

Cassava Genotypes Response to The African Cassava Mosaic Disease In Rainforest Agro ecological Zone

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Abstract

Twelve cassava genotypes were evaluated in the field in two cropping seasons at two locations (Agharho and Uyo) of Nigeria for their reaction to African cassava mosaic disease (ACMD) using visual injury score as the index for resistance. Combined analyses of variance for ACMD and fresh tuberous root yield showed significant ($P < 0.05$) sums of squares for genotypes, environments and G x E interaction. The highest fresh tuberous root yield values of 28.8, 27.0 and 25.7 t/ha were produced by 82/00058, TMS 30572 and TMS 50395, respectively, at 12 months after planting. Lowest indices for ACMD were recorded at Uyo and were significantly different from Agharho indices. TMS 82/00959, 82/00058, TMS 30572 and TMS 50395 showed resistance to ACMD. There was significant negative correlation between ACMD and fresh tuberous root yield. Thus, there is a need to intensify efforts in making available ACMD resistant genotypes to the farmers in this agro-ecological zone.

Keywords: Cassava, Cassava Mosaic, Rainforest Agro ecological Zone

INTRODUCTION

Cassava (*Manihot esculenta* Crantz) is the seventh most important crop of the world and constitutes a staple food for an estimated 800 million people, one-eighth of the world population (CIAT, 1993). Diseases and pests constitute one of the greatest constraint to cassava production in Africa (Theiberge, 1985). Cassava pests reduce root yield by an estimated 50% in the African continent. The yield losses vary with pests and diseases, and the prevailing climatic conditions (Yaninek, 1994). Of the diseases of cassava, African Cassava Mosaic Disease (ACMD) is one of the most important (Yaninek, 1994). Yield losses for individual susceptible cultivars due to ACMD range from 20 to 90% (Beck and Chant, 1958; Briant and Johns, 1940). The causal agent of ACMD is a Geminivirus of the family Geminiviridae (Sub family III) transmitted by whitefly (*Bemisia tabaci* Gem.).

Many workers have demonstrated that ACMD, is a serious disease of the crop (Hahn et al., 1989; Yanink, 1994). Symptoms of ACMD include reduced leaf size, distorted and twisted with chlorotic areas separated by green areas of the leaves (Hahn et al. 1980).

In Nigeria, cassava production has been seriously threatened by ACMD in recent years and different methods have been used in the control of the disease. These include cultural practices (Akinlosotu, 1982), use of resistant cultivars (Atu and Okeke, 1981), biological control and breeding for resistance (Hahn et al., 1981). Of these measures, the use of resistant cultivars and biological control offer a more permanent, sustainable and safe control of the pests (Yaninek, 1994).

One way to ensure this is to select cultivars with adequate levels of resistance to this disease. The objective of this study was to identify cassava genotypes that show low levels of damage by ACMD rainforest agro-ecological zone of Nigeria.

Table 1. Injury scores for African cassava mosaic disease (ACMD) according to Hahn et al., 1989.

Injury score	Severity rating	injury symptoms	Percentage of damage done to plants
ACMD:			
1	Healthy	No visible symptoms	0
2	Mild	A mild distortion only at the base of leaflets with the remainder of leaflets appearing green and healthy	1-5
3	Moderate	Conspicuous mosaic pattern throughout leaf, narrowing and distortion of lower one-third of leaflets	6-50
4	Severe	Severe mosaic, distortion of two-thirds of leaflets and general reduction of leafsize	51-75
5	Very severe	Severe mosaic distortion of four-fifths of leaflets, twisted and mishapen leaves	above 75

Table 2. Combined analyses of variance over two locations and two years for sums of squares of fresh tuberous root yield and African cassava mosaic disease of 12 cassava genotypes.

Sources of Variation	D.f	Fresh tuberous root yield	African cassava mosaic disease
Environment (Env)	3	24819*	15.9*
Rep (Env)	12	2330*	13.2*
Genotype (G)	11	2168*	8.1*
G x E	33	2613*	1.6*

* = significant at $P < 0.05$

MATERIALS AND METHODS

Experimental sites

This study used data collected as part of breeding programmes aimed at identifying cassava genotypes, that are stable yielding in Mangrove swamp forest of Nigeria. Twelve improved IITA genotypes (TMS 30572, TMS 82/00058, TMS 91934, TMS 81/01635, TMS 81/00110, TMS 50395, TMS 82/00942, TMS 30555, TMS 82/00959, TMS 90059 and TMS 4(2)1425) were grown in two locations ((Agbarho (Longitude: 05¹ 44° E, Latitude: 05¹ 31° N, temperature: 28°C, relative humidity: 65-80%, rainfall: 2624mm; altitude: 30masl; soil type: thionic fluvisols), and Uyo (08¹ 30° E, 04 48° N, temperature: 28°C, relative humidity: 68-89%, rainfall: 1560mm; soil type: thionic fluvisols; altitude: 33masl) in Nigeria from 1992 to 1994. The agro-ecological characteristics of the location were collected from IITA Agroclimatological Unit. The genotypes were grown under rainfed conditions at these locations. These sites were chosen to adequately sample the main cassava growing areas of Mangrove swamp forest of Nigeria (Nweke, 1996).

Experimental areas were cleared, ploughed, harrowed, and ridged with a tractor. The experimental design used at each location was the randomized complete block design with four replications. Each plot was 10cm long and 1m apart stem cuttings, each 30 cm long and having at least four nodes, were used as planting material. At 12 months after planting, harvesting was done by hand, stems were cut and tuberous roots uprooted from the soil. The fresh tuberous root weight was determined.

Data collection and analyses

Evaluation of the genotypes for resistance to ACMD in the field was based on the injury done to each genotype by ACMD. Disease severities for ACMD was scored visually on a plot basis on a scale of 1-5 on per individual (Table 1) (Hahn et al., 1989; Yaninek, 1994). The assessment of the genotypes for injury was done at 3, 6, 9 and 12 MAP in both locations. The data on plant damage was collected on the four middle rows per plot which at maturity were used for yield data. Statistical analyses were done on injury scores and fresh tuberous root dry weight (SAS, 1996). The general linear model (GLM) procedure was used for producing analyses of variances and were computed as differences between treatment means and compared by Duncans' Multiple Range Test at $P < 0.05$.

Table 3. Mean of ACMD injury scores and fresh tuberous root weight in Agharho and Uyo at different crop ages. 6.8, 27.0 25.7 by 82/00058, TMS 30572 and TMS 50395

Genotype	Agharho					Uyo				
	3MAP	6MAP	9MAP	12MAP	FTRY	3MAP	6MAP	9MAP	12MAP	FTRY
1992/1993 planting season										
TMS 30572	1.5b	1.6ab	1.9b	1.8ab	26.0a	1.8ab	1.3b	2.0b	2.0ab	27.7a
TMS 91934	2.0a	2.3a	2.6ab	2.0ab	18.0b	2.2a	2.4a	1.7b	2.2b	17.4b
TMS 81/01635	2.0a	1.7ab	2.5ab	2.0a-c	17.0b	2.0ab	1.8ab	1.8b	1.7b	17.0b
TMS 50395	2.0a	2.3a	3.0a	2.3a	25.7a	1.8a-c	1.8ab	1.7b	1.3b	24.0a
TMS 82/00661	1.4b	2.0ab	2.2b	2.0ab	19.0b	2.0ab	1.6ab	1.3c	1.3c	19.0b
TMS 82/00058	1.8ab	2.1ab	2.1b	2.0ab	27.8a	2.0ab	1.7ab	1.4c	1.4c	25.0a
TMS 81/00110	1.5b	1.8ab	2.5ab	1.9ab	19.0b	1.8a-d	1.7ab	2.3ab	2.3a	16.0b
TMS 82/00942	1.8ab	1.7ab	2.7ab	2.4a	23.0ab	1.4cd	1.3b	2.7a	2.8a	16.0b
TMS 4(2)1425	1.8ab	2.2a	2.6ab	1.8ab	19.0b	1.5b-d	1.5ab	1.4c	2.0ab	19.0b
TMS 30555	1.3b	1.7ab	1.5c	1.4b	18.0b	1.2cd	1.3b	1.1c	1.9ab	17.0b
TMS 82/00959	1.0b	1.3ab	1.2c	1.5b	18.0b	1.7a-d	1.7ab	1.5c	1.4b	19.0b
TMS 90059	1.0b	1.2b	1.3c	1.9ab	20.0b	1.5b-d	1.8ab	1.0c	1.8b	21.0b
1993/1994 planting season										
TMS 30572	1.6a	1.8b	2.5a	2.2a	25.0a	1.8a	1.4b	1.9a	1.6b	24.7a
TMS 91934	1.5a	2.2a	2.5a	2.3a	17.0b	1.2b	1.8a	1.5b	1.4b	16.4b
TMS 81/01635	1.5a	2.2a	2.6a	2.0ab	17.0b	1.3b	1.9a	1.8b	1.7a	14.0b
TMS 50395	1.5a	2.3a	2.4a	2.0ab	24.4a	1.8a	1.8a	1.7b	1.3b	23.0a
TMS 82/00661	1.6a	2.0ab	1.7c	1.5b	19.0b	1.2b	1.5b	1.7b	1.3b	19.0b
TMS 82/00058	1.3ab	2.0ab	1.7c	1.8b	26.4a	1.8a	1.8a	1.6b	1.7a	24.0a
TMS 81/00110	1.5ab	1.8b	1.9b	1.9ab	18.0b	1.9a	1.9a	2.1a	1.4b	17.0b
TMS 82/00942	1.4ab	1.7b	2.0b	2.0ab	23.0	1.7a	2.3a	1.9a	1.8a	13.0b
TMS 4(2)1425	1.5ab	2.0ab	2.5a	1.8ab	18.0b	1.5b	1.7ab	1.9a	1.9a	17.0b
TMS 30555	1.3b	1.2c	1.8c	1.4b	18.0b	1.2b	1.5b	1.3b	1.8a	18.0b
TMS 82/00959	1.3b	1.3c	1.6c	1.6b	18.0b	1.7a	1.5b	1.5b	1.4b	19.0b
TMS 90059	1.2b	1.3c	1.7c	1.5b	21.0b	1.6b	1.6ab	1.6b	1.6b	20.0b

Means in the same column and in the same planting season with the same letter(s) are not significantly different at P 0.05. FTRY=Fresh tuberous root weight (t/ha)

RESULTS AND DISCUSSION

Combined analyses of variance for fresh tuberous root yield and ACMD showed significant ($P < 0.05$) sums of squares for genotypes, environments and G x E interaction (Table 2). The differences in environmental effects demonstrated that genotypes responded differently to variation in environmental conditions. This justifies specific adaptation as a goal for local breeding programmes. Similar results have been reported on cassava genotypes (Cock, 1985; Bueno 1986; Akparobi et al 2003) they reported that environmental factors such as temperature, rainfall, solar radiation and soil conditions have strong influences on fresh tuberous root yield.

Also, the result showed that injury scores differed significantly ($P < 0.05$) between the two locations (Table 2). This confirms the significance of the interaction between environment by genotype on disease infestation in cassava. Differences in disease development at Agharho and Uyo were probably due to higher concentration of inoculum in the surrounding cassava fields at Agharho, and could partly be explained also by the high density and the severity of cassava pests at SHELL / IITA's plot where field testing of breeders' selections is being carried out. The resistance of cassava genotypes to disease attack when exposed to natural conditions of infestation and spread of disease was reported by Hahn et al., (1989).

Genotypic differences ($P < 0.01$) were observed among the tested genotypes for fresh tuberous root yield and ACMD (Table 3). The highest fresh tuberous root yield values of 28.8, 27.0 and 25.7 t/ha were produced by 82/00058, TMS 30572 and TMS 50395, respectively, at 12 months after planting. Similar results have been reported by Cock (1985), Ekanayake et al., (1997) and Akparobi et al., (2002) who observed clonal differences among cassava cultivars for tuberous root weight. Among the genotypes tested, TMS 82/00959, 82/00058, TMS 30572 and TMS 50395 showed resistance to ACMD. The results of the injury scores revealed that a valid deduction on the resistance of the cassava cultivars to ACMD could not be made from the data of a single score from the same location due to variations in the score of the same genotype at different scoring time. So only a genotype that consistently had a mild injury score over time and locations can be regarded as resistant. The differences in disease severity among the genotypes may be attributed to inherent resistance mechanisms. Differences in resistance of cassava cultivars to some pests and diseases have been reported by Hahn et al., 1989 and Rossel et al., 1994.

The result showed negative coefficient for fresh tuberous root weight vs ACMD ($r = -0.66^*$, $n=24$). This suggests that the cassava genotypes with high tuberous root yield are those with low tolerance to ACMD. Thus, there is a need to intensify efforts in making available ACMD resistant genotypes to the farmers in this agro-ecological zone.

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