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EFFECT OF NPK FERTILIZER AND COW DUNG ON SOME GROWTH CHARACTERS OF EXTRA-EARLY MAIZE (*Zea mays* L.) IN BAGAUDA KANO STATE, NIGERIA

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ABSTRACT
Field experiments were conducted at Bagauda Agricultural Research Station, Ministry of Agriculture Kano State, Nigeria during the 2015, 2016 and 2017 wet seasons to determine the response of growth and yield parameters of Extra Early maize variety grown at different levels of NPK fertilizer and cow dung. The experiment consisted of 16 treatments with four rates of NPK fertilizers (0, 60, 90 and 120 kg/ha rates of NPK 15: 15: 15) and four rates cow dung (0, 6, 7 and 8t/ha rates of Cow dung). The treatments were factorially combined and laid out in a Randomized Complete Block Design (RCBD) and replicated four times. The growth parameters assessed include plant height, number of leaves per plant, leaf area and leaf area index. The results revealed that most of the parameters assessed were significantly affected by fertilizer and cow dung application levels. These parameters differed significantly with NPK fertilizer and cow dung with the highest increment (120 kg/ha of NPK 15: 15: 15) and (8t/ha COD) producing higher values. Interaction between NPK fertilizer and cow dung was significant in most of the parameters studied. Correlation matrix among various parameters as influenced by NPK fertilizer and cow dung revealed significant and positive associations at 0.01 and 0.05 level of probability. From the results of this investigation, it could be suggested that application of NPK fertilizer at the rate of 120 kg/ha of NPK (15: 15: 15) with COD rate of 8t/ha could be used in Extra early maize production to achieve maximum productivity in Bagauda Kano and related ecologies of the world.

Keyword: Cow dung, Extra-early maize, Growth characters, NPK fertilizer.

INTRODUCTION
Maize (*Zea mays L.*) is one of the most important staple food crop in West and Central Africa. The Savanna of West and Central Africa have one of the greatest potentials for maize production because of their relatively higher incidence of solar radiation and lower incidence of pests and diseases during the cropping season (Badu-Apraku *et al.,* 2006). Maize is third important cereal crop next to rice and wheat. It is one of the most important cereal crops in the world agricultural economy both as food for man and feed for animals. It is a miracle crop, it has very high yield potential, there is no cereal on the earth which has so immense potentiality and that is why it is called 'queen of cereals'. In 2013/14, the World production was estimated to be 973.9 million metric tons, 89.3 million metric tons for Africa and 7.7 million metric tons for Nigeria (USDA, 2014). Northern guinea savanna and Sudan savanna combined produced 75% of Nigeria's maize while humid forest accounted for the remaining 25% (Ado, 2012). Maize is one of the five major crops accounting for 7-70% of the total cereal production in eleven countries of West and Central Africa. Nigeria produces 43% of all maize grown in West Africa (Ajala *et al*., 2000). The crop is especially important in the Northern Guinea Savanna (NGS) where the grain yield potential is high and it is one of the two crops in about 40% of the

area under agricultural production (Kamara *et al.,* 2009). The Northern Guinea Savanna alone took about 92% of total area grown to maize in Nigeria. Maize is also widely believed to have the greatest potentials among food crops for attaining the technological breakthrough that will improve food production in the region (Kamara and Sanginga, 2001). Maize production has expanded dramatically in the Northern Guinea Savanna of West Africa where it has replaced many traditional cereal crops and serves as both food and cash crop.

Maize in general alongside other Agricultural products in Nigeria contributed 36.5% to the GDP in 2009. Maize is used for food, feeding livestock as well as for industrial purposes. It is eaten boiled or roasted and used in the preparation of pap. The stalk and leaves are used in silage or hay. The stalk also is used for fencing. The shell, cob and stalk are used as fuel source (Badu-Apraku *et al.,* 2009).

In the past two decades, maize has spread rapidly into the savannas, including the Sudan Savanna replacing traditional cereal crops like sorghum and millet; particularly in areas with good access to fertilizer input and markets (Ajala *et al*., 2000).

Integrated plant nutrition system (NIPS) however is a holistic approach to plant nutrition by obtaining the nutrients from both organic and inorganic sources to maintain and sustain soil fertility and enhance crop productivity in a framework of an ecologically compatible, socially acceptable and economically viable situation. Hence, an input of organic and inorganic materials is essential com3ponent of the fertility management practices in the West African Savanna (Kamara and Sangina, 2001). Inorganic nutrient inputs are largely in terms of Nitrogen (N) Phosphorous (P) and Potassium (K) Fertilizers. While the organically based nutrients is cow dung (Asadu and Unagwu, 2012).

In the Sudan Savanna of Nigeria, alfisols and inceptisols are the dominant soil types. These soils are characteristically low in organic matter, CEC and plant nutrients, especially N and P and low soil N is one of the most important abiotic factor limiting maize yields, therefore, without adequate supply of organic matter, continuous use of NPK fertilizers leads to soil acidification, nutrient imbalances and degradation in soil physical quality (Fasina, 2013).

In Africa, poor soil fertility and nutrient depletion continue to represent huge obstacles to securing needed harvests (Devries and Toennissen, 2001). Thus, while low input systems may be developed for poor farmers who cannot afford costly inputs such as fertilizers, they may not always be sustainable in the sense of satisfying demands under increasing population pressure. Of all the factors available for agricultural production in Africa, soil appear to be the most important and limiting (Ojeniyi, 2012). The high cost, scarcity and low efficiency of fertilizers make them unprofitable for farmers. Also without adequate supply of organic matter, continuous use of NPK fertilizers leads to soil acidification, nutrient imbalances and degradation in soil physical quality (Fasina, 2013). Better management of soil fertility is imperative for sub-saharan Africa. Saginga and Woomer (2009) reinforced this view by identifying soil fertility depletion in smallholder farm as the fundamental biophysical root course of declining per capita food production in Africa and advocated more integrated problem- solving approaches. Recent development in soil fertility management and plant nutrient supply focuses on integrated nutrient management systems that fully utilize nutrient supply from both organic and inorganic sources (Sanginga and Woomer, 2009). Nearly all attempts to maintain continuous crop production with inorganic fertilizers alone have failed in the country, hence there is need to adopt combined use of organic and inorganic fertilizers which has proven a sound soil fertility management strategy in many countries.

As a result of high nutrient demand by maize, its production requires high inputs of fertilizer. Also the high cost, unavailability and low levels of soil organic matter, alternative organic sources of nutrients needs to be included in maize fertilization. However the use of inorganic fertilizers particularly N, P and K is also needed to ensure an efficient nutrient management in the maize-based cropping systems in Sudan Savanna of Nigeria, however the productivity of maize largely depends on its nutrient requirements and management particularly that of nitrogen, phosphorus and potassium (Arunkumar, 2007). Research conducted in Northern Guinea Savanna and elsewhere also had shown great improvement in the yield of maize crop as a result of improvement in organic matter content of the soil (Boateng *et al.,* 2006).

The application of organic manures such as farmyard manure sustain cropping systems through better nutrient recycling, improved soil structure, increased infiltration rate and increased soil water holding capacity, however inorganic fertilizers such as NPK are not usually available and are always expensive for the resource-poor farmers, farmyard manure is used as an alternative or complement to the use of inorganic fertilizers. It releases nutrients slowly and steadily over a longer period of time and also improves the soil fertility status by activating microbial biomass of the soil (Pullman and Wash, 2010).

Organic manure is however, required rather in large quantities to meet up with the crop nutrient requirement. It is rarely available to small-scale farmers in the required large quantities (Aphane *et al.,* 2003). More so, the manufactured organic fertilizer by the emerging organic fertilizer companies (such as Nomau organic fertilizer company) gave the highest NPK recommendation range for cereal and vegetable crops as 33 – 38 kg N ha^{-1}, 65.94 – 75.36 P_2O_5 kg ha^{-1} and 4.83 – 5.52 K kg ha^{-1}. These figures indicated that the N and K levels are very low and far below the optimum requirement for maize production, while the P is higher than the optimum recommendation. Therefore there is the need to conduct trials on the organic fertilizer in combination with chemical fertilizer to meet the nutrient requirement of the crop based on this combination.

The aim is to evaluate the response of Extra-early maize variety (*Zea mays* ***L.***), to varying NPK fertilizer and cow dung treatments in Bagauda with the following specific objectives:

i. To determine the influence of NPK fertilizer on the growth of Extra Early maize variety.
ii. To investigate the effect of cow dung on the growth of Extra Early maize variety.
iiii. To study the combined effect ofn NPK fertilizer and cow dung on growth characters of Extra Early maize variety.

The research covered Bagauda of Bebeji Local Government area. The work covered all production practices involved in the production of Extra-early maize variety and evaluate all agronomic traits as well as growth indices, yield and yield components.

MATERIALS AND METHODS

Field experiments were conducted during the rainy season of 2015, 2016, and 2017 respectively at the Bagauda Agricultural Research Station, Ministry of Agriculture Kano State, Nigeria. ($11^0$58'N, $8^0$25'E, 450m above sea level). The area has two distinct seasons, a wet season (May to September) and dry season (October to April). The range of rainfall and temperature is between 787mm to 960mm and 21^0 C – 39^0 C respectively (KNARDA, 2001).

The soils of Kano region are generally sandy, derived mostly from wind drift materials. They are inherently low in fertility with low levels of Nitrogen and cation exchange capacity (CEC) and very low in organic matter which is usually less than 0.5% (Olofin, 1987).

Extra Early maize (*Zea mays* ***L.)*** was used in the 3-year study. The seed was sourced from University farm of Kano University of Science and Technology Wudil. As the name implies Extra early maize variety is a short duration crop that matures within 70 to 80 days after planting and high yielding under favourable climate and soil conditions with good cultural Practices.

The treatments consisted of four rates of NPK (0, 60, 90, and 120 kg /ha) and four organic manure rates (0, 6, 7 and 8t/ha). All treatments were factorially combined and laid out in a Randomized Complete Block Design (RCBD) with four replications. NPK and Organic manure were all applied as per treatment. A total of 64 plots (5.25m × 4m each) were laid out with a gross plot size of 21m^2 and net plot size of 6.75m^2. The spacing between plots was 0.5m and 1m between replications respectively.

RESULTS AND DISCUSSION

Analysis of Plant height Affected by Application of NPK Fertilizer and Cow Dung

The plant height was affected by application of NPK fertilizer and cow dung throughout the seasons under study is presented in Table 1. The plant height increased significantly (P = 0.05) with increment in NPK fertilizer and cow dung. There was significant difference between 0 kg/ha and 60 kg/ha rates of NPK with respect to plant height at 9WAS in 2016 and at 6WAS and 9WAS in 2017.

However, it was observed that in 2016 trial no statistical difference was recorded at in all the rates of COD and NPK both at 6WAS sampling periods with respect to plant height. There was significant difference in plant height between all the COD rates at 6WAS while no statistical difference was recorded at 9WAS in 2015. However there was no statistical difference between 60 kg/ha, 90 kg/ha and 120 kg/ha rates of NPK at 6WAS in 2015. There was significant difference with respect plant height between all the NPK rates however no significant difference in plant height between all the COD rates in the combined analysis (Table 1).

Effect of NPK Fertilizer and Cow Dung on Number of Leaves of Extra-early Maize

In 2015 trial, number of leaves was affected by application of COD at 9WAS, significantly application of 6t/ha of COD produced the highest number of leaves, however there was no significant (P=0.05) further increase in number of leaves between all the rates of NPK and COD in the entire sampling periods in 2016 and 2017, respectively (Table 2). This trend was recorded in all sampling periods in 2015(with the exception of COD at 9WAS).

Effect of NPK Fertilizer and Cow Dung on Leaf Area of Extra-early Maize

Throughout the 3-year study period, application of NPK fertilizer resulted in significant (p = 0.05) influence in leaf area of extra early maize, except at 9WAS sampling period in 2016. Leaf area increased significantly with increment in COD at 6WAS in 2016 (Table 3). However there was significant difference in terms leaf area between all NPK treatments on this parameter. COD treatment on the other hand was observed to have no significant effect on leaf area in the combined analysis (Table 3).

Table 1: Effect of NPK Fertilizer and Cow Dung on Plant Height of Extra-early Maize during the 2015, 2016, and 2017 Wet Seasons ar Bagauda

Treatment	**Year**						
	2015		**2016**		**2017**		
	Weeks After Sowing (WAS)						
	6	**9**	**6**	**9**	**6**	**9**	**Combined**
NPK (kg/ha)							
0	156.12b	211.15c	173.05	212.66ab	159.56c	205.07c	209.38c
60	168.40a	210.87c	185.24	221.33a	172.11b	213.58b	218.20ab
90	170.42a	221.72b	171.57	221.41a	180.09a	218.73a	221.48a
120	168.93a	230.45a	167.06	205.51b	185.15a	223.52a	213.11bc
LS	*	*	NS	*	*	*	*
SE±	14.30	12.01	25.03	14.61	10.36	6.92	13.48
6	175.26a	224.75	183.69	221.81a	173.52	212.92	219.43
7	165.80ab	217.06	170.13	208.87b	174.74	216.36	214.33
8	162.58b	216.38	174.01	213.57ab	177.14	217.78	212.93
LS	*	NS	NS	*	NS	NS	NS
SE±	14.30	12.01	25.03	14.61	10.36	6.92	13.48
Year							
1							11.41c
2							12.20b
3							12.86a
LS							*
SE±							13.48
Interaction							
NPKxCOD	*	*	*	*	*	*	*
NPKxY							*
CODxY							*

In a column and row, means followed by same letter are not significantly different at 5% level of probability level by Ducan Multiple Range Test (DMRT).NPK = Nitrogen, Phosphorus and Potassium, COD = Cow dung manure, * = Significance at 5% probability level NS = Not significant Y = Year.

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Table 2: Effect of NPK Fertilizer and Cow Dung on Number of Leaves of Extra-early Maize, during the 2015, 2016 and 2017 Wet Seasons at Bagauda

Treatment	Year						
	2015		**2016**		**2017**		
	Weeks After Sowing (WAS)						
	6	**9**	**6**	**9**	**6**	**9**	**Combined**
NPK (kg/ha)							
0	12.23	11.76	12.93	11.50	12.93	11.50	11.56
60	12.25	11.88	12.97	11.94	12.97	11.94	11.98
90	12.26	11.71	12.78	11.56	12.78	11.56	13.73
120	12.26	11.89	12.76	1181	12.76	1181	11.84
LS	NS	NS	NS	NS	NS	NS	NS
SE±	0.03	0.68	0.85	0.69	0.86	0.69	6.99
COD(t/ha)							
0	12.21	11.93a	12.86	11.4	12.68	11.48	13.76
6	12.21	12.05a	13.11	11.85	12.80	11.70	12.00
7	12.20	11.80ab	12.68	11.70	12.86	11.73	11.83
8	12.20	11.33b	12.80	11.73	13.11	11.85	11.51
LS	NS	*	NS	NS	NS	NS	NS
SE±	0.03	0.68	0.85	0.69	0.86	0.69	6.99
Year							
1							13.36
2							11.78
3							11.69
LS							NS
SE±							6.99
Interaction							
NPKxCOD	*	*	*	*	*	*	*
NPKxY							*
CODxY							*

In a column and row, means followed by same letter are not significantly different at 5% level of probability level by Ducan Multiple Range Test (DMRT).NPK = Nitrogen, Phosphorus and Potassium, COD = Cow dung manure, * = Significance at 5% probability level NS = Not significant Y = Year.

Table 3: Effect of NPK Fertilizer and Cow Dung on Leaf Area of Extra-early Maize

Treatment	Year						
	2015		**2016**		**2017**		
	Weeks After Sowing (WAS)						
	6	**9**	**6**	**9**	**6**	**9**	**Combined**
NPK (kg/ha)							
0	255.63b	248.43c	263.82ab	272.88	248.40c	244.28d	250.48b
60	278.25ab	291.51b	277.58a	284.72	270.16b	260.53c	266.01a
90	290.12a	307.65b	265.95ab	265.59	277.62ab	271.01b	253.31ab
120	276.55ab	330.14a	250.04b	259.31	286.30a	281.55a	251.22b
LS	*	*	*	NS	*	*	*
SE±	30.55	24.39	34.89	38.61	17.94	13.40	35.45
COD(t/ha)							
0	273.47	275.15b	260.02ab	259.12	265.45	258.78	249.11
6	283.92	294.99a	278.11a	286.86	267.68	263.27	262.61
7	270.54	299.44a	250.50b	265.34	272.15	266.49	256.45
8	272.62	308.15a	268.76ab	271.17	277.19	268.83	252.46
LS	NS	*	*	NS	NS	NS	NS
SE±	30.55	24.39	34.89	38.61	17.94	13.40	35.45
Year							
1							200.43c
2							294.43a
3							270.62b
LS							*
SE±							35.45
Interaction							
NPKxCOD	NS	NS	*	*	NS	NS	*
NPKxY							*
CODxY							NS

In a column and row, means followed by same letter are not significantly different at 5% level of probability level by Ducan Multiple Range Test (DMRT).NPK = Nitrogen, Phosphorus and Potassium, COD = Cow dung manure, * = Significance at 5% probability level NS = Not significant Y = Year.

Effect of NPK Fertilizer and Cow Dung on Leaf Area Index of Extra-early Maize

Table 4 present the application of increasing rates of NPK resulted in significant increase in leaf area index per plant of extra early maize between all the rates in all the sampling periods in 2015 and 2017, but there was no effect between all the rates of NPK at all the sampling periods in 2016 trials. However there was no significant difference between all the rates of COD at all the sampling periods in 2015, 2016 and 2017 except between 0 and 6t/ha and rates of COD at 9WAS in 2015 where linear increase in leaf area index was recorded. Significant and progressive increase in leaf area index per plant of extra early maize was recorded in all the NPK and COD treatments in the combined analysis (Table 4). The results of this study demonstrated the importance of NPK fertilizer and cow dung on the height of extra-early maize. Significant increase in height with respect to fertilizer application up to 120 kg/ha of NPK at 6WAS in 2015 might be due to sufficient supply of nutrients. This is in conformity with the findings of Abedi *et al.* (2010) who revealed that mineral nutrition has a synergistic effect in the plant body and this indicates a positive relationship between nutrients levels and plant height. There was no statistical difference between all the rates of NPK and cow dung at all the sampling periods throughout the study period. This was made possibly because of leaching of the highly soluble mineral fertilizer and partly because of the timing of application which may not coincide with plant demand resulting to low use efficiency by the maize crop and hence reduced growth (Oyun, 2008).

The leaf area being the photosynthetic surface plays an important role in determining the total biomass production and quality of photosynthesis available for crop performance (Abedi *et al.,* 2010). Application of 120 kg/ha NPK at 9WAS in 2015 gave significantly higher leaf area of extra early maize as compared to all other treatment combinations. Supply of sufficient amount at that rate made extra-early maize to put more leaf surfaces for plenty photosynthetic assimilation and enhanced photosynthetic rate. These results are in conformity with the findings of Kamara *et al*. (2009), who reported that application of N fertilizer increased the assimilatory leaf area and photosynthetic productivity and Kausadikar *et al.* (2003) reported that N, P and K fertilizer has synergic effect on the growth attributes of crops such as maize.

The application of increasing rates of NPK gave significantly higher leaf area index (LAI) per plant of extra early maize across all the rates at all the sampling periods in 2015 and 2017 (except in 2016). This may be due interplay between genetic and environmental factors coupled with the fact each season may have a distinct growing environment. Significantly higher LAI of 2.13 (in 2015 at 9WAS) and 2.03 (in 2017 at 9WAS) was produced at 120 kg/ha rate of NPK as reported by Abedi *et al.* (2010).

LAI is an important plant growth variable and indeed a major objective of agronomic practices like nutrient management is to have a higher leaf area index for maximum production. In the present investigation, application of NPK fertilizer had a significant influence on leaf area index of extra early maize. There was no significant difference between all the rates of cow dung at all the sampling periods in 2015, 2016 and 2017 (except between 0 and 6 t/ha rates of cow dung at 6WAS). Similar results were reported by earlier studies on maize (Ojeniyi, 2012; Wale and Oare, 2013).

CONCLUSION AND RECOMMENDATIONS

The results indicated that growth parameters represented by plant height, number of leaves per plant, leaf area and leaf area index all differed significantly with higher NPK fertilizer and cow dung application. Based on the results of this investigation, the following are hereby suggested for recommendation to farmers for the production of Extra-early maize:

1. Application of fertilizer at the rate of 120kg/ha of NPK (15: 15: 15) seems more promising for better maize growth and therefore, recommended to farmers.
2. COD rate of 8t/ha could be used in Extra early maize production to achieve maximum growth and productivity of maize in Bagauda, Kano and related ecologies of the world
3. The combined application of fertilizer at the rate of 120kg/ha of NPK (15: 15: 15) with COD rate of 8t/ha could be used in Extra early maize production to achieve maximum growth and productivity in Bagauda, Kano and related ecologies of the world.

Table 4: Effect of NPK Fertilizer and Cow Dung on Leaf Area Index of Extra-early Maize

Treatment	Year						
	2015		**2016**		**2017**		
	Weeks After Sowing (WAS)						
	6	**9**	**6**	**9**	**6**	**9**	**Combined**
NPK (kg/ha)							
0	1.66b	1.51d	1.82	1.67	1.52c	1.65c	1.54b
60	1.81ab	1.81c	1.92	1.81	1.68b	1.79b	1.69a
90	1.88a	1.96b	1.81	1.64	1.74b	1.89b	1.59b
120	1.79ab	2.13a	1.73	1.65	1.88a	2.03a	1.59b
LS	*	*	NS	NS	*	*	*
SE±	0.19	0.14	0.31	0.27	0.13	0.14	0.25
COD(t/ha)							
0	1.78	1.70b	1.79	1.60	1.66	1.86	1.57b
6	1.84	1.85a	1.95	1.81	1.69	1.85	1.67a
7	1.76	1.91a	1.71	1.65	1.72	1.84	1.61ab
8	1.77	1.94a	1.84	1.70	1.75	1.79	1.55b
LS	NS	*	NS	NS	NS	NS	*
SE±	0.19	0.14	0.31	0.27	0.13	0.14	0.25
Year							
1							1.26c
2							1.85a
3							1.69b
LS							*
SE±							0.25
Interaction							
NPK x COD	NS	*	*	*	*	*	*
NPKxY							*
CODxY							NS

In a column and row, means followed by same letter are not significantly different at 5% level of probability level by Ducan Multiple Range Test (DMRT).NPK = Nitrogen, Phosphorus and Potassium, COD = Cow dung manure, * = Significance at 5% probability level NS = Not significant Y = Year.

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