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Growth and yield response of Barley (*Hordeum vulgare* L.) on various Nitrogen Level

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Abstract

Barley is the fourth most important cereal crop after rice, wheat and maize. Barley is commonly produced for animal feed and malt production. A field experiment was conducted during *rabi* season of 2019-2020 at Research Farm of GD Goenka University, Gurgaon, to study the response of barley (*Hordeum vulgare* L.) to varying levels of nitrogen. The experiment was laid out in a Randomized Block Design with four replications keeping six nitrogen levels (0, 30, 45, 60, 75, and 90) in the plots. The growth parameters (plant height, number of tillers per meter row length, dry matter accumulation) increased significantly with every addition of 15 kg N/ha up to 60 kg N/ha at all the periodical stages of crop without any exception. Application of 60 kg N/ha resulted in higher values of growth parameters but it was statistically at par with 75 kg N/ha. More nitrogen application resulted in delay in phenophases. Very few crops respond as well or as quickly to applied fertilizers as barley. Therefore, proper application of nitrogen is a determining factor in the growth and yield of barley.

Keywords: Barley, nitrogen levels, soil application, days after sowing

INTRODUCTION

Barley (*Hordeum vulgare* L.) is an ancient cereal grain, which during domestication has evolved from largely a food grain to feed and malting grain (Baik and Ullrich, 2008; Pourkheirandish and Komatsuda, 2007). The current year barley production has reached a landmark output of 1.59 million tonnes during 2019-2020 from 0.62 million hectares with an average national productivity of 2617 kg/ha (FAO. 2019-20). The life cycle of barley plant begins with the germination of seed.The cultivated barley is one of the oldest of the cultivated plants. It is frequently considered as the most cosmopolitan of the crops and also as poor man's crop because of its low input requirement. It requires less water and is fairly tolerant to salinity, alkalinity, frost and drought. It also has immense potential as quality cereal especially from nutritional and medicinal point of view (Cavallero *et al.* 2002). Barley is used as animal fodder, as a source of fermentable material for beer and certain distilled beverages and as a component of various health foods. The barley products like "Sattu" (in summers because of its cooling effects on human body) and Missi Roti have been traditionally used in India (Verma *et al*. 2011). Each 100g of barley grain comprises 10.6g protein, 2.1g fat, 64g carbohydrate, 50mg calcium, 6.0mg iron, 31mg vitamin B_1, 0.10mg vitamin B_2. This versatile grain has somewhat chewy consistency and a slightly nutty flavor that can complement many dishes. It is also rich in many nutrients. It is available in many forms ranged from hulled barley to barley grits, flakes and flour. Almost all forms of barley utilize the whole grain except the pearl barley, which has been polished to remove some or the entire outer bran layer along with the hull. Barley contains soluble fiber, which reduces hunger and enhances feeling of fullness. It even promotes weight loss. Regularly adding barley to the diet reduces risk factors for heart disease, such as high blood pressure. It is a cheap, edible warm or cold and easily added to a variety of savory and sweet dishes. It is considered fourth largest cereal crop in the world with the share of 7 percent of the global cereal production (Pal *et al*. 2012). Barley gives significant higher grain production over its competitive rabi cereal wheat. If it is irrigated at critical growth stages, it can prove economically superior to wheat crop. Adequate mineral fertilization is considered to be one of the most important pre-requisites for the successful cultivation of any crop. In general, poor fertility of the soil and deficiency of nitrogen are the major production constraints in barley. The amount of nitrogen at our research farm is 125 kg ha^{-1}. As the nitrogen content in the soil is low the study of different levels of nitrogen on barley will be conducted at our research farm. Nitrogen is vitally important and is one of the universally deficient plant nutrients in most of the Indian soils. It is considered as the most limiting factor in the cultivation of non-legumes (Zebarth *et al*. 2009).Use of proper method of split application of nitrogen, to meet the crop requirement throughout life cycle for higher production and less accumulation of nitrogen in grain, may be one of the strategies to achieve the high yield and quality of barley.

MATERIALS AND METHODS

A field experiment entitled **"Response of Barley (*Hordeum vulgare* L.) to varying levels of nitrogen"** was conducted during *rabi* season of 2019-20 at the research farm of School of Agricultural Sciences, GD GOENKA University, Gurugram, Haryana. The soil of the experimental site was silty loam in texture with pH 7.9.

The trials were conducted in Gurgaon region during 2019-20 to determine growth and yield performance of barley. In this investigation, Randomized Block Design was followed. The experimental plot was divided into four equal blocks (replications) having six treatments in each replication *viz*., T_1 – Control (without nitrogen), T_2 – 30kg N/ha, T_3 – 45kg N/ha, T_4 – 60kg N/ha, T_5 – 75kg N/ha and T_6 – 90kg N/ha. The size of each plot was 4×5 m. Sowing time was 08.11.2019 and harvesting was done on 13.3.2020. After harvesting the plots, they were threshed and weighed and plot results were adapted at 10% humidity.

RESULTS AND DISCUSSION

Growth Attributes

Based on study results, the treatment with 60 kg N/ha had promising results and they had higher performance than all the other treatments. The highest growth parameters were recorded in treatment with application of 60 kg N/ha and lowest growth parameters were recorded in control.

Plant height

Perusal of the data revealed that among different nitrogen levels, treatment with 60 kg N/ha recorded significantly higher plant height at all the stages of crop growth have been presented in Table 1 and Figure 1.Treatment with 60 kg N/ha recorded higher plant height. However, 75 kg N/ha was statistically at par with 60 kg N/ha, whereas in control recorded significantly lower plant height as studied in the experiment. The plant height increased significantly with each increasing nitrogen level from 0 to 60 kg N ha^{-1} at all the stages of plant growth. Such increment of plant height with increase in nitrogen levels may be related to the effect of nitrogen which promotes vegetative growth as other growth factors are in conjugation with it. Higher nitrogen levels lead to more nitrogen uptake, which could ultimately result in increased protein synthesis, cell division and cell elongation and finally resulted on increased in height of plants. Increased plant height with the increasing level of nitrogen was also reported in barley by Paramjit *et al*. (2001) and Satyajeet *et al*. (2003).

No. of tillers

The data pertaining to number of tillers per meter row length at different stages of crop growth are presented. Among different nitrogen levels, treatment with 60 kg N/ha recorded significantly higher number of tillers per meter row length at all the stages of crop growth. Treatment with 75 kg N/ha and 90 kg N/ha were statistically at par with 60 kg N/ha where in control recorded significantly lower number of tillers per meter row length. Tillering is the most important trait for grain production and is thereby an important aspect of barley growth improvement. Effective tillering depends primarily on soil physical conditions that were superior due to increase in nitrogen levels. The increase in tillers in barley might be due to adequate quantity and balanced proportion of plant nutrients supplied to the crop as per need during the growing period resulting in favorable environment for crop growth. Similar results were observed by Laghari *et al*. (2010) and Hadi *et al*. (2012).

Dry matter accumulation

The summary of data on dry matter accumulation at different growth stages as affected by nitrogen levels has been presented in Table 1 and Figure 2. Irrespective of treatments, there was consistent increase in dry matter accumulation with advancement of crop growth up to harvest. Crop yield is determined by dry matter accumulation and partitioning into different plant parts which increase throughout crop growing till harvest. The periodic monitoring of dry matter is an indicator of proper plant growth and development. The rate of increase was highest between 60 to 90 DAS. Similar results also observed by Singh *et al*. (2010) and Singh *et al*. (2013).

Yield Attributes

The yield attributing characters and yield increased significantly with increase in nitrogen levels. Maximum spike length was recorded at 60 kg N ha^{-1} which was significantly higher than rest of the treatments. The increase in dose of nitrogen increased the spike length of barley from 0 to 60 kg N/ha while further increase in nitrogen level from 75 to 90 kg N/ha decreased the spike length as compared to 60 kg N/ha. Similar results were reported by Singh (2000) and Yadav (2001). Number of grains/spike as influenced by varying nitrogen levels have been presented in Table 2 and Figure 3. Among different nitrogen levels, treatment with 60 kg N/ha recorded significantly higher grains/spike with 45.50. Whereas in control recorded significantly lower grains/spike with 30. Kumawat and Jat (2005) at SKNAU, Jobner reported that application of nitrogen at 60 kg/ha significantly improved the number of effective tillers, spike length, grains $spike^{-1}$, test weight and consequently the grain yield of barley over 40 and 20 kg N ha^{-1} and control.

Grain yield

The summary of data on grain yield at various levels of nitrogen was presented in Table 2 and graphically depicted in Figure 4. A thorough look on data indicated that grain yield of barley was significantly affected at various treatments. There was significant increase in grain yield of barley with increase in nitrogen doses. The grain yield of crop increased with increase in doses of nitrogen levels from 0 to 60 kg N/ha thereafter further increase in nitrogen levels from 75 to 90 kg N/ha decreased grain yield as compared to 60 kg N/ha. Ramesh and Singh (2005) also observed a significant improvement in grain as well as straw yield and protein content with 60 kg N ha^{-1} compared to 80, 40 and 20 kg N ha^{-1} in barley. Among all the nitrogen levels, treatment with 60 kg N/ha recorded significantly higher straw yield. The straw yield is reflected by growth parameters like number of tillers and plant height. The effect of different nitrogen levels on straw yield of barley crop shown that there was a significant effect of nitrogen.

Table 1: Effect of growth parameters at different levels of nitrogen application

Treatment	**Plant height (cm)**	**Number of tillers**	**Dry matter accumulation (g $plant^{-1}$)**
Control	87.56	73.5	88.75
30 kg/ha	93.58	77.25	102
45 kg N/ha	112.75	93.25	121
60 kg N/ha	120.96	115	175
75 kg N/ha	110.12	111	164.5
90 kg N/ha	111.43	104.5	136
S.E(m)	4.34	3.55	5.23
C.D	12.71	10.40	15.31

Table 2: Effect of yield parameters at different levels of nitrogen application

Treatment	**Spike length (cm)**	**Grains/spike**	**Grain yield (kg/ha)**	**Straw yield (kg/ha)**
Control	5.19	30	1511.50	4269
30 kg N/ha	5.30	33.25	2210.75	5230
45 kg N/ha	5.74	34.50	2322.25	6296.25
60 kg N/ha	7.37	45.50	4027.50	8151.25
75 kg N/ha	6.96	41.25	4003.25	8141.50
90 kg N/ha	6.59	38.25	3949.75	8141.75
S.E(m)	0.22	1.32	112.60	264.07
C.D	0.65	3.87	329.41	772.54

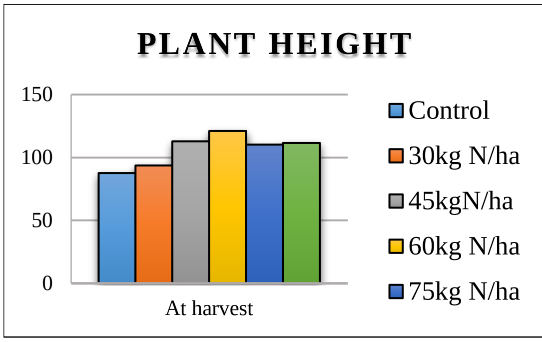

Fig 1: Effect of nitrogen levels on plant height

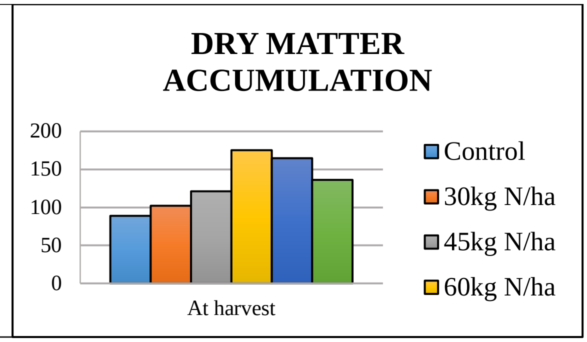

Fig. 2: Effect of nitrogen levels on dry matter accumulation

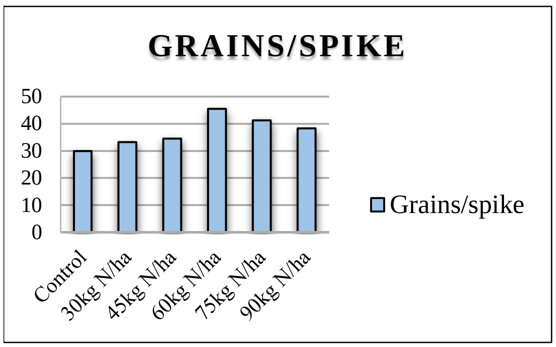

Fig. 3: Effect of nitrogen levels on number of grains/spike

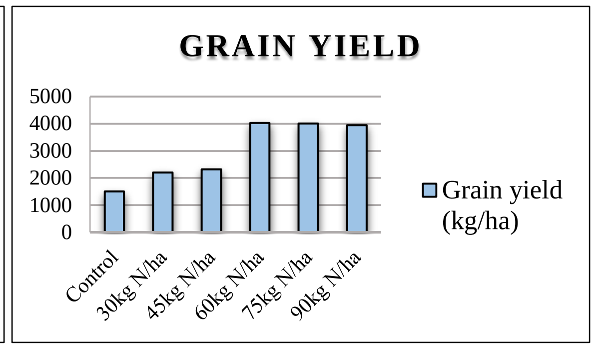

Fig. 4: Effect of nitrogen levels on grain yield

CONCLUSION

The plant height was significantly increased with each increase in nitrogen levels up to 60 kg N/ha which is statistically at par with 75 kg N/ha. The number of tillers per meter row length increased significantly with increase in nitrogen levels up to 60 kg N/ha at all the stages of crop growth. The dry matter accumulation was significantly increased with each increase in nitrogen levels up to 60 kg N/ha. The spike length increased with increase in nitrogen levels up to 60 kg N/ha which was statistically at par with 75 kg N/ha. The maximum number of grains per spike also increased with increase in nitrogen levels up to 60 kg N/ha thereafter further increase in nitrogen level decreased the number of grains per spike compared to 60 kg N/ha. Application of 60 kg N/ha resulted in higher grain yield and it was statistically at par with 75 and 90 kg N/ha. The grain yield was significantly higher at 60 kg N/ha as compared to lower levels of nitrogen of 30 and 45 kg N/ha. Barley crop recorded significantly higher straw yield at 60 kg N/ha compared to lower nitrogen levels whereas it was statistically at par with 75 and 90 kg N/ha. The increase in straw yield was 5230 q/ha, 6296.25 kg/ha and 8151.25 kg/ha with 30, 45 and 60 kg N/ha over control. On the basis of study on **"Response of Barley (*Hordeum vulgare* L.) on growth and yield to Varying Levels of Nitrogen"** it is concluded that periodic growth parameters such as plant height, number of tillers per meter row length and dry matter accumulation and yield parameters like spike length, number of grains per spike, grain yield and straw yield increased with increase in nitrogen levels up to 60 kg N/ha. Results are based on one-year study, hence, it needs to be validated by further experimentation before making final recommendation to researchers and farmers.

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