

California Pest Rating Proposal for

Erysiphe quercicola S. Takam. & U. Braun 2007

Powdery mildew

Current Pest Rating: Z

Proposed Pest Rating: C

Domain: Eukaryota, Kingdom: Fungi,
Phylum: Ascomycota, Subphylum: Pezizomycotina,
Class: Leotiomycetes, Order: Erysiphales,
Family: Erysiphaceae

Comment Period: 11/05/2021 through 12/20/2021

Initiating Event:

In June 2020, a Los Angeles County Plant Pathologist submitted an official sample of *Mangifera indica* (mango) leaves with purple patches. The sample was sent to CDFA's Plant Pest Diagnostics Center at Meadowview. CDFA Plant Pathologist Suzanne Rooney-Latham identified powdery mildew, caused by *Erysiphe quercicola*, on the leaves. The pathogen on mango was previously considered a separate species, *Oidium mangiferae*, but phylogenetic work has shown it to be conspecific with *E. quercicola* (Takumatsu et al., 2015). There are California records of powdery mildew on mango identified only as *Oidium* sp., which likely represent the same powdery mildew species. As this pathogen has not been through the pest rating system, it was given a temporary Z-rating.

In August 2021, a San Mateo County agricultural inspector submitted a sample of *Quercus rugosa* (netleaf oak) leaves heavily colonized with powdery mildew to the Plant Pest Diagnostics Center. The trees were part of an incoming wholesale nursery shipment that originated in Ventura County. The leaves showed signs of *E. quercicola*, and the diagnosis was confirmed by Suzanne Rooney-Latham, this time with PCR and DNA sequencing. Although *E. quercicola* has a wide host range in literature (Farr and Rossman, 2021), this was the first detection on a host other than mango in California. The risk to California from *Erysiphe quercicola* is described herein and a permanent rating is proposed.

History & Status:

Background: For many years, powdery mildew fungi were considered to be highly specific pathogens, and each species was generally thought to be able to infect only a narrow range of host plants, usually in the same genus. Host range was often used as a key feature in powdery mildew taxonomy, along with morphological criteria that could be viewed with microscopy (Cook et al., 1997). This assumption of high specificity came from observations that many powdery mildews of agronomic crop plants, i.e. *Blumeria graminis* in cultivated cereals, show this strict host specificity. Some mildew species could be divided even further into formae speciales on the basis of their very narrow host ranges (Troch et al. 2014). As the use of molecular analyses (principally with ITS sequences) has increased, it has been shown that that host specificity is not as straightforward as previously believed, and morphological features are not the most reliable way to make an identification.

At the same time that improved molecular diagnostics have shown that some powdery mildews previously thought to have a broad host range should be divided into more narrowly defined species, and that some plants can be infected by several species of powdery mildew, it has also been shown that there are some truly polyphagous powdery mildew species that have a wide host range broader than a single family of plants (Braun and Cook, 2012; Takamatsu et al., 2008). The results of an inoculation experiment prompted Boesewinkel (1980) to first suggest that oak and mango powdery mildew in New Zealand were caused by the same fungal species. Recent work in mango orchards in Southern Spain by Desprez-Loustau et al. (2017) confirmed that that *E. quercicola* was infecting both oak and mango.

Hosts: *Abutilon indicum* (Indian lantern-flower), *Acacia auriculiformis* (black wattle), *A. mangium* (black wattle), *Ailanthus excelsa*, *Anacardium occidentale* (cashew), *Anacardium* spp. (cashew), *Bauhinia galpinii* (red butterfly tree), *Bauhinia punctata* (red butterfly tree), *B. purpurea* (butterfly orchid tree), *Bixa orellana* (annatto), *Cassia fistula* (golden shower), *Castanopsis argyrophylla*, *Cinnamomum camphora* (camphor), *Citrus aurantium* (bitter orange), *C. insitorum* (citrange), *C. limon* (lemon), *C. poonensis* (honey mandarin), *C. reticulata* (mandarin), *C. sinensis* (blood orange), *Citrus* sp., *Clitoria fairchildiana* (butterfly pea tree), *Cyclobalanopsis* sp. (oak), *Delonix regia* (royal poinciana), *Durio zibethinus* (durian), *Euphorbia tithymaloides* (devil's backbone), *Hevea brasiliensis* (rubbertree), *Hodgsonia macrocarpa* (Chinese lardfruit), *Jatropha curcas* (Barbados nut), *Kydia calycina*, *Mangifera* sp. (mango), *M. indica* (mango), *Millettia speciosa*, *Mallotus philippinensis* (kamala tree), *Mimosa pudica* (sensitive plant), *Murraya paniculate* (orange jessamine), *Nephelium lappaceum* (rambutan), *Quercus crispula* (Mongolian oak), *Q. glauca* (ring cup oak), *Q. incana* (bluejack oak), *Q. mongolica* (Mongolian oak), *Q. myrsinifolia* (Japanese live oak), *Q. phillyraeoides*, *Q. robur* (English oak), *Q. rugosa* (netleaf oak), *Q. serrata*, *Quercus* sp. (oak), *Rumex crispus* (curled dock), *Tamarindus indica* (Indian tamarind), and *Ziziphus jujuba* (Chinese jujube) (Farr and Rossman, 2021).

Symptoms: Powdery mildews are one of the most easily recognizable plant diseases. On mango, *E. quercicola*, during and after flowering, attacks panicles, leaves and young fruits that become coated with a whitish powdery fungus. Fungal growth can be severe on panicles first, then plants become brown and defoliate. Infection causes mango flowers and young fruits to drop. Fruits that become infected after they have set can develop purple-brown blotchy lesions that crack and form corky tissue as the fruitlet enlarges. On some cultivars, new flushes of growth and younger leaves are highly

susceptible and may curl up and become distorted. Older leaves are more resistant to infection. Grayish, necrotic lesions or large, irregularly shaped spots may form on leaves (Nelson, 2008; Ajitomi et al., 2020; Tam, 2017).

On ubame oak (*Quercus phillyraeoides*), white superficial conidia of *E. quercicola* occurred on adaxial and abaxial surfaces. Along with the typical white powdery mildew growth, spot and/or necrotic symptoms with irregular violet-to-wine red surfaces were also frequently observed on older leaves (Lee et al., 2010). On English oak (*Quercus robur*), symptoms first appeared as thin white colonies, which subsequently developed into hyphal growth on both sides of the leaves and stems. Severe infections often caused necrotic discoloration of the leaves (Cho et al., 2018). On mandarins, heavily infected trees often became defoliated or young leaves deformed, reducing photosynthesis. Worse, this fungus covered the entire surface of young fruits of about 0.5 cm in diameter, causing them to abscise (Tam et al., 2016). On camphor trees (*Cinnamomum camphora*) white to gray rounded irregular patches, consisting of conidia and mycelia of the fungus were observed primarily on the adaxial surface of the leaves of camphor seedlings. When the disease was severe, the entire leaf surface was colonized by the pathogen, resulting in leaf necrosis and defoliation (Dorneles et al., 2018).

Transmission: Conidia of *E. quercicola* are wind-disseminated from other trees or to new leaves from within an infected tree's canopy. The environmental conditions for spread of powdery mildew occur across a broad daily range of temperatures (10–31°C) but require moderate to high relative humidity (60–90%). Infection of mango is favored in Hawaii when cool nights are followed by warm days (Nelson, 2008); these conditions exist in some parts of California, especially along the southern coast.

Powdery mildew is an obligate pathogen that only survives on infected plants and for a period of time, as conidia on fallen leaf debris. Populations can build up rapidly during seasonal flushes of new leaves and flowers. The conidia can be transported long distances by winds. No sexual form of this pathogen has been observed anywhere the disease occurs (Takumatsu et al., 2007).

Damage Potential: The yield and quality of mandarin fruits have suffered severe losses in parts of tropical Asia due to this fungus. Reduction of mandarin fruit yield up to 80% has been reported when trees are not treated (Tam et al., 2016). Very high levels of yield loss have also been reported in mango fruit production in Asia and in Hawaii (Ajitomi et al., 2018; Nelson, 2007). Intense defoliation and reduced seedling development was observed in camphor plants showing signs of *E. quercicola* parasitism in Brazil (Dorneles et al., 2018)

Worldwide Distribution: Africa: Congo, Ethiopia, Egypt, Ethiopia, Kenya, Malawi, Mauritius, South Africa, Tanzania, Uganda, Zambia, Zimbabwe. Asia: Bangladesh, Bhutan, Brunei, Darussalam, China, East Timor, India, Iran, Indonesia, Israel, Japan, Lebanon, Malaysia, Myanmar, Nepal, Pakistan, Palestine, Singapore, South Korea, Sri Lanka, Taiwan, Thailand, Viet Nam. Europe: Greece, Spain, Turkey. Central America: Guatemala, Honduras. North America: Cuba, Jamaica, Mexico, Puerto Rico, United States (California, Florida, Hawaii). Oceania: Australia, New Caledonia. South America: Argentina, Brazil, Colombia, Peru, Venezuela (Farr and Rossman, 2021).

Official Control: None

California Distribution: There are two recent records, one in Los Angeles County and one in San Mateo County for oaks that had just arrived from Ventura County. Older records are less precise, listing *Oidium* sp. on mango from “coast south” or “California” (CDFA PDR database).

California Interceptions: None

The risk *Erysiphe quercicola* would pose to California is evaluated below.

Consequences of Introduction:

- 1) Climate/Host Interaction:** This pathogen requires moderate temperatures with humidity in order to germinate and infect. Some parts California are too cold or too dry. However, in irrigated nurseries, orchards, or landscapes, especially along the south coast, highly favorable climatic conditions can occur.

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:** *Erysiphe quercicola* is a plurivorous pathogen capable of infecting a wide range of tropical fruit trees and woody plants.

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:** Powdery mildews reproduce with massive numbers of asexual conidia. Some have a sexual spore stage, but one has not been found for this species. Spores are windblown but short lived, and long-distance movement can occur with infected planting stock.

Evaluate the natural and artificial dispersal potential of the pest.

Score: 2

- 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.
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- 4) Economic Impact:** Serious damage has been reported in tropical climates on mangos and citrus with reduced yield and reduced fruit quality. Ornamentals also suffer damage when mildew causes defoliation, particularly on seedlings.

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

Economic Impact: A, B

- 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:** The netleaf oak, *Quercus rugosa*, is native to the southwestern United States and Mexico. It is possible that native California oaks are also susceptible to this pathogen.

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

Environmental Impact: A, 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: 3

- 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 *Erysiphe quercicola*: 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.

This pathogen seems to be established on the south coast, with records going back decades on mangos. There are recent detections from Los Angeles and Ventura counties. It is in the nursery trades and it is not under regulatory control.

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 = 10

Uncertainty:

Oak powdery mildew in Europe is induced by two closely related invasive species of *Erysiphe* (*E. alphitoides* and *E. quercicola*) that differ in their mode of overwintering. Marçais et al, 2017, showed that survival of *E. quercicola* was improved after mild winters, with increase of both the flag-shoot infection frequency and the proportion of *Erysiphe* lesions with *E. quercicola* present in spring. Increasing temperatures due to climate change may result in worsening problems with this pathogen.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Erysiphe quercicola* is C.

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Responsible Party:

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***Comment Period: 11/05/2021 through 12/20/2021**

*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](mailto: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.
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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: C
