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The Determination of Nitrogen Fertilizer on Barley Production in Ethiopia: A Review

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Abstract:
The productivity of barley stands in most parts of Ethiopia is constrained by the low fertility status of the soils. In order to address the problem, a review was done with the purpose of figuring out the ideal dose of nitrogen-based fertilizer for barley cultivation in Ethiopia's barley-growing districts. The review found that increasing nitrogen application amounts influenced practically every aspect of growth and yields. According to the review, nitrogen fertilizer application rates ranging between 0 kilograms per hectare and 230 kilograms per hectare produced the best plant height, spike length, grains per spike, straw, biomass yield, and grain yield of barley. However, there are not the same responses to different agro-ecologies and crop varieties. As observed from this review, nitrogen rates, which gave the highest yields, are not the same. It is different from place to place and from crop type to crop type. Therefore, it is necessary to conduct a detailed and further study to identify the optimum nitrogen rate for barley production throughout the country as per location, agro-ecology, and crop variety responses.

Keywords: nitrogen rate, fertilizer, barley production

INTRODUCTION

Barley (Hordeum vulgare L.), a cereal that is produced annually on 48 million hectares across a variety of environments, is the fourth most popular cereal in the world (ICARDA, 2011). Ethiopia, Africa's second-largest producer of barley, contributes almost 25% to the total crops (FAO STAT, 2014). According to CSA (2014–2015), barley ranks fifth in importance among all cereal crops grown in the country, after teff, wheat, maize, and sorghum. Food barley accounts for 90% of barley production, compared to malt barley (Alemu et al., 2014). The national yield of barley continued to be under 1.3 t/ha CSA (2014–2015), even though the potential yield at the experimental farms can approach 6 t/ha (Lakew et al., 1996). Lack of better cultivars and inadequate soil management are cited as reasons for the reduced yield of food barley (Woldeab et al., 1991). In Ethiopia's highlands, soil fertility is the biggest obstacle to the cultivation of barley (Woldeyesus et al., 2002). Poor plant nutrients and inadequate agricultural methods are further causes of low barley productivity (Gete et al., 2010). According to Abera et al. (2011), traditional agricultural practices and deficient soil fertility are the main causes of barley's low productivity.

In significant farming areas of the world, nitrogen tends to be the factor that most restricts crop yield; hence, comprehensive nitrogen management strategies typically result in considerable financial gains for farmers. Efficient nitrogen usage is also vital for reducing environmental pollution (Scharf and Alley, 1988). As a result, splitting nitrogen fertilizer applications to follow the crop's nitrogen requirements throughout the growing season is likely the best technique for achieving large grain yields while maintaining malt quality.

The primary raw substance necessary for plant growth is nitrogen. While it is a necessary part of every protein, it plays a role in every process of plant growth. Furthermore, nitrogen is involved in cell multiplication, which causes an increase in the size and length of leaves and stems, particularly grain and stalks; increases chlorophyll, which gives the leaves their dark green color; participates in the production of proteins in the plant; and is a component of many compounds in the plant, including certain types of basic acids and hormones. Nitrogen lack restricts cell division and expansion, chloroplast development, chlorophyll concentration and expansion, and enzyme activity. General stunting and yellowing, particularly in older plant portions, are symptoms of a nitrogen deficiency. According to Ortiz-Monasterio et al. (1997), nitrogen deficiencies in bread wheat mostly impacts leaf expansion and nitrogen concentration. Hence, a review was done with the purpose of figuring out the ideal dose of nitrogen-based fertilizer for barley cultivation in Ethiopia's barley-growing districts.

OVERVIEW OF NITROGEN

According to Taiz and Zeiger (2006), nitrogen is a mineral that plants need in high concentration, but normally the amount of nitrogen available to plants is constrained. As a result, nitrogen plays a crucial role in plant distribution, biology, which is development, and multiplication, which is why it accounts for the majority of agricultural supplies. The plant must have enough nitrogen in order for additional nutrients to be absorbed. It frequently participates in cell division, which results in the expansion of leaves and stems' size and length. Since nitrogen is a nutrient found in numerous important components, it is impossible to imagine how plants could thrive without it (Hansen et al., 2005).

The amount of nitrogen a plant can absorb has an impact on how well it's able to produce chlorophyll and engage in the process of photosynthesis (Hansen et al., 2005). This influences the amount of protein one at a time. Cereal leaves stay green for an extended period after the process of emergence, enhancing the rate of photosynthesis (Ozen and Onay, 2007). Due to nitrogen's significance as a macronutrient for plant nutrition and its role in promoting plant development by means of enhanced leaf formation and an increase in chlorophyll level in leaves, which may reflect advancements in the mechanism of photosynthesis, higher nitrogen fertilizer levels may increase yield (Mekdad, 2015).

Nitrogen Fertilizer on Plant Growth of Barley

Plant Height:

Kassa and Sorsa (2015) observed that increased nitrogen levels lead plants to grow higher in the Damot Gale District, Wolaita Zone, Ethiopia. They discovered that the shortest (61.3 cm) and tallest (83.1 cm) plants were grown in treated plots, and that a supply of 69/30 kg/ha nitrogen fertilizer resulted in a 32.62% plant height advantage over unfertilized plots. An increase in plant height and an increase in fertilization supply may both be strongly related to nitrogen's consequences, which encourage vegetative development. Similar findings were made by Fasil and Demelash (2021), who noted that the longest plant height (from 71.6 to 82.7cm) was shown as fertilizer with a nitrogen rate raised from 11.5 to 57.5 kg/ha. Nitrogen levels have a substantial impact on the plant's height. Similarly, a plant height advantage of 8.64% was seen for barley with 120 N kg/ha in comparison to a treatment that did not receive any fertilizers.

According to Niguse and Kassaye (2018), fertilizer at 69 N kg/ha produced the highest mean plant height (100.7cm), while fertilizer at 0 N kg/ha produced the lowest mean plant height (100.7cm). Furthermore, the height of the plants increased by 10.7 percent, exceeding the untreated treatment. The addition of large nitrogen contents along with balanced fertilizers has a substantial impact on boosting vegetative growth in crop plants since nitrogen is a crucial component of chlorophyll and proteins, which aid in the growth and development of plants. Kassie et al. (2021) revealed that in the period of three years, the tallest plant's height was achieved with 222 kg/ha of nitrogen given; however, the shortest measurement was from under control.

Spike Length and Grains per Spike:

As reported by a number of researchers, spike length rose dramatically with rising N levels. As stated by Niguse and Kassaye (2018), the variety known as EH1493 yielded the greatest length of spikes (8.06 cm), followed by the one grown locally (7.89 cm), but the HB1307 variety gave the shortest spikes (7.10 cm). In another study, Fasil and Demelash (2021) found that the Holker variety had the longest spike length (5.6 cm) and the Fanaka variety had the shortest spike length (5.0 cm); additionally, the longest and shortest spike lengths (5.7 cm) were recorded from 57.5 N kg/ha and 11.5 N kg/ha use of fertilizer, respectively. The one that was treated with 92 kg/ha of nitrogen fertilizer level application had the longest spikes (6.89 cm), which was 25% longer than the shortest spikes (5.15 cm) found in the plot that received 23 kg/ha of nitrogen fertilizer use (Jemal and Aliyi, 2021). The duration of a malt barley spike is significantly influenced by nitrogen fertilization. According to Addisu (2020), the longest spike length (6.04 cm) was measured at a nitrogen level of 46 kg/ha, while the shortest spike length (7.27 cm) was measured at nitrogen rates of 115 kg/ha, 92 kg/ha, and 69 kg/ha.

According to Hunde and Hirpa (2017), the variety Grace produced the most grain per spike (32.0) at 65 kg/ha of nitrogen fertilizer application, whereas the control plot produced the lowest (26.2) grain per spike. When compared to the lowest grain produced with fertilizer application on the control, this greatest amount of grain improved by approximately 20.61%. In comparison to the control (23.36 kernels per spike), Ejigu and Eticha (2018) achieved the highest level of nitrogen at 50 kg/ha and produced the most kernels per spike (25.76).

Nitrogen on Yield, and Yield-Related Traits of Barley

Yield (kg/ha):

The crop reaction to nitrogen fertilizers in relation to plant development differs with the dosage and timing. In several physiological reactions inside the plant, it is crucial. As a plant grows, it absorbs and uses nitrogen for photosynthesis and other purposes. As a result, a lack of N can significantly affect grain growth and cause a considerable reduction in the amount of grain produced. Nutrient shortages and a lack of balanced fertilizers lower the yield of crops (Khan et al., 2014). Although the productivity and quality of malted barley are improved at the optimum nitrogen levels, too much nitrogen also reduces the yield and quality of barley seeds. Effective nitrogen doses differ depending on the place.

Shewangizaw et al. (2022) studied the effect of four nitrogen doses (0, 46, 92, 138, 184, and 230 N kg/ha) on barley yield in 83 farmers' fields in the main barley-growing Siemen Shewa Zone, the southern Tigray Zone, and the Bale Zone in Ethiopia from 2014 to 2016. They came to the conclusion that, as compared to the control, the nitrogen rate by agro-ecological zones interaction improved grain production by 59 percent in warm sub-moist mid-highlands (SM3), 37 percent in cool sub-moist mid-highlands (SM4), and 18 percent in warm sub-humid mid-highlands (SH3). Furthermore, the SM3 and SM4 agro-ecological zones saw the greatest yield increase. When N rate by soil type interaction was addressed, consistent yield gains of 26 percent (544 kilograms per hectare)–59 percent (1213 kilograms per hectare) on Cambisols and 18 percent (416 kilograms per hectare)–74 percent (1750 kilograms per hectare) on Vertisols were seen when compared to the reference.

Nitrogen fertilizer applied throughout the length of the barley improved its grain production. This is analogous with the research results of Hunde and Hirpa et al. (2017), who observed that nitrogen use at an amount of 65 kilograms per hectare resulted in the highest barley grain production (5880 kg/ha). The neglected plot, on the other hand, generated the least amount of grains (1780 kg/ha), which was reduced by seventy percent when compared to those treated with the highest nitrogen rate (65 kg/ha). The yield of crops improved significantly from 2.05 to 5.29 t/ha when nitrogen levels ranged from 0 kg/ha to 92 kg/ha in the Allicho-Woriro district, Silte Zone, Southern Ethiopia (Mekonnen, 2018). The study also showed that grain yield rose by 158.05 percent as compared with the untreated plots (0 N kg/ha). According to Ejigu and Eticha (2018), the variety known as 'Miscal-21' produced the best yield of grain (3690.66 According to Ejigu and Eticha (2018), the variety known as 'Miscal-21' produced the best yield of grain (3690.66 kg/ha) when using a nitrogen concentration of 30 kilograms per hectare, though the variety 'Holker' produced the smallest quantity of grain (1438 kilograms per hectare) at a nitrogen rate of 0 kilograms per hectare. These results are in line with those of Kefale et al. (2016), who found that the local variety with the lowest nitrogen fertilizer application rate (51.5 kilograms per hectare) produced the highest mean grain yield of nitrogen (4918.3 kilograms per hectare), while the highest nitrogen fertilizer application rate (98.5 kilograms per hectare) produced the highest nitrogen mean grain yield (4918.3 kilograms per hectare). When using a nitrogen concentration of 30 kilograms per hectare, though the variety 'Holker' produced the smallest quantity of grain (1438 kilograms per hectare) at a nitrogen rate of 0 kilograms per hectare. These results are in line with those of Kefale et al. (2016), who found that the local variety with the lowest nitrogen fertilizer application rate (51.5 kilograms per hectare) produced the highest mean grain yield of nitrogen (4918.3 kilograms per hectare), while the highest nitrogen fertilizer application rate (98.5 kilograms per hectare) produced the highest nitrogen mean grain yield (4918.3 kilograms per hectare).

By applying a total of four distinct nitrogen fertilizer dosages (0, 23, 46, and 69 N kilograms per hectare), Niguse and Kassaye (2018) carried out an experiment on the ground in Limo district, Southern Ethiopia, in order to assess the growth and yield indicators associated with three food barley varieties: Local Variety (Darshina), HB 1307, and EH 1493. They arrived at the decision that the cultivar EH 1493 had the greatest average grain production (4510 kg/ha) at a nitrogen application rate of 69 kg/ha. The cultivar HB 1307 with a 0% nitrogen rate produced the least grain yield (1420 kg/ha). Combined with 69 N kg/ha, EH 1493 outperformed HB 1307 and local varieties by roughly 39 and 22%, respectively. Fasil and Demelash (2021) claim that fertilization rates of 57.5 and 11.5 kg/ha with the Ibon and Fanaka cultivars, respectively, resulted in the highest (2.63) and lowest (1.39) t/ha grain yields. Food barley (var. HR0713) was the target of a study by Kassie et al. (2021) that examined the effects of various nitrogen (N) concentrations on yield and yield characteristics over the course of three years, from 2013 to 2016. The highest grain yields of barley came about when nitrogen was applied at a rate of 222 kg/ha, relative to the lowest yields throughout a three-year period when the control was used. Additionally, according to Jemal (2022), the traveler barley varieties treated with a nitrogen fertilizer rate of 150 kg/ha and the Ibon barley varieties treated with a nitrogen fertilizer rate of 0 kg/ha, respectively, produced the highest (2078.10 kg/ha) along with the lowest (1136.30 kg/ha).

Aboveground Biomass and Straw Yield:

As stated in Jemal and Aliyi's (2021) report, The lowest quantity of biomass from above (23 kilograms per hectare) matched statistically equivalent nitrogen fertilizer rates of 46 and 69 kilograms per hectare, while the largest amount of biomass yield (6.23 tons per hectare) was found at a nitrogen fertilizer rate of 92 kilograms per hectare. Furthermore, compared to the 23 kilograms per hectare nitrogen fertilizer rate, the maximum biomass yield of barley increased by 25 percent at the nitrogen fertilizer rate of 92 kilograms per hectare. Likewise, they believed that the use of nitrogen led to notable enhancements in plant height, tillering, spike length, the number of spikelets per spike, and grain yield, which ultimately resulted in an increase in crop biomass yield. These results were in line with those of Hunde and Hirpa (2017), who discovered that nitrogen fertilizer application rates ranging from 0 to 65 kg/ha increased biological yield by sixty percent. They also noticed that the greatest amount of biological yield (12,138.9 kg/ha) occurred at a nitrogen rate of 65 kilograms per hectare, which was much greater than the result obtained from the control plot (4,916.7 kilograms per hectare). This outcome showed that greater nitrogen utilization of fertilizers in addition to crop attributes related to crop biomass were responsible for the effects of nitrogen on the production of biological products. According to these findings, nitrogen encourages plant vegetative development at higher fertilizer application rates per hectare. Increases in the volume of nitrogen applied improved the quantity of straw produced in a linear way, as determined by Addisu (2020). He found that the nitrogen concentration of 115 kilograms per hectare resulted in the maximum straw yield (4920 kg/ha) of malt barely. The minimal straw yield (3870 kilograms per hectare) was produced from 46 kilograms per hectare of nitrogen. The plants' quick vegetative development may be the cause of the higher straw production after high nitrogen applications. The local variety with the highest nitrogen fertilizer application rate (98.5 kg/ha) produced the highest mean straw yield of nitrogen (9127.7 kilograms per hectare), while the Sabini variety with the lowest nitrogen fertilizer application rate (51.5 kilograms per hectare) produced the lowest mean straw yield of nitrogen (3455.3 kg/ha).

CONCLUSION

Generally, the review found that increasing nitrogen application amounts influenced practically every aspect of growth and yields. According to the review, nitrogen fertilizer application rates ranging between 0 kilograms per hectare and 230 kilograms per hectare produced the best plant height, spike length, grains per spike, straw, biomass yield, and grain yield of barley.

However, there are not the same responses to different agro-ecologies and crop varieties. As observed from this review, nitrogen rates, which gave the highest yields, are not the same. It is different from place to place and from crop type to crop type. Therefore, it is necessary to conduct a detailed and further study to identify the optimum nitrogen rate for barley production throughout the country as per location, agro-ecology, and crop variety responses.

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