CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Cowpea mild mottle virus
Angular mosaic of beans

Current Pest Rating: None

Proposed Pest Rating: A

Realm: Riboviria, Kingdom: Orthornavirae,
Phylum: Kitrinoviricota, Class: Alsuviricetes,
Order: Tymovirales, Family: Betaflexiviridae,
Subfamily Quinvirinae, Genus: *Carlavirus*

Comment Period: 02/14/2022 through 03/31/2022

Initiating Event:

The USDA's Federal Interagency Committee on Invasive Terrestrial Animals and Pathogens (ITAP.gov) Subcommittee on Plant Pathogens has identified the worst plant pathogens of greatest concern that are either in the United States and have potential for further spread or represent a new threat if introduced. Cowpea mild mottle virus is on their list. A pest risk assessment of this species complex is presented here, and a permanent pest rating for California is proposed.

History & Status:

Background: Cowpea mild mottle virus (CPMMV) infects a wide range of cultivated legumes and may pose a threat to United States agricultural production, especially to soybeans. This virus is transmitted by a whitefly vector, *Bemisia tabaci*, and is also known to be seed-borne. CPMMV causes mild to severe mosaic and/or necrotic symptoms in leaves, stems, and pods in beans (*Phaseolus* species), cowpeas (*Vigna* species), and soybeans (*Glycine max*). Disease severity appears dependent upon the crop species and cultivar involved. CPMMV is believed to have been introduced from western Africa, where it is presumed to be endemic, into South America, from where it has putatively spread into the Caribbean region and has been detected at one site in Florida with metagenomic sequencing (Rosario et al., 2014).

Carlaviruses are flexuous rods encapsidating a monopartite, positive-sense, single-stranded RNA genome. The type strain is Carnation latent virus. Many carlavirus species cause very mild symptoms or

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are completely symptomless. But some, such as blueberry scorch virus, can cause severe symptoms. Carlaviruses produce particles in the cytoplasm of plant cells, singly or in masses. CPMMV forms inclusion bodies having a feather-like appearance in infected cells that differs from that of inclusion bodies observed for aphid-transmitted viruses (Brunt et al., 1983). Carlaviruses are primarily transmitted non-persistently by aphids or by vegetative propagation with infected plant material, and most are of minor economic importance. CPMMV is unique as it can be very damaging and it is transmitted by the silverleaf whitefly, *Bemisia tabaci*, in a non-persistent mode Some sap transmission occurs by contact of infected and healthy plants and by handling. CPMMV is also transmitted through seed (Brown, 2020). The vector, *Bemisia tabaci*, is widespread in California and C-rated (PDR database).

Hosts: Although most of its natural hosts are leguminous species, CPMMV also occurs naturally in tomatoes in Israel and Nigeria. Isolates of the virus are readily sap-transmissible experimentally to many species of the Fabaceae, and to other families.

Arachis hypogaea (groundnut), *Browallia speciosa*, *Cajanus cajan* (pigeon pea), *Calopogonium mucunoides* (calopo), *Canavalia ensiformis* (jack bean), *Centrosema pubescens* (centro), *Chenopodium giganteum* (large lambsquarters), *Chenopodium quinoa* (quinoa), *Desmodium tortuosum* (Florida beggarweed), *Glycine max* (soybean), *Macrotyloma uniflorum* (horsegram), *Mirabilis jalapa* (four o'clock flower), *Mucuna pruriens* (velvet bean), *Nicotiana clevelandii*, *Phaseolus lunatus* (lima bean), *Phaseolus radiata*, *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Psophocarpus tetragonolobus* (winged bean), *Rhynchosia minima*, *Salvia hispanica*, *Sida, Solanum lycopersicum* (tomato), *Solanum melongena* (eggplant), *Stylosanthes gracile*, *Tephrosia villosa*, *Theobroma cacao* (cocoa), *Trifolium incarnatum* (crimson clover), *Vicia faba* (faba bean), *Vigna mungo* (black gram), *Vigna radiata* (mung bean), *Vigna unguiculata* (cowpea), *Vigna unguiculata* subsp. *sesquipedalis* (asparagus bean), *Voandzeia subterranea* (bambara groundnut) (Brown, 2020).

Symptoms: The symptoms are not diagnostic enough to separate CPMMV visually from other viruses. In general, infected cowpeas, groundnuts, soybeans, tomatoes, and French bean produce leaves with mild to severe chlorotic mottling occasionally accompanied by distortion and stunting. There can be abnormal colors, forms and patterns on the leaves, and whole plants can be dwarfed (Brown, 2020). Differential symptom development can be observed in the same host species and is thought to be due to differences in virulence between the viral isolates, differential susceptibility among the different host plant species and their respective cultivars, and/or to widely variable environmental conditions that occur in different CPMMV affected locales (Rosario et al., 2014). Symptoms on infected soybeans were associated with flower dropping and poor development of the pods. Seed harvested from infected plants showed severe deformation and reduced weight, compared to seeds from healthy, virus-free plants (Rodrigues et al., 2008).

Transmission: The only insect vector of CPMMV is the whitefly *Bemisia tabaci*. It transmits the virus in a non-persistent manner and is non-circulative and unlikely to be transovarially transmitted (Muniyappa and Reddy, 1983). Seed transmission is known to occur in many diverse legume crops. It’s likely that plants that become infected through the seed serve as primary sites of infection for further spread by whiteflies within and to adjacent susceptible crops and weeds. Perennial weed species naturally

infected by CPMMV are possibly important sources of infection for both tomatoes and leguminous crops (Monsour et al., 1998).

Damage Potential: Yield losses due to CPMMV infection of legume crops vary widely and range from 10-80% depending on virus isolate and host species or genotype. Impacts of the virus have been reported primarily from Africa and India. Yield loss in soybean crops in Argentina and Brazil have been extreme in some genotypes, particularly those expressing stem necrosis, and losses ranged from 10-100%, presumably from introductions of CPMMV infected seed. The estimates of crop damage have been best documented based on recent outbreaks in South American countries, where a major breeding program was initiated, particularly in Brazil, to combat the virus disease (Arias et al., 2015; Brown, 2020). In Brazil, CPMMV infection significantly reduced the plant height, the number of pods per plant and the 1,000-grain weight. In addition, estimated yield losses ranged from 174 to 638 kg/ha, depending on the cultivar. It was found to be seedborne and asymptomatic in some of the tested cultivars (da Silva et al., 2020).

If introduced, CPMMV has great potential to spread through seed, on infected ornamental or vegetable transplants, and by the viruliferous whiteflies. The most important potential host of CPMMV in the United States is soybean, which has low acreages in California. Common bean (dry and fresh market), cowpea, garbanzo bean, and peanut, particularly when grown in mild climate locales where the whitefly vector is endemic and typically abundant during the warmest part of the growing season are also at risk.

Worldwide Distribution: Africa: *Benin, Burkina Faso, Cote d'Ivoire, Egypt, Eswatini, Ghana, Kenya, Malawi, Mozambique, Nigeria, Sudan, Tanzania, Togo, Uganda, Zambia*. America: *Argentina, Brazil, Mexico, Puerto Rico, United States of America* (Florida, Oklahoma), *Venezuela*. Asia: *China, India, Indonesia, Iran, Iraq, Israel, Jordan, Malaysia, Taiwan, Thailand, Yemen*. Oceania: *Australia, Fiji, Papua New Guinea, Solomon Islands* (EPPO, 2021; CABI-CPC, 2021)

Official Control: Cowpea mild mottle virus is on the USDA PCIT's harmful organism list for Albania, European Union, French Polynesia, Georgia, Guatemala, Holy See (Vatican City State), Honduras, Japan, Republic of Korea, Republic of Moldova, Monaco, Morocco, New Caledonia, Nicaragua, Panama, Paraguay, San Marino, Serbia, Syrian Arab Republic, Taiwan, Thailand, Turkey, United Kingdom, Uruguay (USDA, 2021). It is on the EPPO's A1 list for Bahrain, European Union, and Turkey, on the A2 list for Jordan, and a quarantine pest for Moldova, Tunisia, and the United States of America (EPPO, 2021)

California Distribution: None

California Interceptions: None

The risk Cowpea mild mottle virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** This pathogen is likely to be found anywhere its hosts can grow.

   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 is large including cultivated crops and annual and perennial weeds.

   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:** The virus reproduces in host plants. It can be vectored by whiteflies, including one species that is widespread in California.

   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:** CPMMV has high potential for rapid spread and could be difficult to control, particularly in areas where the whitefly vector is abundant

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

   Economic Impact: A, C, 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:** With the threat to soybeans, a first detection in the United States is likely to trigger a quarantine response and an Emergency Action Notice from the USDA.

   Evaluate the environmental impact of the pest to California using the criteria below

   Environmental Impact: D

   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 Cowpea mild mottle mosaic virus: High

Add up the total score and include it here. **14**
-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 '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* ***= 14***

Uncertainty:

Although the epidemiology of CPMMV in temperate (as opposed to tropical) climates has not been studied, it seems likely that the virus could survive from season to season with infected plants (asymptomatic or symptomatic) in the mild climate zones in the United States, after an accidental introduction by seed or with the whitefly vector. An isolate of CPMMV has already been identified in whiteflies from Florida (Rosario et al. 2014), however, the exact origin of this isolate has not been determined, nor is it known if CPMMV is more widely distributed in Florida or other states where whiteflies occur. Currently, no monitoring is carried out to study the potential for, or to detect actual, introductions of CPPMV into the United States (Brown and Rodrigues, 2017).

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for Cowpea mild mottle virus is A.

References:

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Responsible Party:

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*Comment Period: 02/14/2022 through 03/31/2022

*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: A
