cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Tomato spotted wilt virus

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Viruses and viroids, Category: Riboviria

Phylum: Negarnaviricota, Subphylum: Polyploviricotina

Class: Ellioviricetes, Order: Bunyavirales

Family: Tospoviridae, Genus: Orthotospovirus

Comment Period: 6/30/2020 through 8/14/2020

Initiating Event:

On August 9, 2019, USDA-APHIS published a list of "Native and Naturalized Plant Pests Permitted by Regulation". Interstate movement of these plant pests is no longer federally regulated within the 48 contiguous United States. There are 49 plant pathogens (bacteria, fungi, viruses, and nematodes) on this list. California may choose to continue to regulate movement of some or all these pathogens into and within the state. In order to assess the needs and potential requirements to issue a state permit, a formal risk analysis for Tomato spotted wilt virus (TSWV) is given herein and a permanent pest rating is proposed.

History & Status:

Background: Named after **To**mato **spo**tted wilt virus, the family **Tospo**viridae includes species able to infect both insect vector, thrips (family Thripidae), and plant hosts. In plant pathology, viruses are often named after the first host they are described on and the most significant symptom they cause. "Spotted wilt" disease of tomato was first described in Australia in 1915. TSWV was the only member of the genus Tospovirus (now Orthotospovirus) until closely related Impatiens necrotic spot virus was characterized and added (Law and Moyer, 1990). The genus Orthotospovirus now contains TSWV as the type member and more than thirty distinct virus species. Most of them are more host specific than TSWV, and they can be separated by serological and molecular techniques (Agrios, 2005; Sherwood et al., 2003).

Tospoviruses cause disease epidemics in tropical, subtropical, and temperate regions of the world. The widespread distribution seems to be the result of international movement of infected ornamentals. Tospoviruses are transmitted by thrips and replicate in both the thrips vectors and their plant hosts. Local incidence and severity depends on the populations of thrips vectors. TSWV has an extremely wide host range, infecting more than a thousand species of ornamentals, vegetables, fruits, and other annual and perennial plants, both monocots and dicots in more than 80 families. Solanaceous, composite, and leguminous plants are particularly vulnerable and some of the hosts most severely affected are tomato, tobacco, peanut, pineapple, papaya, lettuce, dahlia, gloxinia, and impatiens (Sherwood et al., 2003).

Hosts: Over 1000 species in over 85 families, including many vegetables, peanut, and tobacco. The host list includes annuals, perennials, and weeds, with important agronomic and ornamental species. In some areas the virus has been found to be widespread and ubiquitous in the environment, infecting many weeds, landscape plants, and native plants (CABI-CPC, 2020; Brundt et al., 1996).

Symptoms: The symptoms of tospoviruses vary greatly with the host affected, plant organ affected, and age of plant or organ at the time of infection. In general, however, tospovirus symptoms appear as chlorotic or necrotic rings, lines, or spots on leaves, stems, and fruits; necrotic streaks on stems; bronzing, curling, and wilting of leaves; rings, necrotic spots, and malformations on fruits; stunting and necrosis of parts or whole plants; and, generally, greatly reduced yields (Agrios, 2005; Sherwood et al., 2003; UC IPM, 2020).

Transmission: Tospoviruses survive year-to-year in perennial or biennial hosts and flying thrips transmit them to annual hosts. Additionally, viruliferous thrips may overwinter in the field. TSWV can be transmitted by at least 10 species of thrips. These include three species that are in California, the western flower thrips (*Frankliniella occidentalis*), and onion thrips (*Thrips tabaci*), both of which are widespread, and tobacco thrips (*F. fusca*), which occurs in Southern California. Important thrips vectors of TSWV that are not in California are the common blossom thrips (*F. schultzei*) and melon thrips (*T. palmi*). Tospoviruses can be acquired when thrips larvae feed on infected plants but adults do not acquire the virus by feeding. The virus can multiply inside the thrips. Once a larva has the virus, it will retain the virus through molting, pupation, and emergence, so that adult thrips will be viruliferous and can transmit the virus to healthy plants. Inoculation feeding periods generally need to be 30 minutes or longer for the thrips to acquire TSWV. Once introduced by thrips feeding, the virus spreads into phloem and parenchyma cells and multiplies in the cytoplasm. Mature individual viral particles or groups of viral particles are always surrounded by irregularly shaped membranous cisternae that can be seen with microscopy inside infected leaves (Agrios, 2005; Sherwood et al., 2003).

Although it is not seed borne, TSWV can be easily spread by the movement of infected but asymptomatic plants. Spread with infected ornamentals is most likely responsible for the movement of TSWV around the globe (CABI-CPC, 2020).

Damage Potential: TSWV may affect both yield and quality. For example, tomato or pepper plants can be stunted or even killed, and the fruit can be damaged by the appearance of virus symptoms. Losses are proportional to the number of plants infected early in the season by the virus, and infection rates

reaching 50 to 90% are common (UC IPM). Losses are high in cut flowers where chrysanthemum crops can suffer near total losses, and calla lilies, gerbera daisies, dahlias, and phalaenopsis orchids are unmarketable due to malformations and color breaks (Kazinczi et al., 2007; Daughtrey et al., 1997). Although TSWV is not seed transmitted, it may cause the discoloration of seed from infected mother plants.

For peppers and tomatoes, two large California crops that are seriously affected, TSWV has been managed largely through the planting of resistant cultivars. In 2016, severe disease symptoms including stunting, leaf, stem, and petiole necrosis, and concentric rings on fruits appeared in fields of fresh market tomato cultivars with the Sw-5 gene, which confers resistance to TSWV, in Fresno County. Disease incidences there reached 50 to 80%. Batuman et al. (2017) concluded that a TSWV strain has emerged in California that can infect tomato cultivars with the Sw-5 gene. In 2017 and 2018, sweet peppers with the *Tsw* gene for TSWV resistance with ringspot symptoms typical of spotted wilt were found in multiple counties (Macedo et al., 2019). This ability of the pathogen to evolve with new strains able to overcome host resistance genes is a major threat to California production. University of California, Riverside runs a TSWV field risk index and thrips projections website to help growers of lettuce, tomatoes, and peppers in the Central Valley (https://ucanr.edu/sites/TSWVfieldriskindex/).

Worldwide Distribution: Africa: *Algeria, Burkina Faso, Democratic Republic of the Congo, Cote d'Ivoire, Egypt, Kenya, Libya, Madagascar, Mauritius, Niger, Nigeria, Reunion, Senegal, South Africa, Sudan, Tunisia, Tanzania, Uganda, Zimbabwe*; Americas: *Argentina, Ecuador, Bolivia, Brazil, Canada, Chile, Colombia, Costa Rica, Dominican Republic, Guyana, Haiti, Jamaica, Mexico, Paraguay, Puerto Rico, Suriname, United States of America* (Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Hawaii, Idaho, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin, Wyoming), *Uruguay, Venezuela;* Asia: *Afghanistan, China, India, Indonesia, Iran, Israel, Japan, Jordan, Republic of Korea, Lebanon, Malaysia, Nepal, Oman, Pakistan, Saudi Arabia, Sri Lanka, Syria, Taiwan, Thailand;* Europe: *Albania, Armenia, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, France, Georgia, Germany, Greece, Guernsey, Hungary, Ireland, Italy, Lithuania, Malta, Moldova, Montenegro, Netherlands, North Macedonia, Poland, Portugal, Romania, Russia, Serbia, Slovenia, Spain, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom;* Oceania: *Australia, Cook Islands, New Zealand, Papua New Guinea* (CABI CPC, 2020; EPPO, 2020).

Official Control: USDA Harmful Organism List: Albania, China, European Union, French Polynesia, Georgia, Guatemala, Holy See (Vatican City State), Honduras, India, Israel, Indonesia, Japan, Madagascar, Malaysia, Mexico, Monaco, Morocco, New Caledonia, Nicaragua, Nigeria, Norway, Oman, Panama, Philippines, San Marino, Serbia, Sri Lanka, Thailand, Timor-Leste, Tunisia, Turkey, United Arab Emirates (USDA PCIT, 2020; EPPO, 2020).

California Distribution: Detections have been made in 24 counties across California (French, 1989).

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:** There are abundant and diverse hosts throughout all climactic regions of the state. There may be limitations by season for larval thrips to acquire the virus.

   Evaluate if the pest would have suitable hosts and climate to establish in California.

   Score: **3**
   - 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 of this virus is extremely large including important flower and vegetable crops for California.

   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:** Thrips vectors are common in vegetable fields and greenhouses where many important TSWV hosts are grown. Thrips adults can fly and infect new hosts.

   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:** TSWV can be a major problem for pepper and tomato growers in Southern California and the Central Valley. Economic losses to California tomato producers can be up to 90% of plants damaged when there are large populations of western flower thrips and TSWV strains that can overcome host resistance genes. Other important crops affected include lettuce, peppers, eggplant, beans, cabbage, celery, artichokes, potatoes, chrysanthemums, petunias, impatiens, gladiolus, and ranunculus (Trumble et al.). TSWV is a quarantine pest for some trading partners (USDA PCIT).

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

Economic Impact: A, B, C, D, 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 host range of TSWV is very large and includes many native plants that can be directly affected and serve as a reservoir for virus and thrips that move onto healthy plants. Greenhouses may need screens to keep out thrips or apply insecticides for thrips control.

Environmental Impact: A, B, 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 spotted wilt virus: High

Add up the total score and include it here. **15**
-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* **= 12**

Uncertainty:

TSWV has the ability to evolve new strains that can overcome host resistance genes, leading to severe disease outbreaks in previously resistant cultivars of peppers and tomatoes.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for **Tomato spotted wilt virus is C.**

References:

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Responsible Party:

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***Comment Period:** 6/30/2020 through 8/14/2020

***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
