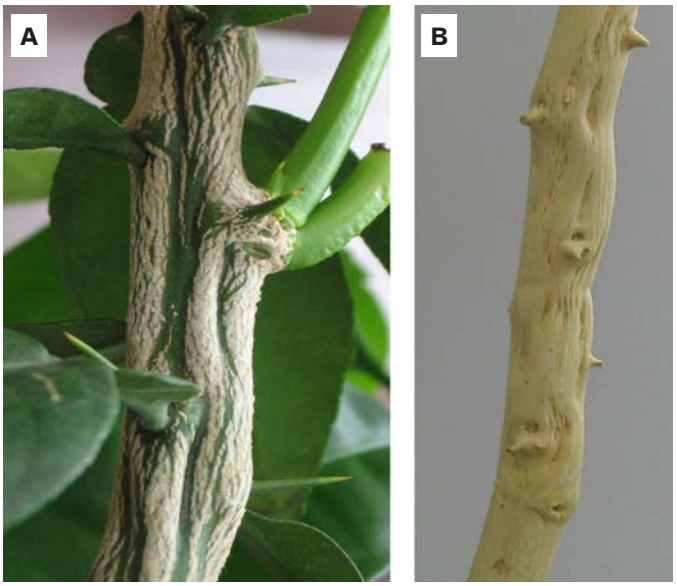

Photos by Cecile Robertson

Figure 1. Stem pitting symptoms on Duncan grapefruit show ropy appearance of the stem (A) and pits in the wood (B).

Stem pitting disease caused by citrus tristeza virus

By Amit Levy, Peggy Sieburth and Ozgur Batuman

When we hear or read about citrus tristeza virus (CTV), we usually think about the decline of sweet orange or grapefruit trees on sour orange rootstocks. However, there are other diseases caused by different isolates of the virus. One of these diseases is stem pitting, mostly caused by the VT isolate of CTV.

Stem-pitting CTV can be very serious, especially on citrus types and varieties that are grown in Florida. It also causes severe disease symptoms in Asia, Australia, South Africa, Brazil and Colombia. Once a tree is infected with stem pitting, the long-term economic effects on the grower might be even worse than the effects from decline isolates of CTV.

VT isolates that induce mild to moderate stem pitting in grapefruit and sweet orange have been reported in Florida and are still present today. Fortunately, CTV isolates that cause severe stem pitting have not been detected in Florida yet.

Stem pitting is caused when CTV alters physiology of vascular tissues (i.e., xylem and phloem, by which water and nutrients are conducted throughout the plant). The xylem is penetrated by a needle-like ingrowth of the bark tissue, causing pits in the wood of the stem and branches and corresponding peaks or pegs in the bark (Figure 1). These symptoms are best observed by removing the bark.

Mild cases show no effect on plant vigor. Once the bark is removed from infected plants, only a few scattered pits can be seen. However, more severe cases will cause extensive pitting in the trunk and branches that is often not noticeable until the bark is peeled. Extremely severe cases cause extensive disruption in the normal differentiation of cambial cells into wood and bark, stunting, small and misshapen fruit, and chlorotic leaves.

COMPLEX DISEASE

Stem pitting is more complex than CTV decline. While CTV decline is caused by one CTV isolate infecting trees grafted onto one specific rootstock (sour orange), different virus isolates can cause stem pitting disease in certain citrus types and various cultivars. Different stem pitting symptoms can also exist within the same citrus type.

Lime, grapefruit, sweet orange, rough lemon and Alemow (*Citrus macrophylla*) are highly susceptible to stem pitting. Mandarins are considered tolerant but may show stem pitting under some conditions. Trifoliate orange and its hybrids carrying the CTV-resistance gene are resistant to stem pitting. Hybrids without the gene may show strong pitting. Some pummelos show selective resistance to a few severe stem pitting isolates but are highly susceptible to others.

There is extensive genetic diversity among isolates of CTV from the virus side, resulting in variations on which citrus types and varieties are susceptible. Decline isolates do not always cause stem pitting, and some stem pitting isolates do not cause decline. The specific regions of the virus genome that are associated with the induction of stem pitting were recently identified by the Dawson group at the University of Florida (UF). At least three different regions in the virus control the development of pits in the infected plants. The group's work showed that specific interactions between these regions are the key to disease initiation, making an already complex situation even more complicated.

TRANSMISSION AND PRESENCE

Stem pitting is transmitted by several species of aphids, especially the brown citrus aphid (*Toxoptera citricida*). Transmission of the disease can also take place by budding and grafting. A mandatory Citrus Nursery Stock Certification Program in Florida was initiated in 1997 to prevent this.

VT is a major isolate known for causing stem pitting and decline in Asia and the Mediterranean countries. Previous surveys all detected the presence of the CTV VT isolate in Florida. Interestingly, there was a big increase in the prevalence of the VT isolate in Florida between 1995 and 2005. This increase took place right when the brown citrus aphid population was established in Florida, which suggests that the spread of stem pitting follows the behavior of the aphids. Indeed, between 2005 and 2014 the relative abundance of VT isolates decreased. This can be explained by the arrival of greening, which led to aggressive

Figure 2, A. Psyllid qPCR Results

	Sample	County	Collection Date	CTV
E-505	Psyllid adults	Glades	10/27/2017	T-36, VT
E-506	Psyllid nymphs	Collier	11/1/2017	T-36, VT
E-510	Psyllid adults	Orange	11/20/2020	T-36, VT
E-514	Psyllid adults	Orange	3/9/2018	T-36, VT
E-515	Psyllid adults	Collier	3/13/2020	T-30, T-36, VT

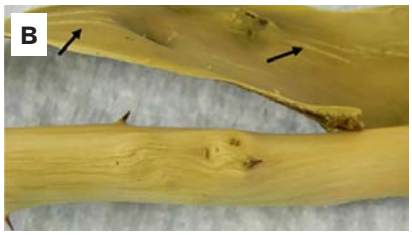

Photo by Danielle Turner

Figure 2. A: Identification of VT isolate (mixed with other CTV isolates) in insect populations from Glades, Collier and Orange counties. **B:** Mild stem pitting symptoms in a VT-positive sweet orange tree from a Polk County grove. Arrows point to ingrowth in the bark.

pesticide sprays that likely limited the movement of the aphid population.

UF researchers conducted additional surveys in Polk County this year and detected the VT isolates in sweet orange and Glen navel trees on a variety of rootstocks. These positive VT trees also exhibited mild stem pitting symptoms in their branches (Figure 2). Psyllid populations were used to quickly screen for VT in additional counties. These insects do not transmit CTV, but they do ingest it while feeding on the phloem of citrus trees. Psyllids are used as a tool to isolate phloem sap and easily screen for CTV.

Researchers found the VT isolate in about a third of the psyllids that were analyzed from Glades, Collier and Orange counties (Figure 2). Importantly, VT was present in a mixed population with other CTV isolates in almost all the trees and psyllids. The presence of mild stem pitting isolates may have some positive outcomes because they could provide some level of natural cross-protection from more severe stem pitting. On the other hand, their existence in viral populations can increase the risk for different isolates to interact and result in a new outcome.

The VT isolate is well established in Florida and could spread, depending mainly on the dynamics of the aphid populations. The presence of mixed populations of CTV strains may result in viral changes. In surveys, researchers have identified trees with high CTV titer that did not test positive for any of the known CTV genotypes, indicating that the CTV population in Florida may be changing. Therefore, it is important to continue studying CTV and its impact in Florida.

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