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Effect of Different Levels of Nitrogen on Growth, Yield and Productivity of Wheat (*Triticum estivum* L.) Cv. Koshan-02

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ABSTRACT

The field experiment was conducted to study the effect of different levels (0, 50, 70, 90 & 110 kg N ha^{-1}) of Nitrogen (N) on growth, yield and yield related parameters of wheat (cv. Koshan-02) in Kabul agro-climate condition at the Agricultural Research Farm of Kabul University, during spring 2020-21. The experiment was laid out in Randomized Complete Block Design (RCBD) with three replications, each replication consisted of five treatments. Total treatments were (15). The size of each plot was (2mx3m=6m^2). The result of our study revealed that the plots treated with highest level (110 kg N ha^{-1}) of N fertilizers produced the highest plant height (85.97cm). maximum number of grains spike^{-1} (35.74), the highest dry matter (3.937t ha^{-1}), The highest number of tillers m^{-2} (152.76 m^{-2}), 1000-grain weight (48.94g), grain yield (2891.1kg/ha) large spike length (10.52), number of grains spikelet^{-1} (2.98), Spikelet number spike^{-1} (11.54), followed by T_4, T_3 and T_2. It was concluded that all treatments have ranked regarding their efficient effects as ((T5 (110 kg N ha^{-1}> T4 (90 kg N ha^{-1}> T_3 (70 kg N ha^{-1}> T_2 (50 kg N ha^{-1}> $T_{Control}$) for all growth, yield and yield helping attributes such as plant height, number of grains spike^{-1}, dry matter (kg ha^{-1}), number of tillers plant^{-1}, 1000-grain weight(g), grain yield (kg ha^{-1}), spike length (cm), number of grains spikelet^{-1}, number of spikelet spike^{-1}, spike number m^{-2} and number of leaves plant^{-1}. So, for obtaining aimed and desirable yield the application of (110 kg N ha^{-1}) is recommended under research area conditions (Agro-Climatic Condition).

Keywords- Nitrogen wheat, growth, productivity & yield.

I. INTRODUCTION

Wheat (*Triticum aestivum* L.) belongs to family of Poaceae and it is the most important cereal crop and considered as an integral component for food security of most part of the world (Nand *et al.*, 2014). Is one of the globally most widely product food grain and as staple food for Asian country especially Afghanistan, Pakistan and other middle east countries. Globally, wheat is consumed by 2.5 billion people in 89 countries (CGIAR, 2020). Wheat is cultivated on around 215.91 million hectares with an annual production around 765.77 million tons worldwide (Bahaudin *et al*., 2022). It is the world's most important cereal crop, accounting for 30% of all cereal food produced worldwide, and is a staple food for nearly 10 billion people in 43 nations. It contributes almost 20% of the total food calories consumed by humans. In terms of area and productivity they are the world's most important crop, second only to rice is a major grain crop in developing countries that delivers 70-90% of all calories and 66-90% of protein. The protein found in wheat is in form as gluten and is therefore good for yeast raised breads, which require an elastic frame work. It provides nearly 55% of the carbohydrate and 20% calories consumed globally (Basheer-Salimia, 2014). It is cultivated worldwide and was one of the first crops to be domesticated some 10000 years ago ((Nand *et al.*, 2014). On the other hand, weak wheat flour is best suited for cakes and biscuit making (Gaines *et al*., 1991; Souza *et al.*, 1994). Area under cultivation of wheat in 2015 is 224.8 million hectares, with productivity of 3.26 tons per hectare and production 732.9 million metric tons

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five major wheat producers in this year are EU-27 China, India, Russia and USA production in these regions are (157.3, 130, 88.9, 60.5 and 55.8 million metric tons respectively (Word Agricultural Production, 2015). Wheat is the most essential food in Afghanistan. It is consumption per capita is estimated toward being 170 kg per year, which is greater than Pakistan consumption rate of 106 kg year (RASTA, 2012). Wheat area, production and productivity in Afghanistan were 0.53, 4.69 and 4.16 per cent per annum, respectively (Bahaudin *et al.,* 2022). Averaged over the period 2005-2012, the NR accounted for 35.9%, NER 23.3%, WR 14.4% and SWR 8.4% of total cultivated area under wheat crop. Irrigated wheat areas were more concentrated in the northern region accounting for 45.9% and north-eastern 29.5% of the total irrigated wheat area (Minister of Agriculture, Irrigation, and Livestock of Afghanistan, 2013). Based on the 2020 annual report of FAO, the production level of some cereal crops in Afghanistan includes wheat (3810,000 tons), rice (592,000 tons), corn (190,000 tons) and other were 110,000 tons totally (USDA, 2024). According to the measurement of national wheat policy of Afghanistan consumption of per capita was calculated around 186 kg per year during 2002-2009. Based on an estimate Afghanistan needs for 7.44 million tons' wheat production per annum, so it needs to cultivate wheat on around 1.7 million hectares per annum when the production being 4500 kg ha^{-1}. According to a report production of wheat in Afghanistan was significantly increased from 5.169 million tons to 5.17 million tons during 2013/14-2023/24 respectively by cultivated area from 2.553 million hectares to 2. 350 million hectares (PS&D Online updated on February 8, 2024). According to the report of Kabul Pajwak Afghanistan produced 3.4 million Metric Tons (MT) of wheat in 2022 which shows 13 percent surge in the wheat yield production comparing the previous years. Wheat are exhaustive crops of as evident from the fact that they remove 43.2-29.3-53.3-24.0 and 25.0-9.0-33.0-4.7 kg of N-P-K-S/ton of economic product respectively (Hussain, 2004). An estimated 150 ± 6 (Mullins and Burmester, 1993) and 294.3 g (Mishra *et al.,* 2006) of Zn are also removed by every ton of cotton lint and wheat grain produced, respectively. Afghanistan's best harvest has been 5.1 million tons in 2009 (FAO, 2012). Afghanistan grows wheat at about 2.5 million ha, about 45% of which is irrigated.

Wheat is the major and staple food that plays a vital role in many food and nutrition security of its people. It accounts for around 70% of total cereal consumption and 60% of the total intake of calories. Wheat accounted for 78.5% of annul aggregate production of cereals in Afghanistan averaged over the period 2005-12. Afghanistan remains one of the world's largest wheat flour importers. The wheat flour imports one million MT per year 2010 to 2014 (national wheat policy, 2015). In Afghanistan annul wheat consumption per capita is estimated 170 kg/year (Food security reporters team Afghanistan, 2012). Wheat produced under both irrigated and rain –fed condition (khanzada *et al*,.2012). Afghanistan's best harvest has been 5.1 $_{million}$ tons in 2009 (FAO, 2012). Afghanistan grows wheat at about 2.5 million ha, about 45% of which is irrigated. Wheat is a cool season crop in Afghanistan. Nitrogen fertilizer is a type of fertilizer that contains nitrogen key nutrient essential for crop canopy development and ultimately canopy photosynthesis determines that final outcome nitrogen is one of the most important element that might diminish wheat outcome if not administered properly, as it is required for fast plant growth and high productivity on per ha. Nitrogen is essential for all of a plants metabolic function. Nitrogen is the most important component and ingredient of plants, notably in increase in production as result in order to produce bumper wheat harvests, nitrogenous fertilizer must be applied to the land (Ali *et el*,.2000). to achieve their maximum yield, cultivars with high genetic output potential require a lot of nitrogen (Behara et al, 2000).

II. MATERIALS AND METHODS

The investigation was conducted to study the effect of five nitrogen (N) levels (0,50,70,90,110 N kg ha^{-1}) on growth, yield and yield trials of wheat (cv. Koshan 02), during two succession seasons of 2020 and 2021. The experiment was repeated at one location for two years on the university campus of Kabul Agriculture Research Farm. The experimental site is situated at 34.5553 N^0 latitude and 69.2075 E^0 longitude at a height of 1791 meters (5.876 feet) above sea level. The experiment was laid out in Randomized Complete Replication Design (RCBD) having three replication consisted 15, with 2mx3m plot size and 30cm apart. Koshan 02 used variety to be tested. The effect of N fertilizers recorded on different characters of wheat *viz,* Plant height (cm), Stem number/m^2, Leaf number $plant^{-1}$, yield and yield attributes, Spike length (cm), Number spikelet $spike^{-1}$, Number of grains $spike^{-1}$, Thousand grain weight (g), dry matter kg ha^{-1} and Grain yield kg ha^{-1}.

Statistical analysis

Data was statistically analyzed according to Steel *et al*. (1996) procedure. Least significant difference (LSD) test at 5% ($P \leq 0.05$) level of significance and used for mean comparison in case of significant difference. Data was analyzed by SPSS software.

III. RESULT

Growth Parameters

Plant height cm

Comparison of statistically analyzed data of same experiment conducted in two sequences (2020-2021) presented in (Table.1). the result revealed that N fertilizers effect was found significant for all growth parameters of wheat in both experimental years. Treated plots with the highest level of N (110 kg ha^{-1}) produced

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the tallest plant height (85.97 cm), highest dry matter (3937.33 kg ha^{-1}) and maximum No. of leaves plant^{-1} (5.08) as compared to other lower levels of nitrogen. Generally, fertilized plots showed better performance in terms of growth parameters as compared to control plots. Statistical effect of two sequences years (2020-2021) found non-significant for growth parameters (Table.1).

Table 1. The growth parameters written under as affected by different levels of Nitrogen

Treatment	Plant height (cm)	Dry matter (kg ha^{-1}	No. of Leaves plant^{-1}
N1 =0	71.5 e	2341.99 e	4.29 e
N2 =50	75.54 cd	2824.83 d	4.69 d
N3 =70	77.61 c	3164.67 c	4.85 c
N4 =90	81.13 b	3628.67 b	4.93 b
N5 =110	85.97 a	3937.33 a	5.08 a
CV	**3.37**	**1.16**	**2.96**
SE	**2.64**	**36.89**	**0.15**
LSD<0.05 %	**4.98**	**69.58**	**0.28**

Yield parameters

In this part of current research, the effect of N fertilizers assessed on yield and yield helping parameters of wheat such as, No. of spike m^{-2}, spike length (cm), No. of grain spike^{-1}, No. of spikelet spike^{-1}, No. of grain spikelet^{-1}, 1000 grain weight (g), grain yield (kg ha^{-1}), dry matter ton ha^{-1} and other yield related characters of wheat presented in (Table.2). According to the statistical analysis indicated that increased in level of nitrogen (N) positively affected all growth and yield parameters. The levels of N fertilizer ((0, 50, 70, 90, 110 N kg ha^{-1}) ranked concerning to their effects for all yielding parameters as (N5 =110>N4 =90> N3 =70> N2 =50>N1 =0$_{control}$). In case of years' (2020-2021) effect, differentiation of years' effect found non-significant for above under studied parameters.

Table. 2. Yield parameters written under as affected by different levels of Nitrogen (2020-21)

Treatment (Nitrogen levels)	No. of tillers m^{-2}	No. of grain spike^{-1}	Spike length (cm)	No. of Spike m^{-2}	No. of Spikelet spike^{-1}	No. of grain Spikelet^{-1}	Grain yield kg ha^{-1}	1000 Grain Weight (g)
N1 =0	109.17 e	23.31 cd	8.43 d	126.64 d	9.18 d	2.23 d	1102.19 e	37.34 e
N2 =50	122.06 d	27.34 c	9.11 c	146.39 c	10.25 c	2.43 c	1621.66 d	40.47 d
N3 =70	132.67 c	30.5 b	9.52 bc	152.41 b	10.66 b	2.6 b	2001.00 c	43.05 c
N4 =90	146.02 b	34.23 ab	9.80 ab	159.44 ab	11.22 ab	2.82 ab	2501.82 b	45.83 b
N5 =110	152.76 a	35.74 a	10.52 a	165.33 a	11.54 a	2.98 a	2891.1 a	48.95 a
CV	**4.79**	**1.92**	**1.52**	**3.93**	**0.8**	**2.39**	**3.97**	**0.84**
SE	**0.23**	**0.58**	**0.14**	**5.9**	**0.8**	**0.6**	**80.31**	**0.36**
LSD (0.05 %)	**0.43**	**1.09**	**0.27**	**11.13**	**0.16**	**0.12**	**151.47**	**0.69**

IV. DISCUSSION

Plant height (cm)

Analyzed data for plant height revealed that the tallest plant height (85.97cm) was recorded with plots treated with highest (110 kg N ha^{-1}) level of N fertilizers whereas the shortest plant height (75.54cm) was obtained from the plots treated with the lowest level (50 kg N ha^{-1}) of N fertilizer. Generally fertilized plots produced tall plants as compared to control plots. Our results confirmed by (Ali *et al.*, 2003) and (Ullah *et al.*, 2018).

Number of tillers m^{-2}

Data on No. of tillers m^{-2} showed that maximum number of tiller m^{-2} (152.76) was recorded with plots treated the highest level (110 kg N ha^{-1}) while, the lowest number of tillers m^{-2} were recorded with plots treated lowest level (50 kg N ha^{-1}). Eventually, all fertilized plots showed aimed and better performance as compared to control plots (79.44 tillers m^{-2}). regarding leaves plant^{-1}, more number of leaves plant^{-1} (5.08) was recorded with plots treated (110 kg N ha^{-1}) while, less number of leaves plant^{-1} (4.69 leaves). In general, all fertilized plots produced more number of leave plant^{-1} as compared to control plots (4.64). This result is parallel with the results of (Ali *et al.*, 2003) and (Ullah *et al.*, 2018).

Yield parameters

Spike length (cm)

Data on spike length (cm) revealed that longest spike length (10.52cm) was recoded with the highest level of N (110 kg N ha^{-1}) whereas, the shortest spike length

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(9.11cm) was observed with the plots treated by the lowest level (50 kg N ha^{-1}) f nitrogen, in total all fertilized plots presented better result than control plots (8.43 cm). This finding was commensurate with by (Ali *et al*. 2011).

Number of grain spikelet^{-1}

Application of various level of N fertilizers significantly affect number of grains spikelet^{-1}. We found from the result that, maximum number of grain per spikelet (2.98) was observed in plots were fertilized with the highest level (110 kg Nha^{-1}) of nitrogen while, less number (2.43) of grain per spikelet were recorded with the plots who received the lowest level (50 kg N ha^{-1}) of N.

Number of spikelet spike^{-1}

Application of (110 kg N ha^{-1}) produced maximum number of *spikelet spike*$^{-1}$(11.54) *while*, minimum number of *spikelet spike*$^{-1}$ *(*10.25). Generally, all treated plots showed better and aimful performance as compared to non-fertilized (control plots) (9.18). our result supported by (Ullah et al., 2018) and (Agha et al., 2016) who reported that increased in N level significantly increase number of *spikelet spike*$^{-1}$.

Number of grain spike^{-1}

The statistical analysis of number of grain per spike indicated that nitrogen fertilizers significantly affected all yield parameters included of number of grain per spike. It is obtained from the result that, application of (110 kg N ha^{-1}) produced maximum of number (35.74) of grain per spike while, minimum number of grain per spike (27.34) was recorded in with plots treated by the lowest level of N fertilizers (50 kg N ha^{-1}. It is concluded that control plots produced less number (23.31) of grain per spike as compared to fertilized plots. Similar result was reported by (Ali *et al*., 2014) who confirmed that increased in nitrogen level had positive effect on number of grain per spike of wheat.

Number of spikes m^{-2}

As regards number of spikes per square meter, highest value (165.33m^2) was recorded with (110 kg N ha^{-1}) plots, followed by treatment 4 (90 kg N ha^{-1}) which produced (159.44) spike per m^2, and the lowest number of spikes per square meter (126.64 m^{-2}) was recorded in control plots (no treated). Our finding has gone parallel with the finding of (Rahman *et al*., 2011) who confirmed that, the application of (120 kg N ha^{-1}) significantly influenced the Number of spikes per square meter.

1000 grain weight (g)

Data for 1000 grain weight (g) after statistical showed that, N fertilizer significantly affected all yield parameters of wheat included 1000-grain weight. It obtained from the result that, heavier 1000-grain weight (48.95g) with the plots treated by (110 kg N ha^{-1}) level of N fertilizers whereas, the lighter 1000-grain weight (40.47g) was obtained from the plots treated with lowest level (50 kg N ha^{-1}) of N fertilizers as well as the lightest 1000-grain weight (37.34 g) was recorded in control plots (no treated).

Grain Yield kg ha^{-1}

Statistical analysis of data for grain yield (kg ha^{-1}) indicated that application of nitrogen fertilizers affected all yield and helping traits included for grain yield (kg ha^{-1}). We got from the result that, the highest grain yield (2891.10) kg ha^{-1} was obtained from the plots were fertilized by the highest level (110 kg N ha^{-1}), followed by Treatment 4 (90 kg N ha^{-1}), treatment 3 (70 kg N ha^{-1}), $treatment_2$ (50 kg N ha^{-1}) and control (0 kg N ha^{-1}) respectively. Same results report by (Ullah *et al*., 2018) and (Yousaf *et al*., 2003) who confirmed that (150 kg N ha^{-1}) resulted grain yield of (4330 and 5160 kg ha^{-1}) during – Rabi 2000-01 and 2001-02.

Dry matter weight kg ha^{-1}

Dry weight kg ha^{-1} is an important character depended on plant architecture and yield potential. In our investigation analysis of data indicated that application of (110kg N ha^{-1}) was effective and statistically significant. We got from the results that, more dry weight kg ha^{-1} (3937.33 kg ha^{-1}) was recorded with plots treated the highest level (110 kg N ha^{-1}), followed by treatment 4 and 3 (3628.67 kg ha^{-1}) and (3164.67 kg ha^{-1}) respectively, whereas the lowest dry weight (2341.99 kg ha^{-1}) was obtained from control plots (no fertilized plots)

V. SUMMARY & CONCLUSIONS

Increase in nitrogen (N) levels up to 110 kg N ha^{-1} had positive and aimed effect on all growth, yield and yield attributes. It was concluded that all treatments have ranked regarding their efficient effects as ((T5 (110 kg N ha^{-1}> T4 (90 kg N ha^{-1}> T_3 (70 kg N ha^{-1}> T_2 (50 kg N ha^{-1}> $T_{Control}$) for all growth, yield and yield helping attributes such as plant height, number of grains spike^{-1}, dry matter (kg ha^{-1}), number of tillers plant^{-1}, 1000-grain weight(g), grain yield (kg ha^{-1}), spike length (cm), number of grains spikelet^{-1}, number of spikelet spike^{-1}, spike number m^{-2} and number of leaves plant^{-1}.

Based on the obtained result, it is recommended that, application of (110 kg N ha^{-1}) increases the growth, yield and yield related characters of wheat under agro-climatic conditions in Kabul, Afghanistan.

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