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Performance of different levels of nitrogen on growth, yield and cost effectivity of wheat (*Triticum aestivum* L.)

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Abstract
This research investigates the influence of seven nitrogen levels, with Treatment 1 serving as the control, on the growth and yield of wheat (*Triticum aestivum* L.) in a field experiment conducted at the experimental field of Sardar Patel University, Balaghat, during the Rabi season of 2022-23. The study aimed to assess the effects of different nitrogen levels on key growth and yield parameters, including the number of tillers, plant height, spikelets per spike, number of grains per panicle, grain yield, straw yield, test weight, and harvest index. Data collected revealed a significant positive impact of different nitrogen levels on all assessed parameters. The nitrogen level in Treatment 4, specifically at 80 kg per hectare, demonstrated remarkable results across multiple metrics. Notably, Treatment 4 exhibited the maximum number of tillers, the tallest plant height, and the highest yield.
The findings underscore the importance of nitrogen management in optimizing wheat crop performance. The increased number of tillers suggests enhanced vegetative growth, while the taller plant height indicates robust plant development. Moreover, the positive effects of nitrogen were evident in the reproductive phase, as reflected by higher spikelets per spike and grains per panicle. The ultimate manifestation of these positive influences was observed in the significantly higher grain yield and straw yield in Treatment 4.

Keywords: Nitrogen, wheat, growth, yield, rabi

1. Introduction
Wheat, a preeminent crop as a food of mankind, is originated in the Central Asian region, which has 225 million ha with global production of 750 million tons. India holds the second position with 109.52 million tons of production and contributes 13% share to the global wheat basket. Wheat acreage has five zones in India where bread, durum, and dicoccum wheat are grown during the rabi season under different production conditions. Nowadays, stagnating yield potential, unavailability of sufficient quantity of quality seeds, low seed replacement, biotic and abiotic stresses in climate change conditions, restrictions to germplasm exchange in new IPR regime, reduced total factor productivity, imbalanced use of fertilizers and yield gaps at farm level have been identified as major challenges to wheat production in the country (Singh *et al.*, 2023) [1].
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. Nitrogen insufficiency influences biomass synthesis and use of sun energy for productivity of the plant, with an extraordinary effect on grain yield and yield contributing parameters (Heinemann *et al.*, 2006) [2]. Nitrogen plays an important role in plant metabolism. All plant processes are related to nitrogen. In fact, nitrogen is a constitutive component of chlorophyll and proteins affecting photosynthesis process. The wheat needs of nitrogen is a complex trait depending on genotypes, years, sites, stage of development, soil type, tillage methods, crop rotation and amount and type of nitrogen fertilizer (López-Bellido *et al.*, 2001) [4]. The sources of chemical fertilizer have a significant role in nutrients availability and crop productivity. The NH4-N promoted more leaf and stem growth than NO3-N in wheat but did not affect the grain yield (Spratt and Gasser, 1970) [5]. However sometimes more application of nitrogen application results in toxicity and harms the plant growth by making it more susceptible to lodging, causing environmental pollution through nitrate leaching and volatilization in form of ammonia. Thus, keeping in mind, the importance of Nitrogen in increasing yield of crops, the present study was conducted to determine an optimum level of Nitrogen, with which economic yield of wheat can be increased.

2. Materials and Methods

The research was carried out during rabi season in the Research Farm from 2022 to 2023 in Sardar Patel University, Balaghat (M.P). Balaghat is located at latitude at 21° 48' north and longitude 80° 11' east at the elevation of 288 m above mean sea level (MSL) and lies under sub-tropical zone with assured but variable rainfall in kharif season, normally cool rabi and associated with hot and dry summer.

Experiment was laid out in randomized block design with 3 replications and 7 levels of Nitrogen treatments T1(Control), T_2(40:40:40 NPK/ha), T_3(60:40:40 NPK/ha), T4(80:40:40 NPK/ha), T_5(100:40:40 NPK/ha), T_6(120:40:40 NPK/ha), T_7(140:40:40 NPK/ha) as of total

21 treatments in all. Wheat seeds were sown at spacing of 22.5 x 5 cm in the experimental field on 13th November 2022 during Rabi season. The parameters were calculated at different intervals such as 30 DAS, 50 DAS, 90 DAS and at time of Harvest.

3. Results and Discussion

3.1 Pre-harvest studies

3.1.1 Plant height (cm)

At 90 DAS the significantly and higher plant height was observed in treatment T_4 (104.09 cm) at the rate of 80:40:40 NPK/ha. However, T_5 (100:40:40 NPK/ha) (102.50 cm) and T_3 (60:40:40 NPK/ha) (100.33 cm) were statistically at par to T_4 (104.09 cm). It is an established fact that organic manure improves the physical, chemical and biological properties of soil and supplies almost all the essential plant nutrients for growth and development of plants along with growth hormones and beneficial microbes which might have developed more favourable environment of nutrients in soil for longer period resulted in increased plant height, new shoots and increased dry matter accumulation. These results are in accordance with the findings of (Atkare and Chaturvedi 2021) [7].

3.1.2 Number of tillers/plant

At 90 DAS the significantly and higher number of tillers/plant was observed in treatment T_4 (16.08) at the rate of 80:40:40 NPK/ha. However, T_5 (100:40:40 NPK/ha) (15.64) and T_3 (60:40:40 NPK/ha) (15.02) were statistically at par to T_4 (16.08).

3.2 Post harvest studies

3.2.1 Number of spikes/plant

At time of Harvest the significantly and higher number of spikes/plant was observed in treatment T_4 (10.52) at the rate of 80:40:40 NPK/ha. However, T_5 (100:40:40 NPK/ha) (10.02) and T_3 (60:40:40 NPK/ha) (9.33) were statistically at par to T_4 (10.52). This might be directly associated with the increased availability of nitrogen through biological fixation and solubility in soil to be readily utilized by the plants as they are atmospheric nitrogen fixers. The results of the present investigation are in conformity with those of (Mali *et al*., 2016) [8] and (Neelam *et al*., 2018) [9].

3.2.2 Length of Spike

At time of Harvest the significantly and higher length of spikes was observed in treatment T_4 (12.23) at the rate of 80:40:40 NPK/ha. However, T5 (100:40:40 NPK/ha) (11.72) and T_3 (60:40:40 NPK/ha) (11.13) were statistically at par to T_4 (12.23).

3.2.3 Number of grains per spike

At time of Harvest the significantly and higher number of grains/spikes was observed in treatment T_4 (47.81) at the rate of 80:40:40 NPK/ha. However, T_5 (100:40:40 NPK/ha) (46.90) and T_3 (60:40:40 NPK/ha) (45.12) were statistically at par to T_4 (47.81). This might be directly associated with the increased availability of nitrogen through biological fixation and solubility in soil to be readily utilized by the plants as they are atmospheric nitrogen fixers. The results of the present investigation are in conformity with those of (Mali *et al*., 2016) [8] and (Neelam *et al*., 2018) [9].

3.2.4 Grain yield kg/ha

At time of Harvest the significantly and higher grain yield was observed in treatment T_4 (4193) at the rate of 80:40:40 NPK/ha. However, T_5 (100:40:40 NPK/ha) (3975) and T_3 (60:40:40 NPK/ha) (3756) were statistically at par to T_4 (4193). This might be due to adequate quantities and balanced proportions of plant nutrients supplied to the crop as per need during the growth period resulting in favourable increase in yield attributing characters which ultimately led towards an increase in economic yield. Similar results were 55 reported by (Kumar and Singh, 2010) [11] and (Mohan *et al*., 2018) [10].

3.2.5 Straw yield kg/ha

At time of Harvest the significantly and higher number of grains/spikes was observed in treatment T4 (5850) at the rate of 80:40:40 NPK/ha. However, T_5 (100:40:40 NPK/ha) (5586) and T_3 (60:40:40 NPK/ha) (5344) were statistically at par to T_4 (5850).

3.2.6 Harvest index (%)

At time of Harvest the significantly and higher number of grains/spikes was observed in treatment T_4 (41.75) at the rate of 80:40:40 NPK/ha. However, T_5 (100:40:40 NPK/ha) (41.57) and T_3 (60:40:40 NPK/ha) (41.28) were statistically at par to T_4 (41.75). Results are in accordance with the reported by (Ram and Mir, 2006).

3.2.7 Economics

Economics analysis of all treatments were calculated according to expenditure incurred from the land preparation till harvesting of the crop. Gross return (t/ha), Net return (t/ha), Cost of Cultivation (INR/ha) were calculated and found to be more profitable in treatment T4 given at 80:40:40 NPK/ha as compared to other levels of treatments and the lowest value was observed in treatment T1 (Control). Similar results were also reported by (Kumar *et al*., 2018) [10].

Table 1: Performance of different levels of nitrogen on pre-harvest studies of Wheat (*Triticum aestivum* L.)

Treatments		Pre-harvest studies (90 DAS)	
		Plant height (cm)	No. of tillers
T_1	Control	89.36	10.73
T_2	40:40:40 NPK/ha	98.33	13.23
T_3	60:40:40 NPK/ha	100.33	15.02
T_4	80:40:40 NPK/ha	104.09	16.08
T_5	100:40:40 NPK/ha	102.50	15.64
T_6	120:40:40 NPK/ha	99.07	14.73
T_7	140:40:40 NPK/ha	95.14	11.75
Grand Mean		25.81	98.40
SE (m) ±		0.07	0.13
CD at 5 %		0.37	0.72

Table 2: Performance of different levels of nitrogen on post-harvest studies of Wheat (*Triticum aestivum* L.)

Treatments		Number of Spikes per plants	Length of Spike (cm)	Number of Grains per Spike	Grain Yield kg/ha	Straw Yield kg/ha	Harvest Index
T_1	Control	6.40	8.20	29.70	2907	4280	40.45
T_2	40:40:40 PK/ha	8.84	10.12	42.65	3182	4567	41.07
T_3	60:40:40 PK/ha	9.33	11.13	45.12	3756	5344	41.28
T_4	80:40:40 PK/ha	10.52	12.23	47.81	4193	5850	41.75
T_5	100:40:40 PK/ha	10.02	11.72	46.90	3975	5586	41.57
T_6	120:40:40 PK/ha	9.05	10.82	44.29	3476	4952	41.24
T_7	140:40:40 NPK/ha	8.17	9.96	42.19	3049	4405	40.90
Grand Mean		8.90	10.60	42.67	3505	4998	41.18
SE (m) ±		0.04	0.04	0.11	13.22	14.78	0.05
CD at 5 %		0.24	0.22	0.60	70.58	78.91	0.25

Table 3: Performance of different levels of nitrogen on Economics of Wheat (*Triticum aestivum* L.)

	Treatments	Total Cost of Cultivation INR/ha	Gross Return INR/ha	Net Profit INR/ha	Benefit Cost Ratio (%)
T_1	Control	25461	74533	49072	2.93
T_2	40:40:40 NPK/ha	26341	81112	54771	3.08
T_3	60:40:40 NPK/ha	26581	95557	68976	3.59
T_4	80:40:40 NPK/ha	26821	106211	79390	3.96
T_5	100:40:40 NPK/ha	27061	100850	73789	3.73
T_6	120:40:40 NPK/ha	27301	88459	61158	3.24
T_7	140:40:40 NPK/ha	27541	77837	50296	2.83
Grand Mean		26729	89222	62493	3.34
SE (m) ±		-	-	-	-
CD at 5 %		-	-	-	-

4. Conclusion

On the basis of trail, it has been founded that the highest growth and yield have been seen in T_4: (80:40:40 NPK/ha) found superior in all the aspects Plant height (cm), Number of tillers (metre-1), Number of spikes/plant, Length of spikes, Number of grains/spikes, Grain yield (kg/ha), Straw yield (kg/ha), Harvest index (%). While the minimum was found from T_1: (Control). However, since this is based on one season experiment, further trials may be needed to substantiate the results. Based on trial, the economic analysis revealed that the maximum profits in terms of Benefit cost ratio was obtained from T_4 (1:3.96) while minimum profit is obtained in T_1 (1:2.93).

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