CHAPTER 1.12

Serological Analysis of Sweetpotatoes Affected by Sweetpotato Virus Disease in East Africa

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Introduction

Infection of sweetpotato (*Ipomoea batatas* [L.] Lam.) by viruses is a major cause of yield reduction worldwide. At least 13 viruses are reported to infect sweetpotato naturally (Moyer and Larsen, 1991). Most of them are insect-transmitted, mainly by whitefly or aphid species. In East Africa, symptoms of sweetpotato virus disease (SPVD) were first reported on sweetpotato in 1945 (Hansford, 1945). However, the presence of viruses was not demonstrated until 1957 when Sheffield (1957) associated two viruses with sweetpotato plants having virus-like symptoms, virus A being aphid-transmitted and virus B being whitefly-transmitted. Virus A was later identified as *Sweetpotato feathery mottle virus* (SPFMV) but the identity of the whitefly-transmitted virus remained unclear. Subsequent efforts to determine the range of viruses occurring in East African sweetpotato crops confirmed SPFMV as the most frequently found virus but also revealed the presence of *Sweetpotato mild mottle virus* (SPMMV), *Sweetpotato latent virus* (SPLV) and *Sweetpotato chlorotic fleck virus* (SPCFV) (Carey et al., 1998). SPFMV has a worldwide distribution, is readily spread by aphids such as *Myzus persicae* (Sulzer) in a non-persistent manner but probably is not spread by seed transmission (Cadena-Hinojosa et al., 1981a). Various strains of SPFMV have been differentiated, mostly by symptoms produced on certain sweetpotato cultivars. In USA, two strains are recognized—the russet crack strain or internal cork strain, which causes internal necrosis of the storage roots of some cultivars, and the common strain, which causes no such symptoms. In East Africa, SPFMV-infected sweetpotato plants typically exhibit no symptoms on either roots or foliage. SPMMV is considered to be whitefly-borne (Hollings and Stone, 1976).

The whitefly-transmitted component virus of SPVD has been named as *Sweetpotato chlorotic stunt virus* (SPCSV) largely on the basis of the symptoms of West African isolates expressed in the indicator plant *Ipomoea setosa* Ker Gawl. (Schaefers and Terry, 1976). SPCSV is synonymous (Gibson et al., 1998) with Sweetpotato sunken vein virus (Cohen et al., 1992) and SPVD-associated closterovirus. An East African strain of SPCSV (SPCSV-SEA) was identified using monoclonal antibodies (MABs) prepared against an Israeli isolate of SPCSV as well as against bacterially

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expressed coat protein of a Kenyan isolate (Hoyer et al., 1996; Gibson et al., 1998). Subsequent analyses using enzyme-linked immunosorbent assays (ELISA) led to the description of two distinct serotypes: SEA1 as originally described from Kenya, and SEA2 (Alicai et al., 1999). In East Africa, SPCSV causes only moderate stunting and yellowing or purpling of the lower and middle leaves when it occurs alone (Gibson et al., 1998). Co-infection of SPFMV and SPCSV is very common and the severe symptoms of SPVD result from a synergistic interaction between SPCSV and SPFMV. SPVD is the most important disease of sweetpotato in Africa (Geddes, 1990). Depending on the genotype, SPVD symptoms comprise leaf strapping, mottling, vein clearing, puckering and stunting of sweetpotato plants (Schaefers and Terry, 1976).

The respective distributions of SPMMV, SPCSV and its synergistic partner, SPFMV, are still poorly understood in the major sweetpotato growing regions of East Africa, although it has long been known that these viruses can cause large yield losses (Mukiibi, 1977). The growing importance of sweetpotato for food security in Africa has increased international exchange of sweetpotato germplasm and thus increased the need to identify and establish the distribution of the common viruses occurring on the crop. Such information is an important prerequisite for the development and appropriate release of cultivars resistant to the prevailing viruses/diseases.

The following work investigates the distributions of SPMMV, SPCSV and its serotypes, and SPFMV in Uganda, Kenya and Tanzania.

Collection and Analysis of Samples

Project partners carried out field surveys according to a common protocol. Additional information on the timing and coverage of the surveys are given in the respective country papers in the present volume (Chapters 1.6, 1.7 and 1.8). The authors analysed samples collected by project partners as follows: those from Uganda were tested fresh at Namulonge Research Institute; dried samples from Kenya and Tanzania were analysed at the Biologische Bundesanstalt für Land und Forstwirtschaft (BBA), Braunschweig, Germany. The samples were analysed using polyclonal antisera or monoclonal antibodies to SPCSV, SPFMV and SPMMV using triple antibody sandwich (TAS), double antibody sandwich (DAS), or nitrocellulose membrane (NCM) ELISA.

More than 200 sweetpotato leaf samples were collected from plants showing possible symptoms of viral infection. Field symptoms observed consisted of leaf strapping, yellowing, purpling, mottling, vein clearing and stunting of sweetpotato plants. Since incidence varied among and within the three countries, different numbers of samples were collected from each country and target area.

Reactions of the Diseased Samples

Table 1 shows the numbers of samples by country and target area that tested positive for SPFMV, SPSCV-SEA and/or SPMMV. Both SPFMV and SPCSV occurred throughout the sampled areas. Overall, SPFMV was most frequently detected, in 151 out of the 243 samples. It was most frequently

Table 1. Results of enzyme-linked immunosorbent assay (ELISA) tests using antiserum/monoclonal antibodies to viruses of sweetpotato for sweetpotato leaf samples collected in Uganda, Kenya and Tanzania.

Country	Survey area	Number of positive samples[a]		
		SPFMV 1	SPCSV (SEA) 2	SPMMV 3
Uganda	Northern	12/38	14/38	0/36
	Eastern	13/36	14/36	0/36
	Central	26/38	34/38	2/38
	Western	19/40	38/40	7/40
	% frequency	46	66	6
Kenya	Coast	2/4	1/4	0/4
	Western	9/12	5/12	4/12
	Nyanza	9/9	5/9	1/9
	% frequency	80	44	20
Tanzania	N. Coast	17/21	5/21	0/21
	S. Coast	23/23	8/23	0/23
	Lake zone	21/22	16/22	7/22
	% frequency	92	44	11

a. Data are number of positive samples / number of samples tested. SPFMV 1, *Sweetpotato feathery mottle virus*: negative control, healthy *Ipomoea setosa*; positive control, SPCSV-Ky38 in *I. setosa*. SPCSV (SEA) 2, East African strain of *Sweetpotato chlorotic stunt virus*: negative control, healthy sweetpotato; positive control, SPFMV-46b in *Nicotiana tabacum* L. SPMMV 3, *Sweetpotato mild mottle virus*: negative control, healthy sweetpotato; positive control, SPMMV-DDR (German Democratic Republic). Values are considered as positive where the mean readings were at least two times greater than the mean of the healthy controls.

detected in samples from Tanzania (92%), slightly less frequently (80%) in those from Kenya and least frequently (46%) in samples from Uganda. One hundred and forty samples reacted positively to MABs specific to the East African strain of SPCSV. Frequencies of detection were 66% in samples from Uganda, 44% in samples from Tanzania and 44% from Kenyan samples. SPMMV was detected only in samples collected from areas around Lake Victoria in Uganda (6% incidence), Kenya (20%) and Tanzania (11%) (Table 1). Co-infections of SPFMV + SPCSV were more frequent (32% of samples) than the occurrence of either SPFMV (22%) or SPCSV (16%) alone. This association was expected because the two viruses co-exist synergistically (Schaefers and Terry, 1976). All combinations of viruses occurring together in samples also were detected but more rarely (Table 2).

Some samples did not react positively to any of the viruses tested, even though they appeared to show virus symptoms in the field. Low virus concentration and the irregular distribution of SPFMV in sweetpotato plants are frequently cited as obstacles to the reliable use of ELISA for virus detection in sweetpotato (Cadena-Hinojosa and Campbell, 1981b). Other possible explanations are that the presence of high concentrations of phenols, latex or other inhibitors adversely affected the reagents used in these tests and that tests on samples from Tanzania and Kenya were done on dried leaf samples stored for various lengths of time. Moreover, symptoms of viral infection can be difficult to recognize under certain circumstances and may have led to the collection of some uninfected samples, particularly in locations where the viruses occur less frequently, as was

Table 2. Single and multiple occurrences of viruses of sweetpotato in leaf samples from three East African countries.

Country	Nothing detected	Sweetpotato viruses[a]						
		SPFMV alone	SPCSV alone	SPMMV alone	SPFMV + SPCSV	SPFMV + SPMMV	SPCSV + SPMMV	SPFMV + SPCSV + SPMMV
Uganda	36	15	40	1	54	0	1	5
Tanzania	0	30	0	0	29	1	0	6
Kenya	2	9	0	1	9	2	1	1
Total	38	54	40	2	92	3	2	12
%	16	22	16	1	38	1	1	5

a. SPFMV, *Sweetpotato feathery mottle virus*; SPCSV, *Sweetpotato chlorotic stunt virus* and SPMMV, *Sweetpotato mild mottle virus*.

the case in northern and eastern regions of Uganda. Alternatively, since all samples tested were selected on the basis of apparent virus symptoms, the lower rates of detection of virus in samples from more easterly areas may indicate the presence there of viruses other than SPCSV, SPFMV or SPMMV (i.e., viruses for which no tests were carried out).

In Uganda, the presence of two serotypes of SPCSV was confirmed using two MABs (Hoyer et al., 1996), both serotypes reacting with one (MAB 2G8) but only SEA2 reacting with the other (MAB 6D12) (Alicai et al., 1999). Serotype SEA2 was detected in 66 of the 96 SPCSV-positive samples, while SEA1 was detected in 30 of the SPCSV positive samples. Serotype SEA2 was found in all districts except for Tororo, Masindi and Iganga, although it was found most frequently in the central and western survey areas. Serotype SEA1 was distributed more evenly across the country and, in contrast to the SEA2, occurred more

Table 3. Distribution of two *Sweetpotato chlorotic stunt virus* (SPCSV) serotypes in sweetpotato leaf samples from 12 districts of Uganda.

Target area	District	No. positive samples		SPCSV serotype	
		MAB 2G8	MAB 6D12	SEA2	SEA1
Northern	Apac	4	1	3	1
	Lira	4	1	3	1
	masindi	5	5	0	5
	Total			6	7
Eastern	Tororo	1	1	0	1
	Palisa	8	6	2	6
	Iganga	5	5	0	5
	Total			2	12
Central	Luwero	11	0	11	0
	Mpigi	9	2	7	2
	Mukono	11	4	7	4
	Total			25	6
Western	Masaka	13	3	10	3
	Rakai	12	0	12	0
	Mubende	13	2	11	2
	Total			33	5

frequently in the northern and eastern survey areas (Table 3). These results confirm the heterogeneity of SPCSV, at least at the serotype level. Further studies would therefore be useful to investigate the diversity of this group of viruses and clarify any implications for disease management.

Conclusions

SPCSV is a common whitefly-borne virus in sweetpotato throughout East Africa, often occurring together with SPFMV, with which it acts synergistically to produce the severe disease SPVD. In contrast, SPMMV is largely restricted to the Lake Victoria region of East Africa.

Differences in the distribution of two SPCSV serotypes have been confirmed. Both SEA1 and SEA2 are widely distributed throughout Uganda but SEA1 is more prevalent in northern and eastern Uganda and SEA2 is more prevalent in central and western Uganda. These areas correspond with areas of lesser and greater whitefly abundance and slower and faster rates of spread (Aritua et al., 1998) but whether this relationship is causal is unclear.

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