



## Response of African Yam Bean to Cucumber Mosaic Virus Infection in South-Western Ecology

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### Abstract

Plant viruses are one of the biotic factors limiting the yield of agricultural crops. The infection of fifteen accessions of African Yam Bean (AYB) by Cucumber Mosaic Virus (CMV) was investigated in three locations in 2016 and 2017 planting seasons. Leaf samples were collected before flowering and were subjected to serological assay using double antibody sandwich Enzyme-linked immunosorbent assay (DAS ELISA). Location, year, accessions and their interactions were significant for CMV titres while location alone was significant for pod number at 1% level of probability. Ibadan had the least occurrence of CMV in 2016 and the virus was absent in the same location in 2017. The occurrence of CMV in Ile-Ife and Kishi was higher in 2016 than in 2017. In each of the two locations, six accessions were positive in 2016 and one accession was positive to CMV in 2017. Three accessions; AYB 45, NGB01349 and TSs152 were not infected with CMV during the two years, implying that the accessions will be good candidates for a breeding program against CMV disease. Principal component analysis revealed that PC1, PC2 and PC3 contributed 28.95%, 18.58% and 12.42% respectively of the total variation observed. Cluster analysis grouped the accessions into three at distance 6.4 with TSs 64 being the only accession in group 1 while the third group comprised ten accessions. Identification of virus resistant genotypes is a prerequisite to a successful breeding program and forms the basis for sustainable disease management. Therefore, AYB 45, NGB01349 and TSs152 can be used in further studies for breeding of resistance varieties of AYB.

**Keywords:** African yam bean; Disease; Genotype; Infection; Virus

### Introduction

*Sphenostylis stenocarpa* (Hoechst. ex. A. Rich.) Harms popularly known as African Yam Bean is regarded as a minor grain legume because of its underutilization (Saka *et al.*, 2004). The cultivation of African Yam Bean (AYB) in different parts of Africa has been reported by several authors (Klu *et al.*, 2001; Saka *et al.*, 2007; Ogah, 2011). The crop has a dual purpose because it produces edible seeds and tubers (Adewale and Dumet, 2011). The protein content of AYB tubers is more than twice that in Sweet potatoes (*Ipomea batatas*) or Irish potatoes (*Solanum tuberosum*) and much higher than that in Yam and Cassava

(Amoatey *et al.*, 2000). The amino acid content of AYB was reported to be higher than that found in pigeon pea, cowpea and bambara groundnut (Uguru and Madukaife, 2001) and it equally has similar essential proteins as soybean (Norman and Cunningham, 2006).

Despite all the nutritional qualities of AYB, its production is limited by pests and diseases among which virus diseases is one, Cucumber Mosaic Virus (CMV) is one of the commonly encountered viruses worldwide infecting more than 1300 plant species in 500 genera belonging to over 100 families (Garcia-Arenal and Palukaitis, 2008). It belongs to the genus *Cucumovirus*

in the family Bromoviridae (Li *et al.*, 2016). The genome of CMV comprises three linear, positive-sense single-stranded RNAs, each encapsidated in 29 nm diameter icosahedral virion. Transmission of CMV is by more than 80 species of aphid in a non-persistent manner (Palukaitis and Garcia-Arenal, 2003).

In view of limited information on virus diseases of AYB, this study aimed at investigating the occurrence of CMV in AYB accessions and evaluating the effect of the virus on grain yield.

### Materials and Methods

Seeds of fifteen accessions of African Yam Bean were obtained from the Institute of Agricultural Research and Training (IAR&T), Genetic Resources Centre of the International Institute of Tropical Agriculture (IITA) and the National Centre for Genetic Resource and Biotechnology (NACGRAB) Ibadan, Nigeria. Two seeds per hill were planted at a spacing of 1m x 1m in a Randomized Complete Block Design (RCBD) with three replicates in Ibadan (transition forest zone; 7°22'N, 3°50'E 182 masl), Ile-Ife (rain forest; 7°33'N4°33'E 256 masl) and Kishi (southern guinea savanna

zone; 9°05'N3°51'E 373masl) during 2016 and 2017 planting seasons. The emerged seedlings were thinned to one seedling per hill two weeks after emergence.

Grain yield was determined by weighing the total number of seeds obtained in the three replicates for each accession.

### Virus detection in African Yam Bean

Leaf samples showing mosaic patterns typical of Cucumber Mosaic Virus (CMV) were collected before flowering and transported to the Pathology Laboratory of the Institute of Agricultural Research and Training, Ibadan in an ice box. Double antibody sandwich ELISA was used to test for the presence of CMV in the samples. The ELISA kits used for the virus detection were purchased from Agdia Inc., USA and the method of Clark and Adams (1977) adopted by Kareem *et al.* (2016) was used for the detection of the virus. Each leaf sample was tested in duplicate wells and negative and positive controls were also included in duplicate wells as quality controls of the kits. Absorbance values ( $A_{405\text{ nm}}$ ) were read on a microtitre plate reader (BioTek™ ELx800) and virus titres that were twice the mean value of the negative control are considered positive.

### Data analysis

Significant accessions, location and season were determined by Analysis of variance (ANOVA) using SPSS v. 20. Cluster analysis was carried out based on CMV titres and pod number and dendrogram was used to classify the accessions into clusters.

### Results

The analysis of variance revealed that the effects of year, location, accessions and their interactions were significant on the

Table 1: Accession and place of collection of African Yam Bean

S/No.	Accession name	Place of collection
1.	AYB45	IAR&T
2.	AYB94	IAR&T
3.	AYB61	IAR&T
4.	AYB1	IAR&T
5.	AYB97B	IAR&T
6.	TSs 79	IITA
7.	TSs 152	IITA
8.	TSs 62	IITA
9.	TSs 125	IITA
10.	TSs 3	IITA
11.	NG/OA/09/11/058	NACBGRAB
12.	NG/AT/APR/01/014	NACBGRAB
13.	NG 01351	NACBGRAB
14.	NGB 01348	NACBGRAB
15.	NGB 01349	NACBGRAB

**Table 2: Location and climatic condition during the experiment**

	<b>Ibadan</b>	<b>Ile-Ife</b>	<b>Kishi</b>
Ecology	Transition zone	Rain forest	Southern guinea savanna
Latitude	7°22'N	7°33'N	9°05'N
Longitude	3°50'E	4°33'E	3°51'E
Altitude	182 m	256 m	373 m
Mean temp. (2016)	27.5°C	26.5°C	26.9°C
Mean temp. (2017)	26.9°C	25.4°C	25.1°C
Precipitation (2016)	82.9 mm	102.8 mm	70.7 mm
Precipitation (2017)	153.0 mm	164.5 mm	169.5 mm

**Table 3: Mean square values for Cucumber Mosaic Virus and grain yield**

Source of variation	Cucumber mosaic virus		Number of pod/plot	
	DF	Mean square	DF	Mean square
Rep	1	0.019**	2	11.072 <sup>ns</sup>
Year (Y)	1	1.512**	1	4.058 <sup>ns</sup>
Location (L)	2	0.019**	2	798.553**
Accession (A)	14	0.024**	14	5.721 <sup>ns</sup>
Y * L	2	0.008**	2	16.953 <sup>ns</sup>
Y*A	14	0.03**	14	10.107 <sup>ns</sup>
L*V	28	0.041**	28	11.719 <sup>ns</sup>
Y*L*A	28	0.021**	28	8.414 <sup>ns</sup>
Error	89	0.000	178	11.784 <sup>ns</sup>

DF = degree of freedom, \*\*Significant at 1% level of probability

titres of Cucumber Mosaic Virus. However number of pods per plot was similar among accessions and across years but significantly different across locations at  $P = 0.01$  level of probability (Table 3).

The ELISA result revealed that the AYB accessions were susceptible to CMV infection but with variations in years and locations. The number of accessions that were positive in 2016 was more than 2017. Six varieties out of the fifteen varieties were positive to CMV in Ibadan in 2016 while in Ile-Ife and Kishi, seven varieties were positive to the virus from each location. During 2017 growing season, there was no occurrence of the virus in all the accessions

planted in Ibadan while one occurrence was obtained in each of Ile-Ife (NG 01351) and Kishi (TSs 79). Three varieties (AYB 45, NGB01349 and TSs152) were not infected with the virus during the two years in all the locations (Table 4).

The principal component analysis showed that the highest percent variation (28.95%) in the varieties was accounted for by principal component (PC) 1, followed by PC 2 (18.58%) and then PC 3 (12.42%). The dendrogram of the titres of CMV and number of pods/plot indicated that at distance 6.4, the cluster was divided into three groups. The first group was made up of only one accession (TSs 62), the second



conditions prevailing in the three agroecologies and one of these is the rainfall pattern.

The high occurrence of CMV in 2016 and the low occurrence in 2017 could be due to the fact that the virus was more predominant in 2016 than 2017. The mean seasonal rainfall in 2016 was lower than 2017 and this could have allowed the proliferation of the aphid vector in 2016. This is in conformity with the study of Egesi *et al.* (2009) which reported that the influence of abiotic and biotic factors at a particular location in different years or different locations in a given year could affect the response of genotypes to diseases. Ibadan had lower occurrence compared to Ile-Ife and Kishi. The low occurrence of CMV in Ibadan in 2016 and its absence in 2017 may be attributed to the fact that the environmental conditions in Ibadan within the two years did not favour the proliferation of the aphid vector. Akhtar *et al.* (2010) reported that many factors could be responsible for virus disease occurrence which includes inoculum levels, environmental factors, age of plants and soil conditions.

The high percentage of PC1 in this study is an indication that it contributed greatly to the variation observed among the 15 accessions. This observation agrees with the study of Adebisi *et al.* (2006) who reported that the most important component showing variation patterns among varieties is the principal component 1.

### Conclusion

The AYB accessions used in this study were susceptible to CMV infection except AYB 45, TSs152 and NGB01349. Although in some instances, the occurrence was low but the high significant levels in year, location and accession is an indication that the virus

load was very high in positive samples and this call for a serious caution. If any of the factors of disease triangle (host plant, pathogen and environment) become adversely affected, then the virus is likely to affect the yield. To prevent yield losses, breeding for resistance is the best method of controlling the virus in the crop. AYB 45, TSs152 and NGB01349 are suggested for further research involving the control of Cucumber Mosaic Virus in AYB.

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