Comparative Response of Different Varieties of Maize (*Zea mays* L) to NPK 15:15:15 Compound Fertilizer and Poultry Droppings Applications

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ABSTRACT: Two similar field experiments were conducted during the early cropping seasons of 2007 and 2008 in the Teaching and Research Farm of Ambrose Alli University, Ekpoma, to evaluate DMSR and TZSR improved varieties as well as a popular local maize for agronomic performance and yield responses to NPK 15:15:15 compound fertilizer and poultry droppings. The three varieties were fertilized with 100,200 and 300kg/ha NPK as well as 6t/ha poultry droppings and a control in a 3 × 5 factorial arrangement fitted into a randomized complete block design replicated three times. The three varieties differed significantly ($P<0.05$) in most of the vegetative parameters monitored including plant height, number of leaves and leaf area, in the order of the local > TZSR >DMSR. The positive and significant ($P<0.05$) response of the vegetative and yield parameters to fertilizer application mostly to 300kg/ha NPK, then poultry droppings and 200kg/ha NPK in that descending order, was independent of variety. The DMSR, the TZSR and the local variety produced tassels and silks in 63 and 73 days, in 66 and76 days, and in 72 and 83 days respectively. The three varieties had similar shelling percentage values (68.5-69.9%). The improved varieties: DMSR and TZSR varieties did not differ significantly, out yielded the local by 18.9% and 10.8% respectively and were found to be adapted to this ecological zone. The DMSR was highest yielding with a 100grain weight of 32.0grams and total grain yield of 4.4t/ha.

[Okaka Victor, Alleh Eric, Ogedegbe Felix, Ayodele Emmanuel. **Comparative Response of Different Varieties of Maize (*Zea mays* L) to NPK 15:15:15 Compound Fertilizer and Poultry Droppings Applications.** Nature and Science 2011;9(3):43-48]. (ISSN: 1545-0740). http://www.sciencepub.net.

Key words: improved varieties; popular local; NPK; Poultry droppings; adapted; ecological zone

1. Introduction

Maize (*Zea mays* L.) is adapted to a wide range of environments (Ajibefu *et al*., 2002) and it is more extensively distributed over the earth than any other cereal crop(Remison,2005).The strategic plan of IITA in 1987 acknowledged the large potential of maize as human food, livestock feed, and industrial use and that the moist savannas have the greatest potential for increased production in West Africa(IITA,1987). FAO (1995)'s estimate of 1.9 million metric tonnes of maize grains from 1.5 million hectares of land in Nigeria translates to about 1.3 tonnes/ha. This aptly shows that the yield of maize in the country is abysmally low considering the demonstrated and potential yields of 4.5t/ha and above 5.0t/ha respectively (Remison, 2005). Despite the all importance of maize and favourable environmental conditions, the present production trend is not keeping pace with growth in demands for the crop products. This apparent production - demand gap is attributed to the inherent poor fertility status of tropical soils due to high rainfall and consequent leaching (Agboola and Unamma, 1991; Forbes and Watson, 1992). Due to population pressure and decreased land per farmer, cropping is continuously done on the same piece of land even on marginal soils. This situation further exacerbates loss of soil fertility and inadequate supply of plant nutrients with attendant low yields (Ojeniyi and Adegboyega, 2003). Farmers are not ignorant of the obvious implications of continuous cropping and how to alleviate same with the commonly recommended inorganic fertilizers. Most farmers lack the resources needed to adapt to the changing context or to integrate this agronomic practice of fertilizer application which may help them to conserve soil nutrients. For enormous are the challenges of scarcity and exorbitant cost of inorganic fertilizers (Ighalo *et al*.,2008) which place them beyond the reach of the low to medium farmers who form the bulk of farmers in Nigeria. According to Ojeniyi and Adegboyega (2003), the scarcity and high cost of the inorganic fertilizers hamper their adequate use in ameliorating soil deficiencies. There is however a solace in organic manures from the ever expanding livestock farming by-products for soil amendments. According to Giller *et al*. (2006), organic materials are important sources of nutrients and are necessary for the management of soil fertility by small scale farmers. There is the need for an empirical evidence of the comparative effects of the commonly sought inorganic fertilizer N.P.K. and the source able poultry droppings on growth and yield of maize. To this end, this study has the main objective of evaluating three commonly grown maize varieties for growth and yield response to organic and inorganic fertilizers. The specific objectives are to;

1. Compare three commonly grown maize varieties in Ekpoma and environs, for growth and yield in a derived savannah ecological zone of Edo state, South South Nigeria.
2. Determine the optimum rate of NPK 15:15:15 compound fertilizer that equates with the rate of poultry droppings used for maize in this ecological zone.
3. Determine the desirability of poultry droppings as a viable alternative to inorganic fertilizer for maize

2. Materials and Methods

Two similar experiments were conducted in adjacent fields of the Teaching and Research Farm, Ambrose Alli University Ekpoma, a rain forest-savannah transition zone of Nigeria in the early cropping seasons of 2007 and 2008. The site had been under bush fallow for two years after harvest of cassava in 2005 before the experiment commenced in 2007. The characteristics of 0-15cm layer of the soil in 2007 were; total nitrogen (N): 0.99, phosphorous (ppm): 7.89, potassium (m-equiv/100g): 0.19, calcium (m-equiv/100g):5.00, magnesium (m-equiv/100g):0.43, carbon (%):1.50, pH (0.01mkcl): 5.9 and Effective Cation Exchange Capacity (ECEC): 5.25. The characteristics of the adjacent soil used in 2008 were as follow; total nitrogen (N): 1.01, phosphorous (ppm):8.25, potassium (m-equiv/100g):0.21, calcium (m-equiv/100g): 4.96, magnesium (m-equiv/100g):0.45, carbon (%): 1.65, pH (0.01 mkcl): 5.6 and Effective Cation Exchange Capacity(ECEC): 5.34.

Three varieties of maize; Downy Mildew Streak Resistant cultivar with red kernels(DMSR-R),Tropical Zea mays Streak Resistant cultivar with white kernels(TZSR-W) and a popular local tagged Ekpoma local were used. Five fertilizer rates including the control, NPK 15:15:15 compound fertilizer at 100,200 and 300kg/ha as well as poultry droppings at 6tonnes/ha equivalents were used to fertilize each variety in a 3 × 5 factorial scheme replicated 3 times. Adjacent plots within and between replicates were spaced 1m apart and 1.5m apart respectively. Each plot measured 4.5m×2m in a total land area of 44m×16.5m.

The organic fertilizer; poultry droppings, dried and earlier analysed for percentage organic matter: 59.9, N:4.5, P_20_5: 2.7, K_20:1.6, Ca:2.9 and Mg:0.8 was worked into plots receiving same, a week before plantings were done. Planting was done on 30th May for the 2007 experiment and on 13th June in the 2008 experiment. Spacing was 75cm×25cm which gave an equivalent population density of 53333plants/ha after supply of missing stands and thinning to 1 plant/stand. Weed control was manual, twice; at 3 and 7 weeks after planting (WAP). The inorganic fertilizer, NPK 15:15:15 compound was applied according to treatment rates, at 3WAP immediately after the first weeding operation.

Data were collected on both vegetative and yield parameters. At the onset of tasseling (i.e. end of vegetative phase) in 9WAP, data were collected on plant height, stem girth, number of leaves and leaf area from five randomly selected plants in the four central rows. Number of days from planting to when half of the plants in a plot tasselled and developed silk was counted for 50% tasseling and 50% silking respectively. The crops were left dry in the field, before harvest. The moisture content was adjusted to the standard 12.5% by oven drying at 80^{o}C for 72hrs. Yield and components of yield data including 100 grain weight, grain yield and shelling percentage were determined on plants from the net plots. All data were subjected to analysis of variance applicable to randomized complete block design (Gomez and Gomez, 1984). Significant means were compared using least significant difference (LSD) at p=0.05. Data for both years were not significantly different (t at 0.05) and thus pooled for presentation.

3. Results and Discussion

The vegetative parameters of maize including plant height, stem girth, number of leaves and leaf area responded positively and significantly ($P<0.05$) to NPK 15:15:15 compound fertilizer and poultry droppings application, independent of variety. The parameters increased with increased rate of NPK fertilizer application up to the highest rate of 300kg/ha used in the study (Table 1). This is in consonance with the earlier observation made by Allan (1984) that an increase in supply of nutrient from a level that is low, commensurately increases growth. The effects of 6t/ha poultry droppings and 200kg/ha NPK application were comparable on plant height, stem girth and number of leaves. Whereas, 6t/ha poultry droppings application compared with 300kg/ha NPK 15:15:15 compound fertilizer on the leaf area of the maize plants. For instance, maize plant height in the unfertilized plots increased 16.7%, 39.5%, 58.0% and 39.6% in response to the application of 100kg/ha NPK, 200kg/haNPK, 300kg/haNPK and 6t/ha poultry droppings respectively. While the leaf area of maize plants in the unfertilized plots increased 43.3%, 61.0%,75.1% and 71.1% due to the application of 100kg/ha NPK, 200 kg/ha NPK, 300 kg/ha NPK and 6t/ha poultry droppings respectively (Table1). Varietal differences in the plant architecture of the three varieties apparently manifested in the plant height, number and size of the leaves. In the consideration of compatibility with other crops in mixtures, the DMSR would be the choice of farmers because of the relatively low number and size of leaves compared to the local and TZSR varieties.

The three varieties differed significantly (P<0.05) in days to 50% tasselling and silking with the DMSR producing tassels and silks earliest while the local variety was latest in both parameters. The DMSR tasselled on the average, 3 and 9 days before the TZSR and the local variety respectively while the TZSR tasselled 6 days earlier than the local variety. Similarly, the DMSR produced silk about 3 and 10 days earlier than the TZSR and the local variety respectively while the TZSR produced silk about 8 days before the local variety (Table 2). Earliness in maturity as a major breeding objective has been a major distinguishing feature of improved varieties of crops from the local varieties.

The non application of fertilizer significantly (P<0.05) delayed tasselling and silking in the three varieties. Tasselling in the 100 and 200 kg/ha NPK, 6t/ha PD as well as 300kg/ha NPK supplied plants was delayed by about 4 days, 5 days and 7 days respectively due to non application of fertilizer. The effects of 100 and 200 kg/ha NPK application on commencement of tasselling were the same while the 300kg/haNPK fertilized plants tasselled earliest. However, silks were developed in the order of plants in the 300 kg/ha NPK plots, 6t/ha PD and 200kg/ha NPK plots, 100kg/ha NPK plots before the control(Table 2). The earliness in tasselling and silking in response to fertilizer application in this study is a negation of the assumption made by Okaka(1992) that fertilizer application may have the tendency of prolonging vegetative growth phase in annuals. It is logical to attribute the prompt development of tassels and silks occasioned by adequate nutrients from fertilizers applied, to enhancement of ample environment for optimal physiological activities of the plants.

Shelling percentage of the maize plants was not significantly (P >0.05) affected by variety. The three varieties had almost similar shelling percentages (68.5% – 69.9%) as shown in Table 3. Most of the crop varieties in vogue are improved and best locals which evolved either by natural or artificial selection for desirable traits. Improved yield has always been the most compelling objective in the development of any plant variety. Relative proportion of seeds(grains) in a maize cob is a trait that determines the yield. Shelling percentage increased slightly (P >0.05) with 100 and 200 kg/ha NPK applications but significantly (P<0.05) with 300kg/ha NPK and 6t/haPD applications. Plants supplied 300kh/ha NPK had the highest shelling percentage though comparable with the plants fertilized with 6t/ha PD. Apparently, adequacy in nutrient supply occasioned by the applications of 300kg/ha NPK and 6t/ha poultry droppings enhanced grain filling irrespective of variety.

The improved varieties and the local variety differed significantly (P<0.05) in grain yield. Though comparable (LSD at 0.05), the DMSR variety was higher yielding than the TZSR variety. Grain yield also differed significantly (P<0.05) among the different fertilizer treatment effects in the order of 300kg/ha > 6t/ha PD= 200kg/ha >100kg/ha > control.

The results of this experiment have shown that response of maize vegetative and yield parameters to 100kg/ha and 200kg/ha NPK 15:15; 15 compound fertilizer was significant (P<0.05) while response to 300kg/ha NPK 15:15; 15 compound fertilizer and 6t/ha poultry droppings was highly significant (P<0.01).

4. Conclusion and Recommendation

The findings in this study show that there is considerable variation in the growth and yield of different varieties of maize in this ecological zone. The yield of the local can be substantially improved by adopting a more yielding variety as DMSR in this study. It is very obvious that the use of fertilizers in this ecological zone is inevitable since most available lands for cropping rarely fallow long enough to recover the nutrients lost to previous croppings. This is evident in the response of the maize varieties to even the lowest rate of fertilizer (100kg/ha NPK) used in the study.

It is worthy of note that yields from even the local variety are far below the potentials because of poor agronomic practices such as non application of fertilizer. Both vegetative and yield components increased consistently with increasing rates of NPK fertilizer up to the highest rate of 300kg/ha used in this study. This exposes the inherent limitations in adopting the blanket recommendation of 300kg/ha of NPK 15:15:15 compound fertilizer for maize cultivation in Nigeria. DMSR is a viable variety for use in this ecological zone and NPK 15:15:15 compound fertilizer at the highest rate used in this study or a higher rate of poultry droppings is recommended.

Further studies are however necessary to:

1. Evaluate all available maize varieties including the locals, the downy mildew and streak resistant varieties for yield response to fertilizers(organic and inorganic), and
2. Increase the rates of NPK and poultry droppings and determine the optimal rates.

Table 1: Effects of NPK 15:15:15 Compound Fertilizer and Poultry Droppings Application on the Vegetative Characters of Different Varieties of Maize

	Variety	0	100	200	300	PD	Mean	Se±
	DMSR	73.0	93.0	138.0	158.6	134.8	119.5.c	
	TZSR	114.7	134.9	147.5	165.1	142.5	140.9b	4.00
	LOCAL	147.4	163.2	182.0	205.9	190.3	177.8a	
	MEAN	111.7d	130.4c	155.8b	176.5a	155.9b		
Plant Height (CM)	SE±			5.16				
	DMSR	5.4	5.8	6.1	7.1	6.4	6.2a	
	TZSR	5.4	5.7	6.2	6.2	5.6	5.8a	0.23
	LOCAL	5.0	6.1	6.2	7.3	6.2	6.2a	
	MEAN	5.3c	5.9b	6.2b	6.9a	6.1b		
Stem Girth (CM)	SE±			0.30				
	DMSR	7.7	9.0	10.3	11.0	10.3	9.7c	
	TZSR	10.0	10.3	10.8	11.2	10.6	10.6b	0.14
	LOCAL	12.7	13.0	14.1	14.4	14.1	13.7a	
	MEAN	10.1d	10.8c	11.7b	12.2a	11.7b		
Number of Leaves	SE±			0.19				
	DMSR	221.7	284.1	359.7	432.1	447.6	349.0c	
	TZSR	317.5	531.2	541.6	597.5	541.3	505.8b	14.91
	LOCAL	399.5	530.0	609.7	613.9	617.1	554.0a	
	MEAN	312.9d	448.4c	503.7b	547.8a	535.3a		
Leaf Area	SE±		19.26					

Table 2: Effects of NPK 15:15:15 Compound Fertilizer and Poultry Droppings Application on 50% Tasseling & Silking of Different Varieties of Maize

NPK (Kg/ha) & Poultry Droppings 6 (t/ha)

50% Tasseling

Variety	0	100	200	300	PD	Mean	Se±
DMSR	68.0	62.7	62.0	60.3	62.3	63.1c	
TZSR	70.3	66.3	66.0	63.0	65.5	66.2b	0.41
LOCAL	74.3	73.3	71.7	70.0	71.3	72.1a	
MEAN	70.9a	67.4b	66.6b	64.4c	66.4b		
SE±			0.53				

50% Silking

Variety	0	100	200	300	PD	Mean	Se±
DMSR	77.7	72.3	71.1	70.7	72.0	72.8c	
TZSR	79.3	76.3	75.0	73.0	74.3	75.6b	0.42
LOCAL	87.7	84.0	82.3	79.7	82.0	83.1a	
MEAN	81.6a	77.5b	76.3c	74.5d	76.1c		
SE±			0.55				

Table 3: Effects of NPK 15:15:15 Compound Fertilizer and Poultry Droppings Application on the Component of Yield & Parameters of Different Varieties of Maize

NPK (Kg/ha) & Poultry Droppings 6 (t/ha)

100 - Grain Weight (g)

Variety	0	100	200	300	PD	Mean	Se±
DMSR	30.8	31.8	31.7	33.9	21.9	32.0a	
TZSR	30.4	31.2	30.5	32.7	32.0	31.4a	0.55
LOCAL	28.6	29.4	30.2	32.0	32.1	30.5b	
MEAN	29.9b	30.8b	30.8.b	32.9a	32.0a		
SE±			0.71				

Shelling Percentage (%)

Variety	0	100	200	300	PD	Mean	Se±
DMSR	65.1	67.3	63.3	75.6	71.1	68.5a	
TZSR	65.9	68.7	67.7	75.0	69.9	69.4a	1.39
LOCAL	67.1	67.9	68.8	73.1	72.9	69.9a	
	66.0b	68.0b	66.6b	74.6a	71.3a		
SE±			1.78				

Grain Yield (tons/ha)

Variety	0	100	200	300	PD	Mean	Se±
DMSR	3.3	4.2	4.5	5.7	4.3	4.4a	
TZSR	3.0	4.0	3.8	5.2	4.3	4.1a	0.13
LOCAL	3.0	3.3	3.8	4.2	4.3	3.7b	
MEAN	3.1d	3.8c	4.0b	5.0a	4.3b		
SE±			0.16				

Acknowledgement:

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12/09/2010