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GENOTYPE X ENVIRONMENT EFFECTS ON CASSAVA RESPONSE TO THE AFRICAN CASSAVA MOSAIC DISEASE IN DERIVED GUNIEA SAVANNAH OF NIGERIA

S. O. AKPAROBI, F. U. OKONMAH, F.O. TOBIH, and E.O. EGHO

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ABSTRACT

Twelve cassava genotypes were evaluated in the field in two cropping seasons at two locations (Ibadan and Ilorin) 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 yields were recorded for TMS 50395, TMS 82/00661, TMS 82/00058, TMS 91934 and TMS 81/01635 at 12 months after planting. Lowest indices for ACMD were recorded at Ilorin and were significantly different from Ibadan indices. TMS 82/00058, TMS 30572 and TMS 50395 showed resistance to ACMD. There was significant negative correlation ($r = 0.69^*$, $n=24$) 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 derived guinea savannah agro-ecological zone.

KEY WORDS: Genotypes, resistance, tuberous root yield, injury scores, disease.

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). African Cassava Mosaic Disease (ACMD) is one of the most important disease of cassava (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; Yaninek, 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.*, 1989). 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 derived guinea savannah agro-ecological zone of Nigeria.

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 derived guinea savannah 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 ((Ilorin: Derived guinea savannah zone, annual rainfall: 1000 – 1300 mm, longitude: 03° 50°E, latitude: 07° 52°N, temperature: 30°C, relative humidity: 64-80%) and Ibadan (Derived guinea savannah zone, altitude: 210 metres above sea level (masl), relative humidity: 65-90%, latitude: 4°46'N, longitude: 2°34'E, temperature: 28±6°C, rainfall: 1545mm)) 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 derived guinea savannah 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 10m square. Stem cuttings of each 30 cm long and having at least four nodes, were used as planting material at spacing of 1 m apart. 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 $P<0.05$.

S. O. Akparobi, Department of Agronomy, Faculty of Agriculture, Delta State University, Asaba Campus, Delta State, Nigeria
F. U. Okonmah, Department of Agronomy, Faculty of Agriculture, Delta State University, Asaba Campus, Delta State, Nigeria
F.O. Tobih, Department of Agronomy, Faculty of Agriculture, Delta State University, Asaba Campus, Delta State, Nigeria
E.O. Egho, Department of Agronomy, Faculty of Agriculture, Delta State University, Asaba Campus, Delta State, Nigeria

Table 1: Symptom severity 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 mosiac. 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

RESULTS

The result showed that the combined analyses of variance for fresh tuberous root yield and ACMD were significant ($P<0.05$) for sums of squares in genotypes, environments and G x E interaction (Table 2) Also, the result showed that injury scores differed significantly ($P<0.05$) between the two locations (Table 2).

Genotypic differences ($P<0.01$) were observed among the tested genotypes for fresh tuberous root yield and ACMD (Table 2). The highest fresh tuberous root yields were produced by TMS 50395, TMS 82/00661, TMS 82/00058, TMS 91934 and TMS 81/01635 at 12 months after planting (Table 3) Injury scores varied with genotype and location However, TMS 30001 and TME1 consistently scored lowest for ACMD at both locations, while TMS 30572, TME2, TMS 50395 and Oko-Iyawo showed moderate resistance to ACMD; and Danduala was susceptible to ACMD in both locations (Table 3) The result showed negative coefficient for fresh tuberous root weight vs ACMD ($r = 0.69^*$, $n=24$)

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	24917*	16.5*
Rep (Env)	12	2437*	14.3*
Genotype (G)	11	2269*	7.7*
G x E	33	2706*	1.7*

* = significant at $P < 0.05$

Table 3. Mean of ACMD injury scores and fresh tuberous root weight in Ibadan and Ilorin at different crop ages in two cropping seasons.

Genotype	Ibadan					Ilorin				
	3MAP	6MAP	9MAP	12MAP	FTRY	3MAP	6MAP	9MAP	12MAP	FTRY
					1992/1993 planting season					
TMS 30572	1.0b	1.3ab	1.6b	1.5b	24a-c	1.4cd	1.4b	1.5c	1.5c	23ab
TMS 91934	2.0a	2.3a	2.6ab	2.0ab	24a-c	2.2a	2.4a	1.7b	2.2b	18ab
TMS 81/01635	2.0a	1.7ab	2.5ab	2.0a-c	24a-c	2.0ab	1.8ab	1.8b	1.7b	23ab
TMS 50395	1.5b	1.7ab	1.6b	1 5b	24a-c	1.6a-c	1.4b	1.7b	1.3c	25a
TMS 82/00661	1.5b	2.0ab	2.2b	2 0ab	25.1ab	2.0ab	1.6ab	1.3c	1.3c	24ab
TMS 82/00058	1.0b	1.3b	1.4c	1 5b	25.4a	1.2cd	1.3b	1.4c	1.4c	24ab
TMS 81/00110	1.6b	1.8ab	2.5ab	1 9ab	22a-d	1.8a-d	1.7ab	2.3ab	2.3a	23ab
TMS 82/00942	1.8ab	1.7ab	2.7ab	2 4a	18c-e	1.4cd	1.3b	2.7a	2.8a	21ab
TMS 4(2)1425	1.8ab	2.2a	2.6ab	1 8ab	24a-c	1.5b-d	1.5ab	1.4c	2.0ab	25a
TMS 30555	1.5b	1.7ab	1.5c	1 4b	13e	1.2cd	1.3b	1.1c	1.9ab	17b
TMS 82/00959	1.0b	1.3ab	1.2c	1.5b	14e	1.7a-d	1.7ab	1.5c	1.4b	18ab
TMS 90059	1.0b	1.3b	1.4c	1.9ab	19be	1.6b-d	1.8ab	1.0c	1.8b	23ab
					1993/1994 planting season					
TMS 30572	1.5ab	1.4c	1.6c	1.6b	28.2ab	1.4b	1.5b	1.6b	1.7b	28ab
TMS 91934	1.6a	2.2a	2.5a	2.3a	30.9a	1.2b	1.8a	1.5b	1.4b	29ab
TMS 81/01635	1.6a	2.2a	2.6a	2.0ab	29ab	1.3b	1.9a	1.8b	1.7a	27b
TMS 50395	1.5ab	1.4c	1.6c	1.5b	28.0ab	1.6a	1.5a	1.6b	1.3b	33a
TMS 82/00661	1.6a	2.0ab	1.7c	1.6b	28.0ab	1.2b	1.5b	1.7b	1.3b	29ab
TMS 82/00058	1.4ab	1.3c	1.7c	1.5b	25.8bc	1.2a	1.5b	1.6b	1.5b	29ab
TMS 81/00110	1.5ab	1 8b	1.9b	1.9ab	20.5d-f	1.9a	1.9a	2.1a	1.4b	22c
TMS 82/00942	1.5ab	1.8b	2.0b	2.0ab	24.5b-d	1.7a	2.3a	1.9a	1.9a	26b
TMS 4(2)1425	1.5ab	2.0ab	2.5a	1.8ab	16.9f	1.5b	1.7ab	1.9a	1.9a	22c
TMS 30555	1.3b	1.2c	1.8c	1.5b	22.2ce	1.2b	1 6b	1.3b	1.8a	23c
TMS 82/00959	1.4b	1.3c	1.6c	1.6b	17.0f	1.7a	1 5b	1 5b	1.4b	19d
TMS 90059	1.3b	1.4c	1.8c	1.6b	18.4ef	1 7b	1 7ab	1 7b	1.7b	20d

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 yield.

DISCUSSION

Combined analyses of variance for fresh tuberous root yield and ACMD showed significant sums of squares for genotypes, environments and G x E interaction. 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 between the two locations. This confirms the significance of the interaction between environment by genotype on disease infestation in cassava Differences in disease development at Ibadan and Ilorin were probably due to higher concentration of inoculum in the surrounding cassava fields at Ibadan, and could partly be explained also by the high density and the severity of cassava pests at 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).

The genotypic differences observed among the tested genotypes for fresh tuberous root yield and ACMD, confirms earlier report 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 82/00058, 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 This suggest 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 derived guinea savannah agro-ecological zone of Nigeria. Also, these identified genotypes should be used for further breeding programmes targeted for derived guinea savannah zones.

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