



EVALUATION OF FIVE MAIZE GENOTYPES (*Zea mays* L.) FOR MORPHOLOGICAL CHARACTERISTICS AND YIELD IN UYO, SOUTH EASTERN NIGERIA

Iorshe, Orsar Isaac

Department of Crop Science, University of Uyo, P.M.B 1017, Akwa Ibom State, Nigeria

Corresponding Author's E-mail: iorsheorsar@gmail.com **Tel.:** +2349027172010

ABSTRACT

A field experiment was conducted at the University of Uyo Teaching and Research Farm in the early cropping season of 2021 to evaluate the morphological characteristics and yield of five maize genotypes in Uyo. The experiment was laid down in a randomized completely block design (RCBD) with three (3) replicates. The experimental materials were five (5) maize genotypes: SC-510, Oba Super – 4, Oba Super – 6, Honey King F₁ (sweetcorn) and Ikom White (local control). The parameters evaluated were, emergence percentage at 1 week after sowing (WAS), plant height (cm), number of leaves, leaf area (cm²), stem girth (cm), number of days to first tassel emergence, number of days to 50% tasselling, number of days to first silking, number of days to 50% silking, number of days to harvest maturity, cob weight (g), cob length (cm), cob circumference (cm), number of rows per cob, number of grains per row, weight of 1,000 grains (g) and grain yield (tha⁻¹). Results showed plant height, leaf area, number of leaves, stem girth varied significantly ($p < 0.05$) at 2, 4, 6, 8, and 10 weeks after sowing. Similarly, significant differences ($p < 0.05$) were obtained in yield components and grain yield such as days to harvest maturity, cob weight, cob length, cob circumference, weight of 1,000 grains and grain yield. This study concluded that Oba Super – 6 showed superior grain yield with SC-510 and Ikom White producing the least grain yield. Honey King F₁ was an early maturity hybrid, SC-510 was medium maturity and Oba Super - 4 and Oba Super - 6 were late maturity genotypes. Based on the result of this study, further evaluation involving Oba Super - 6 and Oba Super - 4 genotypes which performed significantly better compared with other varieties is recommended in the environment.

Keywords: Evaluation, Maize genotypes, Morphological characters, and Yield

INTRODUCTION

Maize (*Zea mays* L., $2n=20$) is an important cereal crop belonging to the tribe *Maydeae*, of the grass family, *Poaceae*, Genus *Zea*, Species *mays*, multitudes of maize sub-species are identified and classified depending upon the extent of starch each have (Piperno and Flannery, 2001). The primary centre of origin of maize is considered by most authorities to be Mexico in Central America where many diverse types of maize are found and was introduced into Europe and Africa in the 16th century by Portuguese explorers (Future Harvest, 2004). Maize is one of the most important grains in Nigeria, based area of cultivation and its economic value. Maize is the third most produced food crop in Nigeria after cassava and yam (FAOSTAT, 2015) and may be consumed roasted, baked, fried, pounded or fermented and milled into starch. Maize is a major component of livestock feed especially for poultry, cattle and pigs as it supplies them energy (Udoh & Ndon, 2016). Despite the increased area of land under cultivation of maize since the mid- 2000s, the production per hectare is still low (1.3 t/ha) compared to 8.6t/ha in developed countries (IITA, 2012). However, the yield of maize in recent years has increased significantly due to several breeding programmes against pests and diseases (Iken & Amusa, 2004). Hybrids usually have higher yields and are more resistant to



pest and diseases, and some mature early and could be intercropped (Udoh & Ndon, 2016). In order to adopt a crop variety, its growth as well as the yield potential in the target environment should be evaluated; hence, the objectives of this work were to:

Assess the morphological characteristics of the maize genotypes and identify those with superior yields and other agronomic traits for production of hybrid varieties for farmers in Uyo, and incorporation into breeding programmes.

MATERIALS AND METHODS

The experiment was conducted at the University of Uyo Teaching and Research Farm, Uyo during the early cropping season of 2021. Uyo is situated between latitudes $5^{\circ}17'$ and $5^{\circ}17'N$ and along longitudes $7^{\circ}27'$ and $7^{\circ}58'E$ and altitude, 38.1m above sea level (Umoh *et al.*, 2013). Uyo is located in the rainforest zone which receives about 2500 mm rainfall annually. The rainfall pattern is bimodal, with long (March - July) and short (September – November) rainy seasons and separated by a short dry spell of uncertain length, usually during the month of August “August Break” (Umoh *et al.*, 2013). The mean relative humidity ranges from 78% - 85%, atmospheric temperature of $25^{\circ}C$ - $30^{\circ}C$ and mean sunshine hour of 10 - 12 hours (Umoh *et al.*, 2013).

Soil samples were collected at two soil depths (0-15 cm and 15-30 cm) using soil auger before planting for the determination of physical and chemical properties at the Agronomy Laboratory of University of Uyo. The soil samples were put in polyethylene bags, labelled and taken to the laboratory for analysis. The soil samples were air dried in the laboratory, crushed and sieved through a 2.0 mm mesh labelled and stored for physical and chemical analysis. Soil pH was determined in water (1:2 / soil - water ratio) using pH metre electrode. Total nitrogen was determined by micro-kjeldahl digestion and distillation method. Organic matter was determined by the dichromate wet oxidation method of Walkey and Black (1934). Available P was determined by Bray-I method (Bray and Kurtz, 1945). Calcium and magnesium was determined in the extracts of EDTA titration of Jackson (1962) while potassium (K) and sodium (N) were determined by the use of flame photometer.

Experimental Design

The entire experimental site which measured 17.0 m x 19.0 m (323 m²) was laid out in a randomized complete block design (RCDB) and replicated three times. The three replicates consisted of 15 plots each. Each plot measured 5.0 m x 3.0 m (15 m²) and was separated from one another with 1.0 m paths. Replicate were separated from one another with 1.0 m paths. Five (5) maize genotypes; SC-510, Oba Super – 4, Oba Super – 6, Honey King F₁ (sweetcorn) and Ikom White (local control) were obtained from, Seedco Nigeria Ltd, Kaduna State, Premier Seed Nigeria Ltd, Zaria, Kaduna State while Ikom White was obtained from a local farmer. The experimental field was manually cleared using machete, tilled and ploughed with spade and divided into blocks. Maize seeds were sown 2 seeds per hole at a depth of 2-3 cm at the spacing of 75 cm x 25 cm, and were later thinned to 1 plant per stand at 2 week after sowing. Weeds were controlled manually at 2 WAS and 6 WAS.

Inorganic fertilizer (NPK 15:15:15) was applied in split doses at the rates of 400 kg/ha, firstly to the topsoil within the root horizon at 5cm away from the plants using ring method at 2 weeks after sowing (WAS), while second dose of Urea was applied at the rate of 100 kgN/ha at 6 WAS. Iron force (a. i: Profenofos 40% and Cypermethrin 4% EC) was sprayed at the rate of 500 ml/ha at 2, 4, 6, 8 and 10 WAS to prevent infestation of army worm.

Data Collection

Data were collected on emergence percentage at 1 week after sowing (WAS) while plant height (cm), number of leaves, leaf area (cm²), stem girth (cm) were determined at 2, 4,

6, 8 and 10 weeks after sowing. Also, number of days to first tassel emergence, number of days to 50% tasselling, number of days to first silking, number of days to 50% silking, number of days to harvest maturity, cob weight (g), cob length (cm), cob circumference (cm), number of rows per cob, number of grains per row, weight of 1,000 grains (g) and grain yield (tha^{-1}).

Data Analysis

One way analysis of variance (ANOVA) was conducted following the procedure of Steel and Torrie (1980) and means separated with Duncan's multiple range test (DMRT) at 5% (0.05) probability level using SPSS computer software program.

RESULTS

Table 1: Physical and chemical Properties of the Soil of the Experimental Site

Properties	Soil Depth (cm)	
	0-15	15-30
Particle Size Analysis		
Sand (%)	80.18	78.78
Silt (%)	9.28	5.10
Clay (%)	10.54	16.12
Textural Class	Loamy Sand	Loamy Sand
Ph	5.24	5.33
EC (ds/m)	0.15	0.11
Organic carbon (%)	2.88	3.19
Organic Matter (%)	4.98	5.52
Total Nitrogen (%)	0.12	0.14
Avail. Phosphorus (mg/kg)	48.69	45.53
Basic Cations		
K (Cmol/kg)	0.14	0.22
Ca (Cmol/kg)	2.80	2.60
Na (Cmol/kg)	0.30	0.19
Mg (Cmol/kg)	1.60	1.10
Exchange Acidity (Cmol/kg)	5.40	5.84
ECEC (Cmol/kg)	10.24	9.95
Base Saturation (%)	47.3	41.3

The soil analysis showed that the soil was acidic with pH value of 5.24 and 5.33 at 0-15 cm and 15-30 cm, respectively (Table 1). The organic carbon was low (2.88% and 3.19% respectively) while available P (mg/kg) was 48.69 and 45.53 at 0-15 cm and 15-30 cm, respectively). The percentage nitrogen was below 0.20% recommended by Udoh & Ndon, (2016). The exchangeable bases (Ca, Mg, Na and K) were also low. The exchangeable K was below 175 kg/ha recommended by Udoh & Ndon, (2016). The particle size analysis indicated high proportion of sand (80.18% and 78.78% at 0-15 cm and 15-30 cm depth, respectively) followed by clay portion of 10.54% and 16.12% at 0-15 cm and 15-30 cm depth, respectively and the particle size analysis revealed that the experimental site was loamy sand.

Table 2: Emergence percentage (%) and Maize Height (cm) as influenced by Maize Genotypes

Maize Genotypes	Emergence (%)	Weeks After Sowing (WAS)				
		2	4	6	8	10
Honey King F ₁	87.29	18.61 ^a	51.94	138.05	167.77 ^b	169.89 ^c
Ikom White	84.12	13.44 ^b	41.78	122.50	199.05 ^a	213.55 ^{ab}
Oba Super – 4	94.44	14.99 ^{ab}	42.66	125.33	216.77 ^a	226.33 ^a
Oba Super – 6	88.09	16.39 ^{ab}	46.39	130.89	209.94 ^a	223.33 ^a
SC-510	92.85	15.77 ^{ab}	45.22	111.99	194.16 ^a	204.94 ^b

Means with the same letter(s) under the same column are not significantly different ($P < 0.05$) using Duncan Multiple Range Test (DMRT)

Significant differences ($p < 0.05$) were observed in maize height at 2, 8 and 10 weeks after sowing (WAS) (Table 2). Oba Super – 4 produced the tallest plant (14.99 cm, 216.77 cm and 226.33 cm at 2, 8 and 10 WAS respectively), followed by Oba Super – 6 with 16.39 cm, 209.94 cm and 223.33 cm respectively while the shortest plants (18.61 cm, 167.77 cm and 169.89 cm respectively) were obtained from the Honey King F₁ hybrid.

However, no significant differences ($p > 0.05$) were observed in maize emergence percentage and plant height among the maize genotypes at 4 and 6 WAS.

Table 3: Leaf Area (cm²) as Influenced by Maize Genotypes

Maize Genotypes	Weeks After Sowing (WAS)				
	2	4	6	8	10
Honey King F ₁	50.77 ^a	281.51	485.41	534.29 ^b	502.16 ^b
Ikom White	26.87 ^b	234.12	563.54	613.51 ^{ab}	628.71 ^a
Oba Super – 4	36.75 ^b	272.12	589.04	683.29 ^a	662.54 ^a
Oba Super – 6	39.02 ^{ab}	220.23	583.98	678.82 ^a	693.75 ^a
SC-510	31.54 ^b	231.79	528.54	624.42 ^{ab}	613.21 ^a

Means with the same letter(s) under the same column are not significantly different ($P < 0.05$) using Duncan Multiple Range Test (DMRT)

Table 4: Stem Girth (cm) as Influenced by Maize Genotypes

Maize Genotypes	Weeks After Sowing (WAS)				
	2	4	6	8	10
Honey King F ₁	2.44 ^a	7.05	8.28	7.55 ^b	6.05 ^b
Ikom White	1.83 ^b	6.05	8.55	8.11 ^{ab}	6.89 ^a
Oba Super – 4	2.27 ^a	6.38	9.22	8.66 ^a	6.99 ^a
Oba Super – 6	2.30 ^a	6.49	8.94	8.33 ^a	7.66 ^a
SC-510	2.27 ^a	6.11	9.16	8.77 ^a	7.61 ^a

Means with the same letter(s) under the same column are not significantly different ($P < 0.05$) using Duncan Multiple Range Test (DMRT)

Table 5: Number of Leaves per Plant as Influenced by Maize Genotypes

Maize Genotypes	Weeks After Sowing (WAS)				
	2	4	6	8	10
Honey King F ₁	5.61	10.89	11.61 ^d	10.72 ^b	7.66 ^c
Ikom White	5.27	9.66	13.44 ^{bc}	13.61 ^a	11.44 ^b
Oba Super – 4	5.44	10.05	14.61 ^a	13.89 ^a	12.66 ^a
Oba Super – 6	5.55	10.55	14.49 ^{ab}	14.72 ^a	12.99 ^a
SC-510	5.28	9.94	13.33 ^c	14.22 ^a	12.22 ^{ab}

Means with the same letter(s) under the same column are not significantly different ($P < 0.05$) using Duncan Multiple Range Test (DMRT)

Leaf area of maize as influenced by genotypes differed significantly ($P < 0.05$) at 2, 8 and 10 WAP (Table 3). Oba Super – 6 produced the highest leaf area (39.02 cm², 678.82 cm² and 693.75 cm² at 2, 8 and 10 WAP, respectively). This was followed by 36.75 cm², 683.29 cm² and 662.54 cm² respectively from Oba Super – 4 while Honey King F₁ hybrid produced the smallest leaf area (50.77 cm², 534.29 cm² and 502.16 cm² at 2, 8 and 10 WAP, respectively). Significant differences ($p < 0.05$) were observed on maize stem girth at 2, 8 and 10 WAS (Table 3). On the average, SC-510 recorded the largest stem girth of 2.27 cm, 8.77 cm and 7.61 cm at 2, 8 and 10 WAP, respectively followed by Oba super – 6 which had 2.30 cm, 8.33 cm and 7.66 cm at 2, 8 and 10 WAS, respectively while the smallest stem girth was from Honey King F₁ (2.44 cm, 7.55 cm and 6.05 cm at 2, 8 and 10 WAS, respectively). There was no significant difference ($P > 0.05$) in leaf area and stem girth among genotypes at 4 and 6 WAS but a reduction in stem girth at 10 WAS among maize genotypes. Number of functional leaves per plant as influenced by maize genotypes differed significantly ($P < 0.05$) at 6, 8 and 10 WAS (Table 3). Oba Super – 6 had the highest number of leaves (14.49, 14.72 and 12.99 at 6, 8 and 10 WAS, respectively), followed by Oba Super – 4 with 14.61, 13.89 and 12.66 at 6, 8 and 10 WAS, respectively, while the lowest number of leaves was observed in Honey King F₁ hybrid (11.61, 10.72 and 7.66 at 6, 8 and 10 WAS, respectively). Similarly, no significant difference ($p > 0.05$) in number of leaves were observed in maize genotypes at 2 and 4 WAS. Also, at 10 WAS, there was a reduction in the number of leaves of all the maize genotypes.

Table 6: Days to First Tassel Emergence, Days to 50% Tasselling, Days to First Silking and Days to 50% Silking as influenced by Maize Genotypes

Maize Genotypes	Days to 1 st Tassel Emergence	Days to 50% Tasselling	Days to 1 st Silking	Days to 50% Silking
Honey King F ₁	36.00 ^b	38.00 ^b	40.00 ^b	43.00 ^b
Ikom White	42.00 ^{ab}	48.00 ^a	47.00 ^{ab}	51.00 ^a
Oba Super – 4	45.00 ^a	52.00 ^a	49.00 ^a	55.00 ^a
Oba Super – 6	46.00 ^a	54.00 ^a	51.00 ^a	57.00 ^a
SC-510	43.00 ^{ab}	50.00 ^a	48.00 ^{ab}	53.00 ^a

Means with the same letter(s) under the same column are not significantly different ($P < 0.05$) using Duncan Multiple Range Test (DMRT)

The period it takes to tassel varied significantly ($P < 0.05$) across the maize genotypes (Table 4). However, Honey King F₁ hybrid recorded the shortest period to tassel (36.00 days), followed by Ikom White 42.00 days. The longest period to tassel (46.00 days) was Oba Super – 6.



The days to 50% tasselling also differed significantly ($p < 0.05$) among the maize genotypes (Table 4). However, days to 50% tasselling ranged from Honey King F₁ (38.00 days) to Ikom White (48.00 days). The longest period to 50% tasselling (54.00 days) was recorded on Oba Super – 6.

Similarly, there were significant differences ($p < 0.05$) for days to first silking (Table 4) and ranged between 40 days to 51 days. The genotype Honey King F₁ produced silks at the lowest mean days in 40.00 days, followed by Ikom White (47.00 days) while the highest mean days to first silking 51.00 days was exhibited by Oba Super – 6.

Significant difference ($p < 0.05$) was also observed for number of days to 50% silking (Table 4) and ranged between 43 days to 57 days. Honey King F₁ produced silks at the lowest days in (43.00 days), followed by Ikom white (51.00 days) and while highest mean days to 50% silking (57.00 days) was exhibited by Oba Super – 6.

Table 7: Yield Parameters of Cobs, Yield Components and Grain Yield of Maize as Influence by Maize Genotypes

Maize Genotypes	Cob Weight(g)	Cob Length(cm)	Cob Circumference(cm)
Honey King F ₁	242.11 ^a	21.05 ^a	14.89 ^{abc}
Ikom White	183.83 ^b	18.55 ^c	14.33 ^{bc}
Oba Super – 4	237.72 ^a	19.99 ^b	15.05 ^{ab}
Oba Super – 6	261.28 ^a	21.39 ^a	15.27 ^a
SC-510	182.72 ^b	18.05 ^c	14.27 ^c

Means with the same letter(s) under the same column are not significantly different ($P < 0.05$) using Duncan Multiple Range Test (DMRT)

Table 8: Yield Components and Grain Yield of Maize as Influence by Maize Genotypes

Maize Genotypes	No. of rows / Cob	No. of grains / row	Weight of 1000 grains	Grain yield (tha⁻¹)	Days to Maturity
Honey King F ₁	14.77 ^{ab}	34.16 ^{ab}	256.00 ^{ab}	0.997.00 ^a	60.00 ^d
Ikom White	13.49 ^{bc}	31.44 ^b	230.00 ^b	0.753.00 ^c	65.00 ^{cd}
Oba Super – 4	14.49 ^{ab}	35.33 ^a	261.00 ^a	1.003.00 ^a	75.00 ^{ab}
Oba Super – 6	15.27 ^a	36.94 ^a	277.00 ^a	1.078.00 ^a	80.00 ^a
SC-510	12.72 ^c	35.94 ^a	254.00 ^{ab}	0.888.00 ^b	70.00 ^{bc}

Means with the same letter(s) under the same column are not significantly different ($P < 0.05$).
LSD – Least Signature Difference

Cob weight of the five maize genotypes showed significant differences ($P < 0.05$) with Oba Super – 6 producing cobs with weight of 261.28 g followed by Honey King F₁ with 242.11 g while SC-510 produced the least cob weight (189.72 g). Also, cob length of the maize genotypes showed significant differences ($p < 0.05$) with Oba Super – 6 producing the highest cob length, (21.39 cm) followed by Honey King F₁ with 21.05 cm while the least had the cob length of (18.05 cm) was produced by SC-510. Similar trend was observed in cob circumference of maize genotypes. Oba Super – 6 produced the highest cob circumference of (15.27 cm) followed Honey King F₁ with (15.05 cm) while SC-510 produced the least cob circumference (14.27 cm), (Table 5).

Days to harvest maturity (Table 5) as influenced by maize genotypes varied significantly ($p < 0.05$). Honey King F₁ matured earlier than other maize genotypes (60.00 days),



followed by Ikom White (65.00 days) while Oba Super – 6 (80.00 days) was late maturing type.

Number of rows per cob of maize genotypes showed significant differences ($p < 0.05$). Oba Super – 6 produced the highest number of rows per cob (15.27) followed by Honey King F₁ with 14.77 number of rows per cob while SC-510 produced the least number of rows per cob (12.72), (Table 5).

Number of grains per row were significantly different ($p < 0.05$) (Table 5) among the maize genotypes with Oba Super – 6 and SC-510 producing 36.94 and 35.94 grains per row, respectively while Ikom White produced 31.44 grains per row which was the least.

Weight of 1,000 grains as influence by maize genotypes was significantly different ($p < 0.05$). Oba Super – 6 produced 1,000 grain weight of 277.00 g followed by Oba Super – 4 with 261.00 g while the least grain weight was Ikom White with 230.00 g (Table 5).

Maize grain yield differed significantly ($P < 0.05$). Oba Super – 6 produced the highest grain yield (1.078 tha^{-1}) followed by Oba Super – 4 with 1.003 tha^{-1} while Ikom White produced the least grain yield per hectare (0.753 tha^{-1}).

DISCUSSION

The differences in emergence percentage recorded at one week after sowing (WAS) agrees with the earlier reports on maize by Prasanna *et al.*, (2001). Plant height of the five maize genotypes differed significantly; this is similar to the findings of Majambu *et al.*, (1996) who attributed the difference in plant height of crops to genetic contributions. Similarly, the differences in the number of leaves of the five maize genotypes was similar to the findings of Sajjan *et al.*, (2002) who also attributes it to the genetic contributions of the genotypes. Similarly, significant differences observed for leaf area were in tandem with the findings of Tollenaar and Lee (2006) who confirmed that leaf areas of maize varieties tends to differ due to genetic factor rather than environment. Other characteristics exhibited significant differences among the maize genotypes; for instance, Obi (1999), Kim (1995) and Olakojo *et al.*, (1998) reported differences in stem girth while Ahmed (2013) reported differences in phenological characteristics. The significant differences ($p < 0.05$) for fresh cob weight, cob length and cob circumference were considered important yield components which could contribute to grain yield. This result agrees with (Eleweanya *et al.*, 2005; Henfy, 2011). Some maize genotypes matured earlier than others. According to Enujoke (2013) earliness in maize is mostly used for screening genotypes for tolerance to stresses especially for drought resistance. Rani *et al* (2017) identified that a significantly higher grain yield observed in the hybrids could be attributed to the significantly higher 1,000 grain weight, number of grains per row, cob weight, cob circumference and plant height are useful characteristics in maize breeding programmes.

CONCLUSION AND RECOMMENDATIONS

Some maize genotypes were superior in grain yield (tha^{-1}) compared to the local genotype, for example, Oba Super – 6 was confirmed as a high yielding genotype, followed by Oba Super – 4, Honey King F₁ (sweetcorn), SC-510 and Ikom White produced the least grain yield. Honey King F₁ (sweetcorn) was the early maturity hybrid, SC-510 was medium maturity while Oba Super – 4 and Oba Super – 6 were late maturing genotypes.

Based on the findings, farmers in Uyo should adopt Oba Super – 6 for high grain yield and resistance to a wide range of biotic and abiotic stresses. Also, Honey King F₁ (sweetcorn) and SC-510 hybrids which were rated early maturing genotypes could be re-evaluated and if confirmed, may be recommended for the farmers.



REFERENCES

- Ahmed, S. (2013). Study on genetic diversity in maize (*Zea mays* L.) inbred lines for the development of hybrids, PhD Thesis, Department of Genetics and Plant Breeding, Bangladesh Agricultural University, Bangladesh.
- Bray, R. H. and Kurtz, L. T. (1945). Determination of Total, Organic and Available Forms of Phosphorus in Soils. *Soil Science*, **59**: 39 – 45.
- Eleweanya, N. P., Uguru, M. I., Eneobong, E. E. and Okocha, P. I. (2005). Correlation and path coefficient analysis of grain yield related characters in maize (*Zea mays* L.) under Umudike conditions of South Eastern Nigeria. *Academic Research Journal of Agricultural Science and Research*, **5**(1): 1 – 9.
- Enujeke, E. C. (2013). Effects of Variety and Spacing on Growth Characters of Hybrid Maize. *Asian Journal of Agriculture and Rural Development*, **3**(5): 296-310.
- FAOSTAT, (2015). Food and Agricultural Organisation of the United Nation. FAOSTAT Database available online, <http://faostat.fao.org/site/567/default.aspx>. accessed
- Future Harvest, (2004). 35 years in the making high protein, high yielding corn to prevent malnutrition among millions. www.futureharvest.org
- Henfy, M. (2011). Genetic parameters and path analysis of yield and its components in corn inbred lines (*Zea mays* L.) at different sowing dates. *Asian Journal of Crop Science*, **3**(3): 106-117.
- IITA (International Institute for Tropical Agriculture). (2012). Hybrids-Maize-Farming-In-Nigeria-Time-To-Start-Your-Planting-For-This-Season. <http://www.naijafinder.com/threads/4870>
- Iken, J. E. and Amusa, N. A., (2004). Maize Research and Production in Nigeria. *African Journal of Biotechnology*, **3**(6): 302-307.
- Jackson, M. (1962). Soil Chemical Analysis. Prentice Hall Inc. Eaglewood Cliffs, New Jersey. Pp 219 – 221.
- Kim, S. K. (1995). Achievement, challenges and future direction of hybrid maize research and production in West and Central Africa. In Proceedings of a Regional Maize Workshop, 29th May – 2nd June, 1995. IITA, Cotonou, Benin Republic. Pp.42-82
- Majambu, I. S., Ogunlella, V. B. and Ahmed, M. K. (1996). Responses of Two Okro (*Abelmoschus esculentus* (L) Moench) varieties to fertilizer growth and nutrient concentration as influenced by nitrogen and phosphorus applications. *Fertilizer Research*, **8**(3): 297-306.
- Obi, I. U. (1999). Effect of nitrogen Rates and Intra – Row Spacing on Local maize (*Zea mays*) in Southern Guinea Savannah Zone of Nigeria. *Journal of Sustainable Agriculture and Environment*, **5**(1): 147-152.
- Olakojo, S. A., Ogundodede, B. A. and Kogbe J. O. S. (1998). Evaluation of Maize (*Zea mays* L.) Top crosses in a Rainforest Location. *Biose res. Comm.*, **11**(2): 141-146.
- Piperno, D. R. and Flannery, K. V. (2001). The earliest archaeological maize (*Zea mays* L.) from highland Mexico: new acceleration mass spectrometry dates and their implications. *Proceedings of national academy of sciences*, **98**: 2101-2103.
- Prasanna, B. M., Vasal, S. K., Kassahum, B. and Singh, N. N. (2001). Quality protein maize. *Current Science*, **81**: 1308-1319.
- Rani, G. U., Rao, V. S., Ahmad, M. L. and Rao, K. L. N. (2017). Character association and path coefficient analysis of grain yield and yield components in maize (*Zea mays* L.). *International Journal of Current Microbiology and Applied Sciences*, **6**(12): 4044-4050.



- Sajjan A. S., Shekhargounda, M. and Badanur (2002). Influence of data of sowing, spacing and levels of nitrogen on yield attributes and seed yield of Okro. *Ikamataka Journal of Agricultural Science*, **15**(2): 267-274.
- Steel, R. G. D., and Torrie J.H. (1980). *Principles and Procedures of Statistics*. A Biometrical Approach 2nd Edition. Hillbook Company Inc., New York: McGraw-Hill. Pp.633.
- Tollenaar, M. and Lee, E. A. (2006). Dissection of physiological processes underlying grain yield in maize by examining genetic improvement and heterosis. *Maydica*, **51**(2): 399.
- Udoh, D. J and Ndon, B. A. (2016). *Crop Production Techniques for the tropics*, Lagos: Concept Publications Limited. Pp. 195 – 197.
- Umoh, M. D., Udo, S. O. and Udoakah, Y. N. (2013). Global Solar Radiation Studies Due to Sunshine Hours and Other Meteorological Parameters. *American Journal of Engineering and Applied Sciences*, **6**(3): 320-326.
- Walkey, A. J. and Black, I. A. (1934). Estimation of soil organic carbon by the chromic acid titration method. *Soil Science*, **37**: 29 – 38.