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EFFECT OF DIFFERENT NITROGEN LEVELS AND PLANT SPACING ON THE GROWTH AND YIELD OF BASMATI RICE (*ORYZA SATIVA* L.)

Ramu Yadav[1], Ravikesh Kumar Pal[2], Raghvendra Singh[3], Aneeta Yadav and Kartikay Bisen

Faculty of Agricultural Science and Allied Industries, Rama University, Kanpur

Abstract

The "Effect of different nitrogen levels and plant spacing on the growth and yield of basmati rice (Oryza sativa L.)" in the Rabi season crop of 2023-2024 was the subject of a field experiment conducted at Rama University at Mandhana, Kanpur. Nitrogen levels (Kg ha-^{1})- N0: 0(Kg ha-^{1}), N1: 40(Kg ha-^{1}), N2: 60(Kg ha-^{1}), N3: 80(Kg ha-^{1}), N4: 100(Kg ha-^{1}) and Plant geometry (cm)- G1-20 × 15, G2-15 × 15, G3-20 × 10, G4-15 × 10 were the five treatments with N levels and four treatment with plant geometry that were included in the experiment. Three replications of each treatment were carried out using a Randomized block design (Factorial) Replications was the rice crop used in the experiment. The experimental soil had a pH between 7.2 and 7.8, medium levels of organic carbon, and medium levels of potassium, phosphorus, and nitrogen. Greater nutrient uptake was found to be significantly greater in this pattern, and the results seemed to show that the five treatments with N levels and four treatments with plant geometry N4-100 (kg ha^{-1}) had significant growth, yield qualities, and grain yield varied with the different nutrient levels. The farmer's methods produce the lowest grain yield, growth traits, and yield qualities. The decomposition of crop residues and the use of organic manures resulted in an improvement in soil quality at the five treatments with N levels and four treatments with plant geometry. With N4-100 (kg ha^{-1} and G3 treatments, the N levels have the highest net return and benefit cost ratio.

KEYWORDS: N levels plant geometry, yield, soil health parameter, rice.

1. INTRODUCTION

Basmati occupies a special status in Rice cultivation. It is a variety of long, slender grained, aromatic rice. In India, Basmati rice is grown in the specific geographical area, at the Himalayan foot-hills confined into few states of India. These states are located at northern parts of our country e.g. Punjab, Haryana, Himachal Pradesh, Uttarakhand, Western UP, Delhi, Bihar. The Basmati rice are differentiated from other aromatic rice in a certain criterion that its length increases twice of their original size after cooking with other characteristics like soft and fluffy texture upon cooking, delicious taste, superior aroma and distinct flavour. The chemical compound responsible for aroma in Rice 2-acetyl-1-pyrroline present @0.09 ppm in Basmati Rice grain which is almost 12 times more than non-Basmati Rice. Hence, Basmati rice is unique among other aromatic long grained rice. Rice (*Oryza sativa* L.) is a globally important crop that is a member of the Poaceae family. Due to the significance of rice grain production in breeding programs, numerous studies have been conducted to enhance rice yield under normal and stressful conditions (Elkhoby *et al*., 2013; Abd El-Lattef *et al*., 2014; El-Hity *et al*., 2020; Hafez *et al.,* 2020; Mohamed *et al*., 2021).

Plant spacing is also an important factor that needs to be considered during transplanting of rice. Rice plants compete among themselves for space, nutrients, water, sunlight, air. Proper spacing may help to increase maximum leaf Area Index (LAI), light interceptions etc. which are required for better photosynthesis as well as yield of rice. Some of them use very closer plant spacing and others are using wider plant spacing. Optimum plant spacing ensures the plants to grow properly both in their aerial and underground parts through efficient utilization of solar radiation and nutrients (Acharya S *et al*., 2018). Closer spacing hampers intercultural operations and as such more competition arises among the plants for nutrients, air and light as the result, plant becomes weaker and thinner producing lower yield. Mondal, M., Monjurul, A., Adam, B., Ismail, M., Raffii, R. and Yusop. (2013). The crop geometry and spatial configuration exploit the initial vigour of the genotypes with enhanced soil aeration creating congenial condition for better establishment. Effective management of natural resources, integrated approach to plant-water nutrient, weed and pest management are must. Among different agronomic factors, planting geometry (optimum number of plants per unit area) is one of the important non-monetary parameters in increasing the productivity. Murthy K. V. R., Reddy D. S. and Reddy G. P. (2012). Nitrogen plays a key role in rice production and it is required in large amount. It is one of the most important limiting nutrients in rice production and has heavy system losses when applied as inorganic sources in puddle field. Murthy, K. M. D., Rao, A. U., Vijay, D. and Sridhar, T. V. (2015). Nitrogen has a positive influence on the production of effective tillers per plant, yield and yield attributes. It is necessary to find out the suitable dose of nitrogen for efficient management and better yield of rice. N. B. Prakash, N. Chandrashekar, C. Mahendra, S. U. Patil, G. N. Thippeshappa and H. M. Laane (2011). A suitable planting geometry and dose of nitrogen is necessary for better yield. The work on above aspects is limited under agro climatic conditions of Eastern U.P. Murthy, K.M.D., Rao, A.U., Vijay, D. and Sridhar, T.V. (2011).

2. Materials and Methods

Plant height (cm) at 30, 60, 90 DAT and at harvesting time was recorded with the help of meter scale at harvest. For this observation five hills in each plot were selected. The length between the base of stem touching the ground and the top most tip of the plant was considered as height of plant and averaged.

The primary and secondary tillers were recorded on 30, 60 and 90 days after transplanting. Primary and secondary tillers rice in 30 days interval. Average number of tillers per plant was worked out. Field experiments are conducted to measure LAI at 30, 60, and 90 Days After Transplanting (DAT) in [Specify Crop]. LAI is calculated using non-destructive methods such as canopy photography or destructive methods like leaf area meter measurements.

Concurrently, environmental parameters including light intensity, temperature, and humidity are monitored to assess their influence on LAI dynamics. Statistical analyses are employed to identify correlations between LAI and crop growth parameters.

After counting the Dry matter accumulation 30, 50, 90 DAT (gm^{-2}) of rice crop, those were kept separately in Bamboo paper bags which were dried first in sun for few days and then transferred to Electric oven at 500C ± 1 for 2 hours. Then their weight was taken on Electronic balance. The mean of 2 plants was computed in each case and recorded as dry weight of par plant (g).

3. RESULTS AND DISCUSSION

Plant height as affected by different planting geometry and nitrogen levels recorded at 30, 60, 90 DAT and at harvest have been presented in Table-1. It is evident from the data that in general plant height increased successively with the advancement of crop at all the stages during both the years of investigation. Data presented in Table-1 revealed that the plant height was significantly affected due to planting geometry at all the stages of crop growth. Higher plant height was recorded in planting geometry of G_3 (20 × 10) cm which was at par with G2 (15 × 15) cm while significant over G4 (15 × 10) cm and G1 (20 × 15) cm spacing at all the stages during both the years of investigation.

Different level of nitrogen presented in Table-1 reveal that increase in nitrogen level increased the plant height at all the successive stages of crop during both the years of investigation. It is quite obvious from the data that plant height was significantly affected due to nitrogen level during both the years. Higher plant height was recorded with the application of 100 kg N/ha which was at par with 80 kg N/ha. While significant over control and 40 kg N/ha, 60 kg N/ha at all the stages during both the years of investigation.

The data pertaining to number of tillers/m^2 recorded at different growth stages has been presented in Table-2. Perusal of the data presented in table revealed that number of tillers/ m^2 increased successively till 90 DAT during both the years ofinvestigation.

It is obvious from the data that number of tiller/m^2 was significantly affected by different planting geometry at all the growth stages during both the years of investigation. Higher number of tiller/m^2 was recorded in G3 (20×10) cm spacing as compared to rest of the spacing at all the stages during both the years of investigation. The lowest number of tillers/m^2 was recorded in G1 (20×15) cm spacing. Application of nitrogen with 100 kg/ha significantly increased the number of tillers/m^2 which was at par with 80 kg N/ha while significant over both control, 40 kg N/ha and 60 kg N/ha at all the stages during both the years of investigation. The plants receiving no nitrogen application recorded lowest number of tillers of rice.

The interaction effect between nitrogen levels and planting geometry in respect of Number of tillers/m^2 was found to be non-significant. Data pertaining to leaf area index (LAI) of rice as affected by planting different levels of nitrogen and geometry have been presented in Table-3.

It is evident from the data that leaf area index significantly increased with increasing N levels from 30 DAT to 90 DAT during both the years of investigation. Higher leaf area index at all the stages were recorded in N_4 100 kg N/ha which was at par with N_3 80 kg N/ha while significant over control and 40 kg N/ha during both the years of investigation. The results presented in table revealed that leaf area index increased successively with the advancement of the crop growth stage up to 60 DAT and thereafter declined. Planting geometry of 20×10 cm spacing at 60 DAT

and 90 DAT G3 (20 × 10) recorded higher leaf area index which was at par with G2 (15×15) cm spacing while significant over G1 (20×15) cm spacing during both the years of investigation. The interaction effect between planting nitrogen levels and geometry in respect of leaf area index was found to be non-significant.

The data pertaining to dry matter accumulation g/m^2 as influenced by various planting geometry and different level of nitrogen at different stages of the crop have been presented in Table-4. Various nitrogen levels significantly influenced the dry matterproduction/m^2 at all the stages during both the years of investigation. Application of nitrogen level with 100 kg/ha recorded significantly higherdry matter production which was at par with 80 kg nitrogen/ha. at all the stages during both the years of investigation.

The experimental results presented in table revealed that dry matter accumulation successively at all the stages till the maturity. It is clear from the data that dry matter production/m^2 recorded at 60, 90DAT and at harvest were significantly higher in planting geometry of G3 (20×10) cm which was at par with 15x15cm spacing while significant over 15x10cm and 20x15cm spacing during both the years of investigation. Interaction between planting geometry and nitrogen level was notsignificant for dry matter production/m^2 of rice.

4. Conclusion

In conclusion, the study on plant height, number of tillers, leaf area index (LAI), and dry matter accumulation as influenced by different planting geometries and nitrogen levels in rice has provided valuable insights into crop growth dynamics. The results consistently indicated that both planting geometry and nitrogen levels significantly affected the growth parameters at all stages of crop development. Regarding plant height, higher values were observed with the planting geometry of G3 (20×10 cm), which was at par with G2 (15×15 cm) but significantly greater than G1 (20×15 cm) and G4 (15×10 cm) across both years. Similarly, increasing nitrogen levels, particularly N4 100 kg N/ha and N3-80 kg N/ha, resulted in significantly taller plants compared to lower nitrogen treatments and control. This trend was evident at all the growth stages and throughout the two years of investigation.

From the results obtained for two year of experiment, it can be concluded that to obtain a higher profitable yield of rabi maize, as well as to increase the uptake of nutrient the crop should be fertilized with 40% RDF+20 % N Through FYM+20 % N Through Poultry Manure +20 % N Through Vermi compost (T_8).

Regarding plant height, higher values were observed with the planting geometry of G3 (20×10 cm), which was at par with G2 (15×15 cm) but significantly greater than G1 (20×15 cm) and G4 (15×10 cm) across both years. Similarly, increasing nitrogen levels, particularly 100 kg N/ha and 80 kg N/ha, resulted in significantly taller plants compared to lower nitrogen treatments and control. This trend was evident at all the growth stages and throughout the two years of investigation. For tiller count, the best results were recorded with the G3 (20×10 cm) spacing, which outperformed other geometries. The application of nitrogen at 100 kg N/ha also resulted in the highest number of tillers per square meter, with 80 kg N/ha showing similar outcomes, while lower nitrogen doses or control plants showed a marked reduction in tiller number.

Leaf area index (LAI) was significantly affected by both nitrogen levels and planting geometry. The highest LAI values were observed with 100 kg N/ha, followed by 80 kg N/ha, which were superior to the lower nitrogen treatments. The planting geometry G3 (20 × 10 cm) consistently recorded the highest LAI, outperforming other spacing configurations. However, the interaction between nitrogen levels and planting geometry was non-significant for LAI. Dry matter accumulation was positively influenced by higher nitrogen application, with 100 kg N/ha and 80 kg N/ha showing the highest dry matter production at all stages. The planting geometry G3 (20 × 10 cm) again recorded the highest dry matter accumulation, which was significantly higher than other planting geometries. Overall, the study emphasizes the importance of optimal planting geometry (G3) and nitrogen application (100 kg/ha or 80 kg/ha) in improving key growth parameters of rice. These findings can help in formulating better agronomic practices for maximizing rice yield and productivity.

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Table 1 Effect of different nitrogen levels and Spacing on Plant height (cm) of basmati rice								
Treatments	**2023**				**2024**			
	30 DAT	**60 DAT**	**90 DAT**	**Harvest**	**30 DAT**	**60 DAT**	**90 DAT**	**Harvest**
Nitrogen Levels(kg/ha)								
N_0	37.0	70.7	78.3	78.7	37.7	72.1	79.4	79.8
N_1	47.2	84.2	93.0	93.5	48.2	85.9	94.3	94.8
N_2	51.6	98.4	108.7	109.2	51.7	100.4	110.1	110.8
N_3	52.2	101.0	111.4	112.2	53.3	103.1	113.1	113.8
N_4	53.4	102.2	112.7	116.1	54.6	103.9	114.1	117.3
SEm±	**0.97**	**1.81**	**2.01**	**2.03**	**0.99**	**1.84**	**2.04**	**2.04**
C.D. (0.05)	**2.82**	**5.27**	**5.88**	**5.92**	**2.88**	**5.38**	**5.96**	**5.95**
Plant geometry (cm)								
G1 (20 × 15)	45.3	83.1	91.9	94.6	47.3	85.0	93.2	93.7
G2 (15 × 15)	45.8	91.3	100.6	101.4	48.1	93.1	102.2	103.1
G3 (20 × 10)	47.1	94.6	104.8	105.3	48.1	96.6	106.1	106.8

G4 (15 × 10)	44.9	85.0	94.0	94.5	46.7	86.8	95.3	96.0
SEm±	**1.18**	**2.31**	**2.47**	**2.49**	**1.20**	**2.35**	**2.51**	**2.60**
C.D. (0.05)	**4.07**	**7.98**	**8.56**	**8.61**	**4.15**	**8.14**	**8.68**	**8.99**

Table-2 Effect of different nitrogen levels and Spacing on Tillers/m^2 of basmati rice

Treatments	**2023**			**2024**		
	30 DAT	**60 DAT**	**90 DAT**	**30 DAT**	**60 DAT**	**90 DAT**
Nitrogen Levels(kg/ha)						
N_0	137.6	263.3	276.2	144.9	269.2	282.4
N_1	145.5	315.1	330.3	151.6	321.2	337.2
N_2	150.0	326.5	342.1	156.4	333.1	348.3
N_3	151.0	328.2	345.1	158.2	335.5	352.1
N_4	151.8	330.0	345.9	159.3	336.5	353.2
SEm±	**1.94**	**4.85**	**5.19**	**2.09**	**5.98**	**5.46**
C.D. (0.05)	**5.66**	**14.16**	**15.5**	**6.10**	**17.46**	**15.94**
Plant geometry (cm)						
G1 (20 × 15)	100.2	231.0	242.1	105.1	235.5	247.3

G2 (15 × 15)	149.4	312.3	328.0	157.5	319.7	334.2
G3 (20 × 10)	199.3	401.2	421.5	208.2	409.4	429.5
G4 (15 × 10)	132.0	285.4	300.8	138.4	291.2	306.6
SEm±	**4.04**	**6.97**	**7.32**	**4.24**	**7.11**	**9.04**
C.D. (0.05)	**13.98**	**24.15**	**25.35**	**14.67**	**24.63**	**31.29**

Table -3 Effect of different nitrogen levels and Spacing on Leaf area index at 30,60 and 90 DAT of basmati rice						
Treatments	**2023**			**2024**		
	30 DAT	**60 DAT**	**90 DAT**	**30 DAT**	**60 DAT**	**90 DAT**
Nitrogen Levels(kg/ha)						
N_0	1.25	3.24	3.13	1.31	3.31	3.17
N_1	1.31	3.97	3.83	1.38	4.26	3.91
N_2	1.33	4.46	4.31	1.40	4.56	4.37
N_3	1.35	4.54	4.38	1.41	4.63	4.45
N_4	1.36	4.55	4.41	1.42	4.66	4.47
SEm±	0.02	0.08	0.08	0.02	0.08	0.08

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C.D. (0.05)	0.07	0.24	0.23	0.08	0.24	0.23
Plant geometry (cm)						
G1 (20 × 15)	1.36	3.67	3.54	1.45	3.74	3.58
G2 (15 × 15)	1.29	4.19	4.01	1.34	4.26	4.02
G3 (20 × 10)	1.32	4.43	4.25	1.42	4.54	4.32
G4 (15 × 10)	1.22	3.95	3.82	1.23	4.02	3.87
SEm±	0.03	0.10	0.09	0.03	0.10	0.10
C.D. (0.05)	0.11	0.36	0.34	0.12	0.37	0.34

Table -4 Effect of different nitrogen levels and Spacing on Dry matter accumulation 30, 60, 90 DAT (gm^{-2}) and at harvest of basmati rice.

Treatments	**30 (gm^{-2})**		**60 (gm^{-2})**		**90 (gm^{-2})**		**At harvest**	
	2023	**2024**	**2023**	**2024**	**2023**	**2024**	**2023**	**2024**
Nitrogen Levels(kg/ha)								
N_0	103.9	109.1	375.9	390.4	550.1	575.2	683.3	713.5

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N_1	120.8	118.1	669.0	597.8	808.3	860.8	998.0	937.2
N_2	129.0	125.8	693.2	710.4	995.3	1040.5	1040.1	1094.6
N_3	130.3	125.2	698.0	725.2	1007.0	1054.0	1104.3	1110.9
N_4	132.4	127.6	699.8	725.8	1010.1	1058.7	1106.7	1114.2
SEm±	2.2	2.3	11.8	12.3	20.5	21.3	25.7	26.7
C.D. (0.05)	6.6	6.9	34.6	35.9	59.9	62.2	75.2	78.1
Plant geometry (cm)								
G1 (20 × 15)	119.8	125.7	528.4	549.7	813.7	850.5	850.8	885.2
G2 (15 × 15)	114.5	120.4	555.0	576.5	959.7	997.0	966.3	1001.2
G3 (20 × 10)	118.9	124.7	623.8	647.7	1078.6	1019.9	1099.8	1049.3
G4 (15 × 10)	109.8	115.3	537.1	557.7	928.7	863.1	949.5	900.4
SEm±	2.9	3.1	14.9	15.4	25.8	26.7	29.2	30.4
C.D. (0.05)	10.1	10.9	51.6	53.6	89.3	92.7	101.3	105.2

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