

California Pest Rating Proposal for *Puccinia pentstemonis* Peck 1885

Penstemon rust

Current Pest Rating: Z

Proposed Pest Rating: C

Kingdom: Fungi; Division: Basidiomycota

Class: Pucciniomycetes; Order: Pucciniales

Family: Pucciniaceae

Comment Period: 9/18/2020 through 11/2/2020

Initiating Event:

The first description of this rust fungus was made by Peck in 1885 as *Puccinia pentstemonis* Stage III on living leaves of *Penstemon linarioides* in Arizona. *Penstemon* is an orthographic variant of the spelling of *Penstemon* Schmidel, which is the accepted name and spelling for this genus today. In 1922, W. C. Blasdale published a preliminary list of the Uredinales of California. Included were records of rust on three species of *Penstemon* in Plumas County, California. The pathogen was identified by the presence of teliospores in pustules. There are two name variant spellings of the pathogen both attributed to Peck: *P. pentstemonis* and *P. pentastemonis*. Subsequently, it was reported in multiple western states and in Mexico. In the 2010s, county agricultural inspectors have submitted multiple samples from ornamental *Penstemon* spp. growing in nurseries and landscapes. Infection of nursery stock can violate California nursery cleanliness standards and requires regulatory action. A temporary Z rating was applied by CDFA disease diagnosticians. The threat to California from *P. pentstemonis* is described herein and a permanent rating is proposed.

History & Status:

Background:

Rust fungi are obligate parasites that must have a living host to parasitize. Rusts can have complex lifecycles involving up to five types of spores produced annually and sequentially. The five types of

spores are: Stage 0: spermogonia-bearing spermatia, Stage I: aecia-bearing aeciospores, Stage II: uredinia-bearing urediniospores, Stage III: telia-bearing teliospores, and Stage IV: Basidia-bearing basidiospores. All five can occur on a single host (i.e. rose rust), or they can colonize two very disparate hosts in a strict, alternating sequence (i.e. cedar-apple rust).

Many of the rusts important to agronomic crops have evolved much simpler life cycles, completing their life cycle on a single host with fewer than five spore stages. These are called microcytic rusts. Some have only uredinia (i.e. hollyhock rust), or telia plus basidia (e.g., chrysanthemum white rust). Penstemon rust is an example of a microcytic rust that infects only a single host by basidiospores. Basidia and basidiospores are produced by meiosis from teliospores.

It is generally believed that microcytic rusts derived from macrocytic species. The teliospores that are produced by the telia inside the leaves break through the epidermis at maturity. The two-celled, binucleate teliospores go through karyogamy to produce a diploid basidium. Then meiosis produces sixteen haploid basidiospores. These spores move with air, germinate, and infect new leaves, producing haploid mycelium that must fuse with mycelium produced by another haploid basidiospore to form the binucleate hyphae again. The telia of microcytic rusts can mimic the aecia of macrocytic rusts and produce symptoms of galling on leaves and stems. The galls are an abnormal plant growth, usually an increase in size and/or number of plant cells, produced in response to rust infection and swollen by the production of abnormal plant tissues (Shaddock, 2004; Agrios, 2005). Penstemon rust forms galls on leaves.

Hosts: Beardtongues- *Penstemon apateticus*, *P. azureus*, *P. bridgesii*, *P. campanulatus*, *P. confertus*, *P. connatifolius*, *P. deustus*, *P. grandifloras*, *P. kunthii*, *P. linarioides*, *P. pentstemonis*, *P. pinifolius*, *P. procerus*, *P. pseudospectabilis*, *P. richardsonii*, *P. roezli*, *P. serrulatus*, *P. spectabilis*, and *P. triphyllus*.

Symptoms: Symptoms are primarily exhibited on the *Penstemon* leaves. Basidiospores spread by air movement or rain splash, land on the top surface of the leaves, germinate, and if there is moisture present, penetrate the leaf epidermis. Pale green to yellow spots up to 5 mm diameter develop on the upper leaf surface. Early infections are very difficult to differentiate from insect damage. The centers of these spots become brown and necrotic with age. Raised, buff or orange to brown pustules that resemble galls and produce the teliospores develop on the corresponding lower leaf surface. The pustules with teliospores begin to produce basidiospores that are very small and hyaline, ephemeral, and usually undetected. As the spots on the upper surface become sunken, the pustules on the lower leaf become quite prominent. Pustules with teliospores are occasionally found on the upper leaf surface. Severely attacked leaves wilt and hang down the stem and gradually dry up completely. Pustules and teliospores occasionally develop on flower bracts and stems.

Transmission: This rust is spread by wind/air currents and rain splash in open environments. Long distance spread is through the movement of infected plants or cuttings. In greenhouses and for mother plants, early and accurate identification is essential to limit the spread and ensure clean stock for propagation. The basidiospores can form without a dormancy period. Although they are very delicate and sensitive to drying and UV light, basidiospores can be dispersed by air currents up to a distance of 700 meters (Zandvoort et al., 1968). It is the dispersal of very large numbers of basidiospores that

explains the rapid development epidemics. Under ideal environmental conditions, the life cycle of similarly behaving *Puccinia* spp. averages 4 weeks but can be as short as 2 weeks (Schubert, 2016). High humidity and a thin film of moisture on the leaf surface are essential for the germination of both telio- and basidiospores. Low humidity is often a limiting factor for *Puccinia* disease spread outside of greenhouses (Horst and Nelson, 1997).

Damage Potential: Rust pathogens rarely kill their hosts but can weaken them and stunt their growth (Agrios, 2005). Large numbers of pustules on leaves, stems, bracts, and flowers cause serious cosmetic damage to potted plants, rendering them unmarketable.

Worldwide Distribution: Canada, Mexico, and the United States (*Arizona, California, Idaho, Oregon, South Dakota, Utah, Washington, and Wyoming*) (Farr and Rossman, 2020)

Official Control: None

California Distribution: San Luis Obispo, San Mateo, Santa Barbara, Santa Cruz, and Plumas counties

California Interceptions: None

The risk *Puccinia pentstemonis* would pose to California is evaluated below.

Consequences of Introduction:

- 1) Climate/Host Interaction:** *Penstemon* spp. are native to western North America. This rust has been reported throughout the native range of *Penstemon*.

Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: 3

- 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 limited to *Penstemon* spp.

Evaluate the host range of the pest.

Score: 1

- **Low (1) has a very limited host range.**
 - Medium (2) has a moderate host range.
 - High (3) has a wide host range.
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- 3) Pest Reproductive Potential:** This rust reproduces with teleospores only and is microcyclic, without an alternate host or repeating uredineospores. Spores are primarily spread by wind, and by movement of infected nursery 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.

- 4) Economic Impact:** Presence of rust can be in violation of California nursery stock cleanliness standards

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

Economic Impact: 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: 1

- **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:** Keeping nursery stock free from rust can require multiple fungicide applications. Rust reduces the esthetic value of plants

Environmental Impact: D, 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.
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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 *Puccinia pentstemonis*: 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 'Medium'. This pathogen was first described in Plumas; now it seems to be well established along the coast in the nursery trades

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 = 8*

Uncertainty:

None.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Puccinia pentstemonis* C.

References:

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Zandvoort, R. 1968. Wind dispersal of *Puccinia horiana*. Netherlands Journal of Plant Pathology 74:124-127.

Responsible Party:

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***Comment Period: 9/18/2020 through 11/2/2020**

***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.
 - ❖ 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
