CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Citrus psorosis virus
Citrus scaly bark

Current Pest Rating: none

Proposed Pest Rating: C

Kingdom: Viruses and viroids; Category: Riboviria;
Phylum: Negarnaviricota; Subphylum: Haploviricotina;
Class: Milneviricetes; Order: Serpentovirales
Family: Aspiviridae; Genus: Ophiovirus

Comment Period: 09/27/2021 through 11/11/2021

Initiating Event:

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

History & Status:

Background: Citrus psorosis affects tree trunks and branches, causing dramatic yield loss, thinning foliage, and stunted growth. Infection shortens the life of citrus trees, which slowly decline over years. The most diagnostic symptom is bark scaling with gum production and wood discoloration below bark lesions. It was first observed in Florida and California in the 1890s but is believed to have originated in Asia. Although psorosis was the first citrus disease proven to be graft transmissible (Fawcett, 1933; Fawcett, 1934) and the first that launched budwood testing programs in California (Calavan et al., 1978), the etiology remained uncertain for almost 100 years. Only in 1986 was the disease associated with the presence of virus-like particles in infected plants (Derrick et al., 1988). It has been accidentally spread among many citrus-growing countries around the world with the movement of infected planting material and budwood (Roistacher, 1991; Roistacher, 1993).

The virions of CPsV observed by electron microscopy appear as kinked or spiraled filaments with at least two different forms. They appear as naked, filamentous, nucleocapsids either in open circular forms (O,) or as linear forms (L). The first genus name suggested for CPsV was "*Spirovirus*" based on the spiral L form virions. To avoid confusion with *Spiroplasma citri*, a bacterium that causes stubborn

disease on citrus, and confusion with the genus *Spiromicrovirus*, which holds the bacteriophages affecting spiroplasmas, this taxonomy was not adopted (Milne et al., 1996). The unique morphology of the virions and clear differences from other genera led to the classification of CPsV as the type member of the new genus *Ophiovirus* which was accepted in 2000 by the International Committee on Virus Taxonomy (Milne et al., 2000). Other viruses in this genus include Mirafiori lettuce big vein virus, Freesia sneak virus, and Lettuce ring necrosis virus, all of which are transmitted by zoosporic, soil-borne fungi in the genus *Olpidium*. Many names in the taxonomy of CPsV including the order Serpentovirales, the family Aspiviridae and the genus *Ophiovirus* are names that denote a resemblance to snakes, as the particles are elongated, twisted, and coiled. CPsV has a tripartite, non-enveloped, negative-sense, single-strand RNA (-ssRNA) genome.

There are three distinct sets of symptoms of CPsV depending on the interaction of strains and their hosts. Two are defined as syndromes. When the lesions are limited to smaller areas of the stem and main branches, this is called psorosis A. If the lesions are rampant and affect even thin branches with sloughing of large strips of bark, this is the more aggressive syndrome known as psorosis B. The fruits of the psorosis B-affected trees may have depressed spots or rings in the rind with discolored tissues in the fruits, and this is the third form with the prior common name “Citrus ringspot”. At one time, Citrus ringspot was thought to be a separate viral agent, distinct from CPsV (EPPO, 2021). Young leaves of the spring flush can show different chlorotic patterns (flecking, blotching, or ring spots) and some new shoots of the spring flush will show a shock reaction with leaf shedding and shoot necrosis. Older leaves show chlorotic blotches in the upper side, with gum impregnated brownish eruptions in the underside (Moreno et al., 2015).

Hosts: Psorosis affects most citrus species and their hybrids. Sweet orange, grapefruit and tangerines are severely affected. Proven hosts include *C. aurantium* (sour orange), *C. x clementina* (clementine), *C. deliciosa* (Mediterranean mandarin), *C. limon* (lemon), *C. reshni* (Cleopatra mandarin), *C. reticulata* (mandarin), *C. sinensis* (sweet orange), *C. x paradisi* (grapefruit), and *Poncirus trifoliata* (Trifoliate orange) (CABI- CPC, 2021).

Symptoms: Citrus psorosis can affect various parts of the tree including the trunk, branches, leaves, and fruits. Although disease development and progress is slow and unspectacular, it is a lethal pathogen. CPsV-infected trees in the orchard first develop bark lesions on the trunk or one or more limbs. There is noticeably thin foliage, low fruit-bearing, and tree decline. The lesions usually begin to appear no sooner than on six-year-old trees, with the average age of first lesion development at twelve to fifteen years. Later, one or more main limbs can develop severe symptoms and fruit production is drastically reduced. Eventually, the tree will lose between one-half to three-fourths of their limbs and fruit. In the final stage before death, most of the limbs are dead and fruit production ceases (Moore et al., 1957).

The most characteristic symptom for psorosis over other diseases is the bark scaling in both the trunk and branches with gum production and wood discoloration below the bark lesions (Moreno et al., 2015). Gum may accumulate below the bark scales and may impregnate the xylem producing wood staining and vessel occlusion. The most susceptible citrus varieties are sweet orange, mandarin, and

grapefruit. The sour orange, sour lemon, pomelo, and rough lemon usually do not show external bark symptoms. There can be some foliar symptoms including leaf flecking, vein clearing, ringspots and oak-leaf pattern. But these foliar symptoms are not diagnostic and could be caused by viruses other than CPsV (Roistacher, 1991).

Transmission: Spread of CPsV is through grafting with infected budwood. It can take years or decades for bark scaling symptoms to appear, so infected but asymptomatic trees were often chosen as source material for propagation. Transmission has been effectively ended as the virus can be eliminated by budwood testing programs. Researchers have reported "naturally spreading psorosis". It is not always clear which disorders or disease symptoms are covered by the term 'naturally-spreading' but it is likely being used to describe the etiology of a progressing level of psorosis that appeared to be spreading in a grove. It was reported in Argentina (Beñatena and Portillo, 1984) and in Florida and Texas (Timmer and Garnsey, 1980).

Knowing that psorosis-infected trees have been inadvertently selected as budwood sources, and because of the very long period needed for bark symptoms to develop, with scaling appearing only after 10 – 15 years (Roistacher, 1981), the gradual development to an eventual high incidence may have been confused with "spread". Although other viruses in the genus *Ophiovirus* can be vectored by the fungus *Olpidium*, this has not been conclusively demonstrated for CPsV (Palle et al., 2005). Root grafting is another potential method of spread within an orchard. Mechanical spread of sap as a contaminant with tools, equipment, people, or insects, is possible with other pathogens, and although there have been observations that suggest this is happening, no experimental evidence has consistently shown this for CPsV (Garnsey and Timmer, 1980). Although CPsV has been confirmed to be seedborne as with most viral particles external to the seed coat, its seed transmission to seedlings has not been demonstrated and could have at best only a limited influence on its spread (D'Onghia et al., 2000). Psorosis virus is pollen borne but not transmissible with pollination of flowers or through seed (Roistracher, 1993).

Damage Potential: Bark-scaling of citrus was first observed in California in the 1890s but the disease has been brought under strict control here and in most advanced citrus-growing countries due to rigorous indexing and quarantine of nursery and propagative stock (Rosa et al., 2007). The disease continues to cause losses in South America and North Africa and is assumed to be widespread in Asia (Belabess et al., 2020). In 1957, Moore et al. calculated the potential economic losses caused by CPsV to citrus producers in Valencia orange orchards in California. They said at that time that "scaly bark" was the primary killer of citrus trees in the state. In an analysis of 220 orchards, they found that 7.8% of the trees examined showed bark lesion symptoms. The severity of the disease ranged from beginning stages, with slightly depressed yields, to advanced stages where affected trees were little more than stumps, with no yields. This disease has been mostly eliminated from commercial orchards in California by the Citrus Clonal Protection Program with no official detections since 1993. The absence of a known vector means that accidental spread from a re-introduction is unlikely.

Worldwide Distribution: Africa: *Algeria, Egypt, Morocco, South Africa.* Asia: *India, Iran Japan, Lebanon, Pakistan, Palestine, Turkey, Viet Nam*. Europe: *Albania, Cyprus, France, Greece, Italy, Russia.* North

America: *Mexico, United States* (Arizona, California, Florida, Texas). Oceania: *New Zealand, Samoa, Tonga*. South America: *Argentina, Uruguay, Venezuela.* (CABI- CPC, 2021, Kyriakopoulou, 2002)

Official Control: Citrus psorosis virus is on the EPPO's A1 list for Bahrain, Egypt, and Jordan. A2 list for Argentina and Turkey. Quarantine pest in Israel, Mexico, and Tunisia (EPPO, 2021). It is on the USDA PCIT's harmful organisms list for China, Egypt, Georgia, Guatemala, Honduras, Israel, Japan, Jordan, Korea, Republic of, Madagascar, Mexico, Nicaragua, Oman, Panama, Taiwan, Thailand, Turkey, and United Arab Emirates (USDA-PCIT, 2021)

California Distribution: Widespread in the 20th century, scaly bark was reported to be statewide (Mayhew and Weins, 1993). Today it is found mainly in old orange and grapefruit orchards (Eskalen and Adaskaveg, 2019).

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:** This virus is likely to be wherever its hosts can grow in California.

   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 host range is limited to citrus species and hybrids plus close relatives in the family Rutaceae.

   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:** This virus has no proven vectors; it is only spread through infected budwood and possibly root grafts. It is a lethal disease and thus becomes self-limiting. Modern citrus germ plasm programs can detect and eliminate this pathogen from propagative materials.

   Evaluate the natural and artificial dispersal potential of the pest.

   Score: 1

- 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:** In the 20th century this was the most economically important disease of citrus in California. Today it seems to have been practically eliminated from commercial nurseries and groves by testing of budwood.

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

Economic Impact: A

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: **1**

- 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:** The disease may still exist in old orchards or in home gardens, or where infected budwood is used for grafting.

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

Environmental Impact: 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: 2

- 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 psorosis virus*:* Low

Add up the total score and include it here. **8**
-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.

There are records of this disease in California for 125 years. It was known to be widespread, especially in oranges and grapefruit, in the middle of the 20th century. The Citrus Clonal Protection Program at UC Riverside reports from their testing programs in nurseries, as part of other surveys, and as new introductions from around the world, that they have detected on average, 1-3 positive trees on average per year over the past 20 years (G.Vidalakis, pers. comm).

Evaluation is 'high'.

Score: -3
-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.

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* ***= 5***

Uncertainty:

Despite our long history with this disease, the pathogen is still considered poorly understood (Belebess et al., 2020). The investigations into possible vectors or routes of transmission are ongoing in other parts of the world where the pathogen is still very destructive.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for Citrus psorosis virus is C.

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Responsible Party:

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***Comment Period: 09/27/2021 through 11/11/2021**

***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.

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.

Proposed Pest Rating: C