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Controlling Citrus Tristeza Virus in the San Joaquin Valley of California

Citrus tristeza virus (CTV) is, arguably, the most serious viral disease of citrus worldwide. In southern California, in the 1940s and 1950s, approximately 3 million citrus trees on sour orange rootstock were killed by CTV. Generally, infection by CTV may be symptom less or may be characterized by single or multiple symptoms including stem pitting, tree stunting, stress responses leading to eventual fruit size, quality and yield reduction and/or quick decline leading to tree death. Citrus tristeza virus, like the common cold that plagues humanity, comes in many strains. Some strains are more severe than others. Often a tree will be infected with more than one strain. Certain mild strains of this virus protect against economic damage caused by the infection, or the symptoms, of other more severe strains. A strain that is mild on one variety of citrus may be quite severe on another. The effect on the tree of infection by several strains may be quite different than the effect of any single strain. The severity of the disease also varies by variety and rootstock. CTV-infected grapefruit, mandarins and oranges, which may rapidly decline on sour orange rootstock, are tolerant of most California CTV strains if grown on commonly used citrange, trifoliate or lemon-type rootstocks.

Characteristics of the virus, how it is spread, and factors that affect its severity makes any management plan for this virus difficult and expensive, and no course of action can guarantee an acceptable outcome. Currently, in Kern County and in parts of several other counties in the San Joaquin Valley of California, the disease is managed through tree monitoring for CTV with mandatory removal of infected trees. This program, actively pursued since the mid 1990s, has resulted in a very low CTV infection in Kern County trees. However, this degree of control has come at a price in both fees paid by the growers for tree monitoring, and in costs associated with lost yield and replacing CTV infected trees that are not covered by the existing reimbursement program. How best to manage CTV is a contentious issue within the California citrus industry. Many trees that have been removed were on CTV-tolerant rootstocks and would have continued to produce normal or near-normal yields of high-quality fruit for some time into the future.

Tree monitoring in Kern County is extensive, and eventually, all orchards and most individual trees in each orchard in Kern County will be tested for CTV. This testing not only includes a test for the presence or absence of CTV, but also involves isolating strains that appear to be more severe. Unfortunately, much remains to be discovered about our ability to identify individual strains, especially if several strains infect the same tree, and to determine their potential for future damage. Constant monitoring is important in that, as happened in other citrus-growing areas of the world, new strains appear that may overcome the tolerance to CTV that many of the existing California rootstocks have. Recently, testing in Fresno County showed that a virulent strain of CTV had been illegally imported as budwood into

California from Japan, and this had then been budded onto trees in a large commercial orchard. The CTV testing resulted in the early discovery of this severe strain and removal of the trees before it could spread throughout the industry.

In South Africa, CTV is endemic and no program of enforced tree removal is in effect. South Africa still has a viable citrus industry. Citrus tristeza virus is controlled by means of cross-protection. Trees are cross-protected by deliberately propagating them with infected budwood containing a mild-strain of CTV, which prevents a more harmful, severe strain from infecting or expressing itself in the tree. Cross-protection does result in fruit yield and quality reductions in South African trees, but does allow the industry to continue. Tree longevity, generally, is reduced when cross-protection is required. CTV strain monitoring continues to be a very important part in the South African CTV control strategy. New strains can appear which can overcome existing cross-protection. Research efforts must be maintained to ensure that new cross-protective strains are available when needed. The CTV management program in South Africa remains an expensive program. Since CTV became widespread suppression of the disease through removal of infected trees is currently no longer a viable option for the South Africans.

The virulence of strains also appears to have a geographic component in South Africa in that different cross-protective strains have to be developed for effective control of CTV for different geographical areas. There is speculation that hot temperatures may suppress CTV and virus levels are very low in trees in the San Joaquin Valley during summer. In the trees of the southern coastal areas of California, where CTV is widespread, the virus is readily detectable throughout the year. No mandatory tree removal program exists in the coastal or southern citrus growing of California and a viable citrus industry continues to exist. There is speculation, however, that continued problems with fruit size and other quality parameters in these areas may be related to CTV in many of these older orchards.

If the mandatory infected-tree removal program is eliminated in Kern County, and if severe strains appear with frequency in citrus trees, the California industry will probably have to develop a program similar to that of South Africa to ensure its survival. This program would not only require the level or higher levels of CTV monitoring than that which currently exists, but would, also, require an expensive research component for development and maintenance of effective cross-protective budwood.

Since CTV is not endemic in the San Joaquin Valley of California, removal of CTV-infected trees remains a valid control option. The continuation of the mandatory CTV-infected tree removal program in Kern County is based primarily on the concern that not enough is known about strain severity, or the severity of combinations of CTV strains, too adequately evaluate the risk that a given tree may pose to the industry. Mandatory tree removal is based on the assumption that eventually; 1) severe strains already present in California or which may appear in the future will continue to spread, and 2) that even if new severe strains or combinations of strains do not appear, existing mild strains in trees on tolerant rootstocks will produce smaller yields of less marketable fruit. On-going research work by Louis Whitendale, at the University of California Citrus Research Center in Lindcove California, suggests that even mild strains of CTV adversely affect citrus fruit yield and quality with time. Louis Whitendale has shown that in areas of the San Joaquin Valley where CTV infected trees are no longer removed, rates of CTV infection in orchards are increasing. His early results suggest that recently infected young trees exhibit symptoms of a typical stress response, which include reduced vegetative growth and production of greater yields of poorer quality fruit. Mature trees, which have been infected for a relatively short time (5 years), show similar stress responses. Yields are higher but fruit quality may be reduced. Results from most parts of the world suggest that the longer the tree is infected (including cross-protected trees) the greater is the deleterious effect on fruit yield, quality and size.

An important component of the current CTV eradication program in Kern County is the lack of an efficient vector of CTV. Currently, the principle vector of CTV in California is the cotton aphid (also called melon aphid), *Aphis gossypii.* The cotton aphid is not as efficient at spreading CTV as is the brown citrus aphid (BrCA), *Toxoptera citricida*. In areas of the world where the BrCA exists, the rate of spread of CTV greatly increases. CTV infections increased from less than 5% to greater than 95% in 2 to 5 years in the Dominican Republic after the introduction of BrCA. Unlike the cotton aphid, BrCA can rapidly build to high populations in citrus. Fortunately, the BrCA is not present in California, but did appear recently in Florida. One reason frequently given for lowering our CTV infection rate through tree removal in

California is to lower our inoculum level prior to the expected arrival of the BrCA. However, the more likely scenario is that once the BrCA arrives even a very low rate of CTV will quickly translate to the rapid spread of CTV. Should BrCA arrive in Kern County, the development of a cross-protection strategy may be our only long-term CTV control option.

Currently, a California Department of Food and Agriculture regulated quarantine is in effect preventing importation of trees from certain areas of California, especially the southern coastal areas, into Kern County. Not only does this quarantine protect our area from CTV, but also potentially from other pests, vectors (like BrCA) and diseases that may enter this part of California illegally from other parts of the world. Should the CTV eradication program be abandoned, the associated broad-spectrum umbrella of a protective quarantine program would also end.

As a farm advisor working in Kern County, the CTV eradication effort has made my job easier. As a result of the trouble and expense that growers have endured to clean their groves of CTV, this disease can normally be eliminated early as a causal factor in diagnosing a sick tree. Additionally, the absence of CTV, undoubtedly, reduces the number of farm calls that I have to make related to tree decline. Obviously, the purpose of controlling CTV is not to make my job easier. Citrus growers are the ones who have been paying the high costs associated with controlling this disease and there appears to be no cheap option over the long term. The good news is that the San Joaquin Valley citrus industry has been very effective in keeping CTV under effective economic control since the early 1960s and, with patience, money and effort, I fully expect this trend to continue for the next forty years.

Moving Glassy-Winged Sharpshooters – Who's Left Holding the Bag?

The citrus fruit picking bag has been a prime suspect involved in the spread of glassy-winged sharpshooters (GWSS) in the Central Valley for some time (See the California Citrus Industry Guide: Glassy-winged Sharpshooter and Related Bacterial Diseases, April 2001 published by the Citrus Research Board in cooperation with the University of California Cooperative Extension). While in some cases picking bags are furnished by the picking contractor, more usually the bags are the property of the fruit picker and after a hard day's work they generally return home with their owners. As many growers know it is not unusual for orchard fruit to go home with the bag itself. The picking bag has to be considered to be as much a source of transfer of GWSS as the load of fruit moving to the packinghouse. GWSS have been shown to survive for up to 9 days in conditions resembling those in a picking bag, especially in the fall when temperatures cool. If the bag contains fruit, it is unlikely that a GWSS will have to spend anywhere near 9 days in the bag. Citrus fruit harvesters are valuable and integral parts of the citrus industry and an integral part of the economies of most communities in the San Joaquin Valley. Picking bags go everywhere. They are a common site on back porches and fences often located immediately adjacent to the plethora of plant species that host GWSS.

Growers and grower representatives should make an issue with their picking contractors of how picking bags are treated at the end of the harvest day. Simply turning the bags inside out at the end of the day should greatly reduce the risk of transporting this insect. Granted, while turning the bag inside out is easy, ensuring that it gets done is not. Picking crews tend to "melt" away as picking comes to an end as temperatures climb or darkness falls. That "take home" bag of fruit is somewhat of a "tradition" that may be hard to break.

The labor contractor or grower at several points during the day could effectively address the problem of moving GWSS. The best time from the standpoint of education would be an announcement of the importance of how to avoid moving GWSS immediately prior to the commencement of picking when ladders are made available to the crews. Another opportunity for ensuring that bags were turned inside out before they were transported home would be toward the end of the day when the picked bins are tallied. Greater scrutiny in the field and enforcement of a rule forbidding picking of fruit for personal use would also lessen the chance of GWSS hitchhikers. Picking crews and contractors tend to run on the independent

and self-governing side and the harvesting practices they follow have been inculcated over many decades and won't be easy to change. As growers know, though, if they as growers make a big enough issue of it, contractors will probably comply. The issue of breakage of microsprinklers during the harvest is a case in point. Buena suerte.

Treating the block of citrus with an appropriate pesticide is another option to reduce GWSS movement by truck or by picking bags.

GWSS Populations Found at Low Levels in Northern Kern and Southern Tulare Counties

For those citrus growers who have not yet been contacted or had the opportunity to attend meetings on the subject, GWSS have been found at low population levels at many sites in northern Kern and Southern Tulare County. Previously, most of the GWSS activity was located in Southern Kern County. Treatment programs have been initiated, as they were in southern Kern, in areas of northern Kern County bordering citrus and grapes. For those of you who have not met with him recently, Mr. Larry Liggett has been hired (supported largely by grower financial support and other monies) to coordinate these control efforts in both citrus and grapes in northern Kern County.

Efforts to control GWSS in southern Kern County have been very successful, thanks to the excellent support and cooperation of citrus and grape growers. Numbers of GWSS have been greatly reduced, in all areas, and the insects are difficult to find in most blocks. Pierce's disease (PD) in grapes continues to appear in the area of the original explosion of GWSS in the General Beale Road area. The suppression of GWSS in citrus, grapes and other crops and plantings should slow the spread of Pierce's disease in grapes. PD infected vines are being destroyed as they are identified, although the apparent degree of infection in some vineyards may warrant more aggressive removal strategies.

Decline and Death of Citrus Trees Common this Summer

Many consecutive days of hot summer temperatures may place sufficient stress on a weakened tree to push it into rapid decline and death. What has been unusual this year is the sheer number of calls received by this office of orchards with declining trees and the large number of trees adversely affected in each orchard. While some of the causes of decline are diagnosable, many have not been. Neil O'Connell, University of California Cooperative Extension Citrus Advisor in Tulare County, reports similar tree decline to that seen in Kern County, in areas not infested with the GWSS, so this insect is not thought to be associated with the problems. Most of the decline appears to be associated with graft union irregularities between early navel varieties and their rootstocks but this is only a preliminary observation. Investigations are planned or underway by UC and other researchers to determine their cause. Much of the research will be dependent upon these researchers obtaining grants from the Citrus Research Board, which you as growers have supported so generously over the years. Many thanks again for this support.

Citrus Peelminer

As of this writing in early August, the citrus peelminer has not caused significant economic damage to sweet oranges in Kern County. Generally, the citrus peel miner appears to prefer larger oranges. As the fruit increases in size growers can expect more mined fruit. Citrus adjacent to cotton or peppers are at greater risk of increased damage as the moths migrate from these crops. A block of pummelos in the Arvin area shows approximately 10% of the fruit in the lower three feet of the canopy to be infested, including some areas of the block that have had an initial chemical treatment of some sort. The incidence of mined fruit can increase quickly beginning in early August and continue through September into October.

Blast from the Past

Occasionally I encounter an interesting article from the past that is associated in some way with a current event that I will excerpt for this newsletter. I thought this one written by P.H. DeBach of the Citrus Experiment Station that was published in The Exchange Pest Control Circular no. 150, June 1947 in Los Angeles fit this category.

"Cottonycushion Scale, Vedalia and DDT in Central California

The cottonycushion scale was accidentally introduced into California from Australia, probably in 1868. So great were its powers of increase and so rapid its dispersal that by 1886 it seriously threatened to eliminate the citrus industry in California. This discouraging trend of events was soon halted, however, after the introduction in 1888-89 of Vedalia, a predatory beetle, and Cryptochaetum, a parasitic fly. Since that time, only occasional very localized outbreaks of cottony cushion scale have occurred.

In 1946, following the widespread use of DDT on citrus and other crops throughout central California, more or less severe cottonycushion scale outbreaks developed on citrus from Edison in the south to Hamilton city in the north. These outbreaks apparently were the result of the elimination of Vedalia from the DDT-treated groves and occurred in certain areas after only one DDT application.

Vedalia from untreated areas was able to reenter groves that had received one or more DDT applications prior to July 1, 1946, and was generally successful in cleaning up these cottonycushion scale infestations. However, in groves, which were retreated with DDT subsequent to July 1, Vedalia was not able to stage a successful comeback. This was because of the prolonged residual action of DDT against Vedalia.

Inasmuch as intensive surveys during the early part of 1947 in Kern and Tulare counties failed to reveal any Vedalia on citrus by mid-March and since cottony cushion scale was beginning to increase rapidly in certain groves, the Division of Biological Control at the University undertook to reestablish Vidalia. ... It is hoped that this work (and other research by the university) may develop a means to use DDT without seriously upsetting the cottonycushion scale - Vedalia complex ... . "

Apparently, things don't change too much in 55 years. There was little mention of the disappearance of Vedalia or increases in cottony cushion scale in later editions of the Pest Control Circular, although plenty of recommendations to use DDT for a variety of citrus pests appeared up through the early 1950s. The problem with cottonycushion scale and the use of DDT must have worked itself out.

TDE Mandarins:

The following news release was largely copied from the following website: *http://www.info.ucr.edu/cgi-bin/display.cgi?id=252*. Take a look at this website for more information.

Sweet Citrus Varieties with Deep Orange Rind (Released by UC Riverside June 19, 2002)

RIVERSIDE, California – Three new varieties of tangerines—the TDE2, TDE3 and TDE4—are the University of California's most recent citrus varieties to be released for commercial production. The tangerines, which are complex hybrids, are siblings since they share the same parents. The varieties will be patented and eventually be given trademarked names. The three tangerines are large fruited compared to other varieties, have a sweet taste, and bear fruit with a deep orange rind. "While the new tangerines share many similarities, they also differ from each other in their characteristics," said Mikeal Roose, professor of genetics at UC Riverside. "They do have one outstanding attribute however: all three are very low seeded, less than one seed per fruit, even when the trees are planted with other varieties. This is a highly-sought attribute for the fresh fruit market."

The TDE2, TDE3 and TDE4 are now being released for commercialization in California under non-exclusive licensing agreements with the University of California. Licensed growers and wholesale nurseries in California can obtain budwood, propagate the varieties and freely market the resulting trees and fruit. The University of California does not produce trees for sale to the public. It will take a year or two before trees become available for planting, and another two or three years before the young trees produce much fruit.

"The tangerines also hold very well on the trees," said Roose. "In Riverside, the TDE2 is good-tasting when picked from the tree anytime between February and May; the TDE3 is good-tasting when picked from the tree anytime between January and March; for the TDE4, the range is February to April."

There are, however, some unknowns associated with the new tangerines. For example, it is not clear how well the trees will yield when isolated from the citrus plants. "Some citrus require pollination or need stimuli like plant hormone sprays to set good crops," said Roose. "We hope to find out in the next two years how our new varieties perform." Like many tangerines, the new varieties also have 'alternate bearing' – a big crop one year followed by a much lower yield the next year(s). When the crops are very light, fruit size tends to get large and the rinds get rough and bumpy, Roose noted.

"The three new varieties are also quite thorny," said Roose. "This is a common characteristic of new hybrids. Moreover, the tree size for all three varieties is large for tangerines. All three new varieties grow more like orange trees, we've found." Average fruit size is in the range of 2.5 to 3 inches with a juice content of 42 to 49%. All three tangerines have an attractive deep orange rind color, have a rich fruit flavor and are marked by the virtual absence of seeds even in mixed plantings.

Craig Kallsen, Farm Advisor
Citrus, Subtropical Horticulture/Pistachios