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Mohit Kumar

Department of Agronomy,
School of Agriculture Lovely
Professional University
Jalandhar, Punjab, India

Influence of nitrogen fertilizer levels on growth and quality of barley (*Hordeum vulgare*) varieties

Mohit KumarDOI: <https://doi.org/10.22271/chemi.2021.v9.i1f.11272>**Abstract**

Nitrogen is the most important essential nutrient that comes under macronutrient category as it plays vital role in various physiological processes in plant as it produce rapid early growth, improve fruit quality, protein content in fodder crops, vegetative growth in plants, leaves, stem growth and imparts dark green color to plants. When different level of nitrogen applied in Barley (*Hordeum vulgare* L.) at different sowing dates, it resulted in increased rate of growth parameters like plant height, number of tillers per hill, CGR (Crop Growth Rate), RGR (Relative Growth Rate), plant dry weight and yield attributes like grain yield, straw yield, number of effective tillers. When nitrogen is given to barley at different concentration (60, 75, 90 kg per ha) maximum nitrogen content in grain and straw yield was found with the application of 90 kg per ha and protein content in grain and grain yield was found to be increased with increased level of nitrogen in Barley in sodic soils. When different levels of nitrogen (i.e. 0, 20, 40, 60, 80 and 100 kg per ha) in different varieties of Barley was applied, it affect yield attributes like grain weight, grain spike, straw yield, grain yield, biological yield, plant and grain nitrogen differently like maximum grain spike, grain and grain yield was recorded in sterling varieties while highest biological yield, straw yield, grain and plant nitrogen was observed in local varieties and nitrogen applied at rate of 60 kg per ha resulted in maximum grain spike, grain weight, biological yield, grain yield and grain and plant N. nitrogen applied at once showed minimum days to emergence of crop and maximum plant height while when applied in three split doses it results good yield with maximum emergence m^{-2} , fresh and dry biomass, tillers and leaves $plant^{-1}$, tillers and spike m^{-2} , grain spike, grain weight and minimum days to spike and maturity in dual purpose Barley. Regarding nitrogen fertilizer application at rates 0, 30, 60, 90, 120 and 150 $kg\ ha^{-1}$ yield was increase upto 90 $kg\ ha^{-1}$ later on it remains steady. Nitrogen accumulation in crops, green fodder yield, vegetative growth of plants is found to be increased upto a certain level of nitrogen applied beyond that limit some parameters are going to stay steady and some going to decline. Along with different nitrogen levels, number of cuttings and timing of cutting also affects parameters as late cutting have positive impact on enhancement of yield of green fodder and lack of cutting enhanced grain yield and most of yield components and high level of nitrogen led to increase in green fodder and grain yield.

Keywords: Nitrogen, growth, barley, fodder**Introduction**

Barley *Hordeum vulgare* L. is an important dual purpose cereal crop grown all over the world. In cereals, barley ranks fourth with respect to area and production after wheat, rice and maize. It is a Rabi cereal crop in India and commonly used as food for human beings and feed for animals and poultry birds (Singh *et al.*, 2012) ^[16]. Barley grain largest use as animal feed in all over the world and in India also. In world, about 70% of barley is used for animal feed, 20% for malting and 5% for direct food use (Dhillon and Uppal 2019) ^[21]. Barley has tremendous potential and variation for production of very high amount of digestible dry matter as well as protein yield per hectare. It is grown successfully in a wider range of climatic conditions than any other cereals. Barley is suitable for dual purpose cultivation for fodder and grain production than other cereals. It is highly efficient in the consumption of water and nutrients in limiting conditions. It is high capacity of crop for tillering and regenerate after cutting and additional capacity for large accumulation of biomass. Area under barley in world is 47.5 mha with 123.7 mt production and 2.68 t/ha Productivity. Russian federation holds first position in all over the world in terms of area and production with 4.94 mha and 8.35 mt respectively.

Corresponding Author:**Mohit Kumar**

Department of Agronomy,
School of Agriculture Lovely
Professional University
Jalandhar, Punjab, India

In India, barley crop was grown over an area of 695.0 thousand hectare with a production of 1743.2 thousand tones and productivity of 2.51 t ha⁻¹ during 2012-13 (Anonymous, 2013) [18]. The importance of any forage crop depends upon the green fodder yield, chemical composition and availability of good quality nutrients.

The chemical composition and nutritive values of fodder are influenced by variety of crops (Gupta *et al.* 1975) [4, 19]. Dual purpose barley is an alternate option crop for fodder purpose. The nutritive value of green fodder is highest at 50% flowering stage and decreases after flowering stage in most of the crops. In dual purpose barley crop, stage of harvesting also determine the regenerative potential of the crop, the regeneration capacity is adversely affected by the higher stage of harvesting for green fodder. Whole barley grain contains important vitamins and high levels of minerals like calcium, magnesium, phosphorus, potassium, vitamin A, vitamin E and niacin. Each 100 g of barley grain comprises 10.6 g protein, 2.1 g fat, 64 g carbohydrate, 50 mg calcium, 6 mg iron, 0.31 mg vitamin B2 and 50 µg folate (Vaughan *et al.* 2006) [20]. This crop has potentials for growing under drought and saline conditions. It requires less input like, fertilizer, irrigation, and insecticides.

Nitrogen is also a major component of amino acids, the building blocks of proteins. Nitrogen being a major food for plants is an essential constituent of protein (build from amino acids that involves in catalization of chemical responses and transportation of electrons) and chlorophyll (enable the process of photosynthesis) present in many major portions of the plant body. Nitrogen plays a most important role in various physiological processes. It imparts dark-green color in plants, promotes leaves, stem and other vegetative part's growth and development. Moreover, it also stimulates root growth. Nitrogen produce rapid early growth, improve fruit quality, enhances the growth of leafy vegetables, increases protein content of fodder crops. It encourages the uptake and utilization of other nutrients including potassium, phosphorous and controls overall growth of plant.

Review

Effect of nitrogen on growth performance of Barley

Nitrogen is very important for growth of barley because it is a major component of chlorophyll, the compound by which plants do photosynthesis. It is also a major component of amino acids, the building blocks of proteins. Without proteins, plants wilt and die.

Different doses of nitrogen affect the fodder yield and grain yield. Increasing levels of nitrogen significantly enhanced plant height, number of effective tillers, spike length, plant population of barley.

Plant population

Meena *et al.* (2011) [11] in experiment response of barley to different level and nitrogen application observed that maximum effective tillers/m² in T₃ (238.43) which is having high nitrogen level (90kg/ha⁻¹) than the T₂ and T₁.

Plant height (cm)

Meena *et al.* (2011) [11] conducted an experiment on response of fodder barley to varying levels and nitrogen application found that maximum plant height measured in T₃ (107.62cm) followed by T₂ (102.69cm) followed by T₁(98.59cm) with nitrogen application 90kg/ha⁻¹,60kg/ha⁻¹ 30kg/ha⁻¹ respectively.

Number of tillers plant⁻¹

Hadi *et al.* (2012) [4] done an experiment on different method of nitrogen application in barley and observed that maximum tiller plant⁻¹ (15.09) were obtained with 120kg nitrogen ha⁻¹. It was followed by 40kg ha⁻¹ (14.31) and 80 kg ha⁻¹ (13.18) treatments and results indicated that foliar application of nitrogen increased number of tillers plant⁻¹.

Dry matter plant⁻¹ (g)

Yadav *et al.* (2020) [7] conducted an experiment on Influence of different nitrogen levels on growth, nutrient content and protein yield of barley and observed that the dry matter yield of barley increased with increasing rates of nitrogen at all the stages. The maximum dry matter accumulation (178.67g/m⁻¹) was recorded under 90 kg N ha⁻¹ which was at par with 75 kg N ha⁻¹ and significantly superior to 60 kg N ha⁻¹ at all stages except at 30 DAS.

Effect of nitrogen on Quality of Barley fodder

Crude protein

The nitrogen content was estimated by Micro-Kjeldahl method. Finely ground sample (0.5 g) in duplicate was digested with 10 ml of concentrated sulphuric acid along with 5–6 g of digestion mixture (K₂SO₄ and CuSO₄ in 9:1). The digested material was distilled in the presence of 40% NaOH. The ammonia liberated was absorbed in 25 ml of 4% boric acid solution containing mixed indicator (Bromocresol green and methyl red in 5:1 ratio in 95% ethanol). Ammonium borate thus formed was titrated against standard H₂SO₄. The % nitrogen was calculated after subtracting the blank (AOAC 1990). The CP content (%) was calculated by multiplying the nitrogen % by 6.25.

Ram *et al.* (2012) [2] conducted an experiment and observed the crude protein was recorded significantly maximum under the treatment F4 (120 kg N +60 kg P₂O₅ha⁻¹). This might be due to adequate nitrogen availability which contributed to increase more crude protein synthesis because of protein is made up of amino acid. So there is more formation of amino acid which results to more accumulation of crude protein in green fodder. The minimum crude protein was recorded under the treatment F1 (60 kg N +30 kg P₂O₅ha⁻¹) due to low accumulation of nitrogen in green fodder of barley.

Midha *et al.* (1994) [3] observed the maximum crude protein was recorded under treatment C1 (45 DAS).The minimum crude protein was recorded under the treatment C4 (75 DAS) because of crude protein content was decreased due to higher fodder yield which led to dilution of photosynthates with the advancement of plant age.

Crude fibre

One gram finely ground sample was taken in a spout less beaker and 100 ml of 1.25% H₂SO₄ was added in it, then boiled and refluxed the contents for 30 min. The contents were filtered through liner cloth fixed on the top of the Buchner funnel. Suction pump was used to quicken the process of filtration. All the contents were washed with the hot water and made it acid free. Again transferred the residue back into the same beaker and 2 ml decalin and 100 ml of 1.25% NaOH solution was added. The contents were boiled and refluxed for 30 min and filtered through the liner cloth and made it alkali free and transferred the contents into dried crucibles and then oven dried the residue over night at 105°C to dryness, cooled in the desiccator and recorded the weight and expressed as crude fibre percentage.

Rawat DS. (2011) ^[13] The crude fiber was recorded significantly maximum under the treatment F4 (120 kg N +60 kg P₂O₅ha⁻¹). This might be due to adequate nitrogen and phosphorus availability which contributed to increase more crude fiber synthesis. The minimum crude fiber was recorded under the treatment F1 (60 kg N +30 kg P₂O₅ha⁻¹) due to low accumulation of fiber content in green fodder of barley.

Kaur *et al.* (2013) ^[14] Crude fiber was significantly affected by cutting schedule. The maximum crude fiber was recorded under treatment C4 (75 DAS) due to increases the fiber content in plant with advancement of plant age. The minimum crude fiber was recorded under the treatment C1 (45 DAS).

Neutral detergent fiber

Finally ground 0.5 g fodder sample was taken in Spoutless beaker and 60 ml neutral detergent solution was added in the beaker. Then beaker was kept on hot plate for 1 h. The contents were filtered through pre-weighed Gooch crucible under vacuum with 4–5 washings with hot distilled water and a final washing was given with acetone. The crucibles were dried to a constant weight at 100°C and weighed. The difference between the initial and final weight of crucible gave the total NDF content in the sample. The NDF content was expressed as percentage on DM basis (AOAC 1990).

Rawat DS. (2011) ^[13] recorded the NDF was significantly maximum under the treatment F4 (120 kg N +60 kg P₂O₅ha⁻¹). This might be due to adequate nitrogen and phosphorus availability which increased the fibre content in green barely fodder. The minimum NDF was recorded under the treatment F1 (60 kg N +30 kg P₂O₅ha⁻¹) due to decreasing rate of nitrogen and phosphorus in comparison to other treatments.

Midha *at et.* (1994) done an experiment and observed that maximum NDF was recorded under treatment C4 (75 DAS) and minimum NDF was recorded under the treatment C1 (45 DAS) because it increased with the crop age advancement due increasing the fibre content in plant.

Ether extract

Finely ground (1 g) sample was transferred to extraction thimble (Whatman No. 1) and extracted with petroleum ether (60–80°C boiling point) in Soxhlet's apparatus for 16 h. The excess of petroleum ether was recovered and the residue extract in the flask was transferred to a pre-weighed beaker and ether was first evaporated on a boiling water bath and finally in an oven to a constant weight. The difference in initial and final weight gave the ether extract content in the sample taken. The ether extract in the sample was expressed as percentage ether extract on DM basis (AOAC 1990).

Mayer *et al.* ^[16] recorded the increase in EE could be due to the production of chlorophyll associated with plant growth that are recovered in ether extract measurement.

Fazaeli *et al.* (2012) ^[17] observed in experiment productivity and nutritive value of barley green fodder yield in hydroponic system and found by extending the growing period day by day ether extract was increased.

Total ash content

Finely ground sample (1 g) was charred in a tarred crucible on a hot plate and then ignited at 600°C in a muffle furnace for 3 h. The crucibles were taken out and kept in a desiccator till room temperature was attained and weighed. The difference between the initial weight of empty crucible and crucible with ash gave the total ash content in the sample. The ash content was expressed as percentage total ash on DM basis (AOAC 1990).

Nand *et al.* (2019) ^[15] observed in Effect of fertilizers and cutting schedule and quality of dual purpose barley crop that the total ash was recorded significantly maximum under the treatment F4 (120 kg N +60 kg P₂O₅ha⁻¹). This might be due to adequate nitrogen and phosphorus availability which contributed to increase dry matter accumulation per unit area which result more biomass production. The minimum total ash was recorded under treatment F1 (60 kg N +30 kg P₂O₅ha⁻¹) due to lower dry matter accumulation on per unit area.

Leaf stem ratio

Samples were taken at the time of forage harvest and oven-dried at 60°C and hand-separated into leaf blade and stem (including leaf weight of leaf and stem sheath and inflorescence) components. Components were weighed and the leaf blade dry weight was divided by the stem dry weight to calculate leaf/stem ratio.

Conclusion

Nitrogen plays a crucial role in plants as plant depends on this nutrient for many of its processes and it affect plant at different stages of its life cycle differently mainly at vegetative stage, if at this stage availability of nitrogen declines then plant remain stunted and photosynthetic activity reduce and it directly affect the green fodder yield and grain yield as well. if we apply nitrogen to barley at different growth stages in different concentrations and at different time of cuttings, increased concentration of nitrogen increases growth and yield parameters upto some extent then they become steady and not increase on increased concentration of nitrogen. And for fodder crops, green fodder yield is more important than grain yield and it can be enhanced by applying nitrogen at vegetative stage of crop growth and after each cutting.

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