Agronomic Characteristics of Maize Genotypes selected for Fresh Maize Production for Rain Forest Agro-ecology of Southeastern Nigeria.

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Abstract

In southeastern Nigeria where maize, yam and cassava are intercropped, maize sustain the people during the "hunger period" while the other crops are yet to mature. To develop maize variety that will be consumed fresh, considerations must be made to the acceptability and nutrient content. Thus, maize genotypes which are commonly consumed locally and others introduced with cherished nutritional values were assembled for the purpose of developing bettercultivars for fresh maize. Consequently, a research study was conducted to evaluate the agronomic characteristics of some maize genotypes intended for fresh maize production. The genotypes comprised three locals namely; Oka Mbaise, Oka Bende and Oka Awaka and five genotypes *viz:*DTMA-4, DMR-ESRY, PVA *syn* 8 F_2, SUWAN-1-SR and DTMA-W at various stages of improvement obtained from International Institute for Tropical Agriculture (IITA), Ibadan, Nigeria. The experiment was conducted using a Randomized Complete Block Design (RCBD) with four replications at a plant spacing of 0.75 × 0.25 m. Data were collected on agronomic traits. Results showed that Oka Mbaise and Oka Awaka, all locals, were late maturing taking about 124 days while the introduced ones matured between 90 to 100 days. The improved genotypes were shorter (103 – 120 cm) and had larger leaf area (390 – 442 cm^2). Significant positive relationships were obtained between yield and other agronomic traits, indicating direct and indirect contributions to yield. Consequently, it is evident that the improved genotypes can only be used as sources of genes for earliness, short plant height in addition to the essential protein and nutrient contents for which they were bred.

Keywords: Fresh maize, nutritional value, hunger period, snack, southeastern Nigeria

1.0 Introduction

Maize is ranked as the second most important food crop in Africa after cassava (Fakorede *et al*., 1989; DeVries and Toennisen, 2001; FAOSTAT, 2009). It is capable of producing well during the appropriate seasons in most parts of the world where farming is done (Akande & Lamidi, 2006). Maize (*Zea Mays L.*) has a variety of uses as it can be used in the livestock industry to make livestock feeds, for export purposes and also used as human food and as industrial and pharmaceutical products. Between 90 and 95 percent of the crop is harvested for grain, the remaining 5 to 10 percent is grown for silage. Maize is also a component of canned corn, baby food, mush, puddings and many more human foods. Introduction of maize into Africa in 1500 AD helped to increase food availability and maize has since become one of Africa's most dominant crops. The way in which maize is processed and consumed varies from country to country, with maize flour and meal being two of the most popular products (USAID, 2002). Fresh maize production remains the best form of utilization in order to avoid waste and maximize the available minerals and vitamins which are concentrated in the outer layers of the grain (Milazzo, 1986; USAID, 2002). In southeastern Nigeria where maize, yam and cassava are intercropped, maize sustain the people during the "hunger period" while the other crops are yet to mature. In the months of May to December fresh maize is usually boiled or roasted and sold as snack in public places and street corners..

Global production exceeds 600 metric tonnes with about 60 % coming from the developed countries, particularly from the United States of America. China produces about 27 % of the world's maize and the rest is grown in Latin America, Africa and Southern Asia with a large proportion being produced in the tropics and sub-tropics (FAO, 1992). Furthermore, productivity of the crop has increased from 1.2 t/ha in the late 90s to its present level of 1.7t/ha due to several interventions by the government (FAOSTAT, 2009).Maize remains one of the most important sources of carbohydrates, minerals and fats for human and animals. Maize grain accounts for about 15 to 56 % of the total daily calories of people in about 25 developing countries, particularly in Africa and Latin America (FAO, 1992).Appreciable achievements have been made in genetic enhancement of crops for nutritional value. However, malnutrition still remains a common problem and is mostly serious in developing countries (Prasanna et al., 2001). Globally, nearly 200 million children under five years are undernourished for protein, leading to a number of health challenges, including stunted growth, low resistance to infections and impaired intellectual development.

Maize (Zea Mays L.) is a very important cereal crop used in human diet and animal feed in most parts of the world (Department of Agriculture, South Africa, 2003). Normally, cereals contain about 2 % lysine, which is less than a half of the concentration recommended for human nutrition by Food and Agriculture Organization (FAO) of the United Nations (Prasanna et al., 2001). Fortification of diets with essential amino acids through artificial means has been fairly possible but not with that of human diet. Maize is not native to Southern Nigeria therefore, all the maize varieties grown in this region must have been improved varieties introduced in not too distant past and maintained by the farmers over the years. Depending on the location, three cultivars namely; Oka Mbaise, Oka Bende and Oka Awaka, are the most distinguishable types popular for consumption as green or fresh maize. Quality Protein Maize (QPM), nutritionally improved maize genotype possessing twice the quantity of lysine and tryptophan(Duarte et al., 2004; Nelson, 1969) comes as a veritable choice as a long term solution and economically viable option to deal with malnutrition in growing children and young adults. Crop plants provide humans with vitamin A in the form of carotinoids (Sudhakar et al., 2003). Vitamin A deficiency contributes to higher rates of anaemia, morbidity from common childhood infections such as respiratory and diarrheal diseases (Pandey, et al., 2003), measles (West, 2000), and Malaria (Shankar, et al. 1999), increased likelihood of HIV/AIDS transmission from mother to child and hasten the progression of the disease in infected persons (Ibeawuchi et al., 2015).Similarly, some maize genotypes have also been developed to provide vitamin A in the form of provit-A maize variety. The maximization of vitamins and minerals available in maize can be achieved by the consumption of maize cultivars which are genetically enhanced to contain the essential nutrients and vitamins. This will of course be better when the maize is consumed both at immature stage and with minimal processing.

Consequently, the first activity in the process of crop introduction is to carry out a field evaluation to ascertain the agronomic performance with the aim of using it as a variety or a source of useful gene. Where such cultivars prove valuable, recurrent selection, backcross and hybrid breeding methods could be adopted to integrate them into the cropping system of the people. Based on maize utilization attributes, cultivated maize varieties have been classified into three groups; the flint, floury and dent types. Flint maize are, considered the most important for human consumption while dent maize which gives the highest grain yield are very useful for feed and industrial uses. The third group, floury maize have soft endosperm and are suitable for starch production. Other important maize types for more specialized uses are the popcorn and sweet maize. (Rehm & Espig, 1991). Fresh maize that will satisfy the need of consumers is expected to have; good taste, be reasonably soft, rich in protein, carbohydrate and minerals. Thus, the objectives of this study was; to assess the agronomic characteristics of eight maize genotypes for fresh maize production, estimate the amount of variability in the characters and estimate the relationships between yield and yield attributes.

2.0 Materials and Methods

The project was carried out at the Research farm of the School of Agriculture and Agricultural Technology, Federal University of Technology Owerri, Nigeria (5' 27' N and 7' 02' E). The location has a mean temperature of 29 ^{0}C, a relative humidity of 89 % during the day in the rainy season and an altitude of 50 m above sea level.

Five of the eight maize genotypes used in this study were obtained from IITA, Ibadan which were at various stages of development while the rest were collected from the local germ plasm collection of the Department of Crop Science and Technology, FUTO (Table 1). The improved genotypes from IITA have emphases for; protein, sugar, vitamin A contents as well as taste and softness whereas the local ones are the leading cultivars in different parts of Southeast Nigeria. The eight maize genotypes were evaluated using randomized complete block design (RCBD) with four replications using 3 m row plots with inter row spacing distance of 0.75 m and intra row spacing distance of 0.25 m (approximately 53,333 plants per hectare).

Table 1: Improved and local maize genotypes and location of collection.

S/n	Genotype name	Assigned name	Location of collection
1.	DTMA-4	DTMA-4	IITA Ibadan, Oyo state
2.	DMR-ESRY	DMR-ESRY	IITA Ibadan, Oyo state
3.	PVA SYM 8 F_2	PVA SYM 8 F_2	IITA Ibadan, Oyo state
4.	SUWAN-1-SR	SUWAN – 1- SR	IITA Ibadan, Oyo state
5.	DTMA – W	DTMA – W	IITA Ibadan, Oyo state
6.	Oka Mbaise	Oka Mbaise	Ahiazu Mbaise, Imo state
7.	Oka Bende	Oka Bende	Umuahia, Abia state
8.	Oka Awaka	Oka Awaka	Awaka, Imo state.

2.1 Cultural Practices

Two seeds were planted per hill, on the 10th of April, 2015, and later thinned to one. Weeding was done manually using hand hoe as at required. Inorganic fertilizer, NPK 15:15:15, was applied at the rate of 400 kg/ha split, first at planting and later at anthesis. Furadan 3 % granular formulation of carbofuran (insecticides) was dropped into the funnel of the young seedlings three weeks after planting to control stem borers.

2.2 Data Collection and Statistical Analyses

Data were collected on some agronomic characteristics such as:

i. Days to 50 % emergence: This is the number of days it took half of the plants in a plot to emerge.

ii. Percentage emergence: This was determined by number of plants that emerge in a block over the total number of plants expected and the value expressed in percentage.

iii. Days to 50 % tasseling (Anthesis): This was determined by recording the number of days it took half of the maize plants in a plot to tassel.

iv. Days to 50 % Silking: This was determined by recording the number of days it took half of the maize plants in a plot to produce silk.

v. Plant height (cm): This was measured as the distance from the base of the plant to the base of the flag leaf.

vi. Number of leaves:This was obtained as average count of number of leaves from four randomly selected plants per plot.

vii. Stem girth:This is the measurement of the diameter of the stem of the maize at the base, using venier caliper.

viii. Leaf area:This was calculated by using the formula: Length x Width of a leaf x 0.75 (constant or correction factor) x Number of leaves/plant(Obiefuna and Ndubizu,1979). The leaf length was measured from the point of attachment to the tip, while the width of the leaf was measured across the leaf (diameter) at the broadest point.

ix. Plant stand: Number of plants that established per plot after planting.
x. Plants at harvest:The total number of plants surviving up to the time of harvest in each plot.
xi. Cob length:This was measured using measuring rule.
xii. Field weight(FWT):The weight in kg of all the de-husked ears in each plot.

$$\text{Grain yield} = \frac{\text{Field weight}}{1000} \times \frac{(100 - \text{Moisture \%}) \times \text{Plot size}}{85 \times 10000}$$

Data collected were analyzed using the analysis of variance according to the procedure outlined by Steel and Torrie (1980) for the Randomized Complete Block Design and detection of the differences between treatment means (Obi, 2002).

3.0 Results and Discussion

Summary statistics for the plant traits is presented in Table 2. Results showed that there were appreciable variability in the traits. Overall means for agronomic characteristics of the genotypes evaluated show on the average that genotypes emerged from the soil in approximately six days with a minimum of four and a maximum of 7 days. In days to 50 % tasseling, genotypes tasseled in 51 days with minimum of 44 and a maximum of 58 days. Similarly, genotypes attained 50 % silking in 62 days but with a range of 52 to 71 days, indicating that the maize genotypes grown in southeastern Nigeria are mainly late maturing (124 days). Number of leaves produced per plant was 11 with a minimum of nine and maximum of 14. Average height of the genotypes was 142.3 cm ranging from, 103.5 to 215.2 cm. With respect to number of plants at harvest, eight plants per plot survived up to harvest, one less the number (plant stand) which survived the seedling stage. Mean field weight of the ears harvested, per plot was 106 g, ranging from 56.7 to 167.8. Grain yield, considered one of the most important traits in any breeding programme, gave a mean of 1.9 t ha-1 with a range of 1.12 to 2.36 t/ha. Most of the top yielders were local cultivars and only one improved from IITA, Ibadan.

Table 2: Primary data on the evaluation of eight maize genotypes for fresh maize production in southeastern Nigeria.

Plant traits	Mean	Minimum	Maximum	Range	Deviation	cv %
Days to 50% emergence	5.63	4.00	7.00	3.00	0.92	16.28
Percentage emergence	77.29	61.10	90.00	28.90	9.24	11.95
Plant stand	8.55	7.20	10.05	2.85	1.16	13.53
Days to 50% tasseling	51.00	44.00	58.00	14.00	5.40	10.58
Days to 50% silking	62.12	52.00	71.00	19.00	7.68	12.36
Plant height (cm)	142.30	103.50	216.20	112.70	41.14	28.91
Number of leaves	10.83	9.00	13.38	4.38	1.39	12.87
Stem girth (cm)	6.61	5.00	7.60	2.60	0.87	13.22
Leaf area (cm^2)	411.50	368.70	481.80	113.10	37.94	9.22
Plants at harvest	8.19	7.00	10.00	3.00	1.10	13.43
Cob length (cm)	10.86	8.38	13.48	5.10	1.71	15.74
Field weight	106.90	56.70	167.80	111.10	39.53	36.98
Grain yield	1.90	1.12	2.36	1.24	0.43	22.51

Coefficients of variation, a measure of the relative levels of variability for traits, obtained in this study showed that low to moderate values of 15 to 30 % were obtained in almost all cases. Field weight had the highest coefficient of variability value of 36.98 %. Coefficient of variations for other traits were much lower ranging from 9.22 % for leaf area to 13.53 % for plant stand (Table 2).

Result of the ANOVA test indicated that there were significant differences in all the traits measured. In percentage seedling emergenceand days to 50 % emergence, genotypesfrom the IITA; DTMA-4, DTMA-W, DMR-ESRY, PVA SYN 8 F_2had lower percentage seedling emergence (61 to 78 %), emerged in 4 to 6 days while the locals, Oka Awaka, Oka Bende and Oka Mbaise emerged and had 82 to 90 % emergence and took in 6 to 7 days to emerge (Table 3). With regards to plant stand count, taken at 3 weeks after planting, the locals had between 9 and 10 plants (75 to 83 %) out of the 12 stands established, while the improved ones had 7 to 8 (60 to 80 %) plants surviving.In days to 50 % tasseling and days to 50 % silking, indicators of maturity time, results showed that DTMA-4, DMR-ESRY and Oka Bende flowered early (44 to 49 days) whereas Oka Awaka, Oka Mbaise, SUWAN-1-SR, DTMA-W and PVA SYN 8 F_2 flowered within 55 and 59 days after planting(Table 4). The results of the silking date followed the same pattern as that of the tasseling. Results show that the local maize genotypes were particularly taller cultivars, 162 to 216 cm, while the improved genotypes were between 103 and 120 cm tall.

In mean number of leaves produced, Oka Mbaise had the highest number of leaves(13) followed by; SWAN-1-SR (11), PVA SYN 8 F_2(11) and Oka Awaka (11)while DTMA-4 had the least number of leaves (9). In a similar order, Oka Mbaise had the biggest girth (7.6 cm) followed by Oka Bende and Oka Awaka (all locals) while DTMA-W had the smallest girth of 5.0 cm. Others had 6 cm of stem girth each. Stem girth determines strength and ability to resist lodging. Increase in stem girth of maize may be due to cell expansion, makes for sturdinessof plants when accompanied withgood root development.

Table 3: Seedling characteristics of eight maize genotypes grown in Owerri West, South Eastern Nigeria.

Genotypes	Days to 50% emergence	Percentage emergence	Plant stand
DTMA-4	4.00	61.10	7.20
DMR-ESRY	5.50	77.10	8.78
PVA SYN 8 F_2	5.50	68.00	7.50
SUWAN-1-SR	5.50	77.00	8.70
DTMA-W	5.00	77.80	7.20
Oka Mbaise	7.00	85.40	10.00
Oka Bende	6.50	81.90	9.00
Oka Awaka	6.00	90.00	10.05
LSD (0.05)	0.83	14.72	0.96

Table 4: Growth characteristics of eight maize genotypes grown in rainforest agro-ecological zone of southeastern Nigeria.

Genotypes	Days to 50% tasseling	Days to 50% silking	Plant height (cm)	Number of leaves	Stem girth (cm)	Leaf area (cm^2)
DTMA-4	44.00	52.00	115.92	9.00	6.10	413.90
DMR-ESRY	47.00	59.00	114.33	10.33	6.70	390.90
PVA SYN 8 F_2	55.00	69.00	120.50	11.33	6.00	428.10
SUWAN-1-SR	45.00	54.00	119.00	11.92	6.80	442.50
DTMA-W	54.00	64.00	103.50	9.67	5.00	368.70
OKA Mbaise	56.00	71.00	216.17	13.38	7.60	481.80
Oka Bende	49.00	57.00	162.08	10.00	7.40	381.80
Oka Awaka	58.00	71.00	187.00	11.00	7.30	384.10
LSD (0.05)	3.31	6.20	28.21	1.35	0.56	26.44

Results obtained for leaf area showed that Oka Mbaise and Oka Bende had the largest mean leaf areawhile DTMA-W had the smallest leaf size. Cob length measured at harvest revealed that Oka Awaka was the longest while DTMA-W was the lowest. In field weight, results showed that Oka Awakahad the highest while the lowest was recorded for DTMA-W. Results obtained for grain yield showed that the local maize genotypes were higher yielding (2.23 to 2.36 t/ha) than the improved ones except DTMA-4 with the grain yield of 2.16 t/ha (Table 5). Whereas the local cultivars produced grain yields within the 2.0 to 3.0 range for open pollinated varies in southern Nigeria, the introduced ones gave below expectation (IITA, 2003)

Table 5: Yield and yield components of maize genotypes grown in Owerri West, Rain Forest Agro-ecology of southeastern Nigeria.

Genotypes	Plants at harvest	Cob length	Field weight	Grain yield
DTMA-4	7.00	11.76	103.80	2.16
DMR-ESRY	7.50	9.90	89.20	1.80
PVA SYM 8 F_2	7.50	9.82	83.80	1.66
SUWAN-1-SR	8.50	9.59	77.90	1.61
DTMA-W	7.00	8.38	56.70	1.12
Oka Mbsise	9.00	11.43	115.00	2.27
Oka Bende	9.00	12.50	161.20	2.23
Oka Awaka	10.00	13.48	167.80	2.36
LSD (0.05)	0.61	2.31	33.47	0.68

3.1 Correlation Study

Correlation studies among the agronomic traits revealed significant relationships among them (Table 6). Days to 50 % emergence was significant and positively related with percentage emergence (r=0.80), plant stand (r=0.82), plant height (r=0.80), number of leaves (r=0.72), stem girth (r=0.75) and number of plants at harvest (r=0.75). Similarly, per cent emergence was correlated with plant stand (r=0.71), height (r=0.71), stem girth (r=0.71), cob length (r=0.80) and field weight. Plant stand was found to have significant and positively related with, plant height, plant girth and number of plants at harvest. Furthermore, yield was significant and positively related to plant height (r=0.75), stem girth (r=0.82), Cob length (r=0.94) and field weight (r=0.87). Days to 50 % tasselingand days to 50 % silking with highly significant positive relationship(r=0.92), both were not significantly related with any other trait measured. This is however contrary to the observation of Ngwuta *et al.,*(2009) who observed that days to 50 % silking was significant and negatively correlated with grain yield.

Any phenotypic differences observed among maize genotypes are attributable to genetic and environmental control. Thus, performance of any single genotype is not likely to remain constant across varying environments. Result indicate that the introduced maize genotypes though more vigorous at the early seedling stage had lower number of seedlings surviving. The reduced percentage total seedling emergence suggested that beyond seedling sprouting, the environmental conditions around the plants could have slowed down emergence or killed the less adapted ones. This is evident in the slow and steady emergence pattern of the local ones. In number of days to flowering, the characteristically early genotypes were improved introductions from IITA, Ibadan. Result indicates that genotypes, DTMA-4 and DMR-ESRY could serve as good sources genes for earliness. Genotypes with reduced plant height showed potentials for containing genes for shorter plant height which is desirable in breeding shorter and sturdy plants that can withstand rainstorms, which characterizes the humid rainforest agro-ecology of southeastern Nigeria. The introduced genotypes from IITA germplasm will be helpful since they are characteristically shorter in plant height in this environment.

Table 6: Relationships among the agronomic characteristics of maize genotypes studied in Owerri West, rain forest agro-ecology, southeastern Nigeria

Plant characteristics	Percentage emergence	Plant stand	Days to 50% tasseling	Days to 50 % silking	Plant height (cm)	Number of leaves	Stem girth (cm)	Leaf area (cm^2)	Plants at harvest	Cob length	Field weight	Grain yield t/ha
Days to 50% emergence	0.80*	0.82*	0.52	0.55	0.80*	0.72*	0.75*	0.33	0.75*	0.34	0.50	0.41
Percentage emergence		0.85**	0.57	0.53	0.71*	0.48	0.59	-0.06	0.82*	0.36	0.52	0.29
Plant stand			0.37	0.42	0.85**	0.63	0.90**	0.27	0.91**	0.60	0.67	0.65
Days to 50% tasseling				0.97**	0.56	0.43	0.09	0.03	0.43	0.18	0.26	0.09
Days to 50% silking					0.58	0.55	0.15	0.17	0.40	0.13	0.19	0.11
Plant height (cm)						0.62	0.80*	0.41	0.83*	0.70*	0.71*	0.75*
Number of leaves							0.54	0.80*	0.52	0.02	0.04	0.19
Stem girth (cm)								0.38	0.84**	0.72*	0.75*	0.82*
Leaf area (cm^2)									0.15	-0.02	-0.14	0.23
Plants at harvest										0.72*	0.80*	0.66
Cob length											0.96**	0.94**
Field weight												0.87**

*, **Correlation is significant at the 0.05 and 0.01 level, respectively (2-tailed),

The genetic constitution of crops does not change in different environments with respect to qualitative traits. However, measurable characters which are controlled by many genes, such as yield, plant height, leaf area, etc. are affected by changes in environments. It was observed that the improved genotypes from IITA, Ibadan, did not perform well in most of the parameters; this could be attributed to inadaptability of the genotypes in a new environment. In grain yield, the local cultivars out-yielded the introduced ones except DTMA-4 indicating that though the introduced ones have been improved to an extent, they were not better in yield than the locals in this environment. However, for the fact that they are valued for earliness, reduced stem height and various nutritional contents, they are good candidate for the generation of new varieties through hybridization. Such genotypes here proposed are expected to combine parental traits and may contain new desirable recombinant genes. Good standability contributes enormously towards higher yield in maize. Well developed root system, strong stem, short plant height, low ear placement, ability to stay green at maturity and resistance to diseases and insects are major factors that affect maize production (Department of Agriculture, South Africa 2003).

The positive and significant relationships with days to 50 % emergence and the percentage seedling emergence, both indicators of seedling vigour, implies that an increase or decrease in vigour of plant at the seedling stage will have direct influence on plant stand, plant height, stem girth, number of leaves, plants at harvest and possibly on the grain yield. Significant positive relationships observed between grain yield and plant height, stem girth cob length and field weight depict direct contributions to grain yield whereas the relationships with these traits with other agronomic characters measured suggest indirect contributions to grain yield of maize.

4.0 Conclusion

Considering the results of the study, it was observed that Oka Mbaise, Oka Bende and Oka Awaka had very good performances in yield performance and is already being grown by intercrossing them with the introduced varieties. This is hoped to increase the nutritional status of the local genotypes because the improved genotypes from IITA namely; DTMA-4, DMR-ESRY, PVA SYM 8 F_2 (PRO VIT A) , SUWAN – 1- SR (QPM) and DTMA – W were bred essentially for high quality protein, high sugar content and pro-vitamin A (carotinoids).

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