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AGRONOMY

Growth of rice affected by different treatment applied in SRI method

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Abstract

Field investigations were conducted at research farm JNKVV Jabalpur (Madhya Pradesh) during *kharif* season of 2010-11 and 2011-12 to study to the growth,development and production efficiency in rice by adopting suitable planting geometry, varieties and planting depth. The study revealed that the 30 cm × 30 cm planting geometry had superiority in parameters viz., plant height, and functional leaves/ hill the 30 cm × 30 cm planting geometry had superiority in various parameters were significantly in plant geometry. Rice variety MR-219 with shallow depth of planting (2.5 cm) recorded better growth parameters viz., plant height, Number of tillers/m^2 and functional leaves/hill were markedly superior in growth parameters. Grain and straw yields were superior with the MR-219 variety and 25 cm × 25 cm planting geometry with shallow depth of planting.

Highlights

- System of rice intensification method plants obtain higher plant growth and development for obtaining higher rice production with suitable wider spacing and improved MR-219 variety and shallow depth.
- The cumulative effects of superior growth and yield attributes were finally reflected interms of higher grain yield were significantly superior in MR-219 with suitable 25 cm × 25 cm planting geometry and shallow depth..

Keywords: Plant height, functional leaves, spacings, varieties, planting depth, yield, SRI

The demand of rice (*Oryza sativa* L.) in India is expected to rise due to increase in population by 1.6% per annum, while the area under rice cultivation is expected to reduce to 40 million hectare in the next 15–20 years. 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).

Rice 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. One fifth of the world's population depends on rice cultivation for their livelihoods. System of rice intensification (SRI) was first developed in Madagascar in 1980. This system was not known outside till 1997.

At present the productivity effects of SRI management have been demonstrated in 42 countries around the world. In India about 1.7 million farmers are estimated to have adopted the technique on more than 7.5 lakh hectares across 160 districts, with so far no major project funding. 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 has been highly emphasized to maximize the production of rice. Among there different agronomic practices, planting geometry and depth of planting play a vital role in achieving higher yield levels of improved varieties 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. System of rice intensification has been highly emphasized to maximize the production of rice. It was against this background that the field investigation was carried out to study the system of rice intensification practices on physiological growth parameters and yield analysis 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 under edaphic and climatic conditions of Jabalpur Madhya Pradesh, India. The three different planting geometries i.e., 20 cm × 20 cm, 25cm × 25 cm and 30 cm × 30 cm between hills and rows were taken in the main plots. Three varieties of rice i.e., MR-219, WGL-32100 and PS-3 were imposed sub plots and two depths of planting, viz; shallow (2.5 cm) and normal (5.0 cm) were imposed as sub-sub plot. The layout of the trial was split-split plot design with three replications. The area of each plot was 21 m^2 (3m × 7 m).

One seedling per hill was planted following SRI method of planting. Application of 10 t FYM/ha was applied 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 N and full dose P and K were applied as basal application just before transplanting. The remaining half dose of nitrogen was applied in two splits at tillering and panicle initiation stages. Standard cultural practices were carried out till harvest. Five hill per plot were taken at random for detailed studies of growth and yield attributing components i.e., functional leaves/hill, number of tillers/m^2, grain and straw yield. The data was analyzed statistically as per the procedure prescribed for split-split plot design (Panse and Sukhatme, 1995) to obtain analysis of variance.

Results and Discussion

Results indicate that wider spacing had linearly increasing effect on the performance of individual plants in comparison due to less mortality of tillers per plants. In comparison to closer spacing some of the late emerged tillers are not well develop and even died. The plants grown with wider spacing had more area around them to draw the nutrition and had more solar radiation to absorb for better photosynthesis and hence performed better as individual plants. Plant density is an important agronomic factor that greatly influences the micro climate of the field and eventually the yield of agricultural crops. Planting geometry had significant influence on growth and yield of rice. Plant height and functional leaves/hill significantly differed in both the years of study (Table 1& 2).

Results showed that the variety MR-219 with 30 cm × 30 cm planting geometry under sallow depth of planting had superiority in various growth attributing characters viz. Plant height and functional leaves/hill. Results showed that number of tillers/m^2 was significantly higher in closer spacing 20 cm × 20 cm as compared to wider spacing of 25 cm × 25 cm and also 30 cm × 30 cm. These finding are in close vicinity with Nayak *et al.* (2003), Alam *et al.* (2015) and Baskar *et al.* (2013). Some of the late emerged tillers are not well develop and even died. Thus, a little reduction in number of tillers/hill was noted at maturity compared to its preceding stage. Physiological parameter was significantly higher at closer plant geometry of 20 cm × 20 cm in compared to the wider plant geometry of 25 cm × 25 cm and 30 cm × 30 cm recorded at maximum tillering and complete heading stage of the crop (Table 3) because no. of total plants per unit area higher in closer spacing in composition to wider spacing.

The results agree with Nayak *et al.* (2003) and Oghalo (2011). Growth parameters observed superior in MR-219 with 30 cm × 30 cm under shallow depth of planting viz. plant height and functional leaves/hill

Table 1: Effect of planting geometries, varieties and depth of planting on plant height (cm) at different stages of crop growth

Treatments	Plant height (cm)											
	30 DAT			60 DAT			90 DAT			At harvest		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Planting geometry												
S_1 - 20 cm × 20 cm	49.61	67.22	58.42	68.66	90.93	79.79	83.83	107.39	95.61	83.28	106.39	94.83
S_2 - 25 cm × 25 cm	53.49	68.50	60.99	72.09	95.47	83.78	88.36	111.11	99.74	87.75	110.22	98.99
S_3 - 30 cm × 30 cm	56.06	69.86	62.96	74.16	98.25	86.20	97.33	112.56	104.94	96.72	111.89	104.31
SEm ±	0.92	0.82	0.55	0.74	0.45	0.41	1.08	1.04	0.47	1.09	1.05	0.47
CD. (p≤0.05)	3.62	NS	2.16	2.92	1.76	1.59	4.24	NS	1.83	4.29	4.13	1.85
Variety												
V_1 - MR-219	52.94	69.55	61.25	74.13	94.61	84.37	86.53	110.89	98.71	85.97	110.00	97.99
V_2 - WGL-32100	51.81	65.15	58.48	66.55	93.21	79.88	86.47	104.86	95.67	85.86	104.08	94.97
V_3 - PS-3	54.42	70.88	62.65	74.23	96.83	85.53	96.53	115.31	105.92	95.92	114.42	105.17
SEm ±	1.58	0.75	0.83	1.93	0.92	1.04	1.89	0.89	0.90	1.91	0.88	0.90
CD. (p≤0.05)	NS	2.30	2.55	5.94	2.83	3.19	5.83	2.74	2.79	5.88	2.73	2.76
Depth of planting												
D_1 - Shallow Depth (2.5 cm)	54.46	68.88	61.67	72.88	96.29	84.58	91.07	111.87	101.47	90.48	110.94	100.71
D_2 - Normal Depth (5 cm)	51.65	68.18	59.91	70.39	93.48	81.94	88.61	108.83	98.72	88.02	108.06	98.04
SEm ±	0.80	0.60	0.43	0.82	1.08	0.49	0.82	0.63	0.40	0.83	0.67	0.41
CD. (p≤0.05)	2.38	NS	1.26	2.43	NS	1.45	2.45	1.89	1.18	2.46	2.00	1.23

Table 2: Effect of planting geometries, varieties and depth of planting on functional leaves /hill at different stages of crop growth

Treatments	Functional leaves /hill											
	30 DAT			60 DAT			90 DAT			At harvest		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Planting geometry												
S_1 - 20 cm × 20 cm	41.02	49.04	45.03	59.50	62.56	61.03	74.89	79.94	77.42	58.83	59.81	59.32
S_2 - 25 cm × 25 cm	43.98	54.71	49.34	64.04	71.80	67.92	79.15	84.31	81.73	63.37	65.39	64.38
S_3 - 30 cm × 30 cm	46.94	63.07	55.01	65.30	79.76	72.53	80.35	85.10	82.73	65.19	71.31	68.25
SEm ±	0.86	0.74	0.30	0.96	1.96	1.07	0.85	0.69	0.73	1.59	2.47	1.99
CD. (p≤0.05)	3.37	2.91	1.17	3.75	7.70	4.20	3.34	2.72	2.85	NS	NS	NS
Variety												
V_1 - MR-219	46.98	56.30	51.64	66.09	79.69	72.89	81.15	86.18	83.66	65.98	71.97	68.98
V_2 - WGL-32100	42.43	60.26	51.34	62.35	66.24	64.30	77.85	82.91	80.38	61.69	64.92	63.30
V_3 - PS-3	42.54	50.26	46.40	60.39	68.19	64.29	75.39	80.28	77.83	59.72	59.61	59.67
SEm ±	1.06	1.21	0.88	1.44	2.27	1.06	1.36	1.50	1.41	1.41	2.03	1.21
CD. (p≤0.05)	3.27	3.73	2.71	4.43	6.99	3.26	4.18	4.61	4.34	4.36	6.27	3.72
Depth of planting												
D_1 - Shallow Depth (2.5 cm)	46.28	57.90	52.09	63.84	75.99	69.91	78.95	83.97	81.46	63.17	67.94	65.56
D_2 - Normal Depth (5 cm)	41.68	53.31	47.49	62.05	66.75	64.40	77.31	82.27	79.79	61.75	63.06	62.40
SEm ±	1.21	0.74	0.77	0.79	1.69	0.89	0.90	0.84	0.82	0.70	1.61	0.92
CD. (p≤0.05)	3.58	2.21	2.30	NS	5.02	2.64	NS	NS	NS	NS	4.79	2.74

under increased with the advancement in growth stages up to the maturity stage as compare to other varieties. The MR-219 variety with shallow depth of planting are best perform to other varieties, but increase in number of tillers/m^2 was negligible or even slightly declined over maturity stage under all the varieties some of the late emerged tillers are not well develop and even died. Thus, a little reduction in number of tillers/hill was noted at maturity compared to its preceding stage.

Yield performance

The growth parameters and yield attributes significantly greater under shallow depth of planting as compared to normal depth of planting. The grain yield was significantly influenced by planting geometries at harvest during both the years. Result showed that rice varieties had worked effect on grain yield Thus, the mean value of 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 (Table 4).

The 25 cm × 25 cm planting geometry produced higher yield due to grain yields of rice directly correlated to the no. of tillers per unit area, not individual plant tillers. The reason for deviation of this linearity in case of grain yield per plot is that the yield does not entirely depend upon the performance of individual plant but also on the total no. of plants per plot and yield contributing parameters within plants. No. of plants per unit area are directly affect the yield per unit area. The grain yields of rice directly correlated to the no. of tillers per unit area, test weight and other physiological parameters. These growth attributing characters were significantly superior in MR-219 as compared to WGL-32100 and PS-3, which attributed to produce higher grain yield with wider spacing under shallow depth of planting. Thus, MR-219 gave 9.94 % more grain yield over WGL-32100 and

Table 3: Effect of planting geometries, varieties and depth of planting on number of tillers/m^2 at different stages of crop growth

Treatments	Number of tillers/m^2											
	30 DAT			60 DAT			90 DAT			At harvest		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
Planting geometry												
S_1 - 20 cm × 20 cm	467	471	469	464	517	491	548	551	549	538	544	541
S_2 - 25 cm × 25 cm	381	381	381	418	438	428	485	502	494	499	504	502
S_3 - 30 cm × 30 cm	249	250	250	256	299	277	297	315	306	312	317	315
SEm ±	3.15	3.03	3.08	7.04	6.01	4.74	6.43	6.07	6.22	5.96	5.79	5.87
CD(p≤0.05)	12.36	11.88	12.11	27.64	23.61	18.62	25.23	23.84	24.44	23.39	22.72	23.05
Variety												
V_1 - MR-219	418	420	419	435	474	454	505	517	511	511	516	513
V_2 - WGL-32100	364	366	365	376	426	401	442	454	448	448	453	450
V_3 - PS-3	315	316	316	327	354	341	384	397	391	391	396	394
SEm ±	6.20	6.11	6.16	8.30	8.34	6.55	7.78	7.74	7.74	7.68	7.59	7.64
CD. (p≤0.05)	19.11	18.82	18.96	25.57	25.68	20.17	23.97	23.84	23.84	23.66	23.39	23.52
Depth of planting												
D_1 - Shallow Depth (2.5 cm)	375	376	376	387	426	407	449	462	455	455	461	458
D_2 - Normal Depth (5 cm)	357	358	358	372	409	390	438	450	444	444	449	447
SEm ±	5.06	5.10	5.08	5.16	6.38	4.33	5.36	5.27	5.29	5.27	5.26	5.26
CD. (p≤0.05)	15.03	15.16	15.09	15.34	18.95	12.87	NS	NS	NS	NS	NS	NS

Fig. 1: Growth of rice varieties at 30 cm × 30 cm planting geometry and shallow depth of planting

Table 4: Yield contributing attributes of grain yield (t/ha), mean grain yield (t/ha) and straw yield (t/ha) as influenced different treatments

Treatments	Grain yield (t/ha)			Straw yield (t/ha)		
	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
S_2 - 25 cm × 25 cm	6.86	7.00	6.93	8.82	9.70	9.26
S_3 - 30 cm × 30 cm	5.81	6.04	5.92	8.15	9.19	8.67
SEm ±	0.10	0.09	0.09	0.42	0.21	0.25
CD. (p≤0.05)	0.38	0.36	0.37	1.64	0.83	1.00
Variety						
V_1 - MR-219	6.83	7.05	6.94	9.46	10.71	10.08
V_2 - WGL-32100	6.22	6.41	6.31	8.83	8.67	8.75
V_3 - PS-3	5.95	6.08	6.02	8.21	8.80	8.51
SEm ±	0.09	0.08	0.08	0.22	0.21	0.14
CD. (p≤0.05)	0.26	0.26	0.26	0.69	0.65	0.43
Depth of planting						
D_1 - Shallow Depth (2.5 cm)	6.49	6.68	6.58	9.11	9.61	9.36
D_2 - Normal Depth (5 cm)	6.18	6.36	6.27	8.56	9.17	8.87
SEm ±	0.08	0.08	0.08	0.19	0.15	0.13
CD. (p≤0.05)	0.24	0.24	0.24	0.57	0.44	0.39

15.37% over PS-3, during pooled average analysis. The results of present investigation are in close agreements with the findings of Ahmed *et al.* (2015), Alam *et al.* (2015) and Baskar *et al.* (2013).

The straw yield was significantly higher at optimum spacing of 25 cm × 25 cm as compared to 20 cm × 20 cm and 30 cm × 30 cm, 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 4). Similar results have also been obtained by Thakur *et al.* (2009) and Sreedhar *et al.* (2010). The same findings have also been obtained by 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. Straw yield of rice is directly related to growth parameters. viz.; plant height and number of tillers per unit area and these growth parameters were superior in MR-219 may be responsible for the differences in straw yield in comparison to WGL-32100 and PS-3 varieties (Table 1 & 2).

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 (Table 9) which may be ascribed to cumulative effect of growth. Significantly higher values of growth attributing characters viz; functional leaves/hill under shallow depth of planting than normal depth of planting. 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).

Conclusion

The overall view of the growth parameters, viz. plant height, tillers/m^2 and functional leaves/hill were superior in MR-219 with 30 cm × 30 cm planting geometry under shallow depth of planting as compared to other treatments. Yield parameters also proved significantly superior by MR-219 (6.94 t/ha) variety as comparison to WGL-32100 (6.32 t/ha) and PS-3 (6.02 t/ha) when planted at shallow depth with 25 cm × 25 cm plant geometry. Therefore, it can be concluded that growing of MR-219 with shallow depth of planting at 25 cm × 25 cm produced the highest grain yield.

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