CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Orchid fleck virus

Current Pest Rating: C

Proposed Pest Rating: B

Realm: Riboviria; Kingdom: Orthornavirae;
Phylum: Negarnaviricota; Class: Monjiviricetes;
Order: Mononegavirales; Family: Rhabdoviridae;
Genus: Dichorhavirus

Comment Period: 04/30/2021 through 06/14/2021

Initiating Event:

In 2005, a sample of *Cymbidium* orchid leaves were submitted to CDFA's Plant Pest Diagnostics Center by a San Luis Obispo County agricultural inspector performing a regulatory nursery inspection. The leaves showed yellow spotting or flecking, and the grower reported that these symptoms seemed to be spreading in the greenhouse. Plant Pathologist Tongyan Tian observed mites on the plants and detected Orchid fleck dichorhavirus using RT-PCR and sequence analysis. It was assigned a temporary Q rating. Between 2005 and 2019, 10 additional samples were submitted from nursery inspections from additional orchid nurseries in San Luis Obispo, San Diego, Santa Barbara, and Santa Clara counties, from *Cymbidium, Epidendrum*, and *Dendrobium* spp. In 2013, prior to the adoption of a formal system, it was given a C-rating.

In July 2020, the Hawaii Department of Agriculture published a New Pest Advisory for Orchid fleck virus found infecting rough lemon and mandarin orange trees on the Island of Hawai'i (https://hdoa.hawaii.gov/pi/files/2020/08/NPA-20-02-Orchid-fleck-virus.pdf). The trees had yellow lesions on leaves and stems, symptoms resembling the viral disease citrus leprosis. In addition, Cook et al. in 2019 detected Orchid fleck virus from symptomatic citrus trees in 27 orchards in South Africa. They suspected that the virus was likely introduced from imported orchids. Leprosis can reduce citrus yields and fruit quality, cause premature fruit drop, and in some instances kill trees. Leprosis is spread by tenuipalpid flat mites, mainly *Brevipalpus californicus*, and although citrus leprosis has not been detected here, the mites are common and widespread in California. With new information on the host range and pathogenicity of this virus now available, the risk to California from Orchid fleck virus is described herein and a permanent rating is proposed.

History & Status:

Background: Citrus leprosis is a damaging viral disease that is currently found in Mexico, Brazil, and other countries in South and Central America. In the 1860s, leprosis was found in Florida and citrus production was drastically reduced. By the 1950s it was reported only on the east coast of Florida and in small isolated areas. It is unclear why the disease disappeared from Florida, but it could have been from increased use of miticides and cold winter temperatures causing a decline in mites, resulting in reduced inoculum and transmission (Childers et al., 2003). Recent studies have shown that multiple virus species in the genera of *Dichorhavirus* and *Cilevirus* cause citrus leprosis symptoms. There are two types of leprosis: C-type (genus Cilevirus) and N-type (genus Dichorhavirus), which refer to the part of the plant cell where the virus is found. C-type is in the cytoplasm, and N-type is in the nucleus. The C-type is considered more aggressive and is more widespread than the N-type. Leprosis has not been reported in Florida since 1968. Based on the viral sequence a sample collected in Florida in 1948, the virus is a distinct Dichorhavirus, named as CiLV0 (Roy et al. 2020).

Orchid fleck virus (OFV) was originally found in leaves of *Cymbidium* sp. with mosaic disease symptoms in Japan (Doi et al., 1969; 1977). OFV has an unusual bipartite genome and it was placed in a new genus, Dichorhavirus, in the family Rhabdoviridae, by Kondo et al. (2006). OFV was the prototype member and type species for this new genus. It has non-enveloped, bullet-shaped, bacilliform particles and filamentous particles. The filamentous particles have a tightly coiled coil structure or a coiled structure with a helical twist (Kondo et al., 2009). Orchid fleck virus has been observed and reported in many parts of the world, including in orchid nursery stock in California, and causes chlorotic or necrotic flecks in plant hosts.

Roy et al., in 2013, observed that the genome assembly of Citrus leprosis virus N and described a close association with Orchid fleck virus. Peng et al, 2013, studying particle morphology and cytopathic effects, showed Citrus leprosis virus N and Coffee ringspot virus both closely resemble Orchid fleck virus and proposed that they all belong to the same genus, Dichorhavirus.

Based on nucleotide sequences, four strains of Orchid fleck virus have been described: OFV-Cit1, OFV-Cit2, OFV-Orc1 and OFV-Orc2. OFV-Cit1 and OFV-Cit2 are only detected in citrus. However, OFV-Orc-1 and OFV-Orc2 have been detected in both citrus and orchid (Velarde et al. 2021). Cook et al. in 2019 detected and described Orchid fleck virus (OFV-Orc1) in South Africa. Full genome sequencing of the virus showed it to be a variant of Orchid fleck virus with closest sequence identity of 99% to an isolate described on Cymbidium orchids but was not as close to strains previously reported on citrus. They reported symptoms typical for citrus leprosis on fruit, leaves and branches in Valencia and Navel orange orchards. Based on the close sequence identity seen in phylogenetic analysis, they concluded that the virus in South Africa that is likely to have originated from imported, infected orchids. In Hawai'i, Velarde et al., 2021, reported detection of Orchid fleck virus (OFV-Orc2) in symptomatic rough lemon and mandarin oranges and the trees were destroyed.

Hosts: OFV can naturally infect 70 orchid species, lilyturf (*Liriope spicata*), and ti (*Cordyline fructicosa*) as well as many types of citrus including oranges, limes, grapefruit, and lemons (Beltran-Beltran et al. 2020; Roy et al., 2020; Dietzgen et al., 2018; Peng et al., 2013; Mei et al., 2016).

Symptoms: New leaves of ornamental hosts including orchids exhibit necrotic flecks with chlorotic rings or necrotic lesions with leaf reddening. Older leaves can be asymptomatic or have large, chlorotic spots. Flowers are not affected (Bratsch et al., 2015).

Citrus leprosis appears as necrotic lesions encircled by chlorotic halos on leaves and immature fruit. On leaves, lesions are mainly chlorotic but as fruits mature, the lesions tend to turn black. Cortical lesions are observed on twigs and later develop into crusty scabs. These symptoms develop at the feeding sites of viruliferous tenuipalpid flat mites (Cook et al., 2019). In Brazil, the disease is characterized by necrotic or chlorotic spots in leaves, branches, and fruit, which progressively leads to the early drop of leaves and fruit, branch dieback, and, occasionally, to death (primarily of the youngest citrus trees) (Ramos-González et al., 2017) . In Hawai'i, symptoms of OFV on citrus are yellow or black bullseye lesions on leaves, twigs, and fruits. They are mostly circular and can fuse if close together. As the lesions age they may change from yellow to brown or black. Each lesion represents a feeding site by *Brevipalpus* mites that transmit the virus. Symptom development differs between citrus hosts and varieties (Cook et al., 2019; Peng et al., 2013).

Transmission: OFV can be spread mechanically (Doi et al., 1977) or (more importantly) by the feeding of the mite vectors *Brevipalpus* spp. OFV is persistent in the mites and is efficiently transmitted by both adults and nymphs. In citrus, leprosis viruses are poorly mechanically transmitted and not graft transmitted since the viruses are not generally systemic in the tree (Peng et al., 2013). According to Kondo et al 2003, viruliferous mites were observed capable of transmission of the virus even after feeding on a virus-immune host for three weeks suggesting persistent transmission by the vector. OFV has not been observed to spread with tools.

Damage Potential: Orchid fleck virus on orchids or other ornamental hosts causes loss of aesthetic quality to leaves that are damaged by the formation of yellow flecks and necrotic ring spots (Ramos-González et al., 2015; Sauvêtre et al., 2018). OFV is increasingly recognized as a serious viral pathogen of orchids because of its wide host range and geographic distribution (Peng et al., 2017).

Citrus leprosis is an economically important disease of citrus in South and Central America and Mexico. Losses incurred due to citrus leprosis are related to leaf and fruit drop and the reduction in market value of symptomatic fruit. Leprosis is considered the viral disease with the greatest economic impact in Brazil, partially due to the cost of mite control (Ramos-González et al., 2017; Bastianel et al., 2010; Cook et al., 2019). Citrus leprosis is a disease of quarantine significance to California. Yield reduction of the infected orchards and costs to prevent or manage infection foci make the disease an economic burden to the citrus industry wherever it occurs.

Worldwide Distribution: Australia, Brazil, China, Costa Rica, France, Germany, Korea, Japan, Mexico, Paraguay, South Africa, United States (Blanchfield et al., 2001; Ramos-González et al., 2016; Peng et al., 2013; Peng et al., 2017)

Official Control: Orchid fleck virus is on the EU's A1 list (EPPO, 2021) and on the USDA's harmful organism list for Georgia, India, Indonesia, and Japan (USDA PCIT, 2021). Dichorhavirus "Citrus Leprosis Virus N" is on the US Regulated plant pest table and actionable if detected at the United States border. Presently, OFV is C-rated in California and not subject to any state quarantine action.

California Distribution: San Diego, Santa Clara, Santa Barbara, and San Luis Obispo counties. All positive samples are from orchids.

California Interceptions: None

The risk Orchid fleck virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** The mite vector of OFV is already widespread in California. The virus is likely to survive wherever its hosts can be grown, which is limited to the warmer parts of the state that currently have citrus.

   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 includes more than 75 species in multiple plant families

   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 is not systemic in its plant hosts but can be persistent in the mite vectors. It is not readily spread by mechanical transmission. Mite feeding causes localized, non-systemic infections in citrus and orchids.

   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: Orchid fleck is a relatively minor, mostly cosmetic problem on ornamental hosts including orchids. Citrus leprosis-N is a disease of quarantine importance, posing a threat to the citrus industry in California. Trees can be killed because of expanding lesions that girdle tree limbs and cause leaf and fruit drop as well as unmarketable fruit. Premature fruit drop results in greatly reduced yields. Mites must be continually controlled to prevent disease spread.

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

Economic Impact: A, B, C, D, 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: OFV does not have any known hosts that are native in California. Some orchids i.e. *Cymbidiums* are planted in home/urban gardens and landscapes, and citrus is planted extensively on residential and commercial properties. Leprosis is a federal quarantine pest in the United States.

Environmental Impact: D, 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 Orchid fleck virus*:* High

Add up the total score and include it here. **13**
-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 'low'. Orchid fleck virus has only been found in orchid nurseries in coastal California but has not been under state quarantine action since 2013.

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 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* ***= 12***

Uncertainty:

Orchid fleck virus has only recently been associated with Citrus leprosis N symptoms. Strains detected in the past were assumed to have host ranges limited to orchids or other non-citrus hosts. Generally, pathogens are regulated at the species level, and not the strain levels.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating Orchid fleck virus for is **B**.

References:

Bastianel, M., Novelli, V. M., Kitajima, E. W., Kubo, K. S., Bassanezi, R. B., and Machado, M. A., 2010. Citrus Leprosis: Centennial of an unusual mite-virus pathosystem. Plant Disease, 94(3), 284–292

Beltran-Beltran, A. K., Santillán-Galicia, M. T., Guzmán-Franco, A. W., Teliz-Ortiz, D., Gutiérrez-Espinoza, M. A., Romero-Rosales, F., and Robles-García, P. L. 2020. Incidence of Citrus leprosis virus C and Orchid fleck dichorhavirus citrus strain in mites of the genus *Brevipalpus* in Mexico. Journal of Economic Entomology, 113(3), 1576-1581

Blanchfield, A.L., Mackenzie, A.M., Gibbs, A., Kondo, H., Tamada, T. and Wilson, C.R., 2001. Identification of orchid fleck virus by reverse transcriptase‐polymerase chain reaction and analysis of isolate relationships. Journal of Phytopathology, 149(11‐12), pp.713-718.

Bratsch, S. A., Lockhart, B. E., and Ishimaru, C. 2015. Confirmation of first report of orchid fleck virus in *Phalaenopsis* hybrid orchids in the USA. Plant Health Progress. PHP-BR-15-0018. http://www.plantmanagementnetwork.org/php/

CABI, 2021. Crop Production Compendium Orchid fleck virus. https://www.cabi.org/cpc/datasheet/37789

Childers, C.C., Rodrigues, J.C.V., Derrick, K.S., Achor, D.S., French, J.V., Welbourn, W.C., Ochoa, R. and Kitajima, E.W., 2003. Citrus leprosis and its status in Florida and Texas: past and present. Experimental & applied acarology, 30(1), pp.181-202.

Cook, G., Kirkman, W., Clase, R., Steyn, C., Basson, E., Fourie, P. H., Moore, S. D., Grout, T.G., Carstens, E., and Hattingh, V. 2019. Orchid fleck virus associated with the first case of citrus leprosis-N in South Africa. European Journal of Plant Pathology, 155(4), 1373-1379

Dietzgen, R. G., Tassi, A. D., Freitas-Astúa, J., and Kitajima, E. W. 2018. First report of orchid fleck virus and its mite vector on green cordyline. Australasian plant disease notes, 13(1), 11.

Doi, Y., Arai, K., and Yora, K. 1969. Distribution of bacilliform virus particles in Masaki mosaic disease and Cymbidium ring spot disease (Abstract). Ann Phytopathol Soc Jpn 35:388

Doi, Y., Chang, M. U., and Yora, K. 1977. Orchid fleck virus. Descriptions of Plant Viruses, no. 183, CMI/AAB, Warwick, UK.

EPPO Global Database, 2021. Orchid Fleck dichorhavirus https://gd.eppo.int/taxon/OFV000

Esquivel, F. A., González, L. R., Sarubbi, H., Kitajima, E. W., and Rezende, J. A. M., 2018. First report of Cymbidium mosaic virus on orchids in Paraguay. New Disease Reports. 3. DOI:10.5197/j.2044-0588.2018.037.003

Kondo, H., Maeda, T., and Tamada, T. 2003. Orchid fleck virus: *Brevipalpus californicus* mite transmission, biological properties and genome structure. Experimental and Applied Acarology, 30(1/3):215-223.

Kondo, H., Maeda, T., Shirako, Y. and Tamada, T., 2006. Orchid fleck virus is a rhabdovirus with an unusual bipartite genome. Journal of General Virology, 87(8), pp.2413-2421.

Kondo, H., Maeda, T. and Tamada, T., 2009. Identification and characterization of structural proteins of orchid fleck virus. Archives of virology, 154(1), pp.37-45.

Mei , Y., Bejerman, N., Crew, K. S., McCaffrey, N., and Dietzgen, R. G., 2016. First report of orchid fleck virus in lilyturf (Liriope spicata) in Australia. Plant Disease. 100 (5), 1028. DOI:10.1094/PDIS-10-15-1205-PDN

Peng, D. W., Zheng, G. H., Zheng, Z. Z., Tong, Q. X. and Ming, Y. L., 2013. Orchid fleck virus: an unclassified bipartite, negative-sense RNA plant virus. Archives of virology, 158(2), pp.313-323.

Peng, D.W., Zheng, G.H., Tong, Q.X., Zheng, Z.Z. and Ming, Y.L., 2017. First report of orchid fleck dichorhavirus from Cymbidium sp. in China. Plant Disease, 101(3), pp.514-514.

Ramos-González, P. L., Sarubbi-Orue, H., Gonzales-Segnana, L., Chabi-Jesus, C., Freitas-Astúa, J., and Kitajima, E. W. 2015. Orchid fleck virus infecting orchids in Paraguay: first report and use of degenerate primers for its detection. Journal of Phytopathology. 164 (5), 342-347. DOI:10.1111/jph.12420

Ramos-González, P.L., Chabi-Jesus, C., Guerra-Peraza, O., Tassi, A.D., Kitajima, E.W., Harakava, R., Salaroli, R.B. and Freitas-Astúa, J., 2017. Citrus leprosis virus N: a new dichorhavirus causing citrus leprosis disease. Phytopathology, 107(8), pp.963-976.

Roy, A., Stone, A., Otero-Colina, G., Wei, G., Choudhary, N., Achor, D., Shao, J., Levy, L., Nakhla, M.K., Hollingsworth, C.R. and Hartung, J.S., 2013. Genome assembly of citrus leprosis virus nuclear type reveals a close association with orchid fleck virus. Genome announcements, 1(4).

Roy, A., Stone, A. L., Otero-Colina, G., Wei, G., Brlansky, R. H., Ochoa, R., Bauchan, G., Schneider, W. L., Nakhla, M.K., and Hartung, J. S. (2020). Reassortment of genome segments creates stable lineages among strains of orchid fleck virus infecting citrus in Mexico. Phytopathology, 110(1), 106-120

Sauvêtre, P., Veniant, E., Croq, G., Tassi, A.D., Kitajima, E.W., Chabi-Jesus, C., Ramos-González, P.L., Freitas-Astúa, J. and Navia, D., 2018. First Report of Orchid Fleck Virus in the Orchid Collection of Jardin du Luxembourg, Paris, France. Plant Disease, 102(12), pp.2670-2670.

Velarde, A. O., Roy, A., Padmanabhan, C., Nunziata, S., Nakhla, M.K. and Melzer, M., 2021. First report of orchid fleck virus associated with citrus leprosis symptoms in rough lemon (*Citrus jambhiri*) and mandarin (*C. reticulata*) the United States. Plant Disease.

Responsible Party:

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***Comment Period: 04/30/2021 through 06/14/2021**

***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