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Mob: +92 300 3008585, Fax: +92 41 8815544
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Research Article
Effects of Different Nitrogen Fertilizer Levels on Sunflower Growth and Yield Attributes

[1]Kwizera Chantal, [2]Basil T. Iro Ong'or, [1]Denis Bandushubwenge, [1]Ndihokubwayo Soter and [1]Shabani Félix

[1]Faculty of Agriculture and Bio Engineering, University of Burundi, Avenue of INESCO N°2, P.O. 2940, Bujumbura, Burundi
[2]Department Civil and Structural Engineering, School of Engineering Built Environment, Masinde Muliro University of Science, P.O. Box 190-50100, Kakamega, Kenya

Abstract

Background and Objective: Controlled application of Nitrogen fertilizer to the soil improves growth and yield of crops. However crops are sensitive to the amount of nitrogen fertilizers applied. Excessive nitrogen fertilization results in reduced sunflower yield, whereas proper nitrogen application optimizes seed yield and quality. The objective of the current study was to determine the optimum nitrogen level which could effectively improve the sunflower growth parameters and yield attributes in Burundi. **Methodology:** A field experiment was undertaken in a randomized complete block design using nine treatments of nitrogen different levels viz. T1: NPK (0-0-0), set as control treatment, T2: NPK(30-50-30), T3: NPK(40-50-30), T4: NPK(50-50-30), T5: NPK(60-50-30), T6: NPK(70-50-30), T7: NPK(80-50-30), T8: NPK(90-50-30) and T9: NPK(100-50-30), with three replications for each. **Results:** The results indicated that treatment T9 i.e., NPK (100-50-30) significantly improved and enhanced sunflower head diameter, plant height, stem girth, total grain yield weight, number of pair leaves, total grains number and full grains number. There was a significant correlation between these parameters, the highest was recorded between full grains number and total grains number ($R^2 = 0.988$) with a $p \leq 0.01$. **Conclusion:** The treatment T9 was the most effective treatment in improving sunflower growth parameters and yield attributes.

Key words: Nitrogen fertilizer, sunflower, plant height, head diameter, stem girth, pair leaves, grain weight

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Corresponding Author: Kwizera Chantal, Faculty of Agriculture and Bio Engineering, University of Burundi, Avenue of INESCO N°2, P.O. 2940, Bujumbura, Burundi

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Chemical fertilizers have been traditionally used to improve and maintain soil fertility for yield improvement. Numerous field experiments conducted throughout the world have shown that nitrogen fertilizer is one of the most prevalent elements for plant survival and acts as a key contributing factor towards wholesome improvement in agriculture production[1]. It is a major nutrient that enhances protein metabolic processes, leading to increased crop vegetative growth and improved yield[2-4]. A number of crops are very sensitive to Nitrogen application, however sunflower is one of them. Bailey[5] reported that excessive nitrogen fertilization results in reduced sunflower yield, while other literature confirmed that a higher nitrogen application reduces oil content[6,2]. Shapiro and Wortmann[7] in their research established that proper nitrogen application optimizes seed yield, seed quality, farm profit, harvest index and minimizes the leaching of nitrogen beyond the crop rooting-zone. This was also affirmed by Anwar-ul-Haq *et al.*[8] in their research on Nitrogen fertilization.

Sunflower is one of the most important oilseeds that contribute to edible oil in the world[6]. Likewise, it is a source of vitamin B6, thiamin, magnesium, copper, phosphorus, manganese and selenium. Sunflower is very rich in Vitamin E, which aids in the proper functioning of the circulatory system and helps the blood to clot readily during external wounds[9]. Use of sunflower oil lowers the risk of cardiac diseases and diabetes through its selenium element which repairs the damaged cells and reduces the cancerous cells infections[8,9]. Sunflower is an important crop that contains a good percentage of protein and soluble sugar[10].

Despite all these attributes, sunflower establishment and associated factors to enhance its performance in Burundi country is of concern. This study was undertaken to assess the required nitrogen level for enhancing sunflower growth parameters and yield attributes.

MATERIALS AND METHODS

Site description and soil properties: The study was conducted in Kinyinya, Bujumbura in Burundi. The soils in the site are predominantly Schists, Precambrian lava and dolomitic limestone, with soil texture chemical properties as: $P^{H}H_2O$ (5.72), $P^{H}KCl$ (4.44), C (1.40%), $N\text{-}NH^{+4}$ (0.0036%), $N\text{-}NO_3$-(0.0034%) and P (6 mg kg^{-1}).

Experiment design: The experiment was carried out in lysimeters, where nine treatments were considered. These are T1: NPK (0-0-0), set as control treatment, T2: NPK(30-50-30), T3: NPK (40-50-30), T4: NPK (50-50-30), T5: NPK (60-50-30), T6: NPK (70-50-30), T7: NPK (80-50-30), T8: NPK (90-50-30) and T9: NPK (100-50-30). These treatments were set in randomized complete block design with 3 replications for each. During the growth period, diseases and pests were controlled through insecticide and fungicide application and all treatments had the same agricultural management practices.

Sampling and data collection: Plant were sampled and monitored in vigorous growth and harvesting period to determine the following:

- Plant height, stem girth and head diameter after the following days of transplanting: 45, 63, 70, 77 and 84
- Grain number per plant focusing on empty grains and full grains
- Pair leaves number and fresh production weight

The harvested production was dried at 70°C till constant dry weight was achieved, in a forced-air oven for two days.

Statistical analysis: The data acquired were processed and analyzed using advanced Excel 2007 and SPSS 15. A comparison among treatments were conducted ($p<0.05$) by using least significant difference (LSD) at 5% level.

RESULTS AND DISCUSSION

Effects nitrogen fertilizers on plant height: Plant height is an important morphological character that acts as a potent indicator of available growth resources in its vicinity. This study revealed that treatment T9 enhances plant height significantly ($p<0.05$) with a mean of 142.6 cm, followed by T8 (132.2 cm), While the control treatment (T1) showed the smallest plant by 75.29 cm (Fig. 1).

The higher performance of T9 may be attributed to the higher nitrogen level used under a conducive environment, hence enough nutrients for plant growth. These results support those of Mostafa and Abo-Baker[11], who reported increased sun flower growth due to higher rate application of nitrogen. Similar experimental results were attained by Shah and Khanday[12] as well as Sarkar and Mallick[13].

Nitrogen fertilizers effects on sunflower head diameter: There was generally an increase in head diameter with applied nitrogen. The highest increase was observed for treatment T9 (54.87 cm), which significantly differed ($p<0.05$) from other treatments. This was followed by treatment T8 (52.28 cm),

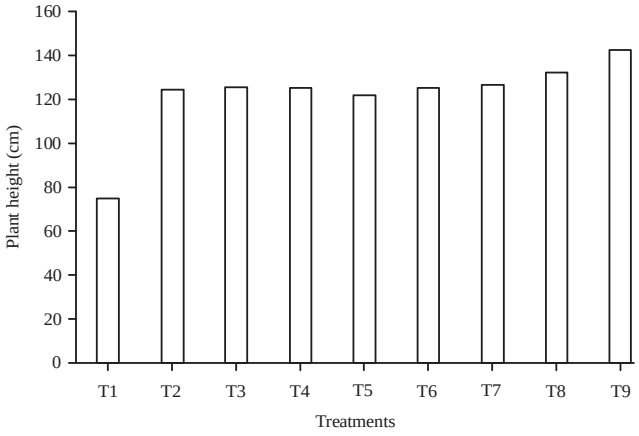

Fig. 1: Effect of different nitrogen levels on plant height

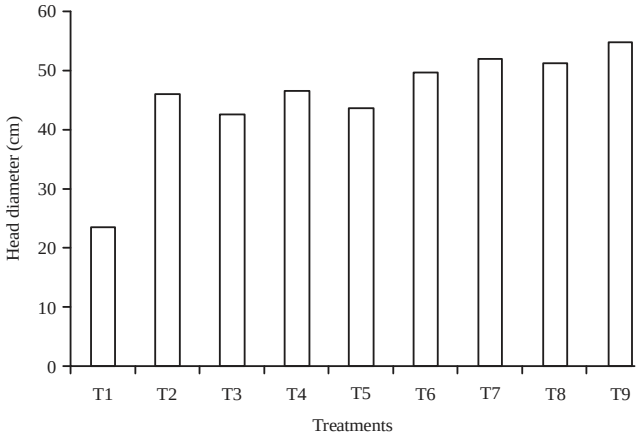

Fig. 2: Effects nitrogen fertilizers on sunflower head diameter

which exceeded ($p<0.05$) the control Treatment (T1). This last (T1) recorded a minimum value of head diameter (23.53 cm) (Fig. 2).

These finding are in agreement with those of Iqbal *et al.*[14] and Munir *et al.*[15]. Generally, larger heads harvested with higher Nitrogen application and were associated with more number of grains thus giving more yields.

Influences of nitrogen different rates on sunflower stem girth: Sunflower stem girth increased sharply as the level of nitrogen fertilizer increases (Fig. 3). Treatment T9 (6.06 cm) got the highest stem girth, followed by T7 (6.02 cm) and T8 (5.89 cm), while T1 (2.92 cm) got the smallest stem girth.

The enhanced stem girth for treatment T9 (Fig. 3) could be due to the applied higher nitrogen level which increased available plant nutrient, hence an improved sunflower stem girth. These results support those of Osman and Awed[16], who reported increased stem girth with applied higher nitrogen rate.

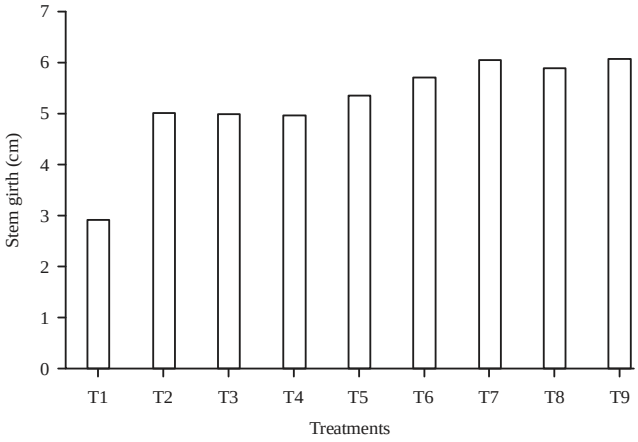

Fig. 3: Effect of different nitrogen levels on sunflower stem girth

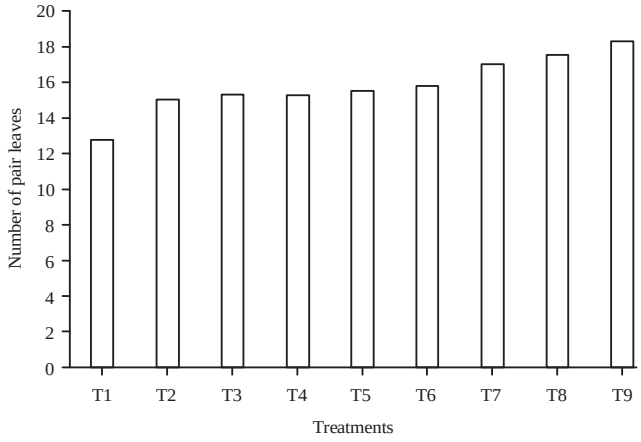

Fig. 4: Effect of different nitrogen levels on pair leaf number

Nitrogen's effects on pair leaves number: The yield of sunflower can be projected from pair leaves. In this study, the highest pair leaves number was attained under treatment T9 (Fig. 4), with a significant difference ($p<0.05$) from the control treatment (T1).The treatments T8 and T7 were the following and significantly exceed ($p<0.05$) the control treatment (T1) which was having a lowest number of pairs leaves.

Even though nitrogen fertilization improved the pair leaves number, treatment T9 was the most effective treatment in increasing the number of pair leaves. As reported by Ali *et al.*[17], this was due to the used nitrogen fertilizer which could stimulate vegetative growth and obviously increased the number of pair leaves.

Effects of nitrogen on yield and grains number: The yield is an index closely linked to different rates of fertilizers applied. While grains number is the most important yield component that a breeder should consider when selecting for higher

Table 1: Influence of nitrogen different rate on yield and sunflower grains number

Treatments	Total full grain number	Full grains (%)	Empty grains number	Empty grains (%)	Total grains number	Total grains yield weigh (kg ha^{-1})
1	188	55.95	148	44.05	336	564.4
2	701	74.65	238	25.35	939	2614.0
3	522	64.93	282	35.07	804	1594.4
4	630	76.27	196	23.73	826	2325.0
5	548	72.77	205	27.23	753	1942.0
6	576	66.90	285	33.10	861	2072.2
7	686	71.01	280	28.99	966	2844.4
8	814	72.30	312	27.70	1126	2752.7
9	821	73.64	294	26.36	1115	2886.1

Table 2: Correlation coefficient between analyzed parameters

	Head diameter	Stem girth	Plant height	Number of pair leaves	Total grains yield weight	Total grain number	Total full grain number	Total empty grain number
Head diameter	1							
Stem girth	0.947**	1						
Plant height	0.9259**	0.926**	1					
Number of pair leaves	0.873**	0.804**	0.840**	1				
Total grains yield weight	0.958**	0.870**	0.837**	0.865**	1			
Total grain number	0.958**	0.916**	0.910**	0.925**	0.946**	1		
Total full grain number	0.955**	0.888**	0.896**	0.901**	0.970**	0.988**	1	
Total empty grain number	0.786**	0.835**	0.781**	0.830**	0.683*	0.848**	0.757**	1

*,**Significant at $p \leq 0.05$ and 0.01, respectively

yields under non-stress conditions as well as for the contribution of oil content. As seen in Table 1, there were significant differences between treatments for full grains. Specifically, treatment T9, with 821 grains, got the maximum full grains, followed by T8 and T7 with 814 and 686 grains, respectively. The minimum was recorded for treatment T1 with 188 full grains. The reduced full grain number in T1 was probably due to the shortage of N which affects the plant development and growth as reported by Wajid *et al.*[18] and Khaliq and Cheema[19]. The full grains ration under treatment T4 (76.27%) was ranked as the highest, while the one of T1 (71.1%) was the lowest.

The number of empty grain were more under treatment T8 (312), followed by T9 (294), while T1 (148) got the lowest value. The ratio of empty grains was highest in T1 (44.05%) and least under treatment T4 (23.73%). Similarly, the total grains number was maximum for T8 (1126), followed by T9 (1115) and minimum for T1 (336). On the other hand, the total grains yield weight of treatment T9 (2886.1 kg ha^{-1}) was highest and significantly exceeded the control treatment (564.4 kg ha^{-1}) and others. The highest total grains yield weight obtained under T9 may be ascribed to the applied higher level of nitrogen which could improve synthesis of sufficient photosynthases[20]. These results are in agreement with the finding of Hocking *et al.*[21] and Mahal *et al.*[22] and supported by Ozer *et al.*[23], who highlighted higher grain yields weight with increased nitrogen rates.

Table 1 shows that the treatment leading to the maximum total yield weight does not necessarily translate into maximum parameters attained. Specifically, the treatment leading to maximum total grains yield and weight did not correspond to maximum full grains number or empty grains number. In essence, if a treatment has the highest proportion of a parameter, its proportion for other parameters was not obviously the highest. Moreover, the treatment with the maximum for some parameters, was not necessary the highest one in the proportion of these parameters. Considering each aspect factor, treatment T9: NPK (100-50-30) was the most effective than other treatments. This illuminated that T9 could improve growth and yield parameters. It might be due to the used higher nitrogen rate which could supply effective and adequate nutrients during sunflower's growth.

Correlation coefficient of analyzed parameters: The correlation coefficient is a measure that determines the degree to which two variables linearly depend on each other. In the present study, the correlation coefficients between two investigated variables are displayed in Table 2.

There exist a strong and positive correlation between parameters as attested by the high significance ($p \leq 0.01$) and correlation coefficients attained. Specifically, total full grains number and head diameter have a very high and strong correlation with other parameters by $p \leq 0.01$.

Generally, the correlation coefficient was noticeably higher between total full grain number and total grain number and total full grain number and total grain yield weight with respective $R^2 = 0.988$ and $R^2 = 0.970$. The lowest ($R^2 = 0.683$) is between total grain number and

total grain yield weight. Similar positive correlation were found in research by Tiwari and Upadhyay[24] and Ertek *et al.*[25].

CONCLUSION

The experimental outcomes showed that the sunflower plant growth parameters and yield attributes were increased significantly with the increase of nitrogen fertilizers. Treatment T9 with NPK (100-50-30) was the most effective and could not only enhance significantly the plant height and head diameter, but also increase stem girth, leaves pair number, grains number, full grains number and remarkably increased total grains yield weight. Treatment T9 could also effectively improve the ratio of sunflower different parts. Likewise, all the analyzed parameters were highly and positively correlated. Considering all tested index in this research, T9, NPK (100-30-50), was the most effective treatment in improving the growth characteristics and yield attributes of sunflower plant. This suggested that treatment T9 could improve sunflower growth parameters and yield attributes in Burundi country. Further research may be required in this area for more improvement of this crop.

SIGNIFICANCE STATEMENT

This study revealed the effect of nitrogen on sunflower cultivation especially on degraded soils of Kinyinya in Burundi. This will help the researchers, extension workers and farmers navigate between the height, weight and diameter of sunflower in an attempt to optimize production and demystify non productivity of degraded soils. Thus a paradigm shift in sunflower production in Burundi.

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REFERENCES

1. Singh, M., M.M.A. Khan and M. Naeem, 2016. Effect of nitrogen on growth, nutrient assimilation, essential oil content, yield and quality attributes in *Zingiber officinale* Rosc. J. Saudi Soc. Agric. Sci., 15: 171-178.
2. Zubillaga, M.M., J.P. Aristi and R.S. Lavado, 2002. Effect of phosphorus and nitrogen fertilization on sunflower (*Helianthus annus* L.) nitrogen uptake and yield. J. Agron. Crop Sci., 188: 267-274.
3. Koutroubas, S.D., D.K. Papakosta and A. Doitsinis, 2008. Nitrogen utilization efficiency of safflower hybrids and open-pollinated varieties under Mediterranean conditions. Field Crops Res., 107: 56-61.
4. Andrews, S.S., D.L. Karlen and J.P. Mitchell, 2002. A comparison of soil quality indexing methods for vegetable production systems in Northern California. Agric. Ecosyst. Environ., 90: 25-45.
5. Bailey, L.D., 1990. The effects of 2-Chloro-6 (Trichloromethyl)-pyridine ('N-serve') and N fertilizers on productivity and quality of Canadian oilseed rape. Can. J. Plant Sci., 70: 979-986.
6. Toosi, A.F. and M. Azizi, 2014. Effect of different sources of nitrogen fertilizer on yield and yield components of sunflower (*Helianthus annuus* L.). Scient. Papers Ser.: Agron., 57: 364-366.
7. Shapiro, C.A. and C.S. Wortmann, 2006. Corn response to Nitrogen rate, row spacing and plant density in Eastern Nebraska. Agron. J., 98: 529-535.
8. Anwar-ul-Haq, A. Rashid, M.A. Butt, M.A. Akhter, M. Aslam and A. Saeed, 2006. Evaluation of sunflower (*Helianthus annuus* L.) hybrids for yield and yield components in central Punjab. J. Agric. Res., 44: 277-285.
9. Organic Facts, 2018. Benefits & uses of sunflower. https://www.organicfacts.net/health-benefits/seed-and-nut/health-benefits-of-sunflower.html
10. Rani, K.U., K.L. Sharma, K. Nagasri, K. Srinivas and T.V. Murthy *et al.*, 2009. Response of sunflower to sources and levels of sulfur under rainfed semi arid tropical conditions. Commun. Soil Sci. Plant Anal., 40: 2926-2944.
11. Mostafa, G.G. and A.A. Abo-Baker, 2010. Effect of bio- and chemical fertilization on growth of sunflower (*Helianthus annuus* L.) at South valley area. Asian J. Crop Sci., 2: 137-146.
12. Shah, A.H. and B.A. Khanday, 2005. Response of sunflower (*Helianthus annuus* L.) to nitrogen and phosphorus under Kashmir valley conditions. SKUAST J. Res., 7: 214-218.
13. Sarkar, R.K. and R.B. Mallick, 2009. Effect of nitrogen, sulphur and foliar spray of nitrate salts on performance of spring sunflower (*Helianthus annuus*). Indian J. Agric. Sci., 79: 986-990.
14. Iqbal, J., B. Hussain, M.F. Saleem, M.A. Munir and M. Aslam, 2008. Bio-economics of autumn planted sunflower (*Helianthus annuus* L.) hybrids under different NPK applications. Pak. J. Agric. Sci., 45: 19-24.
15. Munir, M.A., M.A. Malik and M.F. Saleem, 2007. Impact of integration of crop manuring and nitrogen application on growth, yield and quality of spring planted sunflower (*Helianthus annuus* L.). Pak. J. Bot., 39: 441-449.

16. Osman, E.B.A. and M.M.M. Awed, 2010. Response of sunflower (*Helianthus annuus* L.) to phosphorus and nitrogen fertilization under different plant spacing at New Valley. Ass. Univ. Bull. Environ. Res., 13: 11-19.
17. Ali, H., H.A. Randhawa and M. Yousaf, 2004. Quantitative and qualitative traits of sunflower (*Helianthus annuus* L.) as influenced by planting dates and nitrogen application. Int. J. Agric. Biol., 6: 410-412.
18. Wajid, A., A. Ahmad, T. Khaliq, S. Alam and A. Hussain *et al*., 2010. Quantification of growth, yield and radiation use efficiency of promising cotton cultivars at varying nitrogen levels. Pak. J. Bot., 42: 1703-1711.
19. Khaliq, A. and Z.A. Cheema, 2005. Influence of irrigation and nitrogen management on some agronomic traits and yield of hybrid sunflower (*Helianthus annuus* L.). Int. J. Agric. Biol., 7: 915-919.
20. Awasthi, U.D., S.D. Dubey and S. Shripal, 2011. Effect of nitrogen and moisture conservation practices on yield, uptake, water-use efficiency and quality of linseed (*Linum usitatissimum*). Indian J. Agric. Sci., 81: 383-385.
21. Hocking, P.J., P.J. Randall and A. Pinkerton, 1987. Sulphur nutrition of sunflower (*Helianthus annuus*) as affected by nitrogen supply: Effects on vegetative growth, the development of yield components and seed yield and quality. Field Crops Res., 16: 157-175.
22. Mahal, S.S., H.S. Uppaln and B.S. Hankotia, 1998. Performance of spring sunflower (*Helianthus annuus* L.) under different levels of soil moisture regime and nitrogen. J. Environ. Ecol., 16: 599-602.
23. Ozer, H., T. Polat and E. Ozturk, 2004. Response of irrigated sunflower (*Helianthus annuus* L.) hybrids to nitrogen fertilization: Growth, yield and yield components. Plant Soil Environ., 50: 205-211.
24. Tiwari, J.K. and D. Upadhyay, 2011. Correlation and path-coefficient studies in tomato (*Lycopersicon esculentum* Mill.). Res. J. Agric. Sci., 2: 63-68.
25. Ertek, A., S. Sensoy, I. Gedik and C. Kucukyumuk, 2007. Irrigation scheduling for green pepper (*Capsicum annuum* L.) grown in field conditions by using class-A pan evaporation values. Am.-Eurasian J. Agric. Environ. Sci., 2: 349-358.