

California Pest Rating Proposal for

Tomato apical stunt viroid TASVd

Current Pest Rating: none

Proposed Pest Rating: A

Kingdom: Viruses and viroids, Category: Viroids,
Family: Pospiviroidae, Genus: Pospiviroid

Comment Period: 09/10/2021 through 10/25/2021

Initiating Event:

The USDA's Federal Interagency Committee on Invasive Terrestrial Animals and Pathogens (ITAP.gov) Subcommittee on Plant Pathogens has identified the worst plant pathogens that are either in the United States and have potential for further spread or represent a new threat if introduced. Tomato apical stunt viroid is on their list. A pest risk assessment of this viroid is presented here, and a pest rating for California 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 have no protein coats. All viroids are inhabitants of higher plants, and some cause diseases while others are asymptomatic. Tomato apical stunt viroid (TASVd) replicates using RNA polymerase II; this host cell enzyme is normally associated with synthesis of messenger RNA from plant DNA, but in a plant infected with TASVd it is instead used via "rolling circle" synthesis to make new RNA from the negative strand viroid RNA. Only viroids in Pospiviroidae replicate this way in the nuclei. The other viroid family, Avsunviroidae, replicates by the single-unit nuclear-encoded polymerase in chloroplasts (Agrios, 2005).

A number of viroids infect solanaceous plants and cause severe yield losses. 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, but none are considered established in this country at this time (CABI-CPC, 2021). 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).

Tomato apical stunt viroid was first recognized in tomatoes grown in small gardens in Cote d'Ivoire by Walter et al. in 1980. A nearly identical Indonesian strain of TASVd that induced severe symptoms in tomatoes was found by Candresse et al. in 1987. Since 1999, TASVd has been found with frequency in tomato greenhouses in Israel, where it causes devastating disease losses (Antignus et al., 2002). The potential of TASVd to damage California tomato crops is very high because of its rapid spread and its very damaging effects on the plants.

Hosts: The most important host of TASVd is *Solanum lycopersicum* (tomato), followed by *Capsicum annuum* (chili). There are additional woody ornamental hosts in the family Solanaceae, including *Brugmansia* (angel's trumpet), *Cestrum* sp. (jessamine), *Lycianthes rantonnetii* (blue potato bush), *Solanum laxum* (potato vine), and *Streptosolen jamesonii* (marmalade bush) (Hammond, 2019).

Symptoms: Symptoms of TASVd on tomato include curling of leaves, apical stunting, necrotic lesions, vein yellowing, deformation, and small fruit (Walter, 1987). Symptoms in tomato are like those of other pospiviroid species, and molecular diagnostics are required to determine that the infection is caused by TASVd, or another viroid or virus (Hammond, 2019). Woody ornamental hosts are asymptomatic.

Transmission: The dissemination of this disease worldwide has been the result of movement of infected seeds. Pathways for new introduction include tomato seedlings, tomato seeds and ornamentals. Ornamental solanaceous plants infected by TASVd are asymptomatic (Verhoeven et al., 2017). These plants can act as a reservoir for the spread of viroids in tomato production, especially in greenhouse conditions. TASVd is spread easily through plant sap, e.g. during tomato or pepper pruning and propagation, and there is some evidence of insect transmission greenhouses (Hammond, 2018).

Seed transmission is highly significant in viroid epidemiology. Antignus et al. (2007), showed that TASVd is efficiently transmitted via tomato seed and, in some cases, transmission rates via seed from mechanically inoculated tomato plants were close to 80%. However, Matsushita and Tsuda (2016) found no transmission of TASVd from tomato seeds to seedlings. Seed transmission probably is responsible for the primary infection in commercial greenhouses, and likely variable between strains. Bumble bees are involved in the secondary spread of TASVd in greenhouses, and there is efficient secondary spread via workers' infested hands and tools (Singh and Dhar, 1998). The transmission by bumble bees (*Bombus* sp.) may result from the wounding of flowers and movement of infected sap or possibly pollen during insect visits (Antignus et al., 2007).

Damage Potential: TASVd outbreaks in tomato have occurred in several countries in Asia, Africa, and Europe. Infection in tomato leads to stunted plants, and small and deformed fruit, with up to 100% yield loss. The incidence is sporadic, and, in many cases, the viroid has been locally eradicated by destruction of infected material. TASVd infection causes direct injury to the seed and infected seeds

fail to germinate (Hammond, 2018). Asymptomatic but infected ornamentals should not be sold or moved.

Worldwide Distribution: Africa: *Cote d'Ivoire, Ghana, Senegal, Tunisia*. Asia: *Indonesia, Israel*. Europe: *Belgium, Croatia, Czechia, Germany, Italy, Netherlands, Poland, Slovenia* (Hammond, 2019).

Official Control: Tomato apical stunt viroid is on the EPPO's A1 list for Chile and Jordan and is a quarantine pest in Tunisia (EPPO, 2021). It is on the USDA's harmful organism list for Chile, Georgia, Japan, New Zealand, Taiwan, and Thailand (USDA-PCIT, 2021). Pospiviroids including TASVd are in CDFA's Phytosanitary Field Inspection Manual for export seed programs as a pest of concern for peppers and tomatoes. Mother plants are visually inspected twice, at bloom and young fruit, and at 20-30% fruit maturity.

California Distribution: None

California Interceptions: None.

The risk Tomato apical stunt viroid 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 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 includes multiple species in the Family Solanaceae.

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 occasionally with bumble bees.
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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 the viroid. Strict phytosanitary techniques in greenhouses are key to preventing spread, for tomatoes and for ornamental hosts.

Evaluate the economic impact of the pest to 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 (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: There are many native and naturalized members of the family Solanaceae in California. They could be infected mechanically or by *Bombus* spp. (bumblebees). Detections will likely trigger quarantine actions.

Evaluate the environmental impact of the pest to 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.
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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 Tomato apical stunt 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 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 = 13

Uncertainty:

Differentiation between Pospoviruses requires advanced laboratory techniques. Private diagnostics labs in California occasionally report detections of Pospovirus group 1 from tomatoes. This group includes TASVd 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 Tomato apical stunt viroid is A.

References:

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Responsible Party:

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***Comment Period: 09/10/2021 through 10/25/2021**

***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