

California Pest Rating Proposal for

Columnea latent viroid

Current Pest Rating: none

Proposed Pest Rating: A

Kingdom: Viruses and viroids, Category: Viroids,

Family: Pospiviroidae, Genus: Pospiviroid

Comment Period: 12/05/2023 through 01/19/2024

Initiating Event:

This pathogen has not been through the pest rating system. The risk to California from Columnea latent viroid (CLVd) is described herein and a permanent rating is proposed.

History & Status:

Background: Viroids are the smallest known plant pathogens and are composed of only a short, circular, single-stranded RNA. Although viroids are composed of nucleic acid, they do not encode any protein and do not have protein coats. All viroids are inhabitants of higher plants, and some cause diseases while others are latent or asymptomatic. Columnea latent viroid (CLVd) replicates using RNA polymerase II from plants. This cellular enzyme is normally associated with the synthesis of messenger RNA from plant DNA, but in a plant infected with CLVd, it is instead used via "rolling circle" synthesis to make new RNA from the negative strand viroid RNA. Only viroids in the family Pospiviroidae replicate this way and it occurs in the nuclei of the cells. CLVd is one of the Pospiviroids that forms native "rod-like" secondary structures. The other viroid family, Avsunviroidae, replicates by the single-unit nuclear-encoded polymerase in chloroplasts (Agrios, 2005).

Pospiviroids are emerging pathogens with several species discovered in solanaceous crop plants in the past 20 years and evidence that they are spreading to countries and continents where they have not been previously recorded (CABI, 2023). Several pospiviroids cause severe yield losses, especially in tomatoes. Many countries list these viroids as quarantine pathogens. Among them, Columnea latent viroid (CLVd), Pepper chat fruit viroid (PCFVd), Potato spindle tuber viroid (PSTVd), Tomato apical stunt viroid (TASVd), Tomato chlorotic dwarf viroid (TCDVd), and Tomato planta macho viroid (TPMVd) are major concerns. There have been transient detections of some of these in greenhouse production in

the United States, however, none are considered established here at this time (CABI, 2023). The symptoms of all these viroid diseases are similar and include stunting, apical proliferation, apical leaf narrowing and yellowing, leaf crinkling, tissue brittleness, and necrosis (Singh and Dhar, 1998).

CLVd was first isolated from symptomless *Columnea erythrophae* from a commercial ornamental nursery in Maryland (Owens et al., 1978). Inoculation with CLVd-infected sap caused symptoms in Rutgers tomatoes, similar to, but less severe than, symptoms produced by PSTVd infection. CLVd was sequenced in 1989 by Hammond et al. They showed CLVd contains extensive sequence homology to PSTVd but contains a central conserved region identical to that of Hop stunt viroid. It is named a latent viroid as it does not cause any symptoms in *Columnea* or several other susceptible ornamentals. It was isolated from symptomless commercial *Nematanthus wettsteinii* plants in Canada (Singh et al., 1992). The lack of symptoms leads to a high risk of accidental spread.

In 2021, Tangkanchanapas et al. proposed that CLVd be re-classified into at least three main taxonomic lineages: a “CLVd-tomato Asian lineage” (I), a “CLVd-tomato European lineage” (IV) and a “CLVd-ornamental European lineage” (II), plus two minor lineages (III and V), fitting the International Committee on Taxonomy of Viruses criteria.

Hosts: The most important natural host of CLVd is tomato (*Solanum lycopersicum*). CLVd has additional hosts in the Solanaceae family, such as petunia (*Petunia × hybrida*), bolo maka (*Solanum stramonifolium*), eggplant (*Solanum melongena*), yesterday-today-tomorrow (*Brunfelsia* sp.), Jamaican raintree (*Brunfelsia undulata*), pepper (*Capsicum annuum*) and potato (*Solanum tuberosum*).

Additional hosts in other families are edible chrysanthemum (*Glebionis coronaria*), lipstick vine (*Columnea* sp.), bright eyes (*Gloxinia gymnostoma*, *G. nematanthodes*, and *G. purpurascens*), purple velvet plant (*Gynura aurantica*), and goldfish plant (*Nematanthus wettsteinii*) (Tangkanchanapas et al., 2021; CABI, 2023; EPPO, 2023).

Symptoms: Symptoms caused by CLVd can be seen on some solanums and are very similar to those caused by other pospiviroids. These include stunted growth, epinasty, chlorosis of leaves, and necrosis of leaf veins and stems (Batuman and Gilbertson, 2013). This viroid can cause a reduction in fruit size and seeds that fail to mature in tomatoes (Tangkanchanapas, et al., 2013). CLVd is latent and does not cause symptoms in most ornamental host plants.

Transmission: Viroids have a very stable secondary structure and handling infected plant debris may unintentionally spread the disease quickly in the field. Tools and practices used to cut infected plants can carry viroids to healthy plants, including knife cutting, stem slashing with a razor blade, or even rubbing by hand (Diener, 1987). CLVd is mainly transmitted mechanically through infected sap but spread with infected seeds is also possible. CLVd is seed transmitted in petunia and tomato at rates ranging from 5-100% (Matsushita and Tsuda, 2016). Grafting infected vegetative planting materials is also a method of transmission (Verhoeven et al., 2008). Pollen transmission has been demonstrated in eggplant (Bhuvitarkorn and Reanwarakorn, 2019). Spread can occur with the movement of latently infected, asymptomatic ornamentals.

Damage Potential: Viroid pathogenicity and disease severity are directly related to their viroid genome sequence, in combination with the host plant species and age, as well as environmental factors (e.g., light intensity and ambient temperature) (Flores et al., 2005). In Thailand, CLVd-infected tomatoes showed very severe stunting, strong leaf rugosity, and heavy vein necrosis, combined with very high yield losses (around 50% reduction in fruit size) in several tomato cultivars (Marach, 2008). More mild symptoms and fewer crop losses have been reported from most of the European CLVd isolates (Nixon et al., 2010). This viroid can cause a significant reduction in fruit size and immature seed production in tomatoes, additionally, many countries are likely to take quarantine action against outbreaks, up to requiring full crop destruction (Nixon et al., 2010).

Worldwide Distribution: Africa: *Mali*. America: *Canada, United States (Maryland)*, Asia: *Thailand*. Europe: *France, Italy, Netherlands, and the United Kingdom*.

Official Control: CLVd is on the EPPO's quarantine pest list for the United Kingdom (EPPO, 2023), and the USDA-APHIS harmful organisms list for Georgia, Japan, New Zealand, Taiwan, Thailand, and The Republic of Türkiye (USDA PCIT, 2023).

The USDA-APHIS Federal Order DA-2019-21 required all shipments of tomato and pepper seeds from all countries to be tested for quarantine-significant pospiviroids prior to entry into the United States. The Order became effective in September 2019 and included CLVd. USDA-APHIS conducted a risk assessment that found no evidence that CLVd followed the pepper seed pathway, and in April 2023, they amended the order to remove CLVd from pepper seed phytosanitary requirements. However, they maintained that it follows the pathway for tomato seed. Therefore, no changes were made to the tomato seed import requirements, and CLVd remains listed as a quarantine-significant pospiviroid for tomatoes. Tomato seeds are enterable if tested and found free from CLVd, or if the seeds are produced in a country where CLVd is not known to occur.

California Distribution: none

California Interceptions: none

The risk *Columnea* latent viroid that would pose to California is evaluated below.

Consequences of Introduction:

- 1) Climate/Host Interaction:** The viroid is likely to survive wherever its hosts are grown. Tomatoes are annuals but other solanaceous hosts are woody perennials that can withstand below-freezing temperatures.

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 be established 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 includes multiple species in different families, including ornamentals.

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: Viroids are completely dependent on the cellular mechanisms of their hosts to be able to reproduce. They spread through infected sap, with seeds, and with pollen.

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: Yield losses and quarantine actions against infestations in tomato greenhouses can reach 100%. Seeds need to be screened for the presence of this viroid. Strict phytosanitary techniques for tomatoes and for ornamental hosts in greenhouses are key to preventing spread.

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

Economic Impact: A, B, C, D

- A. The pest could lower crop yield.**
- B. The pest could lower crop value (including increasing crop production costs).**
- C. The pest could trigger the loss of markets (including 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.**
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- 5) Environmental Impact:** There are many native and naturalized members of the Solanaceae family in California which are potential hosts that could develop symptoms or be latently infected. CLVd could be spread mechanically, by seed, or by pollen. Detections will likely trigger quarantine actions.

Evaluate the environmental impact of the pest on California using the criteria below.

Environmental Impact: A, D

- 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 *Columnea* latent viroid: 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.

Evaluation is 'Not established'.

Score: 0

-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 the introduction score minus the post-entry distribution and survey information score: (Score)
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Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information = 13*

Uncertainty:

Differentiation between Pospiviroids requires advanced laboratory techniques. Private diagnostics labs in California occasionally report detections of Pospiviroid group 1 from tomatoes. This group includes CLVd and at least 9 other viroids, but the species are not determined.

Conclusion and Rating Justification:

Based on the evidence provided above, the proposed rating for **Columnnea latent viroid is A.**

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Responsible Party:

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***Comment Period: 12/05/2023 through 01/19/2024**

***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
