Yield and Yield Components of Maize as Influenced by Cultivars and Fertilizer Rates

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Abstract

A field trial was conducted for two years at the Research Farm of the University of Ado-Ekiti; Ado-Ekiti in the rainforest zone of the South Western Nigeria to determine the influence of cultivars and rates of NPK fertilizer on the yield and yield components of maize. Compound fertilizer (NPK 15-15-15) was applied to maize cultivars DMRESRY-Y, SUWAN-Y and DMRLSR-Y at 0, 250 and 750 kg/ha. Results showed that there were significant variations in the yield components among the maize varieties. Maize ear length was consistently longest in DMRLSR-Y followed by DMRESR-Y and shortest in SUWAN-Y while maize ear circumference of SUWAN-Y was either bigger than or similar to that of DMRLSR-Y. DMRESR-Y however, recorded the smallest value for maize ear circumference. Number of maize grains per ear was highest in DMRLSR-Y and followed by SUWAN-Y and DMRESR-Y while grain size was similar in both DMRLSR-Y and SUWAN-Y but smaller in DMRESR-Y than the other two varieties. Maize grain yield was highest in DMRLSR-Y followed by SUWAN-Y and least in DMRESR-Y. The yield and yield components of the three cultivars of maize increased with the increasing rates of NPK (15-15-15) fertilizer till 500 kg/ha after which no significant yield increase was recorded.

Key words: Maize, cultivar, fertilizer rate, yield, yield components.

Introduction

Yield which is the amount or quantity of the harvestable product of any crop is the ultimate index by which any crop plant can be evaluated for good performance and production. Yield, a measurement of fairly exact numerical quantity (Poehlman, 1959) generally varies among species or cultivars of crop plants and according to the environmental conditions to which the crops are exposed. Maize plant may not be an exception to these general characteristics of crop plants. Inspite of the general belief that yield on its own is not heritable (implicating that there is no specific gene(s) for yield), all contributory traits to yield of crop plants are heritable (Poehiman, 1959; Raven etal, 1981). Some of such traits include ear length, number of seeds per ear, seed size, seed weight, chemical constitution of seeds which are very important for the development of improved varieties of crops (Poehlman, 1959).

Studying and understanding the various traits that contribute to the yield of maize will therefore show the basis of the variations in yield among the three different maize varieties under this investigation. The low rate of 200kg/ha generally recommended for maize in the South Western Nigeria by IAR & T (1989) may be two low to elicit the highest responses of maize to fertilizer application. Applying NPK (15-15-15) fertilizer at different rates to the three maize cultivars will also show how yield and yield components of maize can be influenced by the higher rates of NPK fertilizer. There is therefore the need to examine the effects of varietal difference and rates of NPK (15-15-15) fertilizer on the yield and yield components of maize. This study attempts to determine the influence of cultivars and rates of NPK (15-15-15) fertilizer on the yield and yield components of maize in order to identify the basis of yield differences or variations among the three cultivars of maize under investigation.

Materials and Methods

Investigations to determine the effects of rates of NPK (15-15-15) fertilizer on the yield and yield components of three cultivars of maize were carried out at the Research Farm of the University of Ado-Ekiti, Ado-Ekiti, Ekiti State in the rainforest zone of the South Western Nigeria from 2004 to 2005. Precopping surface (0-15cm) soil samples were taken and analyzed for physical and chemical properties using the standard Laboratory procedures (11TA, 1982). Maize cultivars used for the study were DMRESR-Y, SUWAN-Y and DMRLSR-Y which are yellow seeded in colour and also downey mildew and streak resistant were purchased from the Institute of Agricultural Research and Training (IAR & T), Moor Plantation, Ibadan while the NPK (15-15-15) fertilizer rates applied were 0, 250, 500 and 750 kg/ha representing 0, 37.50, 75.00 and 90.00kg/ha of each N, P_20^5 and K_20, respectively. The twelve treatments evolving from the combination of the three maize cultivars and four fertilizer levels were assigned to the various plots using randomized complete block (RCB) design with four replications. Plot size was 2.0 x 3.0m. Maize was plated at four seeds per hole/stand in June 2004 and May 2005 at the spacing of 0.50 x 0.75m and later thinned down to two plants per stand to give a plant population of 53,000 plants per hectare. Application of fertilizer was carried out immediately after the first weeding operation at 3 weeks after planting (WAP). Two subsequent weeding operations through hand weeding by hoeing were carried out in both years of study to keep weed growth in check.

Maize ears were harvested at maturity and dried to moisture content level of 15.5%. Samples of five ears per plot were randomly selected to obtain various data on yield components of maize. Maize ear length and circumference were measured with the use of linen tape rule while the weights of grains and cob per plant were taken with the aid of weighing balance. Number of seeds per ear was determined by physical counting of the shelled maize grains per ear per plot. Maize seed size was determined by finding the product of length and breadth measurements of the grains per row taken from the butt, middle portion and the tip of the ear. The resultant product from the multiplication of length and breadth measurements of maize grain was further multiplied with the correction factor of 0.75 to get the accurate size of the maize grains. Data were subjected to analysis of variance and means separated using Duncans Multiple Range Test (DMRT) at 5% level of probability.

Table 1: Physicochemical properties of the soil in the experimental site

Soil properties	Mean values
Soil pH (H_20)	6.50
% Organic carbon	0.97
% Total N	0.11
Available P (Bray P-1) (mg/Kg)	9.50
Exchangeable K (cmol/Kg)	0.37
Exchangeable Ca (cmol/Kg)	2.42
Exchangeable Mg (cmol/Kg)	0.90
% sand	71.21
% silt	12.20
% clay	8.59

Results

Table 1 shows the physicochemical properties of the soil on the experimental site at the beginning of the experiment. The physical properties and soil nutrient status ranged from low to medium. Maize ear length took the same trend in both years of study while there was variation in the pattern of ear circumference within the two years of experimentation (Table 2). Maize ear length was significantly highest in DMRLSR-Y followed by DMRESR-Y and shortest in SUWAN-Y in both years of study. Maize ear circumference or thickness was similar in DMRLSR-Y and SUWAN-Y and were both significantly thicker than that of DMRESR-Y in 2004 but varied in 2005 in which maize ear circumference was larger in SUWAN-Y than DMRLSR-Y while that of DMRLSR-Y was also significantly thicker than that of DMRESR-Y. Maize ear length and circumference increased with the increasing rates of NPK (15-15-15) fertilizer up till 500 kg/ha after which it leveled out except in 2005 when ear length increased linearly

Table 2: Maize ear length (cm) and circumference (cm) under the different maize cultivars and NPK (15-15-15) fertilizer rates in 2004 and 2005

Yield	Maize	NPK (15-15-15) fertilizer rates (Kg/ ha)									
Components	Cultivars	2004					2005				
		0	250	500	750	Mean	0	250	500	750	Mean
	DMRESR-Y	12.00	13.00	16.00	16.50	14.38b	12.75	13.50	16.75	17.17	15.04b
	SUWAN-Y	11.00	13.65	14.55	14.80	13.50C	11.38	14.13	15.00	15.25	13.54c
Ear length	DMRLSR-Y	14.00	14.50	16.00	17.00	15.38a	13.83	14.75	17.00	18.50	16.02a
(cm)	Mean	12.33c	13.72b	15.52a	16.10a		13.25d	14.09c	14.84b	14.88a	
.	S.E.					0.28					0.18
	C.V. (%)					4.96					3.91
	DMRESR-Y	11.45	12.50	13.50	14.00	12.86b	11.83	13.00	14.13	14.75	13.43c
	SUWAN-Y	14.06	14.67	14.80	14.80	14.57a	14.44	15.13	15.25	15.00	14.96a
Ear	DMRLSR-Y	13.00	13.75	14.75	14.80	14.08a	13.50	14.13	15.13	14.90	14.42b
Circumference	Mean	12.82c	13.64bc	14.35ab	14.53a		13.26c	14.09b	14.84a	14.88a	
(cm)	S.E.										
	C.V. (%)					0.21					0.30
						7.35					4.12

Maize grain and cob weights per plant under the different maize cultivars and NPK (15-15-15) fertilizer rates are presented in Table 3. Maize grain weight was highest in DMRLSR-Y and followed by SUWAN-Y and DMRESR-Y in the two experimental years. Cob weight was also highest in DMRLSR-Y followed by SUWAN-Y and lowest in DMRESR-Y in 2004 while it was similar in DMRLSR-Y and SUWAN-Y but lower in DMRESR-Y than DMRLSR-Y and SUWAN-Y in 2005. Maize grain weight and cob weight increased with NPK fertilizer rates up till 500kg/ha and thereafter stabilized in 2004 while these parameters increased linearly with the increasing rates of NPK (15-15-15) fertilizer in 2005.

Table 4 also shows the number of seeds per ear and grain (seed) size under the different maize cultivars and NPK (15-15-15) fertilizer rates.

Number of seeds per ear/plant followed the same trend in both years of study. There were variations among the maize cultivars with DMRLSR-Y having the highest number of grains per ear followed by SUWAN-Y and lowest in DMRESR-Y. Number of maize seeds per ear increased linearly with the increasing rates of NPK

(15-15-15) fertilizer while the size of maize grain increased with the increasing rates of fertilizer up till 500 kg/ha and thereafter formed a plateaux.

Table 5 shows grain yield as affected by the different maize cultivars and NPK (15-15-15) fertilizer levels. Grain yield varied significantly among the three cultivars with DMRLSR-Y recording the highest yield per hectare and followed by SUWAN-Y and DMRESR-Y.

Maize grain yield also increased with the increasing rates of NPK (15-15-15) fertilizer up till 500 kg/ha beyond which it leveled out.

Discussion

Yield components (ear length and circumference, grain weight and cob weight per plant, number of grains per ear and grain size) of maize differed in DMRESR-Y, SUWAN and DMRLSR-Y because of the variations in the genetic components among the three cultivars. Inspite of the general believe that yield on its own is not heritable, traits that constitute yield are heritable (poehlman, 1959,' Ravene, 1981). This therefore explains the variations that exist between maize cultivars DMRESR-Y, SUWAN-Y and DMRLSR-Y in the various yield components investigated in this study. The result here agrees with the observation of Poehiman (1959) who noted that heredity plays important roles in the impartation of variations in the quantitative and qualitative features/characteristics exhibited by individual varieties of crop plants. Such plant characteristics include growth parameters (height, stem girth, leaf area production), plant chemical constitution, seed colour, seed size, seed weight, number of seeds per ear per plant. Among all these plant characteristics, yield components (seed size, seed weight and number of seeds per ear/plant) are about the most important because they form the basis for crop plant yield which is always the final variable or attribute used in evaluating any crop plant. Similar results showing the importance of yield components in the overall yield of other plants and crops have been demonstrated by other workers. Seken et al.,(2004) in explaining relationship between seed yield and some morphological traits in smooth brome grass found that seed yield was significantly correlated with yield components like seeds per panicle, seed weight per panicle and seeds per m2. There were also cultivar differences in the effects of sowing date and nitrogen rate on the yield and yield components of two summer rap seed cultivars (Ozer, 2003). Vera etal. (2004), May etal (2004) and Taylor etal (2005) also recorded cultivar variations in the response of hemp, oat and soybean to the various treatments investigated.

Table 3: Maize grain and cob weights (g) under the different maize cultivars and NPK (15-15-15) fertilizer rates in 2004 and 2005

Yield Components	Maize Cultivars	NPK(15-15-15) fertilizer rates (Kg/ ha) 2004					2005				
		0	250	500	750	Mean	0	250	500	750	Mean
Grain Weight (g/ plant)	DMRESR-Y	45.0	65.0	85.0	90.0	71.3c	50.3	68.8	91.9	101.3	78.1c
	SUWAN-Y	55.0	80.0	95.0	100.0	82.5b	56.9	75.4	101.3	106.9	85.1b
	DMRLSR-Y	66.0	90.0	105.0	105.0	91.5a	61.9	83.8	110.6	107.8a	92.9a
	Means	55.3c	78.3b	95.0a	98.3a		56.4c	75.9c	101.3b	107.8a	
	S.E.					2.96					3.16
	C.V. (%)					10.46					4.15
Cob weight (g/ plant)	DMRESR-Y	6.69	8.45	10.5	10.6	9.05c	7.82	8.93	15.1	14.4	11.6b
	SUWAN-Y	8.95	12.5	12.9	12.9	11.85b	10.1	13.40	16.9	14.2	13.6a
	DMRLSR-Y	10.3	13.8	14.3	14.3	13.17a	10.1	13.40	15.0	16.3	13.7a
	Mean	8.7c	11.6b	12.6a	12.6a		9.3d	11.91c	14.9b	15.6a	
	S.E.					0.35					0.42
	C.V. (%)					4.79					4.20

Yield and yield components of maize also increased with the increasing rates of NPK (15-15-15) fertilizer because maize yield to which these traits are components followed the trend of the vegetative growth and dry matter yield of maize from which maize grains were eventually formed. Earlier report on this study has shown that maize grain .yield follows the pattern of vegetative growth which subsequently forms the dry matter from where maize grain is eventually formed (Adeyemi, 2009). Results obtained here are in consonance with the findings of Jolaoso, (1987), Adeyemi (1991), Adediran and Banjoko (2003) and Banjoko and Adediran (2003) that showed that maize yield increased with the increasing rates of fertilizer. Results from other crops have also indicated seed yield increase due to the increasing rates of fertilizer. Seed yield in two rap seed cultivars was found to increase with the increasing application rate of N up till 80kg/ha after which it stabilized (Ozer 2004). May et al (2004), Vera etal (2004) and Taylor etal (2005) in separate studies have also reported that seed yield increased with the increasing rates of fertilizer in oat, hemp and Soyabean respectively, May (2005) further reported that panicles per plant accounted for the most of the yield increases achieved from the increasing rates of N.

Conclusion

Results from this trial have revealed that yield and yield components of maize can be influenced by the types of cultivars grown. Consequently, maize ear length and circumference, grain and cob weights, grain size and number per ear performed differently among the DMRLSR-Y, SUWAN-Y and DMRESR-Y maize cultivars used. Specifically cultivars DMRLSR-Y recorded higher variations in ear length, grain weight per plant and number of seeds per ear than SUWAN-Y and DMRESR-Y and which could also result in its consequent higher grain yield than the other two cultivars. Similarly, yield and yield components of DMRLSR-Y, SUWAN and DMRESR-Y maize cultivars can be improved, with the application of NPK (15-15-15) fertilizer up to 500kg/ha beyond which it may not be economical to do so.

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