E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; 7(5): 586-589
Received: 14-02-2024
Accepted: 18-03-2024

Amit Pandey
M.Sc.(Ag) Scholar, Department of Agronomy, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Ravikesh Kumar Pal
Assistant Professor, Department of Agronomy, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Nempal Verma
PhD. Scholar Soil Science, NDUAT, Ayodhya, Uttar Pradesh, India

Durgesh Kumar Maurya
Assistant Professor, Agronomy, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Raghvendra Singh
Assistant Professor, Soil Science, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Sarvesh Kumar
Assistant Professor, Ag. Engineering, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Corresponding Author:
Amit Pandey
M.sc.(Ag) Scholar, Department of Agronomy, Faculty of Agriculture Science and Allied Industries, Rama University, Kanpur, Uttar Pradesh, India

Effect of plant geometry and nitrogen management on productivity in wheat

Amit Pandey, Ravikesh Kumar Pal, Nempal Verma, Durgesh Kumar Maurya, Raghvendra Singh and Sarvesh Kumar

DOI: https://doi.org/10.33545/2618060X.2024.v7.i5h.739

Abstract
A field experiment was conducted during rabi season of 2023-24 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Effect of plant geometry and nitrogen management on productivity in wheat. The soil was normal in pH of 7.65, electrical conductivity (EC) of 0.27 dSm^{-1}, organic carbon content of 0.41%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 217.0, 19.5, and 149.50 kg ha^{-1}, respectively. The experiment was laid out during Rabi season of 2023-24. The experiment consisted of 36 treatment combinations, was laid out in Split plot Design (SPD) with three replications.

Keywords: Planting methods, wheat, nitrogen

Introduction
Triticum aestivum, Triticum dicoccum, Triticum durum, Triticum monococcum, and other species are the various species that make up the Triticum grass family, which is a genus within the Gramineae grass family. Originating in the southeast of Turkey, this crop is significant worldwide (Desai *et al* 2015) [1]. One of the earliest crops to be domesticated, it served as the foundational diet for the great civilizations of Europe, West Asia, and North Africa. Of the three stable crops, wheat is the first. Which 35% of the world's population is predicted to consume (Pyare, 2003) [2].
It is harvested annually from about 715.6 million tons of land across roughly 215 million hectares of land worldwide, contributing roughly US$50 billion to global trade (FAO, 2013/14). Since wheat accounts for 35% of staple foods and occupies roughly 17% of all cropped land worldwide, increasing its production is crucial for ensuring food security. One of the main cereal crops grown in the highlands of Ethiopia is wheat. Despite its significance, Ethiopia's national yield of nun is only 1.3 tons ha^{-1}, which is 24% less than the continent's average and 48% less than the world's average for wheat. from 89 countries, approximately 2.5 billion people (CGIAR research program in wheat, WHEAT CRP annual report 2013). used wheat for fermentation to create bur other alcoholic beverages, as well as flour, flat and steamed breads, biscuits, cakes, cookies, and breakfast cereal (Chauhan *et al*., 2014) [3].
More than 60% of the world's wheat is produced in developing and emerging nations like China and India. Wheat is the main source of protein (gluten) in developing nations. The world's population is growing at a very fast rate, and by 2050, there will be a 60% increase in wheat demand worldwide. (Wheat CRP annual report, 2013, CGIAR research program). India is currently the world's second-largest producer of wheat, with 95.91 million tons produced from an area of roughly 30.75 million hectares and 31.19 kg/ha of productivity. In contrast, China produces 126.2 million metric tons. With a productivity of 30.25q/ha in 2015–16, wheat is the second most important cereal crop in India after rice. It covers an area of 25.63 million hectares and contributes 68.43 million tones to the world's food grain production. (Source: Anonymous, 2016) [4].
From a field experiment conducted in Uttar Pradesh, India, Singh *et al*. (2005) [5] concluded that strip drilling produced the highest growth and grain yield (5.67 t ha^{-1}) in wheat, followed by

zero tillage drilling, conventional sowing, and bed planting. According to Krezel and Sobkowicz (1996) [6], broadcast sowing typically produced a lower yield than sowing in rows. While Raj *et al*. (1992) [7] found that row spacing (15, 22.5, or 30 cm) had no effect on grain yield in 1986–87, but that the yields were lower in the wider row spacing (30 cm) in 1985–86, Ahuja *et al*. (1996) recorded 5.08 t ha^{-1} grain yield with broadcasting while 4.75 t ha^{-1} with sowing in 23 cm apart rows. Comparing cross sowing to the conventional method of sowing (line sowing), Parihar and Singh (1995) [9] found that cross sowing increased grain yield by 4.3 percent.

Some of the vital nutrients crop plants need to grow and develop are missing from the majority of Indian agricultural lands. Nitrogen is one of the most important elements needed for plant growth. Since nitrogen is a fundamental component of proteins and nucleic acids, it is necessary for plants to grow in large quantities. Fertilizer made of synthetic chemicals, such as urea, provides nitrogen. Consequently, in order to achieve a larger yield, a high dose of nitrogenous fertilizers is needed. It has been reported that applying nitrogen to wheat in both timely and late sown conditions can increase yield by up to 120 kg ha^{-1} (Singh and Yadav, 2006) [10]. Because of intensive cropping, the amount of nitrogen needed per unit area had dramatically increased. However, there are now significant barriers to the supply of the entire amount of fertilizers required for increased productivity due to the sharp increase in fertilizer prices. These chemical fertilizers are costly and increase the cost of production, but they also present health risks and problems with soil microbial populations. Bio-fertilizers can be very helpful in this kind of situation (Tomar *et al*., 2006) [11].

The most significant component of plant proteins, nitrogen is needed for crop growth from the vegetative stage to the harvesting stage. It is well known that applying nitrogen primarily increases grain yield, biological yield, and various other characteristics like plant height and 1000 seed weight, among others. According to several studies (Meena, 2013) [12] and (Pandey *et al*., 2015) [13], adding top-dressed nitrogen in the late season as a dry fertilizer material was the most effective way to increase grain protein concentration, yield, and fertilizer recovery and efficiency. Thus, a key factor affecting grain yield and quality is nitrogen availability to wheat at different stages of its growth and development (Maqsood *et al*., 2015) [14]. There has been a lot of interest lately in the evolution and adoption of suitable land management and fertilization strategies for maintaining high production, given the threats of yield stagnation/depression, soil sustainability, and food security. Despite this, strategy isolation efforts have been made; however, no systematic effort has been made to date to determine the relationship between the different factors responsible for higher yield potential.

Materials and Methods

A field experiment was conducted during rabi season of 2023-24 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Effect of plant geometry and nitrogen management on productivity in wheat. The soil was normal in pH of 7.65, electrical conductivity (EC) of 0.27 dSm^{-1}, organic carbon content of 0.41%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 217.0, 19.5, and 149.50 kg ha^{-1}, respectively. The experiment was laid out during Rabi season of 2023-24. The experiment consisted of 36treatment combinations, was laid out in Split plot Design (SPD) with three replications. Planting Geometry (C1: Conventional sowing with rows spaced 20 cm apart, C2: Border sowing with a row gap after every three rows) Five plants were selected from each plot, and data on nitrogen levels (N0-No fertilizer application, N1<50 kg N/ha, N2100 kg N/ha, and N3150 kg N/ha) were collected.

Results and Discussion

Growth Parameter

When using cross sowing, the maximum plant height was observed at every stage and was noticeably greater than when using other sowing techniques. In the current investigation, the crop was sown using conventional methods, and the minimum plant height was noted at every stage of the crop.

Throughout all growth stages, the application of nitrogen resulted in a significant increase in plant height relative to control. The maximum plant height of 150 kg N/ha at harvest was 103.31 cm, which was considerably higher than the experiment's 100 kg N/ha result of 95.53 cm. All stages, however, also revealed that the differences between 50 kg N/ha and 100 kg N/ha were noteworthy.

Number of tillers

In comparison to border and traditional sowing, cross sowing produced a maximum number of tillers per metre row length at 60 DAS, which was significantly higher.

The data unambiguously showed that an increase in nitrogen dose from 50 to 150 kg N/ha resulted in a significant increase in tillers per metre row length. However, throughout all growth stages in the current investigation, the maximum number of tillers per metre row length was recorded with a higher level of nitrogen (150 kg N/ha) Sharma (2017) [15].

Number of leaves per plant

Cross sowing produced the highest number of leaves per plant, which was noticeably more than other sowing techniques at every stage. In the current investigation, the crop was sown using conventional methods, and the minimum number of leaves per plant was noted at every stage of the crop. In the current study, the maximum number of leaves per plant under cross-sowing (22.00) was noted at 60 DAS.

Throughout all phases of plant growth, the application of nitrogen resulted in a notable increase in the number of leaves per plant relative to control. In the current experiment, 150 kg N/ha produced the greatest number of leaves per plant (25.70) at 60 DAS, which was significantly higher than 100 kg N/ha (22.75). All stages, however, also revealed that the differences between 50 kg N/ha and 100 kg N/ha were noteworthy.

Dry matter accumulation

The crop sown using the border sowing method yielded a maximum of 19.27 g/plant of dry matter at harvest, which was significantly higher than the crop sown using the cross sowing method (17.17 g/plant). But in the current investigation, conventional sowing produced the least amount of dry matter at all three stages.

The production of dry matter was considerably higher than the control when 50 kg N/ha was applied. In a similar vein, applying 100 kg N/ha resulted in a notable increase over 50 kg N/ha. The highest dry matter production (19.39 g/plant) at harvest was achieved with 150 kg N/ha, which was significantly higher than any other treatment in the current investigation.

Table 1: Plant height (cm) of wheat as influenced by plant geometry and nitrogen levels

Treatments	Plant height (cm)			
	30 DAS	60 DAS	90 DAS	At harvest
Plant geometry				
Traditional sowing	22.98	62.50	89.67	92.23
Border sowing	23.31	63.67	91.92	94.04
Cross sowing	23.69	65.19	93.08	95.19
S.Em±	0.18	0.55	0.20	0.29
CD at 5%	0.51	1.60	0.57	0.85
Nitrogen levels				
0 kg ha^{-1}	19.75	53.86	83.03	84.25
50 kg ha^{-1}	22.11	61.28	90.39	92.19
100 kg ha^{-1}	23.95	67.47	93.20	95.53
150 kg ha^{-1}	27.50	72.53	99.61	103.31
S.Em±	0.20	0.64	0.23	0.34
CD at 5%	0.59	1.84	0.66	0.98

Table 2: Number of tillers per metre row length of wheat as influenced by plant geometry and nitrogen levels

Treatments	Number of tillers per metre row length		
	30 DAS	60 DAS	90 DAS
Plant geometry			
Traditional sowing	40.29	44.52	41.58
Border sowing	43.67	47.25	44.94
Cross sowing	60.50	63.08	60.02
S.Em±	1.28	1.04	0.80
CD at 5%	3.70	3.01	2.31
Nitrogen levels			
0 kg ha^{-1}	31.33	33.64	31.58
50 kg ha^{-1}	39.67	42.72	40.69
100 kg ha^{-1}	49.09	53.89	51.08
150 kg ha^{-1}	72.53	76.22	72.03
S.Em±	1.48	1.20	0.92
CD at 5%	4.28	3.48	2.67

Table 3: Number of leaves per plant of wheat as influenced by plant geometry and nitrogen levels

Treatments	Number of leaves per plant		
	30 DAS	60 DAS	90 DAS
Plant geometry			
Traditional sowing	14.50	21.02	18.37
Border sowing	16.56	20.98	17.65
Cross sowing	17.52	22.00	19.19
S.Em±	0.17	0.17	0.21
CD at 5%	0.50	0.50	0.60
Nitrogen levels			
0 kg ha^{-1}	10.28	16.83	14.97
50 kg ha^{-1}	13.80	20.06	17.69
100 kg ha^{-1}	18.61	22.75	19.13
150 kg ha^{-1}	22.10	25.70	21.81
S.Em±	0.20	0.20	0.24
CD at 5%	0.57	0.58	0.69

Table 4: Dry matter accumulation (g plant^{-1}) of wheat as influenced by plant geometry and nitrogen levels

Treatments	Dry matter accumulation (g/plant)			
	30 DAS	60 DAS	90 DAS	At harvest
Plant geometry				
Traditional sowing	0.206	1.464	8.95	15.23
Border sowing	0.330	1.897	10.11	19.27
Cross sowing	0.269	1.781	9.69	17.17
S.Em±	0.004	0.042	0.10	0.05
CD at 5%	0.011	0.123	0.29	0.15
Nitrogen levels				
0 kg ha^{-1}	0.182	1.415	8.03	15.33
50 kg ha^{-1}	0.211	1.494	8.99	16.53
100 kg ha^{-1}	0.295	1.687	9.79	17.63
150 kg ha^{-1}	0.387	2.261	11.52	19.39
S.Em±	0.004	0.049	0.12	0.06
CD at 5%	0.013	0.142	0.34	0.17

Conclusion
The results of presented experiment reveal that crop sown by border sowing methpd could be a profitable preposition as it is helpful in maintaining physico-chemical properties of soil favors the plant growth and results higher growth and net return under the residue incorporation. There is no need for applying more than 100 N per ha.

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