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Citrus Diseases Exotic to Florida: Citrus Variegated Chlorosis (CVC)[1]

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Citrus is susceptible to a large number of diseases caused by plant pathogens. Economic losses due to plant diseases can be severe, but fortunately, not all pathogens attacking citrus worldwide are present in Florida. Citrus diseases of economic importance that are currently present in Florida include tristeza, blight, greasy spot, Alternaria brown spot, Phytophthora-induced diseases, melanose, scab, citrus canker, and postbloom fruit drop (PFD). Eradication of citrus canker and greening is ongoing in Florida. There are several serious pathogens that have not been introduced into Florida. Any exotic disease, if introduced, has the potential to significantly increase production costs and thus decrease profitability for Florida growers. The background information for each exotic citrus disease will be presented in a series of fact sheets to provide a basis for evaluating exotic pathogens that may pose potential risks to Florida citrus and to create a decision-making framework to prevent their introduction and spread. This paper will discuss a disease caused by a xylem inhibiting bacterium, Citrus Variegated Chlorosis (CVC).

Why Are We Concerned About CVC?

CVC first appeared in Brazil in 1987 and has rapidly become one of the most economically important diseases affecting sweet orange production in Brazil. CVC has become widespread in most major citrus growing areas through movement of infected nursery stock due to lack of certification programs and high CVC infection rates in Brazil. Losses due to CVC are now estimated to exceed several million dollars per year in Brazil. CVC also has been reported in Argentina and Paraguay, but has not been found outside of South America. The causal agent of CVC is vectored by sharpshooter leafhoppers (Figure 1). Sharpshooters feed on plant xylem (Xylem conducts water within the plant) and acquire the CVC causal agent during feeding, and then spread the pathogen when they move and feed on a new plant. Some of these sharpshooters are already established in Florida. Citrus cultivars grown in Florida are all susceptible to CVC. Climatic conditions in Florida are favorable for the occurrence and establishment of the disease. It appears that if introduced, CVC has the potential to

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become a significant problem for Florida citrus production.

Figure 1. The sharpshooter leafhoppers that transmit Citrus Variegated Chlorosis (CVC).

The Causal Agent of CVC

CVC is caused by the xylem-inhabiting bacterium *Xylella fastidiosa* (Figure 2). Similar strains of *X. fastidiosa* cause Pierce's disease of grape, phony peach, and leaf scorch diseases of almond, coffee, oak, plum and sycamore. These strains can be distinguished by host range and other physiological characteristics. The exact origin of the CVC pathogen is unknown, but it could likely have been transmitted into citrus from another host by sharpshooter vectors and from that point has continued to spread by propagation and insect vectors. Studies have shown that the CVC strain is apparently closely related to the bacterium causing coffee leaf scorch, and inoculation of coffee with the CVC bacterium causes coffee leaf scorch symptoms. The CVC pathogen has been the subject of intensive research in Brazil and its genome has recently been completely sequenced. Identification of the bacterial genes associated with CVC pathogenicity will help characterize relationships among different *X. fastidiosa* strains.

What Cultivars Are Affected?

Nearly all cultivars of sweet orange are susceptible to infection by CVC, but the severity of symptoms may be variable. Lemons, limes, mandarins, mandarin hybrids (including Murcott and Sunburst), kumquats, trifoliate orange and grapefruit show less severe symptoms. Rangpur lime, citron and pummelo are tolerant to CVC. CVC does not kill trees, but trees become less productive within a few years following infection.

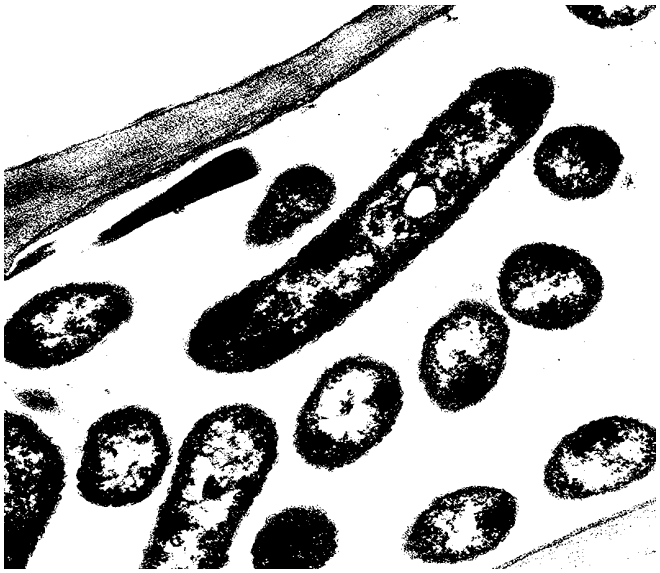

Figure 2. *Xylella fastidiosa* bacterium, causing Citrus Variegated Chlorosis (CVC).

What Are the Typical Symptoms Caused by CVC?

When young trees are infected, CVC causes severe leaf chlorosis between veins (Figure 3), resembling nutritional deficiencies. Leaves on affected trees frequently have brown gummy lesions on the lower side corresponding to yellow areas on the upper leaf surface. Affected trees may exhibit reduced vigor and growth, and show abnormal flowering and fruit set. Affected fruits are often small and hard with high acids, which are not suitable for juice processing or fresh market. As with other *Xylella*-induced diseases, symptoms are most pronounced in older tissues. Symptoms may appear initially on only one limb or branch and then spread to the whole tree. If the affected limb is pruned out, the remaining part of the canopy may remain symptomless for some time. In Brazil, if 30% of trees in a grove are infected, the recommendation is to remove the entire grove.

How is CVC Transmitted?

CVC can be graft-transmitted or vectored by sharpshooters. At least 11 species of sharpshooters are known to vector CVC in Brazil. Two

Figure 3. Leaf chlorosis between veins caused by Citrus Variegated Chlorosis (CVC).

sharpshooter species common in Florida have been shown to be capable of transmitting CVC under experimental conditions. Recently, transmission of CVC through citrus seed from infected trees has been reported. In Brazil, spread of CVC incidence was primarily due to the movement of infected nursery stock into many new locations. Tree-to-tree spread, resulting in clumped patterns of new infections, was due to limited sharpshooter movement within citrus plantings. Symptom severity and disease incidence is greatest in the warmer citrus growing areas in Brazil. Despite the fact that sharpshooters can feed on various plants, the role of non-citrus hosts as a pathogen reservoir remains unknown.

How to Detect CVC in the Field?

Field diagnosis of CVC is difficult, since symptoms caused by CVC are variable and can be confused with other health conditions (diseases, nutritional deficiencies). However, the causal bacterium can be identified by light and electron microscopy and can be cultured on appropriate media. Serological tests are available for rapid diagnosis. Molecular assays based on DNA hybridization or PCR approaches also are available. Since a number of *Xylella* diseases already exist in Florida, and the Pierce's disease agent has been isolated from citrus in Florida and California, molecular methods that specifically distinguish CVC from other *Xylella* strains will be useful.

How to Control CVC?

There is no effective method to cure CVC. It is important to keep it out of Florida and to be able to quickly detect any infections that may occur. Budwood certification and exclusion are the primary strategies to prevent the introduction of CVC to new areas that are not yet affected. In Brazil, control strategies to manage CVC include nursery certification, protection of nursery stock from infection, and pruning of symptomatic parts of trees to remove inoculum sources (labor intensive and time consuming). Control of sharpshooters is very difficult. Long term approaches involve the identification and development of CVC resistant sweet orange cultivars.

What Can Growers Do?

CVC primarily affects sweet oranges. Given that the climatic conditions are highly suited for establishment of the pathogen, CVC is predicted to have significant economic impacts on citrus production if found in Florida. Preventing CVC from entering Florida is much easier than trying to eradicate or control it. It is important to avoid bringing propagation materials from CVC-infected areas into Florida. Any citrus propagating materials **must** be introduced through the Florida Department of Agriculture and Consumer Services, Division of Plant Industry.

A major question is the origin of CVC and if there are non-citrus hosts. Since *Xylella* strains affect other crops that are common in Florida, there may be a possibility that a CVC-like agent could be present in the U. S. More research is warranted to determine the host range of CVC and the differentiation of *Xylella* strains from various hosts.

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