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Effect of different levels of nitrogen on productivity of wheat (*Triticum aestivum* L.)

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Abstract
A field experiment was conducted during *Rabi* 2020-21 at Experimental farm of UIAS, Chandigarh University, Gharuan (Mohali) to study the effect of different levels of nitrogen on productivity of wheat. The experiment consisted of 7 treatments comprising of different nitrogen rates *i.e.* RDF (120% N + 100% P), 25% N + 100% P, 50% N + 100% P, 75% N + 100% P, 125% N + 100% P, 150% N + 100% P and 0% N + 100% P were tested in Randomized block design, replicated 3 times. Results revealed that growth, yield attributes, grain yield and straw yield of wheat were increased with increasing nitrogen rate. Application of 150% N + 100% P being statistically at par with all other treatments and recorded the highest grain yield of wheat over 0% N. Nitrogen application of 150 kg ha^{-1} recorded higher net returns (Rs 71734 ha^{-1}) and net returns per rupee invested (1.35).

Keywords: economics, nitrogen levels, yield, wheat

Introduction
Wheat (*Triticum aestivum* L.) is the second most important cereal crop in the world after rice and is one of the most important stable food crop. Rice-wheat is a major cropping system. These crops are harvested in sequence a year where rice during the wet monsoon season and wheat generally dry and cool winter season. Due to the introduction of high-yielding varieties of rice and wheat, double cropping of these two crops becomes feasible (Hobbs and Morris 1996) [5]. Nitrogen is considered a major element of fertilizer for a good yield. Nitrogen is closely linked to control the vegetative growth of the plant and hence determine the fate of reproductive cycle. Besides N-fertilizer, its application times are also considered a key to high production. Synchronization of fertilizer N supply with plant-N demand reduces the potential for N loss to atmosphere. Similarly, the N use efficiency increases with matching the N supply and demand. The split application of N-fertilizer has been found effective in increasing crop yield compared with the full application of N-fertilizer at sowing time (Ragheb *et al*, 1993) [8]. Based on Alberta research, it appears that with increasing rates of nitrogen fertilizer, wheat yield increases up to some optimal level. Plants grown with an adequate supply of nitrogen make rapid and thrifty growth and are dark green in color. Leaf and stem development is stimulated. Insufficient nitrogen results in lighter green color, reduced tillering, and disturbance of normal cell growth division, and a decrease in rate, and extent of protein synthesis. Because of this crop yields may also be greatly reduced (Alberta, 2019) [2]. Nitrogen is one of the major nutrient which reduce the yield of wheat if not applied in the proper amount as it is needed for the fast growth of plants and to get high production per hectare (Das *et al*, 1993) [3]. N is commonly taken up from the soil in one of two inorganic forms: ammonium (NH^+) and nitrate ($NO3^-$). Different N forms can affect the physiological and metabolic processes of plants, such as nutrient uptake, enzyme activity, photosynthesis rate, respiration rate, water balance, and signaling pathways, thus eventually influencing plant growth and crop yield (Guo *et al*, 2019) [4].

Materials and Methods
The present experiment was conducted in a random block design with three replications to examine the effect of different levels of nitrogen on wheat productivity at an altitude of 309 meters above sea level in the semi-arid, sub-tropical latitude 30º7' N and 76º5' E longitude. The area receives a moderate rainfall 700-800 mm per annum, of which 70-80% received during monsoon months from June to September. The soil of the experimental site was clay loam in texture and nearly neutral in reaction. The soil was rated as low in organic carbon and available nitrogen, medium in available phosphorus and available potassium. The experiment consisted of 3 blocks of seven plots each. Treatments were randomly allocated to each plot using a random number table. The treatments included in this experiment were RDF, 25% N + 100% P, 50% N + 100% P, 75% N + 100% P, 125% N + 100% P,150% N + 100% P and 0% N + 100% P. The layout of the experiment was done manually and the plots were drawn and then flattened with the help of labour. Wheat variety "Unnat PBW-343" was sown using seed rate of 100 kg ha^{-1} in first week on well prepared seed bed in December, 2020. The different fertilizer rate of nitrogen ha^{-1} was used as Basal and top dressing. Nitrogen was added in the form of urea and full dose of phosphorus fertilizers were used at the time of sowing. All the plots were equally irrigated four times during the cropping duration so that hand weeding was done easily to keep the wheat crop free from weeds plants.

Results and discussion
Yield attributes of wheat
A perusal of data on different yield attributes of wheat presented in Table 1 revealed that number of grains per spike and 1000 grain weight were significantly higher due to higher dose of nitrogen. However, the other yield attributes

viz. spike length did not vary significantly due to variation in nitrogen rate.Spike length did not vary significantly with the application of different levels of nitrogen. However, numerically maximum spike length was recorded in nitrogen level of 150 kg ha^{-1}.Maximum number of grains $spike^{-1}$ of wheat was recorded from the treatment where 150% N + 100% P fertilizer applied as basal and top dressing being at par with number of grains per spike recorded from 125% N + 100% P. It might be due to higher nitrogen rate because nitrogen promotes the initiation of spikelets that resulted in more number of grains per spike (Ullah *et al*, 2018) [10]. Similarly, number of grains per spike correlated with biomass and leaf area of crop, as more assimilation and photosynthetic translocation is possible in varieties with higher biomass, thus giving higher number of grains count per spike (Khan Ayaz, 2016) [6] 1000-grain weight was significantly influenced by various levels of nitrogen. The highest test weight of thousand grain weight (46.23) was recorded with 150% N + 100% P which differed significantly from (RDF) 120% N + 100% P, 25% N + 100% P, 50% N + 100% P, 75% N + 100% P and 0% N + 100% P, respectively but it remained statistically at par with 125% N + 100% P. Nitrogen has a key role in the growth and development of grain (Ullah *et al*, 2018) [10]. However, N fertilization in grain filling has a considerable impact on 1000 grain weight (Abedi *et al*, 2011) [1].

Yield of wheat crop

The data on grain yield as influenced by different nitrogen rates have been presented in Table 2. The data revealed that higher nitrogen rate significantly increased the grain yield. Among treatments, 150% N + 100% P produced significantly highest grain yield (4356 kg ha^{-1}) than other treatments. However, it remained statistically at par with 125% N + 100% P. The minimum grain yield per hectare was recorded with 0% N. Among all the essential nutrients applied to the plants, 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 produces more yield due to more production of dry matter (Ullah *et al*, 2018) [10]. The data on straw yield presented in Table 2 revealed that increased level of nitrogen brought about a significant increase in the straw yield of wheat. Maximum yield of straw was recorded with 150% N + 100% P which was statistically at par with nitrogen level of 125% N + 100% P. Various straw yield attributes like higher grain yield showed their additive effect in influencing the straw yield with increasing rate of nitrogen. Ultimately all these straw yield attributes had their pronounced effect in significantly increasing the straw yield of wheat at higher rate of nitrogen application up to 150 kg ha^{-1} (Yadav and Dhanai, 2017) [11]. A perusal of data on biological yield of wheat presented in Table 2revealed that application of 150 kg N ha^{-1} significantly increased the biological yield of wheat crop as compared to other treatments. However, it remained statistically at par with 125% N + 100% P. The increase in biological yield with increase in nitrogen levels may be due to the effect of nitrogen on vegetative growth of wheat as well as increase in tillers number with higher rates of nitrogen. Biological yield and grain yield components increased with higher rate of nitrogen (Shah *et al*, 2011) [9]. The data pertaining to harvest index have been presented in Table 2. The different nitrogen levels did not significantly influence the harvest index of the wheat crop.

Economics of wheat

In order to evaluate the economic feasibility of different treatments, cost of cultivation (Rs 53169 ha^{-1}), gross returns (Rs 124903 ha^{-1}), net returns (Rs 71734) and net returns per rupee invested (1.35) were worked out and the results have been presented in Table 3. However, it remained statistically at par with 125% N + 100% P in case of gross returns and net return. It might be due to the fact that highest dose of nitrogen produced maximum grain and straw yield that positively correlated with economics. Increasing levels of nitrogen up to 150 kg ha^{-1} significantly increased the economics over other treatments. These results obtained in the present investigation were in accordance with those reported by (Pandey *et al*, 2018) [7].

Conclusion

Nitrogen level of 150 kg ha^{-1} recorded maximum grain yield and straw yield than all other nitrogen levels. In case of gross returns and net returns 150% N + 100% P recorded higher gross returns, net returns and net returns per rupee invested over other treatments but remained statistically at par with 125% N + 100% P. It can be concluded from the experiment performed that better yield and more economic profit can be obtained by applying 150% kg N ha^{-1}.

Table 1: Effect of treatments on yield contributing characters of wheat

Treatments	Spike length(cm)	No. of grains $spike^{-1}$	1000 grain weight(g)
RDF	10.81	54.61	43.75
25% N + 100% P	9.45	51.38	41.88
50% N + 100% P	9.79	52.70	42.59
75% N + 100% P	9.91	53.28	43.04
125% N + 100% P	11.69	56.37	45.35
150% N + 100% P	12.14	58.55	46.23
0% N + 100% P	9.00	50.00	39.67
SEm (±)	0.73	0.83	0.76
CD (P=0.05)	NS	2.56	2.34

Table 2: Effect of treatments on yield of wheat

Treatments	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest index
RDF	4060	6670	10729	0.38
25% N + 100% P	3847	6397	10243	0.38
50% N + 100% P	3957	6482	10439	0.38
75% N + 100% P	4005	6532	10537	0.38

125% N + 100% P	4160	6891	11051	0.38
150% N + 100% P	4356	7068	11424	0.38
0% N + 100% P	2820	5410	8230	0.34
SEm (±)	74	93	122	0.01
CD (P=0.05)	227	286	377	NS

Table 3: Effect of treatments on economics of wheat

Treatments	Cost of Cultivation (Rs ha^{-1})	Gross returns (Rs ha^{-1})	Net returns (Rs ha^{-1})	Net returns per rupee invested
RDF	50288	116862	66574	1.32
25% N + 100% P	48068	111153	63085	1.31
50% N + 100% P	49155	113804	64649	1.32
75% N + 100% P	50246	115030	64784	1.29
125% N + 100% P	52078	120062	67984	1.31
150% N + 100% P	53169	124903	71734	1.35
0% N + 100% P	38100	85448	47348	1.24
SEm (±)		1574	1574	0.03
CD (P=0.05)		4850	4850	NS

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