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CITRUS VARIEGATED CHLOROSIS

Observations on Citrus Variegated Chlorosis in Brazil

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ABSTRACT. Citrus variegated chlorosis (CVC) is widespread in São Paulo and Minas Gerais States in Brazil. Observations were made in Rio Preto, in the north of São Paulo State in 1991 and 1992, on the effect of tree age, scion and rootstock variety, and season on symptom expression of CVC. Symptoms are more severe in early fall, which coincides with arrested development of fruit on CVC-infected limbs. The trees are more susceptible when they are 2-to-8 yr-old, although nursery plants can also be affected. On older trees, CVC symptoms commonly occur in a sectorized pattern with little spread into adjacent limbs. An antiserum produced to the xylem-inhabiting bacterium, *Xylella fastidiosa*, cultured from CVC-affected trees, reacted positively in DIBA with extracts from CVC-infected trees of the major orange varieties grown in Brazil, including Pera, Natal, Valencia, Hamlin, and Bahia-Navel. Symptoms of CVC were not observed on Murcott mandarin and Tahiti lime. A Rangpur lime rootstock sprout from a CVC-affected tree did not react in DIBA even though the Pera orange scion reacted positively.

Index words. *Xylella fastidiosa*, symptoms, varieties, rootstock, season.

Citrus variegated chlorosis (CVC), a new citrus disease, has been observed since 1987 in São Paulo and Minas Gerais States, Brazil (3,7). In the 5 yr since the disease was first discovered, it has spread rapidly in nurseries and commercial groves. The disease is characterized by zinc deficiency symptoms. Chlorosis usually occurs on older leaves but may begin on younger leaves as they mature. In newly affected trees, symptoms may affect only a tree sector, whereas trees which have been affected for a period of time show variegated chlorosis throughout the canopy. As the leaves mature, small light-brown, gummy lesions appear on the leaf underside corresponding to the chlorotic areas on the upperside. The lesions on the leaf underside of the leaves may become dark brown or even necrotic and they are somewhat raised, apparently due to gum formation. Fruit ripens early on CVC-affected trees and they have a high sugar content, but they are unmarketable because of their hard rind and small size. While the total fruit set on CVC-affected trees is higher than normal the first year, the number of fruits in subsequent years is low (3).

A gram-negative xylem-limited bacteria, with morphological and structural characteristics of *X. fastidiosa* (5), has been associated with CVC by electron microscopy, culture, and using serological assays (1,2,4,7).

In this paper, we report additional observations on the effect of tree age, scion, rootstock season on symptom expression of CVC affected trees.

MATERIALS AND METHODS

This study was conducted in Rio Preto, north of São Paulo State, where CVC has a high incidence. Plants from 1 to 10 yr old were observed for over 2 yr (1991 and 1992). The symptoms on leaves, branches, fruits, and the whole trees were observed in each season.

The major orange scion varieties used in Brazil - Pera, Natal, Valencia, Hamlin, and Bahia-Navel on Rangpur lime, Cleopatra mandarin, and Volkamer lemon rootstocks were evaluated. Also, Murcott mandarin, Tahiti lime, and Rangpur lime rootstock sprouts from a CVC-affected tree were included in this survey.

The evaluations were made by visual observation for typical symptoms

and dot immunobinding assay (DIBA) using polyclonal antisera prepared against the *X. fastidiosa* cultured from CVC-affected tissue (1,4).

RESULTS AND DISCUSSION

Varieties. Symptoms and positive reaction in DIBA were found in the following varieties: Pera, Natal, Valencia, Hamlin, and Bahia-Navel on Rangpur lime, Cleopatra mandarin, and Volkamer lemon rootstocks. No CVC symptoms and negative results in DIBA were obtained for Tahiti lime, even when planted close to a CVC-affected orchard, and in Rangpur lime sprouts growing from Pera orange budded trees which were positive for CVC in DIBA. A Murcott mandarin on Rangpur lime reacted positively in DIBA, but no symptoms were observed, suggesting that variety is symptomless.

Age of tree. Symptoms of CVC are more severe on trees from 1 to 8 yr old, although nursery plants can be affected. On trees older than 8-10 yr old, usually only some branches are affected, and fruit symptoms are seen on affected limbs. On trees more than 10 yr old, symptoms are commonly seen on a few leaves, and it is unusual to find small fruits. When a young tree is affected by CVC, the symptoms become systemic, production is reduced, and small fruit are found all over the tree. Thus 2 yr after becoming CVC affected, the tree becomes economically worthless.

Seasonal variation of symptoms. Symptoms of CVC are more severe in autumn and winter. In early spring, young leaves begin to show symptoms of zinc deficiency. As the leaves mature in late spring and summer, dark brown spots are observed on the underside. In late winter, leaf drop and dieback are observed. Fruits on affected trees appear to develop normally until late summer. In the fall, they stop growing and ripen prematurely. At the end of the growing season in late fall, fruit

drop is observed and the fruits remaining on the trees are hardened and infected with secondary fungi. Fruits on diseased trees are small, averaging only 77 g, equivalent 500 fruits per Brazilian box (40 kg), whereas normal fruits averages 203 g or 200 fruit per box.

The symptoms of CVC are more severe under conditions of high temperature and drought. In areas where the average temperature during the year is high and long periods of drought occur, some entire groves have become uneconomical due to CVC and have been removed.

Presently CVC is a serious problem in Brazil. Based on the severity of symptoms on trees less than 10 yr old, the high rate of spread, and the wide distribution among citrus growing areas of Brazil, the disease is certainly cause for concern. Since it appears to be a new disease, its impact on the citrus industry in Brazil and worldwide cannot be accurately predicted with accuracy. But, it should be pointed out that diseases caused by *X. fastidiosa* on other crops have proven difficult to manage, short of having resistant varieties. *X. fastidiosa* seems an adaptable plant pathogen, it is readily transmitted by aerial vectors-sharshooters (5), and budding and may reside in numerous alternate hosts, often as latent infections. The wide distribution and rapid spread of CVC in Brazil suggest it is being transmitted by an aerial vector and through budwood. There is no information at this time on non-citrus hosts for the CVC-associated bacterium. In view of its potential threat in Brazil and other citrus growing areas, additional research on CVC is a high priority.

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