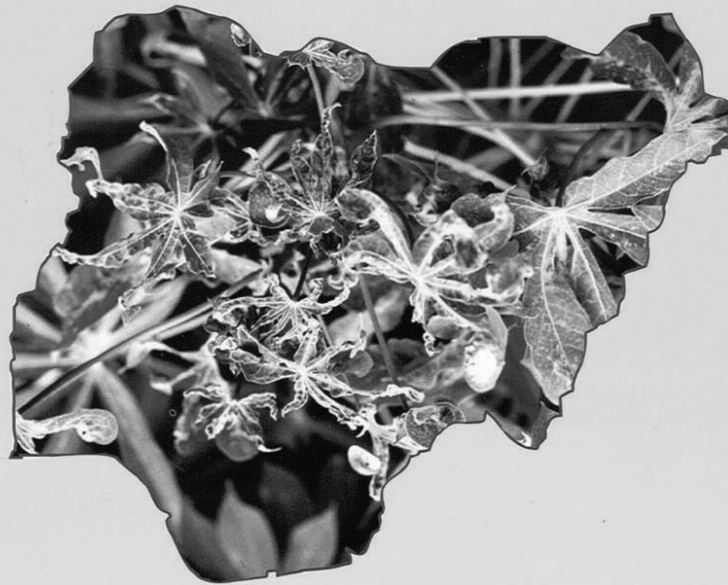


# The status of cassava mosaic disease, cassava begomoviruses and whitefly vector populations in Nigeria

F.O. Ogbe, A.G.O. Dixon, J.d' A Hughes, F. Alabi, and R.U. Okechukwu



# The Status of Cassava Mosaic Disease, Cassava Begomoviruses and Whitefly Vector Populations in Nigeria

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## Abstract

A diagnostic survey was conducted in 2002 and 2003 to determine the status of cassava mosaic disease (CMD) and cassava mosaic begomoviruses in Nigeria and to ascertain if the virulent Ugandan variant of the *East African cassava mosaic virus* (EACMV-Ug2) is present in the country. The survey was an activity of a CMD project on measures to protect cassava production in Nigeria from potential devastating effects of a severe form of the disease. Routes were selected in states of the six geopolitical zones in Nigeria and 418 farmers' cassava fields were visited. The CMD status in each field was rated as mild, moderately severe, or severe. Cassava leaf samples were collected from 1397 plants on which CMD severity was also rated on a five-point scale. Leaf samples of some weeds showing characteristic CMD-like mosaic were also collected. Whitefly counts were made in each farm and samples of this insect vector were collected. The leaf and whitefly samples were tested by polymerase chain reaction for *African cassava mosaic virus* (ACMV), EACMV, the Ugandan variant of EACMV (EACMV-Ug2), *Indian cassava mosaic virus* (ICMV), and *South African cassava mosaic virus* (SACMV).

Cassava in most farms in the south–south and middle belt geopolitical zones showed mild CMD symptoms. On the contrary, most farms in the southeast and northeast zones showed either moderately severe or severe symptoms. The number of farms with cassava with either moderately severe or severe symptoms was about the same as the number of farms with cassava with mild symptoms in the southwest and northwest zones. Taking the entire country, 48% of the farms had cassava with either moderately severe or severe symptoms, which was about the same as the proportion of farms (52%) with cassava with mild symptoms. The farms appeared to be randomly distributed.

Of the 1397 cassava leaf samples, 1106 had symptoms of which 74.1% tested positive for ACMV alone, 0.3% for EACMV alone, 24.4% for mixed infections by the two viruses, and 1.2% did not react with any of the primers used. The two viruses were also detected in 32% of the 291 symptomless plants. ACMV and EACMV were also detected in the whitefly vector samples. EACMV-Ug2, ICMV, and SACMV were not detected in any of the whitefly or leaf samples. Farms in which ACMV occurred in single infection as well as in mixed infections with EACMV predominated. Most doubly infected plants showed severe symptoms. Two biological variants of ACMV based on symptom expression on cassava in the field were identified. A high number of plants expressed symptoms indicative of mixed infections by the two biological variants and in most cases the symptoms were severe. ACMV and EACMV were detected in a leguminous plant *Senna occidentalis* (L.) Link and a weed *Combretum confertum* Lam., which are new natural hosts of the viruses.

Most farms in southern Nigeria had whitefly populations of between 5 and 500 per plant compared to farms in the north, which had whitefly populations of between 0 and 4 per plant. A lot of the farms in the northeast and northwest had no whiteflies.

The virulent Ugandan variant of CMD was not detected. However, the high proportion of mixed infections by ACMV and EACMV, which could result in recombination events such as the one that produced EACMV-Ug2, and the occurrence of variants of ACMV, demand appropriate measures to safeguard cassava production in the country. The CMD project is therefore timely to provide resistant cassava genotypes to Nigerian farmers to forestall any outbreak of severe CMD, either by natural spread from outside Nigeria or by spontaneous recombination between virus strains already present in the country.

# The status of cassava mosaic disease, cassava begomoviruses, and whitefly vector populations in Nigeria

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## Introduction

### **Cassava mosaic disease (CMD) and its impact on cassava production**

Cassava mosaic disease (CMD) is a viral disease of cassava, which was first reported in Tanzania in 1894 by Warburg and it is the most important widespread disease of cassava in sub-Saharan Africa (Fargette et al. 1988; Otim-Nape et al. 1994; Zhou et al. 1997). Yield losses are enormous especially if susceptible cassava genotypes are grown. On such genotypes, 90–100% yield losses were recorded in Uganda during the CMD pandemic (Terry and Hahn 1980; Seif 1982; Otim-Nape et al. 2000). Even on some resistant genotypes, about 35% yield losses have been reported (Ogbe et al. 2003a). Apart from sub-Saharan Africa, CMD also occurs in Asia especially on the Indian subcontinent and Sri Lanka and where yield losses occur.

CMD is caused by the following begomoviruses: *African cassava mosaic virus* (ACMV) (Bock and Woods 1983), *East African cassava mosaic virus* (EACMV) (Hong et al. 1993), *South African cassava mosaic virus* (SACMV) (Berrie et al. 1998), *Indian cassava mosaic virus* (ICMV) (Hong et al. 1993), and *Sri Lankan cassava mosaic virus* (SLCMV) (Saunders et al. 2002). ACMV, EACMV, and SACMV occur in sub-Saharan Africa. Several strains/variants of ACMV and EACMV are known (Robinson et al. 1984; Zhou et al. 1998; Pita et al. 2001a; Ogbe et al. 2003b,c) and which bring about a dynamic CMD epidemiology in sub-Saharan Africa. The viruses and their strains and variants are transmitted by whiteflies, *Bemisia tabacci* Genadius (Seif 1981), which are quite abundant in sub-Saharan Africa.

### **The Ugandan variant of EACMV and its threat to cassava production in sub-Saharan Africa**

An epidemic of a severe form of CMD occurred in Luwero district, in the north of Uganda in 1983 (Otim-Nape et al. 1998). The epidemic devastated cassava production in Uganda and caused starvation and loss of life. The epidemic was caused by a strain of EACMV known as the Ugandan variant (EACMV-Ug2), which is a recombinant of ACMV and EACMV (Zhou et al. 1997). The severe form of CMD, associated with EACMV-Ug2, is mainly due to synergism from mixed infections by EACMV-Ug2 and ACMV.



The epidemic in Uganda was controlled by the introduction and adoption of improved, resistant cassava varieties (Otim-Nape et al. 1998; 2000) that were bred by the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. However, the severe form of CMD had already spread from Uganda to neighboring countries and beyond. Mixed infections by EACMV-Ug2 and ACMV, culminating in severe CMD, were reported from Democratic Republic of Congo, Kenya, Republic of Congo, Rwanda, and Tanzania (Otim-Nape et al. 2000; Neuenschwander et al. 2002).

### **CMD in Nigeria**

CMD is the most important disease of cassava in Nigeria. Earlier studies showed that ACMV and EACMV were the causal agents, with the former virus being more prevalent (Ogbe 2001). Most of the EACMV isolates in Nigeria are in mixed infections with ACMV, producing usually severe CMD symptoms. Variants of the two viruses also occur (Ogbe et al. 2003b, c). CMD pressure is very high in southern Nigeria due to vector abundance and extensive cultivation of cassava. A number of resistant genotypes, either improved or landraces, are being cultivated in Nigeria, which could already have reduced the serious impact of CMD on cassava production in the country as even the less severe isolates can cause significant losses in susceptible genotypes.

### **CMD Project in Nigeria**

Nigeria is the world's largest producer of cassava, in 2002 accounting for 34.5 M tonnes (FAO). Although the crop is predominantly grown in the southern part of the country, its cultivation has expanded northward. Cassava is an important food crop in Nigeria, being widely eaten in processed forms such as *gari* and *fufu/akpu*. The crop is also processed into starch, chips, and pellets, which find uses in ethanol and glue production, confectionery, and livestock feeds. The Nigerian Government has recognized the potential of cassava for foreign exchange earnings. This has further encouraged farmers to increase cassava production. Sustaining cassava production, therefore, becomes paramount.

The CMD project was conceived by IITA to preempt the threat of the severe form of CMD caused by EACMV-Ug2, which is spreading towards West Africa (Neuenschwander et al. 2002). One of the objectives of the project is to introduce CMD-resistant cassava varieties to protect cassava production against the possible invasion by or occurrence of EACMV-Ug2. As earlier stated, the CMD epidemic in Uganda was controlled by the introduction and cultivation of resistant varieties.

The CMD project has attracted the interest of many donors due to the importance of cassava for food security and as a cash crop. Donors include the Federal Government of Nigeria, the petroleum producing states of Nigeria and the neighboring states in the southeast of the country, the Niger Delta Development Commission (NDDC), petroleum companies such as NNPC and Shell, and the United States Agency for International Development (USAID). At present, the project is being conducted in the following states: Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Rivers (south-south geopolitical zone); Abia, Anambra, Ebonyi, Enugu, Imo (southeast zone), and Ondo (southwest zone).

The choice of these states was based on the fact that some of them share borders with Cameroon and are therefore possible routes for the introduction of EACMV-Ug2 into Nigeria. In addition, cassava is extensively cultivated in the 12 states, with a high tendency for the exchange of planting material among farmers, which can enhance the vegetative spread of CMD. The introduction of resistant genotypes to farmers in these states could minimize the impact and slow down the spread of EACMV-Ug2 if it is introduced into the country. Successful control of CMD in southern Nigeria is effectively successful control of the disease in the country. This is because more favorable conditions for the spread of CMD occur in southern than in the northern Nigeria (Akano et al. 1995; Ogbe et al. 2001). However, this CMD project goes beyond the control of CMD. It is envisaged that the introduction and cultivation of resistant genotypes by farmers will lead to an increase in cassava production and therefore, in order to avoid overproduction, this CMD project also encourages strategies to process and market cassava.

One of the core activities to control CMD in the CMD project is to assess the current health status of cassava farms and the current status of cassava begomoviruses in Nigeria. A diagnostic survey was therefore conducted to achieve these objectives and specifically to assess if EACMV-Ug2 has spread to Nigeria.

## Survey routes

The survey was conducted between December 2002 and December 2003. The survey routes were determined using the road maps of Nigeria and such routes included highways, secondary roads, and feeder roads. As much as possible, the routes were selected to intersect the main cassava growing areas and to assure sufficient cassava fields for sampling. The following routes were used in the order presented:

- Ibadan-Benin-Agbor-Uromi-Ekpoma-Auchi-Agenebode
- Auchi-Afuze-Sabongida Ora-Ozalla-Benin
- Benin-Iruekpen
- Benin-Abraka-Eku-Warri-Sapele
- Sapele-Jesse-Igbewhore
- Sapele-Eku-Agbor-Asaba-Warri-Ughelli-Ozoro
- Ughelli-Port Harcourt-Onne-Bori-Ete Eket-Oron-Uyo-Odukpani-Calabar-Oban
- Calabar-Ikom-Mfum
- Ikom- Ogoja
- Nkim Itam-Ikot Ekpene-Umuahia
- Onitsha-Enugu-Nsukka-Obollo Afor-Ikem-Nkalagu-Abakaliki-Mfuma
- Abakaliki-Obubra
- Abakaliki-Afikpo-Ohafia-Bende-Umuahia-Ariam
- Umuahia-Isialangwa
- Umuahia-Port Harcourt
- Aba-Owerri-Okigwe-Umuahia-Owerri-Orlu-Ihiala-Ogbaku-Egbema-Ukwu Igba-Etekuru Egbema-Owerri-Onitsha-Akwa-Igbariam
- Akwa-Enugu-Okigwe
- Ibadan-Oyo-Ogbomoso-Igbeti-Kisi-Igboho-Saki-Ago Are-Okaka-Oke Iho-Igbo Ora-Abeokuta-Olodo
- Abeokuta-Obafemi Ajebo-Isara-Owode-Ofada-Itori-Abeokuta-Meko-Aworo-Igan Alade-Ilaro-Papalanto-Ota-Idi Iroko-Ijofin
- Owode-Ado Odo-Igbesa-Atan Ota
- Ikorodu-Sagamu-Ijebu Ode-Ibadan-Ife-Osogbo-Iwo-Gbongan-Osogbo-Ikirun-Ila Orangun-Okuku
- Ikirun-Ibokun-Osogbo-Ilesa-Ipetu Ijesa-Ilawe-Ado Ekiti-Ikere-Ise Ekiti-Omuo-Ode Ekiti-Isibode Ekiti-Ilasa Ekiti-Ayebode Ekiti-Ikole-Ilu Omoba-Ado Ekiti-Igede-Ijero-Ayegunle-Ido Ekiti-Isan-Ifaki-Ado Ekiti-Akure-Owo-Ikare-Ido Ani-Ipele
- Ilorin-Omu Aran-Odo Ere-Egbe-Pategi-Ndeji-Ilorin-Share-Ndeji
- Share-Bode Saadu-Oko Olowo-Igbeti
- Moshigada-Kaiama-New Busa-Mokwa-Kontagora-Tegina-Minna-Suleja-Kaduna-Kachia-Zamaru Kataf-Saminaka-Pambegua-Zaria-Kaduna

- Lambata-Bida-Mokwa
- Birnin Yauri-Jega-Birnin Kebbi-Argungu-Sokoto-Talata-Mafara-Gusau-Funtua-Katsina-Kano-Bagauda-Tudun Wada
- Gezawa-Gumel-Mallammaduri-Hadejia-Ringim-Kano
- Ogaminana-Kabba-Lokoja-Ajaokuta-Ejule-Idah
- Anyigba-Ankpa-Emare-Makurdi-Otukpo-Yadev-Makurdi-Katsina Ala-Wukari-Jalingo-Beli
- Jalingo-Yola-Mubi-Madagali-Bama-Maiduguri-Damaturu-Potiskum-Gashua-Nguru. Abaji-Abuja-Keffi-Akwanga-Lafia-Langtang-Pankshin-Jos-Bauchi-Gombe-Dukou-Darazo-Bauchi
- Ipetu Ijesa-Ondo-Akure-Igbara Oke
- Ondo-Ore-Okitipupa-Igbotako-Ijebu Ode-Epe-Lagos-Seme-Iworo-Ibadan

### Sample collection

Along the routes, cassava fields were visited at intervals of 10–15 km in southern Nigeria where cassava fields were common. In the north, however, the sampling interval was about 20–30 km due to sparsely spaced cassava fields. A total of 418 fields were visited. In each field, the coordinates were recorded using the Global positioning system (GPS) (model Magellan GPS 315, 960 Overland Court, San Dimas, California, CA 91773). The following five-point scale was used to assess an overall impression of symptom severity of CMD for each field: 1 = no symptom; 2 = mild chlorotic pattern over entire leaflets or mild distortion at the base of leaflets only with the remainder of the leaflets appearing green and healthy; 3 = moderate mosaic pattern throughout the leaf, narrowing and distortion of the lower one-third of leaflets; 4 = severe mosaic, distortion of two-thirds of the leaflets and general reduction of leaf size; and 5 = severe mosaic, distortion of the entire leaf (Terry 1975). The field with an overall impression of symptom severity score 2 was regarded as mild, score 3 as moderately severe, and scores 4 or 5 as severe. A sample was collected from a representative plant showing mild, moderately severe, severe symptoms, or symptomless based on random selection. On average, three samples were collected per field depending on the degree of CMD severity. A description of the symptoms observed on the sampled plant was made. Particular attention was paid to different symptoms on different plants of the same genotype. The severity score of the plant sampled was based on the five-point scale (Terry 1975). A total of 1397 leaf samples were collected: 1106 symptomatic samples and 291 symptomless samples. Leaf samples of weeds showing characteristic symptoms of mosaic in or near the cassava fields were also collected. Whitefly counts were made (Fauquet and Fargette 1990) on ten randomly selected plants and the whiteflies collected using an aspirator in each field if the insect was present. Two hundred and eighty-three whitefly samples were collected and preserved in 70% ethanol in Eppendorf tubes. In transit, whitefly and leaf samples were kept at 4 °C in a mobile refrigerator (model V 200, Norcold Sidney, a subsidiary of Thetford Corporation, Ann Arbor, Michigan, USA) while in the field.

At the end of each day, the samples were kept at 4 °C overnight. Each survey trip took about seven days and at the end of the trip, the samples were taken to where they were stored at –20 °C prior to diagnosis at IITA, Ibadan.

## Laboratory analyses of samples

### DNA extraction

Total DNA was extracted from the cassava and weed samples according to the procedure of Dellaporta et al. (1983). The same procedure was used to extract the total DNA from 3–6 whiteflies from each whitefly sample. In extracting the DNA from the whiteflies, however, the volumes of the reagents were reduced by five times to avoid over dilution of the DNA. For the leaf samples, the extracted DNA was resuspended in 200 µl TE (Tris-HCl 50mM, EDTA 10mM) pH 8.0 while the DNA samples from the whiteflies were resuspended in 50 µl of TE pH 8.0 and stored at –20 °C.

### Testing of the DNA samples

Leaf and whitefly DNA samples were tested by polymerase chain reaction (PCR). DNA from leaf samples was diluted to obtain 2 ng/ul while the DNA from the whitefly samples was used undiluted. Specific primers for the detection of ACMV, EACMV, and EACMV-Ug2 were used in addition to primers that can detect ICMV and SACMV, and a pair of a universal primers for the detection of whitefly transmitted begomoviruses (Table 1). The reaction mixture per tube contained 2.5 µl of thermobuffer (10 × concentration), 1.5 µl MgCl<sub>2</sub> (25 mM); 2.0µl of dNTPs (2.5 mM); 1.3 µl each of forward and reverse primers (10 pM for specific primers, 10 pM or 100 pM for degenerate primers); 0.2 µl (1 unit) of Taq DNA polymerase (Promega product, Promega Corporation, 2800 Woods Hollow Road, Madison, WI 53711-5399, U.S.A) 12.9 µl sterilized distilled water, and 3.3 µl of DNA sample (25.0 µl per reaction tube). The DNA extraction buffer and DNA of virus-free healthy cassava were used as negative controls. The healthy, negative control cassava clone TMS 30572 was obtained from virus-tested in vitro plantlets. EACMV-Ug2 DNA (from Dr Legg of IITA, Uganda through the Nigerian Plant Quarantine Service, Moore Plantation, Ibadan, Nigeria) was used as positive control for the detection of the virus.

The reaction cycles using a PTC DNA Engine system (model PTC 200, MJ Research, Inc., 149, Grove Street, Watertown, Massachusetts USA) were as reported by Zhou et al. (1997). The first cycle consisted of 1 min at 94 °C, 2 min at 52 °C, and 3 min at 72 °C. This was followed by 35 cycles of 1 min at 94 °C, 1 min at 52 °C, and 1.33 min at 72 °C. The final cycle consisted of 5 min at 72 °C. The PCR products were separated by electrophoresis in a 1% agarose gel, which contained 1.5 µl of ethidium bromide (10 mg/ml) in Tris-acetate-EDTA (TAE) buffer (0.04 M Tris-acetate pH 8.0 + 0.01 M EDTA, pH 8.0) at 100 volts for about 1.5 h. The DNA bands were observed under UV light and positive and negative reactions were recorded. For documentation purposes, photographs of some of the gels were taken using a Polaroid camera (Polaroid, Gelcam, Polaroid Corporation, 575, Technology square-2, Cambridge, MA 02139, USA).

**Table 1. Nucleotide sequences of DNA primers used in polymerase chain reaction for the detection of *African cassava mosaic virus* (ACMV), *East African cassava mosaic virus* (EACMV), Ugandan variant of EACMV (EACMV-Ug2), *South African cassava mosaic virus* (SACMV), and *Indian cassava mosaic virus* (ICMV)<sup>a</sup>**

Virus	Name of primer	Sequenc (5' to 3')	Target in DNA <sup>b</sup>
ACMV	ACMV-AL1/F	GCG GAA TCC CTA ACA TTA TC	AC1
	ACMV-ARO/R	GCT CGT ATG TAT CCT CTA AGG CCT G	AV2
	JSP001	ATG TCG AAG CGA CCA GGA GAT	CP
	JSP002	TGT TTA TTA ATT GCC AAT ACT	CP
EACMV	JSP001	ATG TCG AAG CGA CCA GGA GAT	CP
	JSP003	CCT TTA TTA ATT TGT CAC TGC	CP
EACMV/EACMV-Ug2	UV-AL3/F	TAC ACA TGC CTC RAA TCC TG	AC3
	UV-AL1/R2	CTC CGC CAC AAA CTT ACG TT	AC1
EACMV-Ug2	UV-AL1/F	TGT CTT CTG GGA CTT GTG TG	AC1
	ACMV-CP/R3	TGC CTC CTG ATG ATT ATA TGT C	CP
ICMV	ICMV-F	TTC TCT CTC CTC AAT CGG TA	AC1/IR
	ICMV-R	ACT CAG GGA ACT CGT TTA GT	AV2
SACMV	SACMV-CP 5'	GCT GTC CCC ATT GTC CAR GGN	CP
	SACMV-CP 3'	CCT TTA TTA ATT TGT CAC TGC	CP
Whitefly-transmitted geminiviruses	PRIMER A	TAA TAT TAC CKG WKG VCC	CR
	PRIMER B	TGG ACY TTR CAW GGB CCT TCA CA	CR

<sup>a</sup>Sources of primer sequence: Deng et al. 1994; Berrie et al. 1998; Zhou et al. 1997; Pita et al. 2001a. The primers were used in pairs as listed, the first being forward primer and the second being reverse.

<sup>b</sup>AV = DNA-A virus sense (AV2: gene function not yet known), AC = DNA-A complementary sense (AC1: replication initiation protein gene, AC3: replication enhancer protein gene), CP = coat protein gene, IR = intergenic region, CR = common region.

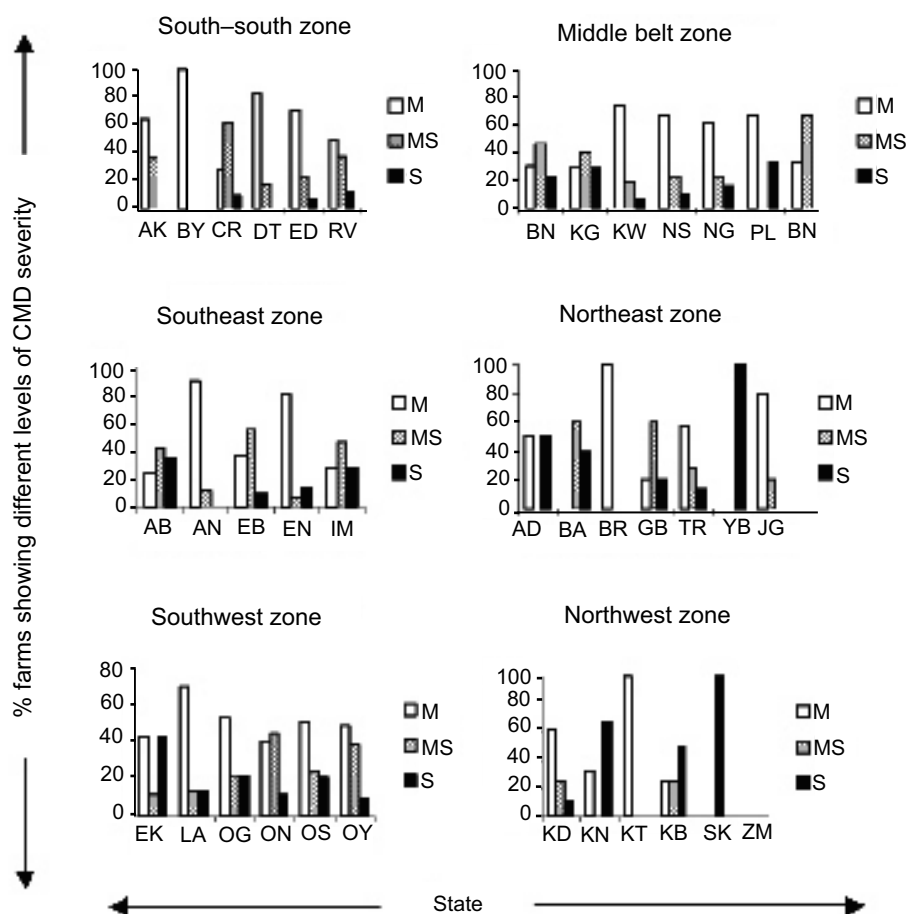
## Results

### CMD status in farmers' fields

CMD symptoms were mild in most farms in Akwa Ibom, Delta, and Edo states (south–south geopolitical zone); Anambra and Enugu states (southeast zone); Lagos State (southwest zone); Kwara, Nassarawa, and Niger states (middle belt zone); Jigawa State (northeast zone), and Kaduna State (northwest zone) (Fig. 1). CMD symptoms were either moderately severe or severe in most farms in Cross River State (south–south zone); Abia, Ebonyi, and Imo states (southeast zone); Ekiti and Ondo states (southwest zone); Benue and Kogi states (middle belt zone); Bauchi and Gombe states (northeast zone), and Kebbi State (northwest zone) (Fig. 1). The number of farms with either moderately severe or severe symptoms was about the same the number of farms with mild symptoms in Rivers State (south–south zone); Ogun, Osun, and Oyo states (southwest zone), and Taraba State (northeast zone) (Fig. 1). In all the states mentioned, the number of farms visited ranged between 4 and 31.

Three farms were visited in Bayelsa State (south–south zone) and cassava in all the farms showed mild symptoms. Of the three farms visited in Plateau State (middle belt zone), the cassava in one farm expressed severe symptoms while symptoms were mild on the plants in the other two farms. In the Federal Capital Territory (middle belt zone) symptoms on cassava were moderately severe in two farms but mild in one farm. In Adamawa State (northeast zone) the cassava in one farm had mild symptoms while in another farm CMD symptoms were severe. In Borno and Yobe states (northeast zone) one farm each was visited. CMD symptoms were mild in Borno State but severe in Yobe. Three farms were visited in Kano State (northwest zone) of which symptoms on cassava were mild in one farm but severe in two farms. One farm each was visited in Katsina and Sokoto states (northwest zone). CMD symptoms were mild in Katsina but severe in Sokoto. Cassava farms were not found along the routes surveyed in Zamfara State.

Between 17 (northwest zone) and 131 farms (southwest zone) were assessed for CMD severity in each geopolitical zone. Cassava in most farms in the south–south and middle belt geopolitical zones expressed mild CMD symptoms (Fig. 2). To the contrary, cassava in most farms in the southeast and northeast zones expressed either moderately severe or severe symptoms. The number of farms in which CMD symptoms were either moderately severe or severe was about the same the number of farms in which CMD symptoms were mild in the southwest and northwest zones (Fig. 2). Throughout the entire country, symptoms were either moderately severe or severe in 48% of the farms, which was almost the same proportion (52%) of farms in which symptoms were mild. The farms with cassava with moderate/severe symptoms and mild symptoms were randomly distributed through the cassava growing areas of the country (Fig. 3).

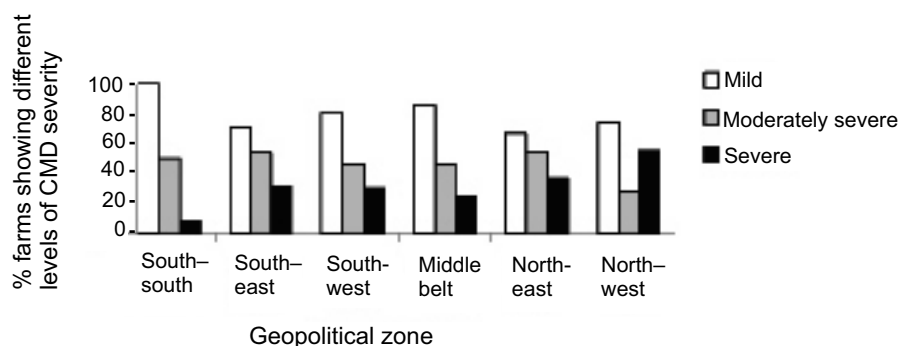


**Figure 1. The proportion of farmers' fields showing different levels of cassava mosaic disease (CMD) severity in states of the geopolitical zones of Nigeria.**

States: AK = Akwa Ibom, BY = Bayelsa, CR = Cross River, DT = Delta, ED = Edo, RV = Rivers, AB = Abia, AN = Anambra, EB = Ebonyi, EN = Enugu, IM = Imo, EK = Ekiti, LA = Lagos, OG = Ogun, ON = Ondo, OS = Osun, OY = Oyo, BN = Benue, KG = Kogi, KW = Kwara, NA = Nassarawa, NG = Niger, PL = Plateau, FCT = Federal Capital Territory, AD = Adamawa, BA = Bauchi, BR = Borno, GB = Gombe, TR = Taraba, JG = Jigawa, YB = Yobe, KD = Kaduna, KN = Kano, KT = Katsina, KB = Kebbi, SK = Sokoto, ZM = Zamfara

Key: M = Mild, MS = Moderately severe, S = Severe





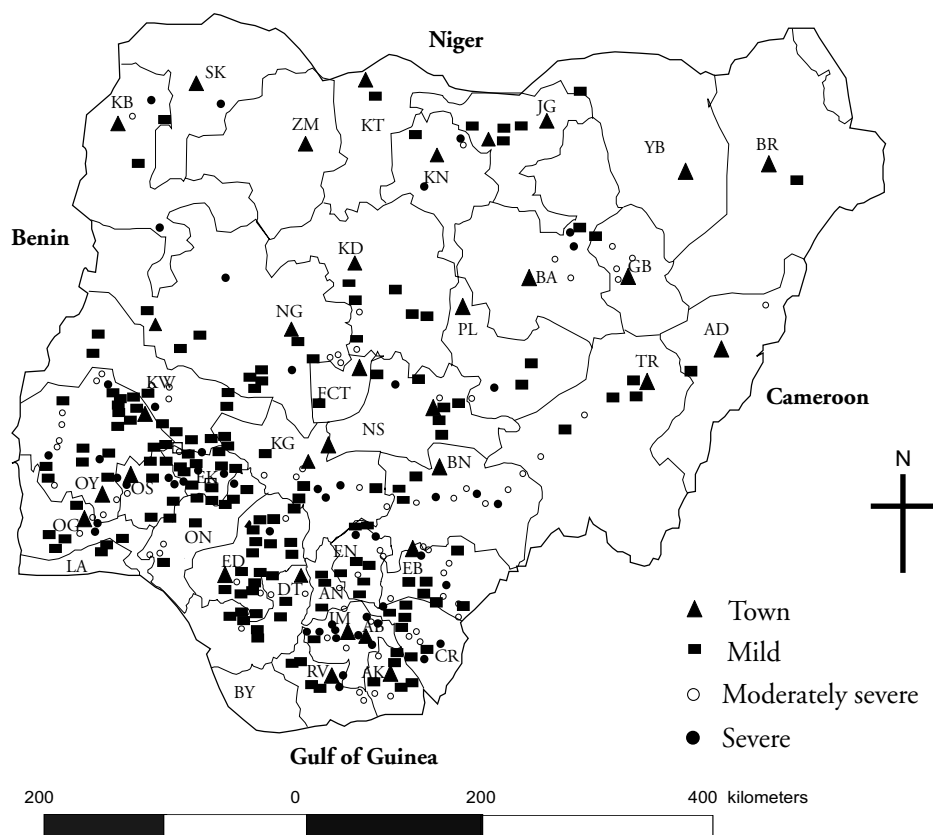
**Figure 2. The proportion of cassava farms showing different levels of cassava mosaic disease (CMD) severity in the geopolitical zones of Nigeria.**

Geopolitical zone	State
South-south	Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Rivers
Southeast	Abia, Anambra, Ebonyi, Enugu, Imo
Southwest	Ekiti, Lagos, Ogun, Ondo, Osun, Oyo
Middle belt	Benue, Kogi, Kwara, Nassarawa, Niger, Plateau, Federal Capital Territory
Northeast	Adamawa, Bauchi, Borno, Gombe, Taraba, Jigawa, Yobe
Northwest	Kaduna, Kano, Katsina, Kebbi, Sokoto, Zamfara

### The status of cassava mosaic begomoviruses in Nigeria

Among the 1106 leaf samples from the symptom bearing cassava plants, 74.1% tested positive for ACMV alone, 0.3% for EACMV alone, 24.4% for mixed infections with the two viruses, and 1.2% failed to give a PCR product with any of the primers. Of the 291 samples from symptomless plants, 27.2% were infected with ACMV alone but none tested positive to EACMV alone, 4.8% tested for both viruses, and 68.0% were apparently not infected with any of the cassava begomoviruses. EACMV-Ug2 was not detected in any of the leaf or whitefly samples (Fig. 4). The six cassava leaf samples in lanes 1–6 and 11–16 (Fig. 4a) tested positive to both viruses. The EACMV primers also detected the DNA of the EACMV-Ug2 that was used as a positive control (Fig. 4a, lanes 17 and 18). The EACMV-Ug2 was, however, differentiated from the Nigerian isolates of EACMV by the EACMV-Ug2 specific primers (Fig. 4b, lanes 17 and 18). Lanes 9, 10, 19, and 20 (Figs. 4a, b) contained samples for the negative control and hence no bands were expected or observed. SACMV and ICMV were not detected in the leaf samples. ACMV and EACMV, singly and in double infections, were also detected in the whitefly vector across the country.

Positive diagnosis of ACMV (lanes 26, 27) and EACMV (lane 36) were obtained, shown in Figure 4c with positive controls in lanes 21 and 23 (ACMV) and 31 and 32 (EACMV) that contained infected DNA from the leaf samples.



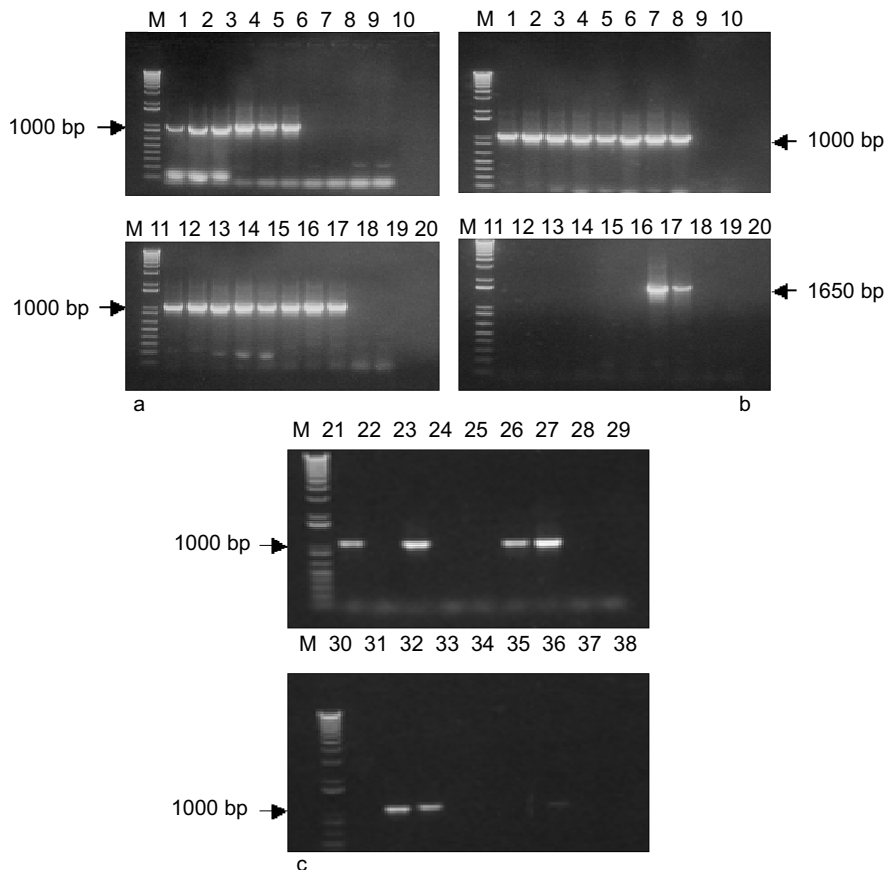
**Figure 3. The distribution of farms showing different cassava mosaic disease (CMD) severity in Nigeria.\***

\* The country is partitioned into states as follow: AK = Akwa Ibom, BY = Bayelsa, CR = Cross River, DT = Delta, ED = Edo, RV = Rivers, AB = Abia, AN = Anambra, EN = Ebonyi, EN = Enugu, IM = Imo, EK = Ekiti, LA = Lagos, OG = Ogun, ON = Ondo, OS = Osun, OY = Oyo, BN = Benue, KG = Kogi, KW = Kwara, NS = Nassarawa, NG = Niger, PL = Plateau, FCT = Federal Capital Territory, AD = Adamawa, BA = Bauchi, BR = Borno, GB = Gombe, TR = Taraba, JG = Jigawa, YB = Yobe, KD = Kaduna, KN = Kano, KT = Katsina, KB = Kebbi, SK = Sokoto, ZM = Zamfara

### **The proportion of plants infected by ACMV and by mixed infections of ACMV and EACMV in the different geopolitical zones**

Single infection by ACMV predominated in all the geopolitical zones. The proportions of plants doubly infected by ACMV and EACMV, however, were about the same as the proportion of plants singly infected by ACMV in Enugu State, Imo (southeast zone); Ondo State (southwest zone); Benue and Kogi states (middle belt zone), and Kano State (northwest zone) (Figure 5). Only one farm was visited in Yobe State (northeast zone) where four plants were sampled and found to be infected with both ACMV and EACMV. Plants infected with ACMV alone were most common in the south–south (81%) and northeast (91%) geopolitical zones (Figure 6). The southeast zone had the least proportion of plants (62.2%)

singly infected by ACMV but had the highest proportion of plants (36.8%) doubly infected by ACMV and EACMV. The proportion of mixed infections in other zones ranged from 7.4% to 26.2% (Fig. 6). Farms in which ACMV occurred in single infection as well as in mixed infections with EACMV predominated and were more random in southern Nigeria

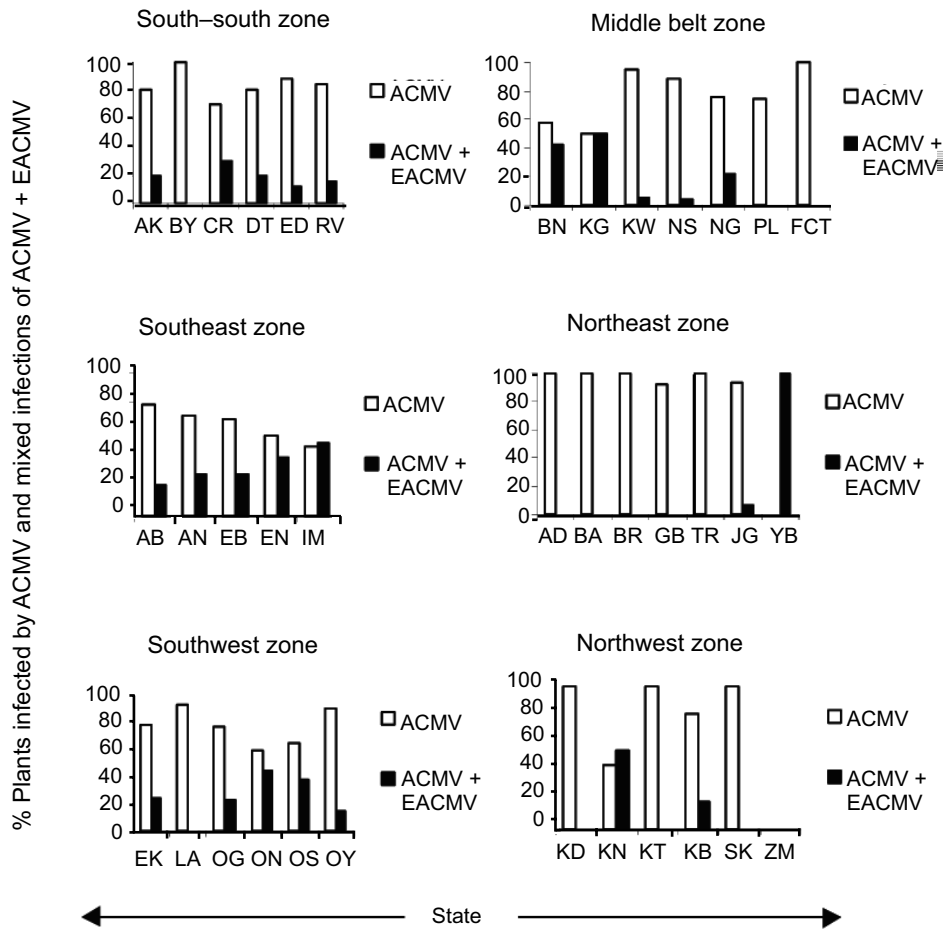


**Figure 4.** African cassava mosaic virus (ACMV) and East African cassava mosaic virus (EACMV) DNA fragments amplified by polymerase chain reaction and analyzed by gel electrophoresis\*.

\* The samples were collected from farmers' fields during a survey in 2002 and 2003 in Nigeria. M = 1 kb plus marker; lanes 1–6 contained the DNA of cassava leaf samples 75, 242, 503, 507, 647, 796, respectively. Lanes 7 and 8 contained the DNA of virulent Ugandan strain of East African cassava mosaic virus (EACMV-Ug2) as positive control. Lanes 9 and 10 contained DNA of a healthy cassava leaf and DNA extraction buffer, respectively as negative controls. This arrangement was repeated for lanes 11–16; 17 and 18; 19 and 20, respectively. Lanes 21–23 contained DNA of cassava leaves samples 1319, 1062, and 1109, respectively. This was repeated for lanes 30–32. Lanes 26 and 27 contained DNA of whitefly samples 1113 and 870, respectively, which was repeated in lanes 35 and 36. Lanes 24 and 25 contained DNA of a healthy cassava and DNA extraction buffer, respectively. This was repeated respectively in lanes 28 and 29, 33 and 34, and 37 and 38. Fig. 4a, Lanes 1–10; Fig. 4c, lanes 21–29 were tested by ACMV primers ACMV –AL1/F/AR0/R. Fig. 4a, lanes 11–20; Fig. 4b, lanes 1–10; Fig. 4c, lanes 30–38 were tested by EACMV primers UV-AL3/F/AL1/R2. Fig. 4b, lanes 11–20 were tested by EACMV-Ug2 primers UV-AL1/F1/ACMV-CP/R3.

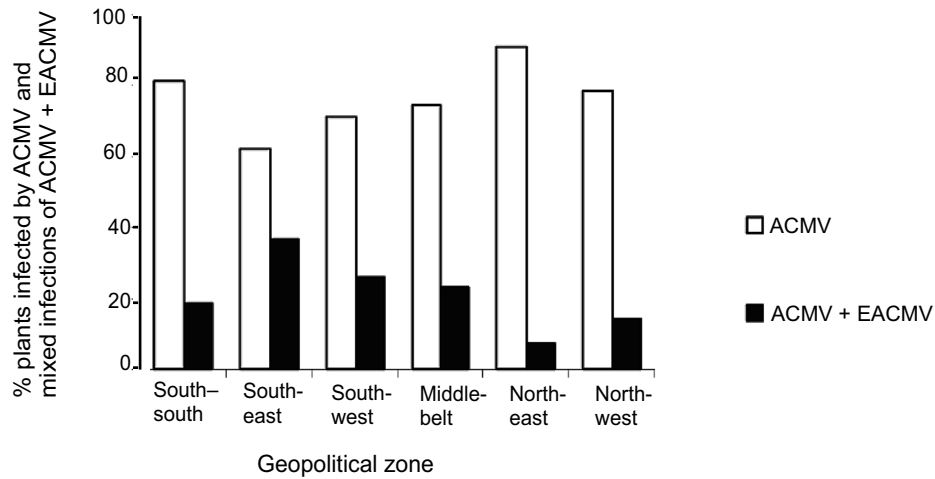
Lanes 24, 25, 28, 29, 33, 34, 37 and 38 contained samples for the negative control, which expectedly did not react.

than in the north (Fig. 7). Farms that contained EACMV in single infection, in addition to mixed infections by ACMV and EACMV, were few and were located in Enugu and Niger states. Only in one farm in Ebonyi State were single infections by ACMV and EACMV observed. Unidentified begomoviruses were detected in Ekiti, Gombe, Lagos, Nassarawa, Ogun, Ondo, and Plateau states (Fig. 7).



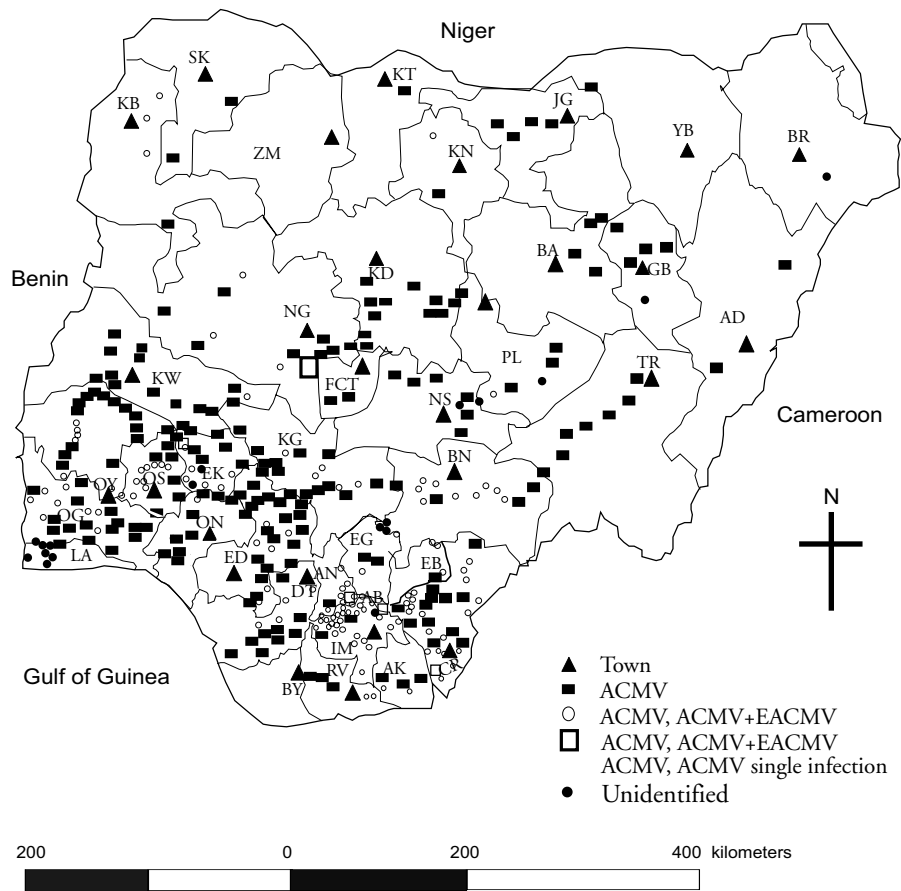
**Figure 5. The proportion of cassava plants infected by *African cassava mosaic virus* (ACMV) and mixed infections of ACMV and *East African cassava mosaic virus* (EACMV) in the different states of the geopolitical zones of Nigeria.**

States: Ak = Akwa Ibom, BY = Bayelsa, CR = Cross River, DT = Delta, ED = Edo, RV = Rivers, AB = Abia, AN = Anambra, EB = Ebonyi, EN = Enugu, IM = Imo, EK = Ekiti, LA = Lagos, OG = Ogun, ON = Ondo, OS = Osun, OY = Oyo, BN = Benue, KG = Kogi, KW = Kwara, NA = Nassarawa, NG = Niger, PL = Plateau, FCT = Federal Capital Territory, AD = Adamawa, BA = Bauchi, BR = Borno, GB = Gombe, TR = Taraba, JG = Jigawa, YB = Yobe, KD = Kaduna, KN = Kano, KT = Katsina, KB = Kebbi, SK = Sokoto, ZM = Zamfara



**Figure 6. The proportion of plants infected by *African cassava mosaic virus* (ACMV) and mixed infections by ACMV and *East African cassava mosaic virus* (EACMV) in the geopolitical zones of Nigeria.**

Geopolitical zone	State
South-south	Akwa Ibom, Bayelsa, Cross River, Delta, Edo, Rivers
Southeast	Abia, Anambra, Ebonyi, Enugu, Imo
Southwest	Ekiti, Lagos, Ogun, Ondo, Osun, Oyo
Middle belt	Benue, Kogi, Kwara, Nassarawa, Niger, Plateau, Federal Capital Territory
Northeast	Adamawa, Bauchi, Borno, Gombe, Taraba, Jigawa, Yobe
Northwest	Kaduna, Kano, Katsina, Kebbi, Sokoto, Zamfara



**Figure 7. The distribution of cassava mosaic begomoviruses in Nigeria\*.**

\*The country is partitioned into states as follow: AK = Akwa Ibom, BY = Bayelsa, CR = Cross River, DT = Delta, ED = Edo, RV = Rivers, AB = Abia, AN = Anambra, EB = Ebonyi, EN = Enugu, IM = Imo, EK = Ekiti, LA = Lagos, OG = Ogun, ON = Ondo, OS = Osun, OY = Oyo, BN = Benue, KG = Kogi, KW = Kwara, NS = Nassarawa, NG = Niger, PL = Plateau, FCT = Federal Capital Territory, AD = Adamawa, BA = Bauchi, BR = Borno, GB = Gombe, TR = Taraba, JG = Jigawa, YB = Yobe, KD = Kaduna, KN = Kano, KT = Katsina, KB = Kebbi, SK = Sokoto, ZM = Zamfara

Key: ACMV = *African cassava mosaic virus*, EACMV = *East African cassava mosaic virus*, ACMV + EACMV = Mixed infections of ACMV and EACMV

### CMD severity associated with single infection by ACMV and mixed infections by ACMV and EACMV

Most ACMV infections were characterized with severe symptoms giving average severity scores that ranged from 2.7 to 3.9 on a scale of 1–5 (Table 2). Generally, symptoms due to the virus were similar in all the states of each zone. The northwest zone had plants that showed more severe symptoms than plants in the other zones, particularly the south–south zone. Only three plants were infected singly by EACMV.

Two of the plants (Ebonyi State, southeast zone and Niger State, middle belt zone) had mild symptoms while the third (Enugu State, southeast zone) had severe symptoms (Table 2). Among the states of each zone, CMD symptoms were generally more severe on plants doubly infected by ACMV and EACMV than on plants singly infected by one of the two viruses (Table 2). In Delta (south–south zone), Anambra (southeast zone), and Benue (middle belt zone) states, however, the average severity of CMD symptoms were similar on plants singly infected by ACMV as well as plants doubly infected by ACMV and EACMV. The doubly infected plants in the three states had lower average symptom severity scores than the other plants from other states in the respective zones. The greater CMD symptom severity scores associated with mixed infections compared to single infections was more distinct on plants in the southern geopolitical zones (south–south, southeast, and southwest zones) than on plants in the northern geopolitical zones (middle belt, northeast, and northwest zones) (Table 2).

**Table 2.** Cassava mosaic disease (CMD) severity on cassava varieties singly and doubly infected by *African cassava mosaic virus* (ACMV) and *East African cassava mosaic virus* (EACMV) in farmers' fields in the geopolitical zones of Nigeria.

Geopolitical zone	State	Mean CMD severity score		
		ACMV	EACMV	ACMV + EACMV
South–south	Akwa Ibom	(21) 2.8 ± 0.53	(0) 0.0	(5) 3.2 ± 0.75
	Bayelsa	(7) 3.0 ± 0.53	(0) 0.0	(0) 0.0
	Cross River	(41) 2.8 ± 0.47	(0) 0.0	(17) 3.6 ± 0.97
	Delta	(44) 2.8 ± 0.50	(0) 0.0	(11) 2.7 ± 0.62
	Edo	(59) 2.7 ± 0.53	(0) 0.0	(8) 3.1 ± 0.78
	Rivers	(17) 2.8 ± 0.71	(0) 0.0	(3) 3.3 ± 0.47
	Mean for the zone	(189) 2.8 ± 0.54	(0) 0.0	(44) 3.3 ± 0.88
Southeast	Abia	(37) 3.2 ± 0.65	(0) 0.0	(10) 3.8 ± 0.87
	Anambra	(14) 3.0 ± 0.53	(0) 0.0	(6) 3.2 ± 0.37
	Ebonyi	(21) 3.1 ± 0.71	(1) 2.0	(9) 3.6 ± 0.50
	Enugu	(18) 3.1 ± 0.81	(1) 3.0	(13) 3.5 ± 0.63
	Imo	(35) 2.9 ± 0.52	(0) 0.0	(36) 3.7 ± 0.83
	Mean for the zone	(125) 3.1 ± 0.65	(2) 2.5	(74) 3.6 ± 0.77

**Table 2 (contd)**

Southwest	Ekiti	(42) 3.2 ± 0.69	(0) 0.0	(13) 3.9 ± 0.83
	Lagos	(15) 3.1 ± 0.72	(0) 0.0	(0) 0.0
	Ogun	(64) 3.0 ± 0.56	(0) 0.0	(19) 3.6 ± 0.82
	Ondo	(44) 2.9 ± 0.45	(0) 0.0	(33) 3.5 ± 0.74
	Osun	(39) 2.8 ± 0.53	(0) 0.0	(23) 3.9 ± 0.90
	Oyo	(66) 3.0 ± 0.55	(0) 0.0	(11) 3.3 ± 0.45
	Mean for the zone	(270) 3.0 ± 0.57	(0) 0.0	(99) 3.6 ± 0.81
Middle belt	Benue	(20) 3.1 ± 0.59	(0) 0.0	(15) 2.9 ± 0.57
	Kogi	(14) 2.9 ± 0.46	(0) 0.0	(14) 3.4 ± 0.61
	Kwara	(33) 3.0 ± 0.55	(0) 0.0	(2) 3.0
	Nassarawa	(23) 3.3 ± 0.55	(0) 0.0	(1) 3.0
	Niger	(28) 3.0 ± 0.42	(1) 2.0	(8) 3.3 ± 0.43
	Plateau	(3) 3.0 ± 0.0	(0) 0.0	(0) 0.0
	Federal Capital Territory	(9) 3.1 ± 0.33	(0) 0.0	(0) 0.0
Mean for the zone	(130) 3.1 ± 0.51	(1) 2.0	(40) 3.2 ± 0.57	
Northeast	Adamawa	(5) 2.8 ± 0.40	(0) 0.0	(0) 0.0
	Bauchi	(13) 3.3 ± 0.46	(0) 0.0	(0) 0.0
	Borno	(3) 3.0 ± 0.0	(0) 0.0	(0) 0.0
	Gombe	(11) 2.9 ± 0.51	(0) 0.0	(0) 0.0
	Taraba	(17) 2.9 ± 0.47	(0) 0.0	(0) 0.0
	Jigawa	(13) 3.2 ± 0.42	(0) 0.0	(1) 3.0
	Yobe	(0) 0.0	(0) 0.0	(4) 3.0 ± 0.71
Mean for the zone	(62) 3.1 ± 0.49	(0) 0.0	(5) 3.0 ± 0.63	
Northwest	Kaduna	(20) 3.4 ± 0.57	(0) 0.0	(0) 0.0
	Kano	(4) 3.5 ± 0.50	(0) 0.0	(5) 3.8 ± 0.75
	Katsina	(3) 3.3 ± 0.47	(0) 0.0	(0) 0.0
	Kebbi	(13) 3.9 ± 0.47	(0) 0.0	(3) 3.7 ± 0.47
	Sokoto	(4) 3.0 ± 0.71	(0) 0.0	(0) 0.0
	Zamfara	#	#	#
	Mean for the zone	(44) 3.5 ± 0.62	(0) 0.0	(8) 3.8 ± 0.66

The double infections were determined by polymerase chain reaction. Severity scores ranged from 1 = no symptoms to 5 = very severe symptoms (Terry 1975). Number in parenthesis were total samples used for the calculation of mean ± standard error.

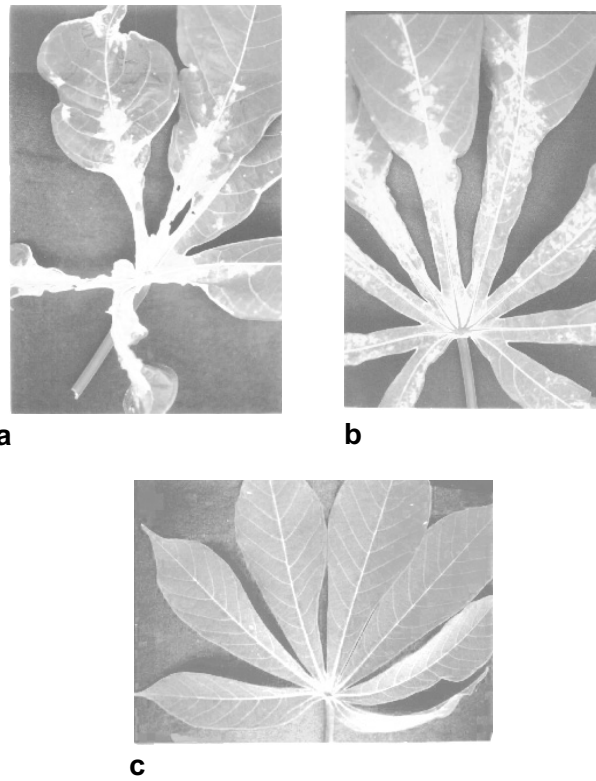
# Cassava fields were not found along the route of the survey in Zamfara.



### **Types of symptoms associated with single and double infections by ACMV and EACMV**

When plants of the same genotypes in the same farm were observed for symptoms, three types of mosaic pattern were noticed. These were yellow-green mosaic, whitish/bleaching-green mosaic (Fig. 8), and a combination of the two types of symptoms. The yellow-green mosaic was usually accompanied with mild leaf distortion (Fig. 8a) while the whitish/bleaching-green mosaic was in most cases associated with severe leaf distortion (Fig. 8b). A healthy leaf is green without blemish and undistorted (Fig. 8c). ACMV and EACMV separately induced the yellow-green mosaic while ACMV was mainly responsible for the whitish/bleaching-green mosaic symptoms (Table 3). The two viruses in mixed infections were also detected in plants separately showing the two types of symptoms and also in plants with a combination of the two types of symptoms (Table 3).

Other symptoms associated with ACMV in single and in mixed infections with EACMV include ragged leaves (Fig. 9a) and reduced and wrinkled leaflets (Fig. 9b). Some ACMV isolates induced severe symptoms and in some cases changed the morphology of the plants (Fig. 9c) as compared to uninfected plants of the same genotype (Fig. 9d). Some of the plants doubly infected by the two viruses had reduced leaf sizes accompanied by defoliation (Figs. 9e, f).



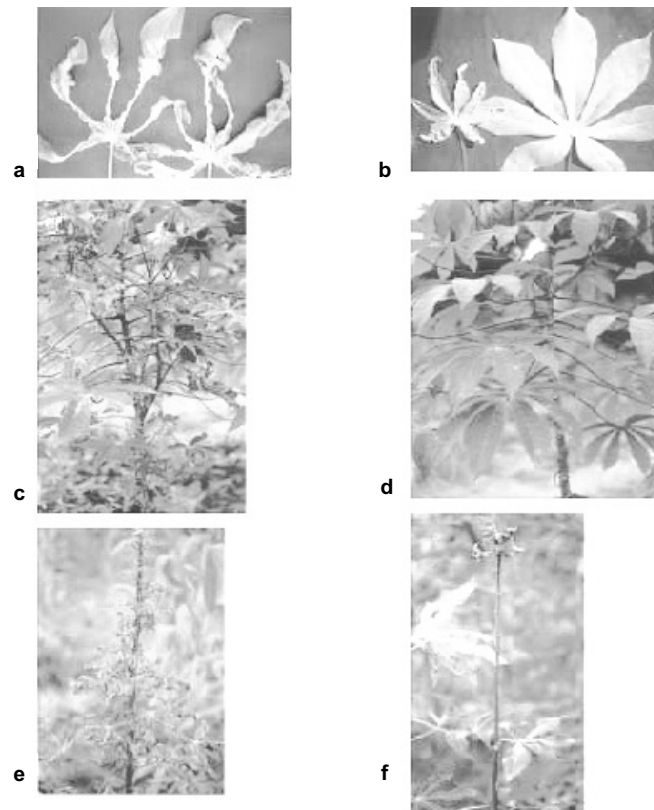
**Figure 8.** Characteristic symptoms of biological variants of *African cassava mosaic virus* (ACMV) on cassava leaf.

The symptoms were observed on different plants of the same genotype in the same farm during a diagnostic survey in 2002/2003 for cassava begomoviruses in Nigeria. Yellow-green mosaic with mild leaf distortion (a), whitish/bleaching-green mosaic with notable leaf distortion (b), and symptomless leaf (c).

**Table 3.** The type of cassava mosaic disease symptoms on cassava associated with single and double infections by *African cassava mosaic virus* (ACMV) and *East African cassava mosaic virus* (EACMV)<sup>a</sup>.

Type of symptom	Number of plants assessed	Percentage associated with		
		ACMV	EACMV	ACMV + EACMV
Yellow-green mosaic	174	78.7	1.7	19.6
Whitish/bleaching-green mosaic	13	76.9	0.0	23.1
Combinations of the two symptom types	207	68.1	0.0	31.9

<sup>a</sup>Only plants of the same genotype were assessed in each field in this study.



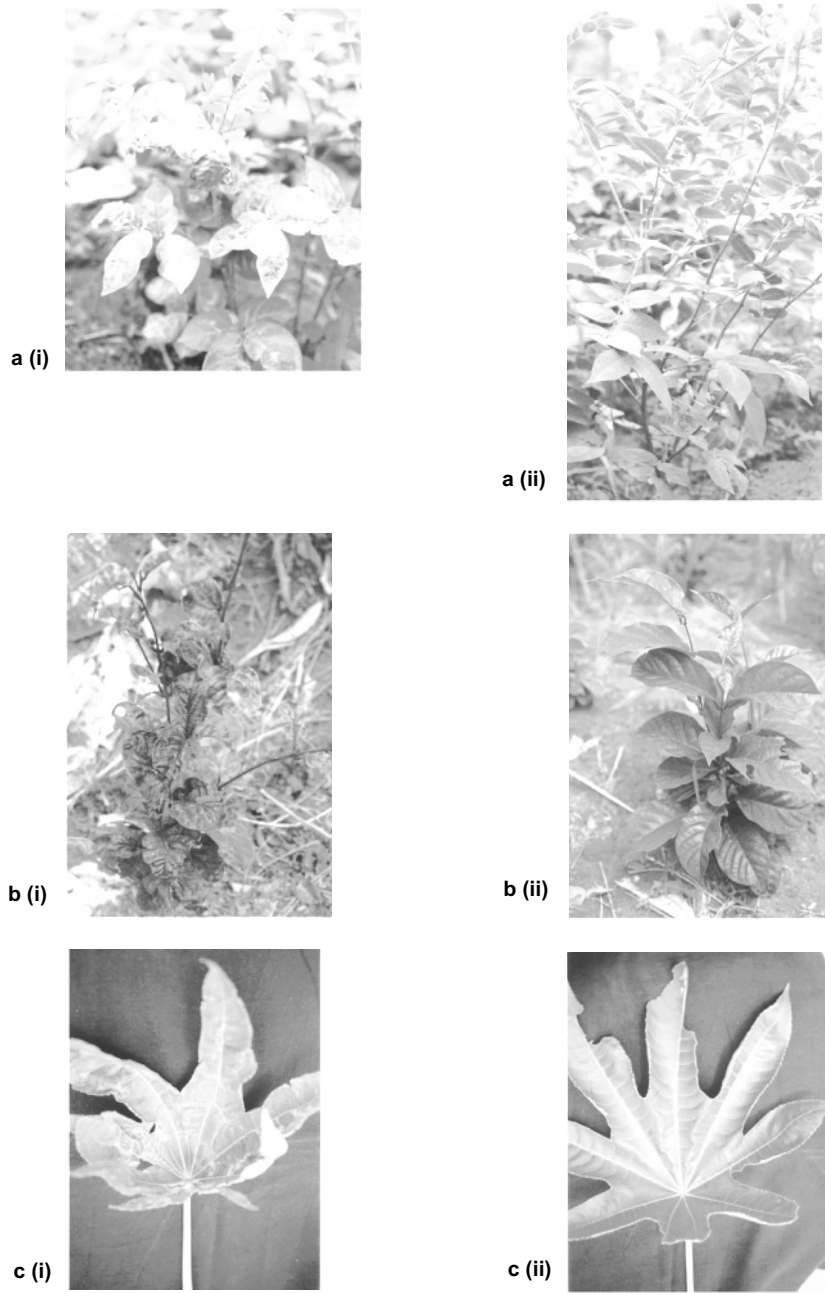
**Figure 9.** Some notable symptoms associated with *African cassava mosaic virus* (ACMV) in single infection and in double infection with *East African cassava mosaic virus* (EACMV).

(a): ragged leaf, (b): reduced and wrinkled leaflets on an infected leaf and uninfected leaf (right), (c): multiple shooting caused by severe symptoms of ACMV, (d): uninfected plant of the same genotype as in (c), reduced leaf size and stunted plant due to mixed infection by ACMV and EACMV, and (f): defoliation caused by mixed infections by the two viruses.

### Alternative host of ACMV and EACMV

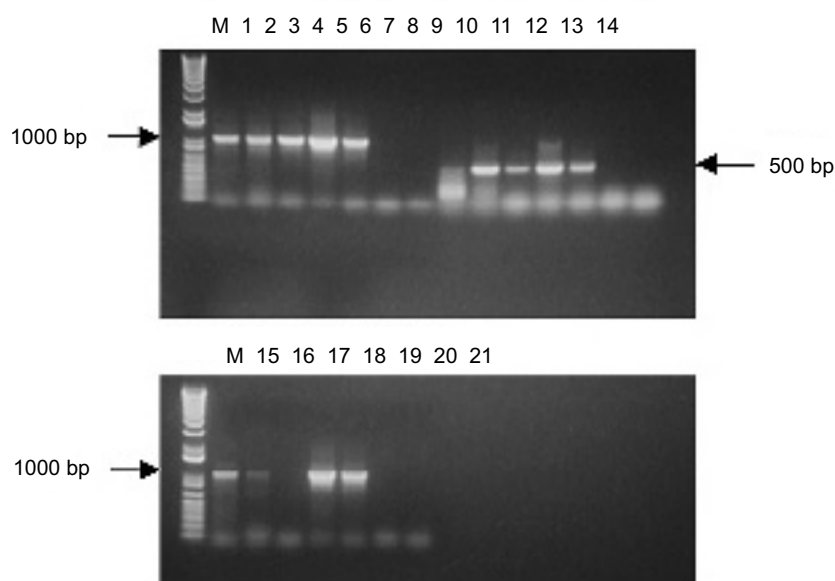
ACMV and EACMV were diagnosed in a leguminous weed (*Senna occidentalis* (L.) Link) showing mosaic symptoms (Fig. 10a [i]) while the plant in Fig. 10a [ii] was symptomless. The two viruses also co-infected *Combretum confertum* Lam. showing very bright mosaic symptoms (Fig. 10b [i]). ACMV was also diagnosed in castor *Ricinus communis* L. with leaves exhibiting coalesced chlorotic spots (Fig. 10c [i]).

By PCR tests, *S. occidentalis* was positive for ACMV and EACMV (Fig. 11). Similarly, *C. confertum* tested positive for the two viruses. ACMV was detected in castor oil leaf while extracted DNA of wild cassava *M. glaziovii*, which was collected during the survey tested positive for ACMV and EACMV. A pair of degenerate primers (Table 1) for the detection of whitefly-transmitted geminiviruses reacted positively with DNA from *C. confertum*, castor, and wild cassava.



**Figure 10.** Natural hosts of *African cassava mosaic virus* (ACMV) and *East African cassava mosaic virus* (EACMV) in Nigeria.

(a) (i): infected *Senna occidentalis* (L.) Link, (ii): healthy *S. occidentalis*; (b) (i): infected *Combretum confertum* Lams., (b) (ii): healthy *C. confertum* Lams.; (c) (i): infected leaf of *Ricinus communis* L, (c) (ii): healthy leaf of *R. communis*.



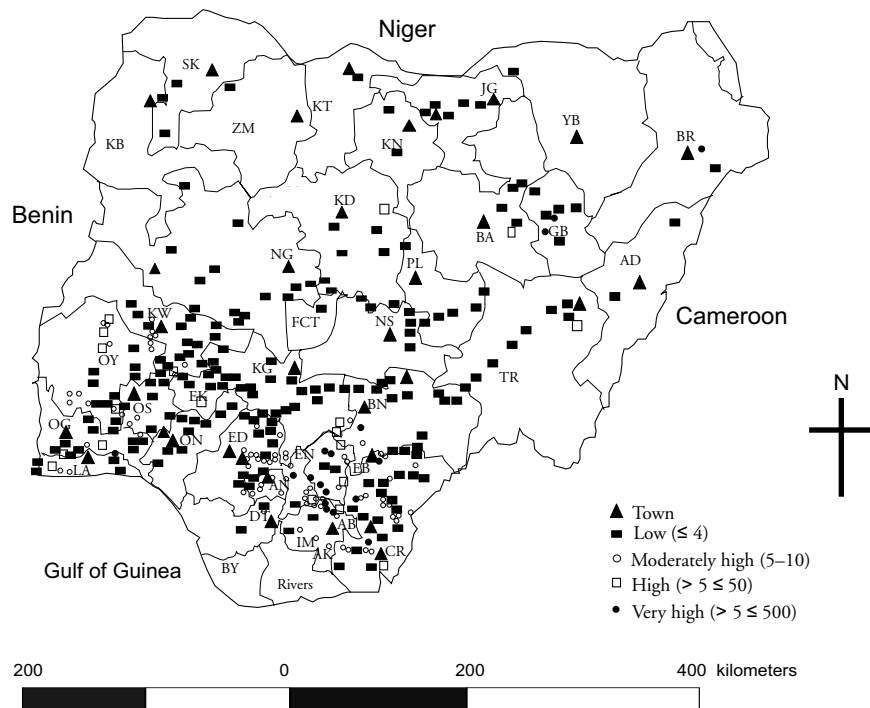
**Figure 11. The detection of *African cassava mosaic virus* and *East African cassava mosaic virus* in weed samples in cassava fields in Nigeria\*.**

\*Total DNA was extracted from the infected leaves of the weed samples and tested by polymerase chain reactions. M = 1 kb plus marker. Lane 1 (*A legume, Senna occidentalis*), 2 (unidentified weed), 3 (Castor oil plant *Ricinus communis*), 4 (wild cassava, *Manihot glaziovii*), 5 (cassava leaf as positive control), 6 (healthy cassava leaf as negative control), and 7 (DNA extraction buffer also as negative control). This arrangement was repeated in lanes 8–14 and 15–21. Lanes 1–7 were tested by ACMV specific primer ACMV-AL1/F/AR0/R (Zhou *et al.*, 1997); lanes 8–14 by a pair of degenerate primers, Primer A/B (Deng *et al.* 1994) and lanes 15–21 by EACMV primers, UV-AL3/F/AL1/R2 (Zhou *et al.* 1997).

### Whitefly populations and their distribution

Whitefly populations ranged from 0 to 500 per plant (Fig. 12). In southern Nigeria, the whitefly population varied within a locality and also within a farm based on the varieties being cultivated. In some farms, it was observed that some varieties supported higher whitefly populations than other varieties (data not shown). Most farms in the south had whitefly populations of between 5 and 500 per plant (Fig. 12). In comparison, most farms in the north starting from the middle belt (Kwara, Kogi, and Benue states) had whitefly populations of between 0 and 4 per plant. A lot of the farms in the northeast and northwest had no whiteflies.

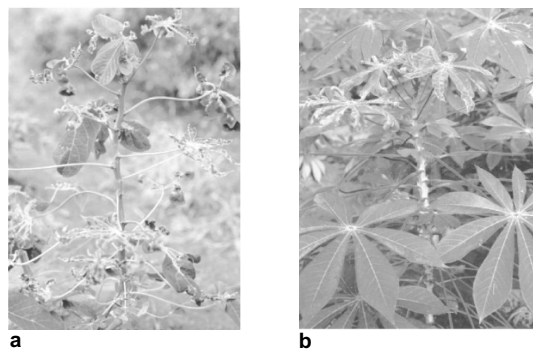
The transmission of CMD in southern Nigeria was observed to be by infected cuttings and by whitefly vectors while CMD transmission was mostly by infected cuttings in the north. When the virus has been transmitted through cuttings, at least the first six leaves at the base of the primary stem are diseased (Fig. 13a), while in vector transmission, the first six leaves at the base of the primary stem are usually symptomless (Fig. 13b) (Ogbe *et al.* 2003a).



**Figure 12.** Whitefly vector populations and their distribution in cassava fields in Nigeria\*.

\*The country is partitioned into states as follows: AK = Akwa Ibom, BY = Bayelsa, CR = Cross River, DT = Delta, ED = Edo, RV = Rivers, AB = Abia, AN = Anambra, EB = Ebonyi, EN = Enugu, IM = Imo, EK = Ekiti, LA = Lagos, OG = Ogun, ON = Ondo, OS = Osun, OY = Oyo, BN = Benue, KG = Kogi, KW = Kwara, NS = Nassarawa, NG = Niger, PL = Plateau, FCT = Federal Capital Territory, AD = Adamawa, BA = Bauchi, BR = Borno, GB = Gombe, TR = Taraba, JG = Jigawa, YB = Yobe, KD = Kaduna, KN = Kano, KT = Katsina, KB = Kebbi, SK = Sokoto, ZM = Zamfara

The figures given in the legend were the whitefly populations per plant.



**Figure 13.** The pattern of mosaic symptoms on cassava plants infected through infected stem cuttings and through whitefly vector transmission

(a) stem cutting transmission: leaves at the base of the primary stem are also symptom-bearing; (b) whitefly vector transmission: the leaves at the base of the primary stem are symptomless.

## Discussion

The predominance of ACMV in single infection over EACMV in Nigeria had been reported from a survey conducted in 1997 and 1998 (Ogbe 2001). In that survey, only one sample (0.05%) was diagnosed to contain EACMV in a single infection out of the 290 samples tested. This was similar to the present survey in which three samples (0.3%) were single infections of EACMV out of the 1106 samples tested. Single infection of EACMV was also not common in Côte d'Ivoire (Pita et al. 2001b) or Cameroon (Fondong et al. 2000). This contrasts with results from the coastal areas of Tanzania, Kenya, and Malawi and Madagascar where single infection by EACMV predominates (Swanson and Harrison 1994; Ogbe et al. 1997a, b). More and wider distribution of mixed infections by ACMV and EACMV was recorded in the present survey than in the survey conducted in 1997 and 1998. The mixed infections were distributed across the entire country (Fig. 7) whereas in the earlier survey the distribution was from the south only to the middle belt of the country (Ogbe 2001). In addition, the 1997/98 survey found 9.3% mixed infections compared with the 24.1% in the present survey. In this survey, more routes were covered, visiting more farms and more plants per farm were sampled than in the 1997/98 survey to increase the sensitivity of the survey, particularly with respect to detecting EACMV-Ug2. Intensive cultivation of cassava and the dissemination of the viruses by whitefly vectors, particularly in southern Nigeria, could also be the cause of a greater number of farms with mixed infections. Mixed infections by ACMV and EACMV with the associated severe symptoms have been reported in Uganda, Tanzania (Harrison et al. 1997; Pita et al. 2001a), and Cameroon (Fondong et al. 2000).

It is important to note that the distribution of farms with cassava plants with either moderately severe or severe CMD symptoms (Fig. 3) was similar to the distribution of double infections by ACMV and EACMV (Fig. 7). This implies that the more the number of farms where mixed infection was detected, the greater the number of farms with cassava with severe symptoms. Since it may be difficult to prevent mixed infections, which are brought about by whitefly transmission and through the planting of infected stem cuttings, the severe symptoms associated with such infections can be mitigated through the cultivation of resistant genotypes. The cultivation of cassava genotypes with adequate resistance to CMD might partly explain why doubly infected plants generally did not show very severe symptoms in Delta State (Table 2) where different genotypes were being cultivated, and some of which were improved genotypes. This is an indication that the CMD project can make the desired impact in combating the severe form of CMD through the introduction of desirable resistant genotypes into the agroecologies of Nigeria.

For most genotypes, either singly or doubly infected in most parts of northern Nigeria, to show similar levels of CMD severity (Table 2) implies that the genotypes might be similar in their reactions. The genotypes may also have not had high levels of CMD resistance.

Observations in southern Nigeria confirmed that it requires double infections to induce more severe symptoms on resistant genotypes than the symptoms induced by single infection. It appears from this study, therefore, that more resistant and heterogeneous genotypes are being cultivated in the south than in northern Nigeria.

Differences in the proportion of resistant genotypes being cultivated in the various states in Nigeria could partly be responsible for this different CMD status (Fig. 1). Another plausible reason for the differences could be a result of differences in the distributions of possible variants of ACMV and EACMV and double infections (Fig. 7).

Biological variants of ACMV reported by Ogbe et al. 2003b were determined on *Nicotiana benthamiana*, an experimental host. In the present study, two biological variants of ACMV based on symptoms on cassava were obvious (Table 3, Fig. 8). The two variants mostly co-infected cassava (Table 3) producing possible synergistic effects that might be responsible for the severe symptoms observed in plants infected only with ACMV (Figs. 9c, 13a, b). Thus mixed infections by ACMV and EACMV and double or mixed infections by variants of ACMV could be more common in Nigeria than single infections. This could partly account for the fairly high proportion (48%) of farms with cassava showing either moderately severe or severe symptoms of CMD (Fig. 3). There is a need to provide farmers with new improved varieties with high levels of resistance to CMD. This indicates that the activities of the CMD project should extend beyond the south–south and the southeastern states in order to control CMD in Nigeria. From the results of this survey, the resistant cassava genotypes selected for introduction to farmers in the south–south and southeast should also be evaluated for adaptation in the southwest, middle belt, northeast, and northwest geopolitical zones.

A genotype with high level of resistance to CMD, if introduced to the northern geopolitical zones, could be cultivated for a longer time than in the southern geopolitical zones with less risk of that genotype becoming infected with CMD. This is because whitefly populations in the northern geopolitical zones are low (Fig. 12) and the intensity of cassava cultivation is low leading to limited exchange of planting material. This has resulted in a low rate of spread of CMD (Akano et al. 1995). The decrease in whitefly population from southern Nigeria (humid region) to the north (semiarid and arid regions) had earlier been observed in Nigeria (Akano et al. 1995; Ogbe et al. 2001). A decline in whitefly populations was also observed from the forest to the savanna agroecologies in Côte d'Ivoire (Fargette et al. 1988). Because of the high vector populations and availability of inoculum the southern geopolitical zones in Nigeria are therefore more suitable for the screening of cassava for resistance to CMD. In these zones, the intensity of cassava cultivation is high leading to possible frequent exchange of planting material; whitefly vector populations are high (Fig. 12) for rapid spread of CMD; and there are high proportions of plants doubly infected by ACMV and EACMV and their variants.

Identification of ACMV and EACMV in *Senna occidentalis* and *Combretum confertum* (Fig. 10a, b) has added to the list of natural alternative hosts of the viruses. Shoyinka et al. (2001) had earlier reported castor oil plant *Ricinus communis* as an alternative host of ACMV and EACMV. In the present survey, ACMV was also detected in *R. communis* leaf



(Figs. 10c, 11). The newly identified natural hosts of ACMV and EACMV (Fig. 10a, b) are fairly common in southern Nigeria as is also the castor oil plant. The wider host range of ACMV in southern Nigeria is of epidemiological importance as the alternative hosts could serve as reservoirs of inoculum.

EACMV-Ug2 was not detected in Nigeria (Fig. 4). This implies that the virulent Ugandan variant has not manifested itself nor been introduced into Nigeria. This corroborates the earlier report by Ogbé (2001). Negative results obtained for the diagnosis of ICMV and SACMV also indicates that these viruses do not presently occur in Nigeria. The unidentified isolates (Fig. 7) further need to be characterized; they could be strains of cassava mosaic begomoviruses. Genetic modification by mutation or recombination of geminiviruses has produced new species and strains such as EACMV-Ug2 (Zhou et al. 1997) and SACMV (Berrie et al. 2001). Although the virulent Ugandan variant was not apparently present in Nigeria, the high proportion of double infections by ACMV and EACMV, and the occurrence of variants of ACMV (Fig. 8), provide suitable conditions for the possible evolution of new strains or species of cassava begomoviruses in Nigeria. The unidentified isolates found in this study could be such newly evolved species or strains. Appropriate measures are, therefore, necessary to safeguard cassava production in Nigeria. This CMD project is timely, providing additional resistant cassava genotypes to the Nigerian farmers to forestall the consequence of any outbreak of a virulent strain or species of cassava begomovirus and to also minimize the impact of EACMV-Ug2 if it eventually spreads to Nigeria.

## Conclusion

In 2002 and 2003, a diagnostic survey was conducted to determine the status of CMD and cassava mosaic begomoviruses in Nigeria. From the results obtained, we have concluded:

- At the time of the survey, ACMV and EACMV were the only cassava mosaic begomoviruses occurring in Nigeria. ACMV predominates occurring as both single infections and as mixed infections with EACMV.
- Double infections by the two viruses were widespread. They were generally characterized by severe symptoms and their distribution was current with the farms with cassava with severe symptoms of CMD.
- Biological variants of ACMV, based on symptoms on cassava, occurred. The proportion of dual infections by the variants was high and the dual infections were characterized by severe symptoms.
- Additional natural hosts of ACMV and EACMV were identified and they could further provide additional disease foci for the spread of CMD by the whitefly vectors.
- The south–south, southeast, and southwest geopolitical zones were most appropriate for the screening of cassava genotypes for resistance to CMD. In these zones, most plants were infected with CMD and a high proportion had severe symptoms. Whitefly vector populations were high and cassava cultivation was intensive in these zones. These conditions enhance the spread of CMD an ideal situation for screening for resistance.
- Additional resistant cassava genotypes should be provided to cassava farmers in Nigeria to mitigate the severe CMD symptoms already occurring at a fairly high level in cassava fields. Such genotypes could also prevent an outbreak of a severe form of CMD, either due to EACMV-Ug2 or other virulent strains of cassava begomoviruses that may evolve in Nigeria, from having devastating consequences.

## References

- Akano, A., S.Y.C. Ng, R. Asiedu, and G.I. Atiri. 1995. Performance in three agroecologies of virus-tested cassava genotypes derived from meristem culture. Pages 194–198 *in* Proceedings of the sixth Triennial Symposium of the International Society for Tropical Root Crops (African Branch), edited by M.O. Akoroda and I.J. Ekanayake. Lilongwe, Malawi.
- Berrie, L.C., K.E. Palmer, E.P. Rybicki, and M.E.C. Rey. 1998. Molecular characterization of a distinct South African cassava infecting geminivirus. *Archives of Virology* 143: 2253–2260.
- Berrie, L.C., E.P. Rybicki, and M.E.C. Rey. 2001. Complete nucleotide sequence and host range of *South African cassava mosaic virus*: further evidence for recombination among begomoviruses. *Journal of General Virology* 82: 53–58.
- Bock, K.R. and R.D. Woods. 1983. Etiology of African cassava mosaic disease. *Plant Disease* 67: 994–995.
- Deng, D., P.F. McGrath, D.J. Robinson, and B.D. Harrison. 1994. Detection and differentiation of whitefly-transmitted geminiviruses in plants and vector insects by the polymerase chain reaction with degenerate primers. *Annals of Applied Biology* 125: 327–336.
- Dellaporta, S.L., J. Woods, and J.B. Hicks. 1983. A plant DNA mini-preparation: version II. *Plant Molecular Biology Reporter* 1: 19–21.
- FAO. 2002. <http://faostat.fao.org/faostat>
- Fargette, D., C. Fauquet, and J.C. Thouvenel. 1988. Yield losses induced by *African cassava mosaic virus* in relation to the mode and the date of infection. *Tropical Pest Management* 34: 89–91.
- Fauquet, C. and D. Fargette. 1990. *African cassava mosaic virus*: etiology, epidemiology and control. *Plant Disease* 74: 404–411.
- Fondong, V.N., J.S. Pita, M.E.C. Rey, A. de Kochko, R.N. Beachy, and C.M. Fauquet. 2000. Evidence of synergism between *African cassava mosaic virus* and a new double-recombinant geminivirus infecting cassava in Cameroon. *Journal of General Virology* 81: 287–297.
- Harrison, B.D., X. Zhou, G.W. Otim-Nape, Y. Liu, and D.J. Robinson. 1997. Role of a novel type of double infections in the geminivirus-induced epidemic of severe cassava mosaic in Uganda. *Annals of Applied Biology* 131: 437–448.
- Hong, Y.G., D.J. Robinson, and B.D. Harrison. 1993. Nucleotide sequence evidence for the occurrence of three distinct whitefly-transmitted geminiviruses in cassava. *Journal of General Virology* 74: 2437–2443.

- Neuenschwander, P., J.d'A. Hughes, F.O. Ogbe, J.M. Ngatse, and J.P. Legg. 2002. Occurrence of the Uganda variant of *East African cassava mosaic virus* (EACMV-Ug) in western Democratic Republic of Congo and the Congo Republic defines the westernmost extent of the CMD pandemic in East/Central Africa. *Plant Pathology* 51: 385.
- Ogbe, F.O. 2001. Survey of cassava begomoviruses in Nigeria and the response of resistant cassava genotypes to *African cassava mosaic begomovirus* infection. PhD thesis, University of Ibadan, Ibadan, Nigeria. 197 pp.
- Ogbe, F.O., G.I. Atiri, A.G.O. Dixon, and G. Thottappilly. 2001. Cassava mosaic disease and its causal agents: the Nigerian situation. Pages 411–422 in *Plant Virology in Sub-Saharan Africa (PVSSA 2001)*. Proceedings of a conference 4–8 June 2001, IITA, Ibadan, Nigeria.
- Ogbe, F.O., G.I. Atiri, A.G.O. Dixon, and G. Thottappilly. 2003a. Symptom severity of cassava mosaic disease in relation to concentration of *African cassava mosaic virus* in different cassava genotypes. *Plant Pathology* 52: 84–91.
- Ogbe, F.O. G.I. Atiri, A.G.O. Dixon, and G. Thottappilly. 2003c. Serological and biological variations of *African cassava mosaic virus* in Nigeria. *Annals of Applied Biology* 143: 203–213.
- Ogbe, F.O., J. Legg, M.D. Raya, A. Muimba-kankolongo, M.P. Theu, G. Kaitisha, N.A. Phiri, and A. Chalwe/ 1997b. Diagnostic survey of cassava mosaic viruses in Tanzania, Malawi and Zambia. *Roots* 4: 12–15.
- Ogbe, F.O., G. Thottappilly, and F.M. Quin. 1997a. Implementation in Africa of serological diagnostic test for cassava mosaic geminiviruses. *African Journal of Root and Tuber Crops* 2: 33–36.
- Ogbe, F.O., G. Thottappilly, A.G.O. Dixon, G.I. Atiri, and H.D. Mignouna. 2003b. Variants of *East African cassava mosaic virus* and its distribution in double infections with *African cassava mosaic virus* in Nigeria. *Plant Disease* 87: 229–232.
- Otim-Nape, G.W., A. Bua, J.M. Thresh, Y. Baguma, S. Ogwal, G.N. Ssemakula, G. Acola, B. Byabakama, J. Colvin, R.J. Cooter, and A. Martin. 2000. The current pandemic of cassava mosaic virus disease in East Africa and its control. NARO, NRI, and DFID publication. 100 pp.
- Otim-Nape, G.W., J. Legg, J.M. Thresh, and T. Alicai. 1998. Advances in research on severe cassava mosaic epidemic in Uganda. Pages 553–562 in *Proceedings of the 7<sup>th</sup> Triennial Symposium of the International Society for Tropical Root Crops-African Branch (ISTRAC-AB)*, edited by M.O. Akoroda and J.M. Ngeve, 11–17 October 1998, Cotonou, Republic of Benin.
- Otim-Nape G.W., M.W. Shaw, and J.M. Thresh. 1994. The effects of *African cassava mosaic geminivirus* on the growth and yield of cassava in Uganda. *Tropical Science* 34: 43–54.

- Pita, J.S., V.N. Fondong, A. Sangare, R.N.N. Kokora, and C.M. and Fauquet. 2001b. Genomic and biological diversity of the African cassava geminiviruses. *Euphytica* 120: 115–125.
- Pita, J.S., V.N. Fondong, A. Sangare, G.W. Otim-Nape, S. Ogwal, and C.M. Fauquet. 2001a. Recombination, pseudo-recombination and synergism of geminiviruses are determinant keys to the epidemic of severe cassava mosaic disease in Uganda. *Journal of General Virology* 82: 655–665.
- Robinson, D.J., B.D. Harrison, J.C. Sequeira, and G.H. Duncan. 1984. Detection of strains of *African cassava mosaic virus* by nucleic acid hybridization and some effects of temperature on their multiplication. *Annals of Applied Biology* 105: 483–493.
- Saunders, K., N. Salim, V.R. Mali, V.G. Malathi, R. Briddon, P.G. Markham, and J. Stanley. 2002. Characterisation of Sri Lanka cassava mosaic and Indian cassava mosaic virus: evidence for acquisition of a DNA-B component by a monopartite begomovirus. *Virology* 293: 63–74.
- Seif, A.A. 1981. Transmission of cassava mosaic virus by *Bemisia tabaci*. *Plant Disease* 65: 606–607.
- Seif, A.A. 1982. Effect of cassava mosaic virus on yield of cassava. *Plant Disease* 66: 661–662.
- Shoyinka, S.A., G. Thottappilly, F.F. McGrath, and B.D. Harrison. 2001. Detection, relationships and properties of cassava mosaic geminivirus in naturally infected castor oil plant, *Ricinus communis* L. in Nigeria. Book of Abstracts, CBN-V, Donald Danforth Plant Science Center, St. Louis, Missouri, USA, 4–9 November 2001. P 88-20.
- Swanson, M.M. and B.D. Harrison. 1994 Properties, relationships and distribution of cassava mosaic geminiviruses. *Tropical Science* 34: 15–25.
- Terry, E.R. 1975. Description and evaluation of cassava mosaic disease in Africa. Pages 53–37 in *The international exchange and testing of cassava germplasm in Africa*, edited by E.R. Terry and R. MacIntyre. IITA, Ibadan, Nigeria.
- Terry, E.R. and S.K. Hahn. 1980. The effect of cassava mosaic disease on growth and yield of a local and an improved variety of cassava. *Tropical Pest Management* 26: 34–37.
- Warburg, O. 1894. Die Kulturpflanzen Usambaras. *Mitteilungen aus den Deutschen Schutzgebieten* 7: 131.
- Zhou, X., Y. Liu, L. Calvert, C. Munoz, G.W. Otim-Nape, D.J. Robinson, and B.D. Harrison. 1997. Evidence that DNA-A of a geminivirus associated with severe cassava mosaic disease in Uganda has arisen by inter-specific recombination. *Journal of General Virology* 78: 2101–2111.
- Zhou, X., D.J. Robinson, and B.D. Harrison. 1998. Types of variation in DNA-A among isolates of *East African cassava mosaic virus* from Kenya, Malawi and Tanzania. *Journal of General Virology* 79: 2835–2840.

**Appendix. Cassava leaf samples of different genotypes collected at different locations in Nigeria for the diagnosis of cassava mosaic begomoviruses and for the assessment of cassava mosaic disease (CMD) and whitefly vector (WF) population.**

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Benin-Agbor Road (starting from the bypass junction)</b>								
1	Adulhanhan	6.3153	5.798	Rubber	3	ACMV+EACMV	M	5
2				Queen	3	ACMV	M	5
3	Km 17, Benin-Agbor Rd.	6.303	5.8833	Unknown	2.5	ACMV	MS	5
4	Evbobanosa	6.2869	5.9775	Lagos?	2	ACMV		
5				Queen	3	ACMV		
6				Rubber	4	ACMV		
7	Ogan	6.2855	6.0628	Agric (30572?)	3	ACMV	M	5
8				Lagos?	2	ACMV		
9	Agbor outskirts	6.2622	6.1486	Unknown	3	ACMV	M	2
10				Unknown	2	ACMV		
<b>Agbor-Uromi Road</b>								
11	Km. 3	6.2928	6.2014	Lagos?	2	ACMV	M	2
12				Lagos?	3	ACMV		
13	Igbanke	6.3758	6.2442	Owede/Lagos?	3	ACMV+EACMV	M	2
14				Owede/Lagos?	2	ACMV		
15	Ologhe-ebeke	6.4817	6.2386	Unknown	2	ACMV	M	3
16				Unknown	3	ACMV		
17	Ubiru	6.6536	6.265	Owede/Lagos?	2	ACMV+EACMV	M	2
18				Owede/Lagos?	3	ACMV		
19	IITA field, Ubiaja	6.6694	6.3458	30572	3	ACMV	M	5
20				30572	3	ACMV		
<b>Uromi-Ewu Road</b>								
21	Km 12	6.7428	6.2694	TME 1/8?	2	ACMV	M	2
22				TME 1/8?	3	ACMV		
23				TME 1/8?	1	-		
<b>Ewu-Auchi Road</b>								
24	Ewu	6.815	6.2575	TME 1	3	ACMV	S	3
25				TME 1	4	ACMV		
26				TME 1	4	ACMV+EACMV		
27				Agric?	3	ACMV		
28	Egono	6.9436	6.2719	TME 1	2	ACMV	M	2
29				TME 1	3	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant	
30				TME 1	1	-			
31	Auchi outskirts (Km 28)	7.0408	6.2744	TME 1	1	ACMV	MS	5	
32				TME 1	2	ACMV			
33				Unknown	2	ACMV			
34				Unknown	3	ACMV			
	<b>Auchi-Agenebode (starting from the junction opposite the Polytechnic gate)</b>								
35	Ughieda	7.0408	6.32	TME 1	1	-	MS	5	
36				Unknown	3	ACMV			
37				TME 1	2	ACMV+EACMV			
38	Ekperi outskirts	7.0283	6.398	TME 1	1	-	M	3	
39				TME 1	2	ACMV			
40	Km 28	7.0311	6.498	TME 1	1	-	MS	2	
41				TME 1	3	ACMV			
42				TME 1	3	ACMV			
43				TME 1	2	ACMV			
44	Egiere (Km 38)	7.0569	6.5792	Unknown	1	-	M	2	
45				Unknown	2	ACMV			
46				Unknown	2	ACMV			
47	Km 48	7.0803	6.6575	Unknown	1	-	M	2	
48				Unknown	3	ACMV			
	<b>Auchi-Afuze Road (starting from All Saints Anglican Church)</b>								
49	Km 6.	7.0225	6.2311	Unknown	3	ACMV	M	2	
50				TME 1	2	ACMV			
51	Km 18	7.0039	6.0955	TME 1	3	ACMV	M	2	
52				TME 1	2	ACMV			
53				TME 1	1	-			
	<b>Afuze-Sabongida Ora Road (starting from the junction of the game village)</b>								
54	Ojavu (km. 8)	6.9347	5.9708	Dan Warri	4	ACMV+EACMV	S	2	
55				Dan Warri	3	ACMV			
	<b>Sabongida Ora-Ozalla Road (starting from bridge Ikon Road Junction)</b>								
56	CRIN bus stop (Km.8)	6.8386	5.9694	30572	2.5	ACMV	M	5	

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
57				30572	3	ACMV		
58				30572	1	ACMV		
59	<b>Benin-Auchi (starting from Ikpoba hill roundabout)</b>							
60	Adumagbarhe (Km 11)	6.3978	5.7489	Queen	3	ACMV	MS	5
61				Queen	2	ACMV		
62				Queen	1	-		
63				Queen	2	ACMV		
64	Ehiozevbaru (Km 25)	6.4772	5.8347	Unknown	3	ACMV	M	2
65				Unknown	2.5	ACMV		
66				Unknown	2.5	ACMV		
67	Ehor (Km 49).	6.6214	5.9833	Unknown	2	ACMV		
68				Unknown	3	ACMV	M	2
69				Unknown	2	ACMV		
70	Iruelken (Km 65)	6.745	6.0455	TME 1	3	ACMV	M	2
71				TME 1	1	ACMV		
72	<b>Benin-Ubiaruku/Abiraka Road (starting from the Nigerian Police HQ Ugbeku, Benin City)</b>							
73	Km 6	6.2805	5.6858	Queen	3	ACMV	M	2
74				Queen	1	-		
75	Agovbe (Km 24)	6.1911	5.8039	Agric (30572?)	3	ACMV	MS	10
76				Rubber	4	ACMV+EACMV		
77				Queen	2	ACMV		
78	Ewesi Camp (Km 61)	6.0028	6.0222	Unknown	2	ACMV	M	2
79				Unknown	3	ACMV+EACMV		
80				Unknown	3	ACMV		
81				Unknown	1	-		
82	Km 73	5.9086	6.0694	TME 1	3	ACMV	MS	2
				Queen	3	ACMV		
83	<b>Abiraka-Eku Road (starting from the junction of Agbor/Sapele Road)</b>							
84	Oria Abiraka (Km 11)	5.7575	6.04	30572?	3	ACMV	M	5
85				Unknown	2	ACMV		
				Unknown	1	-		
86	<b>Ekurwarri Road</b>							
87	Okurekpo (Km 5)	5.7064	5.9617	Queen?	3	ACMV	M	2
				Queen?	4	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction



Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
88				Queen?	2	ACMV		
89				Queen?	1	-		
90	Orerokpe (Km 16)	5.6455	5.8883	TME 1	3	ACMV	M	5
91				TME 1	3	ACMV		
92				TME 1	1	ACMV		
93	<b>Jesse Junction-Igbinoba Road</b>							
94	Km 1	5.875	5.7358	TME 1	2	ACMV	M	2
95				TME 1	3	ACMV		
96				TME 1	3	ACMV		
98	Igbewhore (Km 15)	5.9339	5.8278	Unknown	3	ACMV	M	2
99				Queen?	3	ACMV		
				Unknown	1	-		
100	<b>Sapele-Eku (starting from Amulke junction)</b>							
101	Egbeku (Km 7)	5.8133	5.7628	Unknown	2	ACMV+EACMV	M	2
102				Unknown	2.5	ACMV+EACMV		
103				Unknown	3	ACMV		
104				Unknown	1	-		
105	Aghalokpe (Km 22)	5.7617	5.8769	Ewribowwe (Oyibo)	2.5	ACMV	M	2
106				Ewribowwe (Oyibo)	1	-		
107				Ewribowwe (Oyibo)	1	-		
108	Eku (Km 36)	5.743	5.9961	Erekarhia	3	ACMV	MS	5
109				Erekarhia	2.5	ACMV		
110				Ewribowwe (Oyibo)	3	ACMV+EACMV		
111	<b>Obiaruku-Agbor (starting from Elf fuel station)</b>							
112	Umutu, Obi-Iloh (Km 10)	5.8942	6.2189	Ewribowwe (Oyibo)	2	ACMV	MS	8
113				Unknown	3	ACMV+EACMV		
114	Km 31	6.0744	6.1722	Ewribowwe (Oyibo)	3	ACMV+EACMV	M	2
115				Ewribowwe (Oyibo)	3	ACMV		
116				Unknown	3	ACMV		
117	Agbor (Km 71)	6.2478	6.1792	Unknown	1	-		
				Erekarhia?	2	ACMV+EACMV	MS	5

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
118				Erhakarhia?	2.5	ACMV		
119				Ewribowwe (Oyibo)	3	ACMV		
120	<b>Agbor-Asaba (starting from Sapele Road junction)</b>							
121	Umunede	6.2714	6.2705	Unknown	2.5	ACMV	M	5
122				Unknown	3	ACMV		
123	Iseleuku	6.303	6.458	Unknown	2	ACMV	M	5
124				Unknown	3	ACMV		
125	Asaba outskirts	6.2111	6.665	Unknown	1	-		
	<b>Asaba-Warri (starting from the Benin Road junction)</b>							
126	Km 3.	6.1936	6.7136	Unknown	3	ACMV	M	2
127				Unknown	2	ACMV	M	5
128				Unknown	3	ACMV+EACMV		
129	Ogwashiuku	6.1353	6.5355	Agric?	1	-		
130				Lagos (TME1)	2	ACMV+EACMV	M	5
131				Lagos (TME1)	2	ACMV		
132	Ossisa	5.9055	6.4708	Lagos (TME1)	1	-		
133				Lagos?	3	ACMV	M	5
134				Lagos?	2	ACMV		
135	Km 88 after Kwale	5.6819	6.3773	Lagos?	1	ACMV		
136				Lagos/TME 1	2	ACMV	M	10
137				Lagos/TME 1	3	ACMV		
138a				Lagos/TME 1	3	ACMV		
138a	<b>Warri-Ughelli (starting from the steel plant roundabout)</b>							
138.b	Agbarho IITA/Shell Site	5.568	5.8747	30572	1	-		
139				30572	2.5	ACMV	MS	2
140				30572	2	ACNV		
141				30572	4	ACMV +EACMV		
142				30572	1	ACMV		
143				30572	4	ACMV		
144				30572	2	ACMV		
145	Eruemukohwarien	6.5297	5.9397	30572	3	ACMV		
146				Ewribowwe?	2.5	ACMV	MS	50
147				Ewribowwe?	3	ACMV+EACMV		
				Ewribowwe?	1	ACMV		

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
148	<b>Ugelli-Ozoro Road</b> Oghara-Iyede	5.4875	6.0886	Erekarhia/ Ododoyeye?	3	ACMV	M	0
149	<b>Ughelli-Port Harcourt Road</b> Ewreni	5.363	6.0619	Erekarhia/ Ododoyeye/Agric?	3	ACMV	M	6
150				Erekarhia/ Ododoyeye/Agric?	2.5	ACMV	M	5
151	Mbiama	5.07	6.4328	30572	2.5	ACMV	M	5
152				30572	3	ACMV	M	5
153				30572	1	-	M	5
154	Okogbe	5.0647	6.523	Ewiboywe?	3	ACMV	M	5
155				Rubber/Agric?	4	ACMV	M	10
156	Km 104	5.0594	6.6792	False 30572	2.5	ACMV	M	10
157				30572	3	ACMV	M	5
158				Agric?	2	ACMV	M	5
159	Oduoha-Emohua	4.9203	6.8219	Unknown	2.5	ACMV	M	5
160				Unknown	3	ACMV	M	5
161				Unknown	2	ACMV	M	5
162				Unknown	4	ACMV	M	10
163	Port Harcourt	4.8711	6.965	Unknown	4	ACMV	M	10
164				Unknown	2	ACMV	M	10
165				30555?	2	ACMV	M	5
166	Onne IITA Station	4.7205	7.1758	30555?	1	-	M	5
167				TMS92/0067	3	ACMV	M	5
168				TMS92/0067	1	ACMV	M	5
169	<b>Onne junction-Bori</b> Ereco	4.755	7.1708	Unknown	4	ACMV	S	10
170				Unknown	2	ACMV	S	10
171				Unknown	3	ACMV	S	10
172				Unknown	1	-	S	10
173	Kira	4.7161	7.2561	TME 1	2.5	ACMV	MS	2
174				TME 1	2	ACMV	MS	2

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
175	<b>Bori-Ete Road</b> Km 2	4.6711	7.3939	Unknown	2	ACMV	M	2
176					3	ACMV		
177					1	-		
178					4	ACMV+EACMV		
179	Km 5	4.7075	7.4217	3	ACMV	MS	5	
180				2	ACMV			
181				3	ACMV+EACMV			
182	Bauko, Mimi-Ikpo	4.6869	7.5069	Unknown	3	ACMV	MS	10
183					3	ACMV+EACMV		
184	Ikot Ekara	4.658	7.6344	Mimi-Ikpo	3	ACMV+EACMV	M	2
185	<b>Ete-Ikot Abasi Road</b> Ikot Abasi	4.5758	7.568	30572	2.5	ACMV	MS	2
186					2	ACMV		
187					3	ACMV		
188					4	ACMV+EACMV		
189	<b>Ete-Eket Road</b> Ete	4.6553	7.6744	30572	2.5	ACMV	MS	2
190					1	-		
191					3	ACMV		
192					4	ACMV		
193					2.5	ACMV		
194	Ikot Elkong	4.6269	7.7989	30555?	1	ACMV	M	5
195					2	ACMV		
196					3	ACMV		
197					1	-		
198					3	ACMV		
199	Km 26	4.6317	7.8914	30555?	2	ACMV	MS	5
200					3	ACMV		
201					4	ACMV		
202					3	ACMV		
203					4	ACMV+EACMV		
204	<b>Eket-Oron Road (starting from Community Sec. Com. Schl.)</b> Afaha-Alkai	4.7333	8.0825	30555?	1	ACMV	M	100
205					2	ACMV		
206					3	ACMV		
207					4	ACMV		
208	<b>Oron-Uyo Road (starting from the junction)</b> Km 18	4.8936	8.0839	Unknown	2	ACMV	M	2
209					3	ACMV+EACMV		
210					3	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
207	<b>Uyo-Nkim Itam junction</b>							
208	Mbiatok Itam	5.11167	7.9485	Unknown	3	ACMV+EACMV	M	50
				Unknown	2	ACMV		
209	<b>Nkim Itam junction-Odukpani junction</b>							
210	Okurikang	5.1753	8.01	Unknown	3	ACMV	M	1
211				Unknown	3	ACMV		
212	Km 23	5.1675	8.1542	Unknown	2	ACMV+EACMV	M	5
213				Unknown	1	-		
214	Itana Koyong	5.1864	8.2978	30572?	4	ACMV+EACMV	M	5
215				30572?	3	ACMV		
216				30572?	1	-		
				30572?	5	ACMV+EACMV		
217	<b>Odukpani junction-Calabar</b>							
218	Odukpani	5.143	8.3472	30555	2.5	ACMV	MS	5
219				30555	3	ACMV		
220				30555	1	-		
221	Calabar outskirts	5.0389	8.3555	30555	4	ACMV+EACMV		
222				Unknown	3	ACMV	MS	3
				Unknown	3	ACMV		
223	<b>Calabar-Oban (starting from Efo-Ete junction)</b>							
224	Camp 3 (Km 39)	5.1717	8.5375	Unknown	3	ACMV+EACMV	MS	50
225				Unknown	2.5	ACMV		
226	Oban outskirts	5.3153	8.5764	Unknown	2	ACMV		
228				Unknown	3	ACMV	S	8
				Unknown	1	ACMV		
229	<b>Odukpani junction-Ikom</b>							
230	AwI outskirts	5.2614	8.358	Unknown	2.5	ACMV	MS	5
231				Unknown	3	ACMV		
				30572	3	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
233	Akamikpa outskirts	5.3439	8.3203	Unknown	3	ACMV+EACMV	MS	1
234				Unknown	2.5	ACMV		
235	Uyanga outskirts	5.4903	8.2392	30555?	2	ACMV	MS	10
236				30555?	3	ACMV		
237				30555?	3	ACMV		
238				30555?	1	-		
239	Orida	5.4409	8.1528	30555	5	ACMV+EACMV	MS	10
240				30572	3	ACMV+EACMV		
241				30572	2	ACMV		
242	Kim 58	5.5261	8.1439	30555	5	ACMV+EACMV	MS	5
243				Dan Warri	3	ACMV		
244				30555	1	ACMV		
245				30555	2	ACMV+EACMV		
246	Abini outskirts	5.6711	8.0722	30555?	3	ACMV	M	1
247				30555?	2	ACMV+EACMV		
248	Ugep outskirts	5.8358	8.0967	Unknown (Ame)	3	ACMV	M	2
249				Unknown (Ame)	2	ACMV		
250	Iyima	5.9083	8.213	Ame	2.5	ACMV	MS	5
251				Ame	3	ACMV		
252				Ame	4	ACMV		
253				Ame	1	-		
254	Ochon	5.9433	8.4061	30555?	2	ACMV	M	2
255				30555?	2.5	ACMV		
256				30555?	3	ACMV		
257				30555?	1	-		
258	Ikpokpa Ikom (Km 175)	5.9358	8.6008	Unknown	3	ACMV	MS	2
259				Unknown	3	ACMV		
260				Unknown	3	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Ikom-Mfum Road</b>								
261	Mfum	5.8161	8.8422	30555?	2	ACMV	M	1
262				30555?	3	ACMV+EACMV		
263	Km 6	5.8594	8.8211	Unknown	3	ACMV	MS	2
264				Unknown	3	ACMV+EACMV		
265				Unknown	2.5	ACMV		
<b>Ogoja-Ikom (starting from junction)</b>								
266	Ogoja outskirts	6.5905	8.7869	30555?	2	ACMV	M	2
267				30555?	2	ACMV		
268				30555?	3	ACMV		
269	Ekpogriya	6.4075	8.6997	Unknown	2.5	ACMV	MS	2
270				Unknown	3	ACMV+EACMV		
271				Unknown	2	ACMV		
272				Unknown	4	ACMV+EACMV		
273	Akarasi outskirts	6.2758	8.6564	Unknown	4	ACMV+EACMV	MS	2
274				Unknown	2.5	ACMV		
275				Unknown	2.5	ACMV		
276				Unknown	1	-		
277	Mgbaka/Mkpri (Km 61)	6.1255	8.6572	Unknown	4	ACMV+EACMV	S5	
278				Unknown	5	ACMV+EACMV		
279				Unknown	2	ACMV		
280				Unknown	3	ACMV		
<b>Nkim Iram junction-Ikot Ekpene</b>								
281	Ikot Akpa Ekpuk	5.1655	7.7689	Unknown (Local)	3	ACMV	MS	0
282				Unknown (Local)	2.5	ACMV		
283				Unknown (Local)	1	-		
<b>Warri-Sapele</b>								
284	Okue Jebba	5.7011	5.76	30555/TME 1?	2.5	ACMV	M	8
285				30555/TME 1?	3	ACMV+EACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
286	<b>Onitisha–Enugu (starting from Ogidi main market) (Anambra State)</b> Km 5	6.1975	6.8883	Unknown	4	ACMV	MS	20
287					2.5	ACMV		
288					2	ACMV		
289					1	ACMV		
290					2.5	ACMV		
291	Akwa (opp. University)	6.2425	7.1278	Unknown	1	3ACMV+EACMV	M	10
292					3	ACMV+EACMV		
293	Km 51	6.2644	7.2375	TME 1	3	ACMV+EACMV	M	20
294					2.5	ACMV+EACMV		
295					1	-		
296	<b>9<sup>th</sup> mile–Nsukka (Opi)</b> Ukana	6.5239	7.3833	Akpu Okeme	2.5	ACMV	M	15
297					3	ACMV		
298					1	ACMV		
299	<b>Opi–Nsukka</b> Ede-Oballa	6.7939	7.4222	Oru pan	5	ACMV	S	30
300					4	ACMV+EACMV		
301					2	ACMV		
302					2.5	ACMV		
303	Nsukka	6.8739	7.4022	TME 1	2.5	ACMV	M	20
304					1	-		
305	<b>Nsukka–Obollo-Afor</b> Obollo-Afor	6.9103	7.5044	Ijigolo	3	ACMV	M	20
306					2	ACMV		
307					4	ACMV+EACMV		
308					1	ACMV+EACMV		
309	<b>Obollo-Afor–Ikem (starting from Express Rd junction)</b> Obollo-Eriti	6.8914	7.5797	Ijigolo Ofu marala	2.5	ACMV+EACMV	M	10
310					2.5	EACMV		
311					2.5	ACMV+EACMV		
312	Obollo-Eke	6.8583	7.6536	Ijigolo Ijigolo?	1	ACMV+EACMV	M	30
313					3	ACMV		
314					2.5	ACMV+EACMV		
315					1	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
316	Ikem outskirts	6.7758	7.7105	Ijigolo?	4	ACMV+EACMV	S	300
317					2	ACMV		
318	Ikem-Nkalagu (starting from the junction) Eha-Amufu outskirts 6.6347	6.6347	7.7672	Queen?	1	ACMV	M	1
319					4	ACMV+EACMV		
320					5	ACMV+EACMV		
321	Amagu-Umuhuali	6.5189	7.7644	Odongho	4	ACMV	M	10
322					2.5	ACMV+EACMV		
323	Nkalagu-Abakaliki Km 3	6.4611	7.7944	Ijigolo?	1	ACMV+EACMV	M	NA
324					2.5	ACMV+EACMV		
325					1	ACMV+EACMV		
326	Abakaliki-Ogoja (starting from Onabonyin Junction) Edeichi	6.3025	8.18	Nwugo? Nwojara	2.5	ACMV+EACMV	MS	15
327					1	ACMV+EACMV		
328	Ndiibia	6.3561	8.3161	Akpu Ufe	4	ACMV	M	1
329					3	ACMV		
330	Nduwankwu	6.3542	8.4222	Nwojara?	2.5	ACMV+EACMV	MS	2
331					3	ACMV		
332					2	ACMV		
333	Abakaliki-Obubra Ogbuchi-Amachi	6.3083	8.1644	Unknown	2.5	ACMV	MS	5
334					3	ACMV		
335				Unknown	1	-		
336					4	ACMV+EACMV		
337								
338								
339								

SS = symptom severity; M = mild, MS = moderately severe, S = severe, NA = not assessed - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
340					2	ACMV		
341					2.5	ACMV		
342					1	ACMV		
343	Echialike			Unknown	2.5	ACMV	NA	NA
344	Enyibichiri Alike	6.1808	8.2465	Unknown	3	ACMV	MS	30
345					3	ACMV		
346					3	ACMV		
347					1	-		
348	<b>Abakaliki-Afikpo</b>							
349	Abakaliki outskirts	6.2986	8.1008	TMS 30572	3	ACMV	M	5
350	Amuzu	6.208	8.0633	TMS 30555?	1	ACMV		
351					2.5	ACMV	M	100r
352					4	ACMV		
353	Izzikworo	6.0947	8.0108	Unknown	1	ACMV	M	
354					4	ACMV		
355					2	EACMV		
356	Abaomege outskirts	5.9814	7.9928	Unknown	1	ACMV	NA	NA
357					2	ACMV		
358					3	ACMV		
359					5	ACMV		
360	Amasiri	5.9272	7.9083	Unknown	1	-		
361					4	ACMV+EACMV	MS	15
362					4	ACMV		
363					3	ACMV		
364	<b>Amasiri-Ohiafia</b>							
365	Amangwu-Edda	5.8661	7.873	TMS 91934?	4	ACMV+EACMV	M	5
366					3	ACMV		
367	Ekeje	5.783	7.8244	Unknown	1	ACMV		
368				Unknown	3	ACMV+EACMV	S	10
					4	ACMV+EACMV		
369	<b>Ekoli-Edda Junction-Ohiafia</b>							
370	Okagwe-Ohiafia	5.7269	7.808	Unknown	3	ACMV	MS	150
371					2	ACMV+EACMV		
372					1	ACMV		
					4	ACMV+EACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Ohafia-Bende (starting from roundabout: Udesco filling station)</b>								
373	Eberm	5.6144	7.7867	Unknown	1	-	MS	5
374					3	ACMV		
375					4	ACMV		
376	Ozu Abam outskirts	5.5917	7.7225	Unknown	1	-	S	100
377					5	ACMV+EACMV		
378					3	ACMV		
379					4	ACMV+EACMV		
380					2.5	ACMV		
381	Bende outskirts	5.5642	7.6455	Unknown	4	ACMV+EACMV	MS	100
382					3	ACMV		
383					1	-		
384					5	ACMV+EACMV		
385	NRCRI, Umudike	5.4833	7.5367	TMS 4 (2) 1425	4	ACMV	M	30
386					3	ACMV		
387					1	ACMV+EACMV		
388					1	ACMV		
389				TMS 82/00058	3	ACMV		
390					3	ACMV		
391				TMS 92/0326	2	ACMV		
392					3	ACMV		
393					1	ACMV		
<b>Umudike-Ikot Ekpene Rd (starting from NRCRI)</b>								
394	Okwe	5.4233	7.5725	Unknown	3	ACMV	MS	50
395					3	ACMV+EACMV		
396	Ariam	5.345	7.6192	Unknown	2	ACMV	MS	30
397					3	ACMV		
398					1	ACMV		
399	Ariam outskirts	5.325	7.6283	Unknown	3	ACMV	S	NA
400					4	ACMV		
401					4	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant	
402					1	ACMV			
403	Ogbuebulle Oboro	5.3944	7.5703	Manihot glazovii	4	ACMV			
404	Umuahia-Isialangwa				3	ACMV	S	NA	
405	Amakama Olokoru	5.4553	7.4792	Nwungo?	3	ACMV			
406					1	ACMV			
407	Umuosu-Isiala Ngwa	5.4183	7.4805	Unknown	4	ACMV	S	NA	
408	Umuosu-Isiala Ngwa	5.5225	7.4933	Unknown	3	ACMV	S	NA	
	<b>Umuahia-Port Harcourt (starting from Ubakala Junction)</b>								
409	Ubakala	5.4686	7.4255	Nwungo?	4	ACMV	S	20	
410					4	ACMV			
411	Ahaiba Ihieorji	5.3736	7.3708	Unknown	3	ACMV	M	25	
412					4	ACMV			
413	Amavo	5.2461	7.3261	TMS 30555?	3	ACMV	MS	5	
414					4	ACMV+EACMV			
415					2	ACMV			
416	Ihie (Aba outskirts)	5.0175	7.3117	TMS 30572	4	ACMV	M	200	
417					2.5	ACMV+EACMV			
418					1	ACMV			
419	Km 68	4.9217	7.2319	Unknown	3	ACMV	S	20	
420					4	ACMV+EACMV			
421					1	ACMV			
422					4	ACMV			
	<b>Aba-Owerri (starting from Umuika Junction)</b>								
423	Okpala	5.3167	7.268	Wanjani	4	ACMV	M	300	
424				Try and see	3	ACMV+EACMV			
425				Wanjani	4	ACMV			
426				Try and see	1	-			
427				Wanjani	5	ACMV+EACMV			
428	Km 23	5.3867	7.158	Wanjani?	5	ACMV+EACMV	S	300	
429					3	ACMV+EACMV			
430	Naze-Owerri	5.4386	7.0833	TMS 30572?	3	ACMV	MS	200	
431					3	ACMV			
432				Wanjani?	5	ACMV+EACMV			
433				TMS 30572?	2	ACMV			
434					1	ACMV			

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Owerri–Oligwe (starting from Modotel)</b>								
435	Akabo Ikeduru Amukachi	5.5608	7.0878	Unknown	3	ACMV	S	500
436				Agric	4	ACMV+EACMV		
437				Unknown	3	ACMV		
438				TMS 30572	2	ACMV		
439					1	ACMV		
440	Anara	5.6694	7.1569	Unknown	3	ACMV+EACMV	MS	200
441					2	ACMV		
442				TMS 30572?	2	ACMV		
443				Unknown	3	ACMV		
444				Agric?	4	ACMV		
445	Amuro-Oligwe	5.7869	7.2755	TMS 30555?	3	ACMV	MS	40
446					1	-		
447					2	ACMV		
448					3	ACMV+EACMV		
<b>Oligwe-Umuahia (starting from motor park along the express road)</b>								
449	Km 10	5.7569	7.3642	Agric?	2.5	ACMV	M	5
450					1	-		
451	Km 11	5.7278	7.3755	Agric?	3	ACMV	M	15
452					3	ACMV		
453					1	ACMV		
454	Umudiawa	5.6042	7.4425	Unknown	3	ACMV	MS	20
455					4	ACMV		
456					1	ACMV		
457					2	ACMV		
<b>Umuahia–Owerri (starting from Tower at the express road)</b>								
458	Umu Ngwa Obowu	5.5586	7.413	Unknown	3	ACMV	MS	50
459					3	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	W/F per plant
460	Mbaise Abiazu	5.5269	7.2755	Unknown	1	ACMV	NA	NA
461					4	ACMV+EACMV	NA	NA
462	Aboh Mbaise	5.4786	7.2203	TMS 30572?	3	ACMV	NA	NA
463				TMS 30555?	2	ACMV	NA	NA
464					4	ACMV+EACMV		
465	Emekuku	5.4739	7.1133	Unknown	3	ACMV	S	300
466					2.5	ACMV		
467					4	ACMV+EACMV		
468					2.5	ACMV		
469								
<b>Owerri-Orlu (starting from Alvan Gate)</b>								
470	Ohii	5.5361	7.0133	Agric?	3	ACMV	M	5
471					3	ACMV		
472					1	ACMV		
473	Achara Umuaka	5.6614	7.0169	Agric	4	ACMV+EACMV	MS	50
474				Unknown	3	ACMV+EACMV		
475					3	ACMV		
476					5	ACMV+EACMV		
477					1	-		
478	Owerre Ebeiri	5.7747	7.0314	Agric?	2.5	ACMV	MS	400
479					3	ACMV		
480					1	ACMV+EACMV		
<b>Orlu-Ihiala (starting from Holy Rosary Secondary School, Ihiala)</b>								
481	Ubuluisuzor	5.8422	6.8944	Unknown	2.5	ACMV	MS	10
482					4	ACMV		
<b>Ogbaku-Egbema (starting from Junction of Owerri-Onitsha Rd.)</b>								
483	Ogbaku	5.5636	6.9628	Unknown	2.5	ACMV+EACMV	MS	10
484					4	ACMV+EACMV		
485				Agric	3	ACMV+EACMV		
486	Akabo	5.6153	6.8969	Unknown	4	ACMV	M	1
487					2.5	ACMV+EACMV		
489					1	-		
490					3	ACMV+EACMV		
491	Km 20	5.6611	6.8227	Agric?	3	ACMV+EACMV	MS	10

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
492					3	ACMV		
493					3	ACMV+EACMV		
494					1	ACMV		
495				Unknown	5	ACMV+EACMV		
496					4	ACMV+EACMV		
497	Osu	5.6297	6.7503	TMS 30572	3	ACMV	MS	20
498					3	ACMV+EACMV		
499	<b>Ukwu Igba Egbema-Etekuru Egbema</b>							
500	Ukwu Igba outskirts	5.5439	6.7697	Agric	2.5	ACMV+EACMV	M	10
501					3	ACMV		
502					2	ACMV+EACMV		
503					1	ACMV		
504	Ekugba Egbema	5.4842	6.7955	Onuawurun	5	ACMV+EACMV	MS	10
505				Umuagwo	5	ACMV+EACMV		
506					4	ACMV+EACMV		
507	<b>Etekuru-Owerri</b>							
508	Village 1 Adapalm Ohaji	5.4586	6.8142	Unknown	5	ACMV+EACMV	S	20
509					4	ACMV+EACMV		
510					3	ACMV+EACMV		
511	Avu	5.4494	6.9519	Unknown	3	ACMV+EACMV	S	150
512					2	ACMV		
513					4	ACMV+EACMV		
514	<b>Mgbidi-Onitsha (starting from Orlu junction)</b>							
515	Amorka	5.7564	6.8783	Unknown	3	ACMV+EACMV	M	10
516					3	ACMV+EACMV		
517	Umuohi Okija	5...9128	6.8686	Unknown	2.5	ACMV	M	300
518	Oba	6.0725	6.8178	Unknown	2.5	ACMV		
					3	ACMV	M	3

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
519					1	ACMV		
520					3	ACMV		
521	<b>Igbariam junction-Igbariam</b>				4	ACMV	M	5
522	Igbariam junction	6.2486	6.9472	Unknown	3	ACMV		
523				TMS 30572	1	ACMV		
524	Igbariam	6.3239	6.9647	Agric	3	ACMV	M	1
525				TMS 30572	3	ACMV+EACMV		
526	<b>Akwa (Amawbia)-Alkokwa (starting from roundabout)</b>				3	ACMV	M	2
527	Nise	6.1572	7.038	Unknown	4	ACMV+EACMV		
528					3	ACMV+EACMV		
529					1			
530	<b>Enugu-Okigwe (starting from Abakaliki Rd junction)</b>				3	ACMV	M	0
531	Enugu outskirts	6.4425	7.5389	Agric	3	ACMV		
532				Agric	2.5	ACMV	MS	5
533	Amaofia Agbogugu	6.2586	7.4592	Unknown	2	ACMV		
534					4	ACMV		
535					1	-		
536					4	ACMV		
537	Nhewe	6.1619	7.5083	Unknown	4	ACMV	M	10
538					1	-		
539	Km 56 (Abia State)	5.993	7.4769	Unknown	2	ACMV	M	20
540					3	ACMV		
541	<b>Ibadan-Oyo (starting from IITA gate)</b>				3	ACMV+EACMV	MS	3
542	Km 17	7.6336	3.9214	Ege dudu	3	ACMV+EACMV		
543	<b>Oyo-Ogbomoso (starting from Oyo State Hospital Management Board)</b>				3	ACMV	S	3
544	Oyo outskirts	7.8536	3.96	Ege dudu	3	ACMV		
545				Ege dudu	2	ACMV		
546	Alafara	7.908	4.0133	TME 1?	3	ACMV	M	20
547				TME 1	1	ACMV		
548				TME 1	2.5	-		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
549				TME 1	2.5	ACMV		
550				Ege dudu	4	ACMV		
551	<b>Ogbomoso-Igbeti (starting from Olugbo Hotel gate)</b>			Odongbo	3	ACMV	M	10
552	Onisakara	8.2133	4.1875	TME 1	3	ACMV		
553				TME 1	3	ACMV		
554				TME 1	1	-		
555	Elewura	8.2936	4.188	Odongbo	3	ACMV	M	5
556				Odongbo	1	-		
557	Oke Igba	8.4136	4.2592	Odongoo	3	ACMV	MS	5
558				Odongoo	3	ACMV		
559	Okomowaro	8.4983	4.2167	Odongoo	3	ACMV	M	10
560				Odongoo	2.5	ACMV		
561				Odongoo	3	ACMV		
562				TME 1	1	-		
563	Olokoto outskirts	8.5897	4.1986	Unknown (Agric?)	3	ACMV	M	2
564				Odongbo	3	ACMV		
565	Kim 77	8.6761	4.1889	Unknown	3	ACMV	M	10
566				Odongbo	3	ACMV		
567				Odongbo	1	-		
568				Odongbo	3	ACMV		
569	<b>Igbeti-Kisi (starting from roundabout)</b>			Agric	3	ACMV	M	0
570	Igbeti outskirts	8.7667	4.1108	Unknown	1	-		
571				Unknown	5	ACMV	S	5
572	Km 12	8.8461	4.0617	Unknown	5	ACMV		
573				Unknown	3	ACMV		
574	Soro	8.9858	3.9447	Dan Warri	3	ACMV	MS	5
575				Odongbo	4	ACMV		
576				Odongbo	2	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
577	<b>Kisi-Igboho (starting from the junction)</b> Km 9	8.9344	3.8769	Dan Warri	3	ACMV	M	1
578				Dan Warri	3	ACMV		
579				Dan Warri	3	ACMV		
580	<b>Igboho-Saki (starting from the junction)</b> Igboho outskirts	8.8305	3.7394	Odongbo	3	ACMV	M	NA
581				Oko Iyawo	1	-		
582				Unknown	2	ACMV	M	NA
583				Odongbo	3	ACMV	M	NA
584	Km 31	8.7	3.515	Unknown	3	ACMV		
585				Unknown	4	ACMV		
586	<b>Saki-Ago Are (starting from Freedom Hotel Annex)</b> Km 5	8.6242	3.4122	Oko Iyawo	2.5	ACMV	M	2
587				Odongbo	3	ACMV		
588				TME 1	4	ACMV		
589				TME 1	1	-		
590	Ago Are outskirts	8.483	3.4155	TME 1	3	ACMV	MS	20
591				TME 1	2	ACMV		
592				Odongbo	3	ACMV		
593				Odongbo	1	-		
594	Baasi	8.3169	3.4022	Odongbo	3	ACMV	MS	NA
595				Odongbo	3	ACMV+EACMV		
596				Odongbo	4	ACMV+EACMV		
597	Okaka outskirts	8.2322	3.4497	Odongbo	2	ACMV	MS	10
598				TME 1	3	ACMV		
599				TME 1	3	ACMV		
600				TME 1	3	ACMV		
601	<b>Okaka-Oke Iho (starting from junction)</b> Ortu	8.2055	3.4203	TME 1	1	-	M	30
602				TME 1	1	-		
603				TME 1	2.5	ACMV		
604				TME 1	3	ACMV+EACMV		
605	Ortu towards Oke Iho	8.183	3.4061	TME 1	3	ACMV		
606				Odongbo	4	ACMV+EACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
607				Odongbo	4	ACMV		
608				TME 1	1	-		
609	Ilero outskirts	8.0761	3.3605	Odongbo	3	ACMV	MS	50
610				Odongbo	3	ACMV+EACMV		
611				Odongbo	3	ACMV		
612				Odongbo	1	-		
613	<b>Oke-Iho-Igbo Ora (starting from the roundabout</b>							
614	Oke-Iho outskirts	8.028	3.3369	Odongbo	3	ACMV	MS	3
615				Dan Warri	3	ACMV		
616				Odongbo	2	ACMV		
617	Aderogba	7.8903	3.2333	Odongbo	1	-		
618				Odongbo	3	ACMV	S	NA
619	Abidioko-Igangan	7.753	3.2017	Odongbo	3	ACMV	M	2
620				Odongbo	3	ACMV		
621				TME 1	2	ACMV		
622	Oye	7.6025	3.2036	TME 1	1	-		
623				TME 1	2.5	ACMV+EACMV	M	2
624				TME 1	1	-		
625	Igbo Ora	7.4586	3.2697	TME 1	3	ACMV		
626				Unknown	3	ACMV+EACMV		
627	<b>Abeokuta-Olodo (starting from Egba High School)</b>			Odongbo	3	ACMV		
628	Osiele	7.1944	3.4589	TMS 30572	3	ACMV	MS	0
629				TMS 30572	3	ACMV		
630				TMS 30572	2	ACMV		
631	Ogungbe	7.2464	3.5414	TMS 30572	1	-		
632				TMS 30572	4	ACMV	S	1
633				TMS 30572	1	-		
634	Akintoye	7.3558	3.6542	TMS 30572	4	ACMV		
635				TMS 30572	1	-	S	1
636				TMS 30572	3	ACMV		
637				TMS 30572	4	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Abeokuta-Obademi Ajebo (starting from Olobe shopping complex)</b>								
638	Idi Aba Mechanic village	7.1405	3.3986	TME 1	1	-	MS	20
639				TME 1	3	ACMV		
640				TME 1	3	ACMV+EACMV		
641				TME 1	3	ACMV+EACMV		
642	Km 19	7.1289	3.5353	TME 1	1	-	S	5
643				TME 1	2	ACMV		
644				TME 1	3	ACMV		
645				Unknown	4	ACMV+EACMV		
646				Unknown	5	ACMV+EACMV		
647	Owojo outskirts	7.1211	3.6855	Unknown	5	ACMV+EACMV	MS	3
648				TME 1	2.5	ACMV		
649				TME 1	3	ACMV		
650				TME 1	1	-		
<b>Ajebo-Ishara (starting from the junction)</b>								
651	Ipara Remo	7.0289	3.6747	TME 1	2	ACMV	MS	5
652				TME 1	3	ACMV		
653				TME 1	4	ACMV+EACMV		
654				TME 1	1	-		
655				TME 1	4	ACMV+EACMV		
<b>Ishara-Owode</b>								
656	Ogere Remo outskirts	6.9436	3.623	TME 1	2	ACMV+EACMV	M	3
657				TME 1	3	ACMV		
658				TME 1	1	-		
659				TME 1	2.5	ACMV		
660				TME 1	3	ACMV		
661				TME 1	2.5	ACMV		
<b>Owode-Ofada (starting from the roundabout)</b>								
662	Km 10	6.8842	3.4458	Dan Warri	2.5	ACMV	M	NA
<b>Ofada-Ikori (starting from the junction)</b>								
663	Km 23	6.8658	3.2453	Unknown	4	ACMV+EACMV	M	NA
664				Unknown	3	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Abekuta-Meko (starting from Aiyetoro roundabout)</b>								
665	NATA mechanic village	7.1842	3.2678	Unknown	3	ACMV	MS	3
666				TMS 30572	3	ACMV		
667				TME 1	2.5	ACMV		
668				TMS 30572	1	-		
669	Olorunda outskirts	7.2358	3.1327	Unknown	3	ACMV+EACMV	M	5
670				Unknown	1	-		
671				Unknown	2.5	ACMV		
672	Afon junction	7.4255	2.9467	Unknown	1	-	M	5
673				Unknown	3	ACMV+EACMV		
674				Unknown	3	ACMV+EACMV		
675				Unknown	2.5	ACMV		
<b>Imeko-Aworo (starting from second roundabout)</b>								
676	Idofa	7.4294	2.7994	Unknown	2.5	ACMV	M	3
677				Unknown	1	-		
678	Ewashoro-Idofa	7.4022	2.7883	Idileru	3	ACMV/M	5	
679				Idileru	2.5	ACMV		
680				Idileru	1	-		
681	Aworo farm reserve 1	7.2783	2.7858	Unknown	3	ACMV	M	5
682				TME 1	2.5	ACMV		
683				TME 1	1	ACMV		
684a				Unknown	3	ACMV+EACMV		
<b>Igan Alade-Ilaro</b>								
684b	Km 2	7.0461	2.9228	Unknown	3	ACMV+EACMV	NA	NA
685				Unknown	3	ACMV+EACMV		
<b>Igbogila junction-Ilaro</b>								
686	Ibese	6.9672	3.0355	Edward	1	ACMV	M	3
687				Edward	3	ACMV		
688				Edward	3	ACMV		
<b>Ilaro-Papalanto</b>								
689	Oke Iganmu	6.885	3.078	Unknown	2	ACMV	M	3
690				Unknown	1	-		
691				Unknown	3	ACMV		
692				Unknown	3	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
693	<b>Ota-Idi Iroko (starting from Gate Way Hotel Ota)</b>			Unknown	3	ACMV		
694	Onibuku-Ota	6.6778	3.1322	TME 1	2	ACMV	M	3
695				TME 1	4	ACMV		
696				Idileru	2.5	ACMV		
697				TME 1	1	-		
698	Alaraba	6.6767	3.0389	TME 1	1	-	MS	50
699				TME 1	3	ACMV		
700				TME 1	4	ACMV+EACMV		
701	Ajilere	6.7014	2.9411	Oko Iyawa	4	ACMV	S	3
702				Oko Iyawa	2	ACMV		
703				Oko Iyawa	1	-		
704				Oko Iyawa	4	ACMV		
705	Ihunbo	6.6875	2.8436	TME 1	2	ACMV	M	2
706				Oko Iyawa	3	Unidentified		
707	<b>Idi Iroko-Ijofin (starting from Ipokia Local Govt. School)</b>							
708	Ijofin	6.5133	2.7214	TME 1	2	Unidentified	M	2
				TME 1	1	-		
709	Owode-Ado Odo							
710	Idi Ota	6.6689	2.9853	Idileru	2.5	Unidentified	S	2
711				Idileru	2.5	ACMV		
712				Idileru	5	ACMV+EACMV		
713				Idileru	3	ACMV		
				Oko Iyawa	4	ACMV		
714	<b>Ado Odo-Igbessa (starting from UAMC Primary School)</b>							
715	Km 3	6.5967	2.958	Idileru	2	ACMV	M	2
716				Idileru	3	Unidentified		
717				Idileru	1	-		
718	Paramole	6.6019	3.0658	Oko Iyawa	3	ACMV	M	3
719				Oko Iyawa	3	ACMV		
720				Oko Iyawa	4	ACMV+EACMV		
				Oko Iyawa	1	-		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
721	<b>Ikorodu-Sagamu (starting from the roundabout)</b> Molekere	6.7278	3.5258	TME 1	3	ACMV	M	2
722				TME 1	3	ACMV		
723				TME 1	1	-		
724				TME 1	2	ACMV		
725	<b>Sagamu-Ijebu Ode (starting from the roundabout)</b> Oko Ado	6.8653	3.6758	Oko Iyawa	3	ACMV	MS	20
726				Oko Iyawa	4	ACMV		
727				Oko Iyawa	4	ACMV		
728				Oko Iyawa	2.5	ACMV+EACMV		
729	Agoro Ijebu	6.8503	3.8425	TME 1	1	-		
730				Oko Iyawa	3	ACMV	S	10
731				Oko Iyawa	3	ACMV		
732				Oko Iyawa	2	ACMV		
733				<b>Ijebu Ode-Ibadan (starting from roundabout)</b> Awa	6.9675	3.93	TMS 30572	3
734	TMS 30572	3	ACMV					
735	TMS 30572	1	-				MS	NA
736	Oko Iyawa	3	ACMV					
737	Km 35	7.153	3.8822	Oko Iyawa	2.5	ACMV		
738				TMS 30572	3	ACMV		
739				Unknown	3	ACMV		
740	<b>Ibadan-Ife (starting from the toll gate)</b> Ikire	7.3569	4.1536	TME 1	2	ACMV	MS	3
741				TMS 30572	4	ACMV+EACMV		
742				TME 1	2.5	ACMV+EACMV		
743				TME 1	1	-		
744	Ohimu Gbongan	7.4639	4.3083	Unknown	4	ACMV+EACMV	MS	NA
745				Oko Iyawa	3	ACMV+EACMV		
746				TMS 30572	3	ACMV		
747	<b>Ife-Osogbo (starting from the express road to Akure)</b> Km 6	7.5608	4.4458	TME 1	4	ACMV+EACMV	M	NA
748				TME 1	2.5	ACMV		
749				TME 1	2.5	ACMV+EACMV		
750				TME 1	1	-		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Osogbo-Iwo (starting from the express roundabout)</b>								
751	Ajibandele farm (Km 6)	7.7928	4.4955	TMS 30572	4	ACMV	MS	3
752				TME 1	2.5	ACMV		
753				TME 1	2.5	ACMV		
754				TME 1	2	ACMV		
755				TME 1	1	-		
756				TME 1	3	ACMV+EACMV		
757	Egbedore	7.7122	4.3644	Oko Iyawo	4	ACMV+EACMV	M	3
758				Oko Iyawo	3	ACMV		
759				TME 1	2.5	ACMV		
760				TME 1	1	-		
761	Asamu outskirts	7.6792	4.288	TME 1	2	ACMV	M	2
762				TME 1	3	ACMV+EACMV		
763				TME 1	1	-		
<b>Iwo-Gbongan (starting from Bowen University)</b>								
764	Km 4	7.588	4.198	Odongbo	3	ACMV	S	3
765				Odongbo	2	ACMV		
766				Odongbo	4	ACMV+EACMV		
767				Odongbo	5	ACMV+EACMV		
768	Km 19	7.5264	4.2919	Unknown	5	ACMV+EACMV	S	NA
769				Unknown	5	ACMV+EACMV		
<b>Chongan-Osogbo (starting from the junction)</b>								
770	Odeomu outskirts	7.5592	4.4047	TMS 30572	3	ACMV+EACMV	S	2
771				TMS 30572	4	ACMV+EACMV		
772				Unknown	4	ACMV+EACMV		
773	Km 28	7.685	4.4675	TME 1	2	ACMV+EACMV	M	1
774				TME 1	1	-		
775				TME 1	3	ACMV+EACMV		
776	Osogbo (Km 38)	7.7525	4.5225	Odongbo	3	ACMV+EACMV	M	NA
777				Odongbo	3	ACMV+EACMV		
778	<b>Osogbo-Ikirun (starting from Charity Hotel gate)</b>							
779	Ago Alboja	7.8542	4.6189	Ege dudu	5	ACMV+EACMV	MS	NA
				TME 1	3	ACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
	<b>Ikirun-Ila Orangun (starting from the express junction)</b>							
780	Iree	7.9333	4.7003	TME 1	1	ACMV	M	7
781				TME 1	3	ACMV		
782				TME 1	2.5	ACMV		
783	Oran Ayegebaju (km 32)	7.9592	4.8042	Ege dudu	3	ACMV	M	NA
784				Ege dudu	3	ACMV		
	<b>Ila Orangun-Okuku (starting from the junction)</b>							
785	km 6	8.038	4.8578	TME 1	3	ACMV	M	1
786				TME 1	1	-		
787	Oyan outskirts	8.0433	4.7408	TME 1	2.5	ACMV	M	0
788				TME 1	3	ACMV		
789	Okuku outskirts	8.0019	4.663	Odongbo	2.5	ACMV	M	1
790				Odongbo	2.5	ACMV		
791				Odongbo	1	-		
	<b>Ikirun-Ibokun (starting from roundabout at the motor park)</b>							
792	Ada outskirts	7.858	4.7244	Odongbo	2	ACMV	M	5
793				Odongbo	2.5	ACMV		
794				Odongbo	1	-		
	<b>Egbeda</b>							
795		7.7928	4.6483	Odongbo	3	ACMV		
796				Ege dudu	5	ACMV+EACMV	S	3
797				Ege dudu	4	ACMV		
798				Ege dudu	3	ACMV		
799				Ege dudu	2	ACMV		
	<b>Osogbo-Ilesa (starting from Dugbe roundabout)</b>							
800	Kajola	7.7264	4.6219	TME 1	1	-	MS	5
801				TME 1	4	ACMV+EACMV		
802				TME 1	2	ACMV		
803				Ege dudu	3	ACMV		
804				Ege dudu	5	ACMV+EACMV		
805	Mulele	7.6789	4.7153	Ege dudu	3	ACMV	M	1
806				Ege dudu	1	-		
807				Ege dudu	4	ACMV+EACMV		
	<b>Ilesa-Ipetu Ijesa (starting from express road junction)</b>							
808	Ilesa	7.6172	4.7978	Ege dudu	4	ACMV	MS	2

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
809				Oko Iyawo	3	ACMV		
810				TMS 30572	3	ACMV		
811	Erin Ijesa junction	7.5594	4.88	Ege dudu	2.5	ACMV	S	NA
812				Egu dudu	3	ACMV		
813				Ege dudu	4	ACMV		
814				Ege dudu	5	ACMV+EACMV		
<b>Ipetu Ijesa-Ilawe (starting from the junction at the express road)</b>								
815	Ogotun –Ekiti outskirts	7.5008	4.9547	Odongbo	1	-	S	3
816				Odongbo	2.5	ACMV		
817				Odongbo	2	ACMV		
818				Odongbo	3	ACMV		
819				Odongbo	4	ACMV		
820				Odongbo	4	ACMV		
821	Km 27	7.5289	5.075	Ege dudu	5	ACMV+EACMV	S	NA
822				Ege dudu	3	ACMV		
823				Unknown	3	ACMV		
824	Ado Ekiti outskirts	7.6155	5.1855	Oko Iyawo	3	ACMV	MS	2
825				Oko Iyawo	3	ACMV		
<b>Ikere-Ise Ekiti (starting from the junction)</b>								
826				Unknown	1	-	M	2
827				Unknown	2	ACMV		
828				Unknown	3	ACMV		
829				Unknown	4	ACMV		
830	Ise-Ekiti outskirts	7.4619.	5.3592	Unknown	5	ACMV+EACMV	S	1
831				Unknown	3	ACMV		
832				Unknown	5	ACMV+EACMV		
833				Unknown	2.5	ACMV		
834	Ise-Omuo	7.4822	5.4539	Unknown	2.5	ACMV	M	1
835				Unknown	3	ACMV+EACMV		
836				Unknown	1	-		
837	<b>Ode Ekiti-Isibode Ekiti</b>	7.6533	5.5986	Unknown	2	ACMV		
838				Unknown	4	ACMV	S	1
839				Unknown	4	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
840				Unknown	4	ACMV+EACMV		
841				Unknown	1	-		
842				Unknown	4	ACMV		
843	<b>Ilesa Ekiti-Ayebode</b>	7.8136	5.6508	Unknown	2.5	ACMV	M	1
844				Unknown	3	ACMV+EACMV		
845				Unknown	1	-		
846				Unknown	2	ACMV		
847	<b>Ikole-Ado Ekiti</b>	7.6686	5.4489	Unknown	2.5	ACMV	MS	1
848	Aba Aduloju			Unknown	3	ACMV		
849	<b>Ado Ekiti-Igede (starting from Oodua Textiles)</b>	7.6739	5.1122	Unknown	2.5	ACMV	M	1
850	Km 17			Unknown	1	-		
851				Unknown	4	ACMV		
852				Unknown	2	Unidentified		
853	Km 29	7.7275	5.0539	Unknown	2	ACMV	M	1
854				Unknown	1	-		
855				Unknown	3	ACMV		
856	<b>Ijero-Ido Ekiti</b>	7.8394	5.1039	Unknown	4	ACMV	MS	1
857	Km 45			Unknown	2.5	ACMV		
858				Unknown	3	ACMV		
859				Unknown	1	-		
860				Unknown	2	ACMV		
861	<b>Ido Ekiti-Isan (starting from Ogiren Petroleum)</b>	7.8	5.3108	Unknown	5	ACMV+EACMV	S	1
862	Km 17			Unknown	3	ACMV		
863				Unknown	4	ACMV		
864				Unknown	4	ACMV		
865	Km 47	7.9308	5.3028	Unknown	4	ACMV	M	1
866				Unknown	1	-		
867				Unknown	4	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
868				Unknown	4	ACMV		
869				Unknown	2.5	ACMV		
870	<b>Ifaki-Ado Ekiti (starting from Oye junction)</b>							
871	Km 11	7.7028	5.2661	Unknown	4	ACMV	S	1
872				Unknown	3	ACMV		
873				Unknown	4	ACMV+EACMV		
874				Unknown	4	ACMV+EACMV		
875				Unknown	2.5	ACMV		
876				Unknown	3	ACMV+EACMV		
877				Unknown	1	ACMV		
878	<b>Ado Ekiti-Akure (starting from Maria Assumpta Catholic Hospital)</b>							
879	Km 7	7.5292	5.2214	Unknown	3	ACMV+EACMV	M	1
880				Unknown	1	-		
881				Unknown	4	ACMV+EACMV		
882				Unknown	2	ACMV		
883	Km 31	7.3375	5.2503	Unknown	2.5	ACMV+EACMV	M	2
884				Unknown	2	ACMV		
885				Unknown	3	ACMV+EACMV		
886	<b>Akure-Owo (starting from Ado Ekiti road junction)</b>							
887	Km 4	7.2719	5.2575	Unknown	2.5	ACMV	M	0
888				Unknown	1	-		
889				Unknown	2	ACMV		
890	Km 14	7.2672	5.3536	Unknown	3	ACMV	MS	2
891				Unknown	4	ACMV		
892				Unknown	3	ACMV+EACMV		
893				Unknown	2.5	ACMV		
894	Km 29	7.2594	5.4805	Unknown	2	ACMV+EACMV		
895				Unknown	4	ACMV+EACMV	S	1
896				Unknown	4	ACMV+EACMV		
897				Unknown	5	ACMV+EACMV		
898	Km 45	7.2136	5.6105	Unknown	3	ACMV+EACMV	MS	3
899				Lagos	3	ACMV+EACMV		

SS = symptom severity; M = mild; MS = moderately severe; S = severe; - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
899				Unknown	4	ACMV+EACMV		
900				Unknown	2.5	ACMV		
901				Unknown	2.5	Unidentified		
902	Km 58	7.1086	5.6592	Unknown	3	ACMV	MS	2
903				Unknown	1	-		
904				Unknown	3	ACMV		
905				Unknown	2.5	ACMV		
906				Unknown	2	ACMV		
907	Km 71	7.0136	5.7139	Lagos?	2.5	ACMV	M	1
908				Unknown	2	ACMV		
909				Unknown	2	ACMV		
910	Ifon	6.9286	5.7753	Unknown	4	ACMV	MS	1
911				Unknown	3	ACMV		
912				Unknown	4	ACMV		
913				Unknown	4	ACMV+EACMV		
914				Unknown	3	ACMV+EACMV		
915	<b>Owo-Ikare</b>							
916	Owo outskirts (Km 2)	7.2283	5.6105	Unknown	4	ACMV+EACMV	S	1
917				Unknown	4	ACMV+EACMV		
918				Unknown	4	ACMV+EACMV		
919	Km 15	7.325	5.6786	Unknown	5	ACMV+EACMV	MS	1
920				Unknown	2.5	ACMV		
921				Unknown	3	ACMV		
922				Unknown	4	ACMV+EACMV		
923				Unknown	5	ACMV+EACMV		
924	Km 38	7.4969	5.7483	Unknown	4	ACMV+EACMV	S	1
925				Unknown	1	-		
926				Unknown	4	ACMV+EACMV		
927				Unknown	4	ACMV+EACMV		
928	<b>Akungba-Ido Ani (starting from Okene road junction)</b>							
929	Km 2	7.4533	5.7467	Unknown	2.5	ACMV+EACMV		
				Unknown	4	ACMV+EACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
930				Unknown	3	ACMV		
931	Km 13	7.4514	5.8319	Unknown	2	ACMV+EACMV	M	2
932				Unknown	2.5	ACMV		
933				Unknown	3	ACMV+EACMV		
934	Okene junction	7.4508	5.933	Unknown	2	ACMV+EACMV	M	1
935				Unknown	3	ACMV+EACMV		
	<b>Isua-Ipele (starting from Isua/Okene junction)</b>							
936	Km 13	7.35	5.8911	Unknown	3	ACMV	M	1
937				Unknown	2.5	ACMV		
938				Unknown	3	ACMV		
939	Km 25	7.2744	5.8317	Unknown	2.5	ACMV	M	NA
940				Unknown	3	ACMV		
941				Unknown	3	ACMV		
942	Km 37	7.1847	5.7708	Unknown	1	ACMV	M	NA
943				Unknown	2	ACMV		
944				Unknown	2.5	ACMV		
945				Unknown	2.5	ACMV		
	<b>Ilorin-Omu Aran (starting from Kwara State Corporation park)</b>							
946	Gaa (Km 8)	8.4147	4.628	TME 1	3	ACMV	M	1
947				TME 1	1	-		
948				Dan Warri	3	ACMV		
949				Oko Iyawo	4	ACMV	M	1
950	Omupo	8.2886	4.7764	Odongbo	3	ACMV		
951				TME 1	1	-		
952	Edidi	8.2319	4.9514	Odongbo	2.5	ACMV	M	2
953				Odongbo	3	ACMV		
954				TME 1	1	-		
955	Odo Owa	8.0919	5.1803	Unknown	3	ACMV	M	NA
956				Unknown	3	ACMV		
957				TME 1	1	-		
958	Eruku	8.1314	5.4055	TME 1	1	ACMV	M	1
959				TME 1	2	ACMV		
960				TME 1	3	ACMV		

SS = symptom severity; M = mild, MS = moderately severe; S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Egbe-Pategi (starting from Isanlu –Esa)</b>								
961	Km 28	8.6128	5.645	TME 1	3	ACMV	M	1
962				TME 1	1	ACMV		
963				Odongbo	3	ACMV		
964	Km 47	8.6969	5.7322	Unknown	3	ACMV+EACMV		
965				Oko Iyawo	3	ACMV		
<b>Patigi-Ndeji (starting from Isanlu Esa junction)</b>								
966	Lade	8.7636	5.5997	TMS 30572	3	ACMV	M	0
967				Unknown	2	ACMV		
968				TMS 30572	1	-		
<b>Ilorin-Share (starting from Kwara Polytech. gate)</b>								
969	Silo grain reserve site	8.5542	4.6694	Unknown	2	ACMV	S	1
970				Unknown	3	ACMV		
971				Unknown	4	ACMV		
972				Unknown	4	ACMV		
973				TME 1	1	-		
974	Tirepo	8.6828	4.8786	Unknown	3	ACMV	S	2
975				Unknown	3	ACMV		
976				Unknown	4	ACMV		
977				TME 1	1	ACMV		
<b>Share junction-Ndeji</b>								
978	Km 4	8.8164	4.9553	TME 1	2	ACMV+EACMV	M	1
979				Unknown	3	ACMV		
<b>Share junction-Jebba</b>								
980	Ankoro	8.8328	4.9011	Unknown	4	ACMV	MS	3
981				Oko Iyawo	3	ACMV		
982				TME 1	1	ACMV		
<b>Oko Olowo (Ilorin)-Igbeti</b>								
983	Oko Olowo	8.5355	4.4819	Ege dudu	3	ACMV	M	NA
984	Alapa	8.6422	4.3705	TME 1	3	ACMV	M	3
985				Oko Iyawo	3	ACMV		
986				TME 1	2	ACMV		
987				TME 1	1	-		
<b>Moshigada-Kaiana (starting from the primary school)</b>								
988	Km 11	9.3019	3.8522	Unknown	2	ACMV	M	NA

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	W/F per plant
989				Unknown	3	ACMV		
990				Unknown	3	ACMV		
991				Unknown	3	ACMV		
992	<b>New Bussa-Mokwa (starting from Total filling station roundabout)</b>							
993	Km 5	9.8483	4.5453	Unknown	3	ACMV	M	1
994				Unknown	3	ACMV		
995	Egbian Ibibi outskirts	8.68	4.8939	Oko Iyawo?	1	-		
996				Unknown	3	ACMV	MS	1
997				Unknown	3	ACMV		
998				Unknown	3	ACMV		
999	IITA Mokwa	9.353	5.0155	CM 6740-7	4	ACMV	M	1
1000				Unknown	3	ACMV		
1001				Unknown	2	ACMV		
1002				Unknown	1	ACMV		
1003	<b>Mokwa-Kontagora (starting from Bida road junction)</b>							
1004	Kusogi	9.513	5.2789	Unknown	3	ACMV+EACMV	M	3
1005				Unknown	3	ACMV		
1006				Dan Warri	3	ACMV+EACMV		
1007	Kaboji	10.0625	5.4114	Unknown	1	-		
1008				Unknown	2	ACMV	M	NA
				TME 1	1	-		
1010	<b>Kontagora-Tegna (starting from the junction, Govt. Tech. Coll.)</b>							
1011	Km 22	10.2997	5.6422	Unknown	3	ACMV	S	3
				Dan Warri	3	ACMV+EACMV		
1012	<b>Minna-Suleja (starting from the roundabout close to NECO office)</b>							
1013	Km 16	9.4658	6.6383	Oko Iyawo	3	ACMV	M	NA
1014				Oko Iyawo	3	ACMV		
1015	Faridoki	9.3917	6.8367	Oko Iyawo	1	-		
1016				Dan Warri	4	ACMV	NA	NA
1017				Dan Warri	3	ACMV		
1018				Dan Warri	3	ACMV		
1019	Bonu	9.3403	7.0022	Dan Warri	1	-		
1020				Unknown	3	ACMV	MS	NA
				Agric	1	-		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1021	Kwaka	9.2728	7.1305	Oko Iyawo?	3	ACMV	MS	1
1022				TME 1?	3	ACMV		
1023				TME 1?	3	ACMV		
1024				TME 1?	1	-		
1025	<b>Diko (Suleja)-Kaduna</b> Km 31	9.3614	7.2875	Unknown	3	ACMV	MS	NA
1026				Unknown	4	ACMV		
1027				Unknown	1	-		
1028				Unknown	4	ACMV		
1029	Km 33	9.5017	7.4008	Unknown	5	ACMV	NA	NA
1030				Unknown	1	ACMV		
1031	Km 65	9.7703	7.4478	Dan Warri	3	ACMV	MS	2
1032				Dan Warri	3	ACMV		
1033				Dan Warri	1	-		
1034	Km 88	9.9605	7.4167	Unknown	3	ACMV	M	NA
1035				Unknown	3	ACMV		
1036				Unknown	1	-		
1037	Km 117	10.2136	7.3447	Dan Warri	3	ACMV	M	NA
1038				Dan Warri	1	-		
1039	Dan Warri	3	ACMV					
1040	<b>Kaduna-Kachia (starting from NNPC depot)</b> Cosin	10.1583	7.9817	Unknown	3	ACMV	M	1
1041				Unknown	4	ACMV		
1042				Unknown	4	ACMV		
1043				Unknown	1	-		
1044	<b>Kachia-Zamaru Katarf (starting from the junction)</b> Fadiyamugu	9.7919	8.2167	Odongbo?	3	ACMV	M	3
1045				Odongbo?	3	ACMV		
1046	Zonkwa	9.7744	8.3144	Unknown	3	ACMV	M	5
1047				Unknown	3	ACMV		
1048				Unknown	1	-		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1049	<b>Samaru Kataf-Saminaka</b> Zubina	9.8936	8.5019	Unknown	3	ACMV	S	2
1050				Dan Warri	3	ACMV		
1051				Unknown	4	ACMV		
1052				Unknown	1	-		
1053	<b>Lambata-Bida (starting from the junction)</b> Km 4	9.2619	6.9589	Oko Iyawo?	3	ACMV	M	2
1054				Oko Iyawo?	3	ACMV		
1055				Oko Iyawo?	3	ACMV		
1056				Oko Iyawo?	1	-		
1057	Duga Usman	9.2003	6.7986	Oko Iyawo?	3	ACMV	M	2
1058				Unknown	3	ACMV		
1059				Unknown	3	ACMV		
1060	Km 62 after Lapai	9.0453	6.5436	Oko Iyawo?	1	-		
1061				Dan Warri	4	ACMV+EACMV	S	3
1062				Dan Warri	2	EACMV		
1063				Dan Warri	3	ACMV+EACMV		
1064				Dan Warri	4	ACMV+EACMV		
1065				Dan Warri	1	-		
1066				Dan Warri	3	ACMV+EACMV		
1067	Km 105 close to NCRI	9.0517	6.1617	Agric	4	ACMV	M	0
1068				Agric	3	ACMV+EACMV		
1069				Agric	1	ACMV		
1070				Unknown	3	ACMV		
1080	<b>Birnin Yauri-Jega (starting from Fed. Govt. Coll.)</b> Km 27	10.9786	4.7678	Unknown	4	ACMV	S	2
1081				Unknown	4	ACMV		
1082				Unknown	4	ACMV		
1083				Unknown	4	ACMV		
1084				Unknown	1	ACMV		
1085	Km 136	11.8522	4.4128	Unknown	3	ACMV	M	1
1086				Unknown	4	ACMV		
1087				Unknown	4	ACMV		
1088				Unknown	4	ACMV		
1089	Unknown	2.5	ACMV+EACMV					
	Unknown	1	-					

SS = symptom severity; M = mild, MS = moderately severe; S = severe; - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1090	<b>Birnin Kebbi-Argungu (starting from Waziri Umaru Polytech.)</b> Gidan Gonaka	12.5294	4.3814	Unknown	3	ACMV	MS	1
1091				Unknown	4	ACMV		
1092				Unknown	4	ACMV		
1093				Unknown	1	ACMV		
1094				Unknown	4	ACMV+EACMV		
1095	Unknown	4	ACMV					
1096	<b>Argungu-Sokoto (starting from Fed. Prison)</b> Km 8	12.7169	4.6303	Unknown	4	ACMV+EACMV	S	0
1097				Unknown	4	ACMV		
1098				Unknown	1	-		
1099				Unknown	5	ACMV		
1100	<b>Sokoto-Tatala Mafara (starting from Sokoto city gate)</b> Kamparu Dia	12.6525	5.6047	Unknown	3	ACMV	S	1
1101				Unknown	2	ACMV		
1102				Unknown	3	ACMV		
1103				Unknown	4	ACMV		
1104	Unknown	1	-					
1105	<b>Katsina-Kano (starting from the Fed. Secretariat)</b> Km 17	12.8164	7.6869	Unknown	3	ACMV	M	1
1106				Unknown	3	ACMV		
1107				Unknown	1	ACMV+EACMV		
1108				Unknown	4	ACMV		
1109	Bichi	12.2214	8.2603	Unknown	3	ACMV+EACMV	M	1
1110				Unknown	2.5	ACMV		
1111				Unknown	5	ACMV+EACMV		
1112				Unknown	1	ACMV		
1113	<b>Bagauda-Tudun Wada (starting for the junction of the Nigerian Law Sch.)</b> Km 10	11.5253	8.3728	Unknown	3	ACMV	S	1
1114				Unknown	4	ACMV		
1115				Unknown	1	-		
1116				Unknown	4	ACMV		

SS = symptom severity; M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant			
1119	<b>Gezawa-Gumel (starting from Minjibir junction)</b> Km 18	12.1667	8.8933	Unknown	4	ACMV+EACMV	S	1			
1120				Unknown	1	ACMV					
1121				Unknown	4	ACMV+EACMV					
1122				Unknown	3	ACMV+EACMV					
1123	Km 37	12.2911	9.0094	Unknown	2.5	ACMV	M	0			
1124				Unknown	3	ACMV					
1125				Unknown	3	ACMV					
1126				Unknown	1	ACMV					
1128	Unknown	4	ACMV								
1129	<b>Hadejia-Kano (starting from Gamayin junction)</b> Km 29	12.3305	9.7917	Unknown	3	ACMV	M	1			
1130				Unknown	1	ACMV					
1131				Unknown	4	ACMV					
1132				Unknown	2.5	ACMV					
1133	Km 60	12.3344	9.52	Unknown	1	-	M	1			
1134				Unknown	3	ACMV					
1135				Unknown	2.5	ACMV					
1136				Unknown	2.5	ACMV					
1137	Km 112	12.1194	9.2705	Unknown	3	ACMV	M	0			
1138				Unknown	4	ACMV					
1139				Unknown	1	ACMV					
1140				Unknown	3	ACMV+EACMV	MS	0			
1141	Km 132	12.0997	8.9228	Unknown	1	ACMV					
1142				Unknown	3	ACMV					
1143				<b>Ogaminan Kabba junction-Kabba</b> Ogaminana outskirts	7.6083	6.2219	TME 1	1	ACMV	MS	2
1144							TME 1	2.5	ACMV		
1145	Dan Warri	4	ACMV+EACMV								
1146	Dan Warri	4	ACMV+EACMV								
1147	Unknown	3	ACMV+EACMV								
1148	<b>Kabba-Lokoja</b> Odo Ape Bunu High sch	7.9	6.2133	TME 1?	1	ACMV	M	1			
1149				TME 1?	2	ACMV					
1150				Oko Iyawo	3	ACMV+EACMV					
1151				Queen?	3	ACMV					

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
	<b>Lokoja-Ajaokuta (starting from the Confluence Beach Hotel)</b>							
1152	Km 7	7.7083	6.738	Oko Iyawo	3	ACMV	MS	2
1153				Oko Iyawo	1	ACMV		
1154				Oko Iyawo	4	ACMV+EACMV		
1155				Oko Iyawo	3	ACMV+EACMV		
1156	Ajaokuta outskirts	7.5811	6.628	Oko Iyawo	2	ACMV+EACMV	MS	2
1157				Unknown	3	ACMV+EACMV		
1158				TME 1	1	ACMV+EACMV		
1159				Unknown	4	ACMV+EACMV		
1160				TME 1	1	-	M	2
1161				Agric	3	ACMV		
1162				TME 1	3	ACMV+EACMV		
1163	Aloji	7.4136	6.9339	Unknown	3	ACMV	S	2
1164				Oko Iyawo	4	ACMV+EACMV		
1165				Oko Iyawo	3	ACMV+EACMV		
1166				TME 1	1	ACMV+EACMV		
1167				Unknown	3	ACMV	S	2
1168	Akpagidigbo	7.325	6.9992	Unknown	3	ACMV		
1169				Unknown	4	ACMV		
1170				Unknown	1	ACMV		
1171				Unknown	4	ACMV+EACMV	S	1
1172				TME 1	1	ACMV+EACMV		
1173				Oko Iyawo	3	ACMV+EACMV		
1174	Ikebe outskirts	7.4486	7.4822	Oko Iyawo	3	ACMV	MS	2
1175				Oko Iyawo	2.5	ACMV		
1176				Oko Iyawo	1	ACMV		
1177				Oko Iyawo	3	ACMV		
1178	Km 8	7.4422	7.6939	Unknown	3	ACMV	M	1
1179				TME 1	1	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1180				TME 1	2	ACMV		
	<b>Makurdi-Otukpo through Adoka</b>							
1181	Naka	7.5864	8.2311	Odongbo?	2.5	ACMV+EACMV	M	0
1182				Odongbo?	3	ACMV+EACMV		
1183				Odongbo?	1	ACMV+EACMV		
1184	Km 58	7.5014	8.0753	Odongbo?	3	ACMV	M	1
1185				TME 1	2	ACMV+EACMV		
1186				TME 1	2	ACMV+EACMV		
1187				TME 1	1	ACMV+EACMV	M	1
1189	Km 79	7.4	8.0178	Oko iyawo?	1	-		
1190				Oko iyawo?	2	ACMV		
1191				Oko iyawo?	2	ACMV		
1192				Oko iyawo?	3	ACMV+EACMV		
1193	Km 99	7.2464	8.0825	Unknown	3	ACMV+EACMV	M	NA
1194				Unknown	2	ACMV+EACMV		
1195				Unknown	3	ACMV+EACMV		
1196				Unknown	1	ACMV		
	<b>Orukpo-Yadev (starting from Otobi junction at Otukpo outskirts)</b>							
1197	Taraku	7.2542	8.2469	Unknown	2	ACMV	MS	0
1198				Unknown	3	ACMV		
1199				Unknown	1	-		
1200				Unknown	3	ACMV		
1201	Ahorn (Km 42)	7.2933	8.5089	Unknown	4	ACMV+EACMV	S	1
1202				Unknown	3	ACMV		
1203				Unknown	1	ACMV		
1204				Unknown	3	ACMV		
1205	Akpaghi	7.2961	8.8005	Unknown	3	ACMV+EACMV	MS	NA
1206				Unknown	3	ACMV		
1207				TMS 91934?	3	ACMV+EACMV		
1208				TMS 91934?	1	-		
	<b>Yadev-Katsina Ala (starting from the roundabout)</b>							
1209	Km 3	7.3522	9.0694	Unknown	4	ACMV	S	0
1210				Unknown	4	ACMV+EACMV		
1211				Unknown	1	ACMV		
1212				Unknown	3	ACMV		

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1213	Tyowanye	7.2328	9.2055	Unknown	3	ACMV	MS	1
1214				Unknown	3	ACMV+EACMV		
1215				Unknown	1	ACMV		
1216	<b>Yandev-Makurki (starting from the roundabout)</b>							
1217	Km 20	7.4511	8.928	Dan Warri	3	ACMV+EACMV	MS	NA
1218				Dan Warri	1	ACMV		
1219	<b>Katsina Ala-Wukari</b>							
1220	Km 11	7.2183	9.3583	Unknown	3	ACMV	S	1
1221				Unknown	3	ACMV		
1222				Unknown	1	-		
1223	Km 40	7.4169	9.5205	Unknown	4	ACMV	MS	1
1224				Unknown	3	ACMV		
1225				Unknown	1	ACMV		
1226				Unknown	3	ACMV		
1227	Akaa	7.6114	9.7122	Unknown	4	ACMV	MS	0
1228				Unknown	3	ACMV		
1229				Unknown	1	-		
1230	<b>Wukari-Jalingo</b>							
1231	Gidan-Idi	7.8497	9.9597	Dan Warri	3	ACMV	S	1
1232				Dan Warri	3	ACMV		
1233				Dan Warri	2.5	ACMV		
1234				Dan Warri	1	ACMV		
1235	Bantaje	8.1555	10.1225	Unknown	3	ACMV	MS	0
1236				Unknown	1	ACMV		
1237				Dan Warri	3	ACMV		
1238	Dinya	8.2189	10.2733	Dan Warri	2	ACMV		
1239				Unknown	3	ACMV	M	0
1240				Unknown	2.5	ACMV		
				Unknown	1			

SS = symptom severity, M = mild, MS = moderately severe, S = severe, - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1241	Tela outskirts	8.4125	10.5411	Unknown	4	ACMV	MS	1
1242				Unknown	1	-		
1243				Unknown	2	ACMV		
1244				Unknown	3	ACMV		
<b>Jalingo-Mutum Biyu</b>								
1245	Alin-Gara junction	8.8803	11.2475	Dan Warri	3	ACMV	M	1
1246				Dan Warri	3	ACMV		
1247				Dan Warri	1	-		
1248	Km 50	8.7594	10.9427	Oko Iyawa	3	ACMV	M	0
1249				Oko Iyawa	3	ACMV		
1250				Oko Iyawa	3	ACMV		
1251				Oko Iyawa	1	-		
<b>Jalingo-Beli</b>								
1252	Sunkani	8.6639	11.253	Oko Iyawa	2	ACMV	M	0
1253				Oko Iyawa	1	-		
<b>Jalingo-Yola (starting from the roundabout)</b>								
1254	Km 93	8.9919	12.0111	Dan Warri	2	ACMV	M	0
1255				Dan Warri	3	ACMV		
1256				Dan Warri	1	-		
<b>Yola-Mubi (starting from the roundabout)</b>								
1257	Kalaa	10.2572	13.0397	Oko Iyawa	3	ACMV	S	1
1258				Oko Iyawa	1	ACMV		
1259				Oko Iyawa	3	ACMV		
1260				Oko Iyawa	3	ACMV		
1261				Unknown	2.5	ACMV	M	1
1262				Unknown	2	ACMV		
1263				Unknown	1	-		
1264				Unknown	3	ACMV		
<b>Bama-Maiduguri (starting from a bridge in Bama)</b>								
1265	Km 25	11.6128	13.4686	Unknown	3	ACMV+EACMV	S	0
1266				Unknown	2	ACMV+EACMV		
1267				Unknown	3	ACMV+EACMV		
1268				Unknown	4	ACMV+EACMV		
<b>Gashua-Nguru (starting from Fed. Senior Scien. Sec. Sch.)</b>								
1265	Km 5	12.8378	10.3797	Unknown	3	ACMV+EACMV	S	0
1266				Unknown	2	ACMV+EACMV		
1267				Unknown	3	ACMV+EACMV		
1268				Unknown	4	ACMV+EACMV		

SS = symptom severity; M = mild, MS = moderately severe; S = severe; - = no reaction



Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
<b>Abaji-Abuja</b>								
1269	Wako	8.5928	6.9094	Unknown	1	-	M	1
1270				Unknown	3	ACMV		
1271				Unknown	2.5	ACMV		
1272				Unknown	3	ACMV		
1273	Kwali	8.8111	7.033	Unknown	2.5	ACMV	MS	0
1274				Unknown	1	-		
1275				Unknown	2.5	ACMV		
1276				Unknown	3	ACMV		
1277	Tunganmanje	9.1475	7.2036	Unknown	3	ACMV	MS	1
1278				Unknown	4	ACMV		
1279				Unknown	3	ACMV		
1280				Unknown	1	-		
<b>Abuja-Lafia (starting from opposite Mogadishu Cantonment)</b>								
1281	Km 22	8.9642	7.6747	Unknown	3	ACMV	M	1
1282				Unknown	2	ACMV		
1283				Unknown	1	-		
1284				Unknown	4	ACMV		
1285	Km 56	8.8375	7.9297	Unknown	3	ACMV	S	1
1286				Unknown	2.5	ACMV		
1287				Unknown	1	-		
1288				Unknown	4	ACMV		
1289	Km 100	8.9133	8.2767	Unknown	3	ACMV	M	0
1290				Unknown	4	ACMV		
1291				Unknown	1	-		
<b>Akwanga-Lafia (starting from Govt. Sec. Sch.,Ubbe)</b>								
1292	Km 35	8.673	8.564	Unknown	3	ACMV	MS	0
1293				Unknown	1	ACMV		
1294				Unknown	4	ACMV		
<b>Lafia-Makurdi road (starting from roundabout)</b>								
1295	Km 12	8.3814	8.555	Unknown	3	ACMV	M	0
1296				Unknown	1	-		
1297				Unknown	4	ACMV		
1298				Unknown	2.5	ACMV		

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Sample No	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isoLate	CMD field status	WF per plant
1299	Km 40	8.1478	8.588	Unknown	2.5	ACMV	M	1
1300				Unknown	1	-		
1301				Unknown	4	ACMV		
1302	<b>Lafia-Langtang (starting from Govt. House)</b>							
1303	Km 5	8.5297	8.5772	Unknown	3	ACMV	M	2
1304				Unknown	1	-		
1305				Unknown	2	Unidentified		
1306				Unknown	2.5	ACMV		
1307				Unknown	4	ACMV		
1308	Km 34	8.5844	8.8139	Unknown	3	ACMV	M	1
1309				Unknown	1	-		
1310				Unknown	2.5	ACMV		
1311				Unknown	2	Unidentified		
1312	Km 63	8.6753	9.0436	Unknown	3	ACMV+EACMV	MS	1
1313				Unknown	4	ACMV		
1314				Unknown	1	-		
1315				Unknown	3	ACMV		
1316				Unknown	2.5	ACMV		
1317	Km 100	8.7786	9.3022	Unknown	3	ACMV	S	2
1318				Unknown	1	-		
1319	Km 149	8.8264	9.6744	Unknown	1	-	M	1
1320				Unknown	2.5	ACMV		
1321				Unknown	2	Unidentified		
1322	Km 190	9.108	9.8053	Unknown	2.5	ACMV	M	0
1323	<b>Bauchi-Gombe (starting from Govt. Girls Coll.)</b>							
1324	Km 59	10.2817	10.3686	Unknown	3	ACMV	MS	3
1325				Unknown	4	ACMV		
1326				Unknown	1	-		
1327	Km 124	10.3069	10.9203	Unknown	1	-	MS	2
1328				Unknown	3	ACMV		
1329				Unknown	2.5	ACMV		
1329				Unknown	4	ACMV		

SS = symptom severity; M = mild, MS = moderately severe; S = severe; - = no reaction

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
	<b>Gombe-Kattungo (starting from Gombe International Hotel)</b>							
1330	Km 23	10.0955	11.1244	Unknown	3	ACMV	MS	1
1331				Unknown	1	ACMV		
1332				Unknown	4	ACMV		
1333				Unknown	2.5	Unidentified		
	<b>Gombe-Gilehi (starting from Fed. Medical Centre)</b>							
1334	Km 13	9.3244	9.4333	Unknown	3	ACMV	MS	2
1335				Unknown	1	-		
1336				Unknown	2.5	ACMV		
1337	Km 46	10.6108	11.3778	Unknown	1	-	S	1
1338				Unknown	3	ACMV		
1339				Unknown	2	ACMV		
	<b>Gombe-Darazo (starting from Dukku/Potiskum roundabout)</b>							
1340	Km 21	10.4822	11.0933	Unknown	2.5	ACMV	MS	1
1341				Unknown	1	-		
1342				Unknown	3	ACMV		
1343	Km 81	10.8228	10.6989	Unknown	1	-	M	2
1344				Unknown	3	ACMV		
1345				Unknown	2	ACMV		
1346				Unknown	2.5	ACMV		
1347	Km 115	10.9353	10.445	Unknown	1	-	S	3
1348				Unknown	4	ACMV		
1349				Unknown	2.5	ACMV		
1350				Unknown	3	ACMV		
	<b>Darazo-Bauchu (starting from Dukku junction)</b>							
1351	Km 8	10.9147	10.3869	Unknown	1	-	S	3
1352				Unknown	3	ACMV		
1353				Unknown	4	ACMV		
1354				Unknown	2.5	ACMV		
1355	Km 59	10.5428	10.1294	Unknown	1	-	MS	1
1356				Unknown	2.5	ACMV		
1357				Unknown	3	ACMV		
	<b>Ipetu Ijesha-Ondo (starting from Ipetu Ijesha junction)</b>							
1358	Km 25	7.463	4.9683	Unknown	2.5	Unidentified	MS	2
1359				Unknown	3	ACMV		

Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1360				Unknown	1	-		
1361				Unknown	4	ACMV		
1362	<b>Ondo-Akure (starting from Ile-Oluji junction)</b>							
1363	Km 24	7.2686	5.0347	Unknown	3	ACMV	MS	3
1364				Unknown	1	-		
1365				Unknown	2.5	ACMV+EACMV		
				Unknown	4	ACMV+EACMV		
1366	<b>Akure-Igbara Oke (starting from FUTIA main campus gate)</b>							
1367	Km 13	7.395	5.0678	Unknown	3	ACMV	MS	2
1368				Unknown	2.5	ACMV		
				Unknown	1	-		
1369	<b>Ondo-Ore (starting from Adeyemi Coll. of Education gate)</b>							
1370	Ondo outskirts	7.0367	4.8394	Unknown	2.5	ACMV	M	1
1371				Unknown	2	ACMV		
1372				Unknown	2.5	ACMV		
1373				Unknown	3	ACMV		
				Unknown	1	-		
1374	<b>Ore-Okitipupa (starting from the junction at the express)</b>							
1375	Km 16	6.6625	4.8008	Unknown	3	ACMV	MS	2
1376				Unknown	2.5	ACMV		
1377				Unknown	1	-		
1378	Km 34	6.5452	4.7489	Unknown	3	ACMV	MS	1
1379				Unknown	1	ACMV		
1380				Unknown	3	ACMV		
1381	Igbokoda outskirts	6.4464	4.7711	Unknown	3	ACMV	M	2
1382				Unknown	2.5	ACMV		
1383				Unknown	2.5	ACMV		
				Unknown	1	ACMV		
1384	<b>Okitipupa-Igbotako</b>							
1385	Km 15	6.5308	4.6503	Unknown	3	ACMV+EACMV	MS	5
1386				Unknown	1	-		
				Unknown	2.5	ACMV+EACMV		

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Sample No.	Location	Lat. (N)	Long. (E)	Cultivar	SS	Virus isolate	CMD field status	WF per plant
1387	<b>Ore-Ijebu Ode (starting from the toll gate)</b> Km 76	6.7655	4.1997	Unknown	1	-	M	3
1388				Unknown	2.5	ACMV		
1389				Unknown	3	ACMV		
1390	<b>Ijebu Ode-Epe (starting from Benin express road, Epe junction)</b> Km 16	6.6733	3.9869	Unknown	3	ACMV	M	8
1391				Unknown	2	ACMV		
1392				Unknown	1	-		
1393				Unknown	2.5	ACMV		
1394	<b>Epe-Lagos (starting from Ajah junction)</b> Km 1	6.5722	3.943	Unknown	1	-	M	3
1395				Unknown	2.5	ACMV		
1396				Unknown	3	ACMV		
1397	Km 17	6.485	3.8617	Unknown	2.5	ACMV	M	1
1398				Unknown	2	ACMV		
1399				Unknown	1	-		
1400	<b>Lagos-Seme (starting from Agbara junction)</b> Km 6	6.4847	3.0489	Unknown	2	Unidentified	MS	10
1401				Unknown	1	-		
1402				Unknown	3	ACMV		
1403				Unknown	5	ACMV		
1404				Unknown	2.5	ACMV		
1405	Km 28	6.4267	2.8783	Unknown	4	ACMV	S	10
1406				Unknown	3	ACMV		
1407				Unknown	1	ACMV		
1408	Km 42	6.3864	2.7683	Unknown	4	ACMV	M	2
1409				Unknown	2.5	ACMV		
1410				Unknown	1	-		
1411	<b>Badagry express-Iworo</b> Km 4	6.4347	2.9844	Unknown	1	-	M	5
1412				Unknown	3	Unidentified		
1413				Unknown	2.5	ACMV		

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