CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Watermelon chlorotic stunt virus

Current Pest Rating: Q

Proposed Pest Rating: B

Kingdom: Viruses and viroids, Category: Monodnaviria,
Category: Shotokuvirae, Phylum: Cressdnaviricota,
Class: Repensiviricetes, Order: Geplafuvirales,
Family: Geminiviridae, Genus: *Begomovirus*

Comment Period: 12/20/2023 through 02/03/2024

Initiating Event:

In November 2023, Imperial County agricultural inspectors submitted a sample of honeydew, *Cucumis melo,* to CDFA's Plant Pest Diagnostics Center at Meadowview. The sample was collected from a commercial field in Winterhaven, CA. CDFA Plant Pathologist Tongyan Tian detected Watermelon chlorotic stunt virus (WmCSV) by PCR and sequencing. This was the first official detection of this virus in California. The virus was identified earlier in the year in Yuma, AZ, on watermelon.

History & Status:

Background:

Plant-infecting viruses belonging to the family Geminiviridae have genomes made of circular single-stranded DNA that are encapsulated in twinned semi-icosahedral particles. The genus *Begomovirus*, which is part of this family, is distributed globally, infects dicotyledonous plants, and is spread by whiteflies (Agrios, 2005). The genus *Begomovirus* is the largest among the geminiviruses, including approximately 400 species. Begomoviruses infect a wide range of dicotyledonous crops, noncultivated plants (e.g., weeds), and ornamental plants. However, individually, begomoviruses have relatively narrow host ranges. Begomoviruses are considered to be serious pathogens that severely reduce yields on a range of commercially significant crops (Navas-Castillo et al., 2011). The genomic components DNA-A and DNA-B are found in either one or two (bipartite) genomes of begomoviruses. Old World begomoviruses are primarily monopartite, while New World begomoviruses are primarily bipartite

(Rojas et al., 2005). These viruses are transmitted in a circulative persistent manner from plant to plant exclusively by the sweet potato whitefly, *Bemisia tabaci*.

WmCSV was first found infecting watermelon in Yemen (Bedford et al., 1994). In the following 30 years, it has been extensively documented in several Middle Eastern countries and regions, including Saudi Arabia, Iran, Israel, Jordan, Lebanon, Oman, the West Bank, Palestine, and Sudan in Africa (CABI, 2023). Although it can infect multiple types of cucurbits, WmCSV primarily affects watermelon crops which can show severe symptoms (Abudy et al., 2010).

WmCSV has been found infecting watermelon in Sonora, Mexico (Dominguez-Duran et al., 2018) causing the typical symptoms of leaf curling and yellowing. That was the first identification in the Western hemisphere. In 2021, Fontenele et al. reported the detection of WmCSV in Arizona, in *Consolea spinosissima*, *Solanum* sp., *Stachys byzantine,* and *Opuntia cochenillifera*, and they suggest that finding this virus in native Cactaceae shows it is likely more widespread in North America than previously known.

Hosts: Carica papaya (pawpaw), *Citrullus colocynthis* (colocynth), *Citrullus lanatus* (watermelon), *Consolea spinosissima* (semaphore pricklypear), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cucurbita* spp. (pumpkin), *Cucurbita maxima* (pumpkin/squash), *Cucurbita moschata* (pumpkin/squash), *Cucurbita pepo* (field pumpkin), *Datura innoxia* (downy thorn apple), *Lagenaria siceraria* (bottle gourd), *Nicotiana benthamiana* (benthi), *Nicotiana glutinosa (Peruvian tobacco), Opuntia cochenillifera* (Cochineal nopal cactus), *Sinapis arvensis* (wild mustard), *Solanum lycopersicum* (tomato), and *Stachys byzantine* (lamb's-ear), and *Trichosanthes cucumerina* (snake gourd) (CABI, 2023; EPPO, 2023)

Symptoms: Naturally infected plants show yellowing of foliage, yellow veins, chlorotic mottling, mosaic, leaf curling, and plant stunting. Severe leaf deformations are also observed (Ahmed et al., 2018; CABI, 2023).

Transmission: Small ssDNA viruses including WmCSV are vectored in a circulative persistent manner by the whitefly *Bemisia tabaci* (suborder Homoptera, family Aleyrodidae). *Bemisia tabaci* disseminates viruses very efficiently to cucurbits (Czosnek et al., 2017). Long-distance movement of infected plants, especially cucurbit transplants, can spread the virus to new areas. The virus also can be moved long distances by viruliferous whiteflies that are carried on plant material with or without symptoms. The virus can be maintained in infectious form within whiteflies for up to 9 days. Because *B. tabaci* can move long distances, especially with high winds, the virus may be transported over long distances this way (Aegerter et al., 2008). The virus is not seed-borne.

Damage Potential: WmCSV affects the durability, quality, and yield of cucurbit crops, especially watermelons. The virus can cause serious damage resulting in complete loss in fruit yield and quality and plant death, especially in regions where the whitefly vector is well established during the growing season (Fontenele et al., 2021). Serious economic problems occur in countries that have Mediterranean and desert climates (Ahmead et al., 2018; Kheyr-Pour et al., 2000; Samsatly et al., 2012).

Worldwide Distribution: Iran, Israel, Jordan, Lebanon, Oman, Mexico, Saudi Arabia, Sudan, the United States (Arizona, California), and Yemen (EPPO, 2023).

Official Control: WmCSV is on the EPPO's A2 list for Jordan (EPPO, 2023), and on the USDA PCIT's Harmful Organism list for Georgia, India, Japan, and Taiwan (USDA PCIT, 2023).

California Distribution: Imperial County (see 'Initiating events').

California Interceptions: none

The risk that Watermelon chlorotic stunt virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Evaluate if the pest would have suitable hosts and climate to establish in California.

   WmCSV is likely to be established in the Imperial Valley in Southern California. Its further spread to non-infected sites is limited by the distribution of its vector, *Bemisia tabaci* which to date, has not been found in the cooler climates of northern California counties.

   Score: **2**
   - Low (1) Not likely to establish in California; or likely to establish in very limited areas.
   - Medium (2) may be able to be established in a larger but limited part of California.
   - High (3) likely to establish a widespread distribution in California.

2) **Known Pest Host Range:** Evaluate the host range of the pest.

   The natural host range is mainly cucurbits in the family Cucurbitaceae, which are grown extensively in the lower Sacramento Valley and with substantial production in San Joaquin and Imperial Valleys. Additional hosts include plants in families other than Cucurbitaceae, including native Cactaceae. These non-cucurbit hosts may serve as source plants for the virus and the whitefly vector which then can carry the virus back to cucurbits.

   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:** Evaluate the natural and artificial dispersal potential of the pest.

The virus can thrive in climates that are favorable for its vector. Its potential for spread is completely dependent on the distribution of its vector and infected plant materials. Therefore, factors that increase the movement and activity of the vector and infected plants will also influence that of the virus.

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: Evaluate the economic impact of the pest on California using the criteria below.

WmSCV infections could lower crop yield, increase production costs, and trigger loss of markets. The virus is vectored by the whitefly, *Bemisia tabaci,* which would require the implementation of management strategies to minimize the risk of the introduction and establishment of the virus in non-infected regions within California.

Economic Impact: A, E
A. The pest could lower crop yield.
B. The pest could lower crop value (including increasing crop production costs).
C. The pest could trigger the loss of markets (including 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: Evaluate the environmental impact of the pest on California using the criteria below.

This virus has been detected in native cacti in Arizona. The impact of virus infection on these hosts is not known, but these perennials may act as a persistent source of virus in the environment.

Environmental Impact: A, 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: 3
- 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 chlorotic stunt virus*:*

Add up the total score and include it here.
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

Total points obtained on evaluation of consequences of the introduction of WmCSV to California = 12

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 have been multiple detections in commercial cucurbit fields in Winterhaven, CA, and Yuma, AZ, Yuma is adjacent to Winterhaven, separated by the Colorado River. This virus is likely established in that area.

Evaluation is 'low'.

Score: -1
-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 the 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:

While WmCSV has been found in the Imperial Valley, targeted surveys for the pathogen have not been conducted in other cucurbit production sites. The distribution and establishment of the virus will largely be dependent on the distribution and established infestations of virus-carrying *Bemisia tabaci*. Subsequently, detections outside the Imperial Valley may alter the proposed rating for this virus pathogen.

Conclusion and Rating Justification:

Based on the evidence provided above, the proposed rating for **Watermelon chlorotic stunt virus is B.**

References:

Abudy, A.; Sufrin-Ringwald, T.; Dayan-Glick, C.; Guenoune-Gelbart, D.; Livneh, O.; Zaccai, M.; Lapidot, M. Watermelon chlorotic stunt and Squash leaf curl begomoviruses—New threats to cucurbit crops in the Middle East. Isr. J. Plant Sci. 2010, 58, 33–42.

Aegerter, B.J., Davis, R.M., Stapleton, J.J., and Turini, T.A. 2008. UC IPM Pest Management Guidelines: Cucurbits UC ANR Publication 3445.

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

Ahmad, M.H., Shakeel, M.T., Al-Shahwan, I.M., Al-Saleh, M.A. and Amer, M.A., 2018. Insights into the incidence of watermelon chlorotic stunt virus causing yellowing disease of watermelon in western and southwestern regions of Saudi Arabia. The plant pathology journal, 34(5), p.426.

Bedford, I.D., Briddon, R.W., Jones, P., Alkaff, N. and Markham, P.G., 1994. Differentiation of three whitefly-transmitted geminiviruses from the Republic of Yemen. European Journal of Plant Pathology, 100, pp.243-257.

CABI. 2023. Watermelon chlorotic stunt virus datasheet. Crop Protection Compendium. https://www.cabidigitallibrary.org/doi/10.1079/cabicompendium.15037 Accessed 11/16/23

Czosnek, H., Hariton-Shalev, A., Sobol, I., Gorovits, R. and Ghanim, M., 2017. The incredible journey of begomoviruses in their whitefly vector. Viruses, 9(10), p.273.

Domínguez-Durán, G., Rodríguez-Negrete, E.A., Morales-Aguilar, J.J., Camacho-Beltrán, E., Romero-Romero, J.L., Rivera-Acosta, M.A., Leyva-López, N.E., Arroyo-Becerra, A., and Méndez-Lozano, J. 2018. Molecular and

biological characterization of Watermelon chlorotic stunt virus (WmCSV): An Eastern Hemisphere begomovirus introduced in the Western Hemisphere. Crop Prot. 2018, 103, 51–55.

EPPO Database. 2023 https://gd.eppo.int/taxon/WMCSV0. Accessed 11/16/23

Fontenele, R.S., Bhaskara, A., Cobb, I.N., Majure, L.C., Salywon, A.M., Avalos-Calleros, J.A., Argüello-Astorga, G.R., Schmidlin, K., Roumagnac, P., Ribeiro, S.G. and Kraberger, S., 2021. Identification of the begomoviruses squash leaf curl virus and watermelon chlorotic stunt virus in various plant samples in North America. Viruses, 13(5), p.810.

Kheyr-Pour, A., Bananej, K., Dafalla, G. A., Caciagli, P., Noris, E., Ahoonmanesh, A., Lecoq, H., Gronenborn, B., 2000. Watermelon chlorotic stunt virus from the Sudan and Iran: sequence comparisons and identification of a whitefly-transmission determinant. Phytopathology. 90 (6), 629-635.

Navas-Castillo, J., Fiallo-Olivé, E., Sánchez-Campos, S. 2011. Emerging virus diseases transmitted by whiteflies. Annu. Rev. Phytopathol. 49, 219–248.

Rojas, M.R., Hagen, C., Lucas, W.J., Gilbertson, R.L. 2005. Exploiting chinks in the plant's armor: evolution and emergence of geminiviruses. Annu. Rev. Phytopathol. 43:361–94

Samsatly, J., Sobh, H., Jawhari, M., Najjar, C., Haidar, A., Abou-Jawdah, Y., 2012. First report of Watermelon chlorotic stunt virus in cucurbits in Lebanon. Plant Disease. 96 (11), 1703.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. Watermelon chlorotic stunt virus. Accessed 11/16/23.

Responsible Party:

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***Comment Period: 12/20/2023 through 02/03/2024**

***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: B
