

California Pest Rating Proposal for
***PHYTOPHTHORA BRASSICAE* (De Cock & Man in 't Veld, 2002)**

Current Pest Rating: Q

Proposed Pest Rating: B

Comment Period: 7/11/2019 through 8/25/2019

Initiating Event:

On January 3, 2018, a non-official sample of collapsing cauliflower plants (*Brassica oleracea* var. *botrytis*) with symptoms of root and crown disease from a commercial field in Santa Barbara County was submitted by a Pest Control Advisor to the local County Agricultural Commissioner's office. CDFA Plant Pathologist Suzanne Latham extracted DNA from the roots, amplified a PCR product using oomycete specific primers (including using gel electrophoresis for visual), and then sequenced the PCR product for identification of the species *Phytophthora brassicae*. Subsequently, on February 2, 2018, an official sample was collected by CDFA PDEP Lompoc with Santa Barbara County officials. *Phytophthora brassicae* was detected in culture from the stems, roots and leaf petioles of nearly all plants contained in the sample. The identity of pathogen causing the disease was confirmed by the USDA Mycology Lab in Beltsville, Maryland. This marked a first detection record of *P. brassicae* in California and the pathogen was given a temporary Q rating. The risk of this pathogen to California is assessed here and a permanent rating is proposed herein.

History & Status:

Background: A *Phytophthora* sp. causing storage rot disease of white cabbage (*Brassica oleracea* var. *capitata*) was originally isolated and described in the UK by Geeson in 1976. At that time, it was regarded as *P. porri* based on its morphology and temperature required for growth. However, in subsequent years, studies based on molecular and phylogenetic analyses of isolates from the *Phytophthora* subclade 8b, combined with morphological characters, temperature-growth relations, and pathogenicity experiments, demonstrated that *Phytophthora* isolates from *Brassica* species significantly differed from isolates from *Allium* species and therefore the *Brassica*-infesting *Phytophthora*, it was separated from *P. porri* and elevated to species status as *Phytophthora brassicae* (De Cock and Man in 't Veld, 2002). This pathogen has also been reported as *P. porri* in the United States in Wisconsin on cabbage (Heinmann, 1994), and as *P. brassicae* from Belgium, France, Germany,

the Netherlands, New Zealand, and the United Kingdom on cauliflower (Bertier et al., 2013; Tanguy and Estrogues, 2006; Declercq et al., 2010; Man in 't Veld et al., 2002; Jones et al., 2007; Kroon et al., 2004; Blair et al., 2008; Martin et al. 2014; and Yang et al., 2017), and from *Brassica chinensis* (bok choy) in the Netherlands (Bertier et al., 2013). In laboratory studies, *P. brassicae* could also infect detached leaf disks of Brussels sprout (*B. oleracea* var. *gemmifera*) (Bouwmeester and Govers, 2009).

Hosts: The natural hosts are *Brassica oleracea* (cabbage, cauliflower), *Brassica rapa* var. *pekinensis* (chinese cabbage) and *Brassica chinensis* (bok choy) (Farr and Rossman, 2019). *B. oleracea* var. *gemmifera* (Brussels sprout) were susceptible when inoculated under experimental conditions (Bouwmeester and Govers, 2009).

Symptoms: Cabbage infected with *Phytophthora brassicae* exhibit disease symptoms of storage or head rot including blackish brown wrapper leaves and a brown internal wet rot. The pith of the cabbage stalks rot and exhibit a chambered pattern; i.e., the pith is absent except for a network of tissue that creates a large cell-like pattern. On cauliflower, initial symptoms consist of a root and crown rot and leaf chlorosis, followed by plant collapse in the field. Symptoms on bok choy include roots that are water-soaked and dark in color and rotted roots. Leaves, especially older ones, first turn purple-red and later yellow. The plant may be stunted, and with time, the entire plant wilts. The stem near the soil line on all three hosts may turn black and become soft (Agrios, 2005).

Transmission: Generally, species of *Phytophthora* that cause root and stem rots survive cold winters or hot and dry summers as resting spores (oospores and chlamydospores) or mycelium in infected roots, stems or soil. During spring, the oospores and chlamydospores germinate to produce motile spores (zoospores) that swim in soil pore water towards roots of susceptible hosts. The pathogen infects the host at the soil line causing water-soaking and darkening of the stem. This infected area enlarges and may encircle the entire stem of small plants, which wilt and eventually die. Roots are invaded at the crown area or at ground level. Like other *Phytophthora* sp., mycelium and zoospores of *P. brassicae* grow in abundance in cool, wet soils (Agrios, 2005). The temperature range for the development of *P. brassicae*, a member of subclade 8b, is relatively low, with growth recorded at a temperature of -3°C. The pathogen is often associated with winter grown brassica crops and post-harvest cold storage rots (Bertier et al., 2013; Hermansen and Hoften, 2005). This ability to grow, albeit slowly, at low temperatures explains the ability of *P. brassicae* to cause significant storage rots of cabbages that were held at 0.5-1.5°C (Heimann, 1994; Hermansen and Hoften, 2005).

Like most *Phytophthora* species, *P. brassicae* is soil-borne and water-borne and may be spread to non-infected sites through infected plants, nursery and planting stock, seedlings, pathogen-contaminated soil, run-off, splashing from irrigation and rain, and movement of contaminated cultivation equipment and tools (Agrios, 2005).

Damage Potential: Cauliflower, cabbage and Brussels sprout are important winter crops in coastal California. On white cabbage in Wisconsin, Heimann described a 5% crop yield loss from *Phytophthora* head rot as a post-harvest storage problem. In Norway, Hermansen and Hoften (2005) found that *P.*

brassicae was a limiting factor in the safe storage of Chinese cabbage and the pathogen was able to grow at -3C. Damage and losses were higher in controlled atmosphere storage of cabbages compared with storage in normal atmosphere. On cauliflower in France, Tanguy and Estrogues (2006) reported serious losses including dieback in autumn and stem rot and leaf-spotting in winter, and they cited excessive use of nitrogen fertilizer as a contributing factor to disease losses. In Santa Barbara County (2018), the Pest Control Advisor who was monitoring the cauliflower field estimated that 20% of plants in the field were affected by the pathogen to some degree, ranging from stunting and small heads to plant collapse.

Worldwide Distribution: North America: *United States* (Wisconsin, California); Europe: *United Kingdom, Germany, Belgium, Netherlands, France*; Oceania: *New Zealand* (Farr and Rossman, 2019)

Official Control: Presently, *Phytophthora brassicae* has a temporary, quarantine status and ‘Q’ rating by the CDFA. It is not on the USDA’s PCIT list of harmful organisms or the EPPO A1/A2 quarantine lists.

California Distribution: Santa Barbara County (see “Initiating Event”)

California Interceptions: none

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

Consequences of Introduction:

- 1) Climate/Host Interaction:** *Phytophthora brassicae* may be able to establish in cool climates within California that are wet in the winter. Its in-state establishment is likely to be large but limited to areas where its hosts and a suitable climate for infection co-occur. Its hosts are grown extensively on the coast of California in winter. The pathogen could likely survive in transplant greenhouse conditions and requires wet weather for infection.

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:** Presently, the host range is restricted to brassica species: cauliflower, bok choy, Brussels sprout and cabbage.

Evaluate the host range of the pest.

Score: 1

- **Low (1) has a very limited host range.**
 - Medium (2) has a moderate host range.
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- High (3) has a wide host range.

- 3) Pest Dispersal Potential:** *Phytophthora brassicae* is soil-borne and water-borne and therefore, primarily spreads artificially via movement of infested soils, plants, nursery and planting stock, seedlings, and the movement of cultivation equipment and tools and by irrigation, splash and runoff water, all of which may spread contaminated soil and plant materials to non-infected sites. This pathogen produces swimming zoospores and long-lived resting spores.

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:** Although California losses caused by *Phytophthora brassicae* have only been estimated by one cauliflower grower in Santa Barbara county, the potential for the pathogen to infect winter crops in the cool wet areas of coastal California could result in root, crown and head rot, thereby decreasing healthy stands, causing yield losses, increasing production costs and causing loss of markets for nursery transplants. Also, the pathogen's potential to survive and spread in infected soils and irrigation water could require changes in normal cultivation practices of host plants.

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

Economic Impact: A, B, C, D, 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:** Infestations of *Phytophthora brassicae* could significantly impact home/urban gardening of *brassica* host plants resulting in the imposition of additional official or private treatment programs to prevent spread of the pathogen

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 brassicae*:

Add up the total score and include it here: **11**

- Low = 5-8 points
- Medium = 9-12 points**
- High = 13-15 points

- 6) Post Entry Distribution and Survey Information:** This pathogen has only been found infecting cauliflower in Santa Barbara County

Evaluation is 'Low' -1

Score: -1 (score followed by bolded bullet)

- 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: **11-1=10****

Uncertainty: none

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Phytophthora brassicae* is B.**

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Responsible Party:

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***Comment Period: 7/11/2019 through 8/25/2019**

***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 [plant.health\[@\]cdfa.ca.gov](mailto:plant.health[@]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.
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❖ 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
