CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Botrytis cinerea Pers. (1794)

gray mold

Current Pest Rating: C

Proposed Pest Rating: C

Kingdom: Fungi, Division: Ascomycota

Class: Leotiomycetes, Order: Helotiales

Family: Sclerotiniaceae

Comment Period: 9/8/2020 through 10/23/2020

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 *Botrytis cinerea* is given herein and a permanent pest rating is proposed.

History & Status:

Background:

Botrytis cinerea (teleomorph: *Botryotinia fuckeliana*) is a necrotrophic airborne plant pathogen, that can attack over 500 plant hosts worldwide. The cosmopolitan disease "gray mold", which results from infections caused by *Botrytis cinerea*, effectuates heavy economic losses for important crops in California such as grapes, strawberries, tomatoes, and cut flowers. It is the most common mitosporic plant pathogenic fungus, using mitosis to produce massive numbers of asexual conidia. While infamous for causing blossom blights and fruit rots, this pathogen also causes damping-off, stem cankers or rots, leaf spots, and tuber, corm, bulb, and root rots of many vegetables, flowers, small fruits, and tree fruits (Agrios, 2005). Disease symptoms may become visible in the pre-harvest period, or remain

asymptomatic and quiescent, inside stems, leaves, flowers, fruits, or seeds, until after harvest. *Botrytis cinerea* is also the most extensively studied necrotrophic fungal plant pathogen. A necrotrophic phase commonly follows the quiescent phase once plant organs start to senesce or ripen, during which *B. cinerea* causes the rapid decay of the infected tissues (Elad et al., 2007). *Botrytis* sp. can be pleomorphic with several anatomical forms. *Botrytis cinerea* is a single, well-defined species, which is predominantly found in the asexual "gray mold" form, occasionally producing a *Botryotinia* perfect stage (*Botryotinia fuckeliana*). From a sclerotium, infective ascospores are produced in an apothecium.

Although there are fungicides for its control, many classes of chemicals have failed over time due to the genetic plasticity of this fungus and its ability to evolve resistance (Saito et al., 2016). It has become an important model for molecular study of necrotrophic fungi in terms of relevance to plant pathology (Dean et al., 2012). It can also claim a beneficial use, through its role in some aspects of wine production (Kelly, 2018).

Hosts: Over 500 hosts, mainly dicotyledonous plant species, including important protein, oil, fiber, and horticultural crops. It is most destructive on mature or senescent tissues (Williamson et al., 2007; Farr and Rossman, 2020).

Symptoms: There are multiple types of diseases caused by *B. cinerea*, which include the following: damping off, blossom blights, gray mold and blossom end rot. It can cause watery rotting of all aerial plant parts, and rotting of vegetables, bulbs, fruits, and flowers post-harvest. Infected seed or seedlings can suffer pre- or post-emergence damping off when *B. cinerea* has contaminated the seeds with sclerotia or sclerotia are present in the soil. Blossom blights are caused when conidia germinate and infect the flower petals; flower petals are particularly susceptible when they begin to age. From the senescing petals, the fungus produces abundant mycelium, a whitish-gray or light brown cobweb-like 'mold'. It invades the inflorescence and it can spread to the pedicel, which rots and causes the buds and flowers fall over. The fungus later moves from the petals into the fruit and causes a blossom end rot, which advances and may destroy part or all of the fruit. Infected fruit and succulent stems become soft, watery, and light brown. As the tissue rots, the epidermis cracks open and the fungus produces conidiophores and conidia so abundantly that it is visible to the eye and appears fuzzy and gray. Flat black sclerotia may appear on the surface or are sunken within the wrinkled, dry tissue.

Botrytis cinerea can also cause leaf spots on some hosts, e.g., on gladiolus, onion, and tulip, or flower petal spots (e.g., in roses). The spots start out as small and yellowish, but later become larger, whitish gray or tan, and sunken. They coalesce, and frequently involve the entire leaf. Stem lesions usually appear on succulent stems or stalks. They may spread through the stalk and cause it to weaken and break at the point of infection. In wet weather, diseased plant tissue (e. g. crowns, stems and leaves) becomes covered with a grayish-brown coat of fungus spores, at the end of the season survival structures (sclerotia) remain on debris. Infection of belowground parts, such as bulbs, corms, tubers, and roots, may begin while these organs are still in the ground or at harvest. Infected tissues usually appear soft and watery at first, but later they turn brown and become spongy or corky and light in weight. Black sclerotia are often found on the surface or intermingled with the rotted tissues and mycelium.

Transmission: Botrytis cinerea produces abundant gray mycelium and long, branched conidiophores that have rounded apical cells bearing clusters of colorless or gray, one-celled, ovoid conidia. The conidiophores and conidia form a complex cluster that resembles grapes on a rachis. Conidia are released in high numbers in humid weather and are carried by air currents or dispersed by water. The pathogen frequently produces melanized hard, flat, irregular sclerotia. Seedings can become diseased if seed lots are contaminated with sclerotia or infected by mycelium growing from sclerotia in the soil. Occasionally, *B. cinerea* sclerotia germinate to produce a *Botryotinia* perfect stage in which ascospores are produced in an apothecium. More commonly, sclerotia will overwinter and survive adverse environmental conditions in the soil or in plant debris, then produce mycelium that can directly infect plants (Brandhoff et al., 2017).

Botrytis cinerea occurs abundantly throughout the year as a saprophyte and facultative parasite on a wide variety of living and dead plant materials. Conidiospores enter new living hosts via wounds or natural openings. Infections of non-senescing or unripe plant organs like young fruit usually leads to only limited damage and quiescent infections (Jarvis, 1962). In raspberries and strawberries, despite high concentrations of airborne spores at the time of fruit development, relatively few infections are the result of germinating spores independent of the presence of necrotic floral tissues. The majority of fruit infections are initiated from mycelium growing saprophytically in contiguous plant material or from spores germinating in solutions trapped between such material and the fruit surface (Jarvis, 1994).

Different types of quiescence have been described and are independent of the type of infection. It can be as the delay of conidia germination or growth arrest after germination, endophytic symptomless growth in the apoplast, or colonization of abscising flower organs followed by growth into ovaries or receptacles where then growth arrests. At the end of quiescence, *Botrytis* generally enters a short asymptomatic, biotrophic phase before it begins the disease cycle (Bristow et al., 1986; Veloso and van Kan, 2018).

Damage Potential: Botrytis cinerea is most destructive on mature or senescent tissues, but it usually gains entry to such tissues at a much earlier stage in crop development. It will remain quiescent for a considerable period before rapidly rotting tissues when the environment is conducive, or the host physiology changes. Because the quiescence can silently continue until the fruit ripens, infected fruit may escape notice during picking and marketing, but may rot quickly after purchase. *Botrytis cinerea* also causes massive losses in some field- and greenhouse-grown horticultural crops prior to harvest, or even at the seedling stage in some hosts (Agrios, 2005; Jarvis, 1994; Williamson et al., 2007).

A broad host range, an ability to employ various infection modes, and the capability to survive in unfavorable conditions hinders control of *B. cinerea*. Worldwide the economic losses from *B. cinerea* are estimated from $10 billion to $100 billion (Hua et al., 2018). Serious damage can occur following the harvest of seemingly healthy crops. Some of the most economically damaging diseases caused by gray mold are on strawberry, grapes, and many vegetables, calyx end rot of apples, onion blast and neck rot, blight or gray mold of many ornamentals, bulb rot of amaryllis, corm rot of gladiolus, and

secondary soft rots of fruits and vegetables in storage, transit, and market (Agrios, 2005). Sclerotia are a notable limiter of quality seed and consequently impact trade value

Worldwide Distribution: *Botrytis cinerea* is distributed worldwide from cool temperate areas to the subtropics. Although less common in very arid climates, it thrives in greenhouses and in irrigated agriculture (Farr and Rossman, 2020; CABI-CPC, 2020).

Official Control: *Botrytis cinerea* is on the harmful organism list for Mexico (USDA-PCIT, 2020).

California Distribution: Widely distributed in at least 30 counties.

California Interceptions: Multiple interceptions on incoming shipments, mostly on cut flowers, plus fruits and vegetables for consumption.

The risk *Botrytis cinerea* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Botrytis cinerea* requires relatively cool temperatures, high humidity, and free water for spore or sclerotia germination and for infection. Hot dry weather limits disease but cool weather with fog along the California coast creates epidemics. Environmental conditions in greenhouses can be highly favorable.

   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 pathogen has one of the largest host ranges known with at least 500 plant species.

   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:** *Botrytis cinerea* mainly reproduces with conidia but can also produce ascospores and sclerotia. Spores are spread aerially.

   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:** Losses to *Botrytis cinerea* can occur at many stages of crop production. Often the most severe losses are from post-harvest fruit rotting.

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

Economic Impact: A, B

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: **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:** Fungicide applications are often required to prevent flower and fruit infections. Susceptible hosts are difficult to grow in coastal areas where disease pressure is very high

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 *Botrytis cinerea:*

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'. Botrytis cinerea is widely distributed and very common 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 *Botrytis cinerea* is C.

References:

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Responsible Party:

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***Comment Period: 9/8/2020 through 10/23/2020**

***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
