

California Pest Rating Proposal for

Tobacco mosaic tobamovirus

Current Pest Rating: C

Proposed Pest Rating: C

Realm: Riboviria; Phylum: incertae sedis

Family: Virgaviridae; Genus: Tobamovirus

Comment Period: 5/5/2020 through 6/19/2020

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 Tobacco mosaic virus is given herein and a permanent pest rating is proposed.

History & Status:

Background: Tobacco mosaic virus (TMV) is the type member of a large group of viruses that forms the genus Tobamovirus. TMV has rod-shaped virus particles (virions). A single TMV virion is composed of a coat protein that envelopes one positive single-stranded RNA. This single-stranded RNA encodes four genes: two replicase-associated proteins that are directly translated from the TMV RNA and the movement protein and a coat protein that are translated from subgenomic RNAs.

When study of the tobacco mosaic disease began in 1886, it was the first time that any disease was shown to be caused by a “fluid” without any pathogenic fungi or bacteria. In 1935, TMV was the first virus to be isolated in crystal form. In 1939, the first electron microscope photographs of TMV gave solid evidence of what a virus looks like. Later, in the mid-1950s, TMV was used to demonstrate that the viral RNA was responsible for causing infection. TMV RNA was also the first plant virus RNA to be sequenced and it was also the first for which monoclonal antibodies were produced. In addition to becoming a model system to study host-pathogen interactions, TMV is also used as a vector for the

expression of foreign genes and peptides. Methodologies developed to study TMV have been applied to the study of viruses affecting humans, animals, and microbes (Agrios, 2005; Scholthof, 2000; 2004).

Hosts: Most important hosts of TMV are solanaceous plants including tobacco (*Nicotiana tabacum*) and tomato (*Lycopersicon esculentum*). Additional hosts include *Beta vulgaris*, *Capsicum frutescens*, *Chenopodium amaranticolor* (syn *C. giganteum*), *Chenopodium hybridum*, *Chenopodium quinoa*, *Datura stramonium*, *Lactuca sativa*, *Lycopersicon pimpinellifolium*, *Nicotiana benthamiana*, *Nicotiana bigelovii*, *Nicotiana clevelandii*, *Nicotiana debneyi*, *Nicotiana glutinosa*, *Nicotiana rustica*, *Nicotiana sylvestris*, *Papaver nudicaule*, *Phaseolus vulgaris*, *Physalis floridana*, and *Physalis peruviana*.

Symptoms: Infected susceptible tobacco plants can show abnormal growth and stunting with distorted and dwarfed leaves. Discoloration appears on young leaves 5-6 days after infection, followed by a mottling or mosaic pattern of light and dark-green areas, and later by blistering and fern-shaped leaves (Scholthof, 2000). However, infection of TMV produces local necrotic lesions in tobacco plants with a dominant resistant gene, N-gene.

On tomatoes, symptoms vary with the cultivar and the specific strain. A mild mosaic can develop on leaves with some leaf malformation, including a fern-like appearance. During cooler weather, shoestring-like symptoms appear on leaves. Infection with TMV can be confused with Cucumber mosaic virus or Tomato mosaic virus and plants can be co-infected with multiple viruses. Necrotic patterns may develop on fruit (Davis et al., 2016).

There can be severe outbreaks of TMV on greenhouse grown petunias (*Petunia × atkinsiana*), which are also members of the Solanaceae family. Yellow mottling or mosaic patterns can be seen on leaves, but infected plants can have less obvious symptoms such as stunted growth or yellowing leaves that could be confused with a nutrient deficiency. Other symptoms include distorted growth or lesions on leaves, necrotic tip dieback, strapped shaped or rat-tailing of leaves and yellowing along the leaf veins. Blossoms can be deformed and mottled and could also have color breaks (Pscheidt and Ocamb, 2019).

Transmission: TMV can be easily transmitted when leaves of infected plants rub against a leaf of a healthy plant. It is also spread by sap on contaminated tools and occasionally by workers whose hands become contaminated with TMV after smoking tobacco. The site of entry is through wounded plant cells. TMV can also contaminate seed coats, and the germinating seedlings can become infected. TMV is extraordinarily stable. Purified TMV has been reported to be infectious after 50 years storage in the laboratory at 4°C/40°F. In general, TMV is not considered as insect transmissible. There is some evidence that bumble bees can transmit Tobamovirus in the greenhouse when they are used for pollination (Agrios, 2005; Balique et al., 2012; Scholthof, 2000).

Damage Potential: Tobamoviruses can cause serious losses to their hosts by damaging the leaves, flowers, and fruits and by causing stunting of the plants. The losses are greatest when the plants are infected young. TMV is prevalent in many ornamentals in greenhouses and botanical gardens, likely as a result of transmission from contaminated tobacco products (Agrios, 2005). Losses in agronomic crops have been minimized by the development and selection of TMV resistance genes in susceptible hosts.

Not all susceptible species support systemic movement of virus, many localize the virus in necrotic lesions elicited at the infection points. This is called a hypersensitivity reaction and it limits the virus to small areas, preventing systemic movement and more extensive damage to the host. Hypersensitive varieties are available for tobacco, tomato and pepper (Scholthof, 2000).

Worldwide Distribution: Widespread worldwide (CABI-CPC, 2020).

Official Control: USDA- PCIT harmful organism list for Canada, French Polynesia, Georgia, Honduras India, Japan, Mexico, Namibia, Nicaragua, Panama, Syrian Arab Republic, and Taiwan (USDA, 2020). The EPPO lists TMV as a regulated non-quarantine pest in Egypt and quarantine pest Mexico, and it is on the A2 quarantine list for Jordan (EPPO, 2020).

California Distribution: Widespread in California, the most common hosts are pepper and tomato (French, 1989).

California Interceptions: none

The risk Tobacco mosaic virus would pose to California is evaluated below.

Consequences of Introduction:

- 1) Climate/Host Interaction:** Tobacco mosaic virus has hosts in temperate and tropical climates, climate will not be a limiting factor.

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:** This virus has a large host range with hosts in multiple 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:** Tobacco mosaic virus requires a living host to reproduce but it is particularly stable and long lasting. It can survive for years in perennial plants, in harvested and processed tobacco, on seeds, and in crop debris.
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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: Damage from TMV has been recorded on vegetables and ornamentals.

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

Economic Impact: A, B

- 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: 2

- 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: Strict sanitation is necessary to prevent the spread of this virus, particularly in hand harvested crops such as cucurbits and tomatoes. It also spreads easily in greenhouse crops.

Environmental Impact: 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: 2

- 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.
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Consequences of Introduction to California for Tobacco mosaic 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'. Tobacco mosaic virus has been reported for many years in multiple counties.

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:

None

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for Tobacco mosaic virus is C.**

References:

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Responsible Party:

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***Comment Period: 5/5/2020 through 6/19/2020**

***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](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: C
