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 Response of during the *rabi* season of 2022-23 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), EC (0.305 d S/m), 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 spacing of 30 cm × 5 cm to a seed rate of 100 kg/ha. Consisting of three nitrogen levels (45, 60 and 75 kg N/ha) on different Concentration 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) and Yield attributes *viz.,* No. of effective tillers/m^2 (200.33), number of grains/spike (52.60), test weight (44.66 g), seed yield (4.81 t/ha) and straw yield (6.48 t/ha) recorded to be 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 with respect to area and production after wheat, rice and maize and is a hardy crop grown throughout the temperate, tropical and sub-tropical regions of the world. It is a *rabi* cereal crop in India and usually used as food for human beings and feed for animals and poultry birds **(Singh *et al.,* 2012)**. Globally, barley occupies the area of 48.48 million hectare with a production of 145.10 million tonnes grain and the productivity of 2990 kg/ha during 2020-21 **(United States Department of Agriculture, 2021)**. Barley though recognized as a hardy cereal crop due to its wider adaptability to environment has been

viewed as crop for marginal lands. While the global concern has been focused on food and environment sustainability, the demands on cereals, especially 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 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 either directly fed to the animals or used for making hay and silage. It is a *rabi* cereal crop is India and usually used as food for human beings and feed for animals and poultry birds **(Singh *et al.*, 2012)**. As it can tolerant to saline and alkaline condition than other winter cereals. It's cultivation in India suffered during green revolution period due to replacement from marginal land and rainfed areas by more remunerative oilseed and pulses. However, during 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 as known is very crucial to plants for its growth as it forms the basic structure of protein and nucleic acid which further plays important role in plant physiological phenomenon. Chlorophyll, the most important component, green color material of every plants and the one responsible for photosynthesis have the component nitrogen. Nitrogen is one or other way associated with 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 was the best treatment when considering nitrogen fertilizer only. Irrigation regimes also have significant effect on yield and growth parameters of barley **(Shirazi *et al.*, 2014)**. Nitrogen play a vital role as its presence in the form of protein and nucleic acid is basis for the formation of living material or protoplasm of every cell. This increase plant height, spike length, no of tiller which results into higher production of dry matter and grain yield **(Franklin *et al.*, 2017)**. In addition to nitrogen, phosphorous is of paramount importance for energy transfer in living cells by means of high energy phosphate bonds of ATP. Thus, it plays a pivotal role in formation and

translocation of carbohydrates, fatty acids, glyceroids and other essential intermediate compounds. It also affects seed plumpness, malting quality and protein content of the barley grain as well as 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. The application of 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. a 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)**.

Materials and Methods

The experiment was conducted during the *Rabi season* of 2022-2023 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^{o} N latitude, 87.19^{o} 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 (20 kg/ha) and Nitrogen and Boron were applied as per the treatments. “Experimental data collected was subjected to statistical analysis by adopting Fisher’s method of analysis of variance (ANOVA) as outlined by **(Gomez and Gomez, 1984)**. Critical Difference (CD) values were calculated wherever the ‘F’ test was found significant at 5 percent level”.

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/m^2 (190.02) 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%), grains 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% 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 **(Terefe *et al.*, 2018)**.

Yield attributes

Number of effective tillers/m^2

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

Number of grains/spike

The data apparent that Treatment 9 [Nitrogen (75 kg/ha) + Boron (3%)] was recorded significant and maximum Number of grains/spike (52.60) which was superior over all other treatments. However, the treatment 8 (51.60) [Nitrogen (75kg/ha) + Boron (1.5%)] treatment 7 (48.60) [Nitrogen (75kg/ha) + Boron (1%)], 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 micronutrient gave 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.

S.No.	Treatment combinations	At 80 DAS		
		Plant height (cm)	**No. of Tillers (running row meter)**	**Dry weight (g/plant)**
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

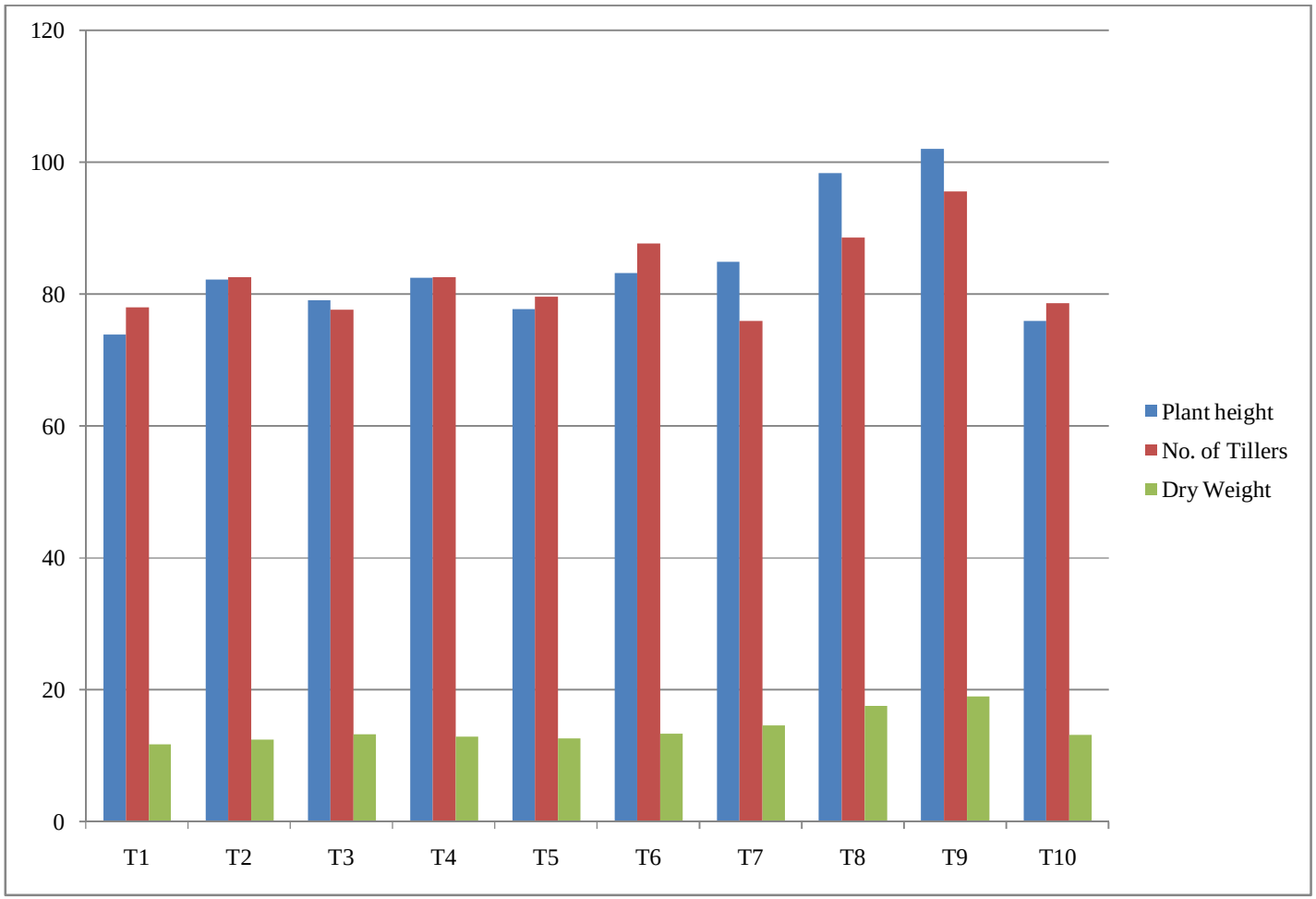

Fig. 1 Effect of Nitrogen and foliar applied Boron on Plant height, No. of Tillers and Dry Weight of Barley.

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

S.No.	Treatment combination	Number of effective tillers/m^2	Number of grains/spike
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
	F-test	S	S
	SEm(±)	5.45	1.29
	CD (p=0.05)	16.19	3.84

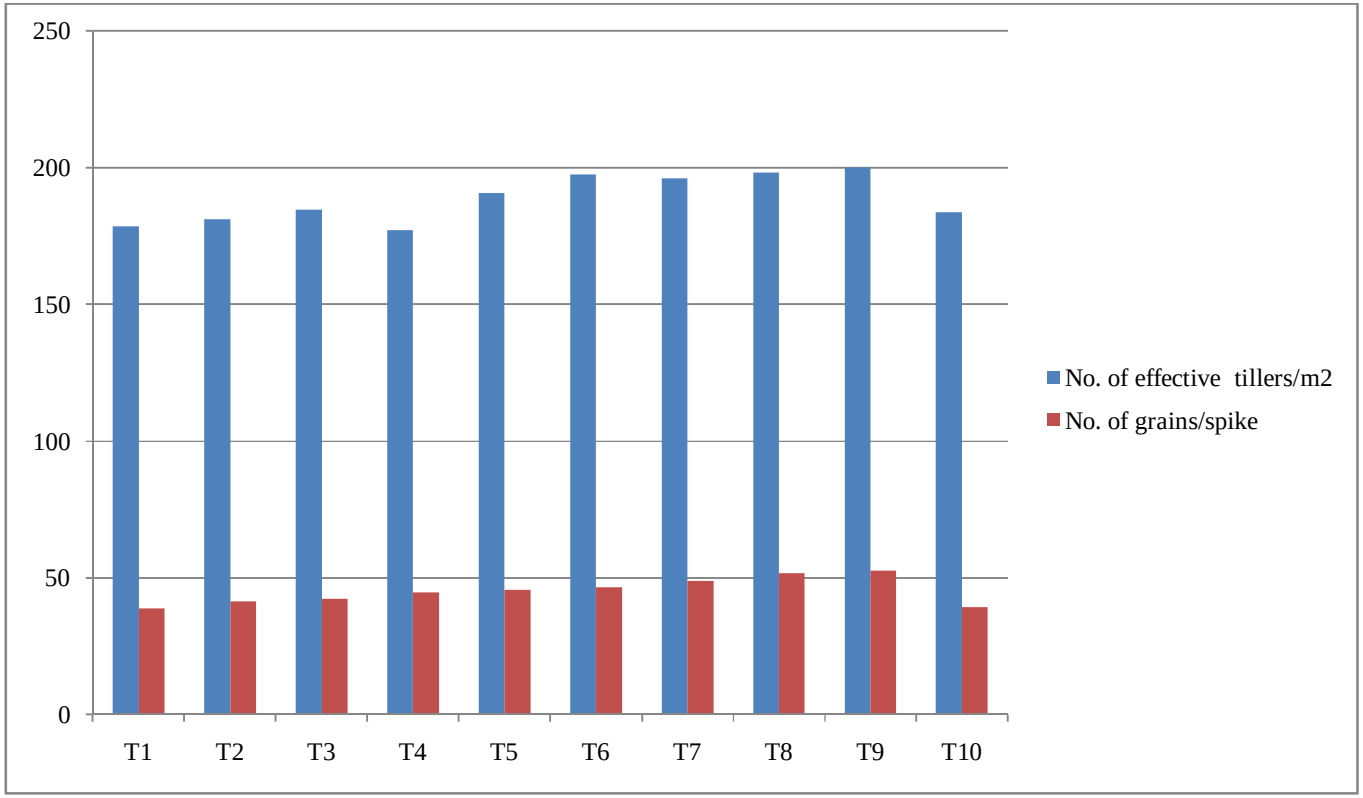

Fig. 2 Effect of Nitrogen and foliar applied Boron on No. of effective tillers/m^2 and No. of grains/spike of Barley.

Reference

Ahmad, S., Raza, T., Imran, S. (2021). Foliar Application of Boron Improves the Growth and Yield in Barley (*Hordeum Vulgare* L.). *Bulletin of University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca: Food Science and Technology*.

Assefa, F. (2018). Effect of urea fertilizer on growth response of food barley (*Hordeum vulgare* L.). *Agricultural Journal*, **13**(2): 40-47.

El-Feky, S. S., El-Shintinawy, F. A., Shaker, E. M. and Shams El-Din, H. A. (2012). Effect of elevated boron concentrations on the growth and yield of barley (*Hordeum vulgare* L.) and alleviation of its toxicity using different plant growth modulators. *Australian Journal of Crop Science*, **6**(12), 1687-1695

Franklin, J. C., Ribeiro, J. D., Fox, K. R., Bentley, K. H., Kleiman, E. M., Huang, X. and Nock, M. K. (2017). Risk factors for suicidal thoughts and behaviors: A meta-analysis of 50 years of research. *Psychological bulletin*, **143**(2), 187.

Grant, D. J. (2000). Nitrogen fertilization of dry land malt barley for yield and quality. Fertilizer Facts: **24**

Kumar T, Kumar J. S. A. and Dawson J. (2013) Effect of different levels of nitrogen and biofertilizers on growth and yield of barley (*Hordeum vulgare* L.). *Advance Research Journal Crop Improvement* **4**: 59-61.

Kumar, R., Yadav, S., Nand, V., Verma, S. K., Yadav, N. and Kumari, A. (2018). Effect of different nitrogen levels and varieties on yield of barley (*Hordeum vulgare* L.) under sodic soil. *Multilogic in Science*, **8**: 242-245.

Maher, M.N. (2017). New utilization of barley as human healthy food. *Journal of Plant Breeding and Agriculture,* **1**(2): 1

Narolia, G. P. (2009). Response of malt barley (*Hordeum vulgare* L.) to levels and scheduling of nitrogen application under varying growing environments (Doctoral dissertation, Ph. D. Thesis, Department of Agronomy, SKRAU, Bikaner).

Parashar, A., Sharma, S., Dogra, P., Parashar, K. and Tyagi, B. S. (2020). Response of malt barley (*Hordeum vulgare* L.) varieties to different levels of nitrogen and sulphur

application under agro-climatic zone III a (Semi-arid eastern plain zone) of Rajasthan. *International Journal of Crop Science*, **8**(4), 2059-2062.

Shirazi, S. M., Zulkifli, Y., Zardari, N. H. and Ismail, Z. (2014). Effect of irrigation regimes and nitrogen levels on the growth and yield of barley. *Advances in Agriculture*. **5**: 1-6

Singh, B., Dhaka, A. K., Solanki, Y. P. S. and Kumar, S. (2012). Optimization of nitrogen dose of malt barley genotypes under irrigated conditions. Abstract: National seminar on "Sustainable agriculture and food security challenges in changing climate" held at CCSHAU, Hisar from March **28**, 2012, 157.

Singh, J., Mahal, S. S. and Manhas, S. S. (2012). Effect of sowing methods, nitrogen levels and irrigation scheduling on yield and quality of malt barley (*Hordeum vulgare* L.) *Indian Journal of Agrnomy*, **57**(3): 259-264.

Terefe, D., Desalegn, T. and Ashagre, H. (2018). Effect of nitrogen fertilizer levels on grain yield and quality of malt barley (*Hordeum vulgare* L.) varieties at Wolmera District, Central Highland of Ethiopia. *International Journal of Research Studies in Agricultural Sciences*, **4**, 29-43.

United States Department of Agriculture (2021). World agricultural production circular series WAP **1**: 16.