

## Original Research Article

### “Response of Nitrogen and Foliar Application of Boron on Growth and Yield of Barley (*Hordeum vulgare* L.)”

#### ABSTRACT

The field experiment entitled “Response of Nitrogen and Foliar Application of Boron on Growth and Yield of Barley (*Hordeum vulgare* L.)” was conducted during the rabi season of 2022 in Crop Research Farm, Department of Agronomy, Naini Agricultural Institute, SHUATS, Prayagraj (U.P.). The experiment was laid out in a Randomized Block Design with ten treatment combinations; the soil in the experimental area was sandy loam with pH (7.6), organic carbon (0.23%), available N (184.8 kg/ha), available P (16.45 kg/ha) and available K (187.64 kg/ha). Seeds are sown at a 30 cm × 5 cm spacing to a seed rate of 100 kg/ha. They consisted of three nitrogen levels (45, 60 and 75 kg N/ha) on different Concentrations of Boron viz., 1, 1.5 and 3% foliar spray. The experimental result reveals that growth parameters viz., plant height (102 cm), number of tillers/running row meter (95.66), plant dry weight (19.08 g), crop-growth rate (CGR) (49.38), relative growth rate (RGR), and Yield attributes viz., No. of effective tillers/m<sup>2</sup> (200.33), the number of grain/spike (52.60), test weight (44.66 g), seed yield (4.81 t/ha) and straw yield (6.48 t/ha) recorded to be were significantly higher with treatment 9 (75 kg N/ha + 3 % boron).

**Key words:** Barley, Nitrogen, Boron, Growth, Yield, quality.

#### Introduction

Barley (*Hordeum vulgare* L.) is an important cereal crop from all over the world. Among cereals, it ranks fourth concerning area and production after wheat, rice and maize and is a hardy crop grown throughout the world's temperate, tropical and subtropical regions. It is a rabi cereal crop in India and is usually used as food for human beings and feed for animals and poultry birds (Singh *et al.*, 2012). Globally, barley occupies an area of 48.48 million hectares with a production of 145.10 million tonnes of grain and 2990 kg/ha productivity during 2020-21 (United States Department of Agriculture, 2021). Barley though recognized as a hardy cereal crop due to its wider adaptability to the environment, has been viewed as a crop for marginal lands. While the global concern has been focused on food and

**Comment [A1]: Inconsistent capitalization**  
You capitalized **Boron** in some cases but not in others. Both styles are acceptable, but it's best to use just one style throughout your document.

**Comment [A2]: Extra verb**  
It appears that the phrase **is a rabi cereal crop** contains an unnecessary verb. Review the sentence to determine the appropriate correction.

environmental sustainability, the demand for cereals, especially those that are hardy and drought-tolerant, such as barley has tremendously increased (Maher, 2017).

In addition, the energy-rich drinks are also prepared from the malt extracts of barley. In India, about 90% of the barley produced is used for human consumption, while in the USA and European countries, most of it is used as cattle feed. The barley grains make palatable and nutritious livestock feed. The straw is used as forage, and green forage is either directly fed to the animals or made for hay and silage. It is a rabi cereal crop in India and is usually used as food for human beings and feed for animals and poultry birds (Singh *et al.*, 2012). It can be more tolerant to saline and alkaline conditions than other winter cereals. Its cultivation in India suffered during the green revolution period due to replacing marginal land and rainfed areas with more remunerative oilseed and pulses. However, during the early nineties, due to economic liberalization, the industrial demand for barley increased and presently, 25-30% of total barley produced is used in the manufacturing of malt extract, which is further utilized for brewing, distillation, baby foods, coca malt drinks and medicinal syrups.

Nitrogen is crucial to plants for its growth as it forms the basic structure of protein and nucleic acid which further plays an essential role in plant physiological phenomena. Chlorophyll, the most important component, is the green color material of every plant, and the one responsible for photosynthesis has the component nitrogen. Nitrogen is, in one way or another, associated with the proper functioning of plants. Thus, barley grain yield, protein content in grain and kernel appearances are the characteristics that are strongly related to available nitrogen (Grant, 2000). Nitrogen also plays an important role in maintaining the yield attributes in barley (Assefa, 2018).

Different doses of nitrogen significantly influenced the grain yield and yield parameters. For the highest grain yield, nitrogen doses of 100 kg N/ha were the best treatment when considering nitrogen fertilizer only. Irrigation regimes also significantly affect barley yield and growth parameters (Shirazi *et al.*, 2014). Nitrogen plays a vital role as its presence in protein and nucleic acid forms the basis for forming living material or protoplasm of every cell. This increases plant height, spike length, and no. of a tiller, resulting in higher production of dry matter and grain yield (Franklin *et al.*, 2017). In addition to nitrogen, phosphorus is paramount for energy transfer in living cells through high-energy phosphate bonds of ATP. Thus, it plays a pivotal role in forming and translocating carbohydrates, fatty acids,

glycerolipids and other essential intermediate compounds. It also affects seed plumpness, malting quality and protein content of the barley grain and fodder (Narolia, 2009).

B has emerged as an important micronutrient in Indian agriculture, next only to zinc in the context of the spread of its deficiency. Applying 0.5 mg/l boron significantly increased ( $P \leq 0.05$ ) shoot fresh weight by 1 %. The addition of 0.5 and 1.5 mg/l boron significantly increased ( $P \leq 0.05$  and 0.01) growth parameters (shoot and root fresh and dry weights) by 5%, leaf area by 4.5% and 7%, Chl. and Chl. b contents by 3 % and 7% at vegetative and flowering stages, respectively, and yield by 5.5%, compared to non-boron-treated barley (Soad Soliman El-Feky, 2012).

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It may be unclear to the reader what **significantly** is modifying. Consider moving the modifier.

## Materials and Methods

The experiment was conducted during the *Rabi season* of 2022 at the Crop Research Farm, Department of Agronomy, Sam Higginbottom University of Agriculture, Technology and Science (SHUATS), Prayagraj (UP). The Crop Research Farm is situated at 25.57° N latitude, 87.19° E longitude and at an altitude of 98 m above mean sea level. This area is situated on the right side of the river *Yamuna* and by the opposite side of Prayagraj City. All the facilities for crop cultivation were available. The experiment was laid out in Randomized Block Design and comprised of Nitrogen and Boron with ten treatments and each was replicated thrice *viz.*, T1- Nitrogen (45 kg/ha) + Boron (1 %), T2- Nitrogen (45 kg/ha) + Boron (1.5 %), T3- Nitrogen (45 kg/ha) + Boron (3 %), T4- Nitrogen (60 kg/ha) + Boron (1 %), T5- Nitrogen (60 kg/ha) + Boron (1.5 %), T6- Nitrogen (60 kg/ha) + Boron (3 %), T7- Nitrogen (75 kg/ha) + Boron (1 %), T8- Nitrogen (75 kg/ha) + Boron (1.5 %), T9- Nitrogen (75 kg/ha) + Boron (3 %), T10- Control (NPK 60-30-20 kg/ha). Seeds are sown at a spacing of 23 cm × 5 cm to a seed rate of 100 kg/ha. The recommended dose of Nitrogen (60 kg/ha), Phosphorus (30 kg/ha) and Potassium (30 kg/ha) and Nitrogen and Boron were applied as per the treatments. Data recorded on different aspects of crop, *viz.*, growth, yield attributes were subjected to statistical analysis by analysis of variance method and economic data analysis mathematical method.

## Result and Discussion

### Growth Parameters

#### Plant Height (cm)

The data apparent that a significantly and maximum plant height (102.00 cm) was recorded in treatment 9 [Nitrogen (75 kg/ha) + Boron (3 %)]. However, treatment 8 (98.40 cm) [Nitrogen (75 kg/ha) + Boron (1.5 %)] were found to be statistically at par with treatment 9.

Nitrogen as being the major constituents of nucleoids, chlorophyll and enzymes directly imparted and played major role in metabolic processes of plants regulating the vegetative phases. Maximum plant height (94.08 cm) and number of tillers (190.02 /m<sup>2</sup>) was recorded at 100 kg N/ha at harvest, however, they were at par with 80 kg N/ha. Increasing nitrogen levels from 80 to 100 kg N/ha, no significant variation was found. This may be due to the plants getting sufficient nitrogen at 80 kg N/ha and further increment in nitrogen dose there was no any remarkable uptake by the plants. The results are in accordance with the results reported by (Parashar *et al.*, 2020).

The results indicated that foliar application of B significantly increased the yield and growth traits in barley. However, 2 % foliar application of B showed the highest value for all studied traits including: plant height (5.6%), number of tillers per plant (2.4 %), spike length (32 %), weight gain per spike (6.2 %), seed index (6 %), grain yield (10 %), and biological yield (4 %). Based on these findings, it can be concluded that the foliar application of B at 2 % can be used to improve the growth and yield in barley. The results are in accordance with the results reported by (Ahmad *et al.*, 2021).

#### **Number of Tillers (per running row meter)**

The data apparent that a significantly and higher Number of Tillers (95.66) was recorded in treatment 9 [Nitrogen (75 kg/ha) + Boron (3 %)]. However, treatment 8 (88.66) [Nitrogen (75 kg/ha) + Boron (1.5 %)] treatment 6 (88.66) [Nitrogen (60 kg/ha) + Boron (3 %)] were found to be statistically at par with treatment 9.

Application of 80 kg N/ha increased number of tillers by 32.11, 16.22, 12.07 and 2.98 per cent over 0, 20, 40 and 60 kg N/ha at harvest, respectively. It was due to the availability of nitrogen in sufficient amount as required by the plants. Nitrogen enhances profuse vegetative growth and is responsible for cell division, cell elongation and protein synthesis resulting higher photosynthetic capacity of plants. Nitrogen as being the major constituents of nucleoids, chlorophyll and enzymes directly imparted and played major role in metabolic processes of plants regulating the vegetative phases (Kumar *et al.*, 2018).

#### **Plant dry weight (g/plant)**

The data apparent that a significantly and higher Plant dry weight (19.08 g) was recorded in treatment 9 [Nitrogen (75 kg/ha) + Boron (3 %)]. However, treatment 8 (17.53 g) [Nitrogen (75 kg/ha) + Boron (1.5 %)], were found to be statistically at par with treatment 9.

Maximum dry matter accumulation (386.46 /ml) was recorded at par with 80 kg N/ha at higher levels of nitrogen, dry matter accumulation was maximum and it was due to the reason that higher nitrogen leads to higher assimilation and utilization of available nitrogen by plants. The dry matter accumulation was higher due to the active tillering and development of growth attributing characteristics at harvest, respectively. Similar findings were reported by (Terefeet *et al.*, 2018).

### **Yield attributes**

#### **Number of effective tillers/m<sup>2</sup>**

The data apparent that Treatment 9 [Nitrogen (75 kg/ha) + Boron (3 %)] was recorded significant and maximum number of effective tillers/m<sup>2</sup> (200.33/m<sup>2</sup>) which was superior over all other treatments. However, the treatment 8 (198.33/m<sup>2</sup>) [75 kg/ha) + Boron (1.5 %)] and treatment 6(197.66/m<sup>2</sup>) [Nitrogen (60 kg/ha) + Boron (3 %)] treatment 7 (196.33/m<sup>2</sup>) [Nitrogen (75 kg/ha) + Boron (1 %)] treatment 5 (190.66/m<sup>2</sup>) [Nitrogen (60 kg/ha) + Boron (1.5 %)], was found to be statistically at par with the treatment 9.

#### **Numberof grains/spike**

The data apparent that Treatment 9 [Nitrogen (75 kg/ha) + Boron (3 %)] was recorded significant and maximum Numberof grain/spike (52.60/spike) which was superior over all other treatments. However, the treatment 8 (51.60/spike) [Nitrogen (75kg/ha) + Boron (1.5 %)] treatment 7 (48.60/spike)], was found to be statistically at par with treatment 9.

Increase in nitrogen levels from 0 to 100 kg N /ha significantly enhanced number of grains per spike and it might be better partitioning of photosynthetic from the leaf to reproductive parts resulted in increased in the number of grains/spike. The results are in accordance with the findings of (Kumar *et al.*, 2013).

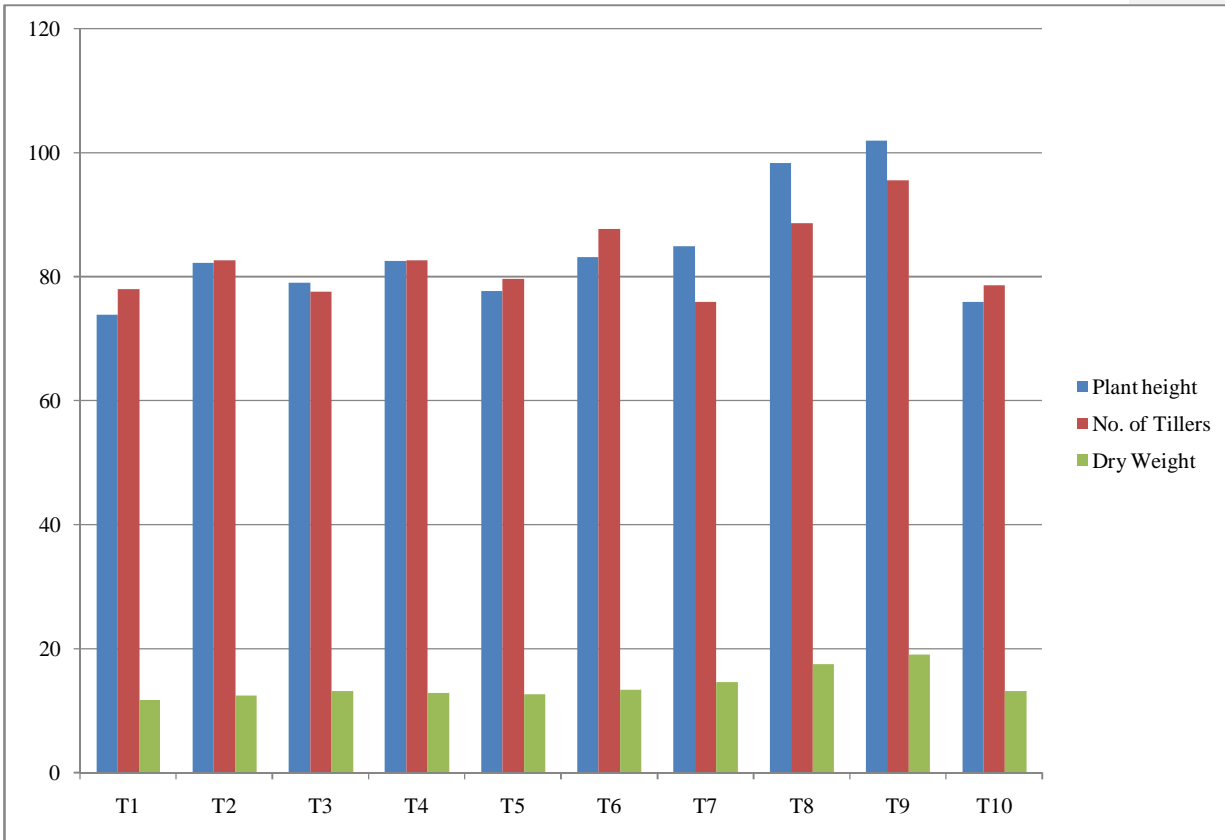
### **Conclusion**

After all the analysis study revealed that application of nitrogen along with micronutrientgave maximum result in most of the parameters. So now we can say that,

treatment where we applied nitrogen(75 kg/ha) and (3 % foliar spray)was best among the rest treatments. After this we can suggest to the farmers to apply this in their barley field for better yield.

**Table 1.Effect of Nitrogen and foliar applied Boron on Growth of Barley.**

		<b>At 80 DAS</b>		
<b>S.No.</b>	<b>Treatment combinations</b>	<b>Plant height (cm)</b>	<b>No. of Tillers (running row meter)</b>	<b>Dry weight (g/plant)</b>
1.	Nitrogen (45 kg/ha) + Boron (1 %)	73.90	78.00	11.71
2.	Nitrogen (45 kg/ha) + Boron (1.5 %)	82.26	82.66	12.49
3.	Nitrogen (45 kg/ha) + Boron (3 %)	79.11	77.66	13.27
4.	Nitrogen (60 kg/ha) + Boron (1 %)	82.54	82.66	12.87
5.	Nitrogen (60 kg/ha) + Boron (1.5 %)	77.78	79.66	12.64
6.	Nitrogen (60 kg/ha) + Boron (3 %)	83.21	87.66	13.39
7.	Nitrogen (75 kg/ha) + Boron (1 %)	84.92	76.00	14.60
8.	Nitrogen (75 kg/ha) + Boron (1.5 %)	98.40	88.66	17.53
9.	Nitrogen (75 kg/ha) + Boron (3 %)	102.00	95.66	19.08
10.	Control (NPK 60-30-20 kg/ha)	75.97	78.66	13.18
	F-test	S	S	S
	SEm(±)	2.43	3.60	0.66
	CD (p=0.05)	7.21	10.69	1.96



**Fig. 1** Effect of Nitrogen and foliar applied Boron on Plant height, No. of Tillers and Dry Weight of Barley.

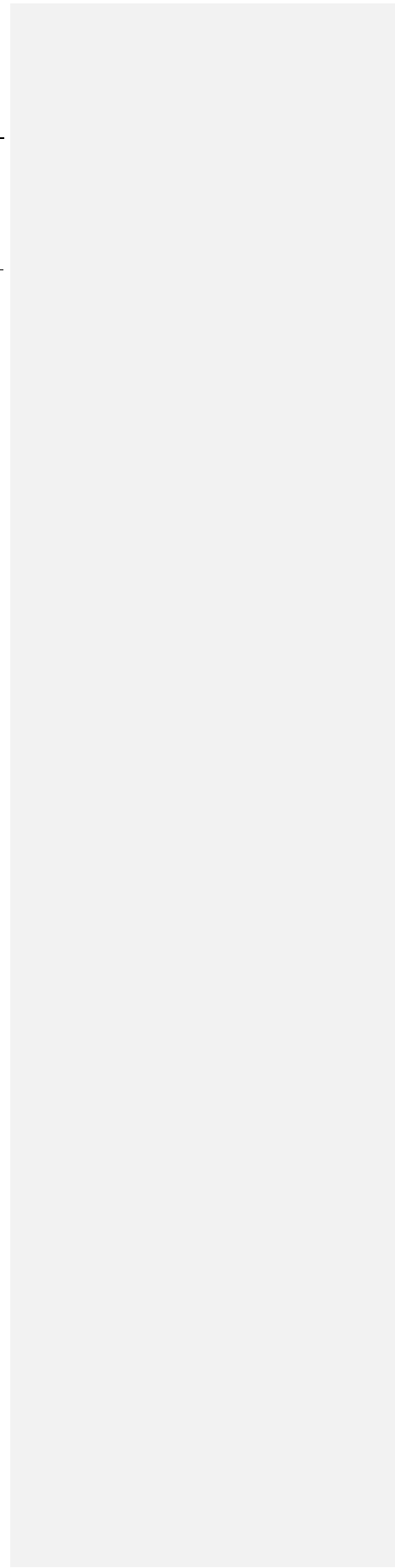
**Table 2. Effect of Nitrogen and foliar applied Boron on Yield attribute of Barley.**

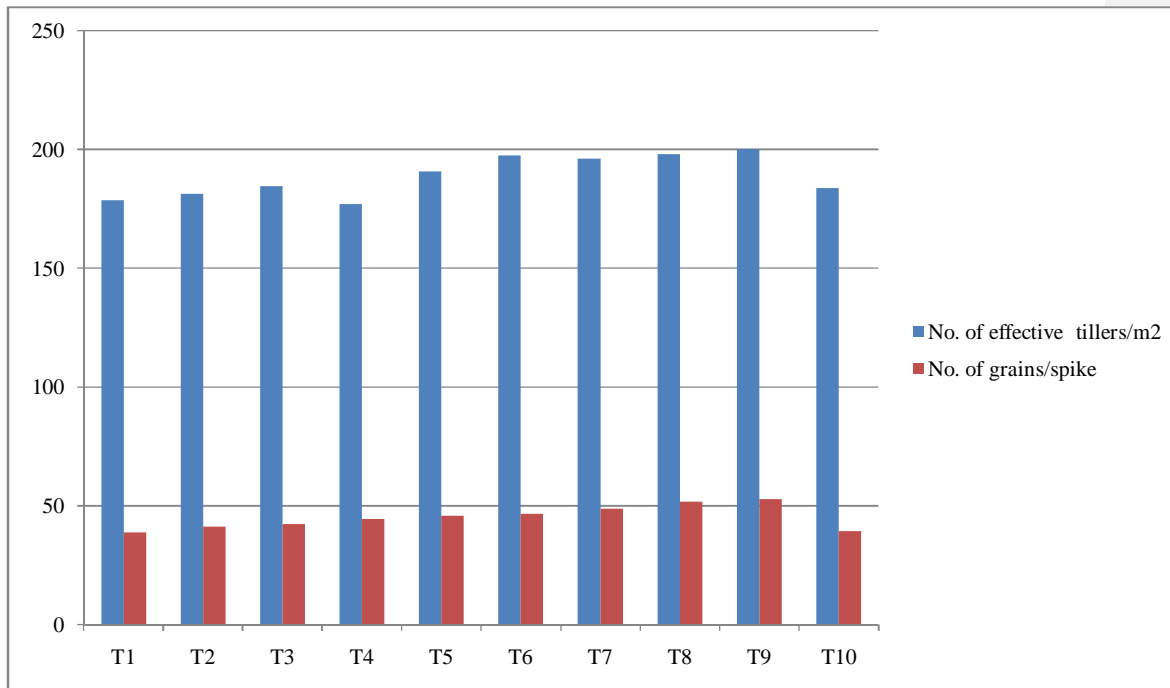
<b>S.No. combination</b>	<b>Treatment</b>	<b>Number of effective tillers/m<sup>2</sup></b>	<b>Number of grains/spike</b>
1.	Nitrogen (45 kg/ha) + Boron (1 %)	178.66	38.86
2.	Nitrogen (45 kg/ha) + Boron (1.5 %)	181.33	41.13
3.	Nitrogen (45 kg/ha) + Boron (3 %)	184.66	42.20
4.	Nitrogen (60 kg/ha) + Boron (1 %)	177.00	44.60
5.	Nitrogen (60 kg/ha) + Boron (1.5 %)	190.66	45.53
6.	Nitrogen (60 kg/ha) + Boron (3 %)	197.66	46.40
7.	Nitrogen (75 kg/ha) + Boron (1 %)	196.33	48.60
8.	Nitrogen (75 kg/ha) + Boron (1.5 %)	198.33	51.60
9.	Nitrogen (75 kg/ha) + Boron (3 %)	200.33	52.60
10.	Control (NPK 60-30-20 kg/ha)	183.66	39.26

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F-test	S	S
SEm(±)	5.45	1.29
CD (p=0.05)	16.19	3.84

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**Fig. 2** Effect of Nitrogen and foliar applied Boron on No. of effective tillers/m<sup>2</sup> and No. of grains/spike of Barley.

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