CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Soybean mosaic virus

Current Pest Rating: none

Proposed Pest Rating: C

Kingdom: Orthornavirae; Phylum: Pisuviricota

Class: Stelpaviricetes; Order: Patatavirales

Family: Potyviridae; Genus: Potyvirus

Comment Period: 6/15/2020 through 7/30/2020

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

History & Status:

Background: The family Potyviridae contains six genera and members are notable for forming cylindrical inclusion bodies in infected cells that can be seen with light microscopy. Of the six genera, the genus Potyvirus contains by far the highest number of important plant pathogens Named after Potato virus Y, "pot-y-virus" particles are flexuous and filamentous and composed of ssRNA and a protein coat. Most diseases caused by potyviruses appear primarily as mosaics, mottling, chlorotic rings, or color break on foliage, flowers, fruits, and stems. Many cause severe stunting of young plants and drastically reduced yields with leaf, fruit, and stem malformations, fruit drop, and necrosis (Agrios, 2005).

Soybean is one of the most important sources of edible oil and proteins for people and animals, and a source of biofuel. There is very limited soybean production in California, but soybean is occasionally

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grown for export seed or in rotation with other field or vegetable crops. Soybean mosaic virus (SMV) is one of the most common diseases of soybeans worldwide. It can cause severe economic damage on susceptible varieties and is considered among the most serious pathogens to soybean (Hill and Whitham, 2014). Since first described in Connecticut in 1915 by Clinton, it has been found in all areas where soybeans are cultivated. It is seed borne and this is the primary factor that has allowed a wide distribution. Soybean mosaic virus can be vectored non-persistently by many species of aphids, including soybean aphids. Soybean aphid is not known to be in California. Soybean mosaic virus infection will reduce soybean oil content, seed germination, and seed quality (Demski and Jellum, 1975).

Hosts: Antirrhinum majus (snapdragon), *Chenopodium album* (pigweed), *Chenopodium quinoa* (quinoa), *Crotalaria spectabilis* (showy rattlebox), *Cyamopsis tetragonoloba* (guar), *Glycine max* (soybean), *Glycine soja* (wild soybean), *Glycine wightii* (perennial soybean), *Lablab purpureus* (hyacinth bean), *Lespedeza stipulacea* (Korean clover), *Lespedeza striata* (Japanese clover), *Lupinus albus* (white lupin), *Macroptilium lathyroides* (phasey bean), *Macrotyloma uniflorum* (horse gram), *Nicandra physalodes* (shoo-fly plant), *Nicotiana benthamiana* (benth), *Nicotiana tabacum* (tobacco), *Passiflora edulis* (passionfruit), *Passiflora foetida* (red fruit passion flower), *Petunia × hybrida* (petunia), *Phaseolus lunatus* (lima bean), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Senna occidentalis* (coffee senna), *Sesbania exaltata* (hemp sesbania), *Strophostyles helvola* (trailing fuzzybean), *Vicia faba* (fava bean), *Vigna angularis* (adzuki bean) and *Vigna unguiculata* (cowpea) (CABI- CPC, 2020; Brundt et al., 1996)

Symptoms: Foliar symptoms include distorted and wrinkled leaves that have a mottled color pattern. Symptoms will be more severe on young leaves, appearing raised, blistered, or distorted. Symptoms are most pronounced at cooler temperatures and often disappear at higher temperatures. Rugosity (wrinkling) of leaves with dark green vein banding and light green interveinal areas, stunting, and leaf curling is also reported. Pods are reduced in number and size, some are malformed, glabrous or seedless, and the yield may be considerably reduced. The size of the seed is also reduced and seed quality is reduced through coat mottling. It also can cause male flower sterility flower deformation, less pubescence, and bud blight (CABI-CPC, 2020).

Proteinaceous viral inclusions are often present in SMV-infected cells. These can help with diagnosis as they can be seen inside the leaf cell cytoplasm or nucleus when stained and viewed with a light microscope. The inclusions do not contain virions and appear as cylindrical pinwheels or as bundles, scrolls, and laminated aggregates (Christie and Edwardson, 1977).

Transmission: Soybean mosaic virus can be transmitted by more than 30 species of aphids, including *Acyrthosiphon pisum*, *Aphis fabae*, *Aphis glycine*, and *Myzus persicae* (Abney et al., 1976; CABI-CPC, 2020). The soybean aphid, *Aphis glycine*, was detected in the US for the first time in 2001 by Hill et al. and is a very efficient vector (approaching 40% transmission rate after a brief probing). The soybean aphid overwinters on European buckthorn (*Rhamnus cathartica*), which is not a California native or widely planted. The soybean aphid has not been found in CA. The virus is transmitted in a non-persistent manner by the aphids feeding. It can also be transmitted by mechanical inoculation with

infected sap. Seed transmission from the mother plant to the seeds can be very high, up to 30%, and the virus can also be transmitted by pollen to the seed or transmitted by pollen to the pollinated plant (CABI-CPC).

Damage Potential: The major issue with soybean mosaic is reduced seed quality due to mottled seeds; yield is generally not affected. Mottling is associated with poor germination and may result in grain grade reduction, particularly for food-grade soybeans. Soybean mosaic virus SMV is found throughout the world wherever soybean is grown, causing yield losses of 8 to 35% (Hill, 2015). Plants infected through seed transmission serve as the primary source of inoculum in the field (Liu et al., 2016). Research has shown that yield reduction is negligible when soybean plants are infected after flowering (Irwin and Goodman 1981).

Worldwide Distribution: Africa: *Ethiopia, Morocco, South Africa, Tanzania, Uganda, Zambia, Zimbabwe*; Asia: *China, India, Iran, Iraq, Japan, Kazakhstan, Malaysia, Pakistan, Philippines, South Korea, Sri Lanka, Taiwan, Thailand, Turkey*; Europe: *Bulgaria, Croatia, Germany, Italy, Moldova, Poland, Portugal, Romania, Russia, Serbia and Montenegro, Sweden, Ukraine*; North America: *Canada, Jamaica, United States* (Hawaii, Iowa, Kentucky, Mississippi, Nebraska, New York, North Dakota, Ohio, Virginia); Oceania: *Australia, New Zealand;* South America; *Argentina, Brazil, Chile, Colombia, Ecuador, Venezuela* (CABI-CPC, 2020; Brundt et al., 1996).

Official Control: Soybean mosaic virus is on USDA-PCIT's the harmful organism list for Argentina, Bangladesh, Egypt, Georgia, Guatemala, Honduras, Japan, New Caledonia, and Panama (USDA-PCIT). Soybean mosaic virus is on the PQ list for phytosanitary seed field inspections (CDFA)

California Distribution: None

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:**

There are no climate limitations within California for SMV, however, the planting of soybeans is limited to small areas in the Sacramento and San Joaquin valleys. Alternate hosts are more widely planted.

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 is primarily soybeans but SMV has been reported on other legumes plus some woody hosts

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 is easily transmitted with aphid vectors, with seed and with infested sap.

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:** Where soybeans are an important crop, losses from SMV to susceptible soybean varieties can be high. In California, soybeans are rarely grown and SMV has not been detected on soybeans or any of the other hosts. Since this virus is mainly transmitted through seed, use of clean seed greatly decreases crop and yield loss. Soybean aphid is the most efficient vector and is not known to be in CA, but could be introduced at any time.

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

Economic Impact:

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: **1**

- **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:** None has been reported.

Environmental Impact:

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: 1
- 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 Soybean mosaic virus: Low

Add up the total score and include it here. **8**
-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.

There are no official records of Soybean mosaic virus in California

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* **= 7**

Uncertainty: none

Conclusion and Rating Justification:

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

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*Comment Period: 6/15/2020 through 7/30/2020

*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