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EFFECT OF PLANTING GEOMETRY AND SEEDLING DENSITY ON GROWTH AND YIELD OF SCENTED RICE UNDER SRI BASED CULTIVATION PRACTICES

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ABSTRACT

The experiment was carried out at Research Cum Instructional Farm of the Indira Gandhi Krishi Vishwavidalaya, Raipur (C.G.) during *kharif* season of 2012 and 2013. The per cent increase in the grain yield and straw yield by 12 days old seedlings (25 cm x 25 cm + S2-3, T2)was 30.13 per cent over 21 days old seedlings. The treatment 25 cm X 25 cm with 2-3 seedlings (T_2) was also produced maximum plant height (cm), yield parameters and ultimately the significantly highest grain yield (38.20 q ha^{-1}) and straw yield (77.91 q ha^{-1}).

INTRODUCTION

Rice is a vital food material for more than half the world's population. 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. More than 90 per cent of the world's rice is produced and consumed in Asia where it is an integral part of culture and tradition. Rice occupies a pivotal place in Indian agriculture and it contributes to 15 per cent of annual GDP and provides 43 per cent calorie requirement for more than 70 per cent of Indians. It is accounts for about 42 per cent of total food grain production and 55 per cent of cereal production in the country.

In India, supply of fine and fine scented rice is very less; therefore its market is comparatively high. Most of the fine scented traditional varieties are tall, low productive, low input responsive, long duration and susceptible towards the insect, pest and diseases. The rice productivity is less than 2 tons per hectare in most of the states (Dash, 2009). 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. 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. So, it is essential to determine suitable spacing and number of seedlings for scented rice varieties to maximize their yield. So, it is necessary to improve its cultural practices like optimum sources and doses of nutrients, seedlings per hill and optimum spacing. The crop geometry and seedlings is the important factor for high yield production in rice crop cultivation (Sridhara *et al.*, 2011). This paper deals with the determination of 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 and 2013. 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 and 1413.6 mm of the total rainfall during both years of its crop growth. 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 four seedlings hill^{-1} here used for S_1, S_2, S_{2-3} and S_{4-5} for respective treatment. Crop was transplanted on 23. 07. 2012 and 21.07.2013 harvested on 02.12.2012 and 10.12.2013. Recommended dose of nutrient was 60 kg N + 40 kg P_2O_5 + 30 kg K_2O /ha on both the years. 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%). Among the quality characteristics aroma is considered as most important quality parameter to high quality rice. Aroma developed by both genetic factor and environment. The major aromatic compound responsible for aroma is considered is 2-acetyl-1-pyrroline (Buttery *et al*. 1983). 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, dry matter accumulation, panicle length, filled grains/ panicle and 1000-grain weight. 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 q/ ha. 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

Data for plant height was presented in Table 1. The plant height was progressively increased with advancement of the age of crop. Among the treatments the treatment 25 cm x 25 cm + S_{2-3} (T_2) on mean basis produced significantly more plant height which was found to be at par with the treatments 25 cm x 25 cm +S_1 (T_1) , 25 cm x 20 cm + S_{2-3} (T_5) and 25 cm x 15 cm +S_{2-3} (T_8). 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. Kumar *et al*. (2011) and Singh *et al*. (2012) also found similar results.

Dry matter accumulation is directly related to the growth pattern of the crop from Table 1, which linearly influences the biological yield. Dry matter accumulation increased with the advancement of crop age. Treatment 25 cm x 25 cm + S_{2-3} (T_2)

Table 1: Growth and yield attributing characters of scented rice as influenced by planting geometry and seedling density under SRI based cultivation practices

Treatment	Plant height (cm)			Dry matter accumulation/hill (g)At harvest			SPAD90 DAT			Filled grains/panicle			Test weight (g)		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
T_1 : 25x25cm^2+S_1	128.74	132.9	130.8	99.2	86.0	92.6	31.8	31.5	31.6	221.1	212.7	216.9	18.2	18.3	18.2
T_2 : 25x25cm^2+S_{2-3}	129.64	137.7	133.7	102.7	92.4	97.5	33.1	32.7	32.9	223.9	216.9	220.4	18.6	21.7	20.1
T_3 : 25x25cm^2+S_{4-5}	124.72	127.8	126.3	93.6	82.6	88.1	31.5	30.0	30.7	206.3	176.3	191.3	17.2	18.1	17.6
T_4 : 25x20cm^2+S_1	123.90	128.0	126.0	91.0	81.6	86.3	30.0	29.4	29.7	213.2	206.0	209.6	17.5	17.3	17.4
T_5 : 25x20cm^2+S_{2-3}	126.34	129.3	127.8	96.1	84.9	90.5	29.8	28.9	29.3	197.1	184.7	190.9	17.7	18.1	17.9
T_6 : 25x20cm^2+S_{4-5}	122.59	125.8	124.2	86.6	81.7	84.2	29.7	29.1	29.4	188.6	175.9	182.3	17.6	16.7	17.1
T_7 : 25x15cm^2+S_1	121.31	125.2	123.3	88.1	80.9	84.5	30.7	29.3	30.0	194.3	189.6	192.0	17.6	16.2	16.9
T_8 : 25x15cm^2+S_{2-3}	125.95	127.5	126.7	92.6	83.0	87.8	27.8	27.8	27.8	177.6	175.1	176.3	17.4	16.8	17.1
T_9 : 25x15cm^2+S_{4-5}	120.66	123.3	122.0	83.0	79.9	81.4	28.9	29.0	29.0	176.9	174.0	175.5	17.5	16.8	17.2
T_{10} :25x10cm^2+S_1	118.88	121.6	120.2	74.7	73.2	74.0	27.0	27.5	27.3	170.9	167.5	169.2	17.7	17.0	17.3
T_{11} :25x10cm^2+S_{2-3}	119.38	122.9	121.1	80.5	74.9	77.7	26.8	26.7	26.7	166.9	153.0	159.9	17.0	17.8	17.4
T_{12} :25x10cm^2+S_{4-5}	114.84	122.1	118.5	69.4	71.3	70.3	26.4	26.5	26.4	164.2	155.7	160.0	17.3	17.7	17.5
T_{13} :20x20cm^2+S_2(2S)	119.20	124.2	121.7	78.6	74.6	76.6	28.9	27.8	28.4	183.6	184.1	183.9	17.6	17.9	17.8
T_{14}: 20x10cm^2+S_{2-3}	115.59	123.9	119.7	64.0	66.4	65.2	27.0	27.5	27.2	146.8	142.2	144.5	16.7	17.2	17.0
SEm +	2.89	2.02	2.5	2.21	2.69	2.45	1.41	0.47	0.94	10.39	14.3	12.3	0.2	0.3	0.3
CD(P=0.05)	8.42	5.87	7.1	6.43	7.81	7.12	4.12	1.38	2.75	30.22	41.5	35.9	0.7	1.0	0.8

Table 2: Yield attributing characters and Yield of scented rice as influenced by planting geometry and seedling density under SRI based cultivation practices.

Treatment	Effective tillers/ m^2			Panicle length (cm)			Grain Yield(q ha^{-1})			Straw yield(q ha^{-1})			HI %		
	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean	2012	2013	Mean
T_1: 25x25cm^2+S_1	187.02	176.7	181.9	24.8	21.6	23.2	36.9	36.0	36.5	75.0	74.3	74.7	34.2	32.7	33.4
T_2: 25x25cm^2+S_{2-3}	196.19	183.3	189.7	24.9	23.0	23.9	38.2	37.9	38.0	77.9	75.8	76.8	34.1	33.3	33.7
T_3: 25x25cm^2+S_{4-5}	164.92	159.7	162.3	23.8	21.4	22.6	34.4	31.9	33.1	72.0	70.7	71.3	32.1	31.1	31.6
T_4: 25x20cm^2+S_1	166.68	162.3	164.5	24.2	21.6	22.9	36.0	32.7	34.4	65.6	65.6	65.6	35.4	33.3	34.4
T_5: 25x20cm^2+S_{2-3}	174.87	172.7	173.8	24.8	21.3	23.0	36.8	34.2	35.5	72.3	70.8	71.6	32.0	32.6	32.3
T_6: 25x20cm^2+S_{4-5}	144.85	141.7	143.3	22.8	19.3	21.1	33.1	29.4	31.3	65.2	66.6	65.9	35.9	30.7	33.3
T_7: 25x15cm^2+S_1	170.84	165.3	168.1	23.6	21.8	22.7	36.4	33.3	34.8	66.4	67.4	66.9	37.0	33.0	35.0
T_8: 25x15cm^2+S_{2-3}	156.78	151.3	154.0	23.8	21.1	22.4	33.9	31.0	32.4	63.0	62.4	62.7	35.1	33.2	34.1
T_9: 25x15cm^2+S_{4-5}	148.39	145.0	146.7	23.0	21.4	22.2	35.5	30.6	33.1	60.4	59.8	60.1	37.4	33.9	35.6
T_{10}:25x10cm^2+S_1	160.81	156.0	158.4	23.5	21.5	22.5	34.3	32.1	33.2	65.0	64.4	64.7	35.8	33.2	34.5
T_{11}:25x10cm^2+S_{2-3}	136.47	134.3	135.4	23.7	20.7	22.2	32.9	28.0	30.5	59.8	58.8	59.3	36.4	32.3	34.3
T_{12}:25x10cm^2+S_{4-5}	132.82	129.0	130.9	23.1	20.6	21.8	32.6	28.0	30.3	57.4	56.6	57.0	36.0	33.0	34.5
T_{13}:20x20cm^2+S_2(2S)	165.45	160.7	163.1	24.1	21.1	22.6	35.6	29.7	32.6	64.7	62.9	63.8	35.7	32.0	33.8
T_{14}:20x10cm^2+S_{2-3}	145.09	142.7	143.9	22.9	20.0	21.5	30.8	27.5	29.2	56.2	55.2	55.7	35.0	33.2	34.1
SEm +	2.03	5.18	3.6	0.47	0.58	0.5	1.28	1.08	1.18	2.18	1.30	1.74	1.66	0.61	1.14
CD(P=0.05)	5.90	15.07	10.5	1.38	1.70	1.5	3.74	3.13	3.43	3.09	3.79	3.44	4.82	1.78	3.30

at harvest on mean basis recorded significantly higher dry matter accumulation and it was accumulated more over all the treatments except treatment 25 cm x 25 cm + S_1 (T_1) and 25 cm x 20 cm + S $_{2-3}$ (T_5) which was statistically similar with the highest dry matter produced treatment 25 cm x 25 cm + S $_{2-3}$ (T_2). 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). The data was recorded for SPAD value at 90 DAT and the observations are presented in the Table 1. The highest SPAD value on mean basis was observed under treatment 25 cm x 25 cm + S_{2-3} (T_2) which was significantly better over all other treatment except treatments 25 cm x 25 cm + S_1 (T_1) and 25 cm x 25 cm + S_{4-5} (T_3). The treatment 25 cm x 25cm + S_{2-3} (T_2) recorded the highest SPAD value, 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. SPAD value under planting of two seedlings was more than that of one seedling hill-1 due to optimum leaf density. Similar findings have also been reported by Krishna *et al.* (2008), Sridevi and Chellamuthu (2007).

The treatment 25 cm x 25 cm + S_{2-3}(T_2) produced significantly higher yield attributing character *viz.*, number of effective tillers m^{-2}, panicle length (cm), filled grains per panicle and test weight (g) The highest panicle length was recorded under the treatment 25 cm x 25 cm + S $_{2-3}$ (T_2) 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 15 cm + S_1 (T_7), 25 cm x 15 cm + S $_{2-3}$ (T_8) ,25 cm x 10 cm + S $_{2-3}$ (T_{10}) and 20 cm x 20 cm + S $_{2-3}$ (2S) (T_{13}). In case of filled grains per panicle from the data revealed that treatment 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) was at par. The yield parameter is important character to evaluate yield and through their contribution maximize the overall yield. The results are in accordance with Luikham (2008). The yield attributing characters were obtained higher with the wider spacing compared to narrow spacing (Thawait *et al.*, 2014).

The grain, straw yield and harvest index were significantly influenced due to different treatments. From the data presented in Table 2, treatment 25 cm x 25 cm + S $_{2-3}$ (T_2) produced the significantly highest grain yield (38.20 q ha^{-1}) and straw yield (77.91 q ha^{-1}), which was statistically similar with the only 25 cm x 25 cm + S1 (T1) in case of grain and straw yield. However, lowest grain yield and straw yield produced in the treatment 20 cm x 10 cm + S_{2-3} (T_{14}). The similar results found by Singh and Singh (2005). The grain yield and straw yield ha^{-1} was significantly higher with 12 days old seedlings. The per cent increase in the grain yield and straw yield by 12 days old seedlings (T_2) was 30.13 per cent over 25 days old seedlings (Farmer practice, T14). The reduction in grain yield and straw yield with 25 days old seedlings was attributed to the lower productive tillers m^{-2} was reported by Krishna et al. (2008) in rice. Significantly higher grain 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 grain and straw yield ha^{-1} under treatment 25 x 25 cm spacing. These findings are in conformity with findings of Ceesay and Uphoff (2003) and Zhang et al. (2004).

REFERENCES

Baloch, A. W., Soomro, A. M., Javed, M. A., Ahmed, M., Bughio, H. R., Bughio, M. S. and Mastoi, N. N. 2002. Optimum plant density for high yield in rice (*Oryza sativa* L.). *Asian J. Plant Sci.* **1:** 25-27.

Banik, M. 1999. Cold injury problem in Boro rice. In Proc. of the workshop on Modern Rice Cultivation in Bangladesh. Bangladesh Rice Res. Inst. Joydevpur, Gazipur, Bangladesh. 14-16 February, p. 37.

Buttery, R. G., Ling, L. C., Juliano, B. O. and Turnbaugh, J. G. 1983. Cooked rice aroma and 2-acetyl-1-pyrroline. Journal of Agricultural and Food Chemistry. **31:** 823-826.

Ceesay, M. M. and Uphoff, N. 2003. The effects of repeated soil wetting and drying on lowland rice yield with System of Rice Intensification (SRI) methods. In: http://ciifad.cornell. Edu. pp. 88-97.

Dash, M. C. 2009. Bio resources as a tool for food security, and Sustainable development for rural livelihood in india In the context of industrial development and environmental protection: an overview. *The Ecoscan.* **3(3&4):** 201-208.

Gomez, K. A. and Gomez, A. A. 1984. Statistical Procedures for Agricultural Research. *J. Wiley & Sons,* New York.

Krishna, A. and Biradarpatil, N. K. and channappagoudar, B. B. 2008. Influence of system of rice intensification (SRI) cultivation on seed yield and quality. *Karnataka J. Agriultural Science.* **21(3):** 369-372.

Kumar, R., Mankotia, B. S. and Shekhar, J. 2011. Effect on growth, yield attributes and productivity of scented and non-scented rice (*Oryza sativa* L.) in system of rice intensification in Himachal Pradesh, *Himachal J. Agricultural Research.* **37(1):** 95-100.

Luikham, E., Yamtong, K. and Mariam Anal, P. S. 2008. Effect of planting geometry and nitrogen levels on productivity of black aromatic rice (oryza sativa l.) under rainfed conditions. *Agric. Sci. Digest.* **28(2):** 153-154.

Miah, M. N. H., Talukder, S., Sarker, M. A. R and Ansari,T. H. 2004. Effect of Number of Seedling per Hill and Urea Supergranules on Growth and Yield of the Rice cv. BINA Dhan4. *J. Biol. Sci.* **4(2):** 122-129.

Singh, A. K. and Singh, G. R. 2005. Effect of seedling density and planting geometry on hybrid rice. *Oryza.* **42(4):** 327-328.

Singh, N., Kumar, D. and Tyagi, V. K. 2012. Influence of spacing and weed management on rice (*Oryza sativa* L.) varieties under system of rice intensification. *Indian J. Agronomy* **57(2):** 138-142.

Sridevi, V. and Chellamuthu 2007. Effect of system of rice intensification (SRI) practices on yield and yield attributes of rice (*Oryza sativa* L.). *In:* Proc. *SRI India Sym. Tripura,* pp. 74-75.

Sridhara, C. J., Ramachandrappa, B. K., Kumarswamy, A. S. and Gurumurthy, K. T. 2011. Effect of genotypes, planting geometry and methods of establishment on root traits and yield of aerobic rice, *Karnataka J. Agric. Sci.* **24(2):** 129-132.

Thawait, D., Patel, A. K., Kar, S., Sharma, M. K. and Meshram, M. R. 2014. Performance of transplanted scented rice (*Oryza sativa* L.) under sri based cultivation practices; a sustainable method for crop production. *The Bioscan.* **9(2):** 539-542.

Verma, A. K. 2009. Manipulation of crop geometry, nutrient, weed and water management practices under system of rice intensifications for maximizing grain yield and profitability of hybrid rice in Alfisols. *Ph.D. Thesis*, Department of Agronomy, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) India. pp. 74-75.

Zhang, J., Xianjun, L., Xilnlu, J. and Tang, Y. 2004. The system of rice intensification for super high yields of rice in Sicuan basin. *J. South China Agric. Univ.* **26:** 10-12.