California Pest Rating Proposal for

Prunus necrotic ringspot virus
Cherry rugose mosaic

Current Pest Rating: C

Proposed Pest Rating: C

Realm: Riboviria, Kingdom: Orthornavirae,
Phylum: Kitrinoviricota, Class: Alsuviricetes,
Order: Martellivirales, Family: Bromoviridae,
Genus: *Ilarvirus*

Comment Period: 10/12/2023 through 11/26/2023

Initiating Event:

This pathogen has not been through the pest rating system. The risk to California from Prunus necrotic ringspot virus is described herein and a permanent rating is proposed.

History & Status:

Background:

Stone fruits, also known as drupes, get their name from the pit or "stone" in their center. They have thin skins that can be fuzzy or smooth. California is known as the "stone fruit state" because it produces over 80% of the nation's stone fruit crops, including 70% of the nation's peaches, 95% of apricots, 95% of fresh plums, 99% of dried plums, and 100% of nectarines. California's stone fruit production was worth $2B in 2022. Almonds are in the same genus, *Prunus*, but considered separately as a nut crop. California produces 82% of the world's almonds, and in 2022, almonds were valued at $5B (https://www.cdfa.ca.gov/Statistics/PDFs/2022_Ag_Stats_Review.pdf). The largest stone fruit-producing counties are in the San Joaquin and Sacramento valleys, but smaller producers and backyard orchards thrive along the coast, in Southern California, and in the Sierra foothills.

Prunus necrotic ringspot virus (PNRSV) is in the genus *Ilarvirus*. It was first described in the USA by Cochran and Hutchins (1941) as the agent responsible for a ringspot disease of peach and was later given its name by Allen (1963). PNRSV is well-described and well-characterized as a positive-strand RNA virus in the family Bromoviridae. *Ilarvirus* are isometric and labile viruses, distributed worldwide, infecting many agriculturally relevant herbaceous and woody hosts including fruit trees, vegetables, and ornamentals. PNRSV causes disease in cultivated stone fruits, including cherry, sour cherry, almond, peach, apricot, and plum, in wild *Prunus*, as well as other plants such as roses (*Rosa* spp.), apples (*Malus domestica*), brambles *(Rubus*), and hops (*Humulus lupulus*) (Pallas et al., 2012). The diseases caused by PNRSV have various common names including necrotic ringspot, tatter leaf, peach ringspot, recurrent ringspot, cherry rugose mosaic, rose mosaic, and almond calico (CABI, 2023).

The most economically important Ilarviruses for stone fruits are Prune dwarf virus (PDV) and Prunus necrotic ringspot virus (Pallas et al. 2012). PNRSV frequently occurs in mixed infections with Prune dwarf virus and/or Apple mosaic virus. All three viruses are transmitted by pollen, seeds, and grafting, which has contributed to their worldwide distribution (CABI, 2023). Coinfection of trees with PDV and PNRSV can result in peach stunt disease (Pallas et al. 2012). Peach stunt disease has more severe symptoms than single virus infections, resulting in premature defoliation, a reduction in trunk circumference, and increased production of water sprouts (Scott et al. 2001).

In nurseries and especially in scion block orchards, it is recommended to use virus-free rootstock and scion wood and monitor trees carefully for virus symptoms. Diseased trees should be immediately removed and destroyed. The spread of the disease from tree to tree can be reduced greatly by keeping orchard weeds and ground covers from flowering until after the trees have bloomed, because the disease may be spread mechanically by thrips feeding on pollen grains containing the virus, or by pollen grains carrying the virus on their surface (Adaskaveg et al., 2009; Greber et al., 1992).

Hosts: Begonia cucullate, Convolvulus arvensis (bindweed), *Corylus avellana* (hazel), *Cucumis sativus* (cucumber), *Humulus lupulus* (hop), *Lilium* (lily), *Malus domestica* (apple), *Morus alba* (mora), *Morus rubra* (red mulberry), *Pelargonium* (pelargoniums), *Prunus* (stone fruit), *Prunus amygdalus, Prunus armeniaca* (apricot), *Prunus avium* (sweet cherry), *Prunus besseyi* (bessey cherry), *Prunus cerasifera* (myrobalan plum), *Prunus cerasoides, Prunus cerasus* (sour cherry), *Prunus domestica* (plum), *Prunus dulcis* (almond), *Prunus fruticosa* (dwarf cherry), *Prunus mahaleb* (mahaleb cherry), *Prunus persica* (peach), *Prunus persica* var. *nucipersica* (nectarine), *Prunus pumila* var. *besseyi, Prunus salicina* (Japanese plum), *Prunus serrulata* (Japanese flowering cherry), *Prunus spinosa* (blackthorn), *Prunus tomentosa* (Nanking cherry tree), *Prunus virginiana* (common chokecherry), *Rosa* (roses), *Rosa canina* (Dog rose), *Rosa chinensis* (China rose), *Rosa damascena* (Damask rose), *Rosa multiflora* (multiflora rose), *Rubus* (blackberry, raspberry) (CABI, 2023).

Symptoms: Symptoms of PNRSV generally consist of chlorosis, necrosis, leaf deformity, and stunting. Entire plants may be affected, or only a portion such as a single branch may show symptoms. Symptom expression depends on the host and the strain or strains of the virus. Localized necrotic reactions (shock symptoms) can develop on young leaves, resulting in perforations and shredding of the blades which, can cause leaves to be shed. In general, symptoms of PNRSV appear in the first year after infection (acute or shock stage), and then commonly become symptomless, although some strains cause recurrent symptoms annually (Wells, and Kirkpatrick 1986). The cherry rugose mosaic strain produces "boating" and turned-up leaf tips, delayed fruit maturity (up to 3 weeks), and enations (ridges of rasp-like growth) on the undersides of leaves. Trees can produce a lighter crop of fruit, the fruit may be deformed, or the maturity of the fruit may be delayed. Symptoms on roses include deformed flowers, reduced number and size of blooms, delayed flowering, line patterns, ringspots, or yellow nets on leaves (Fulton, 1970; Adaskaveg et al., 2009; Uyemoto, 1992; CABI, 2023).

Transmission: PNRSV is transmitted through vegetative propagation from infected mother plants. There is evidence that PNRSV is transmitted via seeds and pollen at variable rates in several hosts, including *Prunus*, hops, and roses, as well as in some experimental hosts such as pumpkins (Card et al., 2007; Hammond, 2011). In at least some of these hosts, pollen transmission is both vertical (resulting in infected seeds and seedlings), and horizontal (resulting in infection of the pollinated mother plant) (Card et al., 2007; Hammond, 2011; Uyemoto et al., 2003).

The role of insects in facilitating pollen transmission is not well understood. Spreading of the virus can be very rapid in young peach orchards, and honeybees have been implicated in spreading the virus as they pollinate flowers (Uyemoto et al., 1992). The thrips species *Frankliniella occidentalis* has been implicated as a transmission facilitator in greenhouse experiments (Greber et al., 1992). Transmission can occur by wounding on the interior surface of flowers that allows the cytoplasmic contents of pollen grains to invade the plant during thrips feeding (Uyemoto et al., 2003).

Damage Potential: Ilarviruses have been considered as latent pathogens when affecting fruit trees and, consequently, their economic incidence has likely been underestimated. PNRSV can cause significant crop losses depending on the host. Yield losses of up to 15% in sweet cherry and of up to 100% in peach (Uyemoto and Scott, 1992). PNRSV can reduce bud-take in nurseries (Saunier, 1972) decrease the growth of fruit (10 to 30%) and decrease the fruit yield (20 to 60%), delay fruit maturity, and increase susceptibility to winter injuries in orchards (Hammond, 2011; Mink, 1992; 110, Uyemoto and Scott, 1992). PNRSV and other ilarviruses act synergistically in mixed infections, causing peach stunt disease. Trees show a progressive decline that can lead to tree death (Uyemoto and Scott, 1992).

Worldwide Distribution: PNRSV has been reported from a very wide range of countries and all continents and is common and widespread in its *Prunus* hosts (CABI, 2023; Hammond, 2011; Uyemoto et al., 1992; Fry and Wood, 1971).

Official Control: PNRSV is on the USDA PCIT's Harmful Organism list for Canada, Georgia, Israel, Japan, Mexico, and Turkey. It is on the EPPO's A1 list for Paraguay, and the A2 list for Egypt, Jordan, and Turkey. It is a quarantine pest in Canada, China, and Mexico, and a regulated non-quarantine pest in Switzerland and the United Kingdom. PNRSV is a regulated harmful organism in the European Union.

The California Department of Food and Agriculture runs a fruit and nut tree registration and certification program. Eligible *Prunus* trees may be registered for the purpose of providing rootstock and scion sources for the propagation of certified nursery stock when inspected and tested for regulated diseases, including Prunus necrotic ringspot virus.

California Distribution: Widespread, likely statewide (French, 1989; CDFA PDR database, 2023).

California Interceptions: none.

The risk that Prunus necrotic ringspot virus would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** This pathogen is likely to be found wherever 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 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:** PNRSV has a rather limited natural host range, including *Prunus* sp., hops, and roses. It has a larger experimental host range.

   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 multiplies only within its hosts. Insects can facilitate transmission but are not true vectors. The ability to spread with pollen leads to very high dispersal potential.

   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:** This virus causes damage to trees and to fruit yield and it is one of the most economically important viruses of stone fruit trees, especially peach, sweet and sour cherry, plum, and almond. It is a quarantine pest for some trading partners.

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

   Economic Impact: A, B, C

   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: **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:** None have been reported, however, this virus can impact home gardening and ornamental plantings.

Evaluate the environmental impact of the pest on California using the criteria below.

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 Prunus necrotic ringspot 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.

This virus is widespread in California.

Evaluation is 'high'.

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 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 **= 10***

Uncertainty: none

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for **Prunus necrotic ringspot virus is C.**

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Responsible Party:

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***Comment Period:** **10/12/2023 through 11/26/2023**

***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