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Effect of Nitrogen and Phosphorus fertilization on the growth and yield of Wheat (*Triticum aestivum* L.)

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Abstract

Wheat (Triticum aestivum L.), a crucial cereal crop globally, serves as a staple diet for a substantial portion of the world's population. The use of chemical fertilizers in modern agriculture poses environmental risks in the pursuit of higher yields. Conversely, applying urea and phosphorus offers a potential avenue to mitigate some of these risks. In line with this objective, a field trial was conducted during the Rabi season of 2022–23 at Rama University's agricultural farm in Kanpur, Uttar Pradesh, to investigate the impact of nitrogen and phosphorus fertilization on wheat growth and yield. The experimental soil, classified as sandy loam with a pH of 7.5, electrical conductivity (EC) of 0.26 dSm^{-1}, organic carbon content of 0.60 percent, and available nutrients at levels of 217.0, 19.66, and 196.66 kg ha^{-1} for nitrogen (N), phosphorus (P), and potassium (K), respectively, was utilized. The main focus of the study was on the "Effect of Nitrogen and Phosphorus Fertilization on the Growth and Yield of Wheat (Triticum aestivum L.)." The standard dosage for the experimental design involved administering 40 kg N + 80 kg P_2O_5 to every treatment. The experiment employed a Randomized Block Design (RBD) with 12 treatments distributed across three replications, including a control group. The results indicated that the combination of 40 kg/ha P_2O_5 and 50 kg/ha N significantly enhanced yield, growth, and various yield parameters. Treatment 5 exhibited the highest values for parameters such as plant height (97.62 cm), number of tillers m^{-2} (375.00), dry matter accumulation (16.53 g/plant), test weight (44.99 g), grains/ear (12.93), effective ear head per m^{-2} (282.66), and straw yield (47.59 quintals/ha).

Keywords: wheat, nitrogen, phosphorus, RBD, growth, yield attributes, and yield.

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Introduction

Wheat (Triticum aestivum L.), a crucial cereal crop, holds a prominent position as the most extensively cultivated crop globally. In the 2022–2023 period, wheat covered approximately 215 million hectares worldwide, yielding a production of 715.6 million tons, equivalent to 2665 tons of grain yield per hectare. Accounting for 35% of staple foods and 17% of the total, increasing wheat production is vital for ensuring food security. Despite its significance in Ethiopia, the country's yield is merely 1.3 tons ha^{-1}, 24% lower than the average yield in Africa and globally [Wheat Crop Annual Report 2013, CGIAR Research Program]. Wheat is a primary ingredient for various food items, including flour, pasta, noodles, cakes, biscuits, cookies, and different types of bread [I. Chakravedi, 2006]. Fermentation processes using wheat produce beer and other alcoholic beverages [Channabasavanna et al., 2001].

China leads in wheat production, generating 126.2 million metric tons, followed by India as the second-largest producer at 95.9 million tons, cultivated across approximately 30.75 million hectares with a productivity of 31.19 kg/ha. The escalating demand for nitrogen due to intensive cropping poses challenges, particularly with the sharp rise in fertilizer prices. The expensive chemical fertilizers not only increase production costs but also pose health risks and affect soil microbial populations. In addressing this concern, bio-fertilizers emerge as a beneficial alternative. Microorganisms play an essential role in chemical transformations in soils, impacting major nutrient accessibility for plants. The use of biofertilizers like Azospeillum, Azotobacter, blue-green algae, VAM, and phosphate-solubilizing bacteria (PSB) can reduce fertilizer application by 20–50%, enhancing crop productivity [Singh et al., 1997].

The utilization of live, beneficial microorganisms in the form of biofertilizers is economically feasible and serves as a self-sustaining source of nitrogen. Non-symbiotic bacteria like Azospeillium and Azotobacter are potential biofertilizers. Azotobacter, for instance, synthesizes compounds promoting plant growth, such as cytokinins, gibberellins, aurins, and certain antibiotic metabolites [Doran et al., 2019; Genc, Y et al., 2000]. Nitrogen, a key structural component of cells, constitutes about 5% of the primary cell wall and varying amounts in cell organelles. It is an integral part of various metabolically active compounds in plant metabolism, including proteins, amino acids, nucleic acids, prophyrin, flavins, purines, pyrimidines, nucleotides, enzymes, and alkaloids.

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Materials and Methods

A field trial was conducted at Rama University's agricultural farm in Kanpur during the Rabi season of 2022–2023 to assess the effects of different fertilization treatments on wheat. The sandy loam soil at the experimental site had a pH of 7.5, low organic carbon content, and a slightly alkaline reaction. Medium levels of available phosphorus and potash were observed. The experimental design employed a randomized block with twelve treatments and three replications. Treatments included control (T1), 0 Kg/ha (N) + 40 Kg/ha P2O5 (T2), 0 Kg/ha (N) + 80 Kg/ha P2O5 (T3), 50 kg/ha (N) + 0 kg/ha P2O5 (T4), 50 kg/ha (N) + 40 kg/ha P2O5 (T5), 50 kg/ha (N) + 80 kg/ha P2O5 (T6), 100 kg/ha (N) + 0 kg/ha P2O5 (T7), 100 kg/ha (N) + 40 kg/ha P2O5 (T8), 100 kg/ha (N) + 80 kg/ha P2O5 (T9), 150 kg/ha (N) + 0 kg/ha P2O5 (T10), 150 kg/ha (N) + 40 kg/ha P2O5 (T11), and 150 kg/ha (N) + 80 kg/ha P2O5 (T12).

Wheat seeds (W.H. 291) were sown on December 12, 2022, with a row spacing of 22.5 cm. At sowing, a full dose of phosphorus and potash along with half the nitrogen dose were applied. The remaining nitrogen was top-dressed in two equal portions, one after the initial irrigation and the other at the onset of the panicle. The chapter presents tables depicting the experimental results for mother shoots, shoot density at the maximum tillering stage, ear density at harvest, production of various fertilization populations at different stages, and the economics of various nitrogen and phosphorus fertilization treatments. Bar diagrams are utilized to illustrate key findings when necessary, and the appendices provide the analysis of variance results.

4. Results and Discussion

3.1 *Effect on Growth Parameters*

3.1.1. Plant height (cm) As the plants continued to grow, there was a noticeable increase in plant height, as indicated in Table 1. Regarding statistical significance, treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5) exhibited the highest plant height (97.62 cm), followed by treatment T8 (100 kg/ha (N) + 40 kg/ha P2O5) and treatment T7 (100 kg/ha (N) + 0 kg/ha P2O5). Achieving 75% of the recommended NPK rate, along with higher plant height compared to other fertility treatments, represents the maximum achievable outcome. Nitrogen, being a vital component of proteins, amino acids, and plant protoplasm, directly influenced plant growth and development by enhancing photosynthesis. The crop generated biomass when nitrogen, in adequate amounts as N_2, was present. Previous studies have consistently reported positive effects of NPK fertilizer on wheat growth, as observed by Genc et al. (2000). A similar study indicated that NPK inoculation significantly increased wheat plant height, ear length, and grain yield (Morsy and Moussa, 1998).

3.1.2. No. of tillers (m^{-2})

At harvest, the highest number of tillers treated with T5 (50 kg/ha (N) + 40 kg/ha P2O5) was 285.66. At harvest, a similar trend in the number of tillers was also observed with all the respective treatments; the maximum number of tillers was obtained with T5 (50 kg/ha (N) + 40 kg/ha P2O5). The minimum number of tillers was recorded with control treatment 221.00 and 215.66. For each treatment, a percentage increase in the number of tillers was observed. The number of tillers at all growth stages was substantially impacted by the levels of zinc and phosphorus. (Sekhawat and Swami, S., 2019).

3.1.3 Dry matter accumulation (g/plant)

The weight of the plant's dry matter increased in tandem with the crop's growth, as shown in Table 1. Treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5) showed a notable and maximum dry matter accumulation (16.53 g/plant). However, treatment T7 yielded results that were statistically similar to those of treatment T8. Jana et al. (2002), P.K. Numerous workers have reported that N2 fertilizers have a positive effect on wheat's dry matter. Wheat received N2 and P2O5 fertilization to a dry weight that was comparable to wheat that received 100% fertilization. Mahmoud (1991) reported that urea, without inoculation, improved plant height, shoot dry weight, and grain yield development more significantly in terms of N_2 uptake. (B. Sade and B. Chenbaev (2002)

4.1. Yield Attributes and Yields

3.2.1 Number of effective tiller per (cm^{-2})

In treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5), a notable and highest count of effective ear head per (cm-2) (285.66) was observed (Table 2). However, the treatment administered to T11, T8, T4, and T12 showed statistically similar outcomes to treatment T2, as reported by Al-Juthery *et al.* (2018).

3.2.2 Number of grains per ear head

Significantly more grains per ear head (12.93) were found in the treatment ear head, which showed statistically comparable outcomes to treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5). However, the treatment was much better than the other treatments and on par with T8 and T1. The phosphorus application rate showed a positive quadratic relationship with wheat grain. Our results are consistent with those published by Ojha et

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al. (2023). According to Morsy, M.A. and Moussa, A.M. (1998), market-driven NPK inoculation enhanced wheat grain yield, ear length, and plant height. According to Singh, Mahendra, and Yadav B.L. (2004), the application of 150 and 180 kg N ha-1 was equivalent in terms of greatly boosting growth yield parameters, including grain yield.

3.2.3 Test weight (g)

The findings show that treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5) saw the highest test weight (44.99). However, therapy T9 However, in comparison to the other treatments, T9 and T1 treatment is on par. Several workers had noted similar outcomes (Singh Yadav 2018).

3.2.4 Spike length (cm)

Results show that treatment T5(50 kg/ha (N) + 40 kg/ha P2O5) showed the maximum Spike length (10.22 cm). However, in comparison to the other treatments, T3 and T10 treatment is on par. The same study found that NPK inoculation significantly raised wheat plant height, ear length, and grain yield. In 1998, Morsy, M.A. and Moussa, A.M.

3.2.5 Grain yield (kg ha^{-1})

Treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5) exhibited a substantial and increased grain yield, reaching 40.75 quintals/ha. Notably, treatments T11 and T6 were found to be superior to the other treatments. The grain yield was significantly influenced by nitrogen, with reports suggesting that urea's synergistic effect enhances the efficiency of traditional fertilizers. This enhancement promotes optimal nutrient absorption by plant cells, leading to improved growth and metabolic processes such as photosynthesis. The increased photosynthetic accumulation and translocation to the plant's economic parts result in a higher yield, attributed to strengthened sources (leaves) and sinks (economic parts) (Ojha et al., 2023). Singh, Mahendra, and Yadav B.L. (2004) reported that the application of 150 and 180 kg N ha-1 had equivalent effects in significantly enhancing growth yield parameters, including grain yield. Additionally, the same study noted that NPK inoculation significantly increased wheat plant height, ear length, and grain yield (Moussa and Morsy, 1998).

4.2.1 Straw yield (q ha^{-1})

The findings showed that treatment T7 had a higher straw yield (47.59 quintals/ha). However, therapy at level T11 and T2. On the other hand, treatment T1 had the lowest

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straw yield. Similar findings were reported by Swami, S. and Sekhawat (2019); according to Vasudeva and Anathanarayana, R. (2001), the maximum straw yield was recorded with 150% NPK.

Conclusion

In summary, it can be concluded that treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5) stands out as the most effective fertilizer treatment, showcasing positive outcomes in terms of growth, yield, nutrient uptake, and fertilizer productivity, as indicated by the aforementioned results. The application of 50, 100, or 150 kg of nitrogen demonstrates a favorable influence on various growth parameters, yield, and yield attributes of wheat. The incorporation of 0, 40, and 80 kg P2O5, along with treatment T5, and the application of 50, 100, and 150 kg nitrogen contribute to enhancing soil health and productivity. It's important to note that these findings are based on a single season, and further research may be necessary to provide more comprehensive insights. The study's results suggest that supplementing urea to the conventional NPK nutrient supply has an overall positive impact on the growth and yield characteristics of irrigated wheat.

Table no. 1. Effect of nitrogen, P2O5 fertilization on the growth of wheat.

No. of Treatment	Plant Height (cm)	Dry matter accumulation (gm plant^{-1}) At harvesting stage	No. of tillers (m-2) At harvesting stage
T_1 (N_0P_0)	63.42	7.82	149.00
T_2 (N_0P_1)	87.65	13.66	246.00
T_3 (N_0P_2)	86.48	13.75	246.00
T_4 (N_1P_0)	83.53	13.50	251.66
T_5 (N_1P_1)	97.62	16.53	285.66
T_6 (N_1P_2)	91.14	13.82	215.00
T_7 (N_2P_0)	95.80	15.44	222.36
T_8 (N_2P_1)	96.75	15.22	255.66
T_9 (N_2P_2)	89.48	14.00	236.33
T_{10} (N_3P_0)	95.75	15.00	246.00
T_{11} (N_3P_1)	93.39	14.77	261.00
T_{12} (N_3P_2)	90.30	13.71	237.33
Sem $\pm$	0.83	0.32	0.28

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CD (P = 2.25%)	0.26	0.92	0.56

Table no. 2 Effect of nitrogen, P2 O5 fertilization on the growth & yield of wheat.

S. No.	No. of Treatment	Number of grains per ear head	Test weight (g)	Length of ear (cm)	Grain yield q/ha	Straw yield q/ha
1.	T_1 (N_0P_0)	11.05	29.54	3.57	25.19	30.21
2.	T_2 (N_0P_1)	9.20	42.87	9.33	37.30	44.75
3.	T_3 (N_0P_2)	8.93	43.38	9.66	37.15	45.02
4.	T_4 (N_1P_0)	7.60	42.11	9.44	36.62	44.06
5.	T_5 (N_1P_1)	12.93	44.99	10.22	40.75	47.59
6.	T_6 (N_1P_2)	10.67	43.45	9.33	37.99	44.12
7.	T_7 (N_2P_0)	11.00	44.25	10.32	39.96	47.02
8.	T_8 (N_2P_1)	11.50	44.36	10.11	40.11	44.27
9.	T_9 (N_2P_2)	10.67	43.64	9.33	37.64	44.27
10.	T_{10} (N_3P_0)	10.98	43.64	9.55	39.29	47.00
11.	T_{11} (N_3P_1)	10.93	43.86	9.33	38.47	44.60
12.	T_{12} (N_3P_2)	9.55	42.05	9.05	32.41	42.56
Sem $\pm$		1.78	0.21	0.79	0.20	0.94
CD 0.05 %		5.21	0.61	2.32	0.59	2.75

References

1. Al-Juthery H. W. A., H. Abdul Kareem., Radhi F. Musa; R.F.Musa and A.H. Sahan. 2018. Maximize Growth and Yield of Wheat by Foliar application of Complete Nano-fertilizer and Some of Bio stimulators. Res. Crops 19:387-393.
2. Al-juthery h. W.a., ali n. S., al-taee d & ali e.a. h . M. 2018. The impact of foliar application of nanaofertilizer, seaweed and hypertonic on yield of potato; Plant

Archive.18(2),2207-2212.

3. Al-Juthery, H. W., Habeeb, K. H., Altaee, F. J. K., AL-Taey, D. K., & Al-Tawaha, A. R. M. (2018). Effect of foliar application of different sources of nano-fertilizers on growth and yield of wheat. Bioscience research, (4), 3976-3985.
4. Channabasavanna, A.S; Yelamali, S.G; Biradar, D.P. (2001). Response of rice (Oryza sativa) to sources of organic manures and levels of Nitrogen sulphate in deep black soils. Indian Journal of Agronomy, 46(3): 458-461.
5. Chaturvedi, I. (2006). Effects of different phosphorus levels on growth, yield and nutrient uptake of Wheat (Triticum aestivum L.) (Triticum aestivum L.). International Journal of Plant Science, Muzaffarnagar, 1(2): 278-281.
6. Doran, I; Aknc, C; Yldrm, M; Gul, I. and Kaya, Z. (2019). Effects of different Nitrogen application methods on agronomic traits of durum Wheat (Triticum aestivum L.) in a semi and Anatolian environment. Asian Journal of Chemistry, 21(5): 3772-3780.
7. Genc, Y; McDonald, G.K. and Graham, R.D. (2000). Effect of seed Nitrogen content on early growth of Wheat (Triticum aestivum L.) (Hordeum vulgare L.) under low and adequate soil Nitrogen supply. Australian Journal of Agricultural Research, 51(1): 37- 45.
8. Genc, Y; McDonald, G.K. and Graham, R.D. (2000). Effect of seed Nitrogen content on early growth of Wheat (Triticum aestivum L.) (Hordeum vulgare L.) under low and adequate soil Nitrogen supply. Australian Journal of Agricultural Research, 51(1): 37- 45.
9. Jana, P.K; Ghatak, R; Sounda, G and Ghosh, R.K. (2002). Response of Wheat (Triticum aestivum L.) to levels of Nitrogen sulphate at farmer's field in red laterite soils. Environment and Ecology. 23(2): 360-361.
10. Kenbaev, B. and Sade, B. (2002). Response of field grown Wheat (Triticum aestivum L.) cultivars grown on Nitrogen deficient soil to Nitrogen application. Communications in Soil Science and Plant Analysis, 33(3): 533-544.
11. Mahmoud (1991). Response of plant to Nitrogen as influenced by phosphorus fertilization. Annal of Agricultural Science, 35(1): 587-594.
12. Morsy, M.A. and Moussa, A.M. (1998). Effect of Nitrogen application on rice yield under Wheat (Triticum aestivum L.)-rice system. Response of some long spike Wheat (Triticum aestivum L.) varieties to different levels of Nitrogen foliar application. Annals of Agricultural Science, 36(4): 2751-2760.
13. Morsy, M.A. and Moussa, A.M. (1998). Effect of Nitrogen application on rice yield

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 UGC CARE Listed (Group -I) Journal Volume 11, Iss 04, 2022

under Wheat (Triticum aestivum L.)-rice system. Response of some long spike Wheat (Triticum aestivum L.) varieties to different levels of Nitrogen foliar application. Annals of Agricultural Science, 36(4): 2751-2760.

14. Singh, Mahendra and Yadav B.L. (2004). Response of organic materials and Nitrogen on yield of Wheat (Triticum aestivum L.) at Nitrogen optimization under high RSC water irrigation. Environment and Ecology, 26(2): 553-556.
15. Singh, Mahendra and Yadav, B.L. (2018). Effect of Nitrogen and organic materials on transformation of Nitrogen and chemical properties in sodic soil. Asian Journal of Soil Science, 3(1): 45-48.
16. Singh, R; Sharma, P.R; Singh, M; Sharma, R. and Laura, R.D. (1997). Phosphorus, sulphur and Nitrogen interactions in Wheat (Triticum aestivum L.) (Hordeum vulgare L.) yield, phosphorus concentration and its uptake. Crop Research, 13(3): 571-577.
17. Swami, S. and Shekhawat, Kapila. (2019). Influence of Nitrogen under different moisture regimes on yield and nutrient uptake or rice in inceptisol. Agricultural Science Digest, 29(2): 36-38.
18. Swami, S. and Shekhawat, Kapila. (2019). Influence of Nitrogen under different moisture regimes on yield and nutrient uptake or rice in inceptisol. Agricultural Science Digest, 29(2): 36-38.
19. Vasudeva; and Ananthanarayana, R. (2001). Response of paddy to different levels of Nitrogen application based on adsorption maxima in acid soils of Karnataka. Madras Agricultural Journal, 88(1): 498-500.