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Authors

Jacomino, A. P.
Salibe, A. A.

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Occurrence of Woody Gall Disease in Citrus in São Paulo State, Brazil

Angelo P. Jacomino and Ary A. Salibe

ABSTRACT. Citrus trees budded on Volkamer lemon in commercial orchards in São Paulo State were found showing woody galls on the rootstock. Biological indexing of these trees using Florida rough lemon indicator plants revealed that the problem was infectious, and probably caused by citrus vein enation virus (CVEV). Uncontrolled budwood importations from other countries known to have the virus, such as Peru, the United States, Japan and Spain, would explain the source of the disease in Brazil. Indexing for CVEV in 75 accessions from commercial orchards and research centers indicated that the virus was present in 32 of them, suggesting that the virus could be widespread in São Paulo State.

Citrus vein enation disease was first described in California, USA where it was shown to be caused by a virus (12, 13). Woody gall disease was described on rough lemon in Australia (4). Wallace and Drake (13) infected young trees of Mexican lime and rough lemon with citrus vein enation virus and demonstrated that both diseases were caused by the same virus, now called citrus vein enation virus (CVEV) (3). This disease has also been reported to occur in South Africa (8), Peru (2), Japan (11) and Spain (9).

Losses caused by this disease are generally low, except in Peru, where rough lemon is widely used as a rootstock and the environmental conditions seem to enhance gall development (2). If galls appear in adult plants, they usually continue to produce fruits normally for 8-10 yr or more, despite extensive gall development on the rootstock. However, if young plants are infected in the nursery, resulting in early and severe gall development, they may grow into weak and unproductive trees (2, 9, 15).

The virus can be transmitted by grafting (5, 12) and the aphids *Myzus persicae* Sulz. (12), *Toxoptera citricidus* Kirk. (7, 8) and *Aphis gossypii* Glover (6).

Mexican lime and sour orange are good indicators for vein enation (10), while woody galls are more frequently found on rough lemon, Volkamer lemon, Mexican lime and Rangpur lime (15).

Wallace and Drake (14) reported that the galls resulted of a combination of the virus action and the plant tissue wounding.

In 1989, lemon trees budded on Volkamer lemon in commercial orchards of São Paulo State, Brazil, were found showing woody galls in the rootstock. The symptoms were very similar to those caused by CVEV.

The objectives of this work were to study the cause and distribution of this disease in the citrus growing areas of São Paulo State.

MATERIALS AND METHODS

Twelve different citrus varieties (Table 1) were used to index the trees with galls. They were grafted on Rangpur lime seedlings in the nursery and were inoculated thirty days after grafting with tissue from lemon trees grafted on Volkamer lemon from commercial orchards showing woody galls on the rootstock. Each indicator plant was inoculated with three grafts. Non-inoculated plants were used as negative controls.

In order to determine whether CVEV was present in germplasm material, young plants of Florida rough lemon budded on Rangpur lime were used as indicators in the nursery. Tissue was collected from both commercial orchards and mother blocks of the Official Centers in São Paulo State. In total, 75 introductions from nine sources and 40 different species and

TABLE 1
INDICATOR PLANTS USED, TOTAL NUMBER OF PLANTS INOCULATED AND NUMBER OF PLANTS SHOWING WOODY GALLS, FOR INDEXING WOODY GALL AFFECTED TREES IN SÃO PAULO STATE, BRAZIL

INDICATOR PLANTS	Total no. of plants inoculated	No. of plants showing woody galls
Volkamer lemon.....	5	1
Rough lemon.....	18	7
Royal lemon.....	3	0
Rangpur lime.....	6	0
Mexican lime.....	7	0
Tahiti lime.....	3	0
Palestine Sweet lime.....	5	0
Do Céu orange.....	4	0
Etrog citron.....	5	0
Dweet tangor.....	4	0
Carrizo citrange.....	7	0
Orlando tangelo.....	4	0

cultivars of citrus were collected. Each sample was inoculated on three indicator plants, using three tissue grafts. Non-inoculated plants were used as negative controls.

All plants were artificially wounded with small needle punctures at different sites to stimulate gall formation. Aphid control was achieved by spraying each eight days with insecticide.

Fig. 1. A) Test plants of Florida Rough lemon budded on Rangpur lime infected with citrus vein enation virus, showing woody galls near inoculation site. B) Woody gall development at a distance from the inoculation site.

Inoculated and control plants were observed periodically for gall development for two years.

RESULTS AND DISCUSSION

The results of the indexing of the woody gall affected trees are shown in Table 1. Although Volkamer lemon was the first indicator to develop galls nine months after inoculation, rough lemon seemed to be the best indicator for woody galls, since a greater proportion of the inoculated plants developed symptoms.

In spite of not showing woody galls, Orlando tangelo showed psorosis symptoms in the leaves and later developed spoon-like leaves, oversprouting and death of apical buds. Spoon-like leaves were related by Navarro (9) as a symptom caused by CVEV. No symptoms were found on negative control plants, suggesting that insect transmission of the virus in the experimental site had not occurred.

The results of indexing germplasm material showed that 32 of the 75 introductions were infected with CVEV. All nine sources had infected trees, and 17 of the 40 citrus varieties had CVEV. The galls appeared on the rough lemon stems both near the site of inoculation and up to 80 cm above it (Fig 1). No

symptoms were found on negative control plants. No vein enation symptoms were found in inoculated and control plants for both experiments.

Because CVEV infects many hosts without inducing symptoms (15), the virus can remain undetected in a region or country for many years. In Brazil, the majority of cultivars were introduced from countries where CVEV is endemic such as the United States, Australia, Peru, Japan and Spain. However, sensitive rootstocks as Volkamer and rough lemons are not frequently used in Brazil.

The results of this study show that the galls on the Volkamer lemon rootstocks are caused by a graft-transmissible pathogen. This pathogen citrus vein enation virus (CVEV), is present in many trees in the germplasm of São Paulo State. Indexing of mother trees for this virus is essential, especially if sensitive rootstocks are used.

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