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Growth and Yield Performance of Early Maturing Maize Cultivars as Influenced by Different NPK Fertilizer in Kabba, Kogi State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author SKO designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author OOE managed the analyses of the study. Author NKIA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out for two consecutive growing seasons (2016 and 2017) at the Research Site of Agronomy Section, College of Agriculture, Kabba to evaluate the growth and yield performance of early maturing maize cultivars as influenced by different NPK fertiliser in Kabba, Kogi State, Nigeria. The experiment was a split plot in a randomised complete block design with three replicates. The main plot treatments were the compoundfertilizer, and the subplot treatments were the four maize cultivars. Data were collected from fifteen randomly selected plants in each plot. Data were taken on the basis of agronomic traits such as on plant height, number of leaves per plant, number of branches, stem girth, leave the area, number of seeds per pod and number of seeds per cob. All the data were subjected to analysis of variance (ANOVA) to determine the significance of variations among the treatments and means were separated using Least Significance Difference (LSD) test at 5% level of probability. From the result of the experiment, the following conclusions were drawn: The early maturing cultivar performed significantly better than the local cultivar (gorogoro) in both growth and yield. Among the early maturing cultivar planted,

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sammaz 39 recorded the highest yield. Plots with fertiliser application recorded better growth and yield compared to the no fertiliser plots irrespective of the fertiliser used. Among the compound fertilisers, plots with NPK 15-15-15 showed greater growth and yield performance in this experiment. Farmers in the study area should plant sammaz 39 and amend the soil with NPK 15-15-15 fertiliser for optimum yield of maize.

Keywords: Cultivar; performance; early maturing; NPK fertiliser and yield.

1. INTRODUCTION

Maize (*Zea mays*) belongs to the family of Gramineae [1]. It is a cereal crop which produces grain that can be used as food for the human being as well as animal. It is the most important cereal in sub-Saharan Africa, and it is mainly used for human consumption and in the livestock industry with a small percentage used in agro-allied industries [2].

In Nigeria, maize is a staple food of great socio-economic importance, and the demand for maize sometimes outstrips supply as a result of the various domestic uses. The demand for maize is increasing at a faster rate daily; this may be because grains are being used for feeding poultry and as main food for many households [3]. The total land area planted to maize in Nigeria is above 2.5 million hectares with an estimated yield of about 1.4 metric tons per hectare [4]. However, the poor performance of maize can be attributed to the fact that, a bulk of the country's farm dependent on subsistence agriculture with the rudimentary farm system, low capitalization and use of cultivar with low yield per hectare [4]. Maize is consumed by the industrial sector for production of flour, beer, malt drink, corn flakes, starch, syrup, dextrose and animal feeds. To meet the local demand for the crop, the government placed a ban on the export of maize in Nigeria. Badmus & Ariya [5], in their study on maize production in different parts of the country, noted that maize had shown increasing importance amidst growing utilisation by food processing industries and livestock feed mills. The crop has thus grown to be a local "cash crop" most especially in the Southwest part of Nigeria where at least 30% of the cropland has been put to maize production under various cropping system. Growing maize in farms of 1-2 ha can overcome hunger in the household, and the aggregate effect could double food production in Africa [6]. Worldwide production of maize is 785 million tons, with the largest producer, the United States, producing 42%. Africa produces 6.5%, and the largest African producer is Nigeria with nearly 8 million tons. Africa imports 28% of the required maize from countries outside the continent.

Yield potential of a crop is mainly dependent upon its genetic makeup as well as the environment in which it is grown. The genetic potential, however, can be exploited to the maximum by providing favourable growth environments. The climatic conditions and existing varieties in the country are highly favourable for increasing the production of maize.

2. MATERIALS AND METHODS

The experiment was carried out for two consecutive growing seasons (2016 and 2017) at the Research Site of Agronomy Section, College of Agriculture, Kabba. The site is located at a latitude of 07°35' N and longitude of 06°08' E and is 435 m above sea level, in Southern Guinea Savanna Agro-Ecological Zone of Nigeria, where the dry seasons are a dry and hot while, wet seasons are cool. The rainfall spans between April to November with a peak in June. The dry season extends from December to March. The mean annual rainfall is 1570 mm per annum with an annual temperature range of 18°C - 32°C. The mean relative humidity (RH) is 60% [7]. The major soil order within the experimental site is Ultisol [8].

The experiment was a split plot in a randomised complete block design with three replicates. The main plot treatments were the compound fertilizer, and the subplot treatments were the four maize cultivars. All these were randomised into three blocks given a total of 36 plots in all. Each plot in a block measured 4 m x 3 m and was contiguous to one another; the distance between the blocks was 1 meter. Weeding was done at 3 and 8 weeks after sowing. The same treatment was allotted to each plot for the 2 years of study.

2.1 Soil Sampling and Chemical Analysis

Before the commencement of the experiment in 2016, surface soil samples (0–15cm depth) were taken randomly from the experimental sites. The samples were bulked, air dried and sieved using a 2 mm sieve and analysed for particle size, soil organic matter total N, P, K, Ca, Mg and pH. Soil samples (0–15 cm depth) were also collected at crop maturity on plot basis and were subjected to routine physical and chemical analyses. The samples were taken, bulked and subsampled as described previously [9]. Particle size analysis was done using the hydrometer method [10] while the organic matter was determined by the procedure of Walkley and Black using the di-chromate wet oxidation method [11]. Total N was determined by the micro – Kjeldahl digestion method [12] and available P was by Bray – 1 extraction followed by molybdenum blue colourimetry [13]. Exchangeable K, Ca and Mg was extracted by EDTA titration method [14]. Soil pH was determined in 1:2 soil-water ratio using digital electronic pH meter.

2.2 Determination of Growth and Yield Parameters

Fifteen plants were randomly selected at the centre of each plot for data collection. Plant height and leaf area per plant were determined at 90 days after planting when the maize plant reached its peak growth. Plant height was measured with a measuring tape from tagged plants from the ground level to the tip of the inflorescences. Ten leaves were taken randomly, and the length (L) and weights (w) were measured, and the leaf area was taken in cm and calculated as follows: Leaf area =length x weight x 0.74 [15]. A vernier calliper was used to measure stem diameter.

2.3 Statistical Analysis

Data on all parameters and response variables were subjected to analysis of variance (ANOVA) using the GenStat statistical package (GenStat, 2007 model). Means were separated using the Least Significant Difference (LSD) method at 5% level of probability [16].

3. RESULTS AND DISCUSSION

The properties of the soil of the site of the experiment are shown in Table 1. The soils are sandy clay loam. The soil of Kabba is slightly acidic (6.7) and high in bulk density (1.38 g/cm^3). Organic matter, total N, available phosphorus (P) and exchangeable potassium (K) were 1.56%, 0.18%, 3.16 mg/kg and 0.32 (mol/kg) respectively. Pre-planting soil analysis indicated that the soil of the experimental site was low in soil nutrients status. The low nutrient status may be due to leaching of basic cations due to intense rainfall or perhaps due to the parent material of quarts and sesquioxides which are poor in plant nutrients. This agreed with the findings of Nnaji et al. [17] who reported large losses of basic cations due to leaching as well as the heavy and prolonged duration of rainfall. Application of fertiliser will be of great benefit to the crop.

Table 1. Pre-planting soil analysis

Parameters	Values
Particle size	
Sand (%)	63.7
Clay (%)	21.6
Silt (%)	14.7
Soil texture	Sand clay loam
Soil PH	6.7
Bulk density (g/cm3)	1.38
Total porosity	36.7
Organic matter (%)	1.56
Total N(%)	0.18
Available P (mg/kg)	3.16
Exchangeable cation (Cmol/kg)	
K	0.32
Ca	3.64
Mg	2.87
Na	1.86

Table 2. Composition of chemical fertiliser used

Compound fertiliser	Formulation
A (NPK)(400 kg/ha)	15-15-15
B(NPK)(400 kg/ha)	20-10-10

Growth characters of maize as influenced by cultivars and different NPK fertiliser applied are presented in Table 3. Plant height (cm), stem girth (cm), and leaf area (m^2) were significantly affected by both the cultivar used, and types of fertiliser applied. Among the cultivars of maize used, plots with sammaz 39 recorded the highest value of all the growth characters while the least values of plant height stem girth and leaf area occurred in plots planted with sammaz 15. Growth characters were better in sammaz 39. This could be linked to the fact that the cultivar responds to the applied fertiliser better than other cultivars. The finding demonstrates the genetic superiority of sammaz 39. This is in line with other findings [18,19]. They reported a similar case of superiority of quality protein variety of maize over the open pollinated variety on growth characters and attributed to differences in the genetical makeup of the varieties. All plots with fertiliser application perform better than no fertiliser plots in plant height, stem girth and leaf area. However, there was no significant difference in plots with the application of NPK 15-15-15 and NPK 20-10-10. Though, the highest plant occurred in plots with NPK 20-10-10 fertiliser application. The better performance of plots with NPK fertiliser application could be attributed to the nutrient supply by the applied fertiliser. These results are in agreement with those of Ali et al. [20] who reported that growth and yield parameters in maize increased with the application of fertiliser. This may be partly due to increasing nutrients use efficiency and adequate nutrient supply by the NPK fertiliser applied.

Table 4 present the results of the effect of different cultivars and NPK fertiliser on days to 50% tasseling and cobbing in maize. The result shows that tasseling and cobbing were earlier in SAMMAZ and it responded better to all inputs applied compared to local variables. Days to 50% tasseling and cobbing delayed most in plots planted with gorogoro cultivar. This could be that gorogoro was genetically inferior to sammaz cultivars. Significance differences were observed in both shoots and root weight of maize due to the difference in cultivars planted.

Shoot and root weight were better in all the early matured cultivars compared to the control. Sammaz 39 recorded the greatest values of the shoot and root weights (Table 5). The least shoot and root weight was observed in gorogoro the local cultivar used. This observation could also be attributed to the difference in genetically makeup of the cultivar [19]. Plots with fertiliser application irrespective of the types of NPK fertiliser had better values of shoot and root weight compared to plots with no fertiliser application. The better performance of the plots fertilised with NPK could be linked to adequate nutrient supply by the NPK fertiliser applied. No fertiliser plots recorded the least value of both shoot weight (76.5 g) and root weight (32.7 g).

Table 3. Growth characters

Treatments	Plant height (cm)	Stem girth (cm)	Leaf area (m^2)	Number of leaves
Varieties (VAR)				
Sammaz 15	187.60	3.15	0.38	12.70
Sammaz 39	213.40	3.91	0.56	13.46
Sammaz 40	201.60	3.56	0.43	12.90
Gorogoro	176.60	3.09	0.34	13.12
LSD	17.41	0.36	0.06	ns
Compound fertilizer (CF)				
15-15-15	214.60	3.96	0.55	13.42
20-10-10	221.60	3.96	0.49	13.91
No fertilizer	126.40	1.89	0.27	12.99
LSD	36.21	0.51	0.09	ns
Interaction				
VAR vs CPF	NS	NS	NS	NS

Table 4. Days to 50% tasseling and cobbing

Treatment	Days to 50% Tasseling	Days to 50% cobbing
Varieties		
Sammaz 15	48.19	62.36
Sammaz 39	48.14	62.74
Sammaz 40	48.06	62.46
Gorogoro	54.71	69.13
LSD	3.56	0.93
Compound fertilizer (CF)		
15-15-15	48.66	62.46
20-10-10	48.21	63.12
No fertilizer	53.14	68.11
LSD	3.14	3.11
Interaction		
VAR vs CPF	ns	ns

Table 5. Shoot and root weight (dry)

Treatment	Root weight (g)	Shoot weight (g)
Varieties (VAR)		
Sammaz 15	41.40	94.10
Sammaz 39	49.30	136.40
Sammaz 40	40.10	91.60
Gorogoro	32.70	88.80
LSD	06.41	27.42
Compound fertilizer (CF)		
15-15-15	42.60	137.10
20-10-10	44.40	142.60
No fertilizer	18.60	76.40
LSD	7.33	27.19
Interaction		
VAR vs CPF	NS	NS

The effects of different cultivars on cob parameters of maize are presented in Table 6. Significant differences were observed in cob weight, cob length and cob diameter due to different cultivars planted. However, a number of row of per kernel per cob was not affected significantly. Plots with fertiliser application had better values of cob parameters compared with the no fertiliser plots. Cob weight, cob length and cob diameter were better in plots with NPK 15:15: 15 with values of 14.7, 16.2 and 6.4cm respectively. This observation could be linked to better nutrients available to the crop [21] and [22].

The result of the effect of different cultivar and types of NPK fertiliser on yield and yield components of maize cultivars are presented in Table 7.

Sammaz varieties were better than gorogoro in seed yield per plant (g), 1000 seed weight (g), a number of seeds per cob and seed yield (t/ha). Plots with sammaz 39 had the greatest yield. The result shows that the cultivar sammaz 39 was superior to both sammaz 15 and sammaz 40 in this experiment. This is in line with the previous findings [18,19]. They reported a similar case of superiority of quality protein variety of maize over the open pollinated variety on yield characters and attributed to differences in the genetical makeup of the varieties. All sammaz cultivars were better than control (gorogoro) in yield and yield components. The better performance could be due to a better response of the cultivars to the fertiliser applied. Gorogoro variety recorded the lowest yield characters. The results demonstrate genetic inferiority between the early maturing maize and the local variety used [23].

Compound fertiliser applied significantly affected yield and yield components of the crop. Plots with compound fertiliser application had better

Table 6. Maize cob parameters

Treatment	Cob weight (g)	Cob length (cm)	Cob diameter (cm)	Number of row of kernel per cob
Varieties (VAR)				
Sammaz 15	14.4	15.3	6.2	13
Sammaz 39	14.7	14.7	5.8	14
Sammaz 40	13.1	14.2	5.5	14
Gorogoro	07.2	08.4	4.2	13
LSD	3.41	03.62	0.70	ns
Compound fertiliser (CF)				
15-15-15	14.7	16.2	6.4	13
20-10-10	14.3	15.9	6.2	13
No fertiliser	06.6	09.1	3.7	14
LSD	2.61	04.51	0.90	ns
Interaction				
VAR vs CPF	ns	ns	ns	ns

Table 7. Yields components of maize cultivars

	Seed yield per plant (g)	1000 seed weight (g)	Number of seeds per cob	Seed yield (t/ha)
Varieties (VAR)				
Sammaz 15	60.88	24.41	398	3.63
Sammaz 39	78.54	26.23	503	4.61
Sammaz 40	64.31	25.90	416	3.84
Gorogoro	47.44	20.48	273	1.98
LSD	12.56	2.42	56.44	0.37
Compound fertiliser (CF)				
15-15-15	88.31	26.40	598	4.66
20-10-10	86.47	26.87	601	4.71
No fertiliser	38.46	18.64	203	1.36
LSD	16.43	3.66	59.41	0.98
Interaction				
VAR vs CPF	ns	ns	ns	ns

yield and yield components than no fertiliser plots. However, the effects of NPK 15-15-15 and NPK 20-10-10 were similar and significantly better than control plot (No fertiliser). The results could be because more nutrients were made available to the crop due to the fertiliser applied and adequate nutrients use efficiency of the two early maturing cultivars [22].

Plot with no fertiliser had least values of seed yield per plant (g), 1000 seed weight (g), number of seeds per cob and seed yield (t/ha). This is because the crop depends mainly on the inherent nutrients in the soil.

4. CONCLUSION AND RECOMMENDATIONS

From the result of the experiment, the following conclusions could be made: The early matured cultivar planted performed significantly better than the local cultivar (gorogoro) in both growth and yield. Among the early matured cultivar planted, sammaz 39 recorded the highest yield. Plots with fertiliser application recorded better growth and yield compared to the no fertiliser plots irrespective of the fertiliser used. Among the compound fertilisers, plots with NPK 15-15-15 show more significant growth and yield performance in this experiment. Farmers in the study area should plant sammaz 39 and amend the soil with NPK 15-15-15 fertiliser for optimum yield of maize in the study area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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