

CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Colletotrichum nymphaeae (Pass.) Aa 1978 Anthracnose

Pest Rating: C

Kingdom: Fungi, Phylum: Ascomycota Subphylum: Pezizomycotina, Class: Sordariomycetes Subclass: Sordariomycetidae, Family: Glomerellaceae

Comment Period: 11/15/2024 through 12/30/2024

Initiating Event:

In August 2021, a Del Norte County Agricultural Inspector submitted rhododendrons with leaf spots found on a shipment originating in Washington County, Oregon, to CDFA's Pest and Disease Diagnostics Lab at Meadowview. Plant pathologist Albre Brown isolated and identified *Colletotrichum nymphaeae* from the diseased leaves and assigned it a Q rating. In September 2024, diseased leaves from a rose of sharon (*Hibiscus syriacus*) shipped from Forsyth County, NC were submitted by San Luis Obispo County Agricultural Inspectors. Plant pathologist Wei Belisle isolated and identified *C. nymphaeae*. Both detections were new hosts for this pathogen. *Colletotrichum nymphaeae* has not been through the pest rating process. The risk to California from *C. nymphaeae* is described herein and a permanent rating is proposed.

History & Status:

Background: Colletotrichum is a common and widespread genus of fungi that causes diseases commonly known as anthracnose on numerous host plants worldwide (Farr and Rossman, 2024). Anthracnose diseases can cause devastating losses in many economically important crops, including tree fruits, small fruits, vegetables, and ornamental foliage plants (Agrios, 2005).

Colletotrichum is the sole genus in the fungus family Glomerellaceae. There are approximately 200 accepted *Colletotrichum* species in eleven species complexes and two dozen singleton species (Jayawardena et al., 2016; Farr and Rossman, 2024). *Colletotrichum* species can also be present as symptomless, cryptic endophytes in living plant tissues, and many appear to be non-pathogenic It is a hemibiotrophic fungus which means it often has a biotrophic, and then later necrotrophic phase (Cannon et al., 2012).



A destructive leaf spot disease was found on *Nymphaea alba* (white waterlily) in lakes in the Netherlands. After comparison of fresh material and herbarium specimens, the causal agent *Colletotrichum nymphaeae* was described in detail in morphological and pathological terms by van der Aa (1978).

Anthracnose diseases affect the leaves, stems, and fruits of many plant species, including a number of significant crops. To understand disease epidemiology and create efficient disease control strategies, accurate species identification is essential. Identification of *Colletotrichum* species based on morphology has always been challenging because there aren't many trustworthy characteristics and many of them rely on experimental setups and techniques which affect their growth. Stable and well-resolved clades within *Colletotrichum* may now be identified with advancements in molecular phylogenetic techniques (Cai et al., 2009). *Colletotrichum nymphaeae* was placed in clade 2 of the *C. acutatum* species complex by Damm et al. (2012).

Strawberry anthracnose is a significant disease in California, known to be caused by the *C. acutatum* species complex. Wang et al. (2019) used multi-locus sequence analysis to characterize hundreds of isolates from strawberry collected over two decades. They concluded that (primarily) *C. nymphaeae* and (secondarily) *C. fioriniae* are responsible for strawberry anthracnose. From these pathogens, strawberry plants suffer fruit rot and flower blight, and under disease-favorable conditions, yield losses of greater than 50% have been reported in susceptible cultivars (Mertely et al., 2015). *Colletotrichum fioriniae* is C-rated (https://blogs.cdfa.ca.gov/Section3162/?p=8642).

Hosts: Actinidia arguta (baby kiwi), Allium cepa (bulb onion), Anemone coronaria (poppy anemone), Anemone sp. (windflower), Apium graveolens (celery), Camellia oleifera (tea-oil camellia), Campanula rapunculoides (creeping bellflower), Capsicum annuum (sweet pepper), Capsicum sp. (pepper), Carya illinoinensis (pecan), Citrus aurantifolia (key lime), C. limon (lemon), Diospyros kaki (Japanese persimmon), Eriobotrya japonica (loquat), Fragaria ananassa (garden strawberry), Fragaria sp. (strawberry), F. vesca (alpine strawberry), Hevea brasiliensis (natural rubber), Hibiscus syriacus (rose of sharon), Ilex serrata-verticillata (winterberry), Juglans regia (walnut), Leucaena sp. (lead tree), Lithocarpus litseifolius (stone oak), Mahonia aquifolium (holly barberry), Malus domestica (apple), M. pumila (paradise apple), Mangifera indica (common mango), Nuphar luteum (yellow pond lily), Nymphaea alba (white water-lily), Nymphaea sp. (water-lily), Oenothera sp. (evening primrose), Olea europaea (olive), Pelargonium graveolens (rose geranium), Persea americana (avocado), Phaseolus sp. (bean), Photinia sp., Protea × compacta-susannae (sugarbush), P. compacta (bot river protea), P. cynaroides (king protea), P. magnifica (bearded protea), P. repens (sugarbush), Protea sp., Prunus dulcis (almond), P. persica (peach), P. salicina (plum), Psidium quajava (guava), Punica granatum (pomegranate), Pyrus pyrifolia (Asian pear), Rhododendron sp. (rhododendron), Robinia pseudoacacia (black locust), Rubus corchorifolius (blackberry), Solanum lycopersicum var. cerasiforme (cherry tomato), Vitis labrusca (fox grape), Vitis sp. (grape), V. vinifera (common grapevine) (Farr and Rossman, 2024).

Symptoms: *Colletotrichum nymphaeae* affects various plant tissues, often leaving them necrotized and black in color. Dry, necrotic leaf lesions can develop into larger areas of dead tissues. Sunken, necrotic



spots on the fruit can lead to significant post-harvest losses. Stem cankers can result in a yellowing and wilting of leaves, affecting the plant's overall vigor and productivity. Symptoms caused by other species of *Colletotrichum* will be extremely similar to those caused by *C. nymphaeae* making field diagnosis impossible.

For strawberries, petiole, runner, and fruit lesions are the most noticeable signs of anthracnose. After planting, some fields may experience plant stunting and yellowing. Although it is less frequent with California annual plantings, plant wilting and collapse are possible. Usually, the collapse of afflicted plants is preceded by petiole and runner lesions or distinctive crown symptoms. Lesions that resemble dark brown or black, lens-shaped, sunken patches emerge on diseased petioles and runners.

The entire plant may wilt and die if the crown tissue becomes diseased. Similar to *Phytophthora* crown rot, anthracnose causes the interior crown tissue to become discolored, although the discoloration ranges from cinnamon to red, while *Phytophthora*-infected tissue is more chocolate brown. Additionally, petiole and runner lesions are not produced by *Phytophthora* spp.

Depending on the environment, anthracnose-induced fruit deterioration may be widespread in production areas, especially after warm, rainy weather. It can impact fruit at any stage of ripeness. On green fruit, tiny, recessed, oval-to-round brown spots form; on red fruit, these spots may grow to cover most or all of the fruit's surface. Salmon or orange-colored spores may develop on the fruit, petiole, and runners when the humidity is high. The tissue of decomposing fruit is dry and solid (Koike et al., 2018).

Transmission: Colletotrichum nymphaea produces abundant asexual conidia during periods of wet weather. No perfect stage is known. *Colletotrichum* sp. can survive in soil between crops without host plants. This pathogen is known to infect weeds such as chickweed, fiddleneck, and vetch which provide inoculum to crops. Strawberries get infected when rain or irrigation water splashes spores from the soil onto their fruit, crowns or stems. The disease typically starts on infected nursery stock or from volunteer strawberry plants in nearby fields. Inoculum may be introduced by surrounding weeds or originate from contaminated soil carried by field equipment or people (Koike et al., 2018).

Damage Potential: Colletotrichum nymphaeae causes economic damage to plants in many genera, and under optimal environmental conditions can cause significant yield loss on soft ripe strawberry fruit (Mertely et al., 2015). Severe damage from celery stunt anthracnose caused by this pathogen has been reported by Yamagishi et al. (2015). Significant yield losses have been reported on walnuts (Ma et al. 2020). For olives, *C. nymphaea* both reduces yields and adversely impacts oil quality (Garcia-Lopez et al., 2023).

<u>Worldwide Distribution</u>: Australia, Belgium, Brazil, Bulgaria, Canada, China, Colombia, Costa Rica, Denmark, France, Hungary, India, Indonesia, Iran, Islamic Republic of, Israel, Italy, Japan, Kenya, Korea, Republic of (South Korea), Malaysia, Mexico, Netherlands, Portugal, South Africa, Spain, Sri Lanka, Switzerland, Taiwan, United Kingdom, United States (*Alabama, California, Florida, Georgia, Kentucky, Louisiana, Massachusetts, Michigan, North Carolina, Ohio, Oregon, South Carolina, Virginia*), Uruguay, and Zimbabwe.



Official Control: Colletotrichum nymphaeae is a U.S.-regulated pest (USDA APHIS 2024).

<u>California Distribution</u>: There are records and publications showing the *C. acutatum* species complex has caused disease in multiple counties throughout California for many years, particularly in areas where strawberries, nuts and tree fruits are grown. This pathogen has likely been identified as *C. acutatum*, not *C. nymphaeae*, across the state, for example, in strawberries and other fruits (CDFA PDR database 2024).

California Interceptions: Multiple incoming shipments, see "initiating events".

The risk that *Colletotrichum nymphaeae* would pose to California is evaluated below.

Consequences of Introduction:

1) Climate/Host Interaction: Anthracnose diseases are most severe under wet conditions or in irrigated crops. Humid, wet, rainy weather is necessary for infection to occur. Epidemics are larger when temperatures are warmer.

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 be established 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 large and includes herbaceous and woody hosts in multiple plant families.

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 with large numbers of conidia. It is spread over longer distances with 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: This disease damages plants and directly infects fruit.

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

Economic Impact: A, B

- A. The pest could lower crop yield.
- B. The pest could lower crop value (including increasing crop production costs).
- C. The pest could trigger the loss of markets (including 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: This pathogen is a U. S. regulated pest and can impact home gardens and ornamental plantings.

Evaluate the environmental impact of the pest on California using the criteria below.

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.
- 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 Colletotrichum nymphaeae: High

Add up the total score and include it here. **13** -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'.

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 the 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:

As molecular diagnostics continue to improve, more diseases previously attributed to the *C. acutatum* species complex are likely to be directly attributed to *C. nymphaeae* or other *Colletotrichum* species in the *C. acutatum* complex. This has implications for regulatory work as new species names will lack post-entry distribution and survey information.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Colletotrichum nymphaeae* is C.

References:

Agrios, G. N. 2005. Plant Pathology, 5th Edition. Elsevier Academic Press. 922 pg

Cai, L., Hyde, K.D., Taylor, P.W.J., Weir, B., Waller, J., Abang, M.M., Zhang, J.Z., Yang, Y.L., Phoulivong, S., Liu, Z.Y. and Shivas, R.G., 2009. A polyphasic approach for studying *Colletotrichum*. Fungal Diversity, 39(1), pp.183-204.

Cannon, P. F., Damm, U., Johnston, P. R., Weir, B. S. 2012. *Colletotrichum*–current status and future directions. Studies in Mycology 73: 181–213. 10.3114/sim0014



Damm, U., Cannon, P.F., Woudenberg, J.H.C. and Crous, P.W., 2012. The *Colletotrichum acutatum* species complex. Studies in mycology, 73, pp.37-113.

Farr, D.F., and Rossman, A.Y. Fungal Databases, U.S. National Fungus Collections, ARS, USDA. Retrieved 10/23/2024, from <u>https://nt.ars-grin.gov/fungaldatabases/</u>

Garcia-Lopez, M.T., Serrano, M.S., Camiletti, B.X., Gordon, A., Estudillo, C., Trapero, A., Diez, C.M. and Moral, J., 2023. Study of the competition between Colletotrichum godetiae and C. nymphaeae, two pathogenic species in olive. Scientific reports, 13(1), p.5344.

Jayawardena, R. S., Hyde, K. D., Damm, U., Cai, L., Liu, M., Li, X. H., Zhang, W., Zhao, W. S., and Yan, J. Y.2016. Notes on currently accepted species of *Colletotrichum*. Mycosphere 7(8): 1192-1260.

Koike, S. T., Browne, G. T., Gordon, T. R. and Bolda, M. P. 2018. Strawberry Anthracnose. UC IPM Pest Management guidelines: Strawberry UC ANR Publication 3468.

Ma, T., Yang, C., Cai, F. and Chen, Z., 2022. Morpho-cultural, physiological and molecular characterisation of Colletotrichum nymphaeae causing anthracnose disease of walnut in China. Microbial Pathogenesis, 166, p.105537.

Mertely, J. C., Seijo, T. E., and Peres, N. A. 2015. Evaluation of products for anthracnose and Botrytis fruit rot control in annual strawberry, 2014-2015. Plant Dis. Manage. Rep. 9: Report SMF019.

Van der Aa, H.A., 1978. A leaf spot disease of *Nymphaea alba* in the Netherlands. Netherlands Journal of Plant Pathology, 84, pp.109-115.

Wang, N.Y., Forcelini, B.B. and Peres, N.A., 2019. Anthracnose fruit and root necrosis of strawberry are caused by a dominant species within the *Colletotrichum acutatum* species complex in the United States. Phytopathology, 109(7), pp.1293-1301.

Yamagishi, N., Fujinaga, M., Ishiyama, Y. 2015. Life cycle and control of *Colletotrichum nymphaeae*, the causal agent of celery stunt anthracnose. J Gen Plant Pathol 81, 279–286.

Responsible Party:

Heather J. Martin, Primary Plant Pathologist/Nematologist, CDFA/PHPPS ECOPERS, 1220 N St Rm 221, Sacramento, CA 95814 Phone: (916) 654-1017, permits[@]cdfa.ca.gov.

*Comment Period: 11/15/2024 through 12/30/2024



***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.

Pest Rating: C