Cassava mosaic disease and associated viruses in Zambia: Occurrence and distribution

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Introduction

Cassava (*Manihot Esculenta,* Crantz) is one of the most important food crops in Africa after maize and rice (FAOSTAT, 2009). In Zambia, cassava yields average only 5.8 t ha^{-1} compared to Africa's average of 10t ha^{-1} (1). The low productivity of cassava is caused majorly by two virus diseases: cassava mosaic disease (CMD) and cassava brown streak disease (CBSD). Cassava mosaic disease was reported to cause annual economic losses of US$1.9-2.7 billion on the continent. While losses due to CBSD varied depending on the cassava cultivar and geographical location (3). We report here the results of a study that aimed to establish the status and distribution of viruses affecting cassava in Zambia in 2009.

Materials and methods

A country-wide survey was carried out in seven major cassava producing provinces of Zambia including: Luapula, Northern, Western, Northwestern, Central and Eastern in April-May 2009. Plants were assessed for cassava mosaic disease (CMD) incidence, symptom severity (2) and whitefly populations (4). PCR was performed using the specific primers: JSP001/2, EAB555F/R and UV-AL1/f & ACMV-CP/R3 for ACMV, EACMV and EACMV-Ug, respectively. Statistical analysis was conducted for analysis of variance (ANOVA) in Genstat and the distribution map drawn using Arcview.

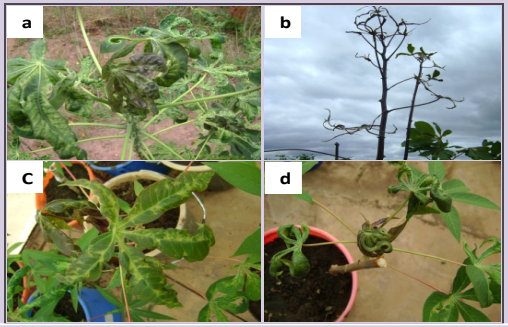

Figure 1. Plants showing: (a) mild and (b) severe filform, candle stick field symptoms and the greenhouse re-produced symptoms of (c) mild & (d) severe filform of cassava mosaic disease.

Results

Disease incidence, symptom severity and whitefly population

Cassava mosaic disease occurred in all the seven provinces of Zambia (Table 1). Disease incidence was significant between province (P<0001, F=4.84, df=6). It was highest in North-western, followed by Lusaka and lowest in Western province. All the surveyed fields had cutting-borne infections. CMD incidence was low (0-20%), moderate (>20<50) and high (>50%) in 21%, 29% and 50% of the fields, respectively (Fig. 2). Plants occurred with mild, severe and 'candle stick' symptoms in the field (Fig. 1a&b) and similar symptoms were re-produced in the screen house at ZARI Mt. (Fig. 1c&d). Symptom severity differed significantly (P<0001, F=62.89, df=6) between provinces. Severity was highest in Eastern (3.94) and Lusaka (3.88) provinces and lowest in Western (2.50) province (Table 1). Adult whitefly populations were generally low and populations differed significantly (P<0.0001, F=42.59, df=6) between the provinces (Table 1). Whitefly numbers were highest in Lusaka and lowest in Central province Cassava brown streak disease (CBSD) symptoms were conspicuously lacking in all surveyed fields.

Table 1. Incidence, symptom severity and whitefly populations in farmers' cassava fields in Zambia, April/May 2009

Provinces	Incidence (%)	Mean symptom severity (scale 1-5)	Mean adult whitefly population
Lusaka	67.4	3.88	2.12
Luapula	56.4	3.48	0.39
Northern	36.6	3.31	0.32
North western	71.2	3.01	1.26
Central	57.3	3.54	0.02
Western	34.3	2.50	0.42
Eastern	37.2	3.94	0.15
Mean	52.0	3.41	0.64
P-value (5%)	0.000	0.000	0.000
F-statistic	4.84	62.89	42.59

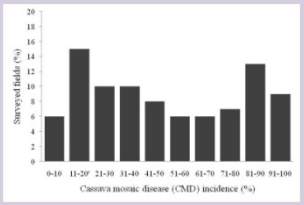

Figure 2. Frequency distribution of cassava mosaic disease incidence in farmers' cassava fields in Zambia in April/May 2009.

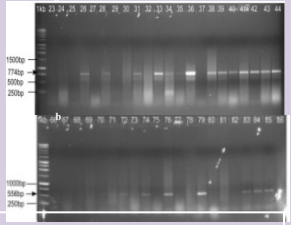

Figure 3. Gel photos of PCR amplification of (a) ACMV and (b) EACMV using specific primers: JSP001/2 (774bp) and EAB555F/R (556bp) with a 1kb ladder.

PCR analysis of cassava mosaic begomiviruses in Zambia

Partial fragments of 774 bp (DNA-A AV1/CP) and 556 bp (DNA-B) were amplified in only 45.1% of the virus isolates using the specific primers JSP001/2 and EAB555F/R for ACMV and EACMV, respectively (Fig. 3). Single infections of ACMV and EACMV occurred in 65.4% (102/156) and 25% (39/156) of the positive samples, respectively. Mixed infections (ACMV+EACMV) were detected in only 9.6% (15/156) of the samples (Table 2).

Table 2. Cassava mosaic begomoviruses occurring in Zambia April/May 2009

Provinces	Cassava mosaic begomoviruses			No. of samples
	ACMV	EACMV	ACMV + EACMV	
Lusaka	13 (52/12.7)	12 (48/30.8)	0 (0/0)	25 (16.0)
Luapula	23 (46/22.5)	17 (34/43.6)	10 (20/66.7)	50 (32.1)
Northern	18 (100/17.6)	0 (0/0)	0 (0/0)	18 (11.5)
Northwesten	12 (100/11.8)	0 (0/0)	0 (0/0)	12 (7.7)
Central	8 (80/7.8)	0 (0/0)	2 (20/13.3)	10 (6.4)
Western	16 (84.2/15.7)	0 (0/0)	3 (15.8/20)	19 (12.2)
Eastern	12 (54.5/11.8)	10 (45.5/25.6)	0 (0/0)	22 (14.1)
Totals	102 (65.4)	39 (25.0)	15 (9.6)	156

Distribution of Cassava mosaic begomoviruses

African cassava mosaic virus occurred in all the surveyed provinces (Table 2, Fig.4). Single infections of ACMV were highest in Northern and Northwestern provinces and occurred in 100% of the samples and lowest in Luapula (46%) province. In contrast, single infections of EACMV occurred in only three provinces of Lusaka (48%), Eastern (45.5%) and Luapula (34%). On the other hand, the mixed infections (ACMV+EACMV) occurred only in Luapula (20%), Central (20%) and Western (15.8%) province, albeit at low incidences. *East African cassava mosaic virus – Uganda variant* (EACMV-Ug) was not detected in any of the samples. Similarly, *Cassava brown streak virus* (CBSV) was also not detected in any of the samples in the current study; confirming the field observations for lack of CBSD-like symptoms on cassava in the country.

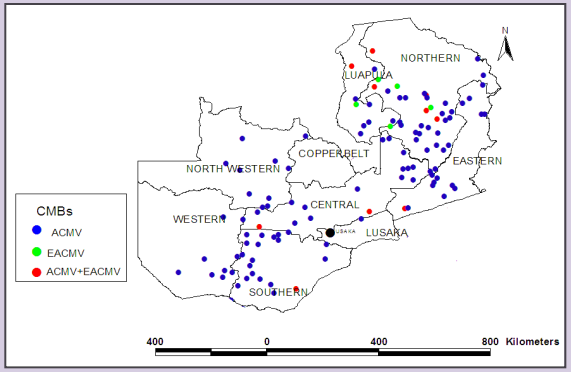

Figure 4. Map of geographical distribution of cassava mosaic begomoviruses in farmers' cassava fields in Zambia in April/May 2009.

Conclusion

Cassava mosaic disease is still the most important constraint to cassava production in Zambia. The disease will continue to cause high yield losses as long as local disease-susceptible cultivars continue to be produced by smallholder farmers. Concerted efforts must be made quickly to develop and promote disease resistant cassava varieties with farmer preferred qualities to accelerate adoption. The risk of spread of CBSD from neighboring Malawi, Tanzania and Mozambique should be minimal through strict quarantine measures and routine field disease monitoring.

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