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Effect of nitrogen on growth, yield and yield attributes of scented rice (*Oryza sativa* L.) under different planting geometry

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ABSTRACT

A field experiment was conducted during kharif 2018 at Research Farm, College of Agriculture, Kaul (Kaithal) to study the effect of planting geometry and nitrogen levels on growth and yield attributes of scented rice variety Pusa 1121. The experiment was conducted with three planting geometry in main plots and five nitrogen levels in sub plots using split plot design with four replications. Results showed that planting geometry did not have any significant effect on plant height even at all the growth stages. However, narrow planting geometry of 20 cm x 15 cm recorded significantly higher number of tillers m^{-2} (309) at peak tillering, dry matter accumulation and crop growth rate at various growth stages. The same planting geometry recorded significantly higher number of effective tillers m^{-2} (273), grain yield (4.4 t ha^{-1}) and straw yield (5.9 t ha^{-1}). Whereas, wider planting geometry of 30 cm x 20 cm recorded significantly higher number of grains per panicle (107). Test weight and harvest index did not show any significant difference among planting geometries. The treatment imposing with 120 kg N ha^{-1} was significantly superior to other treatments with regards to plant height, number of tillers m^{-2} (311), dry matter accumulation and crop growth rate at various growth stages. The same treatment also showed significantly superior response with regard to number of effective tillers m^{-2} (303), number of grains per panicle (115), test weight (25.8 g), grain yield (4.5 t ha^{-1}) and straw yield (5.8 t ha^{-1}).

Key words: Scented rice, planting geometry, nitrogen levels and yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is the most important cereal food crop of the developing world and staple food for more than half of the world's population. Based on aroma, rice varieties are groups into two categories namely scented and non-scented rice. Scented rice gives a distinctive aroma due to the presence of natural chemical compounds and having a unique quality features, excellent cooking and eating quality, long slender grains with delicate curvature and remarkable linear elongation. Since, present population rate in the world is expected to increase to 8.5 billion by 2025; an increase of 2 to 3 per cent (%) of rice production has to be maintained per year within limited land resources in order to maintain self sufficiency in rice production. Hence, crop management practices like judicious application of nitrogen fertilizer and maintenance of planting geometry are of prime importance in rice production. Nitrogen is the key nutritional element for higher productivity of rice crop and a major factor that limits rice yield potential being a component of amino acids, nucleic acids, nucleotides, chlorophyll, enzymes and hormones and also has great physiological importance in plant metabolism. Application of nitrogen plays a major role in plant physiological processes and has great influence on sink size thereby, increasing grain yield in rice. Planting geometry in rice significantly affects the tiller production, number of panicles m^{-2}, total biomass and grain yield. Thus, plant spacing has an important role on growth and yield of rice. Optimum plant population in a proper planting geometry is most important non monetary input and plays a major role in yield maximization of rice. The planting geometry had great influence on tillering pattern and spikelet formation per panicles (Mahato *et al.,* 2017). Considering the importance of nitrogen and planting geometry, a field experiment was undertaken to study the effect of nitrogen and planting geometry on growth, yield attributes and yield of scented rice (Pusa 1121).

MATERIALS AND METHODS

A field experiment was conducted at Research Farm, College of Agriculture, Kaul (Haryana) during *kharif* season of 2018. The experimental field soil was sandy clay loam in texture. The soil was medium in organic C (5.4 g

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kg^{-1}), low in available N (163 kg ha^{-1}), medium in available P_2O_5 (27 kg ha^{-1}) and high in available K_2O (379 kg ha^{-1}) with pH of 7.7 and EC 0.29 dS m^{-1}. The experiment was conducted in split-plot design with four replications having fifteen treatment combinations including three planting geometry *viz.*, 20 cm x 15 cm, 30 cm x 15 cm and 30 cm x 20 cm in main plots and five nitrogen levels *viz.*, control (0 kg ha^{-1}), 30 kg ha^{-1}, 60 kg ha^{-1}, 90 kg ha^{-1} and 120 kg ha^{-1} in subplots. An extra-ordinary scented rice variety Pusa 1121 was used as experimental material and urea as a nitrogen source in the experiment. The nursery was raised in the field itself using seed rate of 40-50 g m^{-2} area and the field was puddled thoroughly at the time of transplanting. The 30 days old seedlings were transplanted manually in the experimental field keeping main plot treatments of different planting geometry with 2 seedlings $hill^{-1}$. At the time of transplanting, half dose of each level of nitrogen along with 60 kg P_2O_5 ha^{-1} and 25 kg zinc sulphate ($ZnSO_4$) ha^{-1} were applied in their respective sub plots. Remaining doses of each level of nitrogen for their respective sub plots were applied in two splits, first at 20 days after transplanting (DAT) and second at 40 DAT as top dressing. Other agronomic practices were followed as per the standard package of practices in rice cultivation. Five plants were randomly selected from each plot to record the plant height at 30, 60, 90 DAS and harvest stage. Number of tillers was counted at peak tillering stage from the five selected hills and the number of tillers m^{-2} was calculated from the average. For dry matter accumulation, three hills were collected from each treatment plot at 30, 60, 90 DAS and harvest stage and were air dried and then oven drying of same samples result dry matter accumulation which is then converted to per square meter area. Crop growth rate was calculated from the same oven dried samples at 30 days time intervals using the formula suggested by Leopold and Kridemann (1975). Number of effective tillers m^{-2} were calculated from five random selected hills prior to harvesting and number of grains per panicle were counted from the seven effective randomly selected panicles per plot at the time of harvesting. Weight of 1000 grains from each treatment plot was recorded after drying to moisture content of 12-14 % to know the test weight. After harvesting, the grain yield and straw yield was recorded from each plots and reported at 12 % moisture. The experimental data obtained were statistically analyzed by using analysis of variance (ANOVA) and F-test was used as per the standard procedure to determine the significance of difference between treatment means.

RESULTS AND DISCUSSION

Growth parameters

Growth parameters like number of tillers m^{-2}, dry matter accumulation and crop growth rate at different growth stages were influenced significantly by different planting geometry except plant height. The effect of planting geometry on plant height was found non significant at all growth stages. The planting geometry of 20 cm x 15 cm recorded significantly higher number of tillers m^{-2} at peak tillering (309) over wider planting geometries (Table 1). Among different planting geometry, a narrow spacing of 20 cm x 15 cm resulted significantly higher dry matter accumulation (138, 376, 556 and 724 g m^{-2}) at 30, 60, 90 DAT and harvest and crop growth rate (4.6, 12.5, 18.5 and 24.1 g m^{-2} day^{-1}) at different growth durations *viz.*, 0-30, 30-60, 60-90 DAT and 90 DAT-harvest as compared to a wider geometry of 30 cm x 15 cm and 30 cm x 20 cm (Table 2). The effect of planting geometry on growth attributes may be due to the fact that the narrow spacing *i.e.*, 20 cm x 15 cm can accommodate more number of hills or plants m^{-2}. Similar results were explained by Nandhakumar and Velayudham (2014), Rajput *et al.* (2016) and Mahato *et al.* (2017). Nitrogen levels showed a significant influence on plant height at all growth stages except 30 DAT. The nitrogen rate of 120 kg ha^{-1} resulted significantly higher plant height at 60, 90 DAT and harvest (99.4, 107.2 and 107.6 cm) as compared to remaining treatments *viz.*, control, 30 and 60 kg N ha^{-1} and at par to 90 kg N ha^{-1}. The number of tillers m^{-2} at peak tillering increased significantly up to 60 kg N ha^{-1} even though higher number of tillers m^{-2} (311) were recorded with 120 kg N ha^{-1} (Table 1).

Table 1: Plant height and number of tillers m^{-2} of scented rice as affected by planting geometry and nitrogen levels

Treatments	Plant height (cm)				Tillers m^{-2} at peak tillering
	30 DAT	60 DAT	90 DAT	At harvest	
Planting geometry					
20 cm x 15 cm	62.1	88.9	99.8	99.9	309
30 cm x 15 cm	63.6	89.5	100.7	101.2	257
30 cm x 20 cm	65.2	91.0	102.5	103.1	227
SE(m) ±	1.0	1.2	1.4	1.4	14.2
CD (p=0.05)	NS	NS	NS	NS	50.1
Nitrogen levels (kg ha^{-1})					
Control	62.4	75.6	95.7	95.9	180
30	63.0	85.5	97.1	97.4	244
60	63.1	92.2	100.4	101.0	286
90	64.6	96.1	104.6	105.0	302
120	65.0	99.4	107.2	107.6	311
SE(m) ±	1.0	1.4	1.7	1.6	12.6
CD (p=0.05)	NS	4.0	5.0	4.6	36.1

The rate of dry matter accumulation increased gradually from 30 DAT to harvesting stage. However, highest dry matter accumulation was recorded at harvesting stage. Crop growth rate was recorded higher at 90 DAT to harvest stage and gradually followed by 60 to 90 DAT, 30 to 60 DAT and 0 to 30 DAT. Among various nitrogen levels, 120 kg N ha^{-1} recorded significantly higher values of dry matter accumulation (147, 458, 636 and 780 g m^{-2}) and crop growth rate (4.9, 15.3, 21.2 and 26.0 g m^{-2} day^{-1}) at all growth stages (30, 60, 90 DAT and at harvest) and durations (0-30, 30-60, 60-90 DAT and 90 DAT-harvest), respectively (Table 2). Nitrogen fertilization increased the cell size, cell elongation and cell division that ultimately enhances the vegetative growth could be the reason for superior growth with 120 kg N ha^{-1}. The similar results were reported by Murthy *et al.* (2015) and Haque and Haque (2016).

Table 2: Dry matter accumulation (g m^{-2}) and crop growth rate (g m^{-2} day^{-1}) of scented rice as affected by planting geometry and nitrogen levels

Treatments	Dry matter accumulation (g m^{-2})				Crop growth rate (g m^{-2} day^{-1})			
	30 DAT	60 DAT	90 DAT	At harvest	0-30 DAT	30-60 DAT	60-90 DAT	90 DAT-Harvest
Planting geometry								
20 cm x 15 cm	138	376	556	724	4.6	12.5	18.5	24.1
30 cm x 15 cm	108	344	528	702	3.6	11.5	17.6	23.4
30 cm x 20 cm	93	326	507	675	3.1	10.9	16.9	22.5
SE(m) ±	3.0	3.1	2.8	3.8	0.1	0.1	0.1	0.1
CD (p=0.05)	10.4	10.9	10.0	13.5	0.3	0.4	0.3	0.5
Nitrogen levels (kg ha^{-1})								
Control	72	244	412	608	2.4	8.1	13.7	20.3
30	96	281	475	654	3.2	9.4	15.8	21.8
60	119	346	538	716	4.0	11.5	17.9	23.9
90	133	413	590	744	4.4	13.8	19.7	24.8
120	147	458	636	780	4.9	15.3	21.2	26.0
SE(m) ±	3.1	7.3	5.0	6.8	0.1	0.2	0.2	0.2
CD (p=0.05)	9.0	21.1	14.3	19.7	0.3	0.7	0.5	0.7

Yield and yield parameters

The response of yield and yield attributes to planting geometry and nitrogen rate is shown in Table 3. Among different planting geometry, a narrow spacing of 20 cm x 15 cm recorded maximum number of effective tillers m^{-2} (273) which was significantly higher than remaining plant geometries of 30 cm x 15 cm and 30 cm x 20 cm. This may be due to higher plant population per unit area under narrow spacing and as reported by Sridhara *et al.* (2011). However, number of effective tillers hill^{-1} increased significantly with wider planting geometry as reported by Bajia *et al.* (2014) and Singh *et al.* (2015). Maximum number of grains per panicle (107) was recorded with wider planting geometry of 30 cm x 20 cm which was significantly superior to 30 cm x 15 cm and 20 cm x 15 cm. Because of wider spacing, plants may get scope for enhanced and vigorous growth and this result collaborates with the findings of Bajia *et al.* (2014) and Ram *et al.* (2014). The grain and straw yield were showing decreasing trend with increase in planting geometry. Among all, narrow spacing of 20 cm x 15 cm recorded significantly higher grain (4.4 t ha^{-1}) and straw yield (5.9 t ha^{-1}) as compared to wider spacing of 30 cm x 15 cm and 30 cm x 20 cm. This may be due to higher number of effective tillers, dry matter accumulation and higher plant population m^{-2} under closer geometry. Similar findings were published by Das *et al.* (2013). Unlike yield and other yield attributes, test weight and harvest index did not show any significant response with planting geometry (Das *et al.,* 2013).

Table 3: Yield attributes and yields of scented rice as affected by planting geometry and nitrogen levels

Treatments	Effective tillers m^{-2}	Grains panicle^{-1}	Test weight (g)	Grain yield (t ha^{-1})	Straw yield(t ha^{-1})	Harvest index (%)
Planting geometry						
20 cm x 15 cm	273	78	25.2	4.4	5.9	42.3
30 cm x 15 cm	235	96	25.3	3.7	5.2	41.7
30 cm x 20 cm	226	107	25.4	3.3	4.8	41.0
SE(m) ±	5.4	1.6	0.2	0.2	0.2	1.7
CD (p=0.05)	19.2	5.6	NS	0.6	0.6	NS
Nitrogen levels (kg ha^{-1})						
Control	162	66	24.9	3.0	4.5	40.0
30	223	82	25.1	3.5	5.2	40.3
60	255	98	25.3	4.0	5.4	41.9
90	281	107	25.5	4.2	5.6	42.8
120	303	115	25.8	4.5	5.8	43.3
SE(m) ±	7.2	2.1	0.1	0.1	0.1	1.2
CD (p=0.05)	20.9	6.0	0.4	0.3	0.4	NS

Significant response was observed with all yield attributes with nitrogen application rates except harvest index. Number of effective tillers m^{-2} (303) and number of grains per panicle (115) were recorded significantly higher at 120 kg N ha^{-1} as compared to remaining nitrogen levels. The test weight (25.8 g) was significantly higher at 120 kg N ha^{-1} over remaining nitrogen rates except 90 kg N ha^{-1}. The rate of increase in grain and straw yield was more up to 30 kg N ha^{-1} and reached to maximum at 120 kg N ha^{-1} (4.5 and 5.8 t ha^{-1}, respectively) which was significantly higher over remaining nitrogen levels except the fact that grain yield at 120 kg N ha^{-1} was statistically at par with 90 kg N ha^{-1}. This trend of increasing yield and yield attributes with increase in nitrogen level was due to overall better growth of plants under higher nitrogen levels. Similar pattern of results were reported by Dubey *et al.* (2016) and Narayan *et al.* (2017).

It may be concluded from the results that the scented rice variety Pusa 1121 produced maximum growth and yield, when transplanted at a narrow planting geometry of 20 cm x 15 cm and supplied with 120 kg N ha^{-1} along with other recommended nutrient sources and management practices.

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