cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Watermelon mosaic virus

Realm: Riboviria; Kingdom: Orthornavirae
Phylum: Pisuviricota; Class: Stelpaviricetes
Order: Patatavirales; Family: Potyviridae
Genus: Potyvirus

Current Pest Rating: C

Proposed Pest Rating: C

Watermelon mosaic virus symptoms on watermelon fruit

Comment Period: 12/07/2020 through 01/21/2021

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 Watermelon mosaic virus (WMV) is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Watermelon mosaic virus is a positive sense ssRNA virus in the family Potyviridae and in the genus Potyvirus. Named after **Pot**ato virus **Y**, this is a large genus and includes many of viruses causing the most severe viral diseases of crop plants. Potyvirus virions are flexuous filaments and the infection produces cylindrical inclusion bodies that look like pinwheels and scrolls in infected plant cells. These cytoplasmic inclusions appear as fibrillar masses using the orange-green stain for light microscopic detection of viral inclusions but do not have virions in them (Christie and Edwardson, 1986). Potyviruses are transmitted mainly by aphids in a nonpersistent manner, and some are also transmitted through the seed in addition to the insect vectors.

Mosaic diseases caused by arthropod-borne viruses are a worldwide problem in cucurbits and a chronic problem for California growers. Four aphid-vectored viruses are known to occur in the major cucurbit growing areas in California, and they are watermelon mosaic virus (formerly known as watermelon mosaic virus 2), papaya ringspot virus-watermelon strain (formerly known as watermelon mosaic virus 1), zucchini yellow mosaic virus, and cucumber mosaic virus (Dodds et al., 1984; Cardwell-Grafton et al., 1996). Watermelon mosaic virus also infects peas and other leguminous, malvaceous, and chenopodiaceous crop plants, ornamentals, and weeds, but cucurbits are the primary hosts. Watermelon mosaic virus is transmitted by at least 38 species of aphids in the nonpersistent manner (CABI- CPC, 2020).

In 1965, Webb and Scott, using serology, divided strains of WMV into two groups, naming them WMV-1 and WMV-2. Subsequent work by Abu-Samah in 1985 using nucleotide sequencing showed that WMV-2 was a distinct virus and that WMV-1 was a strain of Papaya ringspot virus. Some virologists believed isolates of Soybean mosaic virus-N were strains of WMV-2 (Frenkel et al., 1989), although later studies showed they were distinct viral species (Jayaram et al., 1991). In 2000, the International Committee on Taxonomy of Viruses changed the name for the species formally known as Watermelon mosaic virus-2 back to Watermelon mosaic virus (WMV) (van Regenmortel et al., 2000).

Hosts: Citrullus lanatus (watermelon), *Cucumis anguria* (West Indian gherkin), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita moschata* (pumpkin), *Cucurbita pepo* (marrow), *Daucus carota* (carrot), *Dendrobium anosmum*, *Lagerstroemia indica* (Indian crape myrtle), *Luffa aegyptiaca* (loofah), *Malva verticillata*, *Momordica charantia, Panax ginseng* (Asiatic ginseng), *Passiflora edulis* (passionfruit), *Pisum sativum* (pea), *Robinia pseudoacacia* (black locust), *Solanum lycopersicum* (tomato) (CABI-CPC). Brunt et al. (1996) list additional experimental hosts.

Symptoms: WMV symptoms can be very severe and cause significant yield reductions. Symptoms can be diverse, depending on the host species and the cultivar, but the most damaging symptoms are those that occur on the fruit. Disease symptoms include mosaic and leaf distortion on watermelon, systemic mottle or mosaic and occasional leaf malformation on pumpkin and squash, systemic mottle or mosaic and occasional leaf malformation with dark green patches/blotches on the normally yellow-colored surfaces of melons, and necrotic local lesions.

If the plant is infected early in its growth, before fruit is formed, fewer flowers may be produced and the fruit may be aborted, causing partial or entire loss of the crop (Grafton-Cardwell et al., 1996). Fruits that exhibit severe malformations and color alterations are unmarketable (Davis et al., 2020). Intricate, superficial ringspots and spiral patterns can develop on the surface of watermelon fruit. Systemic mottling and necrosis on pea can occur. WMV often occurs in mixed infections with other viruses such as Cucumber mosaic virus and Zucchini yellow mosaic virus, which may mask or modify the symptoms (CABI-CPC, 2020).

Transmission: WMV is spread from plant to plant by several species of aphids in a non-persistent manner. Primarily in California it is spread by the cotton-melon aphid, *Aphis gossypii*, and the green peach aphid, *Myzus persicae*. These aphids are widespread in the state and can transmit WMV in seconds simply by probing or sampling a plant. California research shows that that low numbers of aphids can cause a high level of disease if a source of virus inoculum is nearby (Umesh et al., 1995).

WMV is not known to be seed transmitted. Although the virus is short lived outside of the plant, it can easily be mechanically transmitted between adjacent plants through handling and pruning, which is an issue for greenhouse-grown cucurbits such as cucumbers.

Damage Potential: WMV infection reduces fruit production and quality in watermelons and other cucurbits. Alonso-Prados et al. (1997) reported a 30% reduction in production (number of fruits per plant) due to early infection of WMV on melon. Fields are often infected with multiple strains of potyvirus plus cucumber mosaic virus, making estimates of damage specifically for WMV more difficult (Umesh et al., 1995). Cardwell-Grafton et al. (1996) surveyed central valley fields and found infection rates to vary between 7 and 100% but to commonly be between 50 and 75%. Resistant varieties have been generated by breeding programs and provide protection from WMV (Barbosa et al., 2017).

Worldwide Distribution: Africa: *Egypt, Kenya, Libya, Mauritius, Morocco, South Africa, Sudan, Tunisia, Asia: Bangladesh, China, India, Indonesia, Iraq, Israel, Japan, Jordan, Kazakhstan, Kuwait, Lebanon, Oman, Pakistan, Philippines, Saudi Arabia, South Korea, Syria, Taiwan, Turkey, Yemen*. Europe: *Bosnia, and Herzegovina, Bulgaria, Cyprus, Czechia, France, Germany, Greece, Hungary, Italy, Poland, Russia, Serbia and Montenegro, Slovenia, Spain, Ukraine*. North America: *Canada, Costa Rica, Cuba, Guadeloupe, Honduras, Jamaica, Martinique, Mexico, United States* (Alabama, Arizona, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Hawaii, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maine, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin). Oceania: *Australia, Cook Islands, Federated*

States of Micronesia, Fiji, French Polynesia, Kiribati, New Zealand, Samoa, Solomon Islands, Tonga. South America: *Argentina, Brazil, Chile, Suriname, Venezuela.*

Official Control: Watermelon mosaic virus is on the USDA's harmful organism list for Colombia, Ecuador, French Polynesia, Georgia, India, Japan, Mexico, Taiwan (USDA PCIT 2020). It is on the EPPO's A2 list for Bahrain and Jordan, Quarantine pest in Mexico, regulated non-quarantine pest Egypt (EPPO, 2020).

California Distribution: Alameda, Butte, Colusa, Fresno, Glenn, Imperial, Kern, Madera, Mendocino, Merced, Monterey, Orange, Riverside, Sacramento, San Benito, San Bernardino, San Diego, San Joaquin, San Mateo, Santa Barbara, Santa Clara, Solano, Stanislaus, Sutter, Tehama, Ventura, Yolo, and Yuba Counties (CDFA Database, 2020).

California Interceptions:

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

Consequences of Introduction:

1) **Climate/Host Interaction:** WMV is widespread in California in all areas where cucurbit production is done for fruit including throughout the Central Valley, along the coast, and in the desert.

   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 includes cucurbits plus plants in a few other families.

   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:** This virus multiplies in the sap of infected hosts. It can be moved easily but in a nonpersistent method by aphids. It can overwinter in adult aphids and in weeds.

   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:** WMV is controlled with resistant varieties and by preventing large populations of vectors. It is far more impactful when there are multiple viruses co-infecting plants (Umesh et al., 1995; Davis et al., 2020).

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

Economic Impact: A, 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: **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:** WMV can be found in wild and volunteer cucurbits, and occurs in weeds such as goosefoot, lambsquarters, Russian thistle, various legumes, cheese weed and other related plants. These can be an overwintering source of inoculum to new cucurbit crops.

Environmental Impact: A

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.

Consequences of Introduction to California for Watermelon mosaic virus: Medium

Add up the total score and include it here. **11**
-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'. WMV is found in all major cucurbit growing areas of the state

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* **= 8**

Uncertainty:

There are multiple of species in the family Cucurbitaceae that are native and naturalized in California including *Brandegea bigelovii* (desert star-vine), which is native in the deserts of southern California and Arizona, and three wild *Cucurbita* species (*C. digitata, C. foetidissima,* and *C. palmata*). The latter two occur in both the deserts and Central Valley. Species of *Marah* (man-root), such as *M. fabacea* and *M. watsonii*, are also native in the Central Valley, and *M. macrocarpa* is found in the deserts of southern California. Cultivated plants of *Citrullus* (watermelon), *Cucumis* (cucumber, melon), and *Cucurbita* (squashes, pumpkins, and gourds) are widely present in California including the Central Valley and desert and are known to escape locally in disturbed/agricultural habitats, and the small-fruited feral dudaim melon (*C. melo* var. *dudaim*) is present in Imperial County (Dr. R. Price, CDFA Primary Botanist, pers. comm.). These should be assumed to be potential hosts of WMV and/or aphid vectors. They could be negatively impacted by virus infection or serve as reservoir hosts for agronomic hosts.

Conclusion and Rating Justification:

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

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*Comment Period: 12/07/2020 through 01/21/2021

*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: C