CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Phytophthora capsici Leonian 1922
Stem and fruit rot of peppers

Current Pest Rating: none

Proposed Pest Rating: C

Domain: Eukaryota, Kingdom: Chromista,
Phylum: Oomycota, Class: Oomycetes,
Order: Peronosporales, Family: Peronosporaceae

Comment Period: 04/03/2023 through 05/18/2023

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from *Phytophthora capsici* is described herein and a pest rating is proposed.

History & Status:

Background:

Phytophthoras are filamentous, osmotrophic eukaryotes that resemble fungi morphologically but belong to the class Oomycota in the kingdom Stramenopila. The genus *Phytophthora* include some of the most destructive plant pathogens of agricultural crops, ornamental plants, and forests. The majority of the described *Phytophthora* species are soilborne and waterborne and re primarily responsible for root and collar rots and occasionally bleeding stem cankers. They infect through the release of biflagellate zoospores into soil or surface water. Airborne *Phytophthora* species produce almost exclusively caducous sporangia and primarily infect aerial parts of plants, causing leaf necroses, shoot blights, fruit rots, and bleeding bark cankers on stem and branches. Aerial infections occur through detached sporangia spread by wind and rain splash (Erwin et al., 1996).

Phytophthora capsici was first described from chili peppers in New Mexico in the early 1900s (Leonian, 1922) and in California on honeydew melons in the 1930s (Thompkins and Tucker, 1937). *Phytophthora capsici* is part of a species complex and attempts at resolution over the years have not fully determined whether it is one species with formae speciales, or multiple species (Barchenger et al., 2018). Today it is recognized as having a broad host range including temperate and tropical plants. *Phytophthora*

capsici sensu lato infects 51 plant genera in 28 families and is considered cosmopolitan. Some tropical isolates previously called *P. capsici* have been reclassified to the closely related species, *Phytophthora tropicalis* (Aragaki and Uchida, 2001). *Phytophthora capsici* is in Clade 2b; it is heterothallic and produces oospores, sporangia, and zoospores. Chlamydospores are not produced (Abad et al., 2022).

Primary economic hosts are field- and greenhouse-grown vegetable crops. The host range continues to expand. *Phytophthora capsici* causes root-rots, and stem-, leaf-, and fruit-blights. These diseases are dependent on host species involved, the point of infection, and are influenced by environmental conditions. Disease severity is affected by plant maturity, with more mature plants generally being more resistant than seedlings or young fruits (Erwin and Ribeiro, 1996).

Hosts: Phytophthora capsici can infect many plant species. Important crop plants include members of the Solanaceae (pepper, eggplant, and tomato), Cucurbitaceae (cucumber, watermelon, squash, and pumpkin), and Fabaceae (bean, pea, and alfalfa) (Farr and Rossman, 2023).

Symptoms: *Phytophthora capsici* can infect the crown and root tissue of cucurbit and solanaceous seedlings, resulting in damping-off (seedling death). Roots of plants may become infected, resulting in stunted growth. The crown tissue initially is water-soaked, becoming dark brown, and lesions typically progress upward. Infection of the crown tissue of cucurbit and pepper plants often results in wilting followed by plant collapse. Cucurbits can be affected by other wilt diseases caused by fungi or bacteria, but crown tissue collapse is characteristic of *P. capsici*. Foliar symptoms can develop in pepper, eggplant, and most cucurbits. Seedlings and young plants may exhibit foliar blighting and die when infested soil is splashed onto the cotyledons and young leaves during rainstorms or overhead irrigation (Hausbeck and Lamour, 2004).

Petioles and stems of cucurbits affected by *P. capsici* appear water-soaked and leaves above stem lesions can wilt. On cucurbits and peppers, leaf spots are light green at first and then soon become necrotic, typically maintaining a wilted border, and can enlarge substantially. Leaf spots sometimes start to develop at the edge of cucurbit leaves that are in contact with soil, but most are caused by splash-dispersed spores landing on the leaves. Although *P. capsici* causes leaf spots on potato and tomato that resemble those caused by *P. infestans*, the late blight pathogen, *P. capsici* does not sporulate on leaves under field conditions.

Pre-and post-harvest fruit rot is an important symptom. Affected cucurbit fruit tissue typically appears water-soaked initially, soft to the touch, and with expanding lesions that later become covered with a white coating (McGrath, 2017). Pathogen signs may develop in as few as 5 days post -infection and include white, powdery growth from the development of sporangia on the fruit surface. Younger, smaller fruit are more susceptible than older, larger fruit. Symptoms can also begin around the fruit peduncle due to systemic infection from the vine (McGrath 2017). In the field, fruit rot is generally seen on the fruit surface that is in contact with the soil. *Phytophthora* fruit rot on contracted in the field may be asymptomatic until it develops postharvest during storage or transport. Eggplant and pepper fruit are also susceptible to infection and show white growth of the pathogen on the fruit surface. Tomatoes can develop a characteristic buckeye rot with concentric brownish and water-

soaked lesions. Snap beans exhibit brownish and necrotic collapse at the end of bean pods (Parada-Rojas et al., 2021; CABI, 2023; Davis et al., 2013).

Transmission: The pathogen may be spread to non-infected sites through infected plants, nursery and planting stock, seedlings, soil, irrigation and rain water, and contaminated cultivation equipment and tools. Phytophthora capsici produces oospores which are found embedded in infected tissues. Oospores are sexual propagules with thick cell walls resistant to hot, dry summers. Oospores persist in the soil for several years and germinate to produce mycelia and sporangiophores bearing sporangia under wet conditions (Abad et al., 2022).

Damage Potential: Phytophthora capsici is a constraint on production, and epidemics can occur when weather is favorable for disease. Management of diseases is currently limited by the long-term survival of the pathogen as oospores in the soil, a wide host range, long-distance movement of the pathogen in surface water used for irrigation, the presence of fungicide-resistant pathogen populations, and a lack of commercially acceptable resistant host varieties for multiple agronomic crops (Granke et al., 2012). Losses can occur from damping off of seedlings all the way through to the development of post-harvest fruit rots.

Worldwide Distribution: Africa: *Morocco, Nigeria, Tunisia*. America: *Argentina, Bolivia, Brazil, Canada, Colombia, Costa Rica, El Salvador, Guatemala, Mexico, Panama, Peru, Puerto Rico, Trinidad and Tobago, United States of America* (California, Colorado, Florida, Georgia, Hawaii, Louisiana, Michigan, Mississippi, Missouri, New Jersey, New Mexico, New York, North Carolina, Ohio, South Carolina, Texas, Virginia), *Venezuela*. Asia: *China, India, Indonesia, Iran, Iraq, Japan, Korea Dem. People's Republic, Korea, Republic, Lebanon, Malaysia, Philippines, Saudi Arabia, Taiwan*. Europe: *Bulgaria, France, Greece, Italy, Russia, Serbia, Spain, Türkiye.* Oceania: *Micronesia, Palau* (EPPO, 2023)

Official Control: *Phytophthora capsici* is on the USDA PCIT's harmful organism list for Indonesia, Israel, Madagascar, Mauritius, Mexico, Namibia, New Zealand, Nicaragua, Nigeria, Paraguay, Qatar, South Africa, Thailand, The United Republic of Tanzania, Timor-Leste, Uganda, and Yemen. It is on the EPPO's A1 list for the Inter-African Phytosanitary Council, the A2 list for Bahrain and a quarantine pest in Mexico (USDA PCIT, 2023; EPPO database, 2023).

California Distribution: Calaveras, Monterey, Riverside, San Joaquin, Santa Barbara, Santa Clara, Solano, Stanislaus counties on cucurbits, peppers, tomatoes, and woody ornamentals (CDFA PDR database, 2023). Older records show the disease is widespread in California on cucurbits, peppers and tomatoes (French, 1989).

California Interceptions: none

The risk *Phytophthora capsici* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:**

Phytophthora capsici can be found in vegetable production areas statewide. Infection of plants occurs at any stage of growth when there is free water in the soil. Damage is greatest in poorly drained, compacted, or overirrigated soils.

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 of this pathogen is large, including dozens of agricultural crops and weeds.

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 has tremendous reproductive potential under saturated soil conditions. Hundreds of thousands of sporangia may form on a single infected cucurbit fruit, each of which may be dispersed and germinate directly to infect new hosts or may differentiate to form 20 to 40 biflagellate motile zoospores. Swimming zoospores use electro- and chemotactic signals to target plant roots, and each of these zoospores may potentially cause a new infection (Granke et al., 2012).

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:** Crop losses can be high especially when there are fruit infections. Spores move with contaminated irrigation water.

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

Economic Impact: A, B, G

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:** *Phytophthora capsici* has a large host range that includes many types of weeds, including common purslane, nightshade, horse nettle and Jimson weed. Oospores are produced, which allow *P. capsici* to overwinter and survive for years in the soil even in the absence of a susceptible host. Crop rotations are difficult because of the large host range.

Evaluate the environmental impact of the pest to 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 *Phytophthora capsici:* 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'.

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:

Future taxonomic work may separate new species away from *P. capsici*.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Phytophthora capsici* is C.

References:

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Responsible Party:

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***Comment Period:04/03/2023 through 05/18/2023**

***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