California Pest Rating Proposal for

Tomato infectious chlorosis virus

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Viruses and viroids, Category: Riboviria,
Category: Orthornavirae, Phylum: Kitrinoviricota,
Class: Alsuviricetes, Order: Martellivirales,
Family: Closteroviridae, Genus: *Crinivirus*

Comment Period: 07/08/2022 through 08/22/2022

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from Tomato infectious chlorosis virus is described herein and a permanent rating is proposed.

History & Status:

Background: California tomatoes were valued at nearly $1.2B in 2020, with California growing nearly 100% of the processing tomatoes in the United States. Processing tomatoes are grown in the San Joaquin and Sacramento valleys, with production centered in Fresno, Yolo, San Joaquin, Kings, and Colusa counties. Significant production also occurs in Merced, Stanislaus, Solano, and Sutter counties. Processing tomatoes were valued at $895M with fresh market tomatoes (mostly greenhouse grown in Santa Barbara and Ventura Counties, plus field production in San Diego County) at $280M (CDFA crop statistics, 2020) https://www.cdfa.ca.gov/Statistics/PDFs/2020_Ag_Stats_Review.pdf.

Tomato infectious chlorosis virus (TICV) is a whitefly-transmitted virus that primarily infects tomatoes (*Solanum lycopersicum*). TICV was first found in tomato fields in Orange County in 1993. In one season, the growers suffered $2 million in losses (Duffus et al., 1996; Wisler et al., 1997). High virus incidence coincided with high populations of the greenhouse whitefly, and TICV was found infecting surrounding weeds. In the United States, this virus has been found primarily in commercial greenhouse-grown tomatoes and tomatoes in breeding programs in California and North Carolina (Parella, 2008). TICV infects other agronomic crops including tomatillo, lettuce, potato, and artichoke, and ornamentals growing as greenhouse bedding plants, including ranunculus, China aster, and petunia (Li et al., 1998).

In the 21st century this disease was diagnosed around the world in major tomato-production areas including in Mexico, Europe, the Middle East, as well as East and Southeast Asia (Wintermantel et al., 2009). TICV is closely related to Lettuce infectious yellows virus, which also occurs in California, and is similar in symptoms to Tomato chlorosis virus.

The name closterovirus was first used in the early 1970s for a taxonomic group of plant viruses characterized by an elongated, very flexuous particle morphology and an open particle structure, with the largest RNA genome of any group of plant viruses. The genus *Crinivirus* was founded with Beet pseudo-yellows virus (BPYV) identified in the 1960s (Duffus, 1965). Tomato infectious chlorosis virus has a bipartite genome and induces phloem-limited inclusions characteristic of the closteroviruses (Wisler et al., 1996; 1998b). *Crinivirus* transmission is species-specific and performed exclusively by whiteflies. Criniviruses emerged as a major agricultural threat at the end of the twentieth century with the establishment and naturalization of their whitefly vectors, members of the genera *Trialeurodes* and *Bemisia*, in temperate climates around the globe. Several criniviruses cause significant diseases in single infections whereas others remain asymptomatic and only cause disease when found in mixed infections with other viruses. Whitefly-transmitted viruses have emerged as a major problem for world agriculture and are responsible for diseases that lead to losses measured in the billions of dollars annually (German-Ratana et al., 1999; Tzanetakis et al., 2013).

Hosts: Tomato is the major natural host of TICV. Other species belonging to eight different botanical families were susceptible to TICV in whitefly-inoculation experiments (Duffus et al., 1996). *Anoda cristata* (anoda-weed), *Blitum capitatum* (strawberry-blight), *Callistephus chinensis* (annual-aster), *Capsella bursa-pastoris* (shepherd's-purse), *Chenopodiastrum murale* (nettle-leaf goosefoot), *Chenopodium album* (white goosefoot), *Conium maculatum* (poison hemlock), *Cynara cardunculus* (artichoke), *Cynara scolymus* (globe artichoke), *Dittrichia viscosa* (false yellowhead), *Erodium cicutarium* (common crowfoot), *Geranium dissectum* (cut-leaf geranium), *Helminthotheca echioides* (bristly oxtongue), *Lactuca sativa* (garden lettuce), *Nicotiana benthamiana*, *Nicotiana clevelandii*, *Nicotiana glauca* (tobacco-bush), *Petunia x hybrida* (garden petunia), *Physalis acutifolia* (Wright's ground-cherry), *Physalis alkekengi* (Chinese-lantern), *Physalis floridana* (ground-cherry), *Physalis ixocarpa* (husk-tomato), *Ranunculus asiaticus* (Asian buttercup), *Ranunculus* sp., *Senecio vulgaris* (common fireweed), *Solanum lycopersicum* (tomato), *Solanum tuberosum* (potato), *Sonchus oleraceus* (annual sow thistle), *Trifolium subterraneum* (sub clover), *Zinnia elegans* (garden zinnia) (EPPO, 2022).

Symptoms: The leaves of plants infected with TICV become yellow or red between the veins, stunted, and rolled. Symptoms generally occur on older leaves, while new growth continues to appear normal. As the disease progresses, interveinal necrosis can occur and the leaves become characteristically brittle, thick, and crisp, easily breaking (Davis et al., 2013).

Transmission: Over short distances, TICV can be carried by its vector *T. vaporariorum*. This whitefly has a wide distribution on many crops grown in fields and greenhouses. As is the case for almost all viruses in the Closteroviridae family, TICV is unlikely to be seed-borne. No transmission was detected by mechanical transmission tests in tomatoes (Duffus et al., 1996).

Minimum acquisition access period by *T. vaporariorum* for TICV was after feeding for 1 hr, but TICV was transmitted with greater efficiency after longer feeding periods. TICV was not found to be transmitted by *Bemisia tabaci, Trialeurodes abutiloneu*s, or *Myzus persicae*. As a rule, the virus was detectable in the insects during the first 24-h feeding period, but there were cases where insects were able to retain TICV for 4 days.

TICV symptoms take up to 3 weeks to develop, and during this latent period, movement of infected plant material by the nursery industry can distribute TICV to new regions (Wisler et al., 1998). The virus can survive during non-crop seasons in a wide range of weed hosts near production areas and move into crops as whitefly populations develop and become active. Similarly, some ornamentals or alternate crops such as lettuce can serve as reservoirs for virus transmission to tomato (Duffus et al., 1996a; Wisler et al., 1998a; Font et al., 2004).

Damage Potential: Yield is affected through decreased fruit size and number (Wisler et al., 1996), as well as decreased plant longevity (Wintermantel, 2004). Outbreaks have been unpredictable from year to year and for different locations in California (Davis et al., 2013). Although insecticides can reduce whitefly populations, they often are inefficient for virus control because whiteflies can transmit viruses immediately, before they are killed by an insecticide. Resistance to TICV is not available in commercial tomato varieties, however, studies have indicated that resistance to whitefly feeding can slow TICV disease progress (Mutschler and Wintermantel, 2006).

Worldwide Distribution: Africa: *Tunisia*; Asia: *Indonesia, Japan, Jordan, Taiwan*. Europe: *Bulgaria, France, Greece, Italy*. North America: *Mexico, United States* (California, North Carolina); South America: *Brazil* (CABI-CPC, 2022).

Official Control: TICV is on the USDA's Harmful organisms list for Costa Rica, Georgia, India, Japan, Korea, Republic of, Morocco, Tunisia. It is on the EPPO's A1 list for Argentina, Georgia, Jordan, the A2 list European Plant Protection Organization, and it is a quarantine pest in Morocco, Tunisia, and United Kingdom.

California Distribution: This virus has never been under regulatory control in California. It has been found in major field and greenhouse tomato production areas (CDFA PDR database; Davis et al, 2013). In a very early, limited survey in 1995, Wisler et al. (1997) identified the virus in Yolo, San Joaquin, Stanislaus, Orange, and Monterey counties, and stated that it seems to be established in perennial weed species in the southern coastal region of California, and in greenhouses with tomato breeding programs in northern and central California. The vector *T. vaporariorum* is abundant and destructive as a pest in its own right in greenhouses and fields, on a variety of crops, particularly in warmer climates throughout the state.

California Interceptions: None

The risk Tomato infectious chlorosis virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** TICV is likely to establish wherever there are hosts and vectors, but primarily in warmer areas, especially inside protected structures such as greenhouses.

   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 agronomic crops, plus woody plants, ornamentals, and weeds.

   Evaluate the host range of the pest.

   Score: 3

   - 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:** The virus multiplies in the phloem of plants and is spread semi-persistently by a flying vector that can feed on and transmit the virus to many plant species. However, this virus is not seed borne or mechanically transmitted

   Evaluate the natural and artificial dispersal potential of the pest.

   Score: 2

   - 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:** The impact of this pathogen has been sporadic, and outbreaks are highly correlated with large whitefly populations. It is a quarantine pest in some locations, and it is vectored by pestiferous whiteflies.

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

   Economic Impact: A, 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:** Management of criniviruses is predominantly through management of their whitefly vectors. Criniviruses routinely emerge in areas with regularly occurring or persistent whitefly populations, or as vector populations migrate or are moved to new regions. An effective vector control regimen can slow spread or reduce severity of infections. Ornamental plantings can also be affected.

   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 Tomato infectious chlorosis 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.

   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* ***= 10***

Uncertainty:

Chemical control of vectors has not always been effective for disease management and the development of resistance to insecticides in insect populations and the effect of insecticides on whitefly predators may have a large negative impact on vector and virus control in the future,

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for Tomato infectious chlorosis virus is C.

References:

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Responsible Party:

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***Comment Period:** **07/08/2022 through 08/22/2022**

***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
