CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Heterodera mani Mathews, 1971
Rye grass cyst nematode

Current Pest Rating: Q

Proposed Pest Rating: B

Kingdom: Animalia, Phylum: Nematoda,
Class: Secernentea, Subclass: Diplogasteria,
Order: Tylenchida, Superfamily: Tylenchoidea,
Family: Heteroderidae, Subfamily: Heteroderinae

Comment Period: 09/24/2021 through 11/08/2021

Initiating Event:

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

History & Status:

Background: This nematode was first collected from perennial ryegrass, *Lolium perenne*, in grass fields in Northern Ireland by Mathews (1971). The first official California record was made in June 1980 by CDFA Nematologist Adam Weiner from a collection made of miscellaneous roadside grasses by a CDFA field plant pathologist in San Mateo County. The identification was confirmed by A. M. Golden at USDA, Beltsville, Maryland.

Cyst nematodes are important pests that limit production of grasses and small grain cereals. Extensive nematode feeding reduces root mass and saps plant nutrients and can result in greatly reduced crop yields. Cyst nematodes are biotrophic sedentary endoparasites that can establish prolonged parasitic interactions with their hosts. They are among the most challenging nematodes to control, because the "cyst" is the body of a dead female nematode containing hundreds of eggs. Cysts with viable eggs can persist in dry soil for years, where they remain relatively resistant to chemical and biological stresses. Cysts are easily moved with soil.

There are many closely related cyst nematode species that are found in most regions of the world where small grains are grown. Using morphological and molecular characteristics, the genus

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Heterodera has been divided into nine groups. *Heterodera mani* belongs to the Avenae group and the *H. avenae* complex. (Subbotin et al., 2010; Handoo and Subbotin, 2018). The Avenae group is one of the largest and the species within it parasitize monocots only. Molecular markers based on the internal transcribed spacer (ITS) region of the ribosomal RNA gene and, the cytochrome oxidase I gene can be used to differentiate species in this complex. Currently there are ten published species in the *H. avenae* complex: *H. arenaria, H. avenae, H. aucklandica, H. australis, H. filipjevi, H. mani, H. pratensis, H. riparia, H. sturhani,* and *H. ustinovi*. Five species from this group are considered as pests of small grains and are collectively known as cereal cyst nematodes (CCN) (Smiley et al., 2017). The other species in the complex, including *H. mani*, parasitize grasses but not cereals, and have less importance to agriculture (Subbotin et al., 2018). The internal transcribed spacer regions of the ribosomal RNA sequences of *H. mani* from California are like those of European isolates (Subbotin, unpubl.).

In 2006 pale potato cyst nematode, *Globodera pallida*, a major pest of potato crops, was identified in Idaho. In response, APHIS PPQ devised a multi-year national survey for potato cyst nematodes on certified seed potatoes, and they implemented it in all potato-producing states including California. During this survey in 2010, *H. mani* was isolated from a seed potato field in Sonoma County; no potato cyst nematodes were found.

In 2013, the false Columbia root-knot nematode, *Meloidogyne fallax*, was first reported at a golf course in San Francisco. This species was considered to be a race of the Columbia root-knot nematode, *M. chitwoodi*. These nematodes are also important pests of potatoes and of quarantine significance to the United States. In response to this report, CDFA conducted a survey of golf courses in 25 California counties leading to nearly 600 nematode detections. *Meloidogyne fallax* was not detected, but *H. mani* was found on an annual bluegrass and bentgrass golf course in San Luis Obispo County and on a rough bluegrass overseeded with rye golf course in Riverside County (CDFA PDR database).

Hosts: Alopecurus geniculatus, *Dactylis glomerata*, *Festuca arundinacea*, *F. rubra* var *rubra*, *F. rubra* var *commutata, F. pratensis, Glyceria fluitans, Lolium multiflorum, L. perenne*, *Poa* spp. and *Vulpia bromoides* (Mathews, 1971; Mowat, 1974).

Symptoms: The diagnostic symptoms of cyst nematodes are usually the presence of cysts on the roots, the proliferation of roots, and shallow, bushy root systems. Heavily colonized young plants are stunted, and their lower leaves are often chlorotic, forming pale green patches in the field. Mature plants are also stunted and have a reduced number of tillers. Their roots are shallow and have a “bushy-knotted” appearance, without necrosis or brown lesions. Plants produce smaller heads with shriveled grain kernels (Smiley et al., 2017).

Transmission: The main way this nematode spreads is as cysts moving with soil. Thus, anything that moves soil short or long distances is a potential pathway including agricultural equipment and containers, tools, vehicle tires, and workers clothing or boots. Adults, juveniles, eggs, and cysts can be found in association with infected or contaminated planting stock. Cysts can also move in the soil with water from rainfall or irrigation. Cysts can persist in dry soil for months to years, protecting the eggs, until there is adequate water for hatching (Smiley et al., 2017).

Damage Potential: In Europe, Mowat (1974) reported that *H. mani* had little effect on the yield of perennial ryegrass in pot trials. In field trials with higher inoculum levels, Maas and Brinkman (1977) described *H. mani* causing considerable damage to spring-sown perennial ryegrass and most probably also to autumn sown grass. They showed there was an obvious reduction in growth of perennial ryegrass at the second cut in May, coinciding with a mass invasion of the roots. No damage has been reported specifically from this species in California; however, golf courses and sports fields report nematode feeding damage as an important problem. Often multiple species in addition to cyst nematodes are found, including root knot and lesion nematodes (McClure et al., 2012). Control options for nematodes in turf and pastures are extremely limited (Oka et al., 2007).

Worldwide Distribution: Europe: *Belgium, Estonia, France, Germany, Italy, The Netherlands, Slovakia, United Kingdom*; Africa: *South Africa*; North America: *United States* (California, Washington) (Subbotin et al., 2010; Subbotin et al., 2018; EPPO, 2021)

Official Control: *Heterodera mani* is on the USDA PCIT's Harmful organisms list for Colombia and Peru (USDA, 2021).

California Distribution: There are official records from Riverside, San Luis Obispo, San Mateo, and Sonoma counties, and it seems that *H. mani* occurs in native grassland in California (S. Subbotin, CDFA Nematology, pers. comm.)

California Interceptions: None

The risk *Heterodera mani* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** This nematode is likely to become established wherever suitable hosts can grow. In California it has been found along the coast and in a desert region of Riverside County.

   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 grasses.

   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:** Tens to hundreds of eggs can be produced while the female is alive, with an additional ten to hundreds retained within her cyst after her death. For long and short distance dispersal these nematodes are dependent on movements of cysts, cyst-infested soils, and cyst-infested seed lots.

   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:** Infestations of the grass cyst nematode impacts pasture and sports turf production resulting in direct plant loss and shriveled, unmarketable grains. Cysts in soil could be spread by movements of soil and irrigation water requiring changes in normal cultural practices. It is also a quarantine pest.

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

   Economic Impact: A, B, C, D, 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.
   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:** Infestations of cyst nematodes could significantly affect other grass hosts outside of agricultural crops, potentially including native species. There are very few effective treatments.

   Evaluate the environmental impact of the pest to 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 *Heterodera mani:* High

Add up the total score and include it here. **14**
-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 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* ***= 11***

Uncertainty:

The nematode is likely more widely distributed in California than is documented at this time. However, because it can be a damaging pest, with few treatment options for control or eradication, there is

justification for regulations that would prevent it from establishing in sod and turf nurseries (Chitambar et al., 2018).

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Heterodera mani* is B.

References:

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Handoo, Z.A. and Subbotin, S.A. 2018. Taxonomy, identification, and principal species. In: Perry, R.N., Moens, M. and Jones, J.T. (Eds). Cyst nematodes. Wallingford, UK, CAB International, pp. 365-397

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Subbotin, S.A., Toumi, F., Elekçioğlu, I.H., Waeyenberge, L. and Maafi, Z.T., 2018. DNA barcoding, phylogeny and phylogeography of the cyst nematode species of the Avenae group from the genus Heterodera (Tylenchida: Heteroderidae). Nematology, 20(7), pp.671-702.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. *Heterodera mani*. Accessed 8/31/2021

Responsible Party:

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*Comment Period: 09/24/2021 through 11/08/2021

*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: B