Int.J.Curr.Res.Aca.Rev.2020; 8(11): 54-58

EXCELLENT PUBLISHERS

International Journal of Current Research and Academic Review

ISSN: 2347-3215 (Online) Volume 8 Number 11 (November-2020)

Journal homepage: http://www.ijcrar.com

doi: https://doi.org/10.20546/ijcrar.2020.811.007

Effect of Nitrogen Fertilizer Levels on Growth Response of Food Barley (*Hordeum vulgare* L.)

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Abstract

Fertilizers, particularly those containing nitrogen are the major inputs affecting the growth of barley crop. Therefore, the field experiment was conducted at Hawassa University College of Agriculture in 2019 cropping season. The objective of the study was to evaluate effect of nitrogen fertilizer level on growth response of food barley crop. The experiment was laid out in randomized complete randomized design (RCBD) with four replications having three treatments of nitrogen levels (0kg/ha, 23kg/ha, and 46kg/ha). The results showed that the highest leaf area index (3.621194) and crop growth rate (19.333gmm^{-2}day^{-1}) were recorded from 46kg/ha of nitrogen fertilizer rater. On the other hand, nitrogen fertilizer rate has no statically significant effect on total dry biomass of barley crop.

Article Info

Accepted: 08 October 2020
Available Online: 20 November 2020

Keywords

Growth parameter, barley, Fertilizer and N-rate

Introduction

Barley (*Hordeum vulgare* L.) is an annual, self-pollinating cereal crop that belongs to the same plant family (Poaceous or Gramineae) as maize, oats, rice and wheat; tribe Triticeae and genus Harem. It is world's fourth most important cereal crop after wheat, maize and rice and fifth after teff (Agrostis tef L.) wheat, maize and sorghum in area coverage in Ethiopia (Alkoz *et al.*, 1993). Barley is among the major grain cereals dominantly cultivated in the central highlands of Ethiopia where the soils are often acidic in reaction.

Though barley grain has many uses, including livestock feed, human food and production of malt in Ethiopia, the gram is mainly produced for human consumption and sold for cash. About 90^0 0 of the grain is used for human food and it accounts for over 60^0 0 of the food for the inhabitants of the highlands (Anonymous, 1996). Despite its long history of cultivation and wide range of uses by different communities, the average yield of barley in Ethiopia is 1.27 ton/ha compared to the world average, 5.87-6.31 ton/ha. The main limiting factors are poor soil fertility (Darota, 2003). Low levels of chemical fertilizer usage and low pH. Since, the major barley producing areas of the country are mainly located in the highlands, severe soil erosion, continuous mono-cropping, lack of appropriate soil conservation practices and lack of appropriate crop rotation system (Alemu, 2001) have resulted in soils with low fertility and pH. Thus, managing soil fertility becomes crucial for improving agricultural productivity in the county.

Fertilizers, particularly those containing nitrogen are the major inputs affecting the growth, yield and quality of barley. Edney and Tipless (1997), Bulman and Smith

(1993) and Hailu *et al.*, (1996) and proper use of N fertilizer can markedly increase the grow, yield and improve the quality of barley. Grando and Helena (2005) reported that soils in the highlands of Ethiopia usually have low levels of essential plant nutrients and low organic matter content especially, low availability of nitrogen that has been demonstrated to be the major constraint to cereal production. Barley responds well to balanced application of N fertilizer (Anonymous, 1997). Effect of Nitrogen fertilizer on vegetative growth and biomass of food barely was one of the most important limiting factors. Therefore, the aim of the study was to evaluate effect of nitrogen fertilizer level on growth response of food barley crop.

Materials and Methods

Description of the study area

The field experiment was conducted at Hawassa University, College of Agriculture field during 2019 cropping season under irrigation condition. The site is located 6.7^0 N and $38^0$29'E of latitude at an altitude of 1700 m.a.s.l. with the mean annual rainfall range between 900mm and 1000mm.The mean annual temperature maximum and minimum is 13 ^{0}Cand 27 ^{0}C respectively. The type of soil of the experimental site is sandy loam with pH of 5.5.

Experimental materials

The main experimental materials used during this study were barley seed variety, nitrogen fertilizer (urea).

Experimental design and treatment

The field experiment was laid out in Randomized Complete Block Design (RCBD) with four replication and three treatments. The treatments were Treatment one (T l) 0 kg N/ha used as control, Treatment two (T 2) 23kg N/ha, and Treatment three and (T3) 46 kg N/ha. The experimental area was divided into small homogenous blocks and each replication contained complete set of treatment which was allocated to plots within each block at randomly. The arrangement of block was against concentration gradient, since, concentration of gradient is perpendicular (North-South). Each plot had five rows, the space between row 20cm with drill and the size of plot was 1m*2 m and the distance of 1m and 0.5m were maintained between block and plot respectively.

Experimental procedures

The experimental field was prepared following the conventional tillage practice before planting the seed. In accordance with the specifications of the design, a field layout was prepared and each treatment is assigned randomly to experimental plots within a block.

Seed was sown at the recommended rate of 100 kg/ha drilled in rows on October 2019. Fertilizer was applied within the rows as basal application at planting. The remaining half dose of nitrogen fertilizer was side application at tillering. Plots were kept free of weeds to produce a successful barley crop.

Measurements of observation

Physiologically the study was measured using their standard procedures. During the experiment physiological study for each growth analysis parameters, and Sampling method was area based from the mid vegetative growth phase. Three times data was recorded at 35^{th}, 49^{th} days for leaf area and leaf dry weight after emergence. The first distractive sample was taken on December 04, 2019 from 20cmx40cm ($0.08m^2$), for leaf area and leaf dry biomass and 40cmx100cm ($0.4m^2$). Also, after two weeks later the second sample was taken on December 17, 2019 for leaf area and leaf dry weight analysis.

The leaf area (assimilatory area) was measured by using area meter; the average leaf area of the crop was taken for statistical analysis. Finally, on Jan10, 2020 final data was taken for determining the total biomass from the middle row. The 1^{st} and 2^{nd} samples were oven dried at 70^oC for 48 hours and total biomass was sun dried then calculated commutative growth rate (g $m^{-2}day^{-1}$) by using their standard formula:

CGR= W1-W2/T2-T1X1/GA: where:- W1 = Initial weight, W2 = Final weight, T1 = time at the start of period, T2 = time at the end of period and GA = Ground area.

LAR=A/W

A=Assimilatory
W=total biomass dry weight

LAI=A/P

A=Leaf area

Statistical analysis

The collected data was subjected to statistical analysis using SAS Software. Significant differences between and &or among treatments was separated by Least Significant Differences (LSD) test. Interpretations were done following the procedures described by Gomez and Gomez (1984).

Results and Discussions

Leaf area index

The result of table-1 above showed that application of nitrogen fertilizer has no contribution in the beginning growth period on leaf area index but later grow period in second sampling result showed that increasing of nitrogen fertilizer rate from 0kg/ha to 46kg/ha increased leaf area index. The increasing leaf area index in the second sampling was due to the split application of nitrogen on tillering stage of crop growth. From first sampling to second sampling leaf area index increased from 1.165 to 2.99 in 0kg/ha or in controlled treatments but increased from 1.019 to 3.621 in 46kg/ha application of nitrogen fertilizer rate.

Leaf area ratio

The result of table-2 above showed that the effect of nitrogen fertilizer rate on leaf area ratio of barley crop was decreased from first sampling to second sampling. Leaf area ratio was the ratio of leaf area per unit of leaf dry weight at any given time point. Therefore, leaf dry weight increased leaf area ratio decreased from first sampling of 225.72gmcm^{-2} to second sampling 107.57gmcm^{-2} in control treatment and decreased from first sampling 240.29gmcm^{-2} to second sampling 110.02gmcm^{-2} in 46kg/ha nitrogen level applied. After vegetative grow of crop leaf area reach its maximum and decreased leaf area ratio due to increased leaf dry weight.

Crop growth rate

Based on table-3 result in the above showed that effect of nitrogen fertilizer has a great contribution in crop growth rate of barely crops. Increased nitrogen fertilizer level from 0kg/ha to 46kg/ha increased crop growth rate from 14.85gmm^{-2}day^{-1} to 19.33gmm^{-2}day^{-1}. It was an increased in total dry weight per unit land area of a crop per unit time. The time of growth period increased crop growth rate also increased.

Table.1 The effect of Nitrogen on Leaf area index (LAI)

Nitrogen levels	1stSample-1	2ndSample-1
0kg/ha	1.16± 0.10	2.98±0.29
23kg/ha	1.09± 0.16	3.56±0.58
46kg/ha	1.019 ± 0.06	3.621±0.51

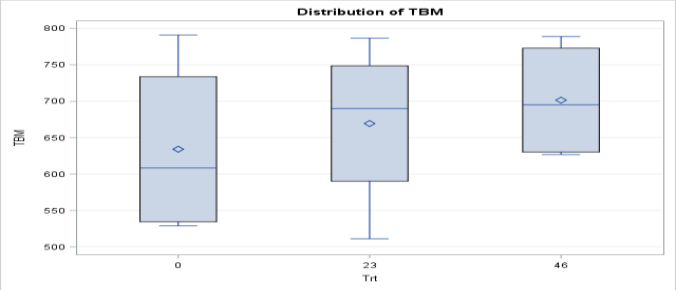
Table.2 The effect of Nitrogen on Leaf area ratio (LAR)in gmcm^{-2}

Nitrogen levels	1stSample-1	2ndSample-1
0g/ha	225.72± 14.05	107.57±7.77
23kg/ha	286.29± 45.01	117.28±16.66
46kg/ha	240.19± 7.53	110.018±2.89

Table.3 The effect of Nitrogen on Crop growth rate (CGR) gmm^{-2}day^{-1}

Nitrogen levels	Sample
0kg/ha	14.86± 0.71
23kg/ha	17.56± 1.623
46kg/ha	19.33± 3.44

Fig.1 Effect of nitrogen on total dry biomass barley (TDM) gmm^{-2}



Total Dry Biomass (TBM)

The analyzed result below in the appendix table showed that there was no significance difference between nitrogen levels on total dry-biomass of barley crop. Which means still based on figure below 46kg/ha of nitrogen fertilizer have variation on total dry biomass as compere to 0kg/ha and 23kg/ha but statically the difference was not significant. The block was also non significance (ns) because P-value is less 0.05 significant levels. Which mean blocking is not effective. This may be because of the cropping history, since we had no information about, soil nitrogen availability.

In conclusion the fertilizers, particularly those containing nitrogen are the major inputs affecting the growth parameters of barley. Barley responds well to balanced application of N fertilizer. Generally, based on our field experiment result I conclude that Leaf area index and crop growth rate of barley crop increased nitrogen fertilizer level increased but leaf area ratio decreased in later growth stage of barley crop because of increased leaf dry weight. Also, there was no statically difference of nitrogen fertilizer level on total dry biomass of the barley crop. Hence, it is difficult to say nitrogen fertilizer level has no significant effect on total dry weight of barley crop. So, further repeat the experiment once more in the up-coming cropping season will be important for conclusive recommendation.

Conflict of interest

There are no conflicts of competition of interests in this paper.

Acknowledgments

I would like to say a few words of thanks. Above all I thank to my God a debt of praise for his presence with me in all ups and downs. Next, I would like to express a great thanks to Hawassa University College of Agriculture particularly Department of horticulture and plant science for preparing such type of learning activity. My special thanks also,go to our respected instructor Walelign W. (Professor) for his unreserved advice and frequent supervision in the entire work of our field research. Lastly my deep appreciation also goes to field assistants for his/they technical support.

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How to cite this article:

Desta Abayechaw and Kedir Wulchafo. 2020. Effect of Nitrogen Fertilizer Levels on Growth Response of Food Barley *(Hordeum vulgare L.). Int.J.Curr.Res.Aca.Rev*. 8(11), 54-58.
doi: https://doi.org/10.20546/ijcrar.2020.810.007