cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Phytopythium vexans (de Bary) Abad, de Cock, Bala, Robideau, Lodhi & Lévesque 2014

Current Pest Rating: Z

Proposed Pest Rating: C

Kingdom: Chromista; Phylum: Oomycota

Class: Oomycetes; Order: Peronosporales

Family: Pythiaceae

Carpentaria californica infected with *Phytopythium vexans*. Photo: J. Kosowitz

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Comment Period: 6/30/2020 through 8/14/2020

Initiating Event:

Phytopythiums and pythiums are among the most common and most important causes of seed rot, seedling damping-off, and root rots. *Pythium vexans* has been known in California for many decades (French, 1989). It was moved into the genus *Phytopythium* in 2015 (de Cock et al.). A recent detection in Santa Barbara County on a new host, the threatened California native plant *Carpenteria californica* (tree anemone), has triggered interest in a permanent pest rating. Therefore, the risk to California from *Phytopythium vexans* is described herein and a permanent rating is proposed.

History & Status:

Background:

Phytopythium spp. are semibiotrophic or nectrotrophic oomycetes that occur worldwide in tropical and temperate climates in agricultural and forest soils and in greenhouses. They are soil inhabitants that are able to survive almost indefinitely as saprophytes and are generally unspecialized parasites that have a wide host range. As is typical for the family Pythiaceae, they cause damping-off of seedlings, seed decay, root rots, stem lesions, rotting of vegetable fruit and tubers on/or in the ground, and cottony blight of turf grasses.

Cooke et al. (2000) noticed that *Pythium vexans* was different from other *Pythium* spp. and from *Phytophthora* spp. (another phytopathogenic oomycete genus) by studying the ribosomal large subunit (LSU) and internal transcribed spacer (ITS) genes of isolates. The genus *Pythium* was divided by Lévesque and de Cock (2004) into 11 clades based on molecular systematic analyses that were supported by morphological features. *Pythium* spp. assigned to clade K were phylogenetically distinct from the other clades and had combined features of both *Pythium* and *Phytophthora*. From this clade, a new genus, *Phytopythium*, was described with *Phytopythium sindhum* as the type species by Bala et al. (2010). Uzuhashi et al. (2010) divided *Pythium* into five new genera. Their genus *Ovatisporangium*, which they assigned to the members of clade K, is a later synonym and the name *Phytopythium* has priority.

The etymology of the name shows that phylogenetically these strains appear to be in between *Pythium* and *Phytophthora*. Their sporangia are *Phytophthora*-like but their zoospore discharge is *Pythium*-like. The sporangium forms a discharge tube through which the contents move out and form a vesicle at the tip with an undifferentiated mass of protoplasm which then differentiates into biflagellate zoospores. Most *Phytopythium* spp. make large, smooth oogonia, and thick-walled oospores. The species epithet vexans means to annoy, torment, or harass.

Hosts: Many diverse genera of herbaceous and woody annuals and perennials from multiple families including: *Ananas* spp., *Annona* spp., *Anthurium* spp., *Antirrhinum* spp., *Brassica* spp., *Camellia* spp., *Carica* spp., *Carpentaria* spp., *Carya* spp., *Clarkia* spp. , *Cinchona* spp., *Citrullus* spp., *Citrus* spp., *Coleus* spp., *Colocasia* spp., *Consolida* spp., *Dendrobium* spp., *Dianthus* spp., *Durio* spp., *Elaeis* spp., *Elettaria*

spp., *Eucalyptus* spp., *Gossypium* spp., *Hevea* spp., *Hydrangea* spp., *Juniperus* spp., *Linum* spp., *Lupinus* spp., *Malus* spp., *Mathiola* spp., *Medicago* spp., *Nicotiana* spp., *Pelargonium* spp., *Persea* spp., *Pinopsida* spp., *Piper* spp., *Poa* spp., *Prunus* spp., *Pyrus* spp., *Ricinus* spp., *Solanum* spp., *Spinacia* spp., *Strelitzia* spp., *Theobroma* spp., *Vicia* spp., *Vigna* spp., *Vitis* spp., *and Zingiber* spp. (EPPO, 2020; French, 1989, Farr and Rossman, 2020; Tao et al., 2011).

***Symptoms*:** *Phytopythium vexans* primarily causes damping-off diseases affecting and killing seeds, seedlings, and small roots. When seeds are attacked, they fail to germinate, become soft and mushy, and then turn brown, shriveling, and finally disintegrating. This is called preemergence damping-off. Seedlings that have already emerged are usually attacked at the roots and sometimes in the stems at or below the soil line. Rapidly, the invaded cells collapse, and the seedling is overrun by the pathogen and dies; this is called postemergence damping-off (Agrios, 2005; Hendrix and Campbell, 1973).

Pectinolytic enzymes secreted by *P. vexans* dissolve the pectins that hold plant cells together, resulting in maceration of the tissues. The hyphae grow between and through the separated cells. Proteolytic enzymes break down the invaded cells, and cellulolytic enzymes cause complete collapse and disintegration of the cell walls. Infected seeds and young seedlings seemingly melt away and turn into a rotten mass covered by fluffy white hyphae. Rootlets can be attacked at any stage of plant growth. The pathogen enters root tips and proliferates, causing a rapid collapse and death of the rootlet. Relatively young or fleshy roots may be invaded, and form lesions several centimeters long. If the infection occurs when the seedling is already well developed and has well-thickened and lignified cells, the hyphae are stopped soon after the point of infection and only small lesions develop. Invasion of older roots is usually limited to the cortex.

For older plants, *P. vexans* is not a strong primary pathogen that causes death, but plants can develop root and stem lesions and root rots, and their growth may be considerably retarded. During extended wet periods, *P. vexans* can attack fleshy organs such as potato tubers, which rot in the field or in storage. Fleshy fruits, stems, or tubers in contact with the soil can also be attacked. An entire cucumber fruit may be invaded within 3 days of inoculation. As the infection progresses, sporangia begin to appear, followed by the production of oospores inside and/or outside the host tissues. The cottony white growth will be seen on the surface of the plant parts while the interior turns into a soft, watery, rotten mass, classified as a “leak”. (Agrios, 2005; Hendrix and Campbell, 1973).

Transmission: *Phytopythium* spp. live on dead plants, as soil saprophytes, and as pathogens of fibrous roots of perennial plants. The pathogen needs free water for its zoospores to swim and infect. When a wet soil is infested heavily with *Phytopythium* spp., any seeds or young seedlings in the soil may be attacked. *Phytopythium* spp. produces white, rapidly growing mycelia that produce infective sporangia. Sporangia can germinate directly by producing one to several germ tubes or can produce a short hypha which forms a balloon-like secondary sporangium called a vesicle. In the vesicle, 100 or more zoospores are produced, which, when released, swarm, round off to form a cyst, and then germinate. The germ tube usually penetrates the host tissue and starts a new infection, but sometimes it produces another vesicle in which more secondary zoospores are formed, and this may be repeated. The mycelium also gives rise to spherical oogonia and once fertilized, becomes a thick-walled oospore.

Oospores are resistant to adverse temperatures and moisture and serve as the survival and resting stage (Hendrix and Campbell, 1973).

Damage Potential: The losses caused by *Phytopythium* spp. are more severe when the soil is wet to saturation point for prolonged periods, when the temperature is too low for the host plant to grow rapidly. The high moisture seems to directly benefit the pathogen, which multiplies and swims with zoospores best in wet soils. Increased moisture may also decrease the ability of the host to defend itself through a reduced availability of oxygen in wet soil and by lowering the soil temperature. Higher levels of disease are also observed when there is an excess of nitrogen in the soil, and when crop rotation is not practiced (Agrios, 2005; Hendrix and Campbell, 1973, CABI-CPC, 2020).

The greatest damage can be done to the seed and seedling roots during germination either pre or post emergence. Seedlings in seedbeds can be completely destroyed. Older plants can suffer drastically reduced yields or be killed in wet soils. Losses vary considerably with soil moisture and temperature combinations. The presence of other pathogens with a similar modus operandi including but not limited to *Pythium*, *Rhizoctonia, Fusarium* and *Macrophomina* for junipers (Raabe et al., 1981). *Phytopythium vexans* co-occurred with *Phytophthora, Cylindrocladium, Cylindrocarpon, Nectria* and *Ilyonectria* on Avocado (Ochoa, 2019). On citrus, *P. vexans* co-occurred with *Pythium* spp. and *Phytophthora* spp. (Benfradj et al., 2017).

Worldwide Distribution: Africa: *Comoros, Republic of the Congo, Liberia, Madagascar, Mauritius, Nigeria, South Africa, Tanzania, Uganda*; Asia: *Brunei, Cambodia, China, Hong Kong, India, Indonesia, Iran, Japan, Malaysia, Pakistan, Sri Lanka, Taiwan, Thailand, Turkey, Vietnam*; Europe: *Bulgaria, France, Germany, Greece, Ireland, Netherlands, United Kingdom*; North America: *Guatemala, Haiti, Jamaica, Panama, United States*; Oceania: *Australia, Fiji, Papua New Guinea, Samoa, Solomon Islands*; South America: *Argentina, Brazil, Venezuela*.(CABI-CPC, 2020)

Official Control: USDA's Harmful organism list for Canada, Honduras, Nicaragua, and Panama (USDA PCIT)

California Distribution: Widespread in agricultural areas, multiple detections associated with crops grown for cut flowers but also native plants from nurseries

California Interceptions: None

The risk *Phytopythium vexans* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:**

Phytopythium vexans is favored by high soil moisture and low temperatures. These conditions occur seasonally in winter and in irrigated agriculture, especially at the time of seed

germination and seedling emergence. Seeds and seedlings are very susceptible to this pathogen.

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 large including herbaceous and woody annuals and perennials plus fruit trees.

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 spreads with soil and has multiple spore stages that can swim or rest for extended periods. It also spreads with contaminated nursery stock

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:** Damping off and root rot diseases are often underdiagnosed as the symptoms are not specific. The ability of the pathogen to move with water and survive in soil necessitates high standards for sanitation and cleanliness in nurseries and greenhouses.

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

Economic Impact: A, D

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 large and expanding host range around the world. With the discovery of *Carpenteria californica,* a California native and a threatened species, as a host, there may be other susceptible native plants identified in the future.

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 *Phytopythium vexans:* 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:

Symptoms caused by *P. vexans* are similar to those caused by other soilborne fungal and oomycete pathogens. The host range and detection record in California may become larger with the improvements in diagnostics.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for ***Phytopythium vexans*** is **C.**

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Responsible Party:

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***Comment Period:** 6/30/2020 through 8/14/2020

***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