CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Coleosporium solidaginis (Schwein.) Thüm. 1878

Pine needle rust/Solidago rust

Current Pest Rating: Z

Proposed Pest Rating: C

Kingdom: Fungi, Phylum: Basidiomycota,

Class: Pucciniomycotina, Subclass: Pucciniomycetes,

Order: Pucciniales, Family: Coleosporiaceae

Comment Period: 12/30/2020 through 02/13/2021

Initiating Event:

Solidago spp., which are shipped widely nationally and internationally as a filler flowers to florists, are frequently intercepted infected with rust in California by County inspectors monitoring shipments for invasive plant diseases. Christmas wreaths also shipped from out of state into California containing pine foliage have occasionally been detected with a different stage of the same rust. Until recently, CDFA Plant Pathologists have diagnosed the rust on *Solidago* spp. and pine as *Coleosporium asterum* (C-rated). Recently, McTaggart and Aime (2018) used genetic and phylogenetic analysis to show that rust strains of *C. asterum* on *Solidago* found in the United States were not the same species as the original type specimen which was collected in Japan. As a consequence of this work, the rust species in the Americas infecting *Solidago* spp. and pine was named *C. solidaginis,* a species formerly synonymized with, but now distinct from, *C. asterum*. *Coleosporium solidaginis* has not been reviewed or formally rated. The risk to California from rust caused by *C. solidaginis* is described herein and a permanent rating is proposed.

History & Status:

Background:

The genus *Coleosporium* contains more than 100 species that cause pine needle Rust. *Coleosporium* spp. mainly occur in the temperate northern hemisphere but are also found in the tropics and have

---

been introduced into Europe, South Africa, and Australia (Farr and Rossman 2020). Most are heteroecious, macrocycle rusts that alternate between two different hosts to complete their full life cycle. While *Solidago* spp. (goldenrods) are common host species, many other members of the Asteraceae are hosts for the uredinial and telial stages of *Coleosporium* spp. in North America (McTaggart and Aime, 2018; Farr and Rossman, 2020).

Coleosporium solidaginis is closely related to *C. asterum*, the causative agent of rust on *Aster* species. In the past, the two were synonymized but are now recognized as genetically distinct species of fungal plant pathogens (Beenkin et al., 2017; McTaggert and Aime, 2018).

Hosts: Telial and uredenial hosts: *Aster acuminatus, A. ageratoides, A. alpinus, A. azureus, A. chilensis, A. chinensis, A. cordifolius, A. curvescens, A. divaricatus, A. drummondii, A. dumosus, A. eatonii, A. engelmannii var. ledophyllus, A. ericoides, A. foliaceus var. canbyi, A. fremontii, A. ianthinus, A. junciformis, A. laevis, A. lateriflorus, A. lindleyanus, A. longifolius, A. lucidulus, A. macrophyllus, A. menziesii, A. multiflorus, A. nemoralis, A. novae-angliae, A. novi-belgii, A. oblongifolius, A. oblongifolius var. angustatus, A. panduratus, A. paniculatus, A. paniculatus var. simplex, A. pauciflorus, A. pilosus, A. prenanthoides, A. pringlei, A. ptarmicoides, A. puniceus, A. radulinus, A. sagittifolius, A. salicifolius, A. shastensis, A. shortii, A. simplex, A. subspicatus, A. tataricus, A. tradescantii, A. umbellatus, A. vimineus, Asteromoea mongolica, Callistephus chinensis, C. hortensis, Chrysopsis oregana, Chrysopsis sp., Erigeron peregrinus, E. peregrinus subsp. callianthemus, Erigeron sp., Gaillardia aristate, Grindelia oregana, Grindelia sp., Grindelia squarrosa, Gutierrezia sp., Haplopappus racemosus subsp. congestus, Haplopappus sp., Heteropappus hispidus, Leptilon pusillum, Liatris pycnostachya, Sericocarpus asteroids, S. rigidus, Solidago altissima, S. arguta, S. aspera, S. bicolor, S. boottii, S. brachyphylla, S. caesia, S. californica, S. canadensis, S. canadensis var. scabra, S. castrensis, S. confinis, S. curtisii, S. decurrens, S. drummondii, S. elongata, S. erecta, S. flexicaulis, S. gigantea, S. gigantea var. leiophylla, S. gilvocanescens, S. glaberrima, S. graminifolia, S. hispida, S. juncea, S. latifolia, S. macrophylla, S. missouriensis, S. mollis, S. monticola, S. multiradiata, S. neglecta, S. nemoralis, S. odora, S. patula, S. petiolaris, S. pitcher, S. puberula, S. radula, S. riddellii, S. rigida, S. roanensis, S. rugosa, S. sciaphila, S. sempervirens, S. serotina, S. spathulate, S. speciose, S. squarrosa, S. tenuifolia, S. tolmieana, S. uliginosa, S. ulmifolia, S. uniligulata, S. virga-aurea, S. virgaurea, S. virgaurea* subsp*. gigantea, S. virgaurea var. gigantea, S. ×rugosa-sempervirens,* and *Solidaster luteus.*

Aecial hosts: *Pinus* spp. (Pinaceae): *Pinus armandii, P. banksiana, P. contorta* var. *murrayana, P. contorta var. latifolia, P. echinate, P. koraiensis, P. massoniana, P. mugo, P. nigra, P. nigra var. austriaca, P. palustris, P. ponderosa* var. *ponderosa, P. ponderosa* var. *scopulorum, P. pungens, P. resinosa, P. rigida, P. silvestris, P. sylvestris, P. taeda, P. thunbergii, P. virginiana,* and *P. yunnanensis.* (Farr and Rossman, 2020)

Symptoms:

On Solidago: Small, yellowish spots appear on the upper leaf surface*s.* These later coalesce and turn into brown, necrotic areas. The yellow spots on the upper leaf surface correspond to developing tiny, raised, yellow-orange, powdery rust pustules borne on the abaxial or lower leaf surface. The pustules produce massive numbers of powdery, bright yellow or yellow orange urediniospores (stage II)

primarily on the undersides of leaves. In some environments, telia produce teliospores (stage III), generally at the end of the season on leaves that are already hosting large numbers of uredinia. As lesions age, they enlarge and coalesce, and the yellow areas develop into sunken, angular, grayish to brown spots. Leaves can become severely diseased and nearly completely covered with pustules. Heavily infected leaves may dry, curl, become distorted, and fall. With repeating cycles of rust infection over time, defoliation can approach 100 percent on a plant. Stems and flowers are not infected (Wang et al., 2016).

On Pine: Fragile, ephemeral basidia with basidiospores (stage IV) are produced from teliospores on the *Solidago* and these basidiospores can infect *Pinus* spp. The basidiospores germinate and the rust grows into and overwinters only inside the needles. Yellow spots appear on the needles the following spring. Subepidermal blisters develop on the pine needles, producing spermagonia (stage 0) and aecia (stage 1). The aecia are bright orange and heavy infections can cause needle cast. The aecial spores infect S*olidago*.

Transmission: Most infections are caused by windborne urediniospores that are produced en masse and easily moved from the leaves by air currents. The spores stick to moist leaves under wet or humid conditions. Spores germinate on leaves, penetrate the surface, and grow as fungal hyphae that infect plant cells. Uredinial sori erupt through the epidermis and the spores are dispersed to new infection sites on the same or other *Solidago* spp. leaves. Windblown aeciospores are produced from aecia on pine needles and spread to *Solidago.* Long distance spread can occur when infected plants are moved as nursery or florist stock.

Damage Potential: Rust pathogens rarely kill their hosts, and this one does not directly damage *Solidago* flowers. Repeating cycles of secondary infection can cause defoliation of *Solidago*, which reduces flower production and weakens the plants. This species is unusual in that it has a large host range (Farr and Rossman, 2020). Minor needle cast and discoloration of needles of pine are observed and, in cases of severe infection, some reduction is seen in terminal growth, but only rarely does it damage the trees (Nicholls and Anderson, 1976).

Worldwide Distribution: Bermuda, Canada, China, Colombia, Cuba, Dominican Republic, Ecuador, Japan, Mexico, South Korea, Switzerland, Taiwan, United States (Alabama, Alaska, Arkansas, California, Colorado, Connecticut, Florida, Georgia, Illinois, Iowa, Louisiana, Maryland, Massachusetts, Maine, Minnesota, Missouri, Mississippi, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Vermont, Wisconsin, Washington, and Wyoming) (Farr and Rossman, 2020).

Official Control: None

California Distribution: Detections of rust on asters has been made in California for more than a century (Blasdale, 1919; French, 1989). In the past, all strains were likely to be classified as *C. asterum*. Detections on *Solidago* spp. are now credited to *C. solidaginis.*

California Interceptions: Multiple interceptions of *Coleosporium* rust have been made on incoming cut *Solidago* spp. florist stock shipments from Colombia, Ecuador and the Dominican Republic, and on wreaths with *Pinus* spp. from Washington.

The risk *Coleosporium solidaginis* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Rusts are obligate pathogens that need a living host to survive and reproduce. *Coleosporium* rust on *Solidago* and other asters has been reported in multiple parts of California including the north and south coast, and in the Sierra Nevada. It has also been found on multiple species of pines in Southern California (French, 1989).

   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 unusually wide for a rust fungus. In addition, as a macrocyclic rust it has both aecial and telial hosts. It has been reported in California on multiple genera of plants in the family Asteraceae and in the genus *Pinus* (French, 1989)

   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 reproduces asexually with massing numbers of autoinfecting urediniospores and disease can increase in severity exponentially. It can also be spread with aecial spores from the pine host. The spores are moved by wind or by the movement of infected leaves or plants.

   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:** Some *Solidago* spp. are grown for their flowers, which are not directly affected by the rust. However, premature defoliation reduces plant vigor and flower yield.

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

Economic Impact: A

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:** *Coleosporium asterum* has been reported on multiple native plants in family Asteraceae and in the genera *Aster, Callistephus, Erigeron, Eucephalus, Gaillardia, Grindelia, Heterotheca, Machaeranthera, Sericocarpus, Solidago, Symphyotrichum*, as well as the pines *Pinus contorta* and *Pinus radiata*. Some of these detections are likely attributable to *C. solidaginis* and others to other closely related species now separated from *C. asterum*.

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 *Coleosporium solidaginis:* 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'. There are official records of *Coleosporium* rust statewide.

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:

At least three species of *Coleosporum* are now known on *Solidago* in North America: *C. solidaginis, C. montanum*, and *C. delictulum*. They were formerly classified as *C. asterum*. All three species have now been confirmed in California, but their distribution as individuals has not been surveyed. However, all three carry similar risks and would likely all receive a C rating.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Coleosporium solidaginis* is C.

References:

Blasdale, W.C. 1919. A preliminary list of the Uredinales of California. University of California Publications in Botany 7: 101-157

Beenken, L., Lutz, M., and Scholler, M. 2017. DNA barcoding and phylogenetic analyses of the genus *Coleosporium* (Pucciniales) reveal that the North American goldenrod rust *C. solidaginis* is a neomycete on introduced and native *Solidago* species in Europe. Mycological Progress 16, no. 11-12: 1073-1085.

Farr, D.F., and Rossman, A.Y. Fungal Databases, U.S. National Fungus Collections, ARS, USDA. Retrieved November 15, 2020, from https://nt.ars-grin.gov/fungaldatabases/

French, A. M. 1989. California plant disease host index. CA Division of Plant Industry. 2nd Ed. 394 pg

McTaggart, A. R. and Aime, M. C., 2018. The species of *Coleosporium* (Pucciniales) on *Solidago* in North America. Fungal biology, 122(8), pp.800-809.

Nicholls, T.H. and Anderson, R.L., 1976. How to identify and control pine needle rust disease. US Department of Agriculture, Forest Service, North Central Forest Experiment Station.

Wang, Q., Li, X.L. and Zhang, J.Z., 2017. First report of goldenrod rust caused by *Coleosporium asterum* in China. Plant Disease, 101(2), pp.389-389.

Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, CDFA/PHPPS ECOPERS, 2800 Gateway Oaks Suite 200, Sacramento, CA 95833 Phone: (916) 654-1017, permits[@]cdfa.ca.gov.

---

*Comment Period: 12/30/2020 through 02/13/2021

*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.

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
