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Citrus Virus and Virus-Like Diseases in Mozambique

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ABSTRACT. Many citrus varieties growing in an experimental field near the Agricultural Station of Umbeluzi in Mozambique were evaluated on the basis of symptoms for the presence of virus and virus-like diseases. In addition, diagnosis of citrus tristeza virus (CTV) by ELISA and of viroids by PAGE and biological indexing was carried out. Microscopic observations and zinc analysis of trunk wood were used for blight detection. Many trees were affected by citrus exocortis and other viroids, CTV stem pitting (SP-CTV), citrus psorosis virus and concave gum. Histological observations of wood collected from blighted trees revealed filamentous occlusions and amorphous plugs in the xylem, and high concentrations of zinc in the outer trunk wood were also found. No evidence of greening nor citrus psyllas was found.

Mozambique is situated on the coast of eastern Africa, and shares common borders with South Africa and Swaziland to the south, Zimbabwe, Zambia and Malawi to the west and Tanzania to the north. Its coastline extends for more than 2,000 km on the Indian Ocean. The climate is principally humid tropical in the northern and coastal zones, and dry tropical in southern and interior regions. In several inland areas the climate is modified by high altitude and is almost temperate.

In spite of the small citrus growing area (less than 3,000 ha of oranges, grapefruits, tangerines and lemons) Mozambique exports about 12,000 tons of citrus fruits annually. The harvesting is done between March and September and is therefore favorable for export to Europe. Two thirds of citrus production is near Maputo in the south, while the remainder comes from Manica, in the central region.

Citrus diseases in Mozambique were investigated between 1960 and 1970 (12), but this information is inconsistent and largely unconfirmed.

In a cooperative program with the University Eduardo Mondlane (Maputo), a survey was carried out to assess the presence of citrus diseases in Mozambique and to prepare a project for rehabilitation of its citriculture. This paper deals with the preliminary observation of virus and virus-like diseases in "Estação Agrária de Umbeluzi" (E.A.U.) and "Empresa de Citrinos de Maputo" orchards.

Tristeza. Symptoms of stem pitting caused by citrus tristeza virus (CTV) (10) were present in each susceptible graft combination, differently affecting the scion and/or the rootstock. Almost every grapefruit tree was affected and some sweet orange trees also showed symptoms. However, some trees with mild symptoms were of normal size.

The variability of symptoms might be explained by the diversity of graft combinations and, presumably, virus strains. However it is noteworthy that several graft combinations developed a good size. The growth of Marsh grapefruit grafted on several rootstocks is summarized in Table 1.

In other blocks alemow performed very poorly, showing overgrowth at budunion line and severe pitting in the wood down to the roots.

ELISA tests performed in Italy on seeds and bark tissue confirmed the field diagnosis for CTV (3, 8). The results suggest that tristeza is being spread by aphids, since the orchards were planted with presumably virus-free budwood introduced in 1967 from California. The high efficiency of the vector, *Toxoptera citricidus*, has allowed a near 100% spread of the virus after planting. This situation is limiting the development of citriculture. However, many trees are performing well in spite of the presence of stem pitting and some "dwarfing" rootstocks appear to reduce the symptom severity. The suggested strategies should be to

TABLE 1
TREE SIZE AND SCION STEM PITTING OF MARSH GRAPEFRUIT TREES GRAFTED ON
DIFFERENT ROOTSTOCKS

Rootstock	Size ^z	Circumference (cm) ^y	Stem pitting on scion ^x
Bittersweet orange	L	79	2
Cleopatra mandarin	L	70	2
Ridge Pineapple sweet orange	L	75	1
Orlando tangelo	L	75	1
Sampson tangelo	L	76	2
Imperador tangerine	L	80	2
Natal tangerine	L	72	1.5
Estes rough lemon	M	56	1
Local rough lemon	M	63	1.75
Beauty Tangerine	M	60	1
Rangpur lime	S	67	1
Carrizo citrange	S	51	0.1
Citrumelo	S	41	0.5
Rubidoux trifoliolate	S	40	0.2

^zEvaluated in comparison with "standard" size L = large; M = medium; S = small

^yDetermined 10 cm above the bud union

^xRated from 0 (no stem pitting) to 2 (severe)

evaluate mild strains of CTV for preimmunization, and use of alternative rootstocks to prevent rapid decline of the trees.

Citrus viroid infection. Several trees of Washington navel, Valencia orange, and Eureka lemon grafted on trifoliolate orange and Rangpur lime showed symptoms of exocortis. Sister plants grafted on trifoliolate orange hybrids showed slightly reduced growth, probably as a consequence of infection. Results of PAGE tests carried out on samples of young bark of Washington navel, Valencia late orange, Eureka lemon and Mexican lime revealed the presence of citrus exocortis viroid (CEVd). Other viroids were found in most of the samples, either alone or associated in different combinations (7).

The occurrence of exocortis might restrict the use of several rootstocks such as trifoliolate orange and its hybrids, unless healthy propagative material is provided. However, the opportunity to utilize propagative materials previously inoculated with well-characterized dwarfing strains of viroids might be possible, considering the experience of other countries (4, 6, 13). In this respect, the biological and biochemical characterization of viroids

infecting citrus in Mozambique is required.

Blight. Symptoms resembling blight (2) were noted in some orchards. The affected trees of sweet orange on rough lemon showed dieback, partial defoliation, lack of new growth flushes, zinc deficiency-like symptoms on the leaves and scattered distribution in the field. The occurrence of citrus blight in neighbouring South Africa and Swaziland (9) suggested the possibility of blight. Water uptake attempts were negative probably because of the poor cultivation and inappropriate season (July). Light and scanning electron microscopy tests (1) were performed on samples of trunk wood detached at a depth of 2 cm from the cambium and 5 cm above the bud union. Unstained sections revealed in some samples a relatively large number of amorphous plugs, naturally appearing yellow or amber in colour and located over the length of vessel lumens or only at the junction of xylem vessels. The brown fibrous plugs were also noted (Figs. 1 and 2). Scanning electron microscopy (Figs. 3 and 4) detected the typical compact amorphous plugs and branching and elongated filamentous plugs along the vessel walls (5). Wood samples from symptomatic plants contained a

Fig. 1-4. Light micrographs of unstained wood tissue containing amorphous (a) and fibrous (f) plugs in transversal (Fig. 1: bar = 100 μm) and longitudinal sections (Fig. 2: bar 100 = μm). Scanning electron microscopy of wood tissue containing amorphous (Fig. 3: bar = 50 μm) and filamentous (Fig. 4: bar = 50 μm) plugs of xylem vessels.

higher content of zinc (15.2 ppm) in comparison to the normal looking plants (4.3 ppm), (Table 2) thus confirming the presence of blight.

Psorosis. Psorosis bark scaling symptoms were widely present on Washington navel orange in both E.A.U. and Empresa de Citrinos, and on Marsh grapefruit, mandarin and local orange cultivars in the E.A.U..

TABLE 2
ZINC CONTENT IN WOOD SAMPLES OF
SWEET ORANGE TREES GRAFTED ON
ROUGH LEMON

Trees	Zinc content (ppm)	
	individual	mean
Healthy looking		
1	2.8	
3	4.1	
4	7.2	4.3
Symptomatic		
1	15.7	
2	14.0	
3	11.4	
4	12.4	
5	20.6	
6	18.0	15.2

Psorosis was widespread in most citrus areas since symptoms were observed in 30-yr-old Washington navel orange trees, which were previously used as bud sources.

Concave gum. Symptoms of concave gum were observed on Marsh grapefruit, Washington navel orange, local orange cultivars and mandarins. Trees on trifoliate orange often also had exocortis symptoms. This is the first report of concave gum in southern Africa.

Greening. Symptoms of greening (leaf mottling) (14) were not observed, despite the fact that the disease has been reported in other states around Mozambique, namely South Africa, Swaziland, Madagascar and the Reunion Islands (9, 11). Evidence of *Trioza erytreae*, the vector of greening in South Africa and Swaziland was not found. The climate in southern Mozambique is unsuitable for both greening and the vector, but the cooler Manica region could be vulnerable. *Diaphorina citri*, the vector of Asian greening, has not been reported in Mozambique.

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