International Journal of Advanced Multidisciplinary Research
ISSN: 2393-8870
www.ijarm.com
DOI: 10.22192/ijamr Volume 5, Issue 3 -2018

Research Article

DOI: http://dx.doi.org/10.22192/ijamr.2018.05.03.002

The Effect of Nitrogen on the Growth and Dry Matter Accumulation of Wheat *(T. aestivum L.)* at Hawassa University College of Agriculture Farm

Shitahun Alemu
Hawassa University, Hawassa, Southern Ethiopia
E- mail: *shitahunam@gmail.com*

Keywords

wheat,
dry weight,
N fertilizer.

Abstract

A field experiment was carried out by sowing wheat (Triticum aestivum L.) in Hawassa Agricultural college Farm, Sothern Nations and Nationalities States of Ethiopia to quantify the effect of increasing the level of nitrogen (N) fertilizer from 0 to 100 kg /ha application on the growth and dry matter application. It was applied using Randomized complete Block Design with four replications. The study quantified the effect of nitrogen (N) on leaf area index, leaf area ratio, growth rate, assimilation rate and total dry weight. Dry weight of wheat was showed significant differences between treatments at ($p = 0.05$). Leaf area index, leaf area ratio, growth rate and assimilation rate were significantly affected by the rate of nitrogen fertilizers. Nitrogen at 100 kg/ha gave significantly higher leaf area index, leaf area ratio, growth rate and assimilation rate. The highest total dry weight was obtained when N level is 100 and the lowest value was obtained when N level is 0.

1. Introduction

Crops are the major agricultural commodities on which the Ethiopians depend for their daily food. There are no substitutes for cereals, pulses and oil crops for the Ethiopian masses. Because of the poor performance of the agricultural sector and the growing of population, which is estimated at over 70 million and growing at a rate of 2.7% per annum, intensification of agriculture, is very critical (CSA, 2010). As a result, there has been an overall effort in the country to increase agricultural productivity to meet the growing demand for food and agricultural raw materials. Among the major cereal crops, wheat is the most widely consumed crops in the country. Wheat is the third important cereal crop after teff (*Eragrostis tef*) and maize (*Zea mays*) in area coverage (CSA, 2010). The total area under wheat (*Triticum aestivum* L.) was about 1.75 million hectares (ha) in 2009/2010 main cropping season, grown primarily as a highland rain-fed crop. Mean wheat yields are around 1.86 tons/ha, well below experimental yields of over 5 tons/ha. Ethiopia's current annual wheat production of approximately 3.24 million tons is insufficient to meet the domestic needs (CSA, 2010).

At critical growth stages, availability of nitrogen fertilizers in the soil is the major yield limiting factors of wheat. Since it enhance protein, protoplasm and chlorophyll formation. These cell components in return show positive influence on cell size, leaf area and ultimately photosynthetic activity (Rahman *et al*., 2000). Nutrient management offers the opportunity for increasing wheat growth, yield and its nutrient components (Dilshad *et al*., 2010; Aslam *et al*., 2011b). It is a key factor to high yields and optimum economic returns by playing an important role in crop productivity (Dilshad *et al*., 2011). Nitrogen deficiency constitutes one of the major yield limiting factors for cereal production (Sarwar *et al*., 2012). A number of recent soil fertility surveys have revealed that among the essential nutrient elements (N, P, K, S, Mg, etc.) soils are mostly deficient in nitrogen (Shaheen *et al*., 2011). Appropriate fertilizer application rates enhance and increase in net assimilation rate (NAR) which is attributed to increased photosynthetic capacity of the leaves with improved nutrition of the plants (Ahmad *et al*., 1990). The Relative Growth Rate (RGR) improves with the increasing levels of nitrogen (Warraich *et al*., 2002).

There for the objective of this study was to analyze the effect of nitrogen fertilizer amount on the growth and development and dry matter accumulation of wheat.

2. Materials and Methods

2.1 Experimental Site Description

The experiments of this study were conducted with wheat during March through May of 2014 at the farm of the Hawassa University College of Agriculture, Hawassa, Ethiopia which lies between the geographical coordinates of (7.08 °N, 38.48 °E) and an altitude of 1750m asl. The experimental site is located at about 272 km away from the capital city, Addis Ababa, in the South West direction. According to the weather record from the Hawassa Regional Meteorology Station the total rainfall of the study area during the growing season (March - May 2014) was 285 mm and the minimum and maximum temperatures were 29 and 20 ^{o}c, respectively.

2.2. Treatments and Experimental Design

The experiment comprised of three treatments (three rates) of N as urea super granule (0, 50 and 100 kg/ha urea). These three treatments were laid down in a randomized complete block design with four replications. The plot size of the experiment was 2 m x 1.2 m = 2.4m^2 accommodating 6 rows, and rows spaced 20 cm apart of 2 m lengths. The blocks and plots were separated by 0.5m wide open spaces.

2.3. Experimental Materials and Procedures

The experimental field was prepared using local cultivating hoe according to farmers' conventional farming practices. Following the seed bed preparation, a field layout was prepared on the experimental field in accordance with the specifications of the design, and each treatment was assigned randomly to experimental units within a block. The test crop used in the study were Wheat (*Triticum aestivum*), which have been widely produced by the farmers in Hawassa. Urea having N, P and K ratio of (46-0-0) and Triple supper phosphate was used as sources of N and P, respectively. Half of the N fertilizer was applied at planting basal, and the remaining half was side dressed at tillering and the full recommended rate of phosphorus (46 kg/ha P_2O_5) in triple super phosphate (TSP) form was applied all at basal to all experimental plots. Seeds of wheat *(T. aestivum L.)* were sown by drilling along the rows at the rate of 150kg/ha. Sowing was completed on the same day and all necessary cultural practices were employed uniformly to raise a successful crop.

2.4. Crop Data Collection on Growth Parameters

Leaf area of wheat were recorded at 26 days after planting by harvesting the crop from two rows 20cm for each rows (0.2m x 0.2m x 2 = 0.08 m^2) of the plot by leaving the first row to minimize border effect for all plots. The sample was taken to laboratory and leaf area and fresh weight was measured and dry weight was measured after the sample is dried using dry oven. Similarly, the second data was also taken after 15 days of the first data collection in the same way. Finally all above ground biomass was harvested from each plot and total dry weight was measured by taking sample to dry oven and the sample dry weight was converted to total biomass. Then Net Assimilation Rate (NAR), Leaf area index, crop growth rate, leaf area ratio and crop growth rate (CGR) were determined through the procedures given by Gardner *et al*. (1985): The main growth analysis parameters are calculated using the following equations.

- **Leaf area Index** (LAI) =A/p where; A = Leaf area and P =ground area
- **Crop Growth Rate** (CGR) = $\frac{W_2 - W_1}{P\,(T_2 - T_1)}$ =g/m^{2}d

;where W_1 and W_2 are the first and second dry biomass weight, P plot (ground) area and t_1 and t_2 are the first and second sampling times respectively.

- **Specific leaf area ratio** (SLR) (cm^2/g) = A/W_{leaf} ; Where A and W_{leaf} leaf area and leaf dry weight respectively.

- **Leaf Area Ratio** (LAR) =LA/W; where, LA= leaf area; W=dry weight of the whole plant in $0.08m^2$ area.

$$\text{Crop growth rate} = \frac{W_2 - W_1}{T_2 - T_1} \times \frac{1}{GA}$$

Where; W_2 = Final dry weight, W_1 = Previous dry weight of plants, T_2 = Weight recording time, T_1 = Previous weight recording time and GA = Ground area

- **Total biomass:** above ground biomass of the plant was measured using electronic sensitive balance. From each plots of one row in 0.2m x 2m = $0.4m^2$ areas were harvested and sun-dried to constant weights for determination of total biomass.

2.5. Statistical Analysis

The data recorded in this study were subjected to analysis of variance using statistical procedures described by Gomez and Gomez (1984) with the help of SAS statistical software. The Fisher's LSD mean comparison method at 5% level of significance was used to separate the treatment means and compare the effects of different rates nitrogen fertilizer on total biomass of wheat.

3. Results and Discussion

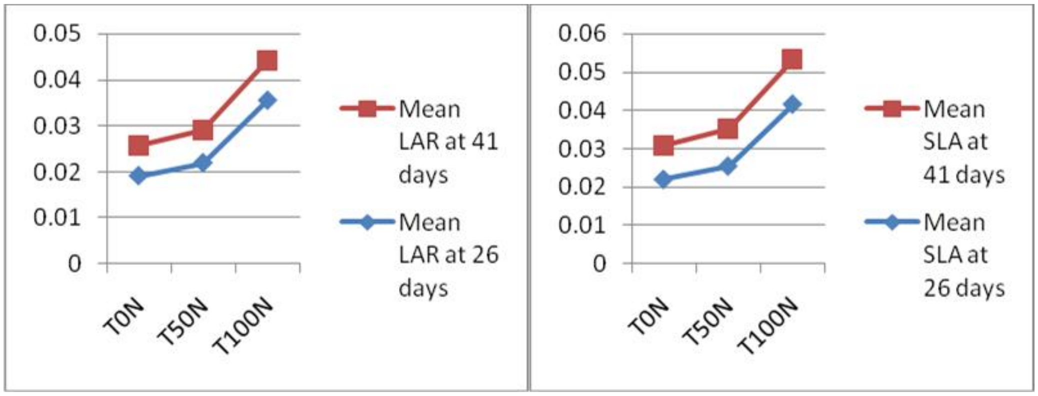
3.1. Leaf Area Ratio (LAR) and Specific Leaf Area (SLA)

The leaf area ratio values increases with increasing N level. The highest value of leaf area ratio was obtained when N level is 100kg/ha and when N level is 50kg/ha it is relatively smaller and when N level 0kg/ha it is the lowest of all. As leaf area ratio increases assimilatory material increases and resulted an increasing dry matter accumulation at final harvest.

Table 1 Leaf area ratio of wheat to different levels of wheat at two different days

Treatments	Mean LAR at 26 days	Mean LAR at 41 days	Mean SLA at 26 days	Mean SLA at 41 days
T0N	0.01910 $\pm$ 0.001159	0.006544 $\pm$ 0.001703	0.02218 $\pm$ 0.001165	0.008717 $\pm$ 0.002290
T50N	0.02193 $\pm$ 0.003939	0.007148 $\pm$ 0.001334	0.02564 $\pm$ 0.004193	0.009664 $\pm$ 0.001724
T100N	0.03556 $\pm$ 0.010648	0.008668 $\pm$ 0.001165	0.04174 $\pm$ 0.011907	0.011536 $\pm$ 0.001508

The different levels of N on specific leaf area had significant effects. The specific leaf area were 0.04174, 0.02218 and $0.02564cm^2/g$ at the first sampling date (26 days after sowing) and 0.008717, 0.011536 and $0.009664cm^2/g$ for N 0, N50 and N100 kg/ha respectively, at the second sampling date (41 days after sowing) (Table 1). As the rate of N application increases specific leaf area increases (Fig. 1). Meziane and Shipley, (2001) reported that the leaf area is the forcing variable that directly affects both leaf nitrogen levels and net photosynthetic rates. Leaf nitrogen then directly affects net photosynthetic rates.



A **B**

Fig. 1 the relationship between nitrogen levels with Leaf area ratio (LAR) (A) and specific leaf area (SLA) (B). As the level of nitrogen fertilizer increases the leaf area increases so that light interception increases and then assimilation and dry matter accumulation also increases.

3.2. Leaf Area Index (LAI)

Leaf area index at 26 and 41 days after sowing (DAS) was determined (Table 2). Results showed significant difference among various nitrogen levels for leaf area index. The highest leaf area index after 26 and 41 days was 28207.47 and 67315.19 respectively found in the treatment receiving 100 kg N/ha. The lowest leaf area index after 26 and 41 days was 15722.75 and 39504.38 respectively found in the treatment receiving 0 kg N/ha.

Table 2 Leaf area index at 26 and 41 Days after Sowing (DAS)

Treatments	Mean LAI at 26 days	Mean LAI at 41 days
T0N	15722.75 ± 3147	39504.38 ± 6544
T50N	26628.5 ± 1860	48828.75 ± 8274
T100N	28207.47 ± 1933	67315.19 ± 14946

Increasing nitrogen rates increased the leaf area index as the highest value was at 100 kg/N ha (Fig. 2). Allen and Morgan, (1972) reported that the increase in LAI in response to an increase in N fertilizer is probably due to enhanced availability of nitrogen which enhanced more leaf area resulting in higher photo assimilates and thereby in more dry matter accumulation. Also, Squire *et al.* (1987) established that the main effect of N fertilizer was to increase the rate of leaf expansion, leading to increased interception of daily solar radiation by the canopy.

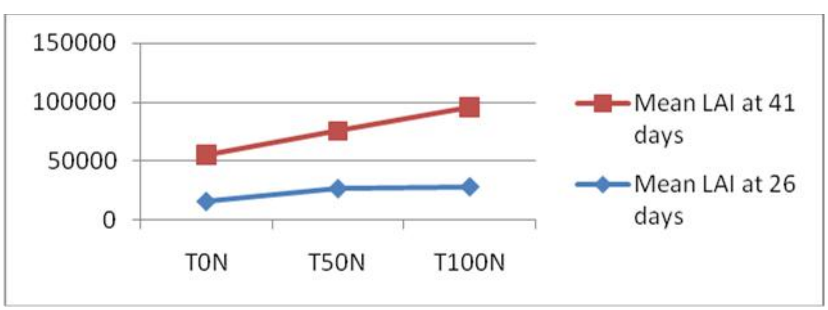


Fig. 2 Explains the relationship between nitrogen levels and leaf area index of wheat.

As the rate of N application increases the leaf area index increases thereby increasing photo assimilates and dry matter accumulations.

3.3. Crop Growth Rate (CGR) and Net Assimilation Rate (NAR)

The rates of N fertilizer significantly enhanced the crop growth rate (Table 3). The highest crop growth rate 19.58 g/m^2/d was recorded in 100 kg N/ha. As the rate of N fertilizer application increases from 0kg/ha to 100kg/ha the crop growth rate increases from 11.81 g/m^2/d to 19.58 g/m^2/d. The increase in CGR ultimately increases total dry matter at the end of growing season. Rahman *et al*., (2000) reported that the increase in CGR at higher N levels was mainly due to larger LAI, since CGR is a product of the LAI and Net Assimilation Rate (NAR). Nitrogen application created a significant impact on leaf photosynthesis, leaf area index, and crop growth rate and biomass production of wheat. Gulser, (2005) reported that high nitrogen levels increased leaf area, leaf number and vegetative growth of plants thus increasing the photosynthetic capacity; consequently the higher dry matter produced increasing crop growth rate (CGR).

Table 3 The effect of N fertilizer on growth rates and net assimilation rates of wheat

Treatments	Crop growth rates	Net assimilation rates g/cm2/d
T0N	11.81 $\pm$ 1.515	0.50
T50N	12.44 $\pm$ 4.572	0.70
T100N	19.58 $\pm$ 5.957	0.98

The Net Assimilation Rate (NAR) of wheat was significantly increased with increased application of nitrogen fertilizers (Table 3). The NAR was 0.78, 0.50 and 0.47 in the treatments receiving nitrogen at 100 kg/ha, 50 kg/ha and 0 kg/ha respectively. Increase in net assimilation rate enhances photosynthetic capacity of leaves with improved nutrition of the plants thereby increasing dry matter accumulation at final harvest (Ahmad *et al*., 1990).

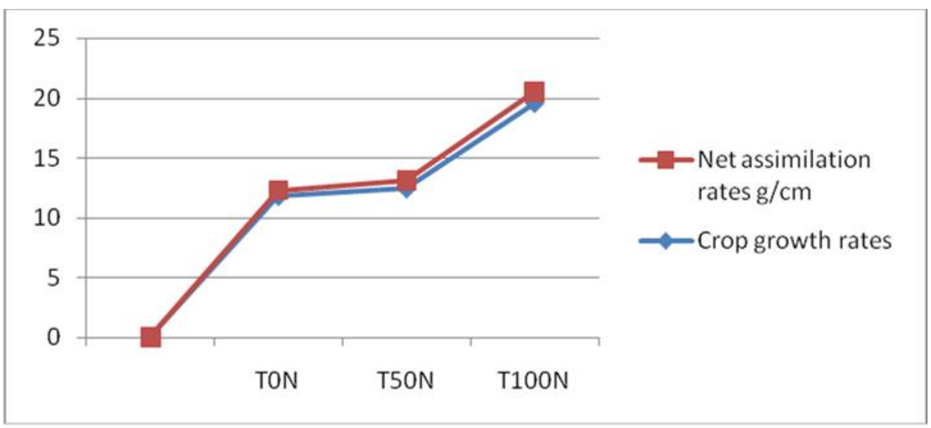


Fig. 3 The relationship between nitrogen level and net assimilation and crop growth rates

3.4. Total Dry Weight

The analysis of variance on the average dry weight produced showed significant differences between treatments (different rate of N fertilizer) at 5% probability (Appendix 1).

The total above ground biomass of the crop was significantly influenced by application of N fertilizers. The rates of N fertilizer significantly enhanced the dry weight. The highest dry weight rate was 719.6 kg/ha recorded in N100 (100 kg N/ha). The lowest dry weight rate was 324.4 kg/ha recorded in N0 (0 kg N/ha) (Table 4).

Table 4 effect of different level of nitrogen on dry weight of wheat

Treatment (N tone/ha)	Dry weight(kg/ha)
0	324.4 $\pm$ 18.53[c]
50	568.2 $\pm$ 71.24[b]
100	719.6 $\pm$ 51.44[a]
LSD (5%)	199.7
CV (%)	21.5

Note: - Means having different letters are significantly different from each other

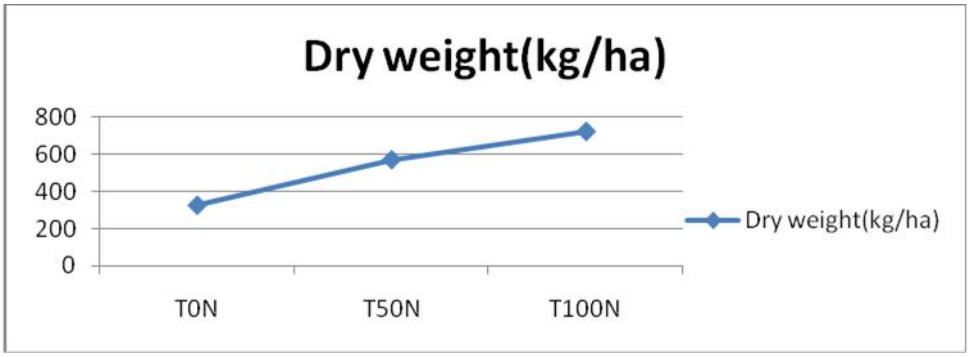


Fig.4. explains the relationship between nitrogen levels and total dry matter of wheat

As the rate of N fertilizer application increases the total dry weight also increases. Nitrogen application creates a significant increase on leaf photosynthesis, leaf area index, crop growth rate and biomass production of wheat (Rahman *et al*., 2000).

4. Conclusion

This study compared different rates of N fertilizer application on the growth parameters of wheat crop. All of the growth characteristics were improved with increased nitrogen levels bearing maximum values at the highest rate of 100 kg N/ha. The leaf area (both specific leaf area and leaf area ratio) increases as the levels of nitrogen fertilizer increases to 100kg N/ha. As leaf area increases assimilatory material increases and resulted an increasing dry matter accumulation at final harvest. Increasing nitrogen rates increased the leaf area index having the highest value at 100 kg/N ha. As the rate of N fertilizer application increases from 0kg/ha to 100kg/ha the crop growth rate increases and these increase in CGR ultimately increases total dry matter at the end of growing season. Based on these, the study concludes increasing rate of N fertilizer from 0 to 100 kg N/ha increases the total dry matter production of wheat.

References

1. Ahmad, N., R. Ahmad, S. Bokhari and A. Ghani, 1990.Physiological determinants of growth and yield in wheat as affected by different levels of nitrogen and phosphorous. Pakistan J. Agri. Sci., 27: 390-404.
2. Allen EJ, Morgan DG (1972). A quantitative analysis of effects of nitrogen on the growth, development and yield of oilseed rape. Journal of Agricultural Science; 78, 315 -324
3. Aslam, M., M.A. Khan, I.U. Awan, E.A. Khan, A.A. Khan and G. Jilani, 2011b. Effect of single and combined use of various organic amendments on wheat grown over green manured soil: II. Nutrient contents in plant and soil. Pak. J. Nutr., 10: 647-652.
4. CSA. September – December 2010. Report on Area and Production of Major crops. Ethiopian Agricultural Sample Survey Private Peasant Holdings, Meher Season (2009/10 (2002 E.C.)) – Volume IV. Statistical Bulletin 446. Addis Ababa: Central Statistical Agency.
5. Dilshad, M.D., M.I. Lone, G. Jilani, M.A. Malik, M. Yousaf, R. Khalid and F. Shamim, 2010. Integrated plant nutrient management (IPNM) on maize under rain fed condition. Pak. J. Nutr., 9: 896-901.

6. Dilshad, M., M.I. Lone, G. Jilani, M.A. Malik, M. Yousaf, R. Khalid and F. Shamim, 2011.
7. Sustaining soil productivity by integrated plant nutrient management in wheat based cropping system under rain fed conditions. Pak. J. Sci. Ind. Res., B: Biol. Sci., 54: 9-17.
8. Gardner, F.P., R.B. Pearce and R.L. Mitchel, 1985.Physiology of crop plants, growth and development. The Iowa State University Press Ames, Iowa 50010.
9. Gomez, K.A. and A.A. Gomez, 1984. Statistical procedure for agricultural research (2nd)ed. John Wiley and Sons Inc., New York.
10. Gulser F. (2005). Effect of ammonium sulphate and urea on NO3- and NO2 accumulation nutrient contents and yield criteria in spinach. Scientia Horticulturae 106, 330-340
11. Meziane, D. and Shipley, B.(2001) Direct and indirect relationships between specific leaf area, leaf nitrogen and leaf gas exchange. Annals of Botany, 88: 915-927.
12. Rahman, M.A., A.J.M.S. Karim, M.M. Hoque and K. Egashira, 2000. Effects of irrigation and nitrogen fertilization on photosynthesis, leaf area index and dry matter production of wheat on a clay terrace soil of Bangladesh. J. Fac. Agric. Kyushu Univ., 45: 289-300.
13. Sarwar, M., G. Jilani, E. Rafique, M.E. Akhtar and A.N. Chaudhry, 2012. Impact of integrated nutrient management on yield and nutrient uptake by maize. Pak. J.., 11: 27-33.
14. Shaheen, A., M.A. Naeem, M. Shafiq and G. Jilani, 2011. Restoring the land productivity through soil water conservation and improved fertilizer application in eroded and of Pothwar plateau in Punjab province, Pakistan. Plant Prod. Sci., 14: 196-201.
15. Squire GR, Ong CK, Monteith JL (1987). Crop growth in semi arid environment. In: Proceedings of 7thInternational Workshop, 7-11 April, 1986, International Crops Research Institute for Semi-Arid Tropics, Patancheru, Hyde-rabad, pp 219-231
16. Warraich, E.A., N. Ahmed, S.M.A. Basra and I. Afzal, 2002. Effect of nitrogen on source-sink relationship in wheat. Int. J. Agri. Biol., 4: 300-302.

Appendix 1 Analysis of variance of dry matter accumulation of wheat grown at Hawassa, Southern Ethiopia

Source of variation	DF	SS	MS	F calculated	Sign. at 5 %
Replication	3	16864	56	0.42	NS
Treatment	2	318094	21	11.94	*
Error	6	79912	159047		
Total	11	414871	13319		

Access this Article in Online

Quick Response Code

Website: www.ijarm.com

Subject: Agricultural Sciences

DOI:10.22192/ijamr.2018.05.03.002

How to cite this article:
Shitahun Alemu. (2018). The Effect of Nitrogen on the Growth and Dry Matter Accumulation of Wheat *(T. aestivum L.)* at Hawassa University College of Agriculture Farm. Int. J. Adv. Multidiscip. Res. 5(3): 13-19.
DOI: http://dx.doi.org/10.22192/ijamr.2018.05.03.002