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Effect of Different Planting Geometry and Nitrogen Levels on Growth and Yield of Rice Crop (*Oryza sativa* L.)

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***Abstract*:** A field experiment was conducted during *kharif* 2020 at research farm of College of Agriculture, Kaul (Kaithal) of CCS Haryana Agricultural University, Hisar to investigate the response of transplanted rice (*Oryza sativa* L.) to nitrogen levels and planting geometry in rice variety HKR-128. The experiment was laid out in RBD factorial design consisting of three planting geometry *i.e.* 20 cm x 15 cm, 20 cm x 20 cm, and random transplanting as main plot treatments and five different levels of nitrogen (0, 50,100,150, and 200 kg/ha) in sub-plots with three replications. Plants attained significantly higher plant height, tillers and dry matter under 20 cm x 15 cm than other two planting geometry at all the growth stages. Number of panicles/m^2 and grains/panicle were significantly higher in 20 cm x 15 cm planting geometry as compared to other two planting geometry but panicle length and 1000-grain weight was not affected by planting geometry. Grain yield was recorded significantly higher in 20 cm x 15 cm planting geometry as compared to other plant spacing. Plant height, no. of tillers/m^2 and dry matter accumulation/m^2 enhanced significantly with successive increase in nitrogen dose up to 200 kg/ha, which was at par with 150 kg N/ha. Various yield attributing characters such as number of panicles/m^2, number of grains per panicle were significantly improved up to 200 kg N/ha being at par with 150 kg /ha.

***Keywords*:** Growth parameters, Nitrogen levels, Planting geometry, Yield

Rice (*Oryza sativa* L.) is most important food cereal of India and second most important cereal crop of world after wheat. The area under rice cultivation in India is about 44 m ha with a production of 118.9 mt (Anonymous 2020). To obtain a high yield, it is imperative to determine the optimum plant population per unit area, spacing, and nitrogen. Through efficient use of solar radiation and nutrients, optimal plant spacing ensures the improvement in plants physiology both above and below ground and hence improper plant spacing reduces the yield. As a result, it is imperative to examine the best planting geometry to obtain maximum rice crop yield. Nitrogen (N) is the utmost important plant nutrient that governs the productivity of crop especially under intensive cultivation. It is a most important input for rice production as the soils are often low in organic nitrogen. Due to continuous raising of nutrient exhaustive cropping pattern such as rice- wheat in the state have further highlighted the vitality of nitrogenous fertilizers. Excess amount of nitrogenous fertilizer application can effect in lodging of the plants, pest susceptibility and reduction of yield. Similarly deficiency of N causes reduction in the yield. Therefore, application of nitrogenous fertilizers in adequate amount is important for obtaining higher crop yield. Planting geometry and crop nitrogen requirements can affect each other and therefore, the amount of nitrogen need of the crop can differ depending on the planting geometry. Furthermore, farmers often use higher fertilizer doses, especially nitrogenous fertilizers to compensate for the insufficient plant density obtained under traditional manual transplanting with the aim of boost productivity. As a result, there is urgent need to determine proper nitrogen dose for different planting geometries, as well as the level to which the higher N dose compensates for the inadequate plant density in the farmer's field.

MATERIAL AND METHODS

Field experiment was conducted during *kharif* 2020 at College of Agriculture, Kaul of CCS Haryana Agricultural University, Hisar. Soil of the experimental field was sandy clay loam in texture, which was medium in organic carbon (0.53%), low in available nitrogen (174 kg/ha), medium in phosphorus (30 kg/ha), high in potassium (382 kg/ha) and slightly alkaline in reaction (8.2) with EC 0.27 dS/m. Rice variety HKR-128 was sown. The experiment was laid out in RBD factorial design consisting of three planting geometry *i.e.* 20 cm x 15 cm, 20 cm x 20 cm, and random transplanting as main plot treatments and five different levels of nitrogen (0, 50,100,150, and 200 kg/ha) in sub-plots with three replications.

Data of various growth factors of crop was taken at different growth stages of crop. Height of plant was documented of the tagged hills in all the plots at 30, 60, 90 DAT and at harvest stage. Height was recorded by measuring the longest tiller from the base of the plant to highest terminal point. Number of tillers per plot were counted from five selected hills at 30, 60, 90 DAT and at harvest. Mean number of tillers per hill were computed by averaging the tillers of selected hills. Treatments P_1, P_2 and P_3 the mean number of tillers per hill were multiplied with 33.3, 25.0 and 17.5, respectively to count the number of tillers per m^2. Dry matter per m^2 in grams was assessed at 30, 60, 90 DAT and at harvest stage. Randomly three hills in each plot were cut down from ground level, then sun dried and later dried in an oven at 70^0C for 48 hours. After averaging dry matter obtained from these three hills, mean dry matter accumulation per m^2 was calculated for each plot for statistical analysis. The mean dry matter per hill was multiplied with 33.3, 25.0 and 17.5 to estimate dry matter accumulation in g/m2 in plots under P1, P2, and P3 treatments,respectively.

Data on yield attributes and yield was recorded at maturity. Panicle length was measured from five panicles collected from each plot at the time of harvesting. The length of each panicle was taken from the base of the panicle to the terminal point. Number of panicles at the time of harvesting was recorded from randomly selected five hills per plot as per the procedure followed for counting number of tillers and were converted into number of panicles per m^2. At the time of harvesting number of grains were counted from ten randomly selected effective panicles taken from each plot. Then for each plot mean number of grains per panicle was computed by averaging the number of grains in all selected panicles. After harvesting, paddy was threshed separately in each plot and then weighted separately (at 14% moisture level) which was then converted to grain yield (kg/ha). The straw from threshed crop of each plot was dried in the sun for three days and weighed. The yield of straw per plot was then converted to straw yield in kg per hectare.

The data were analyzed using the software "OPSTAT" floated /available on official website of CCS Haryana Agricultural University, Hisar for ready use.

RESULTS AND DISCUSSION

Growth Parameters

Plant height: The highest plant height was recorded in 20 cm x15 cm planting geometry at all growth stages. The maximum plant height was recorded with application of 200 kg N/ha which was closely followed with the application of 150 kg N/ha but significantly higher than the other three treatments. The plant height increased in closer spacing due to better

Table 1. Plant height of transplanted rice as affected by planting geometry and nitrogen levels

Treatments	Plant height (cm)			
Planting geometry	30 DAT	60 DAT	90 DAT	At harvest
P_1 (20 cm x 15 cm)	71.3	121.9	135.4	137.0
P_2 (20 cm x 20 cm)	70.8	114.4	126.5	128.3
P_3 (Random)	68.7	106.7	118.9	122.1
CD (p=0.05)	NS	6.1	7.8	5.9
Nitrogen levels (kg ha^{-1})				
N_1=0	69.2	100.2	114.6	120.0
N_2=50	69.5	110.5	124.9	126.6
N_3=100	70.4	116.8	128.3	131.0
N_4=150	70.9	120.7	133.0	133.6
N_5=200	71.3	123.5	133.9	134.4
CD (p=0.05)	NS	3.2	3.9	2.3

Table 2. Number of tillers/m^2 of transplanted rice as affected by planting geometry and nitrogen levels

Treatments	No. of tillers/m^2			
Planting geometry	30 DAT	60 DAT	90 DAT	At harvest
P_1 (20 cm x 15 cm)	257.2	402.0	329.4	327.0
P_2 (20 cm x 20 cm)	213.9	330.4	266.2	259.3
P_3 (Random)	191.8	284.5	229.9	222.4
CD (p=0.05)	9.4	17.4	9.0	7.7
Nitrogen levels (kg ha^{-1})				
N_1=0	177.3	258.8	208.6	206.5
N_2=50	209.6	312.4	252.1	251.2
N_3=100	229.8	350.4	286.2	279.1
N_4=150	244.1	380.1	310.6	300.8
N_5=200	244.0	393.0	318.2	310.2
CD (p=0.05)	12.2	22.4	11.7	9.9

Table 3. Dry matter accumulation (g/m^2) of transplanted rice as affected by planting geometry and nitrogen levels

Treatments	Dry matter accumulation (g/m^2)			
Planting geometry	30 DAT	60 DAT	90 DAT	At harvest
P_1 (20 cm x 15 cm)	78.5	249.3	423.8	515.9
P_2 (20 cm x 20 cm)	61.1	224.8	352.2	472.1
P_3 (Random)	56.2	209.6	329.6	427.1
CD (p=0.05)	4.7	13.7	15.4	27.9
Nitrogen levels (kg ha^{-1})				
N_1=0	55.3	198.8	326.5	361.4
N_2=50	62.0	221.8	354.3	454.7
N_3=100	66.4	233.9	374.1	494.1
N_4=150	70.2	241.1	388.7	519.3
N_5=200	72.4	244.0	398.9	529.1
CD (p=0.05)	3.5	6.3	13.4	21.4

utilization of solar radiation and nutrients. Similar results were recorded by Alam et al (2012) and Singh et al (2015b). In case of nitrogen, plant height increased with the addition of each levels of nitrogen and this can be explained with the fact that nutrient supply increased the photosynthesis and better utilization of photosynthates. The similar results were reported by Sharma et al (2012).

Number of tillers/square meter: The maximum no. of tillers/m^2 was in 20 cm x 15 cm planting geometry at all the stages of rice crop whereas the minimum no. of tillers/m^2 was recorded in random transplanting. The no. of tillers decreased after 60 DAT in all planting geometry. Ashraf et al (2014) and Rajput et al (2016) revealed the similar results. However, Baskar et al (2013) and Dass and Chandra (2012) found that no. of tillers per hill was maximum in wider spacing because plant got enough space below and above the ground for proper growth. In nitrogen levels the maximum no. of tillers were at 30 DAT with 150 kg N/ha which was at par with 200 kg N/ha but significantly higher than the other treatments of nitrogen application. At 60 DAT and after that the maximum no.of tillers/m^2 were recorded in 200 kg N/ha which were significantly higher than control, 50 kg N/ha, 100 kg N/ha but statistically at par with 150 kg N/ha. The minimum no. of tillers/m^2 was observed in control at all the stages of growth. Similar results were recorded by Murthy et al (2015) and Dahipahle and Singh (2018). Nitrogen metabolism and protein synthesis resulted in more vegetative growth and no. of tillers.

Dry matter accumulation: Maximum dry matter reported at harvest in all the treatments. Significantly higher dry matter was in 20 cm x 15 cm planting geometry as compared to 20 cm x 20 cm the planting geometry and random transplanting. Lowest dry matter/m^2 was in random transplanting at all stages of growth. The experiment conducted by Sultana et al (2012) also supported these results. With every increase of nitrogen level the dry matter accumulation increased from control to 200 kg N/ha. The maximum dry matter accumulation/m^2 was in 200 kg N/ha which was closely followed by 150 kg N/ha but significantly higher than the rest of three treatments. The minimum dry matter was in control. Murthy et al (2015) and Sharma et al (2012) also reported similar results. The dry matter accumulation increased with each successive levels of nitrogen due to higher meristematic activity resulted in higher plant height and no. of tillers.

Yield and yield attributes: The numbers of panicles/m^2 were higher in closer spacing *i.e.* in 20 cm x 15 cm as compared to wider spacing *i.e.* in 20 cm x 20 cm and in random transplanting. Number of panicles/m^2 was minimum in random transplanting. Similar results were obtained by Moro et al (2016). As the nitrogen doses increased from 0 to 200 kg N/ha, the number of panicles/m^2 increased considerably. The highest no. of panicles/m^2 was recorded with 200 kg N/ha which was statistically at par with 150 kg N/ha but significantly higher than the other three treatments. The lowest no. of panicles/$m^2$was recorded in control. Kumar and Mahajan (2014) recorded the similar research findings. The highest no. of grains/panicle was counted in closer spacing of 20 cm x 15 cm which was remarkably higher than wider spacing of 20 cm x 20 cm and in random transplanting. The maximum no. of grains/panicle was found at higher level of nitrogen *i.e.* 200 kg N/ha which was statically at par with 150 kg N/ha but significantly higher than the rest of three treatments. Panicle length and harvest index of the crop was

Table 4. Yield attributes and grain yield of transplanted rice as affected by planting geometry and nitrogen levels

Treatments/Planting/Geometry	Yield attributes				Grain yield (kg/ha)
	Number of panicles/m^2	Number of Grains/panicle	Panicle length (cm)	1000-grain weight (g)	
P_1 (20 cm x 15 cm)	324.0	134.8	22.6	25.5	8,412
P_2 (20 cm x 20 cm)	257.5	127.4	22.1	25.8	7,733
P_3 (Random)	221.7	122.0	22.1	25.9	7,013
CD (p=0.05)	29.6	5.5	NS	NS	185.8
Nitrogen levels (kg ha^{-1})					
N_1=0	204.7	119.1	21.6	25.2	5,971
N_2=50	254.3	125.4	22.1	25.7	7,268
N_3=100	280.7	129.8	22.4	25.9	8,105
N_4=150	295.4	132.5	22.6	26.0	8,616
N_5=200	303.6	133.5	22.7	26.0	8,637
CD (p=0.05)	13.7	2.5	NS	NS	239.9

not significantly affected by planting geometry as well as nitrogen levels. The longest panicle length (22.6 cm) was measured in the planting geometry 20 cm x 15 cm with 200 kg N/ha. Alam et al (2012) reported the same results. The maximum grain yield (8412 kg/ha) was obtained in 20 cm x 15 cm which was 19.9 % higher than random transplanting. Mahaddesi et al (2011), Moro et al (2016) recorded higher grain yield in closer spacing as compared to wider spacing. The maximum grain yield (8637 kg/ha) was recorded in 200 kg N/ha which was closely followed by 150 kg N/ha but it was significantly higher than the rest of three nitrogen treatments. With 200 kg N/ha 44.6 % higher grain yield was obtained as compared to control. The lowest grain yield (5971 kg/ha) was reported in control. This might be due to the reason of better growth parameters which ultimately led to more production and translocation of photosynthates.

CONCLUSION

Rice crop transplanted under 20 cm x 15 cm planting geometry recorded higher values of growth parameters. The grain yield of rice under aforesaid spacing also surpassed the other planting geometries tested under study. Application of 150 kg N/ha performed best among different nitrogen levels. Based on the present study it may be concluded that rice should be transplanted at 20 cm x 15 cm planting geometry and should be applied with 150 kg N/ha.

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