

EFFECTS OF DIFFERENT LEVELS OF NITROGEN FERTILIZER ON HEIGHT, STEM DIAMETER AND LEAF AREA OF HYBRID MAIZE (*Zea mays* L.) (FARZ-27) VARIETIES.

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Abstract

A field trial was conducted to determine the effects of different Nitrogen rates on height and stem diameter of hybrid maize (*zea may* L) at Niger State College of education teaching and research farm Minna, Niger State during 2024 growing season. Four nitrogen treatments (T1 control, T2 60, T3 120, T4 160 and T5 180 kg ha⁻¹) and a control were studied in this trial. The application of N fertilizer significantly affected maize height, leaf area and stem diameter of maize plant. Applying 180 kg ha⁻¹ and 160 kg ha⁻¹ of nitrogen resulted in the highest plant heights of 210.23 cm and 199.78 cm, respectively. The maximum stem diameter (3.68 cm) was observed with the highest nitrogen dose (180 kg ha⁻¹), followed by 160 kg ha⁻¹ (3.51 cm) and 120 kg ha⁻¹ (3.46 cm). The lowest stem diameter (2.58 cm) occurred with no fertilizer application, while a minimal nitrogen dose of 60 kg ha⁻¹ resulted in a slightly larger diameter (2.89 cm). These findings suggest that increasing nitrogen levels (60, 120, 160, and 180 kg ha⁻¹) to an optimal range can enhance plant height, stem diameter, and leaf area in hybrid maize (*Zea mays* L) (FARZ-27).

Key words: Maize, Nitrogen levels, height, stems diameter and leaf area

Introduction

Maize is one of the most important cereal crops in the world agricultural economy use both as food for man and feed for animals. It is a short duration, quick growing and has very high yield potential, there is no cereal on the earth which has so immense potentiality and that is why it is called 'King of cereals'. Maize ranks third in the cereals world production after wheat and rice, but in productivity it surpasses all cereals. Among the various factors of production, the nutrient management has been recognized as the most significant factor limiting the yield levels in maize. The productivity of crop decreased in recent years because of decline in soil fertility status as a result of continue cropping, burning of the remains of plants, leaching and soil erosion. Farmers are facing difficulty in maintaining soil fertility because of shortage of production and availability of Nitrogen. Ensuring balanced quantity of nutrients in a given soil for good plant growth is the greatest challenge of the day as yield potentials vary among soils. For maintaining sustained crop production, balanced manuring is essential to build up soil health (peter, 2018). About 2.9 million mt of maize is required per year for food (Timilsina *et al.*, 2016). It has been grown over an area of 15,40,886 hectares in 2020/21 with a production of 26, 53,243 mt, and a productivity of 2.82 mt ha⁻¹ in Niger state (Shrestha, 2019). Its share on AGDP is 15.5% and on GDP is 7.15% (Shrestha, 2019). In Niger state, the demand for maize has been growing constantly by 8% in the last decade (Musa, 2020). A study on maize utilization revealed that 60%, 25%, and 3% of the grain were used for animal feed, food, and seed respectively in hill districts. Whereas the remaining amount of the maize (12%) was sold to different buyers (Timilsina *et al.*, 2016). It has been estimated that for the next two decades the overall demand for maize will be increased by 4% to 6% per annum due to the increasing livestock and poultry industry (BK *et al.*, 2018). The demand for poultry feed and animal feed has been increased by 13% and 8.5% over the last five years in Nigeria (Timilsina *et al.*, 2016). To fulfill the growing feed demand (NMRP, 2017). Despite the increase in land under maize production, the final yield is still low and there is a higher yield gap. Nearly half the area under maize is planted with traditional varieties i.e. home locally saved seeds, which are continuously at the risk of

degenerating (due to open pollination) as well as manures and fertilizers are not applied in sufficient quantities (Koirala, 2020). Declining soil fertility, low yield potential of the existing genotype, limited and irregular access to improved seed and quality fertilizers, and the emergence of new pest species are main constraints for maize production (NMRP, 2017). Thus, maize production could be improved by growing new high-yielding varieties under the most favorable new cultural practices with the application of nutrients in the proper amount and time. Fertilizer management is crucial for maize cultivation (Baral *et al.*, 2015). Maize being a high nutrient mining crop it needs a higher amount of NPK for its economic production (Adhikary *et al.*, 2020). Among the fertilizers, N is very important because this element is responsible for major activities for the growth and development of maize crops (Jat *et al.*, 2019). Nitrogen (N) is a primary nutrient and has a decisive role in the improvement of crop production (Szulc *et al.*, 2016). Nitrogen fertilizer is universally accepted as a vital plant nutrient and a major yield determining factor required for optimal maize production, as it is a nitro-positive crop (Jat *et al.*, 2019). The response of maize plants to the application of N fertilizers varies from variety to variety, location to location, and also depends on the availability of the nutrients (Onasanya *et al.*, 2019). Grain yield, days to flowering, plant height, ear height, kernel rows per ear, no. of kernels per row, ear length, and thousand-grain weight significantly affected due to growing seasons and split applications of nitrogen (Adhikari *et al.*, 2016). Nitrogen supply positively enhances grain yield in all hybrids, primarily by increasing kernel number, ultimately increasing the productivity (Eeman, 2018). Varieties also play an important role in crop yield. Cultivars suited to particular agro-ecological regions, season, purpose, and maturity should be selected to get optimum yield (Zaidi *et al.*, 2017). Two types of cultivars commonly being used are synthetic and hybrid cultivars. Maize hybrids play a pivotal role while deciding about the type and amount of fertilizer to meet the requirements for growth and development throughout the life span of the crop (Eeman, 2018). Hybrid and improved maize varieties are more nitrogen-responsive than local varieties of maize (Shrestha, 2019). Nitrogen fertilizer application had profound effects on grain yield and yield attributing traits of maize hybrids. The application of nitrogen fertilizer at the rate of 150 kg ha⁻¹ increased the grain yield and yield attributing traits namely number of cobs/ha and thousand grain weights in hybrid maize varieties (Sharma *et al.*, 2019). Moreover, most of the farmers in Shiroro, Niger state use a high amount of N fertilizer haphazardly, since there is little information available on the doses and timing of N application on hybrid maize variety. But the hybrid variety with appropriate nitrogen doses is most important to maximize maize yield. So far large numbers of experiments have been carried out throughout the country to find out the optimum level of nitrogen in maize. However, area-specific researches have not yet been done on a different level of nitrogenous fertilizer especially with hybrid maize varieties under local environmental and soil conditions.

The objective of the present study was to evaluate effect of different levels of nitrogen on the height, leaf area and stem diameter of hybrid maize varieties in Minna geopolitical zone.

Materials and Methods

The experiment was conducted at the experimental field of Niger State College of Education, Minna (9^o 45¹ N; 6^o 07¹ E) in the Northern Guinea savanna ecological zone of Nigeria in 2024 cropping season. It is situated in the middle belt zone of Nigeria covering about 74, 244km² or 8% of the total land area of the country. It is characterized with distinct wet and dry seasons with annual rainfall varying from 1,100mm in the Northern part of the State to 1,600mm in the Southern parts (NAERLS, 2011). Based on NPC (2006), the State as at 2017, has a projected population of 6,714,090 with annual growth rate of 3.2% and over 80% of this population engages directly or indirectly in agricultural activities. The major crops cultivated in the study area are; rice and guinea corn and others like maize, millet, yam and groundnut are also produced as minor crops (Jirgi, 2009).

Experimental design and treatments

Field experiment was conducted at Niger state college of education teaching and research farm Minna, during 2024 rain season. The experiment was laid out on randomized complete block design (RCBD) having four replications with a plot size of 4 m × 3 m. The experiment was consist of four treatments of Nitrogen (N) N1 (180 kg ha⁻¹), N2 (160 kg ha⁻¹), N3 (120 kg ha⁻¹), N4 (60 kg ha⁻¹) and Control. All cultural and agronomic practices were followed accordingly which includes hoeing, weeding, and insect management. All pertinent data were collected from net plot area of 2.25 x 2.6m excluding plants from either end of the rows.

Data collection

Soil samples were collected from a depth of 30 cm before planting at random, and one complete composite sample was prepared to determine the particle size distribution and chemical properties of the soil. Soil texture was determined by Bouyoucos hydrometer method (Day, 1965), Organic matter determined based on the oxidation of organic carbon with acid dichromate medium following the Walkley and Black method and total N determined by Kjeldahl method (Dewis and Freitas, 1970) and available soil P determined using Olsen and Dean (1965) method. Soil pH determined in 1:2.5 soils: water ratio using a glass electrode attached to a digital pH

Data analysis

The collected data was analyzed and arranged by using SPSS version 16 (2007) for descriptive statistic such as mean, frequency and percentage and the results were interpreted by using tables and graphs.

Results and Discussion

Major Physico-Chemical Properties of the Soil

The result of the physical and chemical analysis of experimental soil revealed that the textural class of the surface soil (0-30cm) was sandy clay loam with a particle size distribution of 48% sand, 28% silt and 24% clay. According to Tekalign (1991) and Landon (1991) the chemical analysis showed that the soil was strongly acidic with relatively medium nitrogen, low organic matter, and low organic carbon (Table 1).

The available P total N and organic carbon of the soil was 1.64 mg kg⁻¹, .028 and 3.05 respectively. Such soil often responds to P and N application according to Amar (1999) and Landon (1991) respectively.

Table 1. Major soil physico-chemical properties of the experimental field

Parameters	values
A. particle size distributions	
textural class	48
Sand (%)	28
Silt (%)	24
Clay (%)	
B. chemical analysis	
soil pH	5.04
OC (%)	
OM (%)	3.05

N (%)	
Pmgkg-1	5.26
	0.28
	1.64

Field experiment 2024

Table 2. Effects of different levels of nitrogen fertilizer on plant height of hybrid maize (cm)

Treatment code	Treatments (kg/ha)	Weeks after Planting			
		5	6	7	8
T1	Control	80.05	84.03	89.01	91.04
T2	60	142.01	147.01	150.03	155.45
T3	120	169.03	173.05	177.02	180.43
T4	160	175.06	185.01	189.09	199.78
T5	180	179.07	186.03	199.01	210.23

Field experiment, 2024.

Table 3. Effects of different levels of nitrogen fertilizer on plant stem diameter (cm) of hybrid maize at 8 weeks after planting.

Treatment code	Treatment kg/ha	Stem diameter (cm)
T1	Control	2.58
T2	60	2.89
T3	120	3.46
T4	160	3.51
T5	180	3.68

Field experiment, 2024.

Table 4. Effects of different levels of nitrogen fertilizer on leaf area of hybrid maize at 8 weeks after planting.

Treatment	Treatment (kg/ha)	Leaf area at 8 WAP (cm ²)
T1	Control	125.72
T2	60	160.82
T3	120	189.78
T4	160	199.78
T5	180	210.05

Field experiment, 2024.

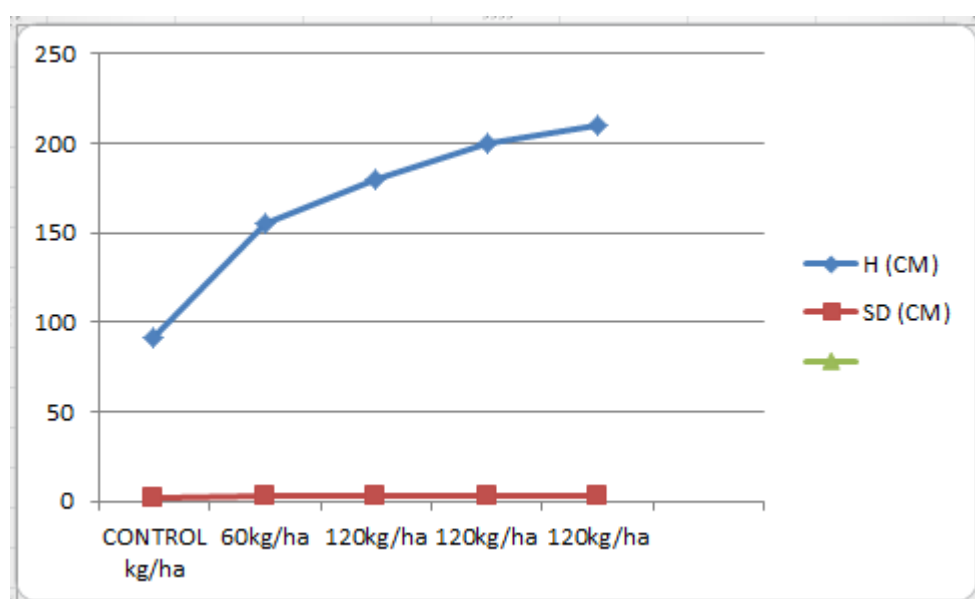
Table 5. Plant height (cm), stem diameter (cm), leaf area per plant (cm⁻²) at eight weeks after planting as affected by different N-level.

Nitrogen Treatments kg ha ⁻¹	Plant Height (cm)	Leaf Area per plant (cm ²)	Stem Diameter (cm)
Control	91.04	125.72	2.58
60	155.45	160.82	2.89
120	180.43	189.78	3.46
160	199.78	199.78	3.51
180	210.23	210.05	3.68

Field Experiment 2024.

Discussion

The tallest plant height (210.23 cm) was achieved with the highest nitrogen dose of 180 kg ha⁻¹, followed by 199.78 cm at 160 kg ha⁻¹ and 180.43 cm at 120 kg ha⁻¹. In contrast, the shortest plant height (91.04 cm) occurred when no fertilizer was applied, with the next lowest height of 155.45 cm recorded at the 60 kg ha⁻¹ nitrogen dose as presented in **Table (5)**. The increment in plant height with the rise in N dose indicated that plants used N during active cell division to form building blocks (protein) for cell elongation (Eeman, 2018). The mean data shows that fodder maize plants receiving a nitrogen dose of 180 kg ha⁻¹ produced the largest leaf area per plant (210.5 cm²), followed by plants with 160 kg ha⁻¹ nitrogen (199.78 cm²). The smallest leaf area (125.72 cm²) was observed in the control treatment (Table 5). The increase in leaf area with higher nitrogen levels can be attributed to accelerated and active cell division within the leaves, leading to larger leaf blades. Similarly, the Leaf Area Index (LAI) also increased as nitrogen levels rose (Peter, 2018). The maximum stem diameter of 3.68 cm was achieved with the highest nitrogen dose of 180 kg ha⁻¹, followed by 3.51 cm at 160 kg ha⁻¹ and 3.46 cm at 120 kg ha⁻¹. In contrast, the smallest stem diameter of 2.58 cm occurred when no fertilizer was applied, with the next lowest diameter of 2.89 cm at the minimum nitrogen dose of 60 kg ha⁻¹ (**Table 5**). An increased supply of N concentration might trigger cell division which eventually attributed to steady expansion in stem diameter (Eeman, 2018).



Key. H (cm) - Plant Height (cm)
SD (CM) - Stem Diameter (cm)

Conclusion

The study found a clear positive relationship between nitrogen application and plant height. The tallest plants (210.23 cm) were observed with the highest nitrogen dose of 180 kg ha⁻¹, followed by those treated with 160 kg ha⁻¹ and 120 kg ha⁻¹, which also resulted in significantly taller plants compared to the untreated control. Conversely, the shortest plant height (91.04 cm) was recorded when no fertilizer was applied, with a modest increase in height (155.45 cm) at the lowest nitrogen dose of 60 kg ha⁻¹.

The results indicate that higher nitrogen doses significantly enhance leaf area and Leaf Area Index (LAI) in fodder maize plants. The largest leaf area (210.5 cm²) was observed with a nitrogen application of 180 kg ha⁻¹, followed by 160 kg ha⁻¹ (199.78 cm²), while the smallest leaf area (125.72 cm²) was recorded in the control treatment. The observed increase in leaf area and LAI with higher nitrogen levels is likely due to enhanced cell division, leading to larger leaf blades. The results of this study indicate that increasing nitrogen application enhances stem diameter, with the maximum diameter of 3.68 cm observed at the highest nitrogen dose of 180 kg ha⁻¹. A decrease in stem diameter was noted with lower nitrogen doses and no fertilizer application, with the smallest diameter of 2.58 cm observed in the control group (no fertilizer). These findings suggest a positive correlation between nitrogen fertilizer applications and stem growth.

Recommendation

Based on the results, it is recommended to apply higher doses of nitrogen, particularly 160-180 kg ha⁻¹, to achieve optimal plant growth and maximize plant height. However, the potential environmental impacts of excessive nitrogen use should be considered, and further studies on nitrogen application efficiency and its long-term effects on soil health are recommended. For areas with limited fertilizer access, even a lower nitrogen dose (60 kg ha⁻¹) can still result in an improvement over no fertilization.

To optimize leaf growth and improve the overall productivity of fodder maize, it is recommended to apply nitrogen at a rate of 160-180 kg ha⁻¹. These levels promote maximum leaf expansion and LAI. However, it is important to consider the economic and environmental implications of high nitrogen inputs, and further research on nitrogen use efficiency and its impact on long-term soil health are recommended.

Based on the observed outcomes, it is recommended that farmers apply a nitrogen dose of at least 120 kg ha⁻¹ to achieve optimal stem growth. For maximum stem diameter, a nitrogen dose of 180 kg ha⁻¹ should be considered, though attention should be given to environmental factors and cost-effectiveness. Further studies could explore the impact of nitrogen fertilization on other growth parameters and yield.

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