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Agronomic evaluation of scented rice (*Oryza sativa* L) under different planting patterns

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Rice is life to a majority of people in Asia. The cultivation of rice represents both a way of life and a means to livelihood. 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}. (Anon. 2012). It is accounts for about 42 per cent of total food grain production and 55 per cent of cereal production in the country. The major portion of rice area is devoted to the coarse and medium slender rice varieties. However, very less area (≥ 20% of the total rice area) has been given to the fine and scented rice. Rice quality is the major factor from consumer as well as marketing point of view. Aromatic rice which has stronger aroma and good quality than ordinary rice has more demand in different countries of the world (Bajpai and Singh, 2010). In India, supply of fine and fine scented rice is very less; therefore its market is comparatively high. Most of the fine and 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 main objective of this experiment is to improve the yield of scented rice by manipulation of planting spacing and number of seedlings per hill.

The experiment was conducted to study the effect of planting parameters on scented rice(cv. Dubraj) at Research cum Instructional-Farm, Indira Gandhi Krishi Viswavidyalaya, Raipur, Chattisgarh, India during *kharif* 2012. The soil of experimental field was '*Inceptisol*' (sandy loam), which is locally known as '*Matasi*'. The soil was neutral in reaction and medium in fertility having low N, medium P, and high K. The climate of the region is humid-sub in nature with an average annual rainfall of about 1200-1400 mm and weekly average maximum temperature (31.9ºC-25.8^{0}C) and minimum temperature (25.8^{0}C-12.75^{0}C). The experiment was laid out in randomized block design with three replications, wherein fourteen treatments were T_1 (25 x 25 cm + S_1), T_2 (25 x 25 cm + S_{2-3}), T_3 (25 x 25 cm +S_{4-5}), T_4 (25 x 20 cm + S_1), T_5 (25 x 20 cm + S_{2-3}), T_6 (25 x 20 cm + S_{4-5}), T_7 (25 x 15 cm + S_1), T_8 (25 x15 cm + S $_{2-3}$), T_9 (25 x 15 cm + S_{4-5}), T_{10} (25 x 10 cm + S_1), T_{11} (25 x 10 cm + S $_{2-3}$), T_{12} (25 x 10 cm + S_{4-5}), T_{13} (20 x 20 cm + S_2), T_{14} (20 x 10 cm + S_{2-3}). Transplanting of one (S_1), two-three (S_{2-3}) and four-five (S_{4-5}) seedlings hill^{-1}were done using seed rate of 10 kg ha^{-1}, 20 kg ha^{-1}, 35 kg ha^{-1} and 40 kg ha^{-1}. Twelve days old seedlings were transplanted in T_1 to T_{13} plots on 23.07.2012, while 23 days old seedlings were transplanted in treatment T_{14}. Standard crop management practices were followed including nutrient management of 60:40:30 kg/ha of $N:P_2O_5:K_2O$, of which half N, full phosphate and were applied as basal, and one-fourth of N was top dressed in two equal splits at tillering and panicle initiation stage. The growth attributes were determined at 90 days after transplanting (DAT), while, yield components and yield at maturity stage. The chlorophyll content of the leaves was recorded through SPAD value (Kariya *et al*., 1982) in each plot at 60 DAT. The average of top, middle and base values were expressed as SPAD (Soil Plant Analysis Development) values. Grain quality parameters (hulling and milling percentage) were analysed in the laboratory and statistical analysis were done following Multiple Range test (Gomez and Gomez, 1984).

It is obvious from the data of plant height progressively increased with advancement of the age of crop. Among the treatments the treatment 25 x 25 cm + S_{2-3} (T_2) produced significantly highest plant height which was found to be at par with the treatments 25 × 25 cm + S_1 (T_1) , 25 x 25 cm + S_{4-5} (T_3), 25 × 20 cm + S_1 (T_4), 25 × 20 cm + S_{2-3} (T_5), 25 × 20 cm + S_{4-5} (T_6), 25 × 15 cm +S_1 (T_7), 25 × 15 cm + S_{2-3} (T_8) and 5 × 15 cm + S 4-5 (T9). Singh *et al*. (2012) also found similar

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results. It 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 x 25 cm + S_{2-3} (T_2) produced significantly the maximum number of tillers hill^{-1} and the treatments 25 x 25 cm +S_1 (T_1), 25 x 25 cm + S_{4-5} (T_3), 25 x 20 cm + S_1 (T_4), 25 x 20 cm + S_{2-3} (T_5), 25 x15 cm +S_1 (T_7), 25 x 15 cm +S_{2-3} (T_8) and 25 x 15 cm + S_{4-5} (T_9), 25 cm x 25 cm + S 4-5 (T_6) 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 x 10 cm + S_{2-3} (T_{14}) *i.e.* farmers practice of scented rice. Younger seedlings (10-12 days old) with wider spacing also helped 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). 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 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 x 25 cm + S_1 (T_1) which was statistically similar with the highest dry matter produced treatment 25 x 25 cm + S_{2-3} (T_2). This result is in accordance with Sridevi, and Chellamuthu (2007).

The SPAD [Chlorophyll content in leaves (Soil Plant Analysis Development Value)] value was taken at 60 DAT indicated that the highest SPAD value was observed under treatment 25 x 25 cm +S_2 (T_2) which was significantly better over all other treatment except treatments 25 x 25 cm + S_1 (T_1), 25 x 25 cm + S_{4-5} (T_3), 25 x 20 cm + S_1 (T_4) and 25 x 20 cm + S_{2-3} (T_5). The lowest SPAD value was observed under treatment 20 cm x 10 cm + S_{2-3} (T_{14}) *i.e* farmers practice. It might be due to wider spacing which resulted in profuse tillering and facilitated plant for better utilization of resources, more space for growth and utilization of nutrients helps in better growth of leaves and better chlorophyll content which results into more SPAD value. These findings are in accordance with Verma (2009).

The results of influence of seedling age, spacing and number of seedlings on seed yield and yield attributing parameters are presented in Table 1 and 2. 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. The highest no. of filled grains and test weight was recorded significant under the treatment 25 x 25 cm + S_{2-3} (T_2). The treatments 25 x 25 cm + S_1 (T_1), 25 x 25 cm + S_{4-5} (T_3), 25 x 20 cm +S_1 (T_4), 25 x 20 cm + S_{2-3} (T_5) and 25 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 x 25 cm + S_1 (T_1) were found to be at par with the same treatment 25 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 panicle length and number of grains per panicle were obtained higher with the wider spacing compared to narrow spacing's. 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. Significantly higher seed yield and straw yield ha^{-1} was noticed with a spacing of 25 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 Zhang *et al.* (2004).

The grain, straw yield and harvest index were significantly influenced due to different treatments. (Table 1 and 2). The treatment 25 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 x 25 cm + S_1 (T_1), 25 x 20 cm + S_1 (T_4), 25 x 20 cm + S_{2-3} (T_5), 25 x 15 cm + S_1 (T_7) and 20 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 x 25 cm + S_1 (T_1). However, lowest grain yield and straw yield produced in the treatment 20 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. The data of quality parameters *viz.* hulling and milling percentage reveal that different treatments were unable to produce significant variation for hulling and milling. Lowest hulling and milling was recorded in the treatment 20 x 10 cm + S_{2-3} (T_{14}) *i.e.* farmers practice. The study concludes that the

Table 1: Growth parameters of transplanted scented rice (at 90 DAP).

Treatment	Plant height (cm)	Number of tillers hill^{-1}	Dry matter accumulation(g hill^{-1})
T_1: 25x25cm^2+S_1	124.10	15.67	60.72
T_2: 25x25cm^2+S_{2-3}	125.44	16.15	62.17
T_3: 25x25cm^2+S_{4-5}	123.53	15.38	59.23
T_4: 25x20cm^2+S_1	120.49	14.65	56.34
T_5: 25x20cm^2+S_{2-3}	123.83	15.37	59.83
T_6 : 25x20cm^2+S_{4-5}	118.49	13.40	54.59
T_7 : 25x15cm^2+S_1	118.81	13.63	56.00
T_8 : 25x15cm^2+S_{2-3}	122.55	14.26	57.82
T_9 : 25x15cm^2+S_{4-5}	117.26	13.30	53.50
T_{10} :25x10cm^2+S_1	113.73	11.73	49.33
T_{11} :25x10cm^2+S_{2-3}	116.65	12.51	52.34
T_{12}: 25x10cm^2+S_{4-5}	113.02	10.56	48.15
T_{13}:20x20cm^2+S_2 (2S)	114.74	11.60	51.34
T_{14}: 20x10cm^2+S_{2-3}	111.50	9.03	45.57
SEm(±)	**2.94**	**15.67**	**0.74**
LSD (0.05)	**8.57**	**16.15**	**2.17**

Table 2: Performance of yield attributing characters and grain yield of scented rice

Treatment	SPAD Value (chlorophyll content)	Panicles hill^{-1}	Filled grains panicle^{-1}	Sterility (%)	Testweight 1000 grains (g)	Hulling (%)	Milling (%)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})
T_1: 25x25cm^2+S_1	33.65	11.69	221.13	5.93	18.17	75.41	69.58	3.69	7.50
T_2: 25x25cm^2+S_{2-3}	34.65	12.26	223.87	6.10	18.57	75.66	70.82	3.82	7.79
T_3: 25x25cm^2+S_{4-5}	32.92	10.31	206.33	5.69	172.20	74.04	69.04	3.43	7.19
T_4: 25x20cm^2+S_1	31.95	8.33	213.20	5.63	175.20	75.24	70.93	3.59	6.55
T_5: 25x20cm^2+S_{2-3}	31.64	8.74	197.13	5.80	177.00	74.91	69.42	3.68	7.23
T_6 : 25x20cm^2+S_{4-5}	31.30	7.24	188.60	6.62	176.00	74.01	68.72	3.31	6.52
T_7 : 25x15cm^2+S_1	30.92	6.33	194.33	7.09	175.70	74.77	69.07	3.64	6.64
T_8 : 25x15cm^2+S_{2-3}	29.93	5.81	177.60	7.79	173.80	75.29	70.20	3.38	6.29
T_9 : 25x15cm^2+S_{4-5}	31.09	5.50	176.93	7.12	175.40	73.96	69.74	3.35	6.03
T_{10} :25x10cm^2+S_1	29.06	4.02	170.93	5.88	176.90	75.08	68.84	3.42	6.49
T_{11} :25x10cm^2+S_{2-3}	28.96	3.41	166.87	6.65	170.00	74.47	68.08	3.28	5.98
T_{12}: 25x10cm^2+S_{4-5}	28.77	3.32	164.20	7.91	172.70	73.87	67.14	3.25	5.74
T_{13}:20x20cm^2+S_2 (2S)	29.32	6.62	183.60	6.01	176.40	75.53	68.83	3.55	6.46
T_{14}: 20x10cm^2+S_{2-3}	27.98	2.90	146.80	5.74	166.90	73.74	66.01	3.07	5.62
SEm (±)	**1.09**	**11.69**	**10.39**	**0.59**	**0.23**	**1.41**	**1.51**	**1.28**	**2.18**
LSD(0.05)	**3.17**	**12.26**	**30.22**	**NS**	**0.68**	**NS**	**NS**	**3.74**	**3.09**

Note: S - seedlings

adoption of system of rice intensification practices in cultivation of aromatic rice improves their production as well as their economic condition also because the price of organic products in the market is too high then the traditional products. It contributes in saving environment and sustainable crop production. The scented rice performed better in most of the evaluating traits like grain yield, straw yield and number of effective tillers per hill, test weight and number of filled grains per panicle in 25 x 25 cm spacing and 2-3 seedlings per hill. This indicates that the treatment (T_2) planting of 2-3 seedlings hill^{-1} transplanted in the spacing of 25 x 25 cm recorded significantly highest *i.e.* Plant height (cm), number of tillers hill^{-1}, dry matter accumulation, root volume, dry weight, along with highest yield attributing characters and grain yield. Therefore its adoption saves the protects the ecosystem as well as increasing production also. Thus, among 14 treatments, T_2 (planting of 2-3 seedlings hill^{-1} at a spacing of 25 cm x 25 cm) recorded significantly highest plant height (125.44 cm), number of tillers hill^{-1} (16.15), dry matter accumulation, (62.17g hill^{-1} at 90 DAT), yield attributing characters (*viz.* panicles per hill, filled grains per panicle and test weight) along with grain (3.82 tha^{-1}) and straw yield (7.79t ha^{-1}). The grain quality parameters like milling (%) and hulling (%) of Dubraj remained unaffected due to planting variables in the study.

The findings are also in good conformity with Gupta and Sharma (2013). They also observed that plant height number of tillers at harvest, LAI, panicle length and grains per panicle are determinants for biological yield and harvest index (Gupta and Sharma, 2013).

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