CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Hyaloperonospora brassicae (Gäumann) Göker, Riethmuller, Voglmayr, Weiss & Oberwinkler
Brassica downy mildew

Current Pest Rating: none

Proposed Pest Rating: C

Domain: Eukaryota, Kingdom: Chromista,
Phylum: Oomycota, Class: Oomycetes,
Order: Peronosporales, Family: Peronosporaceae

Comment Period: 04/22/2025 through 06/06/2025

Initiating Event:

This pathogen has not been through the pest rating process. The risk to California from *Hyaloperonospora brassicae* is described herein, and a permanent rating is proposed.

History & Status:

Background:

Cole crops are cool-season vegetables, primarily *Brassica oleracea* species, including broccoli, cabbage, cauliflower, collards, Brussels sprouts, kale, and kohlrabi, that thrive in cooler weather. 90% of the nation's commercial crops of broccoli, cauliflower, cabbage, Brussels sprouts, and other cole crops are grown in California on 150,000 acres. Most of the production is on the Central Coast, with seasonal production in the desert and in the Central Valley. In 2022/23, California production of broccoli, cauliflower, and cabbage was valued at $1.415B (California Agricultural Statistics Review 2022-2023 https://www.cdfa.ca.gov/Statistics/PDFs/2022-2023_california_agricultural_statistics_review.pdf).

Oomycetes are members of the kingdom Chromista (= Stramenopila) that have mycelium containing cellulose and glucans. They produce oospores as resting spores and zoospores or zoosporangia as asexual spores. Some species also produce chlamydospores as long-term survival structures. The family Peronosporaceae includes several of the most important genera of plant pathogens, notably *Pythium* and *Phytophthora*, and several genera of downy mildews.

Downy mildews are very destructive diseases, primarily acting as foliage blights. Almost all members of this family are obligate parasites of higher plants. They attack and spread rapidly in young, tender

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green leaves, twigs, and fruit tissues and can cause severe crop losses in short periods of time. The diseases they cause are most severe when a film of water is present on the plant tissues and the relative humidity in the air is high during cool periods. In situations in which the pathogen is carried with the seed or bulb, or when infection takes place at the seedling or young plant stage, the pathogen may cause systemic shoot infection of its host, and this can be very damaging. When older plants are attacked, they may develop localized infected areas, or they may allow the pathogen to spread into young tissues and become locally systemic (Agrios, 2005).

The brassicolous downy mildews are currently in the genera *Hyaloperonospora* and *Perofascia*, and many are restricted to this family (Constantinescu and Fatehi, 2002). The pathogens that infect cole crops and others in the family Brassicaceae were originally named *Pernospora parasitica*, and later *Hyalonospera parasitica*. Work by Choi et al. (2003) showed that *H. parasitica* was paraphyletic, but they didn't give any of the clades new names. In 2009, the name *H. parasitica* was restricted to strains that can infect *Capsella bursa-pastoris* and a few others, excluding the primary cole crops grown in California (Göker et al., 2008). The accepted name for the species that infects broccoli, cabbage, radish, and cauliflower is *H. brassicae* (M. Romberg, USDA Mycologist, pers. comm.).

Hosts: Both cultivated plants and weeds in the Brassicaceae family are susceptible to this pathogen. *Armoracia rusticana* (horseradish), *Brassica campestris* (field mustard), *Brassica napus, Brassica narinosa*, *Brassica oleracea* (cabbages, cauliflowers), *Brassica oleracea* var. *alboglabra* (Chinese kale), *Brassica oleracea* var. *botrytis* (cauliflower), *Brassica oleracea* var. *capitata* (cabbage), *Brassica oleracea* var. *gemmifera* (Brussels sprouts), *Brassica oleracea* var. *gongylodes* (kohlrabi), *Brassica oleracea* var. *italica* (broccoli), *Brassica oleracea* var. *viridis* (collards), *Leucosinapis alba* (white mustard), *Raphanus raphanistrum* (wild radish), *Raphanus sativus* (radish), *Sinapis arvensis* (wild mustard), (Farr and Rossman, 2025).

Symptoms: The first symptom of infection on broccoli and cauliflower is small, light green-yellow lesions on the upper leaf surface. The leaf will turn yellow on the upper surface as lesions enlarge. During high humidity, a grayish-white mycelial growth appears as the pathogen produces spores on the underside of leaf spots. Leaf spots may become dry and papery, especially if temperatures are above 75°F. If seedlings are attacked, sporulation develops on both sides of the cotyledons. Damage often forms larger yellow areas bound by the larger veins, so they retain an angular shape. Plants can become systemically infected, especially if infected at the seedling stage, but the black streaking and discoloration inside stems and heads may not become apparent until closer to harvest. Cabbage heads and Brussels sprouts develop sunken black spots, which may be minute or larger than 1 inch in diameter. Frequently, plants become systemically infected in the seedling stage, but the black streaking and discoloration inside the leaves and heads will not appear until near harvest (Nashaat, 2007).

Transmission: High humidity, fog, drizzle, and heavy dew favor disease development and spread. Asexual spores are produced on aerial plant portions and can be dispersed by wind or splashing water to cause the secondary spread of the disease. *Hyaloperonospora brassicae* survives between crops on weed hosts or as resilient oospores in crop residue. Spores are airborne and, under favorable

conditions, are produced in extremely large numbers. Spores may be spread as contaminants on seeds, but there is no proof that the pathogen enters the seed internally (CABI, 2025; Nashaat, 2007).

Damage Potential: Downy mildews often cause rapid and severe losses of young plants still in the seedbed or in the field. They can destroy from 40 to 90% of the young plants, causing heavy or total losses of crop yields. The severity of loss depends on the prolonged presence of wet, cool weather during which the downy mildews sporulate profusely, cause numerous new infections, and spread into and rapidly kill young succulent tissues. In cool, wet weather, downy mildews are often uncontrollable. Systemic infections cause internal dark grey spots and streaks in stems and floret branches of broccoli and cauliflower, leaving them unmarketable (CABI, 2025; Nashaat, 2007).

Worldwide Distribution: This list is compiled from publications using the name *H. brassicae*. There are many more countries that have published records of *H. parasitica,* which likely today would be classified as *H. brassicae*. Asia: *South Korea.* Europe: *Austria, Germany, Portugal, Spain* North America: *Mexico, United States* (Alabama, Alaska, Arizona, California, Colorado, Connecticut, Delaware, Florida, Hawaii, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Virginia, Washington, West Virginia, Wisconsin, Wyoming). Oceania: *Australia* (Farr and Rossman, 2025).

Official Control*: Hyaloperonospora brassicae* is on the USDA PCIT's harmful organisms list for Ecuador, Nicaragua, and Panama (USDA-PCIT, 2025).

California Distribution: Widespread in the north, south, and central coast, the Bay Area, Sacramento Valley, San Joaquin Valley, Coachella Valley, and the Imperial Valley (French, 1989; CDFA PDR database, 2025).

California Interceptions:

The risk that *Hyaloperonospora brassicae* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** Moderate temperatures during the daytime (68°F to 75°F) and high relative humidity, fog, drizzling rains, or heavy dew favor disease development and spread. In areas with mild, wet winters, such as coastal California, downy mildew can also infect fall-planted seed crops during the winter months. This climate is more common on the coast, but serious disease epidemics have been reported in the Imperial Valley (Kontaxis et al., 1979).

   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 includes several species in the family Brassicaceae.

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:** This pathogen produces large numbers of airborne spores under favorable conditions. It has also been found associated with seed.

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:** Large yield losses and complete crop losses have been reported for susceptible cultivars under favorable conditions.

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 impacts home and urban gardening. It infects some native or naturalized Brassica plants.

Evaluate the environmental impact of the pest on 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 *Hyaloperonospora brassicae:* 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'.

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:

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 9***

Uncertainty:

The taxonomy of downy mildews receives periodic revisions. Many seed export requirements still reference Peronospora parasitica. It is important to understand that the concern is with any or all seedborne pathogens of vegetable crops, irrespective of a new species name.

Conclusion and Rating Justification:

Based on the evidence provided above, the proposed rating for ***Hyaloperonospora brassicae*** **is C.**

References:

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USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) *Hyaloperonospora parasitica*. Harmful Organisms Database Report. Accessed 3/21/2025.

Responsible Party:

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***Comment Period: 04/22/2025 through 06/06/2025**

***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
