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Research Communication

Effect of nitrogen levels on yield and yield attributes of rice (*Oryza sativa*) grown under different planting geometry

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ABSTRACT

A field experiment was conducted during the rainy season (*kharif*) 2017 at Kumarganj Ayodhya, Uttar Pradesh, to study the effects of nitrogen on rice (*Oryza sativa* L.) grown under different planting geometry. Four planting geometry, viz. 15 cm × 10 cm, 15 cm × 15 cm, 20 cm × 10 cm and 20 cm × 15 cm and 4 nitrogen levels (0, 60, 120 and 180 kg/ha) were tested in a split-plot design, keeping as main and subplots, respectively, with 3 replications. The crop received a total rainfall of 804.9 mm, while the evaporation was 869.7 mm during the entire crop season. The experimental result revealed that different planting geometry and level of nitrogen had a remarkable influence on the yield-attributing characters and yield of rice. Yield-attributing characters, viz. panicle length, panicles/m², grains/panicle and test weight were increased significantly with the increasing level of nitrogen from 0 to 180 kg/ha. Of the different planting geometry, plant spacing 20 cm × 10 cm resulted in significantly the highest grain yield (5.40 t/ha). The highest grain and straw yields were recorded with the treatment of 20 cm × 10 cm plant spacing and 180 kg N/ha.

Key words: Nitrogen, Planting geometry, Rice, Yield and yield components

Rice is a most important cereal crop of rainy (*kharif*) season, grown under semi-aquatic condition and mostly under submergence or variable ponding conditions (alternate wetting and drying/ 2–4 days after disappearance of ponded water). It is a most important staple food of about more than 60% of total world population. Rice is a nutritious cereal crop, mainly used for human consumption. It is the main source of energy and is an important source of protein, providing substantial amount of the recommended nutrients intake of zinc and niacin. Agronomic management practices such as spacing and nitrogen application are 2 major factors influencing the growth and yield of rice. Optimum dose of nitrogen fertilization plays a vital role in growth and development and grain formation as a result of higher yield of rice plant. Excessive nitrogen fertilization encourages excessive vegetative growth which makes the plant susceptible to insect, pest and diseases, which ultimately reduces yield, whereas less than optimum rate affects both yield and quality of rice to remarkable extent. So, it is essential to find out the optimum rate of nitrogen application for its efficient utilization by the plants for better yield. Since optimum plant spacing ensures plants to grow properly both in their aerial and underground parts through utilization of solar radiation and nutrients, proper manipulation of planting density may lead to enhance the economic yield of transplanted rice (Sampath *et al*., 2017). Planting geometry determines the planting density or plant population in unit area, thereby influencing the input-use efficiency and yield of the crop. Plant spacing is a major non-monetary input which plays a significant role in achieving greater nutrient-use efficiency with higher growth and yield of the crop. Salahuddin *et al.* (2009) reported that, the lowest number of grains/panicle was produced under control (0 kg N/ha) irrespective of the plant spacing. Though grain yield/ha increased with increasing level of nitrogen up to 180 kg/ha, irrespective of plant spacing. Keeping above points in view, the present investigation was carried out to assess the effect of nitrogen in transplanted rice under varying plant spacing in a sandy-loam soil.

The experiment was conducted during the rainy (*kharif*) season of 2017 at the Narendra Deva University of Agriculture and Technology, Kumarganj (26.47° N, 82.12° E

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and 113 meters above mean sea-level), Ayodhya, Uttar Prades (India). The field was well-drained, leveled and having good soil conditions. The soil of the experimental field was silty loam in texture with 8.10 *p*H. It was low in organic carbon (0.43 %) and available nitrogen (160 kg/ha), medium in available phosphorus (16.5 kg/ha) and available potassium (260 kg/ha). Four planting geometry, viz. S_1, 15 cm × 10 cm; S_2, 15 cm × 15 cm; S_3, 20 cm × 10 cm and S_4, 20 cm × 15 cm, and 4 nitrogen levels (N_1, 0; N_2, 60; N_3, 120 and N_4, 180 kg/ha) were tested in a split-plot design, keeping as main and subplots, respectively, with 3 replications. The gross and net plot size was 6.0 m × 3.0 m and 4.8 m × 2.4 m respectively. During the crop season, weekly mean minimum and maximum temperature ranged from 16.7 to 28.7 °C and 29.9 to 37.8 °C respectively. The total rainfall and evaporation during the entire crop season was 804.9 and 869.7 mm respectively. However, the diurnal variation among relative humidity and evaporation rate was 43.5 to 86.1% and 4.3 to 7.2 mm respectively.

The standard procedure was followed for raising the seedlings in the nursery. Healthy and bold seeds of rice variety 'NDR 359' were used @ 40 kg/ha for nursery raising in puddled soil. Transplanting was done as per the treatment with 28-day old plants @ 2 seedlings/hill was used for transplanting. Phosphorus and potassium were applied @ 60 and 40 kg/ha through single superphosphate (16% P_2O_5) and muriate of potash (60% K_2O) basal, at the time of pudding/ leveling of the field respectively. The nitrogen was applied through urea (46% N), as per treatment. Zinc sulphate (21% Zn) was also applied @ 25 kg/ha as micronutrient in the rice field at the time of pudding. Half dose of nitrogen was applied before transplanting of seedlings, plot-wise, and the rest was top-dressed in 2 equal splits first at 30 days after transplanting (DAT) (tillering stage) and second at 55 DAT (panicle-initiation stage). During the year of experimentation, there were sufficient rains during vegetative stage; however, there was occasional moisture stress during reproductive phase, hence only 3 irrigations were given at different stages, viz. flowering, milking and grain-filling, of crop growth. Data were subjected to analysis of variance (ANOVA) using Online Statistical Analysis Package (OPSTAT, Computer Section) at 5% level of significance (P=0.05).

Plant spacing had significant effect on panicle length, panicles/m^2 and grains/panicle (Table 1). Significantly longest panicle, highest number of panicles/m^2 and more grains/panicle were observed with 20 cm × 10 cm spacing (S_3) as compared to rest of the treatments. However, it was found statistically at par with S_4 followed by S_2 treatments. This might be due to the fact that higher plant population/unit area can be achieved at closer spacing. Mahato *et al*. (2007) also reported similar type of variation where closer spacing gave the highest number of panicles/m^2. The improvement in grains/panicles was might be owing to the fact that supply of more food materials, moisture and light for the plant under optimum/wider spacing which ultimately resulted in better environment for growth and development of the crop (Uddin *et al*., 2011). Further, panicle length, panicles/m^2 and grains/panicle also significantly increased with the increase of nitrogen rate up to 180 kg N/ha, being highest in N_4, which was statistically at par with N_3 treatment. Although the shortest panicles and lowest number of grains/panicle were recorded under the control, followed by N_2 treatment. Nitrogen takes part in panicle formation as well as panicle elongation and for this reason, panicle length increased with the increase of nitrogen fertilization up to 180 kg/ha. Plants grown at any plant spacing without N fertilizer produced shortest panicle. Nitrogen helps in proper filling of seeds which resulted in higher production of seeds and thus higher number of grains/panicle. Chopra and Chopra (2000) also reported similar results in transplanted rice. Maximum number of panicle/m^2 was recorded with N_4, followed by N_3 treatment. Although N_2, N_3 and N_4 remained at par with each other in this regard. This was probably due to the key role of nitrogen in hypertrophy and hyperlasia which ultimately increase the total number of plants/unit area. Mahato *et al*. (2007) also reported that, higher levels of N application increased the number of panicles/m^2 and thereafter decreased with further fertilizers application. Excessive nitrogen application decreased the effective number of panicles and grains/panicle and subsequently rice production (Zhu *et al*., 2017). The test weight was not influenced significantly either by the spacing or nitrogen application. Wider spacing showed higher test weight (23.3–23.4g) than closer spacing, S_1. This might be owing to competition of plants for light within the dense plants at closer hill spacing, resulting in lower panicle weight due to reduction in the rate of photosynthesis (Yadav, 2007). The increase in yield-attributing characters of aerobic rice with the increase in N application might be owing to higher availability of N to plants leading to its higher uptake and translocation from vegetative parts, to reproductive parts resulting in increased values of yield attributes (Nayak *et al*., 2016).

Rice grown with a spacing of 20 cm × 10 cm being at par with wider spacing (20 cm × 15 cm), resulted in significantly higher grain and straw yield (5.40 and 7.57 t/ha) than very closer spacing of 15 cm × 10/15 cm which were found undesirable for economic yield (Table 1). Although the lowest grain and straw yields were recorded under 15 cm × 10 cm spacing (4.62 and 6.37 t/ha). The highest grain yield under this treatment was mainly owing to the more values of yield attributes coupled with the growth attributes. Namba (2003) also reported the increased grain

Table 1. Effect of planting geometry and nitrogen levels on yield attributes and yield of rice

Treatment	Panicle length (cm)	Panicles /m^2	Grains/ panicle	Test weight (g)	Grain yield (t/ha)	Straw yield (t/ha)	Harvest index (%)
Planting geometry (cm)							
S_1, 15 × 10	23.9	237.5	150.0	22.8	4.62	6.37	41.4
S_2, 15 × 15	25.7	278.7	158.0	23.2	4.89	6.87	41.3
S_3, 20 × 10	27.1	288.7	165.0	23.4	5.40	7.57	41.8
S_4, 20 × 15	26.0	283.8	160.0	23.3	5.17	7.19	41.6
SEm±	0.7	7.3	4.0	0.6	0.13	0.18	0.11
CD (P=0.05)	3.3	25.2	13.8	NS	0.44	0.61	NS
Nitrogen levels (kg/ha)							
N_1, 0	23.6	208.3	151.9	22.2	3.51	5.41	39.3
N_2, 60	25.2	285.4	156.6	22.9	4.52	6.92	39.5
N_3, 120	26.7	297.9	161.4	23.6	5.17	7.18	41.8
N_4, 180	28.2	299.3	165.0	23.8	5.67	7.69	42.4
SEm±	0.5	5.4	3.2	0.5	0.11	0.15	0.10
CD (P=0.05)	1.6	15.6	9.7	NS	0.31	0.43	NS

yield with optimum plant population that may be attributed to increased number of tillers/unit area and filled grains/ panicle after which plant growth slowed down if it exceed the optimum level. However, Kang *et al.* (2019) observed that the grain yield of rice planted at 30 cm × 12 cm spacing was 4.1 and 12.1% higher than 30 cm × 14 cm and 30 cm × 16 cm spacing respectively. Rice receiving 180 kg N/ ha outyielded control and N_2 by 61.5 and 25.4%. Similarly, the pace of increment in straw yield was 42.1 and 11.1% respectively. Although 120 and 180 kg/ha N remained at par with each other in this regard. It was probably owing to better nutrient uptake leading to higher dry-matter production and its translocation towards sink leading to increased per cent of filled grains and number of panicles/m^2. Similar observations were reported by Mahato *et al.* (2007). The vigorous growth under heavily N fertilization in rice crop which intern resulted into higher straw yield (Chopra and Chopra, 2004). The harvest index was not significantly influenced either by the plant spacing or by nitrogen application, though it was varied from 41.3to 41.8 and 39.3 to 42.4% respectively.

Therefore, it can be concluded that 'NDR 359' rice responds to combination of 180 kg nitrogen/ha along with planting geometry of 20 cm × 10 cm in Ayodhya, Uttar Pradesh.

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