CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Colletotrichum truncatum (Schwein.) Andrus & W.D. Moore 1935

Soybean anthracnose

Current Pest Rating: Q

Proposed Pest Rating: B

Domain: Eukaryota, Kingdom: Fungi,
Phylum: Ascomycota, Subphylum: Pezizomycotina,
Class: Sordariomycetes, Subclass: Sordariomycetidae,
Family: Glomerellaceae

Comment Period: 02/02/2021 through 03/19/2021

Initiating Event:

In 2003, an incoming shipment of *Jatropha* plants from Costa Rica was inspected by a San Luis Obispo County agricultural inspector. The inspector submitted leaves showing dieback symptoms to CDFA's Plant pest diagnostics center for diagnosis. From the leaf spots, CDFA plant pathologist Timothy Tidwell identified the fungal pathogen *Colletotrichum capsici,* which was not known to be present in California, and assigned a temporary Q rating. In 2015, a sample was submitted by Los Angeles County agricultural inspectors from *Ficus* plants shipping from Florida. Plant Pathologist Suzanne Latham diagnosed *C. truncatum*, a species that was synonymized with *C. capsisi* in 2009, from the leaf spots. She was able to culture the fungus from leaf spots and confirm its identity by PCR and DNA sequencing.

Between 2016 and 2020, multiple samples of alfalfa plants from Imperial County with leafspots and dieback were submitted to the CDFA labs as part of the PQ seed quarantine program with infections from *C. truncatum*. Seed mother plants must be free-from specific disease of quarantine significance in order to be given phytosanitary certificates for export. Although not a pest of concern for alfalfa, *C. truncatum* is on the list for beans grown for export seed. The risk to California from *C. truncatum* is described herein and a permanent rating is proposed.

History & Status:

Colletotrichum spp. are important plant pathogens found worldwide. These fungi cause disease symptoms that are generally known as "anthracnose" in a wide range of vegetables, fruits, and other crops. *Colletotrichum* spp. can cause extensive yield losses at both the pre- and post-harvest stages, especially during warm and rainy conditions. Traditionally, *Colletotrichum* spp. have been identified and characterized based on conidia and appressoria morphology. However, species level identifications are difficult to obtain via morphological data alone. Accurate identifications are critical for understanding pathogen host relationships and population distribution. It is necessary to couple genetic and morphological data in order to reliably identify *Colletotrichum* species. When type materials are in poor condition, they cannot provide DNA sequence data or cultures for molecular studies. Work is ongoing to epitypify the important species of *Colletotrichum* making specimens available for research.

Colletotrichum truncatum, originally described on lima bean (*Phaseolus lunatus*), was typified by Damm et al. in 2009 with *Phaseolus* material from Pennsylvania. This species has been associated with anthracnose on legumes and peppers and it has been found on many other hosts (Farr and Rossman, 2021). The *C. truncatum* clade also contains the epitype strain of *C. capsici* from *Capsicum frutescens* from India, which Damm et al. were able to synonymize with *C. truncatum* on the basis of its multi-locus phylogeny and morphology. This combination has produced a broad host list for this pathogen. It occurs worldwide, with the largest number of hosts belonging to the family Fabaceae. Almost all the affected hosts are dicotyledons, with the exceptions of a sedge, *Cyperus rotundus,* found in Brazil, and isolates collected from a human eye (Squissato et al., 2015). Cultural and microscopical characters are variable but the species is not known to form any intraspecific groups (Damm et al., 2009).

Background:

Hosts: Abutilon theophrasti (velvet leaf), *Aeschynomene* sp. (jointvetch), *Aeschynomene americana* (shyleaf), *Amaranthus hybridus* (smooth pigweed), *Apocynum cannabinum* (Hemp dogbane), *Arachis hypogaea* (peanut), *Asclepias* sp. (silkweed), *Cajanus cajan* (pigeon pea), *Capsicum* sp. (peppers), *Capsicum annuum* (bell pepper), *Centrosema* sp., *Centrosema pubescens* (centro), *Chenopodium album* (fat hen), *Cicer arietinum* (chickpea), *Citrus reticulata* (mandarin), *Clitoria ternatea* (butterfly-pea), *Crotalaria juncea* (sunn hemp), *Cyamopsis tetragonoloba* (guar), *Datura stramonium* (jimsonweed), *Desmodium* sp. (tick clovers), *Gliricidia sepium* (gliricidia), *Glycine max* (soy bean), *Hylocereus polyrhizus*, *Hylocereus undatus* (dragon fruit), *Ipomoea* sp. (morning glory), *Jatropha curcas* (jatropha), *Kalanchoe pinnata* (cathedral bells), *Lens culinaris*, *Lens culinaris* subsp. *culinaris* (lentil), *Lupinus* sp.(lupins), *Medicago sativa* (alfalfa), *Panax ginseng* (Asiatic ginseng), *Passiflora edulis* f. *flavicarpa*, *Phaseolus* sp. (beans), *Phaseolus lunatus* (lima bean), *Phaseolus vulgaris* (common bean), *Pisum sativum* (pea), *Polygonum* sp. (knotweed), *Prunus persica* (peach), *Solanum* sp. (nightshade), *Solanum lycopersicum* (tomato), *Stylosanthes* sp. (pencil-flower), *Stylosanthes guyanensis*, *Trifolium pratense* (red clover), *Trifolium subterraneum* (subterranean clover), *Vicia sativa* (common vetch), *Vigna* sp. (cowpea), *Vigna aconitifolia* (moth bean), *Vigna mungo* (black gram), *Vigna radiata* (mung bean), *Vigna unguiculata* (cowpea), *Viola wittrockiana* (wild pansy), *Xanthium strumarium* (common cocklebur), *Zornia* sp., *Zornia diphylla* (CABI-CPC, 2021).

Symptoms: On legumes, *C. truncatum* causes both asymptomatic and symptomatic infections. Anthracnose, the resulting disease, can occur at all growth stages. Early in the season, irregularly shaped, brown areas appear on stems, pods, and petioles. As the disease develops, infected tissues are covered with black fruiting bodies (conidiomata) which produce minute black spines (setae). When pods or pedicels are infected at an early stage, seeds either do not form (pod blanking) or, if they do develop, they are smaller and fewer in number. Symptoms which evolve to pod rot can also cause the immature opening of pods and to the premature germination of grains (Rogerio et al., 2016).

On many plants including alfalfa, foliar symptoms develop after prolonged periods of high humidity, and include necrosis of laminar veins, leaf rolling, and petiole cankers. Sunken, oval spots form on stems; circular spots form on leaves. Lesions are at first green, but later develop a grey center with a reddish-brown to black border. The lower stems may be girdled, become slimy, and eventually the entire shoot may redden and wilt. Premature defoliation may occur if cankers girdle the leaf petiole. The cankers often occur where the leaflets join the petiole, resulting in a shepherd's crook. Diseased plants may be stunted. Affected plants senesce earlier than healthy plants due to the combined effects of the stem and petiole lesions (CABI-CPC, 2021).

Seeds colonized by *C. truncatum* may not show any symptoms, may develop brown staining, or small, irregular, grey areas with black specks. Pre- and post-emergence damping-off may occur when infected seeds are planted in the field. Dark brown, sunken cankers (lesions) often develop on the cotyledons of emerging seedlings. These cankers gradually extend up toward the epicotyl and down to the radicle. During humid weather one or both cotyledons may become water-soaked, wither and fall off. Infection may spread from the cotyledons to the young stems where small, deep-seated cankers form, often killing the seedling (CABI-CPC, 2021).

Colletotrichum truncatum can cause extensive pre- and post-harvest damage to chili pepper fruit with typical anthracnose lesions: sunken necrotic tissues with concentric rings of acervuli (Than et al., 2008). Post-harvest symptoms on papaya show tiny light brown spots initially that develop into deep, water-soaked lesions with black acervuli (Aktaruzzaman et al., 2018).

Transmission: Colletotrichum spp. survive between crops during winter as mycelium on plant residue in soil, on infected plants, and on seeds. During active growth, the pathogen produces masses of hyphae (stromata) which bear conidiophores, on the plant surface. Conidia (spores) are produced at the tips of the conidiophores and disseminated by wind, rain, cultivation tools, equipment, and field workers. Conidia are transmitted to host plants. Conidia germinate, penetrate host tissue by means of specialized hyphae (appressoria) and invade host tissue.

Humid, wet, rainy weather is necessary for infection to occur. These requirements may limit the occurrence of the pathogen in California fields and subsequently, the pathogen may be more of a problem under controlled environments of greenhouses. However, this disease occurs in alfalfa fields grown in Imperial County where high temperatures and dense, humid crop canopies appear to be favorable for transmission and symptom development. Windborne dispersal with infested lentil stubble, dust, debris, and soil, and with microsclerotia has been reported (Buchwaldt et al., 1996).

Colletotrichum truncatum can be transmitted with seed, hyphae, and spores, and it is found both internally and externally in and on seeds and plants. Seeds colonized with *C. truncatum* range from asymptomatic to symptomatic, showing irregular gray spots with black specks and producing compact dark mycelium both intra- and intercellularly in the seed coat, cotyledon and embryo. Acervuli with setae and abundant hyaline sickle-shaped conidial masses can be observed on the surface of infected seeds. Brown conidial masses are produced during incubation and liberated in the form of ooze resulting in maceration and disintegration of the parenchyma tissues of the seed coat, cotyledon and embryo (Begum et al., 2007). Soybean seed infection levels as high as 81% have been recorded in tropical and subtropical regions but far lower levels are reported in temperate regions. The pathogen can survive over 10 years in seed stored at 5ºC (CABI-CPC, 2021).

Damage Potential: On soybeans grown in the tropics, this disease is one of the main limiting factors for yield and losses up to 100% have been reported under favorable weather conditions of high temperature and moisture. The most significant damage is caused by the twisting and aborting of the pods, with additional losses from a reduction in the number of pods, reduced leaf retention and green stem infections in the field (Rogerio et al., 2016). On physic nut (*Jatropha curcas*) which is grown for biofuel, this disease infects the plants and the nuts worldwide (Machado and Pereira, 2012). Anthracnose on papaya and chili fruits causes serious pre- and post-harvest damage and losses of up to 30% (dos Santos Vieria et al, 2020; Oo and Oh, 2020).

On common beans and lima beans grown in California, anthracnose is among the diseases that have potential to cause considerable damage. *Colletotrichum truncatum* has been reported to cause losses of up to 100% in the production and quality of the pods (Gomes and Nascimento, 2018). This reduction seed in quality is important to our phytosanitary programs, as it can compromise California producer's ability to export bean seed.

Worldwide Distribution: Africa: *Burkina Faso, Cameroon, Côte d'Ivoire, Egypt, Ethiopia, Gabon, Ghana, Guinea, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Nigeria, Senegal, Sierra Leone, South Africa, Tanzania, Uganda, Zambia, Zimbabwe*. Asia: *Bangladesh, China, Hong Kong, India, Indonesia, Iran, Japan, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Saudi Arabia, Singapore, South Korea, Taiwan, Thailand, Turkey, United Arab Emirates, Vietnam*. Europe: *Bulgaria, France, Hungary, Italy, Moldova, Russia, Serbia and Montenegro, Slovakia, Spain*. North America: *Barbados, Belize, Canada, Cuba, Guatemala, Honduras, Puerto Rico, Trinidad and Tobago, United States* (Alabama, Arkansas, Florida, Georgia, Hawaii, Illinois, Indiana, Kansas, Kentucky, Louisiana, Maryland, Minnesota, Mississippi, Missouri, North Carolina, North Dakota, Oklahoma, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Washington, Wisconsin). Oceania: *Australia, Federated States of Micronesia, Fiji, Papua New Guinea, Samoa, Tonga.* South America: *Argentina, Brazil, Colombia, Guyana, Venezuela.*

Official Control: The EPPO lists *C. truncatum* as a regulated non-quarantine pest, and it is on the A1 list for Chile. It is on the USDA's harmful organism list for Chile, Israel, Mexico, New Zealand, and Panama. It is listed in CDFA's PQ Phytosanitary field inspection manual as a pest of concern for beans. Idaho

regulates seeds and vegetative parts of lentil, *Vicia* sp., faba bean, peas, Tangier peas, vetch and other hosts of Anthracnose of lentil (*Colletotrichum truncatum*) and (*Colletotrichum destructivum*).

California Distribution: Imperial County

California Interceptions: Interceptions have been made on incoming nursery shipments of ornamental plants from Florida and Central America (see 'initiating event').

The risk *Colletotrichum truncatum* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Colletotrichum truncatum* has been recorded in temperate and tropical regions across North America, including as far north as the Canadian prairies. Lack of moisture is often the limiting factor for its spread and establishment. However, in greenhouses, or in dense and humid plant canopies such as in alfalfa fields in Imperial County, it is able to grow and create epidemics.

   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 for *C. truncatum* is very large, including 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:** This pathogen reproduces with spores. The inoculum is spread via wind, infected plant debris, splash dispersal and transport of infected seed.

   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 pathogen has a large host range and under favorable conditions is documented to cause 100% crop loss. Its seedborne nature is an issue for phytosanitary seed export programs.

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

Economic Impact: A, C

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 has a very large host range with the potential to infect native and naturalized plants and survive independent of cultivated crops.

Environmental Impact: A

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 *Colletotrichum truncatum:* 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 'low'. There is evidence it is stablished in Imperial County where it is a known problem on Alfalfa. It has not been found on other hosts or climates in California.

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* ***= 11***

Uncertainty:

Favorable environmental conditions are very important for anthracnose epidemics. Most of California has been assumed to be too dry for significant levels of disease to develop. Detections on alfalfa in Imperial County show that microclimates can be created that are favorable for fungal growth and crop damage.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Colletotrichum truncatum* is **B.**

References:

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Responsible Party:

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***Comment Period: 02/02/2021 through 03/19/2021**

***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
