



Photo by Lyfe Buss

Figure 2. Brown citrus aphids are vectors of citrus tristeza virus.

An important reminder on citrus tristeza virus

By Amit Levy and Ozgur Batuman

Citrus tristeza virus (CTV) is an important citrus pathogen that, in the past, had a dramatic effect on the citrus industry and caused the loss of almost 100 million trees worldwide. These trees were propagated on sour orange rootstock. The disease created a need for tristeza-tolerant rootstocks to sustain the citrus industry, because only trees on sour orange rootstock are affected by tristeza decline.

Tristeza decline has been avoided in Florida by transitioning the citrus industry to alternative tolerant rootstocks, such as Carrizo and Swingle. However, many trees on these tolerant rootstocks are infected with CTV decline isolates but show no symptoms. Recently, due to huanglongbing (HLB, citrus greening), some growers have made a decision to switch back to sour orange rootstocks.

These growers are assuming that since plants will be infected with HLB anyway, they should not worry whether trees will be infected by CTV decline, and that the Asian citrus psyllid spray program eradicates the vector that transmits CTV. However, these assumptions are not proven, and a re-emergence of tristeza decline in Florida is possible. The purpose of this article is to remind growers that CTV is still in Florida groves, and it should not be overlooked or ignored.

CTV BACKGROUND

CTV is a member of the complex virus family *Closteroviridae*. CTV infects almost all citrus varieties, but it causes different disease symptoms on citrus

plants depending on the virus isolate, the citrus variety and the scion-rootstock combination.

Florida has two dominant strains of CTV: T36, a decline-causing strain, and T30, which normally does not cause decline. Decline is caused when specific isolates of CTV infect trees on sensitive rootstocks, mainly sour orange.

Decline is initiated by phloem necrosis below the bud union, which reduces the flow of sugars to the roots. This results in loss of feeder roots that cannot uptake the necessary amounts of water and nutrients. Affected trees show defoliation and mineral deficiency symptoms and can die quickly during periods requiring rapid water uptake.

The aggressive decline is more pronounced in mature trees, whereas newly planted sensitive trees infected with CTV decline strains usually will be stunted and poorly developed. The main route of CTV transmission into new areas is propagation of virus-infected buds. Local spread is mediated mainly by aphid vector transmission. CTV is transmitted by four aphid species. The brown citrus aphid (*Toxoptera citricida*) is the most efficient vector. Chemical control of the aphid

populations is difficult and usually will not eliminate CTV spread.

During the 1970s, sour orange was the dominant rootstock in Florida because of its excellent horticultural characteristics, including productivity and resistance to diseases such as blight. The extensive spread of CTV decline and the introduction of *T. citricida* in Florida around the 1980s led growers to turn slowly away from the use of sour orange. Swingle citrumelo became the most popular rootstock, due to its tolerance to both blight and CTV decline.

Today, following the establishment of HLB in Florida, there has been an increased interest in the use of sour orange rootstock by growers, especially for grapefruit production due to its high-quality fruit attributes. Many growers, faced with two non-optimal options, decided to utilize the advantages of the sour orange rootstock to get good tree growth and high-quality fruit, until HLB eventually kills the tree. Growers have been assuming that the intense use of insecticides to control HLB-transmitting psyllids will also have a dramatic effect on *T. citricida* levels, and therefore CTV will not spread. Here, we would like to carefully question this dangerous assumption.

CTV IS STILL IN FLORIDA

We have conducted surveys to study the presence of viruses, including CTV, in Florida, using both plant and psyllid

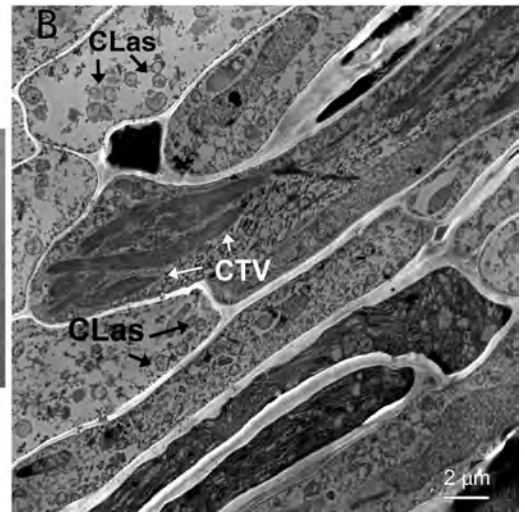
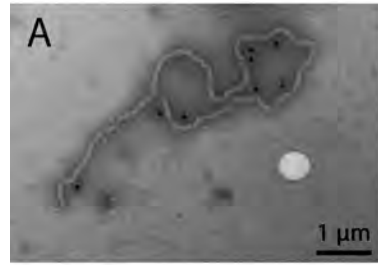


Figure 1. A: The citrus tristeza virus (CTV) was found in psyllids and verified using CTV-specific antibodies fused to gold particles (little black dots). B: CTV and *Candidatus Liberibacter asiaticus* are present in adjacent cells of this grapefruit phloem.

samples. Psyllids were collected from over 20 counties, including Collier, Lee, Hendry, Glades, Charlotte, Sarasota, DeSoto, Highlands, Manatee, Polk, Pasco, Hernando, Lake, Seminole, Orange, Osceola, Indian River, Okeechobee, Saint Lucie and Martin in 2017–2019. Remarkably, we found CTV in each psyllid sample that we analyzed. We isolated the viruses from the collected psyllids and used antibodies to verify CTV presence (Figure 1A).

Psyllids cannot transmit CTV to other citrus trees but acquire the virus in the gut when feeding on CTV-infected trees. These results mean that all the psyllids we tested from counties

across Florida must have fed on trees with CTV infection. We also conducted surveys to detect CTV in the groves, and we found the decline isolate of CTV in scions propagated on sour orange rootstock.

CTV AND HLB

In laboratory analysis, we were able to see mixed infection of CTV and the causal agent of HLB, *Candidatus Liberibacter asiaticus* (CLas), in the same sample and even in the same tissues (Figure 1B). These results demonstrate that CTV is still present in Florida, and therefore could pose a serious threat if it continues to spread to scions on sour orange rootstock.

Unfortunately, we are still missing good scientific data about the consequences of mixed infection by CTV and CLas. Mixed infection by both pathogens may increase phloem defense responses and result in increased symptom (disease) severity, but this is not known yet. However, we speculate that, since the symptoms of young plants infected by either CTV or CLas are similar, it may be very difficult for growers to know if one or the other affects their trees. This can result in the uncontrolled spread of CTV, mistaken for HLB.

APHID POPULATIONS ARE DYNAMIC

All aphids are capable of periodic outbreaks when conditions are right. Brown citrus aphids (Figure 2, page 8), the most dangerous vectors of CTV,

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are no exception. All individuals are females that are born pregnant, with the next generation of embryos already developing inside them. As soon as the insects mature, they begin to give birth to more aphids (with embryos for yet another generation!).

The life cycle takes about a week under Florida conditions. As colonies get crowded, or the tender growth where the aphids live hardens off, the next generation of aphids develops wings. Winged individuals can establish new colonies across the grove.

Usually, there are plenty of natural enemies and environmental factors that eliminate most of the aphids. However, under ideal conditions, large numbers of aphids can develop quickly. In the late summer and early fall of 2013, for example, the area around Immokalee saw high numbers of brown citrus aphids.

Other vector species, although not as efficient, also experience similar boom and bust cycles. Thus, it is not possible to know if or when conditions will be ideal for spread of CTV. Severe outbreaks might be rare, but they can occur at any time when conditions are favorable.

CONCLUSION

In conclusion, growers should be aware that CTV is still present and widespread in Florida, and that the virus can be transmitted to new plants, especially during aphid outbreaks. Therefore, switching to sour orange rootstock always includes the risk of citrus tristeza decline infection and tree losses. We still recommend avoiding sour orange rootstock when possible and continuing to monitor and control vector populations in citrus groves regardless of rootstocks being used.

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Amit Levy and Ozgur Batuman are University of Florida Institute of Food and Agricultural Sciences assistant professors at the Citrus Research and Education Center and the Southwest Florida Research and Education Center, respectively.

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