cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Tomato torrado virus

Current Pest Rating: none

Proposed Pest Rating: A

Kingdom: Viruses and viroids, Category: Riboviria,
Order: Picornavirales, Family: Secoviridae, Genus Torradovirus

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Comment Period: 10/13/2021 through 11/27/2021

Initiating Event:

In 2009, the USDA's Plant Protection and Quarantine agency issued a Federal Order to prohibit the importation of plants used for planting that are hosts of Tomato torrado virus (ToTV) from all countries, except Canada, having determined that the introduction and establishment of this pathogen poses a serious plant pest threat to the agriculture of the United States. This pathogen has not been through the pest rating process. The risk to California from Tomato torrado virus is described herein and a permanent pest rating is proposed.

History & Status:

Background: In 2007, Verbeek et al. reported that since 2001, tomato plants with severe necrotic leaf symptoms were observed in one region of Spain. It did not match to any previously known disease and was characterized by with necrotic spots surrounded by a light green or yellow area at the base of the leaflets, becoming a severe necrosis of leaves and fruits, stunting growth, and causing serious economic damage. It was named "torrado", meaning burned or roasted. The symptoms caused by ToTV may be considered as one of the most severe virus-induced forms of systemic necrosis, which spreads within the whole plant and leads to plant death. This disease was associated with high population levels of whiteflies. It has been found occasionally in other parts of Europe plus Australia, Panama, and Colombia, in both field and greenhouse production.

Analysis of the plants observed by Verbeek et al. (2007) revealed they were infected with Pepino mosaic virus, genus *Potexvirus*, but also with icosahedral virions. Infection with Pepino mosaic virus alone would not explain the severe symptoms. The genome of the isometric particles was two +ssRNA and direct sequence analysis showed that the virus should be in the picornavirus 'superfamily'. ToTV

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shares virion characteristics and sequence similarities with viruses of the genera *Sequivirus* and *Waikavirus* (family Sequiviridae) and the unassigned genera *Cheravirus* and *Sadwavirus*. It was different enough that Verbeek et al. (2007) believed it represented a new virus genus and proposed the name Tomato torrado virus for this species. The genus *Torradovirus* was proposed by Sanfaçon et al. in 2009 (type species: Tomato torrado virus) and assigned this genus to the proposed family Secoviridae in the order Picornavirales.

Today there are six viruses in the genus *Torradovirus*, all causing disease associated with severe necrosis of leaves and fruits (Moodley et al., 2020). Tomato marchitez virus found in Mexico is the closest relative to ToTV (Verbeek et al., 2008), and causes similar symptoms. ToTV along with three other *Torradovirus* species, Tomato marchitez virus, Tomato chocolàte virus, and Tomato necrotic dwarf virus are the only known spherical viruses that are transmitted by whiteflies in the genera *Trialeurodes* and *Bemisia*, and in a semi-persistent manner (Verbeek et al., 2014; Wintermantel et al., 2018).

In addition to tomatoes, natural infection of 22 weed hosts in various plant families was reported in Spain (Alfaro-Fernandez et al., 2008). Other crop plants in the family Solanaceae, including *S. tuberosum* (potato), *S. melongena* (eggplant), *Nicotiana tabacum* (tobacco), and *Capsicum annuum* (pepper) were inoculated and developed symptoms in work by Amari et al., 2008. They also showed that whiteflies, either the sweetpotato whitefly *Bemisia tabaci*, or greenhouse whitefly *Trialeurodes vaporariorum*, could transmit the virus between tomatoes and between weeds. Both whiteflies are present and widespread in California (CDFA PDR database, 2021).

In 2009, the USDA issued a Federal Order for Tomato torrado virus and Tomato severe leaf curl virus to state and territory agricultural regulatory officials. This Federal Order was issued to prohibit the importation of plants used for planting (not including seed) that are hosts of Tomato torrado virus and Tomato severe leaf curl virus from all countries, except Canada, into the United States. https://www.aphis.usda.gov/import_export/plants/plant_imports/federal_order/downloads/tomato_viruses.pdf. APHIS has also determined that it is necessary to prohibit the importation of *Capsicum* spp., *Solanum* spp., *Chenopodium* spp., *Polygonum* spp., *Atriplex* spp., *Halogetum* spp., *Nicotiana* spp., *Lepidium* (synonyms *Senebiera, Coronopus*) spp., *Spergularia* spp., *Amaranthus* spp., and *Malva* spp., with the exception of seed, until a pest risk analysis has been completed and appropriate effective mitigations measures have been established.

In 2012, USDA APHIS issued a quarantine pest evaluation datasheet for Tomato torrado virus describing the scientific evidence that it is a quarantine pest for the United States and describing the damage potential of this pathogen as follows: Infected plants exhibit very distinct necrotic, almost burn-like symptoms on leaves and stems and necrotic blotches or patterns on fruit that become deformed and unmarketable. Plant growth and yields are seriously reduced. This confirmed in regulation the status of *Solanum* (including *Lycopersicon*), *Amaranthus, Atriplex, Chenopodium, Halogeton, Lepidium* (synonyms *Senebiera, Coronopus*), *Malva, Polygonum, Nicotiana* and *Spergularia plants* for planting as “Not Authorized Pending Pest Risk Analysis” from all countries. https://downloads.regulations.gov/APHIS-2011-0072-0044/content.pdf

Hosts: Natural infections have only been observed in *Solanum lycopersicum* (tomato), and several weed species belonging to various plant families (Amaranthaceae, Caryophyllaceae, Chenopodiaceae, Cruciferae, Malvacae, and Polygonaceae). In inoculation studies, ToTV could systemically infect *S. tuberosum* (potato), *S. melongena* (eggplant), *Nicotiana tabacum* (tobacco), and *Capsicum annuum* (pepper).

Symptoms: The first symptom is necrotic spots surrounded by a light green or yellow area at the base of the leaflets. Sometimes the necrotic spots abscise, leaving holes in the leaves. Other plants develop a severe necrosis, moving from the base to the tip of the leaves. Fruits can be distorted with necrotic lines on the surface that is cracked. Plant growth is stunted. The name "torrado", meaning burned or roasted, reflects the severe virus-induced systemic necrosis, which spreads within the whole plant, and leads to plant death (Alfaro-Fernandez et al., 2008).

Transmission: ToTV is poorly transmitted mechanically which could be due to the low stability of the virus in plant sap and low accumulation of ToTV in plants (Pospieszny et al., 2010). ToTV is efficiently transmitted by whiteflies in a semi-persistent manner (Amari et al., 2008; Verbeek et al., 2013). ToTV is transmitted to the next generation of tomatoes via seeds (Pospieszny et al., 2019). Even with a low incidence of vertical transmission of ToTV, seed transmission can be very important for long-distance virus dissemination. Dispersal of infected seeds through the international seed trade explains the spread of ToTV between continents.

Damage Potential: Tomato fruit production is seriously reduced in fields where infection from ToTV is widespread (Verbeek et al., 2007; Alfaro-Fernandez et al., 2008). Disease severity is correlated with high population levels of whiteflies. Whiteflies can be difficult to control in fields and greenhouses. Some whiteflies directly damage tomatoes in addition to acting as virus vectors (Natwick et al., 2013).

Worldwide Distribution: Australia, Colombia, Morocco, Panama, South Africa, Spain (CABI CPC, 2021).

Official Control: ToTV is a quarantine pest in Tunisia (EPPO, 2021), and it is on USDA PCIT's harmful organism list for Georgia, Japan, Republic of Korea and United Kingdom (USDA-PCIT). It is a quarantine pest in the United States, and its hosts are designated as "not authorized pending pest risk analysis", with imports not allowed from any country except Canada.

California Distribution: None

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:** This pathogen is likely to establish wherever its hosts and vectors can survive.

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 *Solanum* spp. and many types of weeds from multiple plant families.

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:** This pathogen replicates in the cells of its hosts, and is spread by an efficient, flying vector that under favorable conditions, can build up to high populations. It is also seed-borne.

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:** There are reports of serious damage to tomato plants from this pathogen. The severity of disease seems to depend on the population of whitefly vectors in the fields. Due in part to this pathogen, tomato plants for planting are prohibited from entering the United States from all other countries except Canada.

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:** The virus may infect and accumulate in weed species, which serve as a potential source of inoculum to economically important plant-hosts including tomatoes. Controlling whiteflies is important in preventing severe epidemics of ToTR.

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 torrado virus*:* 14

Add up the total score and include it here. **High**
-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* ***= 14***

Uncertainty:

ToTV has been detected in mixed infections with other viruses (i.e. Pepino mosaic virus in Spain, and Cucumber mosaic virus in Panama), but it is not known whether this might play a role in the disease severity.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for Tomato torrado virus is A.

References:

Alfaro-Fernández, A., C. Córdoba-Sellés, M.C. Cebrián, J.A. Herrera-Vásquez, J.A. Sánchez-Navarro, M. Juárez, A. Espino, R. Martín, and C. Jordá. 2008. First Report of Tomato torrado virus on Weed Hosts in Spain. Plant Disease. 92(5): 831.

Amari, K., D. Gonzalez-Ibeas, P. Gómez, R.N. Sempere, M.A. Sanchez-Pina, M.A. Aranda, J.A. Diaz-Pendon, J. Navas-Castillo, E. Moriones, J. Blanca, M.D. Hernandez-Gallardo, and G. Anastasio. 2008. Tomato torrado virus is Transmitted by Bemisia tabaci and Infects Pepper and Eggplant in Addition to Tomato. Plant Disease. 92(7): 1139.

CABI Crop Production Compendium 2021. Tomato torrado virus. https://www.cabi.org/cpc/datasheet/108046 accessed 9/8/21

EPPO Global Database. 2021. https://gd.eppo.int/taxon/ TOTV00. Accessed 9/8/2021

Moodley, V., Gubba, A. and Mafongoya, P.L., 2020. Emergence and full genome analysis of Tomato torrado virus in South Africa. Viruses, 12(10), p.1167.

Natwick, E. T., Stoddard, C. S., Zalom, F. G., Trumble, J. T., Miyao, G., Stapleton, J. J. 2013. UC IPM Pest Management Guidelines: Tomato: UC ANR Publication 3470

Pospieszny, H., Budziszewska, M., Hasiów-Jaroszewska, B., Obrępalska-Stęplowska, A. and Borodynko, N., 2010. Biological and molecular characterization of Polish isolates of Tomato torrado virus. Journal of Phytopathology, 158(1), pp.56-62.

Pospieszny, H., Borodynko-Filas, N., Hasiów-Jaroszewska, B., Rymelska, N. and Elena, S.F., 2019. Transmission rate of two Polish Tomato torrado virus isolates through tomato seeds. Journal of General Plant Pathology, 85(2), pp.109-115.

Sanfaçon, H., Wellink, J., Le Gall, O., Karasev, A., Van der Vlugt, R. and Wetzel, T., 2009. Secoviridae: a proposed family of plant viruses within the order Picornavirales that combines the families Sequiviridae and Comoviridae, the unassigned genera Cheravirus and Sadwavirus, and the proposed genus Torradovirus. Archives of virology, 154(5), pp.899-907.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. Tomato torrado virus. Accessed 9/8/21

Verbeek, M., Dullemans, A.M., Van den Heuvel, J.F.J.M., Maris, P.C. and Van der Vlugt, R.A.A., 2007. Identification and characterisation of tomato torrado virus, a new plant picorna-like virus from tomato. Archives of virology, 152(5), pp.881-890.

Verbeek, M., Dullemans, A.M., Van den Heuvel, J.F.J.M., Maris, P.C. and Van der Vlugt, R.A.A., 2008. Tomato marchitez virus, a new plant picorna-like virus from tomato related to tomato torrado virus. Archives of virology, 153(1), pp.127-134.

Verbeek, M.; van Bekkum, P.; Dullemans, A.; van der Vlugt, R.A.A. 2014. Semi-persistent and stylet-borne manner by three whitefly vectors. Virus Res., 186.

Wintermantel, W.M.; Hladky, L.L.; Cortez, A.A. 2018. Genome sequence, host range, and whitefly transmission of the torradovirus Tomato necrotic dwarf virus. Acta Hortic., 1207, 295–302

Responsible Party:

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***Comment Period: 10/13/2021 through 11/27/2021**

***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: A
