cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Papaya ringspot virus

Current Pest Rating: C

Proposed Pest Rating: C

Domain: Virus, Group: Positive sense ssRNA viruses,

Family: Potyviridae, Genus: Potyvirus

Comment Period: 10/13/2020 through 11/27/2020

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 Papaya ringspot virus is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Papaya ringspot virus (PRSV) is in the genus Potyvirus, a large and economically important group of plant-infecting viruses in the family Potyviridae named after the type species Potato virus Y. The genome is a monopartite single-stranded positive-sense RNA. The virions are filamentous, flexuous particles and they induce cylindrical pinwheel inclusions in the cytoplasm of plant cells. As is typical for potyviruses, PRSV is transmitted by aphids in a nonpersistent manner. PRSV has been found worldwide causing very damaging symptoms on papaya and cucurbits (CABI-CPC).

Previously, PRSV was thought as two separate viruses: Papaya ringspot virus on papaya, and Watermelon mosaic virus-1 (there is also a different virus named Watermelon mosaic virus-2) on cucurbits. Serological studies have shown that they are biotypes of the same virus (Gonsalves and Ishii, 1980). Today there are two major biotypes or strains of PRSV based on host range. The papaya

infecting type (PRSV-P) affects both papaya and cucurbits, and the cucurbit infecting type (PRSV-W) affects cucurbits only (Yeh et al., 1992).

The papaya-infecting strains of PRSV-P cause extensive damage to papaya production throughout the tropics and subtropics (Yeh et al., 1992). In the 1990s, genetically engineered papayas with pathogen-derived resistance to PRSV-P were developed by USDA-ARS in Hawai'i. This was the first genetically engineered fruit crop to be commercialized. It was done by creating transgenic papayas, transformed by the addition of a coat protein gene from PRSV-P. The transgenic papayas are otherwise identical to commercial cultivars, and the engineered trait is stably transmitted by seed. Disease resistant, transgenic plants represent 70% of Hawaiian papaya production (Gonsalves et al., 2010).

Hosts: Carica papaya (papaya), *Citrullus lanatus* (watermelon), *Cucumis anguria* (West Indian gherkin), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita moschata* (squash), *Cucurbita maxima* (pumpkin), *Cucurbita pepo* (squash), *Lagenaria siceraria* (bottle gourd), *Momordica charantia* (bitter gourd), *Pisum sativum* (pea), *Ricinus communis* (castor bean), *Robinia pseudoacacia* (black locust), *Siraitia grosvenorii* (luo han guo).

Symptoms: The two most important hosts of PRSV are papayas (PRSV-P strains) and cucurbits (PRSV-P and W strains). Both types of hosts are systemically infected.

In papaya, fruits from infected trees can have bumps and often have dark green 'ringspots', which is the basis for the disease's common name. The leaves develop prominent mosaics and chlorosis on the leaf lamina. Water-soaked oily streaks appear on the petioles and upper part of the trunk. Young leaves and seedlings can show severe symptoms of distortion that result in the development of a shoestring appearance. Young trees remain stunted and will not produce an economical yield. A severe PRSV isolate from Taiwan has been shown to induce systemic necrosis and wilting along with mosaic and chlorosis (Gonsalves et al., 2010).

In cucurbits, the first symptoms are oily streaks on the younger leaves with clearing along the veins that gives a flecked appearance. At later stages, leaves show an intense mosaic with a narrowing of the leaves. Severe cases can result in a shoestring effect that is similar to what is observed in papaya. Plants that become infected at a young age do not develop a fruit crop. Older plants that become infected do produce fruit that often show distinct changes in color and are deformed with green blotches and bumps (Gonsalves et al., 2010).

Transmission: Transmitted by aphid vectors in a non-persistent manner without an incubation period. The most important aphid vectors are the green peach aphid, *Myzus persicae,* and the cotton aphid *Aphis gossypii.* It does not replicate inside the aphids. It is also spread mechanically but seed transmission has not been observed in cucurbits or papaya (CABI-CPC). It is common for cucurbits in California to be co-infected with PRSV-W and other potyviruses and cucumoviruses (Umesh et al., 1995; Grafton-Cardwell et al., 1996).

Damage Potential: PRSV-P is one of the most destructive diseases of papaya and occurs in nearly every papaya growing region of the world. It is a major limiting factor for commercial papaya production in

Hawaii (Yeh et al., 1002; CABI-CPC, 2020). Southern California has residential papaya, but commercial production is limited to greenhouses in Santa Barbara County. PRSV causes of serious losses worldwide in cucurbit crops in tropical, subtropical, and temperate regions. California surveys have found PRSV to be widespread but present at a relatively low frequency compared to other important cucurbit viruses (Umesh et al., 1995; Grafton-Cardwell et al., 1996).

Worldwide Distribution: Africa: *Côte d'Ivoire, Egypt, Mauritius, Nigeria, Tanzania, Tunisia, Uganda*. Asia: *Bangladesh, China, India, Indonesia, Iran, Israel, Japan, Lebanon, Malaysia, Nepal, Pakistan, Philippines, Singapore, Sri Lanka, Syria, Taiwan, Thailand, Turkey, Vietnam, Yemen*. Europe: *Cyprus, Finland, France, Germany, Italy, Poland, Spain*. North America: *Bahamas, British Virgin Islands, Costa Rica, Cuba, Dominican Republic, El Salvador, Guadeloupe, Honduras, Jamaica, Mexico, Puerto Rico, Saint Kitts and Nevis, Trinidad and Tobago, U.S. Virgin Islands, United States* (Alabama, Arizona, Arkansas, California, Delaware, Florida, Georgia, Hawaii, Illinois, Indiana, Kansas, Louisiana, Maine, Michigan, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas, Utah, Vermont, Virginia, Washington, Wisconsin). Oceania: *Australia, Cook Islands, French Polynesia, Papua New Guinea, Samoa, Solomon Islands, Tonga*. South America: *Brazil, Colombia, Ecuador, Paraguay, Venezuela.*

Official Control: PRSV is on USDA PCIT's Harmful organism list for French Polynesia, Georgia, Guatemala, Japan, New Caledonia, New Zealand, Panama (USDA-PCIT, 2020) and on the EPPO A2 quarantine list for Bahrain, Egypt, and Jordan (EPPO, 2020).

California Distribution: Colusa, Glenn, Kern, Los Angeles, Merced, Orange, San Benito, San Joaquin, Solano, Sutter, Tehama, and Yolo counties (French, 1989; CDFA Pest Damage Records, accessed 9/14/2020).

California Interceptions: none

The risk Papaya ringspot virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** PRSV and its vectors are widely distributed in the main cucurbit production areas of the central valley and seed production areas in northern California.

   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 plants from multiple families, but most are cucurbits.

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:** The pathogen multiples and is spread non persistently by a variety of aphid species, it can also be seed borne in some hosts (but not in cucurbits).

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:** PRSV is one of several important viruses of cucurbits in California. Although seed transmission has not been proven, trading partners often require that mother plants grown for export seed be free from all viruses (CDFA phytosanitary inspection manual, 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:** No significant environmental impacts have been described from PRSV in California, but native cucurbits could be minor hosts.

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 Papaya ringspot virus are: Medium

Add up the total score and include it here. **12**
-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'. Papaya ringspot virus has been widespread in cucurbits in California for decades.

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* **= 9**

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 of which 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 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 PRSV 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 Papaya ringspot virus is C.

References:

CABI Crop Production Compendium 2020. Papaya ringspot virus. Accessed 9/14/2020 https://www.cabi.org/cpc/datasheet/45962

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Gonsalves, D., S. Tripathi, J. B. Carr, and J. Y. Suzuki. 2010. Papaya Ringspot virus. The Plant Health Instructor. DOI: 10.1094/PHI-I-2010-1004-01

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Umesh, K.C., Valencia, J., Gubler, W.D. and Falk, B.W., 1995. The incidence of aphids and aphid transmitted viruses in melon cultivars and breeding lines in California. Phytopathology, 85, p.1042.

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Responsible Party:

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***Comment Period: 10/13/2020 through 11/27/2020**

***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