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RESPONSE OF SAMAZ-14 -14 MAIZE (*Zea mays* L.) TO NITROGEN FERTILIZER RATES IN YOLA, NORTHEASTERN NIGERIA

By

Kussiy J. Jonathan¹, Samuel. J.K², Abubakar B.S², Ali I.J, ⁴Christopher.A³, Emmanuel Francis⁵

^{1,3,4}Department of Soil Science and Land Resource Management, Faculty of Agriculture Science, Taraba State University, Jalingo, Nigeria.

^{5,2}National Mathematical Center, Abuja, Nigeria



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Abstract

A field experiment was conducted at Lake Gerio, Jimeta–Yola, Adamawa State, Nigeria, to determine the response of SAMAZ-14 maize to nitrogen fertilizer. Nitrogen was evaluated at 0, 30, 60, 90 and 120 kg N ha⁻¹ within a nitrogen × zinc factorial experiment arranged in a randomized complete block design with three replications. This paper reports the nitrogen main effects for the Yola site. Nitrogen significantly influenced late-season plant height, dry-matter production and major yield attributes. The tallest plants at 75 days after planting (103.14 cm) occurred at 120 kg N ha⁻¹, whereas 60 kg N ha⁻¹ produced the greatest grain number per cob (458.67), 100-seed weight (28.65 g), grain weight per cob (138.33 g) and reported grain-yield value (67.33 in the source table). Relative to the unfertilized control, these responses represented increases of approximately 21.3, 23.7, 15.0 and 22.0%, respectively. The response declined above 60 kg N ha⁻¹ for most yield variables, indicating that maximum vegetative growth did not coincide with maximum reproductive performance. Nitrogen × zinc interactions were significant for 100-seed weight and grain yield; consequently, the 60 kg N ha⁻¹ rate should be regarded as a provisional Yola recommendation until the treatment-combination means, yield units and economic returns are verified.

Keywords: nitrogen fertilizer; maize; SAMAZ-14; grain yield; Sudan savanna; Yola

INTRODUCTION

Maize (*Zea mays* L.) is a premier global cereal, ranking third in worldwide production behind wheat and rice (Zamir et al., 2023). As a versatile, multi-purpose crop, it serves as a critical staple for human diets and livestock feed, playing a foundational role in the food security of sub-Saharan Africa (Abate et al., 2017; Adiaha et al., 2016). Maize adapts well to both irrigated and rain-fed systems, yielding diverse commercial and traditional food products (Okoruwa, 1998). However, regional cultivation is severely limited by inherent soil nutrient deficiencies, which drastically reduce yields. While chemical fertilizers mitigate these deficiencies, improper application risks altering soil pH and increasing acidity, threatening a crop that thrives best in a narrow 6.0 to 7.0 pH range (Dejene, 2021). Optimizing maize growth and yield requires a balanced supply of essential macro and

micronutrients, most notably nitrogen, phosphorus, potassium, and zinc (Aguk et al., 2021 & Olorunfemi & City). Among these, nitrogen acts as the primary limiting driver of vegetative growth and development. Maize (*Zea mays* L.) is an important staple, livestock-feed and industrial crop in Nigeria (Abdulkadir et al.,2025; Awity.M .2025 & Cheptok et al., 2022.) It is a wide adaptation and multiple uses support household food supply as well as commercial processing, but farm yield is often constrained by low soil fertility and limited access to production inputs (Abraham et al., 2015). Continuous cultivation, crop removal and shortened fallow periods accelerate nutrient depletion, particularly in the savanna zones where rainfall and the sandy nature of many cultivated soils encourage nutrient loss (Akinseye et al., 2026; Bedadi et al.,2023 & Mganga.K 2022).

*Corresponding Author: Kussiy J. Jonathan.



Nitrogen is required for chlorophyll formation, amino acids, proteins, nucleic acids, enzymes and energy-transfer compounds (Jayed et al., 2022; Mathew et al., 2024 & Kamil et al., 2024). Its supply therefore affects canopy development, photosynthesis, dry-matter accumulation and grain formation. Maize has a high nitrogen demand, and deficient plants commonly exhibit chlorosis, restricted growth and reduced yield. (Abbas et al., 2021; Farhan et al., 2024) Conversely, excessive nitrogen may promote vegetative growth at the expense of grain production, increase production costs and raise the risk of loss through leaching or gaseous pathways. Selection of an agronomically and economically appropriate rate is therefore more useful than simply applying the highest available rate. However, the response of maize to nitrogen rates is highly variable and depends heavily on soil texture and specific varietal genetics. Studies conducted in similar environments within Adamawa State demonstrate this critical sensitivity to application rates (Amegbor et al., 2022)

For instance, in Mubi, the effect of different rates of nitrogen fertilizer and cow dung established that increasing nitrogen levels up to 120 kg N ha⁻¹ significantly boosted maize cob length, 100-grain weight, and overall grain yield compared to unfertilized control plots (Audu.I 2020) Similarly, localized research in Yola revealed that while nitrogen use efficiency peaked at 120 kg N ha⁻¹ on sandy-loam soils, pushing application rates further to 160 kg N ha⁻¹ delivered the highest overall grain yields (Lwin . P 2019).

Despite these findings, there remains a critical gap in literature regarding how newly introduced, improved open-pollinated or hybrid varieties respond to these exact inputs under Yola's microclimate. Because over-application significantly diminishes economic returns and drives up soil acidity, establishing the specific agronomic requirements for the Samaz-14 variety is necessary to safeguard local smallholder productivity

This study evaluated growth and yield responses of SAMAZ-14 maize to increasing nitrogen fertilizer rates at Yola. The objectives were to characterize the experimental soil, quantify vegetative and reproductive responses, and identify a provisional nitrogen rate for further on-farm and economic validation. The null hypothesis was that nitrogen rate would have no effect on the measured maize variables.

Materials and Method

The research was conducted in Lake Gerio, Yola North Local Government Area of Adamawa state). The locations had two distinct seasons, dry and wet season with temperature and humidity varying with the seasons. The wet season begins in May and ends in September 70% of the total rainfall in the area falls within June to August. The mean annual rainfall for the area is 982mm, while the temperature ranged from 27 °C to 40 °C.

The experiment was laid in a 5 X 5 factorial Randomized Complete Block Design with the five (5) N levels (0kg, 2.5kg, 5kg, 7.5kg and 10kg N per ha) while Samaz-14 Maize was used as the test crop Urea as the source of nitrogen were procured from Northern Scientific chemical store Jimeta, Yola and Samaz-14 maize seed was procured from IAR Zaria which is characterized by high lysine and tryptophane contents, medium maturity and good seed quality, high yield and tolerance to striga.

The treatments consist of five rates of N :0kg Zn (0kg, 2.5kg, 5kg, 7.5kg and 10kg N per ha) per hectare using Urea as source of nitrogen, while Samaz-14 Maize was used as the test crop. The experiment at each location was laid in the field with total area of 14m x 14.5m. The plot was divided into five blocks of 14mx2.1m each with a space of 1.0m between blocks each block was divided into 5 equal sized subplots of 2.1m x 2.0m, with 0.5m space between subplots. The sub-plot was sown to maize at 20cm x 70cm of 3 rows per subplot. This gave a total of 15 maize stands per sub-plot and data were collected from the 3 maize stands in the middle row, while all others were considered boarder rows. The fertilizer rates were randomly allotted to each subplot of each block and applied in a ring form.

Planting was done manually immediately after the field preparation. The seed was planted at a seed rate of 1 seed per stand at 5cm depth, the gross plot of this experiment consisted of 4 ridges, the inter row spacing was 70cm and intra row spacing was 20cm and the plots size was 6.72 m². A distance of 0.5m was used between plots and 1m between block, 1.5 m between replications while the boarder row was used as boarder distance.

Treatments (Fertilizers) were applied at different rates per plots, N0kg (0.0g per plot), N2.5kg (1.68g per plot), N5.0kg (3.36g per plot), N7.5kg (5.04g per plot) and N10kg (6.72g per plot) per hectare, the application of fertilizer was done basally at the distance of 5cm away from the stalk.

Weeding was done manually by hoe at two weeks after planting and 5 weeks after planting. Data were collected on plant height, stem girth and number of leaves on the maize plants on 5 carefully selected plants devoid of diseases per plot. Plant height was taken at 25, 50 and 75 days after sowing, and were measured from the soil surface to the tip of panicle and the average height calculated in cm. Stem girth were by the use of Vernier caliper at the time of taking the plant height in cm. Numbers of leave were by visual countering and the average number of leaves recorded. Maize harvest was done at 75 per cent sulking and the harvests were weighed separately for the fresh yield, and then sundried to constant weight. The data collected were subjected to Analysis of variance (ANOVA) and significant mean differences were separated using Duncan Multiple Range Test (DMRT) at 5 % level of probability using Statistical Analysis System (SAS).

Results and Discussion

Physical Properties of the soil sample

The sand contents of this study sites were generally high about (66.0%) in soils. Soil is considered one of the most important criteria affecting soil behavior and land management, that influence several soil characteristics, plant growth and development, which are based on the soil texture (Isabel et al., 2017). The textural class is predominantly Sandy loam (SL) which has low clay and with the low organic matter content, and the soils are prone to nutrient leaching (Sutradhar et. al., 2016)

Table 1: Soil Physical Properties of the studies area in Jalingo Showing the surface and subsurface soil.

Property	Surface	Subsurface
Depth (cm)	0-20	20-50
Sand (%)	66.0	64.0
Silt (%)	16.8	14.8
Clay (%)	17.2	21.2
Texture	SL	SL
Bulk density (g/cm ³)	1.48	1.45
Porosity (%)	44	45

The mean bulk density values recorded were 1.48 g/cm³ for the surface layer and 1.45 g/cm³ for the subsurface layer. These values fall within the optimal range for agronomic activities and are deemed suitable for maize cultivation, as they do not restrict root penetration above 1.75 (g/cm³) would be detrimental to plant root penetration while soil with high bulk density affects soil physical properties which limit microbial activities and biochemical processes which are crucial for nutrient availability and overall plant growth and development. The total porosity of the soils of the study area was 48% for surface and subsurface and a mean value of 45% for the surface and subsurface levels respectively. These values were high enough to ensure water retention therefore, continuous nutrients supply and absorption by crop for tissue build up that may eventually result to better plant performance (Abebe *et al.*, 2021).

Chemical Properties of the Experimental Sites before Experiment

The soils chemical properties (Table 2) showed that mean soil pH was 6.65 at the surface and 6.61 for sub-surface soil respectively, these, values indicated a slightly acidic soil condition. The Electrical Conductivity (EC) of the soils of less than 1.0 dSm⁻¹ indicates that Na and soluble salts could not be a threat to crop production in the areas (Hossein and Farshad 2023). The Organic Carbon content obtained decreased with

depth in (Table 2) the surface soil Organic C was high; this may be attributed to continuous cultivation of the soils over the years due to removal of vegetative cover without conscientious replacement. The potassium content of the soils was found to be high at the surface (0.74 cmol/kg) and medium (0.36 cmol/kg) at the sub surface level.). The soil Total Exchangeable Bases (TEB) at the surface and subsurface were 8.88cmol/kg, and 11.87cmol/kg respectively. The ECEC of the soils surface and sub-surface soils was 12.76 and 11.996cmol/kg respectively. Total Exchangeable Acidity (TEA) at surface and sub-surface were 1.820 and 1.710cmol/kg respectively. The Percentage Base Saturation (PBS) was 82.990% - 87.408%.

Table 2 Soils chemical properties of soil samples in Jalingo.

Property	Surface	Subsurface
Depth (cm)	0-20	20-50
PH 1:2.5	6.65	6.61
E C (dS/m)	0.18	0.06
Org. carbon (g/kg)	10.20	7.40
Total Nitrogen (g/kg)	0.97	0.70
K ²⁺ cmol/kg)	0.34	0.36
Na ²⁺ (cmol/kg)	0.41	0.35
Ca ²⁺ (cmol/kg)	6.13	7.12
Mg ²⁺ (cmol/kg)	1.08	3.79
TEA (cmol/kg)	1.82	1.71
ECEC(cmol/kg)	10.70	13.58
PSB (%)	82.99	87.41
ESP (%)	8.53	6.61
Zn(mg/kg)	2.11	2.04

Growth Parameters

Vegetative Growth

Nitrogen did not produce a consistent early-season increase in plant height, but differences became clear at 75 DAP (Table 3). Plant height increased from 90.96 cm in the control to 103.14 cm at 120 kg N ha⁻¹. Leaf number varied only slightly among rates; the largest value at 75 DAP was 14.37 leaves at 120 kg N ha⁻¹. Stem girth at 75 DAP was also greatest at 120 kg N ha⁻¹ (2.29 cm). The source value of 11.80 cm for stem girth at 25 DAP under 60 kg N ha⁻¹ is inconsistent with the remaining observations and should be checked against the field sheet.

Table 3: Effect of nitrogen rate on vegetative growth of SAMAZ-14 maize at Yola

N rate (kg ha ⁻¹)	Plant height (cm)			Number of leave			stem girth(cm)		
	25 DAP	50 DAP	75 DAP	25 DAP	50 DAP	75 DAP	25 DAP	50 DAP	75 DAP

0	16.45a	43.78a	90.96b	6.08a	9.52a	13.83b	0.73b	1.96a	1.90b
30	18.91a	40.95a	96.46b	6.08a	10.21a	14.28a	0.66b	1.99a	1.96b
60	16.67a	41.35a	92.27b	6.06a	10.57a	13.13b	11.80a	2.09a	2.01b
90	17.71a	41.97a	93.59b	6.16a	10.60a	13.48b	0.75b	2.11a	1.92b
120	16.36a	42.82a	103.14a	6.02a	10.46a	14.37a	0.84b	2.03a	2.29b
MSD	0.82	2.30	3.85	-	-	-	0.46	0.32a	0.11a
NX Zn	NS	NS	NS	NS	NS	NS	NS	NS	NS

Within a column, means followed by the same letter were reported as not significantly different at $p < 0.05$. DAP, days after planting; MSD, mean separation difference; NS, not significant. †Apparent source-table anomaly requiring verification.

Dry matter response

At Yola, dry matter increased markedly between 25 and 75 DAP (Table 4). The largest values at all three sampling

dates occurred at 60 kg N ha⁻¹, with 240.66 g recorded at 75 DAP compared with 186.66 g in the control. Grain and straw dry matter at harvest were likewise greatest at 60 kg N ha⁻¹. The nitrogen × zinc interaction was significant for 75-DAP dry matter and grain dry matter at harvest, showing that the nitrogen main effects for these variables depend partly on zinc rate.

Table 4: Effect of nitrogen rate on dry-matter production at Yola.

N rate (Kg ha ⁻¹)	25 DAP	50 DAP	75 DAP	Grain at harvest	Straw at harvest
0	23.66d	148.00c	186.66d	110.50c	151.67c
30	26.66c	162.67b	226.66c	115.50b	160.33bc
60	28.83a	170.33a	240.66a	120.00a	172.33a
90	28.33ab	168.00a	238.00b	118.30b	165.33b
120	28.00b	167.67ab	234.83bc	116.20b	160.33bc
MSD	0.96	3.28	3.5	0.65	0.80
NX Zn	NS	NS	*	*	NS

Means followed by the same letter were reported as not significantly different at $p < 0.05$. *Significant interaction; NS, not significant. Sample basis and units should be verified.

Yield and Yield attribute

Nitrogen improved all reported yield attributes at Yola (Table 5). The 60 kg N ha⁻¹ treatment produced the highest grain number per cob (458.67), 100-seed weight

(28.65 g), grain weight per cob (138.33 g) and reported grain-yield value (67.33). Increasing nitrogen to 90 or 120 kg N ha⁻¹ did not produce a further yield benefit. Compared with the control, the 60 kg N ha⁻¹ treatment increased grain number per cob by 21.3%, 100-seed weight by 23.7%, grain weight per cob by 15.0% and the reported grain-yield value by 22.0%.

Table 5: Effect of nitrogen rate on yield and yield attributes of SAMAZ-14 maize at Yola.

N rate(kg ha ⁻¹)	Grainscob ¹ (number)	100 seed weight (g)	Grain weight cob ⁻¹	Reported grain yield(source value)
0	37.00d	23.17c	120.33c	55.17c
30	416.00c	27.22b	130.00ab	65.00ab
60	458.67a	28.65a	138.33a	67.33a
90	445.00a	27.02b	133.10b	65.67b
120	434.00b	26.59ab	132.67ab	65.00ab

MSD	2.74	1.32	4.81	1.94
CD(0.05)	8.33	4.02	14.61	5.89
N X Zn	NS	*	NS	*

Discussion

Growth and dry matter

The low initial total nitrogen and organic carbon at Yola support the observed crop response to applied nitrogen. Nitrogen promotes chlorophyll formation, protein synthesis and canopy development, which can increase radiation interception and biomass accumulation. In the present study, however, early height and leaf number responded weakly, while differences became more evident in late-season height, stem girth and dry matter. This pattern suggests that crop nitrogen demand became more visible as the canopy expanded and native soil supply became increasingly inadequate.

Maximum plant height at 120 kg N ha⁻¹ did not translate into maximum dry matter or yield. Excess nitrogen can sustain vegetative growth without a proportional improvement in reproductive allocation (Farhan et al., 2024). The dry-matter peak at 60 kg N ha⁻¹ and its decline at higher rates indicate diminishing agronomic returns. Similar dependence of maize biomass and productivity on adequate, but not excessive, nitrogen has been discussed by Zhai et al., 2022.

Yield response and agronomic interpretation

The consistent maxima for grain number per cob, seed weight, grain weight per cob and reported grain yield at 60 kg N ha⁻¹ provide the strongest evidence for an intermediate nitrogen optimum at Yola. Nitrogen deficiency in the control probably limited assimilate production and grain set. Rates above 60 kg N ha⁻¹ may have supplied more nitrogen than the crop could convert efficiently into grain under the prevailing rainfall, soil and management conditions

The numerical response should nevertheless be interpreted with care. The experiment included zinc as a second factor, and nitrogen × zinc interactions were significant for 100-seed weight, grain yield, 75-DAP dry matter and grain dry matter at harvest. For these variables, the performance of 60 kg N ha⁻¹ cannot be assumed to be identical at every zinc rate. The full interaction means are required to identify the best fertilizer combination and to determine whether the nitrogen optimum changes with zinc supply.

The reported grain-yield units also require correction or confirmation. Values of 55.17–67.33 kg ha⁻¹ are much lower than expected for maize and are not readily reconciled with grain weight per cob. They may represent plot weights, a scaled yield index or a transcription error. Until net-plot area, moisture content

and the conversion equation are verified, the recommendation should rely primarily on the internally consistent yield attributes and should not be presented as a final economic rate

Conclusion and recommendation

Nitrogen fertilizer improved dry-matter production and yield attributes of SAMAZ-14 maize at Yola. Although 120 kg N ha⁻¹ produced the tallest plants, 60 kg N ha⁻¹ gave the highest grain number per cob, 100-seed weight, grain weight per cob and reported grain-yield value. On the basis of the supplied Yola data, 60 kg N ha⁻¹ is the provisional agronomic rate for further validation. Before a farmer recommendation is issued, the original nitrogen × zinc treatment means, grain-yield conversion, fertilizer costs and maize price should be verified. The rate should then be tested across additional seasons and representative farms in the Yola area.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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