GROWTH AND YIELD RESPONSE OF MAIZE (*Zea mays* L.) VARIETIESTO DIFFERENT LEVELS OF NITROGEN FERTILIZER APPLICATIONIN MINNA, NIGERIA.

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ABSTRACT

Nitrogen (N) management in maize production is one of the main concerns since it is the most important and primary nutrient for growth and development of the crop. Field trial was carried out at Teaching and Research Farm of Federal University of Technology MinnaGidanKwanoto determine the growth and yield response of maize varieties to different levelsof nitrogen fertilizer application

The experiment was laid out in 3 × 4factorial in a Randomised Complete Block Design (RCBD) and replicated three times Three varieties of maize used were OBA SUPER, SAMMAZ 17 and KAMPA 6. The treatments were four application levels of Nitrogen fertilizer namely: control(no application), 20kg/ha, 60kg/ha and 100kg/ha. Five stands of maize were randomly selected and tagged from each plot for data collection. Data collected were plant height, number of leaves, days to 50% tasselling, numberof cobs, cob length, cob weight, and grain weight. Data collected were subjected to analysis of variance and means were separated using Duncan Multiple Range Test at 5% level of probability. Result obtained showed that SAMMZA 27, KAMPA6 varieties and application of nitrogen fertilizer(N) at 100 kg/ha produced optimum growth and yield of maize. The application of nitrogen fertilizer at 100 kg/ha and cultivation of SAMMAZ 27 and KAMPA6 maize varieties are hereby recommended for farmers in the study area for optimum growth and yield of maize.

KEYWORDS: Nitrogen fertilizer,Maize and levels

INTRODUCTION

Maize can grow on a wide range of soils though it performs best in well drained aerated loam or silty loams or alluvial soils with a pH of 5.5-7. It can grow in a wide range of agro-ecological zones.

Nitrogen is vital plant nutrient and a major growth and yield determining factor required for maize production. It makes up to 4% of dry matter of the plants, and is a component of protein, nucleic acids and many other compounds essential for plant growth processes which includes chlorophyll and enzymes (Tisdale *et al.*, 1999). Its availability in sufficient quantity throughout the growing season is essential for optimum maize growth. The optimal amounts of other essential elements such as phosphorous in the soil cannot be utilised efficiently, if N is deficient in plants. Several researchers (Jehan*et al.*, 2006; Festus *et al.*, 2007, Hafiz *et al.*, 2011, and Mohammed and Hassan, 2011) ascribed lower yield in maize when the crop was subjected to a high dose of N, while time of N application improved N uptake and protects the soil environment. Similarly, at low N supply, crop growth rate slows down causing reproductive structures to decline, and this results in lower maize grain yield and its components(Ronald *et al.*, 2005; Hafiz *et al.*, 2011; Waga 2011; Mohammed and Awale, 2013; Merkebu and Ketema, 2013). Time of N application at appropriate crop growth stage is also another main focus to enhance N use efficiency and increase maize productivity. Among several functions, nitrogen plays a key role on plants metabolism. This element takes part in different metabolic pathways of great importance to plants (Sangoi*et al.*, 2008). Among the crops of agronomic interest, maize express nutritional dependence, especially of nitrogen (Cancellier *et al.*, 2011).

Ferreira *et al.* (2001) concluded that nitrogen fertilization improved grain quality increasing protein and mineral nutrients content, intervening positively in the number of ears per plant, weight of ears, as the mass of a thousand seeds increased according to the nitrogen doses.

MATERIALS AND METHODS

Field trial was conducted at the Teaching and Research Farm of Federal University of Technology Minna, GidanKwanoMinna (latitude 09° 37.86' N and longitude 06° 33.28'E in sub-humid tropical climate, southern Guinea savanna of Nigeria. Minna has a mean annual rainfall of about 1284 mm and a distinct dry season of 6 months duration occurring from November to April. The maximum temperature remain high throughout at about 33.5 °C, particularly in March and June. Soil samples were collected from twelve points along diagonal transects at the depth of 0-15 cm at the Teaching and Research Farm before sowing, surface soil sample were bulked together to form a composite sample. The soil samples were air-dried, gentle crushed and passed through 2-mm sieve. The processed soil samples were analysed for some physical and chemical properties following the procedures outlined by Agbine, (1995). The plot size was 40 m × 12 m which was cleared and prepared manually. The experimental site was divided into 36 plots. Weeding was carried out at regular interval. The treatment consist of four levels (20kg/ha, 40kg/ha, 100kg/ha and control) of nitrogen fertilizer application, and three varieties (OBA SUPER, SAMMAZ 27 and KAMPA 6) of maize. The design of the experiment was 3×4 factorial arrangement fitted to Randomized Complete Block Design and replicated three times. Data collected were plant height, number of leaves, days to 50% tasselling, number of cobs, cob length, cob weight, and grain weight Data collected were subjected to analysis of variance and means were separated using Duncan Multiple Range Test at 5% level of probability.

RESULTS AND DISCUSSION

The results of some physical and chemical properties of the soil prior to sowing are presented in Table 1. The results revealed that the soil texture of the experimental site was sandy clay loam, slightly acidic in water which make it suitable for plant growth because of the availability of plant nutrients for plant uptake at P^H 5.5-6.5 (Brady and Weil, 2002). The result also showed that soil was also low in inorganic carbon, available phosphorus and medium in total nitrogen.

Analysis of data revealed that nitrogen levels had no significant (P≥0.05) effect on number of plant leaves, however maize variety had significant effect on number of leaves of plant Table 2. The effect of levels of nitrogen fertilizer application on number of leaves was significant (P≤0.05) at 3 and 9 weeks after sowing (WAS) on maize variety. The maize variety SAMMAZ 27 recorded highest number of leaves (6.42) while lowest (5.92) was observed in KAMPA 6 at 3 weeks after sowing. The result obtained also indicated that maize varieties did not show any significant (P≥0.05) differences in the number of levels at 6 weeks after sowing. However, at 9 weeks after sowing (WAS) significant (P≤0.05) effect was recorded in the number of leaves where highest number of leaves (12.17) was observed in OBA SUPER 1. This result is in line with the work of Badi and Authman (2006) who reported that increasing nitrogen fertilizer rate from zero up to 250 kg N/ha significantly increase the number of leaves. The result of the analysis showed that nitrogen levels had no significant (P≥ 0.05) effect on days to 50% tasselling, days to 50% silking, and number of cobs. However, maize variety had significant (P≤0.05) effect on days to 50% tasselling and days to 50% silking (Table 3). The result revelled that OBA SUPER 1 recorded highest number of days to 50% tasseling (57.00), while lowest was observed in SAMMAZ (55.75). This result agreed with the findings of Hafiz *et al.* (2011) who reported that maize crop took 50 days for tasseling and 103 days for maturity when N was applied at 130 kg/ha under rain- fed condition. Jehan *et al* (2006), Mahamed and Awale (2013) also reported that days to tasseling and maturity were significantly affected by the successive additions of N, and with increasing rates of N fertilizer, the crop took a shorter period to mature than the treatments receiving either no or lower rates of N.

The results of the significant variety ×N level interaction effects observed at four levels of N on cob length, presented on Table 4 revealed that KAMPA 6 recorded highest cob length (14.00) where N fertilizer was not applied while lowest cob length (8.90) was obtained in SAMMAZ 27. The results also showed that KAMPA 6 recorded highest cob length when 20 kg N/ha (14.00), 60 kg N/ha (14.47) and 100 kg (13.33) N/ha were applied respectively while OBASUPER 1 and SAMMAZ 27 recorded lowest cob length.

The interaction effect of Nitrogen fertilizer levels and maize varieties significantly affected the cob length. This implies that the responses of different maize varieties to levels of N fertilizer were different. Le Gouis *et al.* 2000 confirmed that there is genetic variability for grain yield at low N level and that the genotype ×N level interaction is significant.

The results of the significant interactive effects of maize variety and N levels presented in Table 5 show that there was significant different(P≤0.05) in the cob length among the maize varieties where nitrogen was not applied. The results of the analysis revealed that OBASUPER 1 recorded highest cob weight (0.54) while lowest (0.19) was observed SAMMAZ 27. However, KAMPA 6 recorded highest cob weight when 20 kg N/ha and 60 kg N/ha were applied respectively, while application of 100 kg N/ha resulted in highest cob weight in SAMMAZ 27. This result is similar to experiment conducted by Ronald *et al.* 2005 who observed that grain yield is the end result of many complex morphological and physiological processes occurring during the growth and development of the crop

The interactive effects of nitrogen fertilizer levels on maize grain weight shown on Table 6 revealed that significant ($P \leq 0.05$) different was recorded among maize varieties where N fertilizer was not applied. OBASUPER 1 recorded highest grain weight (0.41) while SAMMAZ 27 recorded lowest (0.39) grain weight. The application of 20 kg N/ha and 60 kg N/ha significantly affected the maize grain weight among the varieties, in which KAMPA 6 recorded highest grain weight while lowest grain weight was recorded in SAMMAZ 27. However, application of 100 kg N/ha resulted in highest grain weight in SAMMAZ 27 and lowest was in OBASUPER 1. This results are in line with the research conducted by Gul *et al.* 2015 who reported that maize grain yield was linearly influenced by nitrogen levels applied. Bashir (2012), Okumura *et al.* (2011), Deparis*et al.* (2007), Cruz *et al.* (2008) and Bastos*et al.* (2008) showed also linear behaviour linked to yield in maize induced by increase in nitrogen level.

CONCLUSIONS

Nitrogen fertility of soil has a major role in maintaining and maximizing the productivity of the maize. However, a number of factors limit yields even when N fertility is optimal. The result obtained from this study show that significant differences were observed for the growth parameters, as well as grain yield. Maize growth parameters such as leaves and plant height increased significantly with increase in nitrogen level. Maize yield characters like cob length, cob weight and grain weight also increase significantly with increase in N level. Further studies may continue along the lines of investigating the optimum application levels of N fertilizer which gives the best results.

Table 1Some physical and chemical properties of the soil before sowing

Parameters	Values
Sand (g kg^{-1})	752
Silt (g kg^{-1})	15
Clay (g kg^{-1})	232
Textural classes	Sandy clay loam
pH in H_2O (1:2.5)	6.32
Total Nitrogen (g kg^{-1})	0.20
Available P (mg kg^{-1})	8.00
Organic Carbon (g kg^{-1})	7.20
Exchangeable Cation (cmol kg^{-1})	
Mg^{2+}	1.02
Ca^{2+}	2.14
K^{+}	0.41
Na^{+}	0.27
Exchangeable Acidity (cmol kg^{-1})	0.01
ECEC (cmol kg^{-1})	3.90

Table 2Effects of nitrogen fertilizer levels on the number of leaves on three varieties of maize.

	Numbers of Leaves		
Treatments	3WAS	6WAS	9WAS
Fertilizer (F)			
Control	6.22a	11.22a	11.56a
20kg N/ha	6.00a	11.22a	11.67a
60kg N/ha	6.11a	10.89a	11.78a
100kg N/ha	6.22a	11.11a	12.00a
LSD	0.49	0.89	0.65
Variety (V)			
OBASUPER 1	6.08a	10.75a	12.17a
SAMMAZ 27	6.42a	11.50a	11.17b
KAMPA 6	5.92b	11.08a	11.92a
LSD	0.42	0.77	0.56
Interaction (FXV)	NS	NS	NS

Means with the same letter (s) in a column of a treatment group are not significantly different at 5 % level of probability

NS= Indicate not significantly different at p> 0.05WAS= weeks after sowing

Table 3 Effects of Nitrogen fertilizer (N)on days to 50% tasselling and days to 50% silking and number of cobs per plot.

Treatments Fertilizer (F)	Days to 50% Tasseling	Days to 50%silking	Number of cobs per plot
Control	53.89a	64.56a	5.00a
20kg N/ha	54.89a	63.67a	5.00a
60kg N/ha	55.33a	63.11a	5.00a
100kg N/ha	54.00a	61.78a	5.00a
LSD	2.31	4.23	0
Variety (V)			
OBASUPER 1	57.00a	67.83a	5.00a
SAMMAZ 27	50.83b	58.67c	5.00a
KAMPA 6	55.75a	63.33b	5.00a
LSD	2.00	3.66	0
Interaction (FXV)	NS	NS	NS

Means with the same letter (s) in a column of a treatment group are not significantly different at 5 % level of probability.
NS= Indicate not significantly different at p> 0.05

Table 4 Interactive effects of Nitrogen fertilizer (N) rates and maize varieties on cob length(cm).

	control	Fertilizer 20 kg N/ha	60 kg N/ha	100 kg N/ha
Variety				
OBASUPER 1	12.93ab	12.27ab	11.10bcd	9.20d
SAMMAZ 27	8.90b	9.40cd	11.07bcd	12.83ab
KAMPA 6	14.00ab	14.00ab	14.47a	13.33ab
S.E±		1.04		

Means with the same letter (s) in a column or row of a treatment group are not significantly different at 5 % level of probability.
SE± = Standard Error

Table 5: Interactive effects of Nitrogen fertilizer (N) rates and maize varieties on cob weight(kg)

	control	Fertilizer 20 kg N/ha	60 kg N/ha	100 kg N/ha
Variety				
OBASUPER 1	0.54a	0.45abc	0.33bcd	0.19d
SAMMAZ 27	0.19d	0.25cd	0.37abcd	0.53ab
KAMPA 6	0.52ab	0.52ab	0.52ab	0.51ab
S.E±		0.073		

Means with the same letter (s) in a column or row of a treatment group are not significantly different at 5 % level of probability
SE± = Standard Error

Table6: Interactive effects of Nitrogen fertilizer rates and maize varieties on grain weight(kg).

	Fertilizer			
	control	20 kg N/ha	60 kg N/ha	100 kg N/ha
Variety				
OBASUPER 1	0.410a	0.33abc	0.22bcd	0.13d
SAMMAZ 27	0.150d	0.19cd	0.17cd	0.43a
KAMPA 6	0.39a	0.38ab	0.36ab	0.37ab
S.E±		0.059		

Means with the same letter (s) in a column or row of a treatment group are not significantly different at 5 % level of probability.
SE± - Standard Error

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