

**California Pest Rating Proposal for
Erysiphe pisi (de Candolle 1805) ex St-Amans**

Powdery mildew of peas

Current Pest Rating: Z

Proposed Pest Rating: C

Kingdom: Fungi; Phylum: Ascomycota
Subphylum: Pezizomycotina; Class: Leotiomycetes
Order: Erysiphales; Family: Erysiphaceae



Erysiphe cf. *psii* on Palo Verde (*Parkinsonia* sp.)

Comment Period: xx/xx/2020 through xx/xx/2020

Initiating Event:

In 2019, samples of powdery mildew on palo verde trees (*Parkinsonia* sp.), collected in the cities of Anaheim and Orange, California, were sent to CDFA's plant pest diagnostics center for identification. By DNA sequence analysis, they were a very close match (differing by one base pair) to published DNA sequences in GenBank from *Erysiphe pisi*, powdery mildew of pea. However, none of the *E. pisi* sequences were from true voucher specimens or published as epitypes. The morphology of the samples was very similar to those reported for *E. pisi* except the conidial sizes on samples from palo verde were slightly narrower. CDFA plant pathologist Cheryl Blomquist diagnosed the powdery mildew on palo verde as *Erysiphe* cf. *pisi*, where the abbreviation cf. means "compare to" or "confer."

History & Status:

Background: Powdery mildew has been observed for decades on palo verde trees (recorded first as *Oidium* sp. on *Cercidium floridum*) on the southern coast of California by French (1989). The common name "palo verde" is Spanish meaning "green stick" and is in reference to its seasonally leafless green trunks and branches. Mexican palo verde, *Parkinsonia aculeata* [syn *Cercidium aculeata*] has a natural range that reaches as far north as Arizona and Texas and then south into South America and has naturalized in low desert washes in California. The specific epithet is from the Latin word 'aculeat' and means "with prickles" in reference to the thorns. Blue palo verde, *Parkinsonia florida* [syn *Cercidium floridum*] is a native tree or shrub in the Sonoran Desert region of California, Arizona, and Mexico, and is one of the most popular trees for desert gardens. Additionally, there is a popular hybrid *Cercidium* x 'Desert Museum' that is widely available in the nursery trade. There are records of powdery mildew affecting all three types of palo verde in coastal areas of California (French, 1989), but no reports of powdery mildew on palo verde in Arizona (Olsen, 1999).

Accurate pathogen identification is always essential for regulatory work and effective disease management. Powdery mildews are obligate biotrophs and historically have been difficult for taxonomists. Many species require molecular techniques to separate them from closely related species because they lack distinguishing morphological characters. There are many ambiguous names in the literature and old records using these names should be treated with caution. Molecular taxonomy and phylogeny for powdery mildews can be problematic. Often there is only very old type material from limited geographical areas that needs epitypification in order to have reliable reference sequences. *Erysiphe pisi* has only a few ITS sequences published on *Pisum* from Japan and Australia (Takamatsu et al., 1999) and only one from the United Kingdom, (Ellingham et al., 2019). *Erysiphe pisi* has been described on thousands of hosts in the Fabaceae (Farr and Rossman, 2020) and is likely a species complex.

According to the new generic taxonomy, based on molecular sequence analyses and a reassessment of morphological features of the anamorph and teleomorph (Braun and Takamatsu, 2000; Braun et al., 2002), *E. pisi* belongs in the genus *Erysiphe* and section *Erysiphe*. For now, our detections on palo verde trees can only be classified as "*Erysiphe* cf. *pisi*". Other scientific names are *Alphitomorpha pisi*, *E.*

communis, *E. communis* f. *hosackiae*, *E. communis* f. *phaseoli*, *E. communis* f. *pisi*, *E. communis* f.sp. *medicaginis-lupulinae*, *E. macropus*, *E. martii*, *E. pisi* f.sp. *medicaginis-sativae*, *E. pisi* f.sp. *pisi*, *E. pisi* f.sp. *viciae-sativae*, *E. polygoni*, and *Ischnochaeta pisi*.

Hosts: For *Erysiphe pisi* sensu lato, reported hosts include hundreds of species in the family Fabaceae. Cultivated hosts include *Arachis* spp. (ground nuts), *Lens* spp. (lentils), *Lupinus* spp. (lupins), *Medicago* spp. (lucerne), *Phaseolus* spp. (beans), *Pisum* spp. (peas), *Trifolium* spp. (clovers) and *Vicia* spp. (vetches). California detections on these species prior to the use of molecular diagnostics were often attributed to *E. polygoni*. Recently, genetic analysis has determined that *E. polygoni* is restricted to the *Polygonum* species group. Today there are two powdery mildew species recognized on Fabaceae, *E. pisi* and *E. glycines* with the latter reported only in Asia, the northeastern US and central US.

Symptoms: Powdery mildews seldom kill their host but are responsible for water and nutrient loss and impair plant growth and development. Powdery mildew fungi are obligate and largely ectoparasitic parasites. They produce their asci (sexual spores) in fruiting bodies in completely closed chasmothecia. In many species of powdery mildew, mycelium, conidia, and chasmothecia are produced on the surface of the host plant. Others have hyphae under the surface of the leaf and the conidiophores emerge through the stomates. They extract nutrients from their hosts by haustoria which penetrate the epidermal cells. In the early stages of development, most powdery mildew appears as gray spots or patches on the host tissue. These spots can enlarge, coalesce, and completely cover the infected organs of the host. The surface of leaves, buds, and stems can be completely covered by the powdery white mildew mycelium and spores. Leaves can show a purpling and may curl. This powdery growth is the mycelia and conidia (asexual spores) of the fungus. The conidia and conidiophores of the powdery mildews can generally be seen with a hand lens (10x). The mycelial growth is most common on the upper side of leaves; with many plant hosts, the young succulent growth of leaves, buds and fruit are the most susceptible tissues and are more often infected than the older parts of the host plant (Agrios, 2005).

Transmission: Infection begins by germination of ascospores or conidia on the surface of the host plant, originating from overwintered mycelium in dormant buds or from persistent mycelium on overwintering green leaves or stems. Infected buds can contain hyphae and conidia, and after breaking dormancy, infected buds give rise to “flag shoots” that can be covered with profusely sporulating mycelia, supplying the primary inoculum to new crops (Glawe, 2008). The infection process is influenced by the condition of the host and environmental factors. The optimum temperature range for growth is 11-28°C and that for germination is 15-28°C. The maximum survivable temperature is 30-35°C and the minimum is 2-4°C (CABI- CPC, 2020). Spore dispersal is more efficient during low humidity (Glawe, 2008). Conidia are wind dispersed and can be moved with infected planting material (Agrios, 2005). *Erysiphe pisi* can also be transmitted by seed (Smith et al. 1988). Conidia contain vacuoles and large amounts of water, possibly contributing to their ability to germinate in the absence of free water (Glawe, 2008).

Damage Potential: Powdery mildews can increase plant respiration and transpiration and interfere with photosynthesis as the grown thick mats of hyphae and spores over the plant surfaces. Heavy

levels of infection diminish plant growth and reduce yield, with distorted growth and premature leaf fall. Losses are often in the range of 20-30% (Smith et al., 1988). Infections can occasionally reach epidemic proportions. Plants with high nitrogen levels produce young, succulent growth, a prolonged vegetative period, and delayed maturity which make them more susceptible to powdery mildew attack for longer periods (Agrios, 2005).

Worldwide Distribution: *Erysiphe pisi* sensu lato occurs worldwide everywhere Fabaceae members grow (CABI-CPC, 2020; Farr and Rossman, 2020).

Official Control: *Erysiphe pisi* pv. *pisii* is on the harmful organism list for Panama (USDA PCIT)

California Distribution: Recent detections from coastal cities in Orange, Santa Barbara, and Santa Clara counties. Historical detections (as *E. polygoni*) have been made statewide.

California Interceptions: None

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

Consequences of Introduction:

- 1) Climate/Host Interaction:** Powdery mildews in general thrive in climates with low summer rain fall but higher humidity. South coastal California provides ideal summer weather for powdery mildew, as do the irrigated desert areas in the winter. The central valley and mountains are generally less humid in the summer and have fewer problems with powdery mildew.

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:** Diverse members of Fabaceae are hosts of this powdery mildew

Evaluate the host range of the pest.

Score: 2

- 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 are obligate biotrophs that must have a living host. Some produce thick-walled chasmothecia with sexual spores that are more resistant to environmental stresses, but these have not been found for this mildew species in California. Some species can survive
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winter as mycelium inside buds. Reproduction is with asexual conidia that are produced in mass and are wind borne.

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.

- 4) Economic Impact:** For palo verde, powdery mildew is a limiting factor for its growth and aesthetic value in coastal areas where the pressure is high. For other hosts in Fabaceae, disease control is usually possible with the use of resistant cultivars.

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:** *Erysiphe pisi* has a large host range in literature including many cultivated agronomic crops, weeds, and native California species. Mildews do not kill their hosts but can reduce growth and seed production.

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.
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- **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 pisi*: Medium

Add up the total score and include it here. **10**

- 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'. Powdery mildew has been known on palo verde infecting plants on the southern coast of California since before 1989 (French) There are limited reports on other hosts in Fabaceae. Powdery mildew is a limiting factor in the planting of palo verde trees (especially the 'Desert Museum' hybrid) in coastal areas.

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 = 7*

Uncertainty:

There is taxonomic uncertainty in the detections on palo verde because the DNA sequences and the spore width does not precisely match the voucher sequences and morphological description published for *E. pisi*. This group of powdery mildews on pea relatives are generally regarded to be a species complex and research work needs to be done to separate them.

Conclusion and Rating Justification:

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

References:

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Responsible Party:

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***Comment Period: xx/xx/2020 through xx/xx/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](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.
- ❖ 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.
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- ❖ Posted comments shall be those which have been approved in content and posted to the website to be viewed, not just submitted.
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Proposed Pest Rating: C
