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AGRONOMY

Performance of rice varieties grown under different spacings with planting depths in system of rice intensification

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Abstract

An experiment was conducted during the *kharif* seasons of 2010-11 and 2011-12 at Krishi Nagar farm, Department of Agronomy, JNKVV, Jabalpur (Madhya Pradesh) to study to the production efficiency and monetary advantage in rice by adopting suitable planting geometry, varieties and depth of planting. The experiment comprises on 18 treatment combinations consisted of three planting geometry (20 cm × 20 cm, 25 cm × 25 cm and 30 cm × 30 cm) as main plot treatment and three varieties (MR-219, WGL-32100 and PS-3) as sub plot treatments and two depths of planting shallow (2.5cm) and normal (5.0 cm) as sub-sub plot treatments were tested in split-split plot design with three replications. Results showed that the 25 cm × 25 cm planting geometry had superiority in various yield attributing characters viz; weight of panicles, grains/panicle, test weight, healthy grains/panicle, less no. of chaffy grains/panicle, sterility percent, more, harvest index and yield in comparison to other planting geometries with MR-219 variety and shallow depth of planting.

Highlights

- System of rice intencification method was used for higer rice production efficiency and monetary advantage by adopting suitable 25 cm × 25 cm planting geometry, MR-219 variety and shallow depth of planting.
- In system of rice intencification method yield attributing parameters were significantly superior in MR-219 with suitable 25 cm × 25 cm planting geometry and shallow depth of planting.

Keywords: Varieties, depth of planting, planting geometry, sterility percent, test weight, harvest index, yield, SRI

Rice (*Oryza sativa* L.) is the most important cereal food crop of the developing world and the staple food of more than 3 billion people or more than half of the world's population. India is considered to be one of the original centers of rice cultivation, and mostly cultivated state West Bengal, Uttar Pradesh, Andhra Pradesh and Punjab, production 104.32 MT of rice with an average productivity of 3.06 t ha^{-1} (irri.org, 2015). System of rice intensification (SRI) was first developed in Madagascar in 1980. This system was not known outside till 1997. In SRI method careful transplanting of young seedlings 8-15 days old seedlings at a wider spacing under SRI cultivation ensures more root growth. Through appropriate water management strategies under SRI the field is kept moist and not flooded. Working of rotary weeder churns the soil and provides greater aeration which helps in buildup of enormous microbial growth, thereby enhancement of nutrient supply to root which ultimately result in healthy plant growth and higher yields at lower costs. System of rice intensification is not a fixed package of technical specifications but a system of production with four main components viz. soil fertility management, planting method, weed control and water management. System of rice intensification has been highly emphasized to maximize the production of rice. It is because the proper distribution of crop plants per unit area and efficient utilization of available resources as well as environment, but it appears that the available improved agro-techniques for achieving increased production of hybrid and inbred rice may or may not be suitable for exploiting the production potential. The poor farmers losing interest in rice cultivation as factor productivity is declining (Das *et al.,* 2009). Hence, there is a need to increase the productivity of rice using reduced inputs and resources to feed the burgeoning population (Shobarani *et al.,* 2010). In this context, new technologies like SRI and ICM appears to have potential that saves inputs, protects the environment and could improve productivity and soil health (Satyanarayana *et al.,* 2006 and Balasubramanian *et al.,* 2007). Therefore present experiment was conducts for Yield contributing attributes studies in the optimum planting geometries, improved varieties under depths of planting for getting maximum yield of rice.

Material and Methods

The experiment was conducted at research farm of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (Madhya Pradesh) during *kharif* season of 2010-11 and 2011-12. The three different planting geometries i.e., 20 cm × 20 cm, 25 cm × 25 cm and 30 cm × 30 cm between hills and rows were kept for growing the crop and to identify their effect on grain yield parameters. Three varieties of rice (MR-219, WGL-32100 and PS-3) and two depths of planting shallow (2.5 cm) and normal (5.0 cm). The layout of the trial was split-split plot design with three replications having planting geometry as main plots, varieties as sub plot treatments and depths of planting shallow and normal as sub-sub plot treatments. The area of each plot was 3 × 7m^2 . Seedlings were transplanted with an average of one seedling per hill in the SRI method of planting. Application of 10 t FYM/ha was given uniformly to all the plots before final puddling and leveling. Fertilizer with a uniform dose of 120: 60: 40 kg per hectare N, P and K through urea, DAP and MOP was applied in all the plots. Half dose of nitrogen and full dose phosphorus and potassium were applied as basal application just before transplanting. The remaining half dose of nitrogen was applied in two split doses at tillering and panicle initiation stages. The data was analyzed statistically as per the procedure

Table 1: Yield contributing attributes of effective tillers per meter square, length of panicle (cm) and weight of panicle/hill (g) asinfluenced by planting geometries, varieties and depth of planting

Treatments	Effective tillers per meter square			Length of panicle (cm)			Weight of panicle		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Planting geometry									
S_1 - 20 cm × 20 cm	408.72	446.89	427.81	24.35	25.41	24.88	3.58	3.66	3.62
S_2 - 25 cm × 25 cm	456.22	494.50	475.36	26.84	27.95	27.40	4.73	4.31	4.52
S_3 - 30 cm × 30 cm	261.50	299.50	280.50	30.28	31.34	30.81	5.74	5.39	5.56
SEm ±	6.58	6.66	6.62	0.25	0.21	0.23	0.08	0.06	1.43
CD. (p≤0.05)	18.28	18.48	18.38	0.70	0.60	0.64	0.30	0.25	5.63
Variety									
V_1 - MR-219	406.36	444.42	425.39	28.16	29.22	28.69	5.06	4.81	4.94
V_2 - WGL-32100	369.47	407.81	388.64	26.08	27.13	26.61	4.76	4.53	4.65
V_3 - PS-3	350.61	388.67	369.64	27.24	28.36	27.80	4.23	4.01	4.12
SEm ±	4.42	4.41	4.42	0.34	0.33	0.33	0.09	0.06	4.11
CD. (p≤0.05)	9.64	9.60	9.62	0.73	0.72	0.72	0.29	0.19	12.66
Depth of planting									
D_1 - Shallow Depth (2.5 cm)	386.67	424.78	405.72	27.76	28.88	28.32	4.88	4.59	4.74
D_2 - Normal Depth (5 cm)	364.30	402.48	383.39	26.56	27.59	27.08	4.49	4.31	4.40
SEm ±	4.33	4.33	4.33	0.25	0.26	0.25	0.08	0.05	3.15
CD. (p≤0.05)	9.09	9.10	9.10	NS	0.55	0.53	0.23	0.16	9.37

Table 2: Yield contributing attributes of no. of grains /panicle, healthy grains/panicle, chaffy grains/panicle, sterility (%) and 1000- grain weight as influenced by planting geometries, varieties and depth of planting

Treatments	No. of grains /panicle			Healthy grains/ panicle			Chaffy grains/ panicle			Sterility (%)			1000- grain weight		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Planting geometry															
S_1 - 20 cm × 20 cm	227.6	239.4	233.5	212.1	224.2	218.2	15.9	15.1	15.5	7.1	6.4	6.8	18.9	20.0	19.4
S_2 - 25 cm × 25 cm	257.2	268.9	263.0	243.1	255.5	249.3	14.1	13.4	13.8	5.5	5.0	5.3	21.0	22.1	21.6
S_3 - 30 cm × 30 cm	266.3	277.4	271.8	251.3	263.6	257.4	15.0	14.3	14.7	5.7	5.2	5.4	22.8	23.9	23.3
SEm ±	3.1	1.8	1.7	1.9	2.2	2.0	0.7	0.7	0.7	0.3	0.3	0.3	0.6	0.6	0.6
CD. ($p \leq 0.05$)	12.1	7.2	6.5	5.2	6.1	5.7	2.0	2.0	2.0	1.0	0.9	0.9	1.8	1.8	1.8
Variety															
V_1 - MR-219	259.3	269.8	264.5	245.6	257.5	251.6	13.5	12.8	13.2	5.2	4.8	5.0	23.2	24.2	23.7
V_2 - WGL-32100	259.9	271.9	265.9	245.3	257.5	251.4	15.1	14.4	14.8	5.9	5.4	5.7	19.1	20.2	19.7
V_3 - PS-3	231.9	243.8	237.8	215.5	228.2	221.9	16.4	15.6	16.0	7.1	6.5	6.8	20.5	21.5	21.0
SEm ±	3.0	1.3	1.7	3.9	3.8	3.9	0.4	0.4	0.4	0.2	0.2	0.2	0.6	0.6	0.6
CD. ($p \leq 0.05$)	9.1	3.9	5.2	8.5	8.4	8.4	0.9	1.0	0.9	0.4	0.4	0.4	1.3	1.3	1.3
Depth of planting															
D_1 - Shallow Depth (2.5 cm)	260.2	271.4	265.8	244.4	256.5	250.5	15.7	15.0	15.4	6.1	5.6	5.9	21.5	22.6	22.1
D_2 - Normal Depth (5 cm)	240.4	252.3	246.4	226.5	239.1	232.8	14.3	13.6	13.9	6.0	5.5	5.8	20.3	21.4	20.8
SEm ±	2.3	1.0	1.2	3.0	3.0	3.0	0.5	0.4	0.4	0.2	0.2	0.2	0.4	0.4	0.4
CD. ($p \leq 0.05$)	6.7	3.1	3.6	6.4	6.3	6.3	1.0	0.9	0.9	0.4	0.4	0.4	0.7	0.7	0.7

prescribed for split-split plot design (Panse and Sukhatme, 1995) to obtain analysis of variance.

Results and Discussion

Effect of planting geometry on yield attributes and yield

The analysis of variance resolved that the yield parameters of the planting geometries. Results showed that the 25 cm × 25 cm planting geometry had superiority in various yield attributing characters viz.; effective tillers/m^2, weight of panicles, grains/panicle, test weight, healthy grains/panicle, and more harvest index etc. (Table 1). Results indicate that wider spacing had linearly increasing effect on the performance of

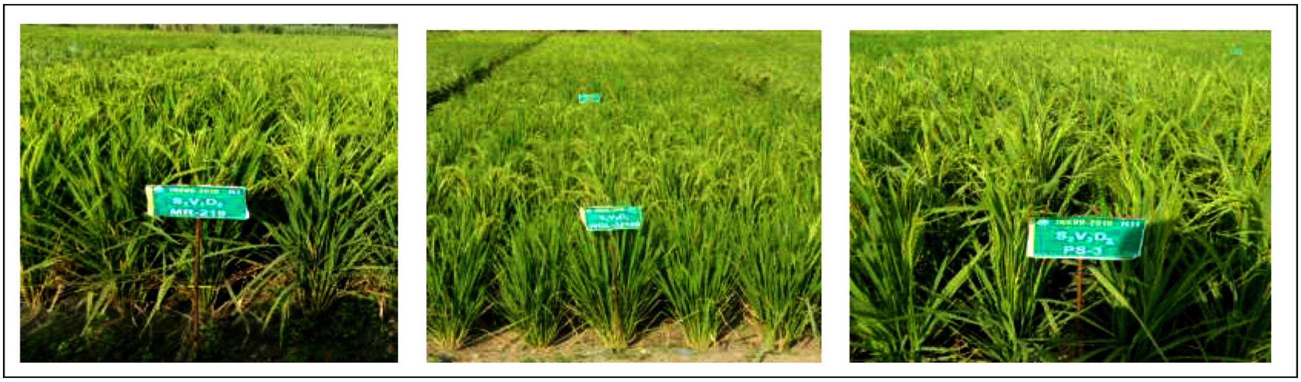

Fig. 1: View of rice varieties at different planting geometries depth of planting

individual plants. The plants grown with wider spacing have more area of land around them to draw the nutrition and had more solar radiation to absorb for better photosynthesis process and hence performed better as individual plants. Tusekelege *et al.* (2014) also observed similar result number of productive tillers was the only parameter found to have a significant influence on the grain yield in both management practices, Profitability measurement indicated that SRI (25 cm × 25 cm) is more profitable than the conventional method (20 cm × 20 cm) farming practices. The weight per panicle, number of grains per panicle, healthy grains per panicle and 1000-grain weight were significantly higher in wider spacing of 30 cm × 30 cm as compared to closer spacing of 20 cm × 20 cm and 25 cm × 25 cm and chaffy grains per panicle and sterility percentage were significantly higher in closer spacing of 20 cm × 20 cm as compared to other spacings (Table 2). Similar results have also been obtained by Gorgy (2010), Ogbodo *et al.* (2010), and Durga (2012).

The grain yield was significantly influenced by planting geometries at harvest during both the years. Result showed that rice varieties had worked effect on pooled grain yield also higher in 25 cm × 25 cm planting geometries (6.93 t/ha) produced significantly higher grain yield than 20 cm × 20 cm planting geometries (6.43 t/ha) and 30 cm × 30 cm planting geometries (5.92 t/ha) during pooled mean analysis, which might be due to production per hill which may develop better than higher tillers per hill and number of plant per m^2 (Table 3) Ultimately, 20 cm × 20 cm produced significantly higher straw (9.53 and 9.23 t/ha) yields over 25 cm × 25 cm having straw yield of (8.82 and 9.70 t/ha) and 30 cm × 30 cm having straw yields of (8.15 and 9.19 t/ha) during both the years (Table 3). Similar results have also been obtained by Thakur *et al.* (2009), Sreedhar *et al.* (2010), Ahmed *et al*. (2015), Alam *et al.* (2015) and Baskar *et al*. (2013). The higher yield in 25 cm × 25 cm plant geometry might be due to higher effective tillers per m^2 and less chaffy grains per panicle (Table 3) in comparison to 30 cm × 30 cm plant geometry. The same findings have also been obtained by Verma *et al.* (2002) and Deb *et al.* (2012). Likewise grain yield also decreased significantly with increase in plant geometry. Similar results have also been obtained by Rashid *et al*. (2006). Harvest index was significantly higher at optimum spacing of 25 cm × 25 cm in compared to other spacings (Table 3) which may be due to

Table 3: Yield contributing attributes of grain yield (t/ha), mean grain yield (t/ha), straw yield (t/ha) and harvest index (%) as influenced by planting geometries, varieties and depth of planting

Treatments	Grain yield (t/ha)			Straw yield (t/ha)			Harvest index (%)		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Planting geometry									
S_1 - 20 cm × 20 cm	6.34	6.51	6.43	9.53	9.29	9.41	40.06	41.32	40.69
S_2 - 25 cm × 25 cm	6.86	7.00	6.93	8.82	9.70	9.26	44.14	41.97	43.05
S_3 - 30 cm × 30 cm	5.81	6.04	5.92	8.15	9.19	8.67	41.64	39.89	40.76
SEm ±	0.10	0.09	0.09	0.42	0.21	0.25	1.17	0.50	0.70
CD. (p≤0.05)	0.38	0.36	0.37	1.64	0.83	1.00	NS	NS	1.95
Variety									
V_1 - MR-219	6.83	7.05	6.94	9.46	10.71	10.08	42.12	39.74	40.93
V_2 - WGL-32100	6.22	6.41	6.31	8.83	8.67	8.75	41.45	42.55	42.00
V_3 - PS-3	5.95	6.08	6.02	8.21	8.80	8.51	42.26	40.89	41.58
SEm ±	0.09	0.08	0.08	0.22	0.21	0.14	0.61	0.70	0.50
CD. (p≤0.05)	0.26	0.26	0.26	0.69	0.65	0.43	1.33	1.53	1.09
Depth of planting									
D_1 - Shallow Depth (2.5 cm)	6.49	6.68	6.58	9.11	9.61	9.36	41.79	41.07	41.43
D_2 - Normal Depth (5 cm)	6.18	6.36	6.27	8.56	9.17	8.87	42.10	41.05	41.58
SEm ±	0.08	0.08	0.08	0.19	0.15	0.13	0.83	0.44	0.59
CD. (p≤0.05)	0.24	0.24	0.24	0.57	0.44	0.39	NS	NS	NS

higher mortality of tillers per hill in wider spacing and closer spacing which reduced grain ratio in total biological yield. Similar results have also been obtained by Verma *et al.* (2002).

Effect of varieties and depth of planting on yield attributes and yield

Rice MR-219 variety was markedly superior in various all yield attributing characters viz; effective tillers/m^2, weight of panicle, grains/panicle, test weight, healthy grains/panicle more harvest index and less no. of chaffy grains/panicle and sterility percent over WGL-32100 and PS-3 with wider spacing under shallow depth of planting. Dahal and Khadka (2012) also reported that the crop planted in the geometry of 25 cm × 25 cm produced significantly higher effective tiller per m^2 (328), higher 1000 grain weight (21.50 g) and grain yield (8.54mt/ha). The cumulative effects of superior growth and yield attributes were finally reflected in terms of higher grain yield.

Both grain and straw yields were also higher in the MR-219 over WGL-32100 and PS-3. Ultimately, MR-219 produced significantly higher grain (6.83 and 7.05 t/ha) and straw (9.46 and 10.71 t/ha) yields as compare to WGL-32100 having grain yield of (6.22 and 6.41 t/ha) and straw yield of (8.83 and 8.67 t/ha) and PS-3 having grain yield of (5.95 and 6.08 t/ha) and straw yields of (8.21 and 8.80 t/ha) during both the years.

Further, harvest index is mainly governed by genetic make-up of plant that would not be mostly affected by various practices (Table 3). The grain yields of rice directly correlated to the no. of effective tillers per unit area, number of grains/panicle and test weight. These yield attributing characters were significantly superior in MR-219 as compared to WGL-32100 and Pusa Sugandha-3, which attributed to produce higher grain yield. Similar results have also been obtained by Parte Archana (2007). Thus, rice MR-219 gave 9.94 and 9.98 % more grain yield over WGL-32100 and 14.78 and 15.98 % over Pusa Sugandha-3, during 2010 and 2011, respectively and MR-219 gave 9.94 % more grain yield over WGL-32100 and 15.37% as compared to PS-3, during pooled average analysis (Fig. 1).

Harvest index (HI) of rice was significantly influenced due to varieties during both the years. Pusa Sugandha-3 (42.26% and 40.89%) had significantly higher HI in compared to MR-219 (42.12% and 39.74%) and WGL-32100 (41.45% and 42.55%), which may be owing to greater partitioning of photosynthesis towards the production of straw rather than the grain yield (Table 3). The all varieties might have high coefficient for partitioning of photosynthesis in production of grain out of the total crop biomass and accordingly the higher HI was obtained under it. Significantly higher grain yield of rice was obtained under shallow depth of planting (6.49 and 6.68 t/ha) in compared to normal depth of planting (6.18 and 6.36 t/ha) during both the years which may be ascribed to cumulative effect of growth. Significantly higher values of yield attributing characters viz; panicle length and weight healthy grains/panicle, 1000-grain weight under shallow depth of planting than normal depth of planting. The shallow depth of planting did not show significant effect on straw yield and harvest index (HI) during 2010 but during 2011 significantly higher straw yield was obtained under shallow depth of planting (9.61 t/ha) as compared to normal depth of planting (9.17 t/ha). The results are on line with those of Kumar *et al.* (2016) and Sarwar *et al.* (2014).

Conclusion

The variety MR-219 had significantly higher yield attributing parameters and more grain yield with more light intercepted by 25 × 25 cm spacing compared to wider crop geometry under shallow depth of planting compared to other planting geometries and depths of planting under sub-tropical climatic condition of Jabalpur.

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