

## California Pest Rating Proposal for

*Aphelenchoides besseyi* Christie, 1942

Strawberry summer crimp nematode

**Current Pest Rating: A**

**Proposed Pest Rating: A**

Kingdom: Animalia, Phylum: Nematoda,  
Class: Secernentea, Subclass: Diplogasteria,  
Order: Aphelenchida, Superfamily: Aphelenchoidea,  
Family: Aphelenchoididae, Subfamily: Aphelenchoidinae

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**Comment Period: 06/25/2021 through 07/25/2021**

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### Initiating Event:

This nematode has not been through the pest rating process. The risk to California from *Aphelenchoides besseyi* is described herein and a permanent pest rating is proposed.

### History & Status:

#### Background:

J. R. Christie in 1942 published a description of a strawberry population of the foliar nematodes from Willard, North Carolina, and named them *Aphelenchoides besseyi*. In 1948, T. Yokoo described a foliar rice nematode from Kyushu and Hokkaido in Japan and named it *A. oryzae*. They both have a stellate tail terminus and overlap in many morphological characters. This led M. W. Allen in 1952 to consider *A. oryzae* a junior synonym of *A. besseyi*. This resulted in *A. besseyi* becoming a well-known foliar nematode that primarily parasitizes rice, but occasionally is found on strawberry and other plants including ornamentals. It has been observed in multiple states and many countries. It is also a quarantine pest in countries where it is not established, primarily over concerns for rice.

This classification has recently been challenged by the work of Subbotin et al. (2020). Using an integrated approach and supported by molecular and phylogenetic analysis, they have shown *A.*

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*besseyi* sensu lato to be a species complex with several cryptic species that are not well delimited by morphology.

A species delimitation among *A. besseyi* s. l. populations is very important for phytosanitary purposes and for the selection of crop cultivars resistant to these nematodes. Subbotin et al. has separated populations as species and calls for a reinstatement of *A. oryzae* as a valid species name for the nematode that causes white tip of rice, separated from *A. besseyi*, sensu stricto, which infects strawberries only. Their work also provides the means to classify other foliar nematode populations damaging ornamental plants and agronomic crops, such as cotton and soybean, as new species, including one called *A. pseudobesseyi* and another called *A. pseudogoodeyi*.

Nematodes in the genus *Aphelenchoides* feed ectoparasitically and endoparasitically on aboveground plant parts. The populations are predominately adult females with some males, and normally are amphimictic (reproduction in which sperm and eggs come from separate individuals and cross-fertilize), although parthenogenetic reproduction (egg develops into an embryo without being fertilized) has been reported (Sudakova and Stoyakov, 1967).

*Hosts:* *Aphelenchoides besseyi* s. s. parasitizes only strawberry (*Fragaria* spp.) (Olivieria et al., 2019; Subbotin et al., 2020).

*Symptoms:* Strawberries infested with *A. besseyi* will have aboveground symptoms which can include stunted growth, reddened leaves, small curled or crinkled leaves (crimp), deformed buds and flowers, and a reduction in flowering and fruiting. In the early stage of infection, the cells of the vein sheath stop the extension of the nematodes and leaf necrosis across the veins, which gives a clear pattern on the leaves. The leaf cells turn brown and collapse, shrink and die, prompting the nematodes to exit and find new leaves to invade. A reduction in flowering and fruiting which helps distinguish a foliar nematode infestation from an insect infestation (i.e., thrips), which produce similar leaf symptoms. In advanced stages of infection, even the leaf veins break down, and the nematodes and the leaf necrosis spread over the entire leaf. Heavily infected leaves fall to the ground. There are no reported belowground symptoms from foliar nematodes (Ploeg and Westerdahl, 2018). Although the common name “summer crimp” is used to differentiate *A. besseyi* from the “spring crimp” nematode, *A. fragariae*, the timing of damage symptoms cannot be used to separate them. *Aphelenchoides ritzemabosi* has also been reported as causing similar symptoms on strawberries in California (Siddiqui et al., 1973).

*Transmission:* Strawberries are vegetatively propagated. This nematode moves long distances with infected daughter plants, and shorter distances within a field by splashing or with people handling the plants. The nematodes overwinter in buds, growing points, and dead leaves on the ground. In the spring they become active and can climb up the stems by swimming in films of water. Once at the growing points, they attack leaves by entering through the stomata and moving between cells. The eggs, juveniles and adults all develop in the leaves. This nematode is not thought to survive long periods in the soil between crops (Cralley and French, 1952).

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**Damage Potential:** The feeding of strawberry foliar nematodes (all species) may cause plant stress and reduce yields. Presence of foliar nematodes on planting stock prevents nurseries from receiving CDFA certification, greatly reducing the value of the planting stocks.

**Worldwide Distribution:** *Aphelenchoides besseyi* s. s. has been reported from Florida on *Fragaria x ananassa* (Oliveira et al., 2019). Older records should be re-evaluated following the work of Subbotin et al. (2020), for differentiation between species within the *A. besseyi* species complex

**Official Control:** *Aphelenchoides besseyi* s. l. is on the EPPO's A1 list for Azerbaijan, Bahrain, Comunidad Andina, Chile, Inter-African Phytosanitary Council, Jordan, Russia, Ukraine, Uruguay; on the A2 list for Comité Regional de Sanidad Vegetal del Cono Sur, Egypt, European plant protection organization, and Turkey; It is a quarantine pest for Israel, Mexico, Morocco, and Tunisia (EPPO, 2022).

It is listed on the USDA's harmful organism list for Albania, Algeria, Argentina, Cambodia, Chile, Colombia, Egypt, Eurasian Customs Union, European Union, French Polynesia, Georgia, Guatemala, Holy See (Vatican City State), Honduras, Indonesia, Israel, Jordan, Mexico, Monaco, Morocco, Namibia, New Caledonia, Nicaragua, Oman, Panama, Paraguay, Peru, Qatar, San Marino, Serbia, South Africa, Thailand, Timor-Leste, Tunisia, Turkey, United Arab Emirates, United Kingdom, Uruguay, and Viet Nam (USDA PCIT, 2022).

**Status in California:**

1963, *A. besseyi* s. l. was detected in a fungal culture of *Sclerotium oryzae*, which causes stem rot of rice. The fungus was collected from a rice field in Butte County that was used by a research facility that exchanged seed with areas in the southeastern United States. In 1997 in order to improve our ability to meet the export requirements of trading partners, 490,000 acres of commercial rice spread over 13 counties were surveyed and one confirmed and three suspect finds of *A. besseyi* s. l. were made from four composite samples representing 33 fields, collected from Colusa and Sutter counties.

**California Distribution:** Strawberry summer dwarf disease on strawberry occurred sporadically in California from the 1930s until 1959, but *Aphelenchoides besseyi* s. s. is currently unknown anywhere in California (Chitambar, 1999).

**California Interceptions:** In 1959, a strawberry sample from Canby, Oregon, was intercepted at a nursery in Stanislaus County.

The risk *Aphelenchoides besseyi* s. s. would pose to California is evaluated below.

## Consequences of Introduction:

- 1) Climate/Host Interaction:** *Aphelenchoides besseyi* needs a continuous supply of moisture to migrate and feed on growing tips of plant stems and leaves. Atmospheric humidity of at least 70% is required
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for nematode development. Strawberries are mostly grown in cool, coastal areas where there is moisture from fog and condensation, but the foliage is not wet for long periods of time.

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:** The host range is narrow, restricted only to *Fragaria*.

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.

**3) Pest Reproductive Potential:** Seed-borne nematodes, and those that attack vegetatively propagated plants such as strawberries, always have a high potential for artificial spread. Under ideal conditions, this nematode has a very short lifecycle leading to high populations.

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:** Currently, there is no record of strawberry losses caused by *A. besseyi* s. s. in California, which has no recent recorded detections. CDFA's strawberry nursery certification programs will detect this nematode species if it were present. Since 1989, *A. besseyi* has never been detected in tens of thousands of strawberry samples and garlic samples processed by CDFA's Nematology Laboratory. However, new pathotypes are possible and this nematode is a quarantine pest in other countries. It can be moved with splashing water, particularly with overhead irrigation.

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

**Economic Impact: A, C, G**

- 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.
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**G. The organism can interfere with the delivery or supply of water for agricultural uses.**

**Economic Impact Score: 3**

- 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:** There are multiple species of *Fragaria* that are native to California, including *F. chiloensis*, *F. vesca*, *F. virginiana*, and *F. x ananassa*. In addition to being damaged, these could act as reservoir for the nematodes in California, although their spread would be limited. Their phytosanitary status in nursery production programs for survey and eradication.

Evaluate the environmental impact of the pest to California using the criteria below

**Environmental Impact: A, D**

- 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 *Aphelenchoides besseyi*: 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.

Over decades of strawberry nursery testing, this nematode has not been found in California.

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***Evaluation is 'Not established'.***

**Score: 0**

-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 = 12*

**Uncertainty:**

Sequencing of Californian samples identified as *A. besseyi* on rice and molecular identification has confirmed they are not *A. besseyi* or *A. oryzae*. To better understand what *Aphelenchoides* species we have in California would require a comprehensive survey, which has not been done for more than 20 years (S. Subbotin, CDFA, pers comm, 2022).

**Conclusion and Rating Justification:**

Based on the evidence provided above the proposed rating for *Aphelenchoides besseyi* is A.

**References:**

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### **Responsible Party:**

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**\*Comment Period: 06/25/2021 through 07/25/2021**

### **\*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](mailto:permits[@]cdfa.ca.gov).

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### **Comment Format:**

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- ❖ 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: A**

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