Chapter 1.7

Kenya

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Introduction

Cassava mosaic disease (CMD) is caused by cassava mosaic begomoviruses (CMBs), which are transmitted by the whitefly *Bemisia tabaci* (Gennadius). Further spread may occur through farmers distributing and planting virus-infected cuttings (Harrison, 1987). The disease causes higher production losses than any other virus disease of cassava in Kenya (Bock, 1994b). Sweetpotato virus disease (SPVD) results from co-infection of sweetpotato (*Ipomoea batatas* [L.] Lam.) by two distinct viruses: *Sweetpotato chlorotic stunt virus*, transmitted by *B. tabaci*, and *Sweetpotato feathery mottle virus*, transmitted by the aphid, *Myzus persicae* (Sulzer) (Gibson et al., 1998). Although SPVD is the most prevalent viral disease of sweetpotato in farmers' fields in Kenya (Carey et al., 1998), its effects on growth and yield have yet to be quantified.

The early history of CMD in Kenya is obscure but work on cassava under the East African breeding programme in the mid-1950s is described by Doughty (1958) and resulted in the release of CMD-resistant hybrids to research stations in the country. However, farmers did not replace their local traditional Kenyan cultivars of cassava (*Manihot esculenta* Crantz) with this improved germplasm, except for 46106/27 "Kaleso", which became widely grown in Coast Province (Bock, 1994b).

Research on CMD and its whitefly vector only became important in Kenya during the 1970s, when a major plant virology project was initiated. The work of this project initially emphasized the isolation of the putative *Cassava mosaic virus* (Bock, 1975), which was later shown to cause CMD (Bock and Woods, 1983). Subsequent epidemiological work by Bock (1983) noted that the incidence of CMD was generally high in coastal and western Kenya, where it exceeded 80% in some districts and approached 100% on individual farms but the spread of disease into initially CMD-free plantings was generally slow. Additional studies associated with this project were the description of the population dynamics of *B. tabaci* (Seif, 1982; Robertson, 1987), assessments of yield loss (Seif, 1981) and the development of control methods (Bock, 1994a). During the 1990s, a series of surveys conducted to reassess the incidence of the disease in the country indicated increased spread and incidence of CMD in farmers' fields.

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Recent epidemiological studies on CMD in the region have provided evidence of the spread of severe CMD from Uganda to western Kenya (Legg, 1999). This is associated with the spread of a novel and particularly virulent CMB (Harrison et al., 1997; Legg, 1999). Major losses have been experienced already in Western Province, and districts of Nyanza Province are now threatened. Efforts have been made to control the disease by introducing resistant material into western Kenya from the breeding program of the International Institute of Tropical Agriculture-Eastern and Southern Africa Regional Center (IIITA-ESARC) in Namulonge, Uganda. Continuing work by the cassava program of the Kenya Agricultural Research Institute (KARI) emphasizes the evaluation and multiplication of the initial stock of resistant material, in collaboration with international research institutions and networks such as the East Africa Root Crops Research Network (EARRNET) (Legg et al., 1999).

Research on SPVD began during the 1950s, when Sheffield (1957) reported the presence of a severe sweetpotato mosaic disease on sweetpotato fields in East Africa. More recently, surveys have been carried out to assess the occurrence and importance of sweetpotato viruses in Kenya (Carey et al., 1998) and the Centro Internacional de la Papa (CIP) now has a major germplasm introduction and development program based in Kenya. Whilst cultivar resistance has been identified as the principal strategy for managing SPVD, little detailed research has been done on yield loss or the epidemiology of the disease.

A study was conducted in mid-1998 to identify whiteflies and whitefly-transmitted viruses prevalent in Kenya and to assess producers' knowledge of whiteflies and the diseases they transmit on cassava and sweetpotato. Three "target areas" representing the major cassava and sweetpotato growing areas in the country were selected: Coast Province, Western Province and Nyanza Province (Figure 1). Within these areas, 3 to 5-month-old cassava fields and 3-month-old sweetpotato fields were randomly selected at regular intervals along main roads.

Figure 1. Cassava- and sweetpotato-growing areas surveyed for whitefly incidence in Kenya.

Increased Biological Understanding

Whitefly species and abundance

Whitefly nymph samples were obtained from most but not all surveyed sites and, for each sample, from one to three nymphs were identified to species level. Two whitefly species, *B. tabaci* and *Bemisia afer* (Priesner and Hosny), were identified on both cassava and sweetpotato. Seventy whitefly nymph samples were identified from cassava;

of which 58 were *B. tabaci* and 12 were *B. afer*. Only 35 whitefly samples were identified from sweetpotato (attributable to the lower populations on that crop), comprising 31 *B. tabaci* and four *B. afer*. The two species occurred throughout the three target areas.

Adult whitefly populations were relatively low on both cassava and sweetpotato (Table 1). Whiteflies on cassava were more numerous in Coast Province, while whiteflies on sweetpotato were more abundant in Nyanza Province. Mean adult whitefly numbers ranged from 0.2 to 2.9 per top five leaves on cassava and 0.5 to 4.4 per minute count on sweetpotato in the surveyed regions (see also Figure 2, Chapter 1.14, this volume).

Disease incidence and symptom severity

Mean CMD incidence in the surveyed regions was 51.3% and incidence was highest in Western Province and lowest in Nyanza (Table 1). Diseased cuttings provided the main source of infection in all three target areas. CMD symptom severity was mild in the Coast and Nyanza Provinces and more severe in Western Province. SPVD incidence ranged between 3% and 53% in farmers' fields. The disease was more prevalent in Western and Nyanza Provinces than in Coast Province.

Whitefly parasitoids

The survey identified two species of aphelenid parasitoids; 15 individual parasitoids were identified, comprising 13 *Encarsia sophia* (Girault and Dodd) and two *Eretmocerus* sp. Little is known, however, about the role of natural enemies in the population dynamics of whiteflies in Kenya.

Increased Socio-Economic Understanding

Farmers' assessment of whitefly-related problems

About half of the producers surveyed (52% of cassava farmers and 46% of sweetpotato farmers) were able to recognize whiteflies, although the names they used were non-specific. Of the farmers who recognized whiteflies on either crop, 61% considered them a production problem.

Most cassava farmers (88%) recognized CMD as a disease of their crop, whilst only 58% of sweetpotato farmers recognized SPVD. The

Table 1. Incidence (%) of cassava mosaic disease (CMD) and sweetpotato virus disease (SPVD), disease severity and whitefly abundance on cassava and sweetpotato in three provinces of Kenya, surveyed during May and June 1998.

Province	Cassava[a]						Sweetpotato[a]		
	No. fields	Whitefly counts	CMD				No. fields	Whitefly counts	SPVD incidence
			Whitefly infection	Cutting infection	Total incidence	Severity			
Coast	17	2.9	19 (35.9)	37	56	2.3	15	0.5	0.4
Western	15	0.2	14 (65.9)	71	85	2.9	18	2.5	6.9
Nyanza	18	0.6	2 (2.3)	11	13	2.2	17	4.4	6.7
Average	-	1.2	11.7 (21.6)	39.7	51.3	2.5	-	2.5	4.7

a. Figures are means for each province. Whitefly counts, whitefly abundance on cassava (number of whiteflies per top five leaves) and on sweetpotato (per minute count); whitefly infection, figures in parentheses transformed to multiple infection units to allow for multiple infection (Gregory, P. H. 1948. The multiple infection transformation. Ann. Appl. Biol. 35:412-417); severity of disease measured on an ascending 1-5 scale, from low to severe.

respective diseases were recognized as a production constraint by 68% of cassava farmers and 44% of sweetpotato farmers. Most cassava farmers (82%) considered CMD to occur every year, whilst only 52% of sweetpotato farmers believed this to be the case. Farmers had different views regarding the trend of symptom severity for CMD and SPVD. Fifty-four percent of cassava farmers considered that CMD severity was increasing, whilst only 40% of sweetpotato farmers considered that SPVD was becoming more important. In both cases, a majority of cassava (72%) and sweetpotato (62%) farmers believed that climate influences disease severity. The two diseases were thought to be more severe during periods of low rainfall by 70% of cassava farmers and 44% of sweetpotato farmers. This was consistent with farmers' views that the two diseases were more severe during periods of moderate temperature.

Yield loss estimates due to CMD varied between regions. In Western Province, 21.4% of farmers estimated losses at >75%. This is understandable in view of the impact that the CMD pandemic has had in this area (Legg, 1999). Yield loss estimates were rated at between 25% and 50% by 79% of farmers in Coast Province and at only 25% by 47% of farmers in Nyanza Province. At the time of the survey, the CMD pandemic had affected only Western Province and losses recorded elsewhere were consequently less. Only 14% of sweetpotato farmers considered SPVD to be a significant source of crop loss, estimating these losses at only 25%.

Managing whiteflies and whitefly-transmitted viruses

Cassava and sweetpotato producers reported a number of management tactics, including selection of disease-free planting material, roguing of diseased plants and use of insecticides. In extreme cases, heavily infested crops were simply abandoned. The most widely used practices, however, were roguing and selection. Just over one third (38%) of cassava farmers used roguing, with 28% of farmers considering that this practice would reduce CMD incidence, 6% that it would prevent the spread of CMD and 2% that it would reduce the number of poorly growing plants. Among sweetpotato farmers, 30% used roguing, 18% believing that it would reduce SPVD incidence and 8% believing that it would prevent spread of the disease. Both cassava and sweetpotato farmers rogued infected plants before the crop was 4 months old. Selection of clean planting material, based on the absence of disease symptoms, was used as a disease management tactic by 32% of cassava farmers and 12% of sweetpotato farmers. However, even those farmers who used roguing and selection of clean cuttings considered these measures to be only partially effective in controlling the diseases.

Only one cassava farmer and none of the sweetpotato farmers mentioned chemical control as a control method. The cassava farmer used the organophosphate insecticide dimethoate, applied it more than 10 times and sprayed when whiteflies and damage were observed in the field. Few farmers reported abandoning the production of cassava (12%) or sweetpotato (2%) but many reported occasional shortage of clean planting material. None of the farmers grew improved varieties, although 42% of cassava farmers and 20% of sweetpotato farmers noted differences in response to CMD and SPVD between varieties. However, most farmers who noted differences between varieties had no idea what caused the differences. Only 4% of cassava farmers and 2% of sweetpotato farmers considered the differences to be the result of differences in levels of resistance to disease. Very few cassava (10%) and sweetpotato (4%) farmers had received any technical assistance in the management of whiteflies and whitefly-transmitted viruses on their crops. However, more than 30% of farmers of each crop were willing to monitor whitefly and disease problems if it would help in the management of either CMD or SPVD.

Conclusions

Farmers noted that CMD and SPVD are becoming increasingly important constraints to cassava and sweetpotato production in the country. Some farmers were attempting to control the diseases, mainly using roguing and selection, initiatives that in general they considered to be developed from their own knowledge. However, farmers recognized the methods employed in controlling the two diseases as being only partially effective. During this survey in 1998, no farmer reported using resistant varieties. The limited understanding that farmers demonstrated of the causes and effects of CMD and SPVD, coupled with their reliance on their "own" control methods, suggests weaknesses in the systems of information flow, both from research through extension to farmers and from farmers back to research.

During the survey conducted in this study, the impact of the pandemic of severe CMD has been captured both through the description of the unusually high incidence and severity of the disease in Western Province and through the estimates of major yield losses provided by farmers interviewed. Considerable experience in tackling this problem has been developed already in neighbouring Uganda (Otim-Nape et al., 1997) with the focus on the deployment of host plant resistance supported by some phytosanitation. In the immediate future, some of this experience clearly needs to be transferred to the situation in western Kenya where the CMD pandemic continues to expand. CMD-resistant germplasm will need to be introduced from Uganda to Kenya and evaluated in participatory trials with farmers, whilst at the same time encouraging the maintenance of the quality of planting material through the use of selection and roguing in multiplication plots. Given the evident shortcomings in the understanding of both CMD and SPVD in Kenya, participatory learning should be a key feature of any future control programs. SPVD is clearly not as acute a problem in Kenya as is CMD. However, the report by farmers that SPVD is becoming more important is a concern and future work should aim therefore at identifying resistant germplasm and evaluating this and possible phytosanitary approaches to SPVD control through participatory research with farmers.

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