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

Abstract

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.) to identify optimum Nitrogen and phosphorus fertilizers rates.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: growth, nitrogen, phosphorus, RBD, wheat, yield attributes and yield.

Introduction

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.Wheat Flour is used for Pasta making, noodles, cakes, biscuits, cookies, and steamed and flat breads are among the food items(Chakravedi, 2006).

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.

Nitrogen and phosphorus are essential elements that play a vital role in the plant's metabolic activities. Macronutrient nitrogen occupies an important place in the plant metabolism system where it is an essential component of a protein associated with all vital processes in plants (Stewart *et al*., 2005). In particular, nitrogen (N) and phosphorus (P) supply can play a vital role in plant development and optimal grain yield (Mussarat *et al.*, 2021). On the one hand, fertilization increases production costs, but on the other hand, the correct amount of fertilizer distributed at the right moment can enhance both wheat quality and quantity (Mandic *et al*., 2015; Ferrari *et al*., 2016). In plants, N is a key component of proteins, enzymes, and chlorophyll, thus affecting photosynthesis, substance synthesis and distribution, organ construction, and physiological processes (Maathuis, 2009).In soil, N is mainly related to the soil organic matter (OM), as it is a component of OM and is subjected to transformation via microorganism activity (Cotrufo *et al*., 2013; Kallenbach *et al*., 2013). Different nitrogen and phosphorus levels significantly affect the agronomic parameters like, plant height, grain spike, thousand grain weight and root biomass (Ahmed *et al*., 2010). P is involved in cellular respiration and energy transfer via adenosine triphosphate (ATP) and participates in the formation of cellular membranes and physiologic processes such as cell division and development in the roots and the growing tip (Maathuis, 2009; Plaxton and Tran, 2011). Phosphorus in adequate amount is necessary for earlier maturity, rapid growth and improves the quality of vegetative growth (Khan*et al*., 2014). Soils contain usually high pools of total P, but a small amount of readily available P. The P availability is mainly influenced by soil pH. Deficiency of phosphorus is responsible for small ears in maize due to crooked and missing rows as kernel twist (Masood *et al*., 2011).

Appropriate and balanced fertilization on wheat is not only cause's yield enhancement but also has good impact on phosphorus uptake by these crop plants (Rehman *et al.*, 2006). Better matching of N and P fertilizers at rates suitable to the local climate and soil type can increase the productivity of wheat (Soofizada *et al*., 2023). Determining the appropriate NP fertilizer combinations rate is hence necessary for maximizing wheat economic yields. Therefore, the objective of this study is to determine the optimum N and P combination rates for the study area.

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)

The analysis of variance or statistical analysis indicated that plant height was significantly ($P \leq 0.05$) affected by NP fertilizer combination (Table 1). The tallest plant (97.62 cm) was recorded from the treatments combination of 50 kg N ha^{-1} with 40 kg $P_2O_5ha^{-1}$ followed by treatment 100 kg N ha^{-1} with 40 kg $P_2O_5ha^{-1}$and the shortest plant height (63.42cm) was obtained from control. This might be due to Nitrogen is a crucial component of proteins, amino acids, and proto plants, nitrogen had a direct impact on plant growth and development by improving photosynthesis. The combination of phosphorus fertilizer with a sufficient amount of Nitrogen generated high amount of biomass and the plant height may increase. (Genc *et al*., 2000) reported that the positive effects of NPK fertilizer on wheat growth. A similar study found that NPK inoculation significantly increased wheat plant height, ear length, and grain yield (Morsy and Moussa, 1998).

3.1.2. No. of total tillers

At harvest, the analysis of variance indicated that number of total tiller produced was highly significant or significant ($P < 0.05$) affected by the combined N and P fertilizers (Table 1). The highest number of tillers (285.66) counted at tillering stage was recorded from treatment combinations of 50 kg N ha^{-1} with 40 kg $P_2O_5ha^{-1}$ while the minimum number of tillers (149) was recorded with control treatment. 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, 2019).

Dry matter accumulation (g $plant^{-1}$)

The weight of the plant's dry matter increased with the crop's growth (Table 1). The treatment combination of 50 kg N ha^{-1} with 40 kg P_2O_5 ha^{-1} showed maximum dry matter accumulation of (16.53 g/plant). Jana *et al*. (2002) have reported that Nitrogen fertilizers have a positive effect on wheat's dry matter. Wheat received N and P_2O_5 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 uptake.

3.2. Yield Attributes and Yields

3.2.1 Number of effective tiller

Treatment 50 kg N ha^{-1} with 40 kg $P_2O_5ha^{-1}$, counts thehighest(285.66) effective per spike. (Table 2). Similar was reported by Al-Juthery *et al.* (2018).

3.2.2 Number of grains per spike

The result revealed that NP fertilizer showed significant effect with respect to the number of grains per spike. The highest number of grains (12.93) per spike was recorded from treatments 50 kg N ha^{-1} with 40 kg P_2O_5 ha^{-1} while the minimum (7.60) were recorded from treatment 50 kg N ha^{-1} with 0 kg P_2O_5 ha^{-1}. This may bedue to the phosphorus application rate showed a positive quadratic relationship with wheat grain. The results are consistent with Ojha *et al*. (2023). Similarly, (Singh *et al*., 2004) reported that 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 50 kg N ha^{-1} with 40 kg P_2O_5 ha^{-1} showed the highest test weight (44.99) and the lowest was recorded from no fertilizer. Similar, outcomes was reported by (Singh, 2018).

3.2.4 Spike length (cm)

Results show that the longest spikes (10.22 cm) was recorded at the combined application of both 50 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} fertilizers, whereas the shortest spikes (3.57 cm) was recorded under no fertilizer application (Table 2). The same study by Morsy and Moussa (1998) found that NPK inoculation significantly raised wheat plant height, ear length, and grain yield.

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

The result regarding grain yield showed that grain yield was found to be significantly impacted by combination of N and P fertilizer application. The highest grain yield (40.75qha^{-1}) was obtained from 50 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} fertilizer rates. While the lowest (25.19 qha^{-1}) grain yields were recorded from zero fertilizer applications (Table 2). This may be due to urea's synergistic effect increases the effectiveness of causing plant cells to absorb optimal nutrients, 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 or leaves and sinks or economic parts (Ojha *et al*., 2023). According to Singh *et al*., 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 by (Moussa and Morsy, 1998) found that NPK inoculation significantly raised wheat plant height, ear length, and grain yield.

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

The findings showed that the highest straw yield of 47.59 q ha^{-1} was obtained at 50 kg N ha^{-1} and 40 kg P_2O_5 ha^{-1} fertilizer rates whereas the lowest straw yields of 30.21 q ha^{-1} was from the control (Table 2). The result is consistent with that of (Nasser and El-Gizawy, 2009) who reported increased straw yield of wheat with increase in NP fertilizers rates up to 90/45 kg ha^{-1}. Similar findings were reported by (Swami and Sekhawat, 2019); (Vasudeva and Anathanarayana, 2001) reported the maximum straw yield was recorded with 150% NPK.

Conclusion

As conclusions, the Phosphorus either Nitrogen fertilizer alone or high quantity does not increase the yield of wheat. The fertilizer rates of 50 kg N ha^{-1} with 40 kg P_2O_5 ha^{-1} are significantlyincreased wheat growth and yields. However, as one-season and one-location experiment, the experiment has to be repeated over locations and seasons together for further recommendations.

Table no. 1.Effect of nitrogen, P_2O_5fertilization 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 ±	0.83	0.32	0.28
CD (P = 2.25%)	0.26	0.92	0.56

Table no. 2 Effect of nitrogen, P_2O_5 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 ±		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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