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EVALUATION OF MORPHOLOGICAL CHARACTERS AND YIELD VARIABILITY OF SOME ELITE CASSAVA (*MANIHOT ESCULENTA* CRANTZ) IN UYO, SOUTHEASTERN NIGERIA

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ABSTRACT

Field experiment was carried out at Okigwe to evaluate some morphological traits and yield variablility of some elite cassava varieties with aim of making innovative recommendation to farmers. The experiment laid out in a complete block design, replicated three times. The treatments were six cassava varieties; TMS 30572, TME 419, TMS 98/0505, TMS 98/0581, TMS 01/1412 and local variety known as Obubit Okpo. Data collected from growth and yield were subjected to analysis of variances. Significant means were compares using least significant difference (LSD) at 5% probability level. Among the cassava varieties; TMS 98/0581 had superiority over in four characters namely; leaf area, storage root length, storage root circumference and yield. Also TMS 01/1412 was superior in terms of number of leaves per plant and number of storage roots per plant while TME 419 was superior in terms of plant height. Since TMS 98/0581 had four major characters, it could be disseminated to farmers in Uyo, Akwa Ibom State, while the other varieties TMS 01/1412, and TME 419 which were superior in two and one characters respectively could be incorporated into breeding programme with TMS 98/0581 to produce hybrid varieties with higher yield for the study area.

Keywords: Cassava, characters, breeding and yield.

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INTRODUCTION

Cassava (Manihot esculenta) is a very important root crop in the tropical and sub-tropical regions of the globe. It has been cultivated for several centuries, yet the yield is low. It is a key component of the diet of over 800 million people across several continents (El-Sharkawy, 2012). About 70 million people drive more than 500 kcal per day from consuming cassava storage roots (Burns *et al.,* 2011). In Nigeria, cassava is processed into different local diets such as garri, fufu or apu, abacha, akpu mmiri, adibo, etc (Ikeh 2017). Ikeh (2017) noted that cassava is a major dominant component crops in crop mixtures especially in southeastern Nigeria. Due to high demand of cassava product in local market, couple with its low yield, different cassava breeding programms has tend to proffer a solution on how to triple its yield.

Plant breeding has the highest rate of return among the investment in agricultural research of which cassava has also benefited (Ceballos et al; 2012; Utomi, 2015). Bassey and Harry (2013) revealed that high and stable production of fresh storage roots is the key breeding objective in most cassava breeding projects. Ikeh (2017) indicated that productivity plays a major role in industrial uses of cassava, whether for starch, animal feed or bio-ethanol, whereas stability of production is fundamental in the regions where cassava is the main subsistence crop. Conventional breeding of cassava involves selection of out-performed parental genotypes for the characters or traits of interest, hybridizing them and conducting multi-stage offspring selections (Jennings and Iglesias, 2002; Ceballos et al; 2012; Bassey and Harry, 2013). This is often aimed at the accumulation of beneficial alleles and elimination of detrimental ones. High frequency genes of specific desirable characteristics, including yield components, yield stability, storage root quality and quantity, resistance to pests and diseases, to clearance to soil and climatic factors stresses, and good processing qualities are progressively accumulated through recurrent selection of cassava bred.

Variability among cassava genotypes is a means of selecting for desirable traits which had led to significant progress in cassava improvement programme (Akinwale et al 2010; Ikeh 2017). Variation among varieties of cassava is not only genotypic in nature but influenced by the environment (Aina, 2007). The overall variability in cassava could be partitioned into heritable and non-heritable components with the use of suitable genetic parameters, such as coefficient of variation, heritability estimates, genetic advance and phenotypic variance for traits. (Bassey and Harry,2015; Utomi, 2015). Cassava varieties could be distinguished from one another by morphological characteristics such as leaf size, colour and shape of leaves, branching habits, plant height, colour of the stem, leaf area, storage root shape and colour etc.

Evaluation and morphological characterization of cassava varieties can by classify into morpho-types based on important agronomic traits. Characterization determines the expression of characters ranging determines the expression of characters ranging from morphological or agronomic features to seed protein or molecular marker (Engels and vassal, 2003). Characterization is essential to provide information on the traits accessions, assuring the maximum utilization of the plants. According to Ezebiro et al (2013) cassava characterization can be carried out at any stage of the plants growth as long as there is sufficient number of materials to sample. Several attempts through field research have made in producing improved cassava varieties at different locations in Nigeria but due to various in both biotic and abiotic factors at different parts of the country sometimes the best performing cassava varieties in one region are not among the best in some other region. Therefore evaluation of cassava genotypes under this condition would help to identify those varieties that are adaptable to Okigwe local conditions for use by farmers and also s elect promising ones for production of hybrid varieties for the area.

MATERIALS AND METHDOS

The study was conducted at the National Cereals Research Institute (NCRI), Uyo Out-Station, Akwa Ibom state, during the early and late planting season of 2017 between the months of March and December. The experimental site is situated between latitude 04^{o}58$^{'}$ N and longitude 07^{o}56$^{'}$E and about 67 m above sea level. The area which lies within the humid tropical rainforest zone of southeastern Nigeria has average annual rainfall of about 2500 mm and mean monthly sunshine of about 3.14 hours. The mean annual temperature range is 26°C- 28°C. Uyo has an annual mean relative humidity of 79% and evaporation rate of 2.6 cm^2. The rainfall pattern of Uyo is bimodal. Rain usually starts in mid- March and ends in Mid-November, with a short period of relative moisture stress in August traditionally referred to as "August Break" (Peters *et al*., 1989). Temperatures are generally highest in the months of February through April (Peters *et al*., 1989).The soil has been described as a typical acid soil.

The experiment site was manually prepared into ridges of 1m apart. The ridges were marked 5m long and separated by 1m paths. Composite soil samples were collected at two soil depths (0-15cm and 15-30cm) using soil auger before planting. The soil samples were carefully put in polyethylene bags and labeled before being taken to the laboratory for analysis. At the laboratory, the soil samples were air dried, crushed and sieved through a 2.0mm mesh, and labeled and stored for phyisco-chemical analysis. Soil pH was determined in water 1:2 (soil water ratio) using pH meter with glass electrode (Bates, 1954). Total nitrogen in the soil was determined by microkjeldahl digestion and distillation method (Ibia and Udo, 2009). Organic matter was determined by the dichromate wet oxidation method of walkley and Black (1934). Available P was determine by Bray-I method of Bray and Kurtz (1945). Exchangeable bases were extracted with neutral ammonium acetate solution. Calcium (Ca) and Magnesium (Mg) was determined in the extracts of EDTA titration of Jackson (1962), while potassium (K) and soium (Na) were determined by the use of flame photometer. Exchangeable acidity was extracted with 1mol of KCl solution, while exchangeable acidity was determined by titration with NaOH as described by Kamprath (1975). The exchangeable hydrogen was obtained by subtracting exchangeable aluminum from the exchangeable acidity. Effective cation exchange capacity (ECEC) was obtained by the summation of exchangeable cations and exchangeable acidity (Ibia and Udoh, 2009).

The experimental design used was a randomized complete block design (RCBD) with three replications. Six cassava varieties used as treatments were; TMS 98/0505, TNS 98/0581, TME 419, TMS 01/1412, TMS 30572, with one local cultivar Ohu pam as check. The treatments (varieties) were randomly assigned to plots to eliminate bias. The six cassava varieties namely; TMS 98/0505, TMS 98/0581, TME 419, TMS 01/1412, TMS 30572, were obtained from the National Root Crops Research Institute (NRCRI) Umudike, Abia State, while Obubit Okpo (local cultivar) was obtained from Farmers field in Uyo Akwa Ibom State. The experimental area was 36m x 23 ($828m^2$). There were 18 plots in the experimental area, each measured 5m x 5m and demarcated from one another by 1m paths. Similarly, each block was demarcated from one another by 2m. Planting was done on March, 2018 and 2019 immediately after land preparation. Healthy stem cutting of 25cm long were planted in an incline position of 45^0 on the crest of ridges, at 1m intra and inter row spacing. Manual weeding was carried out at 1 and 5 months after planting with aid of a weeding hoe, followed by slashing at 8 months after planting. Fertilizer (NPK: 15:15:15) was applied 2 months after planting at 400kg/ha, using the ring application method. The cassava storage roots were harvested at 12 months after planting.

Data Collection

Six (6) plants were randomly tagged within the next plots for data collections and the following growth and yield data were measured.

Establishment percentage was done at first months after panting. This was calculated as the number of established stands over total number of planted stands in a plot and expressed in percentage. Cassava height was obtained by measuring tagged plants from the ground level to terminal point of the plants 3, 6 and 9 months after planting (MAP). Leaf areas were determined by measuring the length of each lobe and width of all the leaf lobes of each tagged plant. The means for length of all the leaf lobes and the sum of width of all leaf lobes were multiplied and the product was further multiplied by a correction factor of 0.74 (Hammer, 1980). Number of leaves per plant was determined by physical counting of all functional leaves of tagged cassava plants. Number of harvested tubers per plant was done by counting all the cassava tubers produced by each plant and of all the tagged plants in each plot and the means recorded for each variety. The length of storage roots harvested from sample cassava plants was measured from the proximal to distal and using a flexible measuring tape in centimeter. The circumference of storage roots determine by measuring circumference of storage were of cassava plants with the aid of flexible measuring tape in centimeter at the middle portion of the storage root. Fresh storage root yield per plant was weighed with the aid of top load weighing balance in kilograms and converted the yield in tonnes per hectare.

Data Analysis

Data of all growth characters and yield components were subjected to analysis of variance with aid of sensate significant means were compared using the least significant difference at 5% probability level.

RESULTS AND DISCUSSION

The physicochemical properties of the soil obtained from the experimental site are shown in Table 1. The result showed that the soil was slightly acidic with low cation exchange capacity (CEC) and suffered from multi-nutrient deficiencies. The soil may be classified as sandy loam. For intensive cultivation of the soil, appropriate soil management techniques were adopted to improve the nutrient status and general soil conditions. The fertilizer (NPK 15:15:15) was applied at two months after planting at the rate of 400kg/ha and all the cassava genotypes received equal treatments.

The result of establishment percentage as influenced by cassava genotypes showed no significant differences ($P \leq 0.05$). All the cassava genotypes had higher establishment percentage and ranged between 95.00% in TMS 98/0581 to 100% recorded for the following varieties; TMS 01/1412, TME 419 and Obubit Okpo in 2018/2019 cropping season and range of 99-100% in 2019/2020. Subsequent differences (P≤0.05) were observed following plant height among the cassava varieties in all the months under investigation (Table 3). TME 419 variety was the tallest plant in all the sampled months; 95.40, 176.77 and 215.98 cm in 2018/2019 while height of 101.20, 182.80 and 220.88 cm was recorded in 2019/2020 season, at 3.6 and 9 MAP respectively. TMS 98/0581 was the shortest variety in both cropping seasons; 51.08, 83.40 and 125.31cm in 2018/2019 whereas 53.92, 91.30 and 133.71cm were recorded in 2019/2020 cropping seasons.

The result showed significant differences (P≤0.05) among the cassava varieties for number of leaves per plant in all the months under study (Table 4). TMS 01/1412 had highest number of leaves per plant; 98.25, 281.16 and 325.12 in 2018/2019. The following number of leaves per plant 101.22, 306.33 and 359.48 was recorded in 2019/2020 cropping season at 3.6 and 9MAP, respectively. TME 419 had the least number of leaves per plant; 71.55, 139.08 and 188.41 in 2018/2019 while 68.50, 143.92 and 200.60 leaves per plant was recorded in 2019/2020 cropping season. Obubit Okpo which was the local variety had significant higher number of leaves compared to TME 419 and TMS 98/0571. Significant differences (P≤0.05) were observed among the cassava genotypes for leaf area (Table 5). Leaf area of all the cassava genotypes evaluated increased from 3 MAP to 6 MAP and started declined at 9 MAP to MAP. In all the cassava varieties evaluated, TMS 98/0581 had the largest leaf area for all the months under investigations, followed by TMS 01/1412 while TMS 98/0505 had the least leaf area in all the months under investigation. Number of cassava tubers per plants varied significantly (Table 6). The result showed that TMS 01/1412 produced significant highest number of storage roots per plants; 10.25 and 9.82 in 2018/2019 and 2019/2020 cropping years, followed by TMS 98/0581, with 8.50 and 8.75, respectively. TMS 30572 had lowest number of storage root plants 4.80 and 5.20 respectively. Length of tubers per plant differed significantly (P≤0.05) among the cassava varieties sampled. TMS 98/0581 had significant longest tubers, 45.60cm and 44.20m by TME 419 with 44.20 and 43.18cm. TMS 30577 recorded the shortest storage root; 30.81 and 33.10 cm respectively. The result showed the circumference of tubers differed significantly among the cassava genotypes (P≤0.05). The largest tuber circumference was recorded for TMS 98/0581, 21.88cm and 22.30cm followed by 20.40cm and 22.18cm recorded in TME 419 in both cropping seasons. TMS 30572 had the least storage root circumference; 15.33 and 15.25cm in 2018/2019 and 2019/2020 respectively.

Fresh tuber yield of cassava genotypes differed significantly (P≤0.05). The genotype TMS 98/0581 recorded the highest fresh storage root yield of 39.25t/ha and 41.50t/ha followed by TME 419 with 38.60t/ha and 39.01t/ha while the lowest fresh storage root yield in all the cassava varieties recorded for TMS 30527 with yield of 25.15t/ha and 24.58t/ha in both years.

Discussion

The result showed that number of leaves and leaf are of cassava genotype different significantly (P≤0.05), cassava varieties that produced higher number of leaves at certain stages of growth. In this study, higher number of leaves seems to correlate with increase in photosynthetic in cassava. For example, the varieties TMS 98/0581, TMS 01/1412, TME 419 with higher number of leaves per plant and leaf area also produced higher fresh storage root yield (t/ha), while TMS 30572 98/0505 and Obubit Okpo with lower number of leaves per plant produced lower fresh storage root yields (t/ha). Higher storage yield observed for some varieties showed that the plants had powerful source (leaves) and sink capacity roots. This observation agrees with the earlier report by IITA (1990) and El-stairway (2008) that number of leaves may influence crop yield. Similarly, leaf area increased as number of leaves also increased. Also number of leaf and leaf area decreased considerably under adverse environmental conditions such as the appearance of dry season. This was observed at 9MAP which agrees with the observation of Fermont (2009) that leaf area index increases as the number and size of individual leaves increased reaching a peak of 4 to 6 MAP. However, in this study an association could be established between leaf area and number of leaves per plants, and fresh tuber yields (t/ha) of cassava. This observation was in line with the report of Bassey and Harry (2013). The varieties TMS 01/1412, TMS 98/0581 and TMS 419 with highest number of leaves and largest leaf areas also produced highest storage root yields. This result also agrees with Fermont (2009); Ikeh 2017 and IITA (1990) that tuber yields is determined by certain growth characteristics such as number of leaves, leaf area and plant habit.

Table 1. Soil physico-chemcial properties of the experimental site before planting

Soil parameter	0-15 cm Soil depth.
pH	5.50
Electric conductivity (ds/m)	0.035
Organic matter (%)	1.58

Total nitrogen (%)	0.07
Available p (mg/kg)	42.30
Exchangeable bases (cmo1/kg)	
Ca	2.12
Mg	1.08
Na	0.06
Exchangeable	2.20
Acidity (cmol/kg)	
ECEC (Cmol/kg)	5.46
Particle size analysis (%)	
Sand	86.50
Clay	4.80
Silt	8.70
Soil textural class	Loamy soil

Table 2: Sprouting percentage of cassava varieties

Cassava Varieties	**2018/2019**	**2019/2020**
TMS 98/0505	98.00	100.00
TIMS 98/0581	95.00	99.00
TME 419	100.00	100.00
TMS 30572	96.00	100.00
TMS 01/1412	100.00	100.00
Ohu Pam	100.00	100.00
LSD (p<0.05)	**Ns**	**Ns**

* Ns = Not significant

Table 3: Cassava height as influenced by varieties

Cassava varieties	2018/2019 Months after planting			2019/2020 Months after planting		
	3	6	9	3	6	9
TMS 98/0505	62.14	121.81	163.50	58.60	128.90	170.09
TIMS 98/0581	51.08	83.40	125.31	53.92	91.30	133.71
TME 419	95.40	176.77	215.98	101.20	182.80	220.88
TMS 30572	60.19	102.50	138.80	65.11	118.16	145.12
TMS 01/1412	70.33	152.61	193.25	71.06	169.44	201.82
Ohu Pam	64.20	148.00	176.70	65.22	156.18	183.14
LSD (p<0.05)	**3.40**	**5.25**	**6.81**	**4.77**	**5.28**	**4.80**

Table 4: Number of leaves per plant

Cassava varieties	2018/2019 Months after planting			2019/2020 Months after planting		
	3	6	9	3	6	9
TMS 98/0505	80.50	258.30	285.06	77.51	233.01	262.48
TIMS 98/0581	78.60	208.36	202.40	92.18	199.43	216.75
TME 419	71.55	129.08	188.41	68.50	143.92	200.60
TMS 30572	52.13	192.30	215.22	59.20	201.40	227.73
TMS 01/1412	98.25	281.16	325.12	101.22	306.33	359.48
Ohu Pam	65.48	182.42	205.31	70.60	188.41	250.19
LSD (p<0.05)	**2.87**	**5.57**	**9.25**	**2.92**	**4.22**	**6.62**

Table 5: Leaf Area of Cassava as Influenced by Varieties

Cassava varieties	2018/2019 Months after planting			2019/2020 Months after planting		
	3	6	9	3	6	9
TMS 98/0505	120.40	130.22	125.60	125.39	137.44	135.22
TIMS 98/0581	185.20	198.39	191.16	192.50	201.20	201.01
TME 419	180.41	193.09	188.20	185.21	198.25	190.41
TMS 30572	116.50	119.28	110.88	108.99	120.82	112.30
TMS 01/1412	178.33	180.70	180.20	172.66	193.49	190.00
Ohu Pam	129.81	142.24	140.01	133.80	158.08	151.26
LSD (p<0.05)	**4.25**	**5.29**	**3.33**	**2.71**	**5.75**	**5.39**

Table 6: Yield and yield Components of cassava as Influenced by Varieties

Cassava varieties	2018/2019				2019/2020			
	Number of storage root/ plant	Storage root length (cm)	Circumference of storage root	Storage root yield (t/ha)	Number of storage root/ plant	Storage root length (cm)	Circumference of storage root	Storage root yield (t/ha)
TMS 98/0505	6.22	31.60	16.71	3250	6.01	33.11	15.80	29.60
TIMS 98/0581	8.50	45.60	21.88	39.25	8.76	44.20	22.30	41.50
TME 419	7.20	44.20	20.40	38.60	8.50	43.18	22.18	39.01
TMS 30572	4.80	30.81	15.33	25.15	5.20	33.10	15.25	24.58
TMS 01/1412	10.25	38.29	20.11	35.50	9.82	40.61	21.09	37.52
Ohu Pam	7.55	36.95	18.55	33.09	6.31	35.20	17.88	32.55
LSD (p<0.05)	**2.58**	**3.18**	**2.88**	**3.48**	**2.16**	**2.27**	**2.40**	**3.91**

CONCLUSION

Based on the result findings, the following conclusions were drawn: The TMS 01/1412, TMS 98/0581, and TME 419 which produced the highest storage root yields above the local variety (Obubit Okpo) could be disseminated to local farmers in Uyo. Also Obubit Okpo which produced higher number of storage roots, be longer tubers and larger storage circumference when compares to TMS 98/0505, and TMS 30572 could be incorporated into breeding programmes involving the high yielding types (TMS 01/1412, TMS 98/0581, TME 419) to produce high yielding varieties for the area.

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