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Effect of different nitrogen levels on growth and yield of wheat (*Triticum aestivum* L.)

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Abstract
The present investigation entitled "Effects of Different Nitrogen Levels on Growth And Yield Of Wheat (*Triticum aestivum* L)" was conducted during the year 2021-2022 at the Research farm of Agronomy, Dev Bhoomi Uttarakhand University, Manduwala, Dehradun (UK). The experiment consisted of eight treatments T1: control, T2: 25 Kg N+RDF-P&K, T3: 50 Kg N+RDF-P&K, T4: 75 Kg N+RDF-P&K, T5: 100 Kg N+RDF-P&K, T6: 125 Kg N+RDF-P&K, T7: 150 Kg N+RDF-P&K, T8: 175 Kg N+RDF-P&K. The study revealed that, among the treatments,T6 (125 Kg N+RDF-P&K) recorded highest plant height at 30, 60, 90 and harvest (21.82cm, 41.65cm, 71.89cm, 93.56cm), total dry matter per plant at 30, 60, 90 and harvest (18.22g, 30.64g, 64.01g, 100.33g), Leaf are index at 30, 60, 90 and harvest (1.21dm², 3.29dm², 4.55dm² and 4.41dm²) respectively, number of seeds per straw yield (58.367q ha¹), grain yield (5576.0 kg ha¹, biological yield (14728kg ha¹), harvest index (37.85%), cost of cultivation (18,800.33 Rs ha¹), total gross returns (62,908.33 Rs ha¹), net returns ((44108.33 Rs ha¹) and benefit cost ratio (3.34) compared to control. In the present study, it can be concluded that the T6 is the best treatment for wheat variety on basis of Growth and yield.

Keywords: nitrogen, yield, wheat, *Triticum aestivum* L.

Introduction
Wheat (*Triticum aestivum* L.) is a staple food of the world and belongs to family Poaceae (Gramineae). It is a C_3 plant primarily grown in temperate regions and also at higher altitude under tropical climatic areas in winter season. Wheat is the single most important cereal crop that has been considered as integral component of the food security system of the several nations. It has been described as the 'King of cereals' because of the acreage and high productivity which also occupies a prominent position in the international food grain trade. Wheat provides nearly 55% of the carbohydrate and 20% of food calories which is consumed by two billion people (36% of the world population) as staple food. It is said that as a food, wheat is more nutritive as compared to the other cereals. It has good nutrition profile with 12.1 percent protein, 1.8 percent lipids, 1.8 percent ash, 2.0 percent reducing sugars, 6.7 percent pentose's, and provides 314 Kcal/100g of food. Wheat is also a good source of minerals and vitamins *viz*., calcium (37 mg/100g), iron (4.1 mg/100g), thiamine (0.45mg/100g), riboflavin (0.13mg/100g) and nicotinic acid (5.4mg/100mg). Unlike other cereals, wheat contains a high amount of gluten, the protein that provides the elasticity necessary for excellent bread making. Hard wheat is high in protein (10-17%) and yields a flour rich in gluten, making it particularly suitable for yeast breads. Wheat ranks first in the world among the cereals both in respect of area (221.68 million hectare) and production (757.92 million metric tonnes) with productivity of wheat 3.29 tonnes per hectare (FAS/USDA 2016-17). In India, total production of wheat crop was 86.53 metric tonnes from an covered area of 30.23 million hectare during the past 2015-2016 *rabi* season and account for 38% 4th Advance estimate.

Materials and Methods
Experimental site and situation
The experiment was conducted at, Research farm of Department of Agronomy, Dev Bhoomi Uttarakhand University Naugaon Manduwala, Dehradun. The farm lies between 78° 04' E longitude and 30° 13' N latitude, at an elevation of 435 m above MSL and in the lesser Himalayan region.

Topography and climatic condition

The experimental site falls under sub-tropical zone in Uttarakhand region and lies between $26^{0}47^{'}$North latitude, $82^{0}12^{'}$East longitudes, at an altitude of about 113.0 meter from mean sea level and is subjected to extremes of weather conditions. The region received an average rainfall of about 1200 mm out of which about 80% is concentrated from mid June to end of September. The winter months are very cold whereas summer months are hot and dry. Westerly hot winds are started from the April and remain continue till onset of monsoon.

Soil characteristics of the experimental field

In order to determine the fertility status and soil class. Soil samples were taken randomly from different places of the experimental field with the help of soil auger to a depth of 0-15 cm. The collected soil samples were mixed together to make composite sample representing the fertility of the whole field. These samples were air dried and grind with the help of pestle mortar and packed in polythene bag and analysed for different soil parameters.

Design and layout

The experiment was laid out in randomized block design with variety (PANT-505) and treatments of different nitrogen doses with three replications. The experimental field was divided into 24 plots. Each gross plot size was 3m x 3.0 m and net plot size was 2m x 2m and row to row distance was maintained 20 cm.

Treatment details

The treatments and their symbols used in the experiment were given as under:

Table 1: Treatment details

S. No.	Treatment	Symbols
1.	Control	T_1
2.	25 Kg N+RDF-P&K	T_2
3.	50 Kg N+RDF-P&K	T_3
4.	75 Kg N+RDF-P&K	T_4
5.	100 Kg N+RDF-P&K	T_5
6.	125 Kg N+RDF-P&K	T_6
7.	150 Kg N+RDF-P&K	T_7
8.	175 Kg N+RDF-P&K	T_8

Result and Discussion

Plant Height

Different levels of nitrogen affected the plant height significantly. Maximum plant height (107.60 cm) was recorded from treatment T6 where nitrogen was applied @ 125 Kg N+RDF-P&K minimum plant height was recorded form T1 where nitrogen was not applied. As the level of nitrogen increased plant also gradually increased. Cells protein content increase as the application of nitrogen increase and size of plant cell increases, as a result of that leaf area and photosynthesis rate rises which ultimately make the plant taller.

Table 2: Effect of Different Nitrogen Levels on growth and yield of wheat on plant height (cm)

S. No.	Treatments				
		Plant height	No. of Tillers	Dry matter	Leaf area index
T_1	Control	91.02	52.66	95.12	1.74
T_2	25 Kg N+RDF-P&K	91.14	52.88	95.63	3.36
T_3	50 Kg N+RDF-P&K	91.45	53.04	96.01	3.77
T_4	75 Kg N+RDF-P&K	91.71	53.33	96.54	3.87
T_5	100 Kg N+RDF-P&K	91.98	53.48	96.87	3.16
T_6	125 Kg N+RDF-P&K	93.56	55.71	100.33	4.41
T_7	150 Kg N+RDF-P&K	92.04	53.92	98.42	3.62
T_8	175 Kg N+RDF-P&K	92.20	54.05	99.65	3.69
SEm+		0.2822	0.342	0.6804	0.2772
Mean		91.89	53.63	97.32	3.453

Number of Spiklets

Number of spiklets/spike were significantly different in treatments where no application of nitrogen (T1) was done and in T6 (125 Kg N+RDF-P&K) while in other treatments means difference was non-significant. Maximum number of spiklets/spike (19.867) were recorded in T6 (125 Kg N+RDF-P&K) while minimum number of spiklets/spike (18.533) were found in T1 where no nitrogen was applied. Nitrogen has mainly effected on the vegetative growth of plant while at reproductive stage its role is less considerable that's why different levels of nitrogen did not effected the number of spiklets/spike significantly. These results are in contradiction. Many researchers concluded form their studies that if there is more absorption of nitrogen by the plants produce a greater number of spikes per unit are, enhanced vegetative growth and more number of tillers per unit area.

Number of seeds/ spike

Number of seeds per spike were also significantly increased by the high levels of nitrogen application. Maximum number of seeds/ spike (60.133) were recorded from T7 (150 Kg N ha^{-1}) that were also statistically at par to T3, T4, T5, T6 and T8 while minimum were observed in T1 where no nitrogen was applied. Nitrogen promotes the initiation of spiklets that resulted in more number seeds/spike but more nitrogen from 150 Kg N ha^{-1} level decreased the number of seeds due to increased vegetative growth as was observed in case of plant height. These results are quite in line with Gundapur and Bhatti (2002). Nitrogen fertilizer applied in optimum dose decrease the chance of seeds to deteriorate in the spikes otherwise in case of seed deterioration grain yield reduced.

1000 Grain Weight

Due variation in nitrogen levels 1000 grain weight was significantly different. Maximum 1000 grain weight was found in T6 (46.082 g) statistically identical to T5 (45.102 g), while where nitrogen was not applied recorded the minimum grain weight (32.461g). These results indicate that nitrogen

has a key role in the growth and development of grain. These results are similar to those reported by, Patel and Upadhyay (2003) who concluded that higher dose of nitrogen significantly increased grain weight.

Biological Yield

Different levels of nitrogen fertilizer application increased biological significantly. Maximum biological yield (47.87 q) was harvested from T6 (125 Kg N+RDF-P&K), While maximum (39.97 q) was recorded from the treatment where nitrogen was not applied. More application of nitrogen gave tall plants, more grain yield, number of tillers per unit and total dry matter which collectively resulted in higher biological yield.

Grain Yield

Wheat grain yield was also significantly increased by different levels of nitrogen. Maximum grain yield (12.46.q) was obtained from T6 (125 Kg N+RDF-P&K) while minimum grain yield (10.29 q) was recorded from the treatment where no application of nitrogen was done. Among all the essential nutrients applied to the plant's nitrogen is the major one which has a key role in the process of photosynthesis. Increased rate of photosynthesis by the high dose of nitrogen gave more yield because large amount of dry matter, more assimilates were produced and transported to fill the seeds as a result of more applied nitrogen.

Harvest Index

Under different levels of nitrogen harvest index differ significantly. Maximum harvest index (37.857%) was calculated from T6 (125 Kg N+RDF-P&K) while minimum Harvest (17.227%) was calculated from T2 (25 Kg N+RDF-P&K). When harvest index is low it means that there is less translocation of assimilates from the source to sink which results in less development of seeds and make them shriveled size. When harvest index is high it means that more assimilates were translocated from source to the grains which result in improved development and filling. Harvest index is directly associated with the plant dry matter and grain weight which ultimately depends upon the availability and uptake of nutrient specially nitrogen. The more will be the nitrogen amount the more will be growth and development but upto to a certain limit beyond that limit it can cause toxicity to the plant and reduce it yield.

Table 3: Effect Different Nitrogen Levels on Yield attributes of growth and yield of wheat

S. No.	Treatments	Yield attributes			
		No. Spikelet's per spike	Length of ears (cm)	No. of ears Plant^{-1}	Ear Weight (g)
T_1	Control	18.53	7.87	29.40	69.80
T_2	25 Kg N+RDF-P&K	18.90	8.12	33.33	78.81
T_3	50 Kg N+RDF-P&K	18.93	8.17	33.53	76.67
T_4	75 Kg N+RDF-P&K	19.93	8.28	35.47	85.13
T_5	100 Kg N+RDF-P&K	19.16	8.16	34.32	84.40
T_6	125 Kg N+RDF-P&K	19.86	9.50	43.25	93.25
T_7	150 Kg N+RDF-P&K	19.23	8.95	39.40	91.53
T_8	175 Kg N+RDF-P&K	19.36	9.09	42.67	88.67
SEm+		0.139	0.2054	3.344	1.727
Mean		19.17	8.51	84.74	36.42

Summary and Conclusion

The protection measures as per recommendation. The salient features and conclusions drawn are summarized here under. The growth characters of wheat *viz.*, plant height, number of tillers, leaf area index and dry matter accumulation increased significantly with increasing level of nitrogen. Nitrogen level *viz.*, 125 Kg N+RDF-P&K produced significantly the highest values of all growth attributes at all the stages. The yield attributes of wheat *viz.*, number of spikes m^{-2}, spike length, number of grains spike^{-1} and 100-grain weight increased significantly with increasing level of N.

Grain and straw yields significantly increased with increasing levels of nitrogen. Nitrogen level *viz.*, 125 Kg N+RDF-P&K produced higher grain and straw yields. The maximum gross return 71,200.00 was recorded with the application of 125 Kg N+RDF-P&K T6 as compared to other treatments. When nitrogen applied then the maximum net return 50,498.24 benefit cost ratio (3.41) was recorded with application of 150 Kg N+RDF-P&K followed by T_6: 25 Kg N+RDF-P&K net return (Rs. 49,830.33 ha^{-1}), benefit cost ratio (3.39). The best growth and development was observed in T_6 25 Kg N+RDF-P&K) followed by treatment T_8 (175 Kg N+RDF-P&K). The treatment with T_6: 125 Kg N+RDF-P&K, the suitable combination of fertilizers for higher and sustainable wheat production being followed by (100 Kg N+RDF-P&K) T5. During *Rabi* seasons of 2018-19 the highest net return (Rs. 50,498 ha^{-1}) and B:C ratio (3.41).

Credit authorship contribution statement

Savan Kumar, Poonam Gusain, Priya Rawat: Conceptualisation; Methodology; Data curation; Writing-original draft. Prerna Gupta, Minnu Sasi: Review & editing; Validation; Supervision.

Declaration of Competing Interest

The authors declare no conflict of interest.

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