CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Phytophthora tropicalis Aragaki & J.Y. Uchida 2001

Current Pest Rating: Z

Proposed Pest Rating: B

Kingdom: Stramenopila, Phylum: Oomycota,
Class: Oomycetes, Order: Peronosporales,
Family: Peronosporaceae

Comment Period: 07/18/2022 through 09/01/2022

Initiating Event:

Phytophthora tropicalis has been assigned a temporary Z-rating by the California Department of Food and Agriculture (CDFA), Plant Health and Pest Prevention Services, but has not previously gone through the current pest risk analysis process. The risk to California from *P. tropicalis* is described herein and a permanent 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 number of recognized *Phytophthora* species is rapidly increasing and currently includes more than 180 provisionally named species (Yang et al., 2017). With DNA sequencing, the taxonomic concept for the genus has evolved from morphology to molecular phylogeny-based, and this has increased our understanding of *Phytophthora* evolution and pathology. The genus is currently organized into clades (and subclades) based on genetic relationships. *Phytophthora tropicalis* is in clade 2b, close to *P. capsici*, a well-known pathogen of vegetables (T. Bourret, UC Davis, pers. comm).

Phytophthora tropicalis was described formally in 2000 by Aragaki and Uchida as an evolutionarily distinct species based initially on phenotypic characters. The type strain was collected from macadamia (*Macadamia integrifolia*) inflorescences in an orchard at Keaau, Hawai'i, by M. Aragaki in 1975. Prior to its formal description as a species nova, isolates were placed first into *P. palmivora* which is in clade 4, and from there were moved into a revised version of *P. capsici* in clade 2 before being raised to a

species (Uchida and Aragaik, 1989). Single and multi-gene phylogenies show *P. tropicalis* is closely related to *P. capsici* (Zhang et al., 2004; Donahoo and Lamour, 2008). Both *P. tropicalis* and *P. capsici* are widely distributed parts of the US, with *P. tropicalis* found in the ornamental and fruit tree nursery trades and *P. capsici* in essentially all areas of intensive vegetable production (Uchida and Kadooka, 2013). These two species differ in their host ranges as well; *P. tropicalis* is not usually found on pepper, tomato, or cucurbits, where these are primary hosts of *P. capsici* (Farr and Rossman, 2022).

A survey of nurseries in California in 2005-06 identified 16 species of *Phytophthora* from foliar lesions, including *P. tropicalis* (Yakabe et al., 2009). The lesions were generally dark, often brown to black, and were not diagnostic of any one species. It is generally believed that foliar Phytophthoras are common in ornamental nurseries and the movement of infected pothos (*Epipremnum*) specifically has spread *P. tropicalis* with nursery trade across the United States. In Europe, both pothos and ivy (*Hedera*) cuttings have been implicated in the spread of *P. tropicalis* (Orlikowski et al., 2006).

Hosts: Albizia julibrissin (mimosa-tree), *Allamanda* sp. (allamanda), *Annona cherimola* (cherimoya), *Anthurium andraeanum* (flamingo-lily), *Arbutus unedo* (strawberry-tree), *Artocarpus altilis* (breadfruit), *Camellia* sp. (camellia), *Carica papaya* (papaya), *Catharanthus roseus* (bright-eyes), *Citrus* sp. (citrus), *Cuphea ignea* (cigar-flower), *Cyclamen persicum* (florist's cyclamen), *Dianthus caryophyllus* (carnation), *Epipremnum aureum* (golden pothos), *Hedera helix* (ivy), *Leucospermum* sp., *Macadamia integrifolia* (macadamia-nut), *Pandorea jasminoides* (bowerplant), *Pieris japonica* (lily of the valley bush), *Piper nigrum* (black pepper), *Prunus armeniaca* (apricot), *Radermachera* sp.*, Rhododendron catawbiense* (mountain rose bay), *Rhododendron sp., Rosa* sp.*, Rosmarinus officinalis* (rosemary), *Sechium edule* (chayote), *Sesamum indicum* (sesame), *Sinningia speciosa* (gloxinia), *Solanum melongena* (eggplant), *Theobroma cacao* (cacao), *Vanilla* sp. (vanilla), *Verbena ×hybrida* (verbena) (Farr and Rossman, 2022).

Symptoms: Phytophthora blights caused by *P. tropicalis* can be easily confused with blights caused by other *Phytophthora* species and with *Rhizoctonia* blight and *Erwinia* soft rot.

On cocoa (*Theobroma cacao*), the pods or cherelles (immature pods) may be infected at any place on the surface, but infection is most often initiated at the tip or stem end. The first symptom is the development of a brown to black spot on the pod, which spreads rapidly in all directions, eventually covering the entire pod. Under humid conditions, a white bloom of mycelium and sporangia forms on the surface of the diseased pods. As the disease progresses to advanced stages, *P. tropicalis* invades the internal tissue and causes discoloration and shriveling of the cacao bean. Diseased pods eventually turn black and mummify. Black pod may have a distinct seaweed-like odor (Sreenivasan and Quesnel, 1977; Chavez-Ramirez et al., 2021). There is also a stem canker on cocoa, with the first visible symptom of defoliation, which is caused by coalescence of the cankers that girdle the stem or fan branches. In early stages of canker development, the bark can be peeled to reveal wood with a watery gray appearance, often with reddish streaks that intensify in color after exposure to air. In advanced stages, a reddish fluid exudes from cankers and dries into a rusty stain. The wood turns brown, and blackish streaks can often be seen. A protuberance or "bottom bulge" may be observed on the surface of diseased trunks that exudes a reddish-brown substance.

Phytophthora tropicalis can infect the flowers and the nuts of macadamia. Initially it causes a dark brown to black discoloration on the nut; sometimes it can penetrate under the husk of the nut and kill the kernel. A more damaging disease caused by *P. tropicalis* is macadamia quick decline, where trees exhibit dull green, yellow or brown leaves, with sap bleeding from the trunks (Keith et al., 2010).

On camellia leaves collected in California nurseries, Yakabe et al., 2009, described lesions that are generally dark, often brown to black. Rose periwinkle symptoms begin with tiny dark green to black lesions on the leaves and increase in size until the leaves are brown, wilted and completely necrotic. Infections move easily into the stems causing dark blights of shoots (Hao et al., 2010). Redeckar et al. (2020) reported foliar blight and shoot dieback of containerized *Pieris japonica* in Oregon nurseries from *P. tropicalis*. Pothos cuttings infected with *P. tropicalis* exhibit extensive, dark brown tissue necrosis usually starting with the petiole, extending into the leaf base, and spreading rapidly towards the leaf tip. Other foliar symptoms include dark brown, variously shaped leaf spots (Leahy, 2006; Orlikowski et al., 2006).

Cyclamen wilt caused by *P. tropicalis* was described by Gerlach and Schubert (2001), as a change in leaf color from dark green to olive green, followed by flagging and yellowing of the entire crown. Containerized pothos may exhibit symptoms of root rot as well, which is seen as dark, mushy, sloughing roots. Rooted cuttings and containerized pothos usually develop both root rot as well as foliar blight symptoms as the disease progresses.

Transmission: Like most *Phytophthora* species, *P. tropicalis* is soil-borne and water-borne and may be spread to non-infected sites through infected plants, nursery and planting stock, seedlings, soil, run-off and splash irrigation and rainwater, and contaminated cultivation equipment and tools. For foliar *Phytophthoras* like *P. tropicalis*, producers of leaf and stem cuttings of plants such as ivy and pothos are often implicated as the source of inoculum and the cause of rapid international spread (Leahy, 2006). Contact of diseased cocoa pods with healthy ones allows the pathogen to spread as mycelium. The disease is spread during heavy rainfalls and with physical contact between diseased and healthy plants.

Damage Potential: Herbaceous ornamentals such as ivy are quickly killed by leaf and stem rots caused by *P. tropicalis*, but for larger hosts such as mature trees, it may take years for them to succumb. On plants such as *Anthurium*, even small black blemishes on the spadix prevent marketing of flowers, leading to large losses (Uchida and Kadooka, 2013). Serious damage has been reported on macadamia nut trees in Hawai'i (Keith et al., 2010), but many of the hosts are more tropical, found in only very limited parts of California. For a host such as ivy, which is widely planted, damage could be severe in areas with abundant rainfall or sprinkler irrigation as water is necessary for infection and spread.

Worldwide Distribution: *Phytophthora tropicalis* has detection records in the following places around the world: Brazil, French Polynesia, Germany, India, Italy, Mexico, Poland, Netherlands, New Guinea, Spain, Taiwan, United States (*California, Hawai'i, North Carolina, Oregon, Tennessee,* and *Virginia*) (Farr and Rossman, 2022).

Official Control: none

California Distribution: Official samples include two from nurseries in San Francisco and Solano counties and there is a record of one unofficial landscape sample from Orange County (CDFA PDR database, 2022).

California Interceptions: In 2012, San Diego County inspectors intercepted a shipment of pothos (*Epipremnum* sp.) cuttings infected with *P. tropicalis* arriving from Guatemala. An incoming nursery shipment of *Pieris japonica* infected with *P. tropicalis* from Oregon was intercepted in 2018 in San Bernardino County at retail nursery outlets.

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

Consequences of Introduction:

1) **Climate/Host Interaction:** As the name suggests, this *Phytophthora* species has mostly been associated with more tropical plants and climates. The minimum temperature for growth is 6°C, optimum 27–30°C, and maximum 33°C (Abad et al., 2019). However, it has been detected in outdoor nurseries in Oregon and Virginia (Bush et al., 2006). Phytophthoras are dependent on water to spread, making their detection more common in areas with more rainfall.

   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 is broad, containing both woody and herbaceous plants in multiple 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 *Phytophthora* species is heterothallic, capable of producing oospores. It also produces asexual sporangia and chlamydospores (Abad et al., 2019). It spreads easily with splashing water and movement of infected plants and soil.

   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:** *Phytophthora tropicalis* can cause economic impacts in nursery trade, impacting several nursery-produced plants that are commonly used in California landscapes. In addition to lowered crop yields and lowered crop values due to increased need for protective treatments, the management of infestations of a soil- and water-borne pathogen such as *Phytophthora* spp. in a commercial nursery may be a laborious and expensive problem that would involve alterations in the normal cultural practices such as choice of sites to grow susceptible hosts, and water and growth medium management practices to ensure pathogen propagule-free irrigation water and growth media.

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

Economic Impact: A, B, 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:** It has not been reported on any native plants, but that cannot be completely ruled out as the host range has not been extensively studied, and there is potential for it to hybridize with other *Phytophthora* spp.

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

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 *Phytophthora tropicalis:* 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.

   There have been detections in multiple counties. It has been in California for decades, not under regulation beyond those that ensure general cleanliness of nursery stock.

   Evaluation is medium'.

   Score: -2
   -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:

This species may have been reported before 2001 as *Phytophthora capsici*; therefore, the full geographic distribution is unclear.

Conclusion and Rating Justification:

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

References:

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Responsible Party:

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***Comment Period: 07/18/2022 through 09/01/2022**

***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: B