

California Pest Rating Proposal for

Cucumber mosaic virus

Current Pest Rating: C

Proposed Pest Rating: C

Realm: Riboviria; Phylum: incertae sedis

Family: Bromoviridae; Genus: Cucumovirus

Comment Period: 04/16/2020 through 05/31/2020

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

History & Status:

Background: Cucumber mosaic virus (CMV) occurs worldwide and infects more species of plants than any other plant virus. It is in a group called Cucumoviruses, the genus named after Cucumber mosaic virus, and this is a small group that includes Tomato aspermy virus and Peanut stunt virus. The genome of CMV consists of three single-stranded RNAs. Many isolates also contain small single-stranded satellite RNAs. The satellite RNAs are associated with these CMV strains, but are not required for virus replication and spread, but can alter symptom expression on the host plants. Some of the satellite RNAs increase and others reduce the severity of the symptoms. CMV genomic RNAs are encapsidated by a coat protein that forms the shell of isometric virions and also determines the transmissibility of the virus from plant to plant by its aphid vectors.

CMV infects and multiplies in phloem and parenchyma cells. The viral particles may appear scattered in the cytoplasm or in crystalline aggregates in the cytoplasm and the vacuoles. They can appear to be

aligned in multiple rows in the cytoplasm or in a single row passing through plasmodesmata (Agrios, 2005).

Hosts: Cucumber mosaic virus has a wide host range and infects more than 1200 species in over 100 families of monocot and dicot plants, including many vegetables, ornamentals, and woody and semi-woody plants. The primary host families are Cucurbitaceae, Solanaceae, and Araceae. Some CMV strains are host specific and infecting certain hosts within a single family (Zitter and Murphy; 2009; CABI-CPC, 2020; Brunt et al., 1996)

Symptoms: Symptoms of cucumber mosaic can vary greatly depending on the crop infected and the age of the plant when infection occurs. CMV infection causes mosaics, stunting, and leaf and fruit malformations on its susceptible hosts. It can also be largely symptomless.

Almost all cucurbits are susceptible to CMV. In cucurbits, the first symptom is vein clearing followed by mosaic patterns. Mosaics are irregularly shaped areas, with dark green alternating with light green or yellow areas on the leaves. Most serious field infections occur when the plants are about six weeks old (younger seedlings do not show symptoms). Four or five days after inoculation, the developing leaves become mottled, distorted, and wrinkled and their edges begin to curl downward. All subsequent growth is reduced drastically and the plants appear dwarfed as a result of stem internodes and petioles being shorter. Leaves are only half their normal size. There is an extreme “shoestring” manifestation of leaves in some varieties in addition to distortion of flowers and fruits. Infected plants produce fewer vines and flowers and may even be killed. Malformations of the cucurbit fruit can also occur and produce a warty appearance on the skin. Cucumbers infected with CMV often have a bitter taste and on pickling become soft and soggy (Davis et al., 2009; Agrios, 2005; Zitter and Murphy, 2009).

On dry beans, severe leaf symptoms include dark green blisters, vein banding, interveinal yellowing, and general distortion. Milder symptoms include a light-green to dark-green mottle and some green vein banding. Symptoms can be confused with those of Bean yellow mosaic virus and Bean common mosaic virus (Frate et al., 2018).

Foliar symptoms of pepper plants typically include a chlorosis of young leaves with mature leaves developing necrotic areas shaped like oak leaves and ringspot patterns as the plant ages. Leaves that develop after systemic infection are often deformed with sunken interveinal lamina and protruding primary veins. These leaves also have a dull light green appearance as opposed to the dark green of healthy leaves. CMV-infected plants can be stunted. Pepper fruits may develop ringspotting and roughness. In the field it is difficult to separate symptoms of CMV from symptoms of potyviruses. Mixed infections are very common, with CMV and one or more of the potyviruses simultaneously infecting plants (Koike et al., 2012).

Cucumber mosaic virus infection of spinach is often referred to as spinach blight. CMV and other virus diseases often appear similar and may be difficult to differentiate in the field when symptoms are primarily stunting or poor growth. CMV-infected leaves are chlorotic with necrotic spots, mosaics, ringspots, mottling, and crinkling or puckering. Infected younger leaves may have slight chlorosis with an inward rolling of the margins. In advanced stages of disease, the plants often appear stunted and

the crown leaves may become completely blighted, killing the growing point (Koike and Le Strange, 2012).

On tomatoes, plants appear lighter in color and are bushy and stunted. Leaves, especially on the younger leaves, show mosaic or a shoestring-like appearance (Davis et al., 2013). The leaves may show a mottle similar to that caused by Tomato mosaic virus (ToMV) but the unique symptom of CMV is filiformity or shoestring-like leaf blades. Symptoms can be transitory, with the bottom leaves or newly developed top leaves showing severe symptoms, while the middle leaves may appear almost normal. Severely affected plants produce few fruits, which are usually small, often mottled or necrotic, with delayed maturity (Zitter and Murphy, 2009).

Transmission: Spread is by several methods including mechanically, with infested seeds and by aphids. The most common aphid vectors are *Myzus persicae* (green peach aphid) and *Aphis gossypii* (melon aphid) but over 80 species of aphids can transmit CMV in a non-persistent manner (CABI-CPC, 2020). The virus is stylet-borne and all instars of aphids can be efficient vectors. Transmission efficiency varies with the aphid species, virus strains, host plant species, environmental conditions, and time of the year (Zitter and Murphy, 2009).

The rate of seed transmission is highly variable. It can reach up to 100% in soybeans but is more commonly around 10% in beans and other legumes (Davis and Hampton, 1983). In many vegetable crops including cucurbits, CMV is transmitted at a very low level. Most epidemics in these crops occur when virus inoculum exists in external reservoirs such as weeds and is spread to the crop plants by aphids.

Damage Potential: Crop yields are reduced in quantity and are often lower in quality because of CMV. Plants can be seriously affected in the field as well as in greenhouses. Crop losses vary year to year since the amount of disease depends upon the planting of potentially infected seeds and the number of aphids transmitting the virus in the spring. If the spring is cool and wet, aphid numbers are decreased and virus spread is sporadic. If aphids are the primary method of transmission, infected plants will primarily be located in rows bordering the edges of the field. However, if the spring is warmer with less frequent rains, aphid populations can increase and the virus can spread rapidly into young crops that are especially attractive to migrating aphids. In such cases, infection rates may approach 100% and the crop may have to be abandoned. On average, losses of 10-20% are common, and in some instances the crop may still be harvested but has poorer quality and appearance. Seeds should not be harvested from symptomatic fields (Zitter and Murphy, 2009).

Worldwide Distribution: Cucumber mosaic virus is distributed worldwide in both temperate and tropical climates (CABI-CPC, 2020).

Official Control: Cucumber mosaic virus is on the USDA PCIT harmful organisms list for Bangladesh, Cambodia, Canada, Egypt, French Polynesia, Georgia, Guatemala, Japan, Namibia, New Caledonia, Nicaragua, Panama, South Africa, and Syrian Arab Republic.

California Distribution: Statewide on vegetable row crops, seed crops, and ornamentals.

California Interceptions: None.

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

Consequences of Introduction:

- 1) **Climate/Host Interaction:** Climate is not a limiting factor and hosts are abundant.

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 an extremely large host range.

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 Dispersal Potential:** This virus reproduces in hundreds of symptomatic and non symptomatic hosts. It spreads mechanically, with insects, and with seeds.

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:** Cucumber mosaic virus can cause serious crop losses or failures. Infestation of mother plants prevents issuance of phytosanitary certificates for seed movement to some trading partners.

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

Economic Impact: A, B, 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:** Hosts of CMV include woody plants, perennial crops (i.e. alfalfa), and weeds that can create permanent reservoirs of virus in an area.

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.

Consequences of Introduction to California for Cucumber 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
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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'. This virus is already widespread in California with hundreds of confirmed detections (French, 1989).

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 = 11*

Uncertainty:

None.

Conclusion and Rating Justification:

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

References:

Brunt, A. A., Crabtree, K., Dallwitz, M. J., Gibbs, A. J., Watson, L. and Zurcher, E. J. (eds.) 1996. Plant Viruses Online: Descriptions and Lists from the VIDE Database.

<http://biology.anu.edu.au/Groups/MES/videl/>

Agrios, G. N. 2005. Plant Pathology, 5th Edition. Elsevier Academic Press. 922 pg

CABI Crop Production Compendium 2020. Cucumber mosaic virus.
<https://www.cabi.org/cpc/datasheet/16970> . Accessed 3/20/2020

CDFA County Procedural Training Manual Phytosanitary Field inspection.

Davis, R. F., and Hampton, R. O. 1986. Cucumber mosaic virus isolates seedborne in Phaseolus vulgaris: Serology, host-pathogen relationships, and seed transmission. Phytopathology 76:999-1004

Davis, R. M., Turini, T. A., Aegerter, B. J., Stapleton, J. J. 2009. UC IPM Pest Management Guidelines: Cucurbits UC ANR Publication 3445.

Davis, R. M., Miyao, G., Subbarao, K. V., Stapleton, J. J., Aegerter, B. J. 2013. UC IPM Pest Management Guidelines: Tomato UC ANR Publication 3470

EPPO Global Database. 2020. Cucumber mosaic virus. <https://gd.eppo.int/taxon/CMV000>. Accessed 3/20/2020

Frate, C. A., Gepts, P. G. and Long, R. F. 2018. UC IPM Pest Management Guidelines: Dry Beans. Cucumber mosaic virus. UC ANR Publication 3446

French, A. M. 1989. California plant disease host index. CA Division of Plant Industry. 2nd Edition. 394 pg

Koike, S.T., and LeStrange, M. 2012. Virus Diseases. UC IPM Pest Management Guidelines: Spinach UC ANR Publication 3467

Koike, S. T., Davis, R. M. and Subbarao, K. V. 2012. Cucumber mosaic virus. UC IPM Pest Management Guidelines: Peppers. UC ANR Publication 3460

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PEXD) Harmful Organisms Database Report. Cucumber mosaic virus. Accessed 3/20/2020

Zitter, T. A., and J. F. Murphy. 2009. Cucumber mosaic virus. The Plant Health Instructor. DOI: 10.1094/PHI-I-2009-0518-01

Responsible Party:

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***Comment Period: 04/16/2020 through 05/31/2020**

*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
