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EVALUATION OF CASSAVA (*MANIHOT ESCULENTUM* CRANTZ) GENOTYPES IN NSUKKA AGRO-ECOLOGY OF SOUTHEASTERN NIGERIA

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ABSTRACT
Field experiments were conducted during the 2008 and 2009 cropping seasons to evaluate 15 new cassava genotypes and one local check (Okwoko) for adaptation to Nsukka agro-ecology in the face of global climate change. The experiments were sited at the research farm of the Faculty of Agriculture, University of Nigeria, Nsukka. Pre-planting soil samples were collected at 0 – 15 cm depth in each experimental unit after land preparation and subjected to routine chemical analysis. The new cassava genotypes were obtained from the National Root Crops Research Institute, Umudike, Abia State, Nigeria while the local (Okwoko) was obtained from the farmer's field in Obukpa, near the University of Nigeria. The experiment was a randomized complete block design (RCBD) with three replications per trial. The cassava sticks were cut 30 cm long and planted at a spacing of 1 m apart. Data were collected on survival count, plant height, number of branches, tuber weight and disease incidence. Highest stem yield (780 bundles/ha) was obtained from TMS01/1368 while the lowest stem yield (320 bundles/ha) came from NR03/1555 in 2008 and 2009. Tuber yield (t/ha) was significantly ($P \leq 0 .05$) lowest with the local genotype in both years. Among the improved genotypes, TMS98/2132 significantly ($P \leq 0 .05$) recorded the highest root yield (42.04 t/ha) in 2008 and (43.50 t/ha) in 2009. Cassava mosaic disease (CMD) incidence was significantly higher than root rot among the genotypes.

Keywords: Germplasm, cassava, evaluation, environment

INTRODUCTION
Cassava (*Manihot esculantus*) belonging to the family of Euphorbiaceae is one of the important root crops in West and Central Africa. Although the crop is grown in every country of the African continent, cultivation is concentrated in the humid tropical regions (Nweke, 1996). In Africa generally, food production is fundamentally based on rainfed farming systems and is therefore faced with inherent risks resulting to marked variations in seasonal and annual food supply. Cassava crops can relatively adapt to marginal soils and erratic rainfall conditions compared with other crops and have the capability of maintaining continuity of supply throughout the year. The need to increase food production is always a priority in Africa.

To feed the ever increasing urban population in Nigeria, food supply from every farm household has to increase by at least 63% in 10 years (Sanni *et al.*, 2009). Cassava is a food security crop worldwide (Nweke, 2003) because of its ability to grow under a wide range of conditions, some of which are quite unsuitable for other crops. Farmers prefer the improved varieties of cassava because of their higher yields, earlier maturity and high suppression of weed and greater resistance to diverse diseases and pests (Akoroda *et al.*, 1985, 1987; Ikpi *et al.*, 1986). Research in cassava has witnessed tremendous progress with the development of improved varieties of the crop and accompanying improved management recommendations by IITA, Ibadan and NRCRI, Umudike. Events, particularly flooding, excessive rise in temperature, frequent dry spells, desert encroachment, resurgences of new pests and diseases among others are evidences of climate change which invariably affect establishment and development of crop in a region (Adesina *et al*, 2007; UmuBig and Camer, 2007). Vulnerability to climate change refers to the degree in which a system or region is susceptible to, or unable to cope with adverse effects of climate change, including climate variability and extremes (Leary *et al*, 2008). Against this background, this research was designed to determine the adaptability potentials of new cassava genotypes to Nsukka agro-

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ecology in response to the global climate change. Thus, the specific objective was to evaluate the agronomic parameters of 15 cassava genotypes and one local check for adaptation to Nsukka agro-ecology

MATERIALS AND DMETHODS

Experimental sites: Field experiments were conducted in 2008 and 2009 in the rainforest zone of South Eastern Nigeria. The area is located by latitude 6^0 52^1 N and longitude 7^0 23^1 E, altitude 400 m above sea level and has a humid tropical climate. The mean annual rainfall ranges from 1600 to 2000 mm. The temperature is uniformly high throughout the year but the annual mean maximum temperature does not exceed 35^0C (Asadu, 1990). The soil was derived from falsebedded sandstone parent material. It is sandy loam and has been classified as Typic Kandpaleustult or Dystric Nitosol, belonging to Nkpologu series (Nwadialo, 1989) and the vegetation has been described as derived savannah. The experiments were sited in the same location but in different fields for the two years. The first experiment was on 12th April 2008 while the second was 3rd March 2009. Land was prepared each year by disc ploughing, harrowing and ridging to obtain a smooth seed bed.

Soil sampling and analysis: Pre-planting soil samples were collected at 0-15 cm depth in each treatment plot one week after land preparation. Soil samples were air-dried and sieved using 2 mm sieve. The samples were subjected to routine chemical analysis as described by Tel (1984).

Crop establishment and experimental design: The treatments were 15 cassava genotypes: AR-1-82, NR02/00I8, NR02/0007, CR-12-45, TMS01/1368, TME98/2132, TMS03/0155, NR03/0174, CR-36-5, NR03/0211, AR-37-108, TMS01/1412, TMS01/1371, TMS01/1206, TMS30572 obtained from the National Root Crops Research Institute, Umudike and one local check. The design was a randomized complete block design (RCBD) with three replications per trial. The plot size was 6 x 5 m and was separated from one another by 1 m distance. The cassava sticks were cut 30 cm long and planted at a spacing of 1 m apart. The cuttings were planted such that about 20 cm or 4 to 5 nodes were inside the ground and necessary husbandry practices were carried out. Manual hoe weeding was done three times and fertilizer, NPK-Mg, 12:12:12:2 was applied at the rate of 400kg/ha (Enwezor *et al.*, 1989).Each field was harvested at 9 months after planting.

Diseases assessment: Cassava mosaic disease (CMD) was characterized by a pathologist using known observable symptoms. The visual assessment was done using a 5 point hedonic scale where:

0 = No sign of infection or symptom;

1 = mild distortion at the base of the leaflet only

2= moderate narrowing and distortion of the 1-3 of the leaflet

3 = severe mosaic distortion of the 2-3 of the leaflets and general reduction of leaf size

4 = severe mosaic distortion of the entire leaf

The assessments were done at intervals of 1, 3 and 6 months after planting and the average was calculated and used as the disease parameter.

Similarly, root-rot was determined based on the evidence of rot on the harvested tubers using visual assessment where:

0 = No root-rot
1 = < 25% root-rot
2 = 26 – 50% root-rot
3 = 51-75%
4 = 76% and above

Data collection: All data were collected from the middle rows containing six plants. Data were collected on the survival counts, plant height, number of branches, tuber weights, tuber length, presence or absence of disease and severity.

Statistical data analysis: The data were analyzed by one way analysis of variance test using Statistical Analysis System (SAS) package. Treatment means were compared by the Least Significant Difference technique (Steel & Terrie, 1980) at $P \leq 0.05$ levels. Cluster analysis was performed to group the genotypes into characteristic similarities. Disease incidences and severities were graphically presented using excel chart wizard.

RESULTS

Pre-planting soil properties showed that the soils of the study area were slightly acidic, moderate in organic matter content and low in Nitrogen content (Table 1). The meteorological data for the period of studies in the area are summarized in Table 2. Rainfall stability was earlier and also higher in intensity in the year 2009 than 2008. Soil temperature was higher in 2008 than in 2009 from January to April and very low in May, 2008. Wind speed was very high in 2009 and maintained higher speed rate from January to December than what was obtained in 2008.

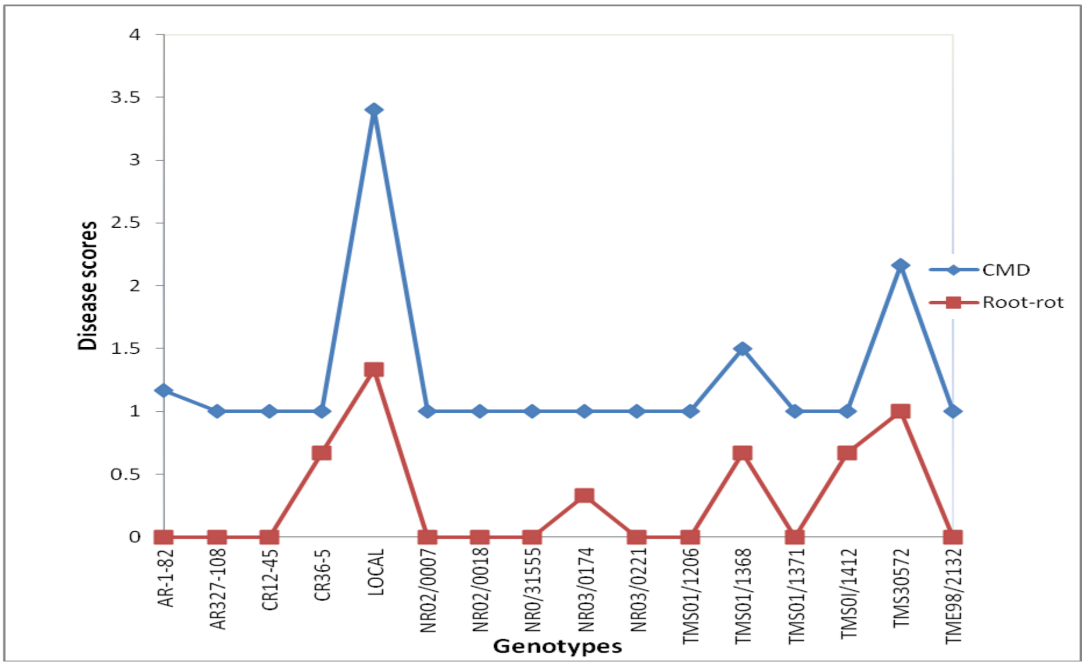

Fig. 1 Incidences of CMD and Root rot diseases averaged over 2008 and 2009 cropping seasons

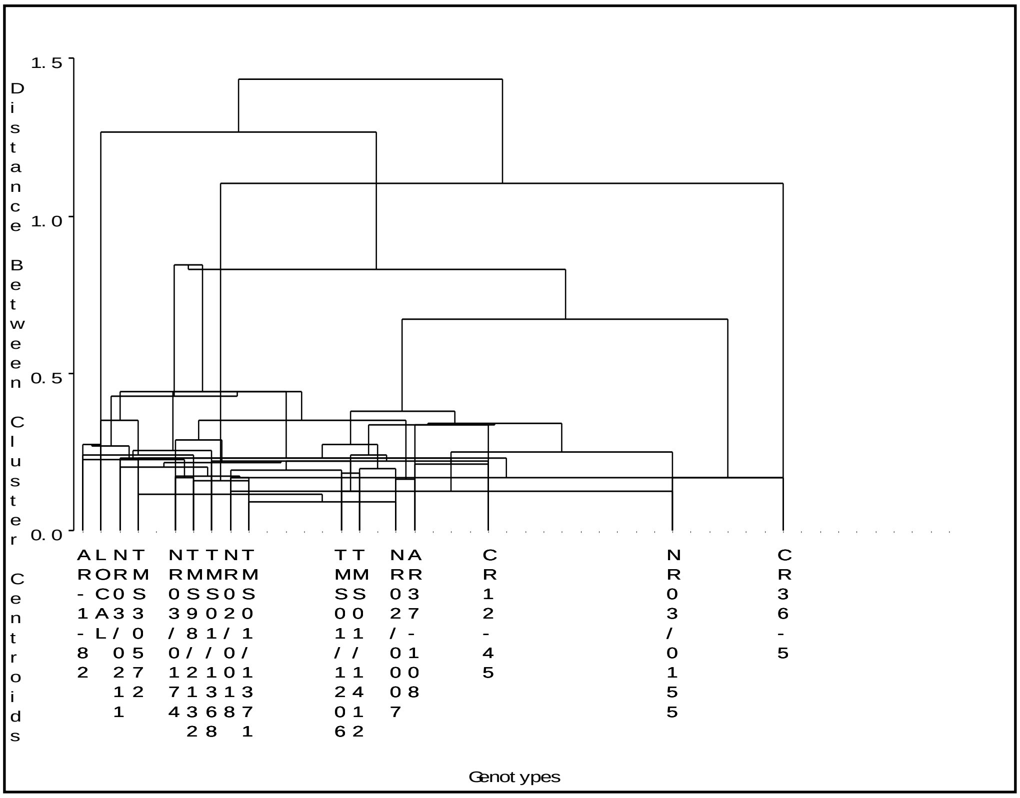

Fig. 2 Dendrogram showing groupings of genotypes into characteristic similarities

Table1. Pre-planting soil properties

Soil properties	2008	2009
pH (H20)	5.44	5.36
Organic matter (%)	2.60	2.55
Nitrogen (%)	0.10	0.11
Phosphorus (ppm)	17.70	18.06
Magnesium(meq/100g)	2.60	2.65
Calcium (meq/100/g	8.85	8.90
Sodium (meq/100g)	012	0.12
Potassium (meq/100g)	0.12	4.43
CEC (meq/100g)	4.40	4.41
H^+ (meq/100g)	13.60	13.43
Al^{3+} (meq/100g)	Nil	Nil

Table 2. Weather records for the site of the experiments for 2008 and 2009 cropping season

	2008				2009			
Month	Total rainfall (mm)	Soil temp (^oC)	Total radiation (cal/cm^2/hr^1)	Wind speed (kmhr^1)	Total rainfall (mm)	Soil temp (^oC)	Total radiation (cal/cm^2/hr^1)	Wind Speed (kmhr^1)
Jan	4.6	29.2	918.2	124.0	0.0	28.1	949.9	56.5
Feb	0.0	30.4	930.8	151.9	45.0	31.3	849.9	109.5
Mar	3.0	32.6	962.1	163.3	168.2	30.4	919.9	119.4
Apr	173.7	31.0	868.3	167.7	164.7	29.6	811.8	75.1
May	96.6	20.7	818.7	124.2	341.9	28.3	843.1	50.2
Jun	206.4	28.2	745.7	93.0	196.0	27.8	717.1	51.5
Jul	264.8	26.4	560.7	80.9	321.4	26.4	574.8	36.5
Aug	185.5	25.8	544.2	72.3	345.6	25.7	481.3	35.4
Sept	235.6	26.8	676.2	57.5	200.6	26.5	633.8	27.7
Oct	210.6	27.6	760.9	53.9	227.0	26.4	669.6	20.9
Nov	6.1	29.8	849.0	50.7	9.9	28.9	926.9	22.3
Dec	36.1	28.6	746.9	65.9	0.0	28.2	1018.1	64.8

Growth parameters: Variability in most growth parameters of the 16 genotypes were significant ($p \leq 0$ .05) in both 2008 and 2009 cropping seasons (Table 3). Genotypes which produced high number of main branches (AR37-108, CR12-45, NR03/174, NRO3/0221, TMS01/1371 and TMS10/1412 had low plant height in 2008 and maintained same trend in 2009. The Local genotype significantly ($p \leq 0$ .05) recorded the highest plant height in both years. Among all the cassava genotypes, plant height varied from 150.4 cm to 300.4 cm in 2008 and from 150.0 to 306.0 cm in 2009. Genotype AR37-108 had the longest root length while NR03/1555 had the shortest root length in both years.

Yield parameters: There were significant differences in stem yield among the genotypes (Table 4). Highest stem yield (780 bundles/ha) was obtained from TMS01/1368 while the lowest yield (320 bundles/ha) came from NR03/1555 in 2008. In 2009 cropping season, the stem yield varied from 373 bundles to 745 bundles/ha. Root yield (t/ha) was significantly ($P \leq 0.05$) lowest with the Local genotype compared with the improved genotypes in 2008 and also maintained the same trend in 2009 cropping season. Among the improved genotypes, TMS98/2132 significantly ($p \leq 0$ .05) recorded the highest root yield (42.04 t/ha) in 2008 and (43.50 t/ha) in 2009. Highest number of roots/stand was obtained from TMS 2132 in 2008 whereas CR36-5 produced the highest number of roots/stand in 2009.

Disease parameters: Cassava mosaic disease (CMD) incidences were observed in all the 16 genotypes though with varying levels of infection while root rot disease was totally absent in some genotypes (Fig. 1).The Local genotype appeared to be more susceptible to both CMD and root rot diseases among all the genotypes evaluated. Incidence of CMD was mild among the improved genotypes except TMS30572 and TMS01/1368 where it was severe whereas root rot was totally absent.

Table 3. Growth parameters of 16 cassava genotypes in 2008 and 2009 cropping season

	2008			2009		
Genotypes	Number of main branches/stand	Plant height(cm)	Root length (cm)	Number of main branches/stand	Plant Height (cm)	Root Length (cm)
AR-1-82	2.81	175.0	54.3	3.10	180.0	58.98
AR37-108	3.61	298.5	85.0	3.76	298.3	90.21
CR12-45	3.91	240.6	60.3	4.08	241.7	60.0
CR36-5	1.82	230.9	71.7	1.87	231.7	69.98
TMS98/2132	2.84	210.0	63.7	2.87	107.0	67.34
NR02/007	3.30	155.5	57.3	3.23	148.7	57.98
NR02/0018	3.14	205.0	57.8	3.15	204.3	61.0
NR03/1555	3.26	233.3	49.3	3.21	232.0	50.21
NR03/174	2.94	176.8	60.8	2.89	163.7	60.23
NR03/0221	2.83	164.0	61.0	2.87	215.0	63.21
TMS01/1206	2.02	211.2	64.7	2.13	210.0	64.93
TMS01/1368	3.44	211.0	52.7	3.34	150.0	54.48
TMS01/1371	3.91	150.4	52.2	3.76	171.7	43.25
TMS01/1412	4.43	171.6	53.0	4.65	194.0	53.79
TMS30572	3.11	194.5	52.8	3.14	210.0	54.24
LOCAL	2.19	300.4	60.0	2.23	306.0	62.60
LSD (5%)	1.01	24.9	19.86	1.20	25.35	20.04

Table 4. Yield parameters of 16 cassava genotypes for 2008 and 2009 cropping season

	2008			2009		
Genotypes	Stem bundles/ha	Root weight (t/ha)	Number of root/stand	Stem bundles/ha	Root weight (t/ha)	Number of root/stand
AR-1-82	460	20.0	5.6	510	22.0	4.94
AR37-108	580	22.06	4.8	600	24.0	4.99
CR12-45	600	32.20	6.7	590	34.20	6.56
CR36-5	580	28.80	7.10	632	30.30	7.60
TMS98/2132	680	42.04	7.50	698	43.50	6.7
NR02/007	620	21.40	6.10	623	26.23	5.89
NR02/0018	410	22.40	6.80	462	28.50	6.20
NR03/1555	320	26.14	6.81	373	26.80	6.86
NR03/174	450	26.46	4.30	512	27.0	4.25
NR03/0221	460	25.06	4.21	510	28.06	4.24
TMS01/1206	710	24.0	6.35	689	25.45	7.10
TMS01/1368	780	27.20	5.58	745	27.19	6.25
TMS01/1371	640	34.20	6.70	634	28.23	7.0
TMS01/1412	490	27.0	5.59	512	32.24	5.6
TMS30572	480	26.20	5.50	523	32.0	6.24
LOCAL	690	18.66	3.4	509	24.67	4.10
LSD (5%)	21.0	4.25	2.45	23.4	3.87	2.20

DISCUSSION

Weather and climatic conditions of any agricultural zone are major contributory factors to the success of rain-fed agriculture of this area. Rainfall stability was earlier and also higher in intensity in the year 2009 than 2008. This probably explained differences in yield in both years.

Growth parameters: Plant height or branching pattern is an inherent trait of crop plants. In this study, cassava genotypes which produced multiple branches had low plant height. Differences in time of planting, intensity of rainfall, soil temperature and total radiation probably influenced growth and yield differences in 2008 and 2009. Odedina *et al* (2009) earlier reported varying growth yields among cassava genotype grown in different environments.

Yield parameters: Stem yield was generally high with a range of 320-780 bundles/ha in 2008 and 373-745 bundles/ha in 2009 compared to 400-600 bundles/ha estimated by Eke-Okoro (2005) cited by Odedina et al (2009). TMS01/1368, the Local genotype generally among the improved variectes had the highest sten yeald and had the lowest root yield suggesting that high yield of stem in cassava is at the expense of root yield. The finding corroborates the report of Mbah et al (2005) that increased number of shoots per plant diverted photosynthates to stem and internodes elongation at the expense of root development. Cassava root yield was generally higher in 2009 than in 2008 and this could be attributed to earlier planting in 2009 as the rains came early (March) and stabilized, whereas 2008 cropping season witnessed sparse rainfall that started in April and stabilized in May. Other yield indices such as number of main branches per stand and number of roots per stand did not differ significantly in almost all the genotypes in both seasons suggesting a manifestation of pure genetic traits that were not affected by environmental factors.

Diseases parameters: Cassava is known to be attacked by many diseases but only cassava mosaic disease (CMD) and cassava root rot (CRR) were assessed in this study because of their prevalence in the study area. All the genotypes evaluated in this study were attacked by the CMD but the attack did not inflict any noticeable yield reduction especially on the majority of the improved genotypes. This result is similar to the observation by Nweke *et al* (1999) that CMD and CRR did not seem to have adverse effects on yield because the improved varieties which were widely grown had become more tolerant of the diseases than the local land races. The less tolerant improved genotypes in this study are likely to have similar characteristics with the local land race and this is confirmed by the cluster analysis. The inability of the improved genoytpes to tolerate these diseases could probably be part of the reasons for the consistent low yield maintained by few improved genotypes and the local land race in the two cropping seasons.

CONCLUSION

All the genotypes evaluated in this study expressed distinct genetic capability in terms of growth, disease tolerance, components of yield and actual root yield. Root yield of TMS98/2132 was consistently the highest in the two years of evaluation. All other genotypes manifested change-order interaction with respect to root yield. However, the root yield of CR12-45 and TMS01/1371 were high with slight rank-order change across the two years. Averaged over two years, the highest root yielder in order of importance were TMS98/2132, CR12-45, and TMS01/1371; suggesting that these genotypes were the most adaptable to Nsukka agro-ecology. It was also apparent in this study that seasonal differences in environmental factors such as rainfall (timing, amount and intensity), temperature, wind speed and total radiation probably caused variability in yield parameters of cassava genotypes during the two-year evaluation period as reported in this study.

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