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PERFORMANCE OF TRANSPLANTED SCENTED RICE (*ORYZA SATIVA* L.) UNDER SRI BASED CULTIVATION PRACTICES; A SUSTAINABLE METHOD FOR CROP PRODUCTION

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ABSTRACT

The experiment was carried out at Raipur during season of 2012 to find out the performance of transplanted scented rice under different planting geometries and seedling densities. The treatment (T_2) *i.e.* planting of 2-3 seedlings hill^{-1} transplanted in the spacing of 25 cm x 25 cm recorded significantly highest *i.e.* Plant height (129.64cm), number of tillers (15.70 tillers hill^{-1}), dry matter accumulation (102.65 g hill^{-1}) and yield attributing characters along with highest grain yield *i.e.* 38.20 q/ha and straw yield (77.91 q/ha). Therefore its adoption protects the ecosystem as well as increasing production also.

INTRODUCTION

Among cereals rice is more nutritious and about 40% of world population consumes it as a major source of calorie (Banik, 1999). Rice is the most important cereal food crop of the world providing major source of the food energy for more than half of the human population. In world the total production of rice is 463.3 million tonnes (milled basis) in 2011–12 (Anonymous, 2012a). India is second largest producer after china and has an area of over 42.2 million hectares and production of 104.32 million tonnes with productivity of 2372 kg ha^{-1}. The rice productivity is less than 2 tons per hectare in most of the states (Dash, 2009).

The chemical fertilizers are considered as essential part of modern farming and their use in different countries has increased considerably day-by-day. Their application directly or indirectly causes series of changes in physical, chemical and biological properties of soil. (Divya and Belagali, 2012) In recent years, water table is running down at a very rapid rate throughout the globe, thus, poses alarming threats and limiting the scope for cultivation of high water requiring crops very seriously. Rice being water requirement crop, there is a need to search for alternate methods to reduce water requirement without reduction in the yield (Krishna *et al.,* 2008). System of Rice Intensification (SRI) is another emerging water saving technology, with many fold increase in crop yield (Laulanie, 1993). The excessive use of chemicals in agriculture causes water pollution and human health hazards. After years of high yields, rice soils are depleted of nutrients. Therefore the application system of rice intensification technology would be necessary for sustainable rice production in the future. Most of the fine scented traditional varieties are tall, low productive, low input responsive, long duration and susceptible towards the insect, pest and diseases. Due to this, farmers are unable to make their cultivation a profitable enterprise in this region. It is therefore important to achieve high yield with good quality from scented rice varieties through proper agronomic manipulation. The crop plants growing depends largely on temperature, root volume, moisture and soil fertility for their growth and nutritional requirements (Singh and Singh, 2005). An unsuitable population crop may have limitation in the maximum availability of these factors. It is, therefore necessary to determine the optimum density of plant population per unit area for obtaining maximum yield. Wider spacing had linearly increasing effect on the performance of individual plants. The plants grown with wider spacing had more solar radiation to absorb for better photosynthetic process and hence performed better as individual (Baloch *et al*., 2002). The optimum seedlings per hill ensure the plants to grow in their both aerial and underground parts through efficient utilization of solar radiation, water and nutrients (Miah *et al.,* 2004). When the planting densities exceed the optimum level, competition among plants becomes severe and consequently the plant growth slows and the grain yield decreases. As the tiller production in scented rice is very low and most of them are low yielding. This paper deals with the objective to determine suitable spacing and number of seedlings for scented rice varieties under SRI based cultivation practices to maximize their yield.

MATERIALS AND METHODS

The experiment was carried out at Research Cum Instructional Farm, I.G.K.V., Raipur (C.G.) during *Kharif* 2012. The soil of experiment field was '*Inceptisols*' (sandy loam) which is locally known as '*Matasi*'. The soil was neutral in reaction and medium in fertility having low N, medium P, high K Climate of this region is sub- humid with an average annual rainfall of about 1200-1400 mm and the crop received 1315.9 mm of the total rainfall during its crop growth. The weekly average maximum and minimum temperature varied in between 25.8°C – 31.9°C and 12.75°C – 25.8°C, respectively. The experiment was laid out in randomized block design (RBD) with three replication, fourteen treatments and one variety *Dubraj* and the treatments *viz.* 25 cm x 25 cm + S_1 (T_1), 25 cm x 25 cm + S_{2-3} (T_2), 25 cm x 25 cm +S_{4-5} (T_3), 25 cm x 20 cm + S_1 (T_4), 25 cm x 20 cm + S_{2-3} (T_5), 25 cm x 20 cm + S_{4-5} (T_6), 25 cm x 15 cm + S_1 (T_7), 25 cm x15 cm + S_{2-3}(T_8), 25 cm x 15 cm + S_{4-5} (T_9), 25 cm x 10 cm + S_1 (T_{10}), 25 cm x 10 cm + S_{2-3}(T_{11}), 25 cm x 10 cm + S_{4-5} (T_{12}), 20 cm x 20 cm + S_2 (T_{13}), 20 cm x 10 cm + S_{2-3} (T_{14}). Transplanting of one, two-three and three-four seedlings hill^{-1}, using seed rate of 10 kg ha^{-1}, 20 kg ha^{-1}, 35 kg ha^{-1} and 40 kg ha^{-1} at the spacing of 25 cm x 25 cm, 25 cm x 20 cm, 25 cm x 15 cm, 25 cm x10 cm, 20 cm x 20 cm, 20 cm x 10 cm respectively. The 12 days old seedlings were transplanted from T_1 to T_{13} while 23 days old seedlings were transplanted in the treatment T_{14}. Cultural operations were done as and when necessary. Crop was transplanted on (July) 23. 07. 2012 and harvested on (December) 02.12.2012. Recommended dose of nutrient was 60 kg N + 40 kg P_2O_5 + 30 kg K_2O ha^{-1}. The fertilizers were applied as per the treatments. Entire quantity of phosphorus and FYM was applied before transplanting. Nitrogen, Phosphorus and potassium applied through urea, single super phosphate and muriate of potash respectively. Nitrogen was applied in 3 splits (basal, tillering and panicle initiation stage (@ 50:25:25%). The plants of outer row and the extreme ends of the middle rows were excluded to avoid border effect. Five hills were randomly selected from each treatment for recording observations on plant height, total tillers/hill, panicle length and weight (Chaki *et al.*, 2012) filled grains panicle^{-1}and 1000-grain weight (Yadav, 2007). Grain yield, straw yield, and harvest index were recorded at harvest. The straws were sun dried and the yield of grain and straw/plot were converted to t/ha (Rajbhandari, 2007). Collected data were analyzed statistically following ANOVA technique and the mean differences were adjudged by Duncan's multiple Range lest (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effect on Growth of scented rice

It is obvious from the data of plant height progressively increased with advancement of the age of crop. Among the treatments the treatment 25 cm x 25 cm + S_{2-3} (T_2) produced significantly highest plant height which was found to be at par with the treatments 25 cm x 25 cm +S_1 (T_1) , 25 cm x 25 cm + S_{4-5} (T_3), 25 cm x 20 cm + S_1 (T_4), 25 cm x 20 cm + S_{2-3} (T_5), 25 cm x 20 cm + S_{4-5} (T_6), 25 cm x 15 cm +S_1 (T_7) and 25 cm x 15 cm +S_{2-3} (T_8). Kumar *et al.* (2011) and Singh *et al.* (2012) also found similar results. The highest plant height was observed in the treatment 25 cm x 25 cm + S_{2-3} (T_2) is due to Younger seedling, optimum seedling density, seedling age and wider spacing helped to attain higher plant height due to fact that early transplanting preserves potential for crop growth and wider spacing provides efficient use of nutrients with less competition. Treatment 25 cm x 25 cm + S_{2-3} (T_2) produced significantly the maximum no. of tillers hill^{-1} and the treatments 25 cm x 25 cm +S_1 (T_1), 25 cm x 25 cm + S_{4-5} (T_3), 25 cm x 20 cm + S_1 (T_4), 25 cm x 20 cm + S_{2-3} (T_5), 25 cm x15 cm +S_1 (T_7), 25 cm x 15 cm +S_{2-3} (T_8) and 25 cm x 15 cm + S_{4-5} (T_9) was found to be at par with the same treatment. The lowest number of tillers was observed in treatment of 20 cm x 10 cm + S_{2-3} (T_{14}) *i.e.* farmers practice of scented rice. These findings are in accordance with Balsubramanian *et al.* (2000) and Yadav and Tripathi (2008). It may be due to the sharing of nutrients, light, temperature, etc. among the plants in inter and intra-hills. Younger seedlings (10-12 days old) with wider spacing helped plants to attain higher number of tillers due to fact that early transplanting preserves potential for tillering and wider spacing provides efficient use of nutrients with less competition. The results are also in consonance with the findings of Singh and Singh (2005). The dry matter accumulation is directly related to the growth pattern of the crop, which linearly influences the biological yield. Dry matter accumulation increased with the advancement of crop age. In the treatment 25 cm x 25 cm + S_{2-3} (T_2) recorded significantly higher dry matter accumulation and it was significantly best over all the treatments except treatment 25 cm x 25 cm + S_1 (T_1) which was statistically similar with the highest dry matter produced treatment 25 cm x 25 cm + S_{2-3} (T_2). This result is in accordance with Sridevi and Chellamuthu (2007) and Sridhara *et al.* (2011). The higher value of dry matter accumulation might be due to higher availability and translocation of nutrients during growth and development stages. It depends upon the photosynthesis and respiration rate which finally increase the plant growth with respect to plant height, tillers etc. Irrespective of planting methods and crop geometry, plant dry biomass was significantly higher under two seedlings hill^{-1}. Similar result was also found by Verma (2009).

Effects on yield attributes and yield of scented rice

The results of influence of seedling age, spacing and number of seedlings on seed yield and yield attributing parameters are presented in Table 1.2. Number of productive tillers m^{-2} varied significantly due to age of the seedlings, spacing and seedling densities. Panicle bearing tillers are termed as effective tillers. The number of effective tillers per m^{-2} is an important yield attributing character, which ultimately determines the yield of rice crop.

Twelve days old seedlings recorded maximum productive tillers m^{-2} (196.19), compared to 25 days old age of seedlings. The present findings are in conformity with results of Manhan and Siddique (1990) and Das *et al.* (1988). Among the spacing's followed, wider spacing of 25 cm x 25 cm recorded significantly higher number of productive tillers (196.19) compared to closer spacing's and among the seedling densities two seedling hill^{-1} significantly recorded the higher number of effective tillers. Planting in square method with wider spacing might have resulted in profuse tillering under SRI cultivation, which might have facilitated plants for better utilization of the resources. This advantage of SRI method in enhancing tiller numbers has been reported earlier by Gani *et al.* (2002). The treatment 25 cm x 25 cm + S_{2-3}(T_2) produced significantly higher number of effective tillers m^{-2}, which was found to be superior with all other treatments. Panicle length and weight are one of the important yields attributing character, which influenced the yield directly. The number of filled grains panicle^{-1} and test weight of sound grains are another important yield attributing characters, which directly affecting the grain yield of crop. Number of filled grains panicle^{-1} and test weight were significantly influenced due to different treatments (Table 1.2). The highest no. of filled grains and test weight was recorded significant under the treatment 25 cm x 25 cm + S_{2-3} (T_2). The treatments 25 cm x 25 cm + S_1 (T_1), 25 cm x 25 cm + S_{4-5} (T_3), 25 cm x 20 cm + S_1 (T_4), 25 cm x 20 cm + S_{2-3} (T_5) and 25 cm x 15 cm + S_1 (T_7) were found to be statistically similar with the same treatment. In case of test weight the treatment 25 cm x 25 cm + S_1 (T_1) were found to be at par with the same treatment 25 cm x 25 cm + S_{2-3} (T_2). The increased plant spacing considerably resulted in vigorous plant growth and caused a significant increase in 1000 grain weight. The results are in accordance with Edwin (2008). The panicle length and number of grains per panicle were obtained higher with the wider spacing compared to narrow spacing's. Ramaswamy and Babu (1997) also found reduction in yield contributing characters under increased plant density. The seed yield and straw yield ha^{-1} was significantly higher with 12 days old seedlings. The per cent increase in the seed yield and straw yield by 12 days old seedlings was 21.56 per cent over 25 days' old seedlings. The reduction in seed yield and straw yield with 25 days old seedlings was attributed to the lower productive tillers m^{-2} was reported by Biradarpatil (1999) in rice. Significantly higher seed yield and straw yield ha^{-1} was noticed with a spacing of 25 cm x 25 cm compared to other spacing's. The optimum level of plant population coupled with better yield parameters might have resulted in higher seed and straw yield ha^{-1} under 25 x 25 cm spacing. These findings are in conformity with findings of Ceesay and Uphoff (2003) and Zhang *et al.* (2004). The grain, straw yield and harvest index were significantly influenced due to different treatments. The data presented in Table 1.2. The treatment 25 cm x 25 cm + S_{2-3} (T_2) produced the significantly highest grain yield and straw yield, which was statistically similar with the treatments 25 cm x 25 cm + S_1 (T_1), 25 cm x 20 cm + S_1 (T_4), 25 cm x 20 cm + S_{2-3} (T_5), 25 cm x 15 cm + S_1 (T_7) and 20 cm x 20 cm + S_{2-3} (2S) (T_{13}) in case of grain yield. Whereas in case of straw yield it was found to be at par with the treatment 25 cm x 25 cm + S_1 (T_1). However, lowest grain yield and straw yield produced in the treatment 20 cm x 10 cm + S_{2-3} (T_{14}). The better seed quality with seed produced from wider spacing may be due to higher test weight values. These results are in conformity with

Manonnmani and Jacquilin (1995) and Singh *et al.* (2012).

Table 1.1: Performance of growth characters of transplanted scented rice (*oryza sativa* L.) under SRI based cultivation practices

Treatment	Plant height (cm)at harvest stage	No. of tillers(hill^{-1}) at harvest stage	Dry matter accumulation (g hill^{-1}) at harvest
T_1: 25x25cm^2+S_1	128.74	15.27	99.20
T_2: 25x25cm^2+S_{2-3}	129.64	15.70	102.65
T_3: 25x25cm^2+S_{4-5}	124.72	14.83	93.55
T_4: 25x20cm^2+S_1	123.90	14.27	91.01
T_5: 25x20cm^2+S_{2-3}	126.34	14.87	96.14
T_6 : 25x20cm^2+S_{4-5}	122.59	12.62	86.63
T_7 : 25x15cm^2+S_1	121.31	13.10	88.06
T_8 : 25x15cm^2+S_{2-3}	125.95	13.61	92.58
T_9: 25x15cm^2+S_{4-5}	120.66	12.63	82.97
T_{10}:25x10cm^2+S_1	118.88	11.07	74.71
T_{11} :25x10cm^2+S_{2-3}	119.38	12.11	80.51
T_{12}: 25x10cm^2+S_{4-5}	114.84	9.99	69.35
T_{13}:20x20cm^2+S_2(2S)	119.20	11.07	78.61
T_{14}: 20x10cm^2+S_{2-3}	115.59	8.60	63.96
SEm ±	2.89	1.05	2.21
CD (p = 0.05)	8.42	3.07	6.43

Table 1.2: Performance of yield attributing characters and grain yield of transplanted scented rice (*Oryza sativa* L.) under SRI based cultivation practices

Treatment	Harvest index (%)	Effective tillers m^{-2}	Filled grains panicle^{-1}	Sterility (%)	Testweight (g)	Grain Yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1: 25x25cm^2+S_1	34.19	187.02	221.13	5.93	18.17	36.91	75.04
T_2: 25x25cm^2+S_{2-3}	34.06	196.19	223.87	6.10	18.57	38.20	77.91
T_3: 25x25cm^2+S_{4-5}	32.08	164.92	206.33	5.69	17.22	34.35	71.97
T_4: 25x20cm^2+S_1	35.44	166.68	213.20	5.63	17.52	35.98	65.56
T_5: 25x20cm^2+S_{2-3}	32.04	174.87	197.13	5.80	17.7	36.84	72.33
T_6 : 25x20cm^2+S_{4-5}	35.92	144.85	188.60	6.62	17.6	33.10	65.23
T_7 : 25x15cm^2+S_1	36.98	170.84	194.33	7.09	17.57	36.40	66.40
T_8 : 25x15cm^2+S_{2-3}	35.07	156.78	177.60	7.79	17.38	33.88	62.96
T_9 : 25x15cm^2+S_{4-5}	37.42	148.39	176.93	7.12	17.54	33.51	60.36
T_{10}:25x10cm^2+S_1	35.76	160.81	170.93	5.88	17.69	34.25	64.95
T_{11} :25x10cm^2+S_{2-3}	36.41	136.47	166.87	6.65	17.00	32.89	59.81
T_{12}: 25x10cm^2+S_{4-5}	36.04	132.82	164.20	7.91	17.27	32.58	57.42
T_{13}:20x20cm^2+S_2(2S)	35.72	165.45	183.60	6.01	17.64	35.59	64.68
T_{14}: 20x10cm^2+S_{2-3}	34.99	145.09	146.80	5.74	16.69	30.79	56.21
SEm ±	1.66	2.03	10.39	0.59	0.23	1.28	2.18
CD (p = 0.05)	4.82	5.90	30.22	NS	0.68	3.74	3.09

S - Seedlings

These findings are observed because the scented rice don't have the potential to perform well in traditional method as well as in single seedlings per hill (SRI Method) and it is find from that experiment that two seedlings per hill along with the spacing of 25 cm from row to row and plant two plant along the use of organic ferlizers found best for growing scented rice. These methods of rice cultivation help in increasing the production as well as protect the environment from hazardous chemicals and maintain the sustainability in the ecosystem.

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