

# PHYTOPHTHORA BISHERIA Z. G. ABAD, J. A. ABAD & F. J. LOUWS, 2008

California Pest Rating for  
*Phytophthora bisheria* Z. G. Abad, J. A. Abad & F. J. Louws, 2008  
Current Pest Rating: B  
Proposed Pest Rating: C

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Comment Period: **11/16/2021 – 12/31/2021**

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## PEST RATING PROFILE

### Initiating Event:

During summer 2021, samples from a raspberry breeding nursery in Merced County were tested for *Phytophthora rubi* among other pathogens to obtain an export phytosanitary certificate as part of a raspberry breeding program. In doing the sequencing of the PCR product, Drs. Blomquist and Rooney-Latham in the CDFA diagnostic lab detected *Phytophthora bisheria*.

*P. bisheria* has been detected in greenhouse nursery operations of several raspberry breeding programs in California by the CDFA, usually at low levels (1-2 selections positive out of 80-90 selections being tested for export) and over the past several years since an initial find in 2013 (Chitambar 2015).

**History & Status: Background:** In 1999, Abad *et al.* isolated an unknown *Phytophthora* sp. from strawberry plants growing in a greenhouse in North Carolina and showed symptoms of slight yellowing and root rot. They tentatively named this species *Phytophthora bisheria* in 2001 and deposited genetic sequences of the internal transcribed spacer (ITS) of the nuclear ribosomal DNA (rDNA) gene region in GenBank before publishing an official morphological and molecular description of the species. Soon other researchers in the Netherlands and Australia discovered that they were working with the same species associated with root rot of roses and raspberry based on the similarity of their test ITS sequences with that of *P. bisheria* in GenBank. Abad *et al.*, (2008) provided an official description of the species and validated *P. bisheria* as a new *Phytophthora* species found in strawberry, rose and raspberry.

The genus *Phytophthora* is a fungus-like genus that contains more than 80 species including several important plant pathogens. *Phytophthora bisheria* belongs to the Oomycetes in the kingdom Straminipila. It is a self-fertile (homothallic), very slow growing species that characteristically produces semipapillate (small protuberant growth), persistent sporangia

(specialized structures containing spores) and unique paragynous antheridia (male sexual organs) that broadly attach to the oogonial (female sexual organs) walls.

**Hosts:** Presently, the known host range includes three different hosts in the plant family Rosaceae, namely strawberry (*Fragaria ananassa*, *Fragaria* sp., *Fragaria x ananassa*), rose (*Rosa* sp.) and raspberry (*Rubus idaeus*) (Abad *et al.*, 2008; Farr & Rossman, 2014). In addition, *P. bisheria* has also been isolated from soil in an old growth *Chamaecyparis* forest in Taiwan in 2008 (Brasier *et al.*, 2010), and from roots of containerized rhododendron (Ericaceae plant family); several isolates of *P. bisheria* originating from rhododendron in North Carolina are available through the World Phytophthora Genetic Resource Collection <https://phytophthora.ucr.edu/>, which were initially collected by Mike Benson of North Carolina State University. *P. bisheria* has also been intercepted on trumpet vine (*Campsis radicans*, family Bignoniaceae) in the U.K. (DEFRA 2020). This species is likely much more widely distributed than documented, as it can be difficult to retrieve isolates from infected material because of its slow growth rate *in vitro*.

**Symptoms:** Symptoms of *Phytophthora bisheria* infected plants are reported as mainly root rot and yellowing and wilting of above ground growth. Infected strawberry plants exhibit symptoms of slight yellowing and root rot. Rose plants show stunting, fewer side shoots, smaller dull green leaves that yellow and shed prematurely. Newly formed roots are rotted with numerous spores and sexual structures (sporangia, oospores, oogonia) that are only visible through a microscope. Infected raspberry plants can show a range of symptoms of stunting, root rot, general wilting of plants, and yellow or purplish leaves with necrotic margins, but also limited to no apparent symptoms.

For example, Driscoll's plant pathologists have isolated *P. bisheria* from the roots of symptomless raspberry breeding material growing in greenhouses. These plants appeared overall healthy and did not show any pronounced plant health symptoms (pictures below). Upon further inspection of the root systems, slight necrosis of small feeder roots was observed. We consider *P. bisheria* a weak pathogen and believe other stress related cultural conditions, such as overwatering, are necessary to initiate symptom development. In addition, County Ag Commissioner staff have also collected small feeder roots from healthy looking mother plants in our greenhouses and which later were found to have *P. bisheria* isolated from them.



**Damage Potential:** Quantitative economic losses in plant production due to *Phytophthora bisheria* have not been reported. It is possible that infestations may result in significant damage and loss in production and stands of host plants mainly by causing root rot of infected plants. However, we consider *P. bisheria* a weak pathogen and believe other stress related cultural conditions, such as overwatering, are necessary to initiate symptom development. We have isolated this pathogen from asymptomatic raspberry plants on numerous occasions.

**Disease Cycle:** Generally, species of *Phytophthora* that cause root rot survive cold winters or hot and dry summers as mycelium in infected host tissue or soil or thick-walled, resting spores (oospores and chlamydospores). These resting spores are liberated into the soil once infected tissue dies and decompose. During spring, the oospores and chlamydospores germinate, and mycelium within infected tissue grow, to produce specialized structures (sporangia) containing motile spores (zoospores) that are released and swim around in soil water to roots of susceptible hosts. In general, for *Phytophthora* species commonly associated with raspberry root rot, the range of temperatures for zoospore release is 4-25°C (Wilcox, 1991). The production of sporangia is favored by very wet to moist soil conditions. Soil moisture is also required for the dispersal of zoospores. Optimum zoospore discharge occurs when soils become completely saturated with water and discharge is severely hindered when moisture is drained from soils. Roots are invaded at the crown area or at ground level. Mycelium and zoospores grow in abundance in cool, wet weather causing damage where the soil is too wet for normal growth of susceptible plants and low temperatures (15-23°C) prevail (Agrios, 2005).

**Transmission:** Infected soils, plants, nursery and planting stock, seedlings, run-off and splash irrigation water, cultivation equipment and tools may spread contaminated soil and plant materials to non-infected sites. Reports on the distribution of the species indicate that *P. bisheria* is mainly spread through infected nursery plant materials.

**Worldwide Distribution:** Australia (Victoria), *Europe:* the Netherlands, U.K., and Spain, *North America:* USA (North Carolina, California, Washington State (Stewart *et al.*, 2014), and *Asia:* Taiwan (Brasier *et al.*, 2010). It is likely that the distribution of this species may be wider than what is currently known but has been unnoticed as it is a slow growing species that is difficult to isolate (Abad *et al.*, 2008).

An ITS sequence of *P. bisheria* isolated from raspberry in Spain was submitted to GenBank in July 2019 but never published (NCBI 2019). In addition, another ITS sequence of *P. bisheria* isolated from torch ginger in Brazil was submitted to GenBank in May of 2011 (NCBI 2011). . Along with the detection of *P. bisheria* in soil from an old growth *Chamaecyparis* forest in the Ma-kau Ecological Park in north eastern Taiwan (Brasier *et al.*, 2010), and from trumpet vine in the U.K. (DEFRA 2020), these findings imply that this organism is more globally distributed among different hosts in different ecosystems than previously thought. The original CDFA published pest rating mentioned the host range of *P. bisheria* was limited to plants in the Rosaceae (Chitambar 2015).

Interestingly, the U.K. Department for Environment, Food and Rural Affairs rated *P. bisheria* with a low relative risk rating (DEFRA 2020). As they state: “This pest has been assessed for the Risk Register and is considered to pose a low risk to the UK. The information on this pest was correct as of 19/05/2020, but is no longer actively maintained. It will only be updated if new information is received which indicates the potential for a significant increase in risk to the UK (DEFRA 2020).

**Official Control:** No official control has been reported. Currently, *Phytophthora bisheria* is currently a B-rated pathogen in California (Chitambar 2015).

**California Distribution:** Tehama, Merced and Santa Cruz Counties have reported finding this pathogen, usually related to breeding nursery propagation. During 2013-14, *Phytophthora bisheria* was detected in *Rubus* sp. nursery stock intended for export and grown in nursery greenhouses in Tehama and Santa Cruz Counties. The 2013 detection marked CDFA’s first official record of the pathogen in California. Subsequent detections have occurred in Santa Cruz and Tehama County and more recently in Merced County.

**California Interceptions:** There are no records of the interception of *Phytophthora bisheria* in incoming plant shipments to California.

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

### **Consequences of Introduction:**

**1) Climate/Host Interaction:** Evaluate if the pest would have suitable hosts and climate to establish in California. Score:

**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.

**Risk is Medium (2)** – *Phytophthora bisheria* has mostly been isolated from plants grown within greenhouse environments in California – as well as internationally. Although California provides suitable and wet climate conditions favorable for the establishment of this pathogen, researchers have suggested that the latter may be less aggressive under field conditions than under controlled greenhouse conditions. In 2021, a finding in a field soil in Merced County appears to be the first finding of the pathogen in soil in California.

**2) Known Pest Host Range:** Evaluate the host range of the pest. Score:

**Low (1)** has a very limited host range.

**Medium (2)** has a moderate host range.

**High (3)** has a wide host range.

**Risk is Low (1)** – Currently the known host range of *Phytophthora bisheria* is mostly associated with strawberry, rose and raspberry – all members of the plant family Rosaceae. But it has also been detected on rhododendron (family Ericaceae), torch ginger, *Etlingera elatior* (family Zingiberaceae; Genbank <https://www.ncbi.nlm.nih.gov/nuccore/JF917303.1>), trumpet vine (*Campsis radicans*,

family Bignoniaceae) and in soil from an old growth Chamaecyparis forest in the Ma-kau Ecological Park in north eastern Taiwan (Brasier et al., 2010).

**3) Pest Dispersal Potential:** Evaluate the natural and artificial dispersal potential of the pest.

Score:

**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.

**Risk is High (3)** – *Phytophthora bisheria* is primarily spread artificially via infested plants, nursery planting stock, seedlings, soils, run-off and splash irrigation water, cultivation equipment and tools that may spread contaminated soil and plant materials to non-infected sites.

**4) Economic Impact:** Evaluate the economic impact of the pest to California using the criteria below. Score:

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.

**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.

**Risk is High (3)** – The pathogen could lower crop yield, although there are no published records of this occurring. It could increase production costs and cause loss of markets mainly of infected nursery stock in greenhouses. The capability of the pathogen to survive and spread in infected soils and irrigation water could require changes in normal cultivation practices of host plants.

**5) Environmental Impact:** Evaluate the environmental impact of the pest on California using the criteria below.

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.

Score the pest for Environmental Impact. Score:

**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.

**Risk is Medium (2)** – The impact that *Phytophthora bisheria* may have on the environment is currently not well known as this pathogen has mostly been detected in plants grown in greenhouses. *Phytophthora bisheria* is thought to be a less aggressive pathogen in field environments, potentially associated with poor cultural practices such as overwatering and plant cultivation in heavy soils. Nevertheless, there is always the likelihood that under conditions most suitable for its growth and spread, this pathogen may impact home/urban gardening or ornamental plantings.

### **Consequences of Introduction to California for *Phytophthora bisheria*:**

Add up the total score and include it here. (Score)

-**Low** = 5-8 points

-**Medium** = 9-12 points

-**High** = 13-15 points

Total points obtained on evaluation of consequences of introduction of *Phytophthora bisheria* to California = **(11)**.

### **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. (Score)

-**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.

**Evaluation is (-2).** The pathogen has been detected in 3 counties: Santa Cruz, Tehama, and Merced counties, most frequently in greenhouse operations, however, in 2021 it was detected in Merced county in a raspberry breeding nursery in soil.

### **Final Score:**

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:

The host range of *Phytophthora bisheria* is primarily associated with plants in the Rosaceae, however this organism has been detected on plants in several other families at low frequency. Further host range studies are needed to determine a more complete host range. Also needed are statewide surveys specifically for *P. bisheria* in nursery, field and natural environments to provide further information on its distribution.

### Conclusion and Rating Justification:

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

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**Responsible Party:**

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