during Kharif Season

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Abstract

The field experiment was conducted during *kharif* season of 2015 to investigate the effect of different planting techniques and inputs on yield attributes and yield of rice (*Oryza sativa* L.) at Agronomy Farm, College of Agriculture, Dapoli, Dist. Ratnagiri (Maharashtra). The field experiment was laid out in strip plot design comprising 21 treatment combinations replicated thrice. Main plot treatments consisted of three planting techniques, flat bed seed sowing (P_1), raised bed seed sowing (P_2), transplanting on wet unpuddled soil (*thomba* method) (P_3). The sub-plot treatments consisted Control- No fertilizer (T_1), RDF Recommended dose of fertilizer (T_2), STBFR- Soil test based fertilizer recommendation for N, P, and K (T_3), STBFR + WC (weed control) (T_4), STBFR + WC+ MN (Zn, Cu) (T_5), STBFR + WC + MN (zn, cu) + GM (Glyricidia) (T_6), STBFR + WC + MN (zn, cu) + GM (Glyricidia) + PP (Plant protection) (T_7). On the basis of present investigation it could be concluded that for obtaining higher grain yield of the rice, crop should be grown as direct seeding on flat bed along with adoption of all inputs viz., soil test based fertilizer recommendation, weed control, micronutrients (Zn, Cu), green manuring (Glyricidia) and plant protection.

Keywords: Inputs, planting techniques, rice.

Introduction

Rice (*Oryza sativa* L.) is the most important staple food grain crop of the world which constitutes the principle food for about 60% of the world's population. Rice based production system provides the income and employment for more than 50 million households. Therefore rice is not only a staple food of the region but also a way of life. Total area under rice in India is 45.05 million hectares with annual production of 103.27 million tonnes, Though production is huge, the per hectare yield is very poor i.e. 2.29 t ha^{-1} (Wailes and Chavez 2012) as compared to other rice growing countries like Egypt (6.45 t ha^{-1}), USA (5.63 t ha^{-1}), Japan (4.73 t ha^{-1}) and China (4.74 t ha^{-1}). In Maharashtra, rice is cultivated over an area of 15.16 lakh hectares and an annual production of about 28.78 lakh tonnes with a productivity of 1.902 t ha^{-1} (Anonymous 2013).

Rice in Konkan is being grown mostly as puddled transplanted crop. This method of cultivation is labour intensive. Here it is cultivated over an area of 4.20 lakh hectares with an annual production of about 10.07 lakh tonnes with average productivity of 2.40 t ha^{-1} (Anonymous 2014). The main reasons for low productivity in Konkan are untimely or delayed transplanting, low plant population per unit area, broadcast application of fertilizers in imbalanced proportion, poor water and weed management practices etc. Continuous adoption of puddling and transplanting for rice cultivation has been reported to cause decline in soil and crop productivity (Nambiar and Abrol 1989).

Rice production systems are undergoing several changes and one such change is shift from transplanted rice to direct seeding. Dry direct seeded rice differs from transplanted rice in terms of crop establishment as well as subsequent crop management practices. The broadcast sowing/drilling/dibbling of dry seeds in soil is called direct seeded rice (DSR). It offers many advantages such as more efficient water use, high tolerance to water deficit, less methane gas emission, reduced cultivation cost, prevents the formation of hard pan in sub-soil and minimizes labour input (Balasubramanian and Hill 2002). It is more conducive to mechanization and also eliminates transplanting shock. Direct seeding offers certain advantages i.e. saves labour, faster and easier planting helps in timely sowing, less drudgery, early crop maturity by 7-10 days, less water requirement, high tolerance to water deficit, often higher yield, low

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production cost and less methane emission.

Often farmers need to sustain economic losses while growing crops like rice by following traditional practices of rice cultivation in this region. Therefore, possibility of growing direct seeded rice in Konkan is need of the present era. Accordingly many farmers and research workers have started work for developing technology of growing direct seeded rice. Due to unavailability of rain, puddling and transplanting is not possible. But it delays transplanting and reduces yield. Hence farmers intend to transplant rice seedling timely by cultivating field similar to nagli i.e thomba method (transplanting on wet unpuddled soil). This can save puddling under unavailability of sufficient rainfall.

Among various agronomic inputs, green manures and fertilizers, micronutrients, weed management at right time and plant protection measures are the most important factors, which play major role in rice production.

Direct sowing of rice is quicker, easier and economical one, but the infestation of weeds in such crop is the main problem. Weed pressure is often two to three times more in direct seeded rice as compared to transplanted one. The yield losses due to weeds range from 36 % in case of transplanted rice and as high as 84 % in case of direct sown rice (Ravichandran 1991). Research has shown that in the absence of effective weed control options, yield losses are greater in direct seeded rice than in transplanted rice (Baltazar and De Datta 1992; Rao *et al*. 2007). Weeds are more problematic in direct seeded rice than in transplanted rice. Pillai and Rao (1974) reported the extent of yield reduction due to infestation of weeds to be 15-20% under transplanted system and 30-35% under direct seeded system. Micronutrients often act as co-factors in enzyme systems and participate in redox reactions. Micronutrients also involved in the key physiological processes of photosynthesis and respiration (Srivasatava *et al*. 2000) while for rice zinc deficiency is a major yield limiting factor in several Asian countries (Rehman *et al*. 2012).

Application of soil-test-based fertilizer doses to a crop would help to realize greater response ratio and greater benefit-cost ratio, as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient. In addition, the correction of the nutrient imbalance in soil would help to harness the synergistic effects of balanced fertilization (Rao and Srivastava 2000).Such recommendations are helpful in maintaining and enhancing soil fertility simultaneously with improving crop production and nutrient-use efficiencies. Green manuring refers to addition of green plant tissues to the soil for increasing fertility and soil physical properties. Incidence of serious insects, pests and diseases is another important factor responsible for the low yield of rice. Pests like gall midge, stem borer, brown plant hopper, rice hispa, blue beetle and army worm are of major significance limiting rice production. Nath and Dutta (2002) reported that highest yield loss by rice hispa (27.65%) was observed in completely unprotected plots and there was no yield loss in completely protected plots. Yield losses range from 21 to 51% due to insect pests.

In general due to poor economic condition of the rice farmers, they are unable to purchase these costly inputs. It is therefore not possible for the farmers to apply all these inputs at right time and in optimum quantity. Therefore, it is necessary to study the comparative effects of these inputs on rice production and to identify the most critical inputs, which play major role in increasing rice production. Once the most critical inputs are identified, the farmers having poor economic condition can be suggested to give more attention towards the management of these critical inputs. Taking into consideration these aspects, a field experiment entitled “Effect of different planting techniques and inputs on growth yield and quality of rice (*Oryza sativa* L.) during Kharif season.”

Materials and Methods

The field experiment was conducted during Kharif season of 2015. The soil of the experimental plots was clay loam in texture, moderately acidic in reaction, high in organic carbon content. It was medium in available nitrogen, low in available phosphorus and fairly high in available potassium. In respect of micronutrients the soil was deficient in available zinc and copper.

The field experiment was laid out in strip plot design comprising 21 treatment combinations replicated thrice. Main plot treatment consisted of three planting techniques, flat bed seed sowing (P_1), raised bed seed sowing (P_2), transplanting on wet unpuddled soil (thomba method) (P_3). The sub plot treatment consisted, Control- No fertilizer (T_1), RDF Recommended dose of fertilizer (T_2), STBFR- Soil test based fertilizer recommendation for N, P, and K (T_3), STBFR + WC(weed control) (T_4), STBFR + WC+ MN (Zn, Cu) (T_5), STBFR + WC + MN (Zn, Cu) + GM (Glyricidia) (T_6), STBFR + WC + MN (Zn, Cu) + GM (Glyricidia) + PP (Plant protection) (T_7). For ascertaining the effect of different treatments on growth and development of rice, periodical observations were recorded. The observations were recorded at every 30 days interval from the date of sowing and at harvest.

Results and Discussion

The data pertaining to the yield attributing characters of rice viz., number of panicle m^{-2}, panicle length (cm), number of filled grains per panicle, number of unfilled grains per panicle, 1000 grain weight, grain yield (q ha^{-1}) and straw yield (q ha^{-1}) are presented in Table 1.

Effect of planting techniques

The mean number of panicles m^{-2} of rice was significantly influenced due to different planting techniques at harvest. The treatment flat bed (P_1) recorded the highest number of panicles m^{-2} (307.94) which was significantly superior over treatment raised bed (P_2) and transplanting with thomba method (P_3) in descending order. Perusal of the data presented in Table 1 showed that, the mean length of panicle of rice was found to be significantly influenced due to planting techniques. Significantly the highest length of panicle (23.93 cm) was recorded by the treatment transplanting with thomba method (P_3) over treatment flat bed (P_1) and raised bed (P_2) in descending order. The scrutiny of the data presented in Table 1 showed that, the different planting techniques failed to exhibit any significant effect on the mean 1000 grain weight (g). However, numerically the highest 1000 grain weight (29.05 g) at harvest of rice was observed in treatment of transplanting with thomba, flat bed and raised bed in descending order. Planting techniques found to be significantly different with respect to the mean number of filled grains panicle^{-1} (156.94) of rice under *kharif* season. The treatment transplanting with thomba methods (P_3) recorded the highest number of filled grains per panicle which was significantly superior over all other treatment which was closely followed by treatment of the flat bed (P_1) and significantly the lowest filled grain per panicle (132.37) was observed in the treatment of raised bed. It was found that the effect on mean number of unfilled grains panicle^{-1} of rice remained non significant due to different planting techniques. However, maximum number of unfilled grains panicle^{-1} of rice (15.10) was observed in treatment of flat bed which was closely followed by the treatment raised bed and minimum number of unfilled grain panicle^{-1} of rice (13.14) was observed in treatment of transplanting with thomba method (P_3) in descending order. Also different planting techniques significantly influenced the mean grain yield (q ha^{-1}) of rice. Treatment flat bed (P_1) recorded significantly more grain yield (42.08 q ha^{-1}) over the treatments raised beds (P_2) and transplanting with thomba methods (P_3) in descending order. Increase in the grain yield due to P_1 and P_2 over P_3 was to the tune of 19% and 10.22% respectively. The mean straw yield of rice was significantly influenced due to different planting techniques. Treatment flat bed (P_1) recorded significantly higher straw yield (51.58 q ha^{-1}) over the rest of treatments followed by raised beds (P_2) and significantly lower straw yield (q ha^{-1}) was recorded in treatment of transplanting with thomba methods (P_3). Increase in the straw yield due to P_1 and P_2 over P_3 was to the tune of 16.72 and 11.15%, respectively. These results corroborated the findings of Jha *et al*. (2011), Tang *et al*. (2006) and Ma'shum *et al*. (2009).

Effect of different inputs

From the data presented in Table 1 it was evident that, the different inputs failed to exhibit any significant effect on the number of panicle m^{-2} after harvest. However, numerically maximum number of panicle m^{-2} (250.35) was recorded in treatment of T_7 which was followed by T_6, T_5, T_4, T_3 and T_2 in the descending order at harvest. The lowest number of panicles m^{-2} (238.63) was recorded in treatment control, where no any inputs was

Table 1: Mean yield attributes of rice number of panicle m^{-2}, panicle length (cm), number of filled grains per panicle, number of unfilled grains per panicle, 1000 grain weight, grain yield (q ha^{-1}) and straw yield(q ha^{-1}) as influenced by different treatments

Treatment	Number of panicles m^{-2}	Length of panicle (cm)	1000 grain weight (g)	Filled grains $panicle^{-1}$	Unfilled grains $panicle^{-1}$	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
Planting techniques							
P1 : Flat bed (DSR)	307.94	23.07	28.71	146.51	15.10	42.08	51.58
P2 : Raised bed (DSR)	226.56	21.87	28.08	132.37	14.80	38.93	49.12
P3 : Transplanting (TM)	198.23	23.93	29.05	156.94	13.14	35.32	44.19
S.E m. ±	4.81	0.15	0.67	2.28	0.78	0.50	0.76
C.D. at 5%	14.04	0.43	NS	6.65	NS	1.45	2.23
Different inputs							
T1 : Control (No fertilizer)	238.63	21.28	26.03	117.42	22.40	18.03	24.87
T2 : RDF	241.33	22.12	27.49	129.37	18.27	31.63	37.32
T3 : STBFR	242.43	22.47	28.09	138.12	13.43	33.63	41.11
T4 : STBFR + WC	242.97	22.86	29.10	142.72	13.33	43.73	52.38
T5 : STBFR +WC+MN (Zn, Cu)	246.32	23.69	29.80	162.11	12.40	46.93	59.10
T6 : STBFR +WC+MN (Zn, Cu) + GM (Glyricidia)	247.70	23.91	29.89	163.76	11.83	48.00	60.02
T7 : STBFR +WC+MN (Zn, Cu)+ GM (Glyricidia) + PP	250.35	24.38	29.88	163.42	8.74	49.50	63.26
S.E m. ±	6.46	0.18	0.97	2.72	1.15	0.70	1.29
C.D. at 5%	NS	0.54	NS	7.93	3.36	2.05	3.76
Interaction effect							
S.E m. ±	7.82	0.19	0.42	8.52	1.91	1.42	1.69
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS
General mean	**244.25**	**22.96**	**28.61**	**145.27**	**14.34**	**38.78**	**48.29**

given to crop (T_1). The scrutiny of the data presented in Table 1 implies that, the mean length of panicle of rice was significantly influenced due to different inputs. Significantly the highest length of panicle was recorded by the treatment of STBFR with weed control, micro nutrient (Zn and Cu) and green manuring (24.38 cm) (T_7) over rest of treatments, except treatment T6 where plant protection inputs was excluded. Similarly, treatment T_6 which is followed by T_5 but, they were found to be at par with each others and treatment T_4 where STBFR with weed control inputs were given remained similar with T_3 from which weed control inputs was excluded from T_4. Significantly the lowest panicle length (21.28 cm) was observed in treatment T_1 i.e. control. The data presented in Table 1 showed that the mean 1000 grain weight (g) remain (was non significantly) uninfluenced due to different inputs. However, numerically the highest 1000 grain weight of rice (29.89 g) was recorded in treatment of STBFR + weed control + micro nutrient (Zn and Cu) + green manuring (Glyricidia) + plant protection (T_7) which was followed by the treatment of T_6, T_5, T_4, T_3 and T_2 in that descending order and minimum 1000 grain weight (26.03 g) was observed in treatment control where non of the inputs was given to crop (T_1). The mean number of filled grains per panicle was significantly influenced due to different inputs. Significantly the highest number of filled grains per panicle (163.76) was recorded by treatment soil test based fertilizer requirement + weed control + micronutrient (Zn, Cu) + green manuring (Glyricidia) (T_6) which was followed by the treatment T_7 and T_5 wherein (in this treatment) green manuring and plant protection was excluded and found to be significantly superior over control (T_1). Similarly, the treatments T_4 and T_3 on par with each other but found significantly superior over T_1. (The significantly lowest filled grains per panicle was recorded in the treatment of control where various inputs was not given to crop (T_1). The mean number of unfilled grains panicle^{-1} was influenced significantly due to different inputs. The lowest number of unfilled grains panicle^{-1} (8.74) was found in treatment of STBFR along with weed control, micronutrient (Zn and Cu), green manuring and plant protection (T_7) which was significantly superior over treatment control where all the inputs was not given to crop (T_1) but found to be statistically at par with treatment of T_6 where plant protection measures was excluded from treatment T_7. (Significantly the lowest number of unfilled grains panicle^{-1} (8.74) was found in treatment of STBFR along with weed control, micronutrient (Zn and Cu), green manuring and plant protection (T_7) over treatment control where all the inputs was not given to crop (T_1) but found to be statistically at par with treatment of T_6 where plant protection measures were excluded from treatment T_7. However, treatment control (T_1) recorded significantly the highest number of unfilled grains panicle^{-1} which is followed by treatments T_2, T_3, T_4 and T_5 in that descending order. These findings are close conformity with those of Sepat *et al*. (2010).

Scrutiny of data presented in Table 1 indicated that the highest grain yield (49.50 q ha^{-1}) was recorded by the treatment T_7 where all the inputs (STBFR + WC + MN (Zn and Cu) + GM (Glyricidia) + PP) were given to the crop (T_7) followed by the treatment T_6 where only plant protection was excluded from the various inputs. However, both the treatments remained statistically at par with each other, but found significantly superior over rest of the treatments. Similarly, treatments T_5 which was followed by treatments T_4, T_3 and T_2 in the descending order of significance recorded significant more grain yield than control (T_1). The lowest grain yield was recorded by the treatment T_1 of control where all the inputs were not given to crop (T_1) which was significantly lowest over rest of the treatments. Increase in grain yield due to treatments T_2, T_3, T_4, T_5, T_6 and T_7 over treatments T_1 was to the tune of 75.42, 86.52, 142.54, 160.28 and 174.54 per cent, respectively. Assessment of impact of different inputs indicated that reduction in the yield of rice due to various inputs was to the tune of 3.03% due to plant protection, 2.23% due to green manuring (Glyricidia), 6.82% due to micronutrients (Zn and Cu), 23.10% due to weed control, 5.95% due to soil test based fertilizer recommendation over recommended dose of fertilizer and 42.99% due to recommended dose of fertilizer over control. Data indicated that the mean straw yield of rice was significantly influenced due to different inputs. The treatment T_7 recorded significantly more straw yield (63.26 q ha^{-1}) of rice over rest of treatments, except treatment T_6, which remained on par with each other. However, both these treatments were found significantly superior over all other treatments under study. Similarly, T_5 treatment followed by T_4, T_3 and T_2 in the descending order of significance. Increase in straw yield due to treatments T_2, T_3, T_4, T_5, T_6 and T_7 over treatments T_1 was to the tune of 50.06, 65.29, 110.61, 137.63, 141.33 and 154.36%, respectively. These results confirm with the findings of Mishra and Dash (2013) and Rawat *et al*. (2012).

Interaction effects

All the interaction effects between planting techniques and different inputs didn't reach to the level of significance with respect to mean number of panicle m^{-2}, panicle length, number of filled grains per panicle, number of unfilled grains per panicle, 1000 grain weight, grain yield (q ha^{-1}) and straw yield(q ha^{-1}) of rice.

Conclusion

On the basis of present investigation it could be concluded that, for obtaining higher grain yield of the rice, crop should be grown as direct seeding on flat bed along with adoption of all inputs viz., soil test based fertilizer recommendation, weed control, micronutrients (Zn, Cu), green manuring (Glyricidia) and plant protection.

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