

California Pest Rating Proposal for

Citrus tristeza virus

Current Pest Rating: A

Proposed Pest Rating: A

Domain: Virus; Group: Positive sense ssRNA viruses;
Family: Closteroviridae; Genus: Closterovirus

Comment Period: 05/26/2021 through 07/10/2021

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from Citrus tristeza virus (CTV) is described herein and a permanent pest rating is proposed.

History & Status:

Background: The family Closteroviridae includes viruses with flexible and elongated particles and monopartite or divided genomes composed of linear, positive sense, single-stranded RNA. They are transmitted in nature by insect vectors in a semi-persistent manner and they are mostly phloem-limited pathogens. CTV was the first closterovirus to be biophysically characterized (Moreno et al., 2008) and is comprised of a complex of genetically distinct strains (Moreno and Garnsey, 2010). CTV is transmitted by several species of aphids, but in California, *Aphis gossypii* is the principal vector of CTV (Yokomi and DeBorde 2005). Citrus tristeza virus has been a primary concern in the San Joaquin Valley since its detection there in 1956. At that time, virus eradication was deemed necessary and originally was undertaken by CDFA. Later the Central California Tristeza Eradication Agency (CCTEA) became the lead agency responsible for locating and removing CTV infected trees in Fresno, Tulare, and Kern counties. The CCTEA is grower-funded by a special assessment on citrus acreage.

The name 'tristeza' means 'sadness' in Spanish and Portuguese. CTV is the most destructive viral disease affecting citrus; it has caused the severe decline or death of millions of trees where sour orange was used as a rootstock (Bar-Joseph et al., 1989). CTV causes three distinct syndromes i) quick decline, which induces bud union girdling leading to rapid tree death, ii) stem pitting that causes stunting of the tree, low yield, and poor fruit quality, and iii) seedling yellows. These different syndromes are the result of differential interaction of CTV strains from different regions with different

scions and rootstocks (Moreno and Garnsey, 2010). Some CTV isolates are mild and cause symptomless scion infections, and there are CTV-resistant or -tolerant rootstocks.

Hosts: Natural hosts for CTV include nearly all citrus species in the genera *Citrus* and *Fortunella*. CTV can be detected when experimentally inoculated (by aphids, grafts, or mechanically) into citrus relatives including: *Aegle*, *Aeglopsis*, *Afraegle*, *Atalantia*, *Citropsis*, *Clausena*, *Eremocitrus*, *Hesperethusa*, *Merrillia*, *Microcitrus*, *Pamburus*, *Pleiospermium* and *Swinglea*, and some intergeneric hybrids (Moreno et al., 2008). The only natural non-citrus hosts that have been reported are *Passiflora* spp. (Kitajima et al., 1974).

Symptoms: Symptoms of CTV are variable depending on the rootstock/scion combination and the viral strain involved. They range from mild, causing no real economic impact, to severe, causing rapid tree death (Bar-Joseph et al., 1989).

Quick Decline: The most dramatic expression of CTV is quick decline, a syndrome in which the infected tree initially shows wilt symptoms and can completely collapse in a few weeks. Affected trees have dull green or yellow and thin foliage, leaf shedding and twig dieback. Leaves are small and chlorotic, similar to the effects of nitrogen deficiency, with small, pale fruits that are unmarketable. Quick decline is the result of the collapse and necrosis of sieve tubes and companion cells close to the bud union, resulting in non-functional phloem (Schneider, 1959), and a decline of the root system which results in wilting, chlorosis and dieback symptoms.

Stem Pitting: CTV infection can cause an interruption of meristematic activity at limited areas of the cambium that results in irregular radial growth with local depression at the inactivated points, referred to as stem pitting (Schneider, 1959). Extensive pitting limits radial growth and leads to stunting, and thin foliage with small yellow leaves, low bearing trees and small fruits with low juice content. Sensitive cultivars can be affected as seedlings, or if used as a grafted rootstock or a scion. Stem pitting does not usually kill the trees, but unthrifty growth and chronic yield reductions are serious symptoms (Timmer et al., 2000).

Seedling Yellows: This form of the disease presents as seedling stunting, production of small pale or yellow leaves, a reduced root system and sometimes a complete cessation of growth of sour orange, grapefruit or lemon seedlings (McClellan, 1960). Sometimes plants recover and produce a new flush with normal leaves, and they are used for rootstocks with the mistaken belief that the final trees will be unaffected. This syndrome is induced by specific pathogenicity determinants in the CTV genome (Satyanarayana et al., 2001) and cannot be “filtered out” by grafting on to resistant scion varieties.

Transmission: CTV moves to new regions primarily with the movement of infected plants or propagation with infected buds. It is vectored by several aphid species in a semi-persistent manner. *Aphis gossypii* (melon aphid), *A. spiraecola* (spirea aphid), *Toxoptera aurantii* (citrus aphid), and *T. citricida* (brown citrus aphid) are all proven vectors. The first three are common and widespread in California but *T. citricida* is not known to be in the state (Eskalen and Adaskaveg, 2019; Timmer et al., 2000). Transmission of CTV is higher with *T. citricida*, because this aphid is a more efficient CTV vector

and because its host range is restricted to the family Rutaceae (Yokomi et al., 1994). Seed transmission has not been observed (McClellan, 1957).

Within an orchard, pathogen spread may occur via two mechanisms: primary and secondary. Primary spread occurs due to movement of inoculative aphid vectors into an orchard from the outside, whereas secondary spread occurs due to vector acquisition of CTV within the orchard, followed by tree-to-tree movement (Yokomi et al., 2020).

Damage Potential: CTV is generally recognized as the most economically important viral disease of commercial citrus, causing large yield reductions and even death of trees (Bar-Joseph et al., 1989). In California, depending on the strains involved, CTV can be mild, causing no economic impact, or severe including collapse of sweet orange varieties grafted onto sour orange rootstock, stem pitting of sweet orange and grapefruit, decreased lifetime productivity of a tree, stunting, and small fruit size (Gottwald et al., 2002). Considerable effort is made by the growers of the San Joaquin Valley to monitor virus titer levels and remove symptomatic trees, while practicing aphid management. CTV is a quarantine pest in other states and countries.

Worldwide Distribution: Africa: *Algeria, Angola, Benin, Cameroon, Central African Republic, Chad, Comoros, Congo, Democratic republic of the, Cote d'Ivoire, Egypt, Eswatini, Ethiopia, Gabon, Ghana, Kenya, Libya, Madagascar, Mauritius, Morocco, Mozambique, Nigeria, Reunion, Sao Tome & Principe, Somalia, South Africa, Sudan, Tanzania, Uganda, Zambia, Zimbabwe.* America: *Antigua and Barbuda, Argentina, Aruba, Bahamas, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guadeloupe, Guatemala, Guyana, Honduras, Jamaica, Martinique, Mexico, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Lucia, Suriname, Trinidad and Tobago, United States of America (Alabama, Arizona, California, Florida, Hawaii, Louisiana, Texas), Uruguay, Venezuela, Virgin Islands (British).* Asia: *Afghanistan, Bhutan, Brunei Darussalam, China, India, Indonesia, Iran, Israel, Japan, Jordan, Korea Republic, Lebanon, Malaysia, Nepal, Oman, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Syria, Taiwan, Thailand, United Arab Emirates, Vietnam, Yemen.* Europe: *Albania, Bosnia and Herzegovina, Croatia, Cyprus, France, Georgia, Greece, Italy, Montenegro, Portugal, Spain, Turkey.* Oceania: *American Samoa, Australia, Fiji, French Polynesia, New Caledonia, New Zealand, Papua New Guinea, Samoa, Tonga* (EPPO, 2021).

Official Control: CTV is on the EPPO's A1 list for Azerbaijan, European Union, and Uzbekistan. CTV is on the A2 list for APPPC (Asia and Pacific Plant Protection Commission), Argentina, Bahrain, Egypt, EPPO (European Plant Protection Organization), Georgia, IAPSC (Inter-African Phytosanitary Council), Jordan, and Turkey, and is a quarantine pest for Mexico, Morocco, and Tunisia (EPPO, 2021).

CTV is on USDA's Harmful Organism list for Albania, Antigua and Barbuda, Argentina, Chile, Egypt, El Salvador, European Union, French Polynesia, Grenada, Georgia, Guatemala, Holy See (Vatican City State), Honduras, Israel, Jamaica, Japan, Madagascar, Mexico, Monaco, Morocco, New Caledonia, Panama, Paraguay, San Marino, Serbia, Turkey, Viet Nam, United Kingdom, Uruguay, and Uzbekistan (USDA-PCIT, 2021).

Puerto Rico restricts the movement of nursery stock from California due to tristeza quick decline. Louisiana requires shipments of citrus nursery stock, scions and budwood to originate from a part of California where tristeza does not occur, with a certificate of inspection. Texas prohibits entry of all citrus plants and other regulated materials from California. All citrus nursery stock transported into Alabama must have been inspected and found free of all citrus diseases and pests within 30 days of shipment. Arizona requires citrus nursery stock be certified under an origin state department of agriculture authorized program or National Clean Plant Network program that ensures it is foundation or source material, or has been propagated from a foundation or source tree that has been tested and found free of CTV within the previous thirty-six months (<https://nationalplantboard.org/>).

California has a state interior quarantine for portions of the state known to be generally infected with CTV where there are no significant efforts to control or suppress the disease. The quarantine area is the counties of Orange and Ventura and portions of Los Angeles, Riverside, San Bernardino, San Diego, and Santa Barbara counties. The quarantine includes a suppressive area, which is that portion of the State in which the citrus tristeza virus has been detected, in which a pest control district has been established, and where an active control or suppression program is being conducted. The suppressive area is the county of Kern and portions of Fresno, Tulare, and Riverside counties (<http://pi.cdfa.ca.gov/pqm/manual/pdf/404.pdf>).

California Distribution: Tristeza is widespread throughout Southern California, but the efforts of various groups, notably the Central California Tristeza Eradication Agency and the California Department of Food and Agriculture, have maintained CTV at very low levels in the San Joaquin and desert valleys. CTV is regulated by a State Interior Quarantine and CTV abatement districts.

California Interceptions: None

The risk Citrus tristeza virus would pose to California is evaluated below.

Consequences of Introduction:

1) Climate/Host Interaction:

CTV lives within its hosts and insect vectors. It could establish everywhere in California that grows susceptible citrus.

Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: 2

- Low (1) Not likely to establish in California; or likely to establish in very limited areas.
- **Medium (2) may be able to establish in a larger but limited part of California.**
- High (3) likely to establish a widespread distribution in California.

2) Known Pest Host Range:

The natural host range is *Citrus* and *Fortunella* spp., plus *Passiflora* spp.

Evaluate the host range of the pest.

Score: 2

- Low (1) has a very limited host range.
- **Medium (2) has a moderate host range.**
- High (3) has a wide host range.

3) Pest Reproductive Potential:

CTV multiplies inside the phloem of its host trees and spread mainly by grafting. It can be vectored by several species of winged aphids in a semi-persistent manner.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 3

- Low (1) does not have high reproductive or dispersal potential.
- Medium (2) has either high reproductive or dispersal potential.
- **High (3) has both high reproduction and dispersal potential.**

4) Economic Impact:

CTV damages the leaves and fruit, and some strains can kill trees. It is a regulated quarantine pest within California, the US, and other countries. It is managed with vector control, budwood certification programs, surveying and tree removal.

Evaluate the economic impact of the pest to California using the criteria below.

Economic Impact: A, B, C, E

- A. The pest could lower crop yield.**
- B. The pest could lower crop value (includes increasing crop production costs).**
- C. The pest could trigger the loss of markets (includes quarantines).**
- D. The pest could negatively change normal cultural practices.
- E. The pest can vector, or is vectored, by another pestiferous organism.**
- F. The organism is injurious or poisonous to agriculturally important animals.
- G. The organism can interfere with the delivery or supply of water for agricultural uses.

Economic Impact Score: 3

- Low (1) causes 0 or 1 of these impacts.
- Medium (2) causes 2 of these impacts.
- **High (3) causes 3 or more of these impacts.**

5) Environmental Impact:

CTV is under regulatory control in parts California. Trees with high virus titer are generally removed from orchards. There are no treatments if a tree is infected with CTV. There are eradication treatments for aphids which may be necessary if the brown citrus aphid is introduced.

Evaluate the environmental impact of the pest to California using the criteria below

Environmental Impact: D, E

- A. The pest could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes.
- B. The pest could directly affect threatened or endangered species.
- C. The pest could impact threatened or endangered species by disrupting critical habitats.
- D. The pest could trigger additional official or private treatment programs.**
- E. The pest significantly impacts cultural practices, home/urban gardening or ornamental plantings.**

Environmental Impact Score: 3

- Low (1) causes none of the above to occur.
- Medium (2) causes one of the above to occur.
- High (3) causes two or more of the above to occur.**

Consequences of Introduction to California for Citrus tristeza virus: High

Add up the total score and include it here. **13**

- Low = 5-8 points
- Medium = 9-12 points
- High = 13-15 points**

- 6) Post Entry Distribution and Survey Information:** Evaluate the known distribution in California. Only official records identified by a taxonomic expert and supported by voucher specimens deposited in natural history collections should be considered. Pest incursions that have been eradicated, are under eradication, or have been delimited with no further detections should not be included.

CTV is considered established in Southern California but is under regulation in the San Joaquin Valley and the desert.

Evaluation is 'Medium'.

Score: -2

- Not established (0) Pest never detected in California or known only from incursions.
 - Low (-1) Pest has a localized distribution in California or is established in one suitable climate/host area (region).
 - Medium (-2) Pest is widespread in California but not fully established in the endangered area, or pest established in two contiguous suitable climate/host areas.**
 - High (-3) Pest has fully established in the endangered area, or pest is reported in more than two contiguous or non-contiguous suitable climate/host areas.
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7) **The final score** is the consequences of introduction score minus the post entry distribution and survey information score: (Score)

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information = 11*

Uncertainty:

There is a constant risk of the accidental introduction of the brown citrus aphid, *Toxoptera citricida*, into California. The threat from this efficient vector, along with the risk associated with more aggressive strains, are reasons why eradication programs have been supported for more than 60 years. Where virulent stem-pitting strains of CTV are largely absent, productivity of citrus grown on CTV-tolerant or -resistant rootstocks should continue to be good despite presence of CTV in central California, as long as current management measures continue (Yokomi et al., 2020). Strains capable of breaking resistance to trifoliolate orange rootstocks have been detected in California (Yokomi et al., 2017). This is significant because trifoliolate orange and its hybrids are popular rootstocks.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for **Citrus tristeza virus** is **A**.

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Responsible Party:

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***Comment Period: 05/26/2021 through 07/10/2021**

***NOTE:**

You must be registered and logged in to post a comment. If you have registered and have not received the registration confirmation, please contact us at [permits\[@\]cdfa.ca.gov](mailto:permits[@]cdfa.ca.gov).

Comment Format:

- ❖ Comments should refer to the appropriate California Pest Rating Proposal Form subsection(s) being commented on, as shown below.

Example Comment:

Consequences of Introduction: 1. Climate/Host Interaction: [Your comment that relates to “Climate/Host Interaction” here.]

- ❖ Posted comments will not be able to be viewed immediately.
 - ❖ Comments may not be posted if they:
 - Contain inappropriate language which is not germane to the pest rating proposal;
 - Contains defamatory, false, inaccurate, abusive, obscene, pornographic, sexually oriented, threatening, racially offensive, discriminatory or illegal material;
 - Violates agency regulations prohibiting sexual harassment or other forms of discrimination;
 - Violates agency regulations prohibiting workplace violence, including threats.
 - ❖ Comments may be edited prior to posting to ensure they are entirely germane.
 - ❖ Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.
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Proposed Pest Rating: A
