CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Diplodia seriata De Not. 1842
(≡ *Botryosphaeria obtusa* (Schwein.) Shoemaker 1964)

Current Pest Rating: Z

Proposed Pest Rating: C

Kingdom: Fungi, Phylum: Ascomycota,
Subphylum: Pezizomycotina, Class: Dothideomycetes,
Order: Botryosphaeriales, Family: Botryosphaeriaceae

Comment Period: 11/17/2021 through 01/01/2022

Initiating Event:

This pathogen has not been through the pest rating process and has a temporary Z- rating. The risk to California from *Diplodia seriata* (syn. *Botryosphaeria obtusa*) is described herein and a permanent pest rating is proposed.

History & Status:

Background:

The fungus known for many years as *Botryosphaeria obtusa* (Schwein.) Shoemaker (1964) is an important pathogen of apples, causing frog-eye spot, black rot, canker and shoot dieback, and an important trunk canker pathogen of grapevines. It also causes canker, dieback, fruit rot and leaf spot diseases on economically important forest and horticultural species. The teleomorphic genus *Botryosphaeria* was evaluated through a study of genomic sequences by Crous et al. (2006). They showed that *Botryosphaeria* sensu lato was composed of 10 phylogenetic lineages that represent individual genera. In order to avoid the need to add numerous new generic names, they chose to use existing asexual generic names for most of the lineages and restricted the use of "Botryosphaeria" to only two species, *B. dothidea* and *B. cortices*. Therefore, the name *Botryosphaeria* is no longer acceptable for most of the species with *Diplodia*-like anamorphs, including *D. seriata*. The taxonomic position of this species was verified by a phylogenetic study of "*B. obtusa*-type" specimens (Phillips et al. 2007). Their study determined that *D. seriata* De Not. was the oldest name available for the asexual morph of what had been previously referred to as *B. obtusa,* and this is the currently accepted species name.

Hosts: the USDA's Fungal database lists 896 records under hosts of *Diplodia seriata* and its synonyms. This host list includes multiple plant genera in multiple plant families. It is described as 'plurivorous', causing cankers, dieback, fruit rot, and leaf spot (Farr and Rossman, 2021).

California hosts: Aralia spp. (Japanese aralia), *Arctostaphylos densiflora* (Howard McMinn manzanita), *Acer palmatum* (Japanese maple), *Ceanothus gloriosus* (Pont Reyes ceanothus), *Citrus latifolia* (Persian lime), Citrus limon cv. 'Lisbon' (Lisbon lemon), *Citrus ×sinensis* cv. *Valencia* (Valencia orange), *Corylus avellana* (common hazel), *Corylus cornuta* var. *californica* (western hazelnut), *Eriobotrya japonica* (loquat), *Juglans regia* (English walnut), *Malus domestica* (apple), *Malus sylvestris* (crabapple), *Olea europaea* (olive), *Pinus longaeva* (western bristlecone pine), *Pistacia vera* (pistachio), *Punica granatum* (pomegranate), *Prunus dulcis* (sweet almond), *Prunus persica* (peach), *Pyrus communis* (pear), *Vitis vinifera* (grapevine) (PDR database, 2021; French, 1989).

Symptoms: *Diplodia seriata* causes several types of diseases such as fruit rots, dieback and cankers on a wide range of economically and environmentally important plants. The symptoms of cankers and dieback are similar across many species.

On apples, this pathogen affects multiple parts including leaves, fruit and branches. A blossom end fruit rot may develop starting as a purple spot on fruit with a red ring. The fruit rot phase is known as black rot and causes the fruit to rot both pre- and post-harvest. The disease can be latent and not seen until after harvest, after the fruit are put into storage. The first visible symptoms are small black lesions (2-4 mm diam.) which are slightly sunken with a corky texture, followed by a rapidly progressing pale brown rot developing in 2-3 weeks on ripening or stored fruit. The active stage has concentric zones of lighter and darker brown colors, later the rotted areas turn black. Pycnidia may develop in the lesions. In advanced stages the fruit is completely rotted, spongy to firm, and light brown. Fruit can mummify and remain attached to the tree.

The fungus also causes a distinctive leaf spot, known as "frog-eye" spot. Leaf lesions are initially small, purple specks that enlarge to form spots 3 to 6 mm in diameter, these spots have light brown-to-grey centers that are surrounded by one or more darker rings of tissue and a purple border. Dark pycnidia of the fungus may develop in the center of older leaf spots. Infected leaves fall prematurely from the tree. Stem symptoms begin as slightly sunken, reddish-brown patches within the bark. These areas enlarge and darken to form cankers with sunken centers and raised margins. Cankers can girdle the twigs or branches. Bark of infected limbs becomes slightly sunken with reddish-brown areas. The canker may just be a superficial roughening of the bark or may develop into necrotic cracks with discolored vascular cambium (Urbez-Torres et al., 2016; Reeder, 2020).

On grapevines *D. seriata* can cause the death of spring buds, leaf chlorosis, fruit rot and trunk dieback, with brown, hard necrosis of the wood that appears as wedge-shaped necrosis in cross sections of the affected plant parts. Other symptoms include internal streaking and pith necrosis of wood, failure of graft union in young vines and cane bleaching. *Diplodia seriata* is one of the most often identified Botryosphaeriaceae species occurring on grapevines worldwide and is frequently associated with the 'black dead arm' disease of grapevine (Urbez-Torres et al., 2006; Urbez-Torres, 2011).

On citrus, *D. seriata* is one of several species responsible for "bot gummosis", causing canker and dieback on many citrus cultivars. Initial symptoms are scattered dieback of twigs and branches, where portions have dead outer bark over a sunken canker. The dead bark may exude gums, and the cambial layer of wood underneath the bark may turn brown to yellowish. Cankers can be found on the main trunk, branches, twigs, and exposed roots (roots above ground) (Adesemoye et al., 2014).

Transmission: The fungus enters its host primarily through wounds and possibly natural openings. Some woody hosts such as apple, peach and pistachio can also be infected through natural openings such as stomata and lenticels or with direct penetration of host tissue (Michailides, 1991). Asexual fruiting bodies (pycnidia) are produced within 24 weeks and will continue to produce spores for about two years. On branches, pycnidia are in black masses of fungal tissue (stromata) on and embedded in the bark. Spore production and germination are favored by moisture. During winter rainfall, spores are released, and wounds made by winter pruning provide infection sites (Smith et al., 2014). The extensive host range of this species means that it is more likely to become established in new areas, as establishment will not depend on the presence of specific hosts. The widespread distribution of this species is presumably as a result of the word-wide movement agricultural, forestry and ornamental plants (Reeder, 2020).

Damage Potential: Reports of the virulence of this pathogen vary depending upon the crop, varieties and hosts involved and it is often regarded as a stress-related pathogen taking advantage of weak or stressed plants. *Diplodia seriata* is regarded as an important pathogen of apple with fruit losses up to 50% in highly conducive climates. Rain favors infection, but drought stress worsens branch cankers (Brown and Britton, 1986). On grapevine, dead-arm and bot canker are leading vineyard disease problems estimated to cause damage in the hundreds of millions of dollars per year (Siebert, 2001), but multiple fungal species are implicated, and mixed infections are common (Bettiga, 2013).

Worldwide Distribution: Africa: *Algeria, Kenya, Sierra Leone, South Africa, Tanzania, Tunisia, Zambia, Zimbabwe*. Asia: *China, Georgia, India, Iran, Iraq, Japan, Lebanon, Malaysia, Pakistan, South Korea, Sri Lanka, Taiwan, Turkey*. Europe: *Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cypress, Czechia, France, Germany, Greece, Hungary, Italy, Latvia, Netherlands, Portugal, Romani, Russia, Serbia and Montenegro, Slovakia, Slovenia, Spain, Ukraine, United Kingdom*. North America: *Canada, Mexico, United States* (Alabama, Arkansas, California, Connecticut, Delaware, Georgia, Kansas, Kentucky, Maryland, Michigan, Minnesota, Missouri, Nebraska, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas, Virginia, Washington, West Virginia). Oceania: *Australia, New Zealand, Papua New Guinea*. South America: *Argentina, Bolivia, Brazil, Chile, Ecuador, Uruguay, Venezuela* (Reeder, 2020).

Official Control: *Diplodia seriata* is on the USDA PCIT's harmful organism list for Nicaragua (USDA, 2021).

California Distribution: Colusa, Contra Costa, Fresno, Kern, Los Angeles, Madera, Monterey, Napa, Sacramento, San Diego, San Joaquin, Santa Barbara, Shasta, Sonoma, Tulare, Yolo counties (PDR database, 2021; French, 1989).

California Interceptions: One interception in Alameda County on an incoming shipment of chestnut (*Castanea sativa*) nuts from Iowa

The risk *Diplodia seriata* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Diplodia* spp. require rain and wet conditions for spore production, dissemination, and infection. California weather conditions are generally favorable for adequate periods in the winter and spring, and commonly occur in coastal parts of the state. It is less likely to be found in the desert.

   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:** This pathogen has an extremely large host range, mainly woody plants, but 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:** *Diplodia* spp. produce large numbers of conidia but they require wet weather to spread and infect. They may require a wound or natural opening, but some can directly infect intact bark.

   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: Epidemics are often associated with pre-existing or concurrent environmental stresses and wounding from pruning. During times of environmental stress, branch cankers and dieback can have a significant impact on tree health and yield. There are differences in susceptibility between hosts.

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: This pathogen is able to infect many families of mostly woody plants, including some of which have members that are rare or threatened e.g. manzanita and ceanothus. The susceptible horticultural crops including grapes, pome fruit and citrus, plus olives, pistachio and pomegranate are widely planted across huge acreages, guaranteeing opportunity for pathogen spread to natural communities and managed landscapes.

Evaluate the environmental impact of the pest to California using the criteria below

Environmental Impact: A, B, C, 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 *Diplodia seriata:* Medium

Add up the total score and include it here. **12**
-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'.

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* ***=9***

Uncertainty:

Some reports suggest that *D. seriata* is mainly a weak pathogen to hosts such as grapevine, and possibly only causes significant damage to weak or stressed plants (Qiu et al., 2016). There is variation in virulence between strains, and the virulence of any given isolate may vary according to the host that is being attacked. Accurate species recognition and identification is important when many fungi cause similar symptoms on the same hosts and mixed infections are common (Reeder, 2020).

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Diplodia seriata* is C.

References:

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Responsible Party:

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***Comment Period: 11/17/2021 through 01/01/2022**

***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