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

Abstract

One of the most important cereal crops in the world, wheat (*Triticum aestivum* L.) provides a staple diet for a large proportion of the world's population. The use of chemical fertilizers in modern agriculture increases the risk to the environment in the quest for higher yields. On the other hand, applying urea and phosphorus presents a possible way to somewhat reduce this risk. To achieve this goal, a field trial was carried out as an experiment during the Rabi season of 2022–23 at the farm of R.M.P. (P.G.) College Gurukul–Narsan, Haridwar (U.K.) in order to address this objective. Sand loam soil 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 used for the experiment. Uttar Pradesh. "Effect of Nitrogen and Phosphorus Fertilization on the Growth and Yield of Wheat (Triticum aestivum L.)" was the main topic of the study. The common dosage for the experimental design was 40 kg N + 80 kg. P2O5 was administered to every treatment. The experiment was designed using a Randomized Block Design (RBD) with 12 treatments spread across three replications, along with a control group. Based on the results, it was found that the mixture of 40 kg/ha P2O5 and 50 kg/ha (N) significantly improved yield, growth, and other yield parameters. The data for treatment 5 showed the highest values for the following parameters: plant height (97.62 cm),),number of tillers m-2 (375.00), dry matter accumulation (16.53 g /plant), test weight (44.99g , 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.

Introduction

The most significant and extensively grown crop in the world is wheat (*Triticum aestivum* L.), one of the cereals. During 2022–2023, there were about 215 million hectares of wheat planted worldwide, yielding a production of 715.6 million tons (or 2665 tons of grain yield per hectare). Since wheat makes up 35% of staple foods and makes up 17% of the total, increasing its production is crucial for ensuring food security. Even though wheat is significant in Ethipoia, the country's yield is only 1.3 tons ha-1, which is 24% less than both the average yield in Africa and the world [Wheat Crop Annual Report 2013, CGIAR Research

Program]. Flour is made from wheat. Pasta, noodles, cakes, biscuits, cookies, and steamed and flat breads are among the food items. (I. Chakravedi, 2006) According to Channabasavanna et al. (2001), fermentation produces beer and extra alocholic beverages. According to the data, China produces 126.2 million metric tons of wheat, while India is the second-largest producer at 95.9% million tons from an area of roughly 30.75 million hectares with productivity of 31.19 kg/ha.

Due to intensive cropping, the amount of nitrogen required per unit area has increased significantly. However, the sharp rise in fertilizer prices has created a significant barrier to the supply of all the fertilizers required for higher productivity. These chemical fertilizers are expensive and increase the cost of production, but they also present health risks and problems with soil microbial populations. The use of bio-fertilizers can be very beneficial in this circumstance. An essential role for microorganisms in chemical transformations Because soils have an impact on the major nutrients that plants can access, such as nitrogen, phosphorus, potassium, and sulfur, applying fertilizer can be cut by 20–50% by using biofertilizers. To boost crop productivity, biofertilizers such as Azospeillum, Azotobacter, blue green algae, VAM, and phosphate soloubilizing bacteria (PSB) can be employed (Singh et al., 1997).

It is undeniably economically feasible to use live, beneficial microorganisms in the form of biofertilizers as a self-generating source of nitrogen. Potential biofertilizers include non-symbiotic bacteria similar Azospeillium and Azotobacter. It has been discovered that azotobactor synthesizes compounds that promote plant growth, including cytokinins, gibberellins, aurins, and certain antibiotic metaboles (Doran, *et al.* 2019). Azotobactor thus plays a beneficial role in plant growth (Genc, Y; *et al*. 2000).

One of the main structural components of a cell is nitrogen. While the primary cell wall contains approximately 5% nitrogen, the cytoplasm and particulate fractions of the cell organelles contain varying amounts of nitrogen, mostly in combination with carbon, hydrogen, oxygen, phosphorus, and sulfur. Because it is a necessary component of many different types of metabolically active compounds, including proteins, amino acids, nucleic acids, prophyrin, flavins, purines, pyrimidines, nucleotides, enzymes, and alkaloids, nitrogen plays a significant role in plant metabolism.

Materials and Methods

At the farm of R.M.P. (P.G.) College Gurukul-Narsan, Haridwar (U.K.), a field trial was held during the Rabi season of 2022–2023 to determine the impact of various fertilization treatments. Observations were made on the growth and development of the ear and grain characters, yield, harvest index of wheat, and population at the appropriate stages. The pH of the sandy loam soil at the experimental site was 7.5. The experimental field's soil had a low organic carbon content and reacted slightly alkaline. Both the available Phosphorus and Potash are medium. A randomised block design comprising twelve treatments and three replications was used to set up the experiment. T1-Control plot, T2-0 Kg/ha (N) + 40 Kg/ha P2O5, and T3-0 Kg/ha (N) + 80 Kg/ha P2O5 were the treatments. T4–50 kg/ha (N) plus 0 kg/ha P2O5, T5–50 kg/ha (N) plus 40 kg/ha P2O5 T6–50 kg/ha (N) + 80 kg/ha P2O5, T7–100 kg/ha (N) + 0 kg/ha P2O5, T8–100 kg/ha (N) + 40 kg/ha P2O5, T9–100 kg/ha (N) + 80 kg/ha P2O5, T10–150 kg/ha (N) + 0 kg/ha P2O5, T11–150 kg/ha (N) + 40 kg/ha P2O5, T12–150 kg/ha (N) + 80 kg/ha P2O5. On December 12, 2022, wheat seeds (W.H. 291) were planted with a row spacing of 22.5 cm. A dosage of 40 kg N and 80 kg P2O5 fertilizer At the time of sowing, a full dose of phosphorus and potash and a half dose of nitrogen were drilled. The remaining half of the nitrogen dose was top-dressed in two equal portions, one following the initial irrigation and the other at the onset of the panicle.

This chapter includes tables that show the experimental results for mother shoots, shoot density at the maximum tillering stage, ear destiny at harvest, production of various fertilization populations at different stages, and the economics of various nitrogen and phosphorus fertilization treatments. When deemed necessary, bar diagrams have also been used to illustrate the main findings. The appendices contain the analysis of variance results.

3. Results and Discussion

3.1 Effect on Growth Parameters

3.1.1. Plant height (cm)

As the growth progressed, a discernible increase in plant height was noted, as shown in (Table 1). In terms of statistical significance, treatment T5 (50 kg/ha (N) + 40 kg/ha P2O5) yielded 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).

Obtaining 75% of the suggested rate of NPK in addition to a higher plant height than other fertility treatments is the maximum that can be achieved. Because it is a crucial component of proteins, amino acids, and proto plants, nitrogen had a direct impact on plant growth and development by improving photosynthesis. When combined with a sufficient amount of N_2, the crop generated biomass. Many researchers have previously reported on the positive effects of NPK fertilizer on wheat growth (Genc, Y; R.D. et al., 2000). A similar study found that NPK inoculation significantly increased wheat plant height, ear length, and grain yield (Morsy, M.A. and Moussa, A.M. (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)

3.2. 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 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) showed a significant and elevated grain yield (40.75 quintals/ha). Treatment at par T11 and T6, however, was noticeably better than rest treatments. Grain yield was found to be significantly impacted by nitrogen. There are reports that state that urea's synergistic effect increases the effectiveness of conventional fertilizers, causing plant cells to absorb nutrients optimally, which in turn promotes optimal growth and metabolic processes like photosynthesis. Higher photosynthesis accumulation and translocation to the plant's economic parts follow, which in turn lead to a higher yield that is attributed to stronger sources (leaves) and sinks (economic parts) Ojha et al. 2023. 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. The same study found that NPK inoculation significantly raised wheat plant height, ear length, and grain yield. In 1998, Moussa, A.M. and Morsy, M.A.

3.2.6 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 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 conclusion, it can be said that treatment T5(50 kg/ha (N) + 40 kg/ha P2O5) is the best fertilizer treatment in terms of growth, yield, nutrient uptake, and fertilizer productivity. This is based on the results mentioned above. Applying 50, 100, or 150 kg of nitrogen has a positive impact on wheat's growth parameters, yield, and yield attributes. Apply 0, 40, and 80 kg P2O5 along with treatment (T5) and 50, 100, and 150 kg nitrogen to improve soil health and productivity. It's crucial to remember that these findings are based on a single season, and more research may be required to provide more assurance. The study's findings showed that adding urea to conventional NPK nutrient supply had a generally positive impact on the growth and yield characteristics of wheat grown under irrigation.

Table no. 1.Effect of nitrogen, P2O5 fertilizationon 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
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

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