California Pest Rating Proposal for

Monilinia fructicola (G. Winter) Honey 1928

Brown fruit rot

Current Pest Rating: C

Proposed Pest Rating: C

Comment Period: 1/21/2020 through 3/6/2020

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 some or all these pathogens with state plant pest permits. In order to assess the need for a state permit, a formal risk analysis for *Monilinia fructicola* is given herein and a permanent pest rating is proposed.

History & Status:

Background: Brown rot diseases, caused by fungi in the genus *Monilinia*, are among the most important and damaging diseases of stone fruit worldwide. In the United States, *M. fructicola*, American brown rot, is the most commonly observed *Monilinia* species, although it is only one of four closely related *Monilinia* spp. that cause considerable economic damage around the world. The other important species in California is *M. laxa*. *Monilinia laxa* usually causes more severe blossom and twig blights, while *M. fructicola* causes more severe fruit decay. In addition, *M. laxa* is common on almonds and apricots, while *M. fructicola* is the dominant pathogen causing brown rot of peaches, nectarines, and plums (Michailides et al., 2007). The other species of *Monilinia* that cause brown rot around the world are *M. fructigena*, European brown rot, and *M. polystroma*, Asiatic brown rot.

Monilinia fructicola is widespread in California where it infects blossoms, twigs, branches and fruits. The most important hosts are *Prunus* spp., but where high levels of inoculum are present, it can cause disease on apples, pears, and ornamental plants in the family Rosaceae.

Hosts: Actinidia deliciosa (kiwifruit), *Amelanchier* (serviceberry), *Cerasus*, *Carica papaya* (pawpaw), *Chaenomeles* (flowering quinces), *Cornus mas* (cornelian cherry), *Crataegus* (hawthorns), *Cydonia oblonga* (quince), *Eriobotrya japonica* (loquat), *Feijoa sellowiana* (pineapple guava), *Fragaria x annanassa* (strawberry), *Gaylussacia* (huckleberry), *Malus domestica* (apple), *Myrica rubra* (Chinese bayberry), *Prunus* (apricots, plums, prunes, peaches, nectarines, cherries, and almonds), *Pyrus* (pears), *Rubus fruticosus* (blackberry), *Vitis vinifera* (grape) (CABI-CPC, 2019; EPPO, 2019; Farr and Rossman, 2019).

Symptoms: *Monilinia fructicola* causes two distinct types of diseases. The first is a blossom blight plus twig and branch dieback, and the second is brown rot of fruits. Flower blossoms can be infected early in the spring, develop a water-soaked appearance and partially collapse. Blighted blossoms often stay attached to the twigs or spurs and serve as a source of secondary inoculum. The green wood and twigs can be infected and develop either discrete or girdling lesions that cause dieback. Cankers can extend from young twigs and shoots towards larger branches, or the fungus may directly infect two to three-year-old wood. As a response to infection, profuse gumming can occur from the base of the flowers or on the twigs and branches (Ogawa et al., 2005).

Infected blossoms may cling to enlarging fruit and with moisture they produce spores and serve as sources of inoculum for infection of the developing green fruit. Infections of green fruit begin as soft, water-soaked, dark areas. Rot first develops in clustered fruit, at contact spots, and on insect- or wind-damaged fruit (Michailides et al., 2007). Fruit are most susceptible to infection during the 2-3 week period prior to harvest (Ritchie, 2000). The first symptoms on fruit are small dark spots that enlarge rapidly. The fruit remains relatively firm and under high humidity, masses of buff-colored spores form in concentric rings as the growth of the fungus rapidly expands to encompass the entire fruit. Fruit infections can be quiescent (occurring earlier but not being visible) until the fruit begin to ripen, or they can appear post-harvest. Fruit that is infected on the tree can shrivel to form a hard dry “mummy”. Pseudosclerotia (part fungus and part fruit tissues), also known as mummified fruit, is most often formed from shriveled infected ripe fruit, and occasionally from infected dried green fruit (Ogawa and English, 1991). The mummies serve as an inoculum source both on the tree and ground.

Transmission: The pathogen can survive long periods of adverse environmental conditions as mycelium within mummified fruits, twigs, cankers, and other infected tissues. Under favorable conditions (usually after a dormant period), two types of spores are produced on infected tissues and the fungus is dispersed to start a new cycle of infection, which coincides with early spring growth of host plants.

The primary source of spring inoculum is derived locally from overwintering fruit mummies and branch cankers, remaining on standing trees and the orchard floor. Warm temperatures with moist or humid conditions trigger the production of ash-gray-brown colored sporodochia (tufts of conidiophores) bearing conidia (asexual spores) in chains. Rapid mycelial growth is possible in as little as 24 hours and conidia germination can be observed in 3-5 hours (Ritchie, 2000). Conidia are transported by wind, water, or insects to susceptible plant parts. *Monilinia* spp. have been observed to produce ascospores (sexual spores) in sacs on cup or disc-shaped apothecia on mummified fruit on the ground. These ascospores can also be a source of primary inoculum to infect the flowers and wood. Fallen or thinned fruit on the orchard floor during the growing season can be infected and act as a significant inoculum source for healthy trees and fruit (Hong et al., 1997). Any infected tissue in which the moisture content is sufficient for sporulation may serve as a source of secondary inoculum (Biggs and Northover, 1998).

Damage Potential: Brown rot is one of the most important diseases of peaches and sweet cherries in the temperate fruit growing area of North America. In California in the 1950s before the development of effective fungicides and improved management methods, almost the complete destruction of the peach crop occurred following a single rain (Ogawa et al., 1995). Losses are primarily from the fruit rotting on the trees in the orchard, but serious losses may also appear post-harvest during transport and storage. In severe epidemics, blossoms are blighted so a percentage of fruit does not form, then 50-75% of the fruit may rot on the trees. Fruit infection can take place in the orchard and also after harvest, in storage, and in transit. Healthy fruit may also be attacked by conidia of the pathogen any time between harvest and sale to the consumer and the fungal mycelium can grow and directly onto healthy fruit that comes in contact with infected fruit. One infected fruit in a harvested tray can spread disease to adjacent healthy fruit, as ripe fruit are very susceptible to infection (Adaskaveg et al., 2015; Pscheidt and Ocamb, 2019). Branch, twig and spur cankers, dieback, and gumming in response to infection are all detrimental to the trees.

Worldwide Distribution:

Asia: *China, India, Japan, Republic of Korea, Taiwan, Yemen*; Africa: *Nigeria, Zimbabwe*; North America: *Canada, Mexico, United States*; Central America and Caribbean: *Guatemala, Panama*; South America: *Argentina, Bolivia, Brazil, Ecuador, Paraguay, Peru, Uruguay, Venezuela*; Oceania: *Australia, New Caledonia, New Zealand*; Europe: restricted areas or with sporadic occurrence in *Azerbaijan, Croatia, Czech Republic, France, Italy, Germany, Greece, Hungary, Poland, Romania, Serbia, Slovenia, Spain*, *Switzerland* (EFSA, 2011; Riccioni and Valente, 2015; Abate et al., 2018).

Official Control:

Monilinia fructicola is a quarantine pathogen in the European and Mediterranean Plant Protection Organization area and is included on the A2 List, although the disease is now established in several EU Member States (Ricconi and Valente, 2015). It is on the harmful organism list for Bosnia and Herzegovina, Canada, China, Egypt, Eurasian Customs Union, Holy See (Vatican City State), Honduras, India, Israel, Jordan, Monaco, Morocco, Nicaragua, Norway, Oman, San Marino, Serbia, South Africa, Tunisia, Turkey, United Arab Emirates (USDA-PExD).

California Distribution: Statewide in all stone fruit production areas (French, 1989).

California Interceptions: One interception at a border station on a peach from Alabama.

The risk *Monilinia fructicola* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Host infection by *M. fructicola* is favored by high humidity and mild temperatures (Ogawa and English, 1991). Although California generally has warm dry summers, spring conditions can be very favorable for disease development. Under favorable weather conditions in early spring, the conidia or ascospores produced from primary inoculum sources are capable of infecting first blossoms and then immature fruit. Under unfavorable weather conditions, the primary infections may remain latent until the weather conditions become conducive to disease expression.

   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:** Host range includes rosaceous fruit trees, especially peaches, and other *Prunus* spp. To a lesser extent, apples and pears can be hosts. The fungus has also been found on flowering quinces, hawthorns, quinces, loquat, and blackberries. A report from Japan (Visarathanonth et al., 1988) claims that *M. fructicola* also causes a brown rot of grapes, *Vitis vinifera*.

   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:** With both ascospores and conidia acting as primary inoculum, and multiple source of conidia as secondary inoculum, brown rot can cause severe epidemics when weather is condusive. Spores are airborne.

   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:** The pathogen can potentially infect all aerial host plant parts, such as blossoms, buds, shoots, twigs, branches, peduncles, and fruit (Ogawa et al., 1995). In plum, even leaves can be infected by *M. fructicola* (Michailides et al., 2007). In the first half of the 20th century, before effective fungicides were developed and without knowledge of integrated pest management, total crop loss was possible for very susceptible stone fruit (Ogawa et al., 1995).

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

Economic Impact: A, B, D.

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: Removing thinned fruit from the orchard helps to reduce fruit brown rot incidence and severity. There are very effective fungicides available to commercial fruit producers, but they are preventive, not eradicative; they must be applied to uninjured fruit before infections occur. (Adaskaveg et al., 2015).

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 *Monilinia fructicola:* 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 'high'. *Monilinia fructicola* is widespread in California.

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 **= 10***

Uncertainty:

None.

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Monilinia fructicola* is C.**

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Responsible Party:

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*Comment Period: 1/21/2020 through 3/6/2020

*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.

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