



Wheat Growth, Yield, and Yield Contributing Attributes as a Function of Nitrogen Levels

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Abstract: To evaluate the effect of different levels of nitrogen on growth and yield of wheat a field experiment was conducted in 2017-18 at research area of cereals and pulses section, Ayyub agricultural research institute, Faisalabad. Eight levels of nitrogen i.e. 0, 29, 58, 87, 116, 145, 174, 203 kg ha⁻¹ were evaluated. Experiment was laid out under randomized complete block design (RCBD) with three replications with a net plot size of 10×5m. Data were recorded for growth and yield parameters like number of tillers, plant height, spiklets per spike, seeds per spike, biological yield, 1000 grain weight, grain yield and harvest index. Different levels of nitrogen significantly increased all the growth and yield parameters. Maximum number of tillers, highest plant height and biological yield was recorded from the treatment where nitrogen was applied @ 203 Kg ha⁻¹ while 1000 grain yield, seeds per spike and grain yield was achieved highest from where nitrogen applied @ 145 Kg ha⁻¹.

Keywords: Nitrogen Levels, Wheat Growth and Yield, Plant Height, Biological Yield, Grain Yield, Harvest Index

Introduction

Wheat (*Triticum aestivum* L.) has the highest importance among the crops grown for the grain purpose worldwide. It is used as a staple food by 10 billion individuals over all the world mainly in 43 countries and contributing 30% to overall grain demand of the world standing at top in cereal crops. It gives around 20% of the aggregate food calories for mankind [1]. Being a main source of food for the people Pakistan, wheat is grown on a large area to fulfill its requirement. Regardless of its cultivation on large scale, Pakistani farmers are still unable to get the potential yield of wheat and their average production of wheat is far below than that [2]. According to economic survey of Pakistan, the total cultivated area under wheat was 8.734 million ha which was 2.6 % less in comparison to the last year cultivated area of

8.972 million ha. During 2017-18 total wheat yield was recorded 25.492 million tonnes showing a decrease of 4.4% as compared to the production of previous year which was 26.674 million tonnes. There were various factors involved in the low production of wheat including application of nitrogenous fertilizer in improper amount or no application of nitrogen, edaphic properties, availability and quality of irrigation water, prevailing climatic conditions and mismanagement of field operations by the farmers due to lack of knowledge and awareness.

Nitrogen is one of the major nutrients which reduce the yield of wheat if not applied in proper amount as it is needed for fast growth of plants and to get high production per hectare. Nitrogen play important role in all the metabolic processes of plants. Nitrogen is the main component and major constituent of plants especially in living tissues formation. Every single indispensable process in the plant are related with protein, of which nitrogen is a fundamental constituent. Nitrogen is an integral part of proteins, phytochromes, compounds, coenzymes, chlorophyll and nucleic acids. All the biochemical processes occurring in plants are mainly governed by nitrogen and its associated compounds which make it essential for the growth and development of wheat [3]. Therefore, it is necessary to apply nitrogenous fertilizer in the soil to get bumper yields of wheat [3]. The varieties which have high genetic yield potential require high amount of nitrogen to produce their maximum production [4].

To get the maximum yield of wheat, application of nitrogen in adequate amount is considered as a key to success. Application of nitrogen in splits has not considerable effect on economic yield, nevertheless it reduces the crop lodging and no. of spikes per plant, however 1000 grain weight increases [4]. Some of the researchers concluded from their experiments that by the application of nitrogen 120 kg per hacter maximum yield of wheat can be achieved [5,6]. [5] concluded that the by increasing the amount of nitrogen application resulted in more no. of spikes, high yield of grains and more grain weight. According to several reports about the use of nitrogen in wheat, under favorable climatic and good management conditions the effect of nitrogen application from 90-225 kg per ha was not so significant [7]. In case of irrigated areas, the application of nitrogen up to 156 kg per ha showed an increasing trend of wheat grain yield i.e. 6472 kg per ha [8]. Many researchers reported the to get the maximum yield of wheat the optimum rate of nitrogen application is 70-120 kg per ha [9,10]. [10] concluded that the application of nitrogen at 30 kg gave 2400-31000 kg ha⁻¹, 70 kg nitrogen resulted in 2650-3000 kg and 90 kg nitrogen produced 2650-3400 kg ha⁻¹ of wheat yield. 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 [8]. The inconsistency in soil and climatic conditions related with forms that influence nitrogen elements in the root zone and their association with the plant may prompt variation in nitrogen accessibility and its necessity to plant [11,9].

Furthermore, the arrival of new cultivars with various requirement for their nutrition upsets

summed up proposals of nitrogen fertilizers for wheat crop. The enthusiasm for boosting wheat yields has urged progressive farmers to perform the farm management operations intensively. It should be kept in mind that the optimized level of nitrogen application should be low for the cultivar less responsive to its application and the rate of nitrogen should be high for the variety that is more responsive to its application and records more yield otherwise yield potential of the varieties would be decreased. 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 [12], which become a cause of high cost production resulting in less net benefit to the farmers because only 1/3 part of applied nitrogenous fertilizer is taken-up by the cereal crops and assimilate it to their grains [15].

In view of the importance of nitrogen for crop production present study is planned with the objectives to determine the optimum nitrogen requirement of the wheat crop.

Materials and Methods

To evaluate the effect of different nitrogen levels on growth and yield of wheat (*Triticum aestivum* L.) an experiment was conducted in the research area of cereals and pulses section, Agronomic research institute, Ayyub agriculture research institute Faisalabad during Rabi 2017- 18. The experiment was laid out in a randomized complete block design (RCBD) with three replications having a plot size of 5m × 10m. Line to line distance was maintained at 23cm apart while plant to plant distance was not maintained. The wheat variety Ujala-2016 was sown at the rate of 100kg ha⁻¹ on 10 November 2017 through mechanical method using sowing drill. Before sowing, seed was treated with Benlate and Topsin-M solution following the standard recommendations to keep protect it from the soil borne diseases. All the fertilizer including potash and phosphorus at the rate of 84, 62 kg ha⁻¹ respectively while 1/3 portion of nitrogen (as per treatments) was incorporated in the soil at the time of seedbed preparation. All the other remaining Nitrogen was applied with the first irrigation. Potassium Sulphate, Single super phosphate and Urea were used as a source of fertilizer for Potash, Phosphorus and Nitrogen Respectively. To control narrow and broad leaf weeds Axial and Phenoxyprop were sprayed together at the rate of 825- and 750-ml ha⁻¹ respectively after 40 days of sowing. All the other management practices were kept same in all the treatments, except those under study.

During that study eight different levels of nitrogen i.e. 0, 29, 58, 87, 116, 145, 174, 203 kg ha⁻¹ were assessed. Data was recorded for the growth and yield contributing parameters like number of tillers m⁻², plant height, biological yield, number of spikelets per spike, number of seeds per spike, 1000 grain weight, grain yield and harvest index. To calculate spikelets per spike and seeds per spike, 10 spikes were taken from each plot. For 1000 seed weight, seeds were counted and weighed. The data were analyzed statistically using STATIX 8.0 and LSD test was applied at 5% probability level to compare treatment means.

Result and Discussion

Plant Height

Different levels of nitrogen affected the plant height significantly (table 1). Maximum plant height (107.60 cm) was recorded from treatment T8 where nitrogen was applied @ 203 Kg ha⁻¹ while minimum plant height was recorded from T1 where nitrogen was not applied. As the level of nitrogen increased plant was 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 [9]. Wheat growth can be increased by nitrogen by increasing the process of cell division and also help to uptake other nutrients from the soil through synergistic effect which increases the shoot length of plant [18]. The increase in plant height was because nitrogen increases leaf area which results in high rate of photosynthesis, more production of assimilates and plant dry matter. These results are similar to who also reported that plant height was significantly increased by different doses of nitrogen [13,14].

Table 1. Effect of different nitrogen levels on growth and yield parameters of wheat

Treatments	No. of tillers (m-2)	Plant Height (cm)	Biological Yield (g m-2)	1000 Grain weight	No. of spiklets per Spike	No.of seeds per spike	Grain Yield (Kg ha- 1)	Harvest Index (%)
0 Kg N ha-1	264.00F	75.78F	10044E	32.461F	18.533B	28.5C	1881.3H	18.730E
29 Kg N ha-1	360.67E	98.91E	12710D	38.919E	18.900AB	47.4B	2189.3G	17.227E
58 Kg N ha-1	381.67DE	100.35DE	12893D	39.688DE	18.933AB	54.133A	4623.2E	35.857B
87 Kg N ha-1	386.67DE	102.10CD	14515C	41.416BC	19.333AB	55.633A	4818.8D	33.203C
116 Kg N ha-1	392.33D	102.83BCD	14580C	45.102A	19.167AB	56.800A	5137.7C	35.243B
145 Kg N ha-1	418.67C	103.71BC	14728C	46.082A	19.367AB	58.367A	5576.0A	37.857A
174 Kg N ha-1	453.00B	105.80AB	15257B	42.724B	19.233AB	60.133A	5402.3B	35.457B
203 Kg N ha-1	512.00A	107.60A	16134A	40.861CD	19.867A	58.200A	4127.0F	25.730D

Number of Tillers

Number of tillers were significantly increased by different nitrogen levels (table 2). Maximum number of tillers m⁻² (512.00) were recorded from T8 (203 Kg N ha⁻¹) while the treatment where no application of nitrogen was done gave the minimum number of tillers (264.00). Increased levels of nitrogen resulted in reduction of mortality of tillers and produced more tillers from the main stem. These results are confirmatory to those revealed by [13-15].

Number of Spiklets/Spike

Number of spiklets/spike were significantly different in treatments where no application of nitrogen (T1) was done and in T8 (203 Kg N ha⁻¹) while in other treatments means difference was non-significant. Maximum number of spiklets/spike (19.867) were recorded in T8 (203 Kg N ha⁻¹) while minimum number of spiklets/spike (18.533) were found in T1 where no nitrogen was applied. Nitrogen has mainly effect on the vegetative growth of plant while at reproductive stage its role is less considerable that's why different levels of nitrogen did not affect the number of spiklets/spike significantly. These results are in contradiction to [16,13]. Many researchers concluded from their studies that if there is more absorption of nitrogen by the plants produces more number of spikes per unit area, enhanced vegetative growth and more number of tillers per unit area [17,18].

Number of seeds/spikes

Number 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 (174 Kg N ha⁻¹) that were also statistically similar to T3, T4, T5, T6 and T8 while minimum were observed no nitrogen applied treatment. Nitrogen promote the initiation of spiklets that resulted in more number seeds/spike but more nitrogen from 174 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 [6]. 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 [19]

1000 Grain Weight

Due variation in nitrogen levels 1000 grain weight was significantly different. Maximum 1000 grain weight was found in T6 (46.082) statistically identical to T5 (45.102), while where nitrogen was not applied recorded the minimum grain weight (32.461). These results indicate that nitrogen has a key role in the growth and development of grain. These results are similar to those reported by who concluded that higher dose of nitrogen significantly increased grain weight [20,21].

Biological Yield

Different levels of nitrogen fertilizer application increased biological significantly.

Maximum biological yield (16134 g m⁻²) was harvested from T8 (203 Kg N ha⁻¹), while minimum (10044 g m⁻²) 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. There are many studies which revealed that with increasing the nitrogen rate biological yield increased [22]. During pollination high levels of nitrogen increased the total dry matter that help to get more grain yield [23]. Many other scientists reported that high levels of nitrogen yield in more straw and grain weight [24]. As a result of more biological yield a plant with its large canopy is able to intercepts more sun radiation and produce more assimilates.

Grain Yield

Wheat grain yield was also significantly increased by different levels of nitrogen. Maximum grain yield (5576 kg ha⁻¹) was obtained from T6 while minimum grain yield (1881.3 kg ha⁻¹) 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. In case of treatment where nitrogen was applied @ 203 Kg ha⁻¹ crop lodging occur due to which yield was reduced dramatically.

Harvest Index

Under different levels of nitrogen harvest index differ significantly. Maximum harvest index (37.857) was calculated from T6 (145 kg N ha⁻¹) while minimum Harvest (17.227) was calculated from T2 (29 Kg N ha⁻¹). 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 shrivled 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 [20].

Conclusion

Concluded from the findings of current study that application of nitrogen @ 145 along with phosphorus 62 and potash 84 Kg ha⁻¹ gave highest grain yield per hectare under irrigated conditions of Faisalabad.

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