

California Pest Rating Proposal for

Heterodera trifolii Goffart, 1932

clover cyst nematode

Current Pest Rating: D

Proposed Pest Rating: C

Kingdom: Animalia, Phylum: Nematoda,
Class: Chromadorea, Order: Rhabditida,
Family: Heteroderidae

Comment Period: **08/14/2023 through 09/28/2023**

Initiating Event:

During the 1950s and 1960s, several species of plant parasitic nematodes were given a 'D' rating as they were considered to be parasites, predators, or organisms of little or no economic importance that did not require State-enforced regulatory action. However, these nematode species were incorrectly assigned a D rating as most, if not all, are plant parasitic and therefore, capable of damaging plant production and causing significant economic losses, especially at the county and local residential/grower level. Furthermore, the detection of plant parasitic nematodes in nursery stock may be an indication of contamination in violation of the State's standard of pest cleanliness required for nurseries. Among these nematodes originally rated D is *Heterodera trifolii*. This pathogen has not been through the pest rating process. The risk to California from *Heterodera trifolii* is described herein and a permanent rating is proposed.

History & Status:

Background:

Schmidt (1871) established the genus *Heterodera* from the Greek heteros = other and deros = skin. *Heterodera* is the type and oldest genus for the family Heteroderidae, which holds nematodes with sexual dimorphism, in which the mature females become swollen, and lemon-shaped, while the males remain vermiform. *Heterodera trifolii* is a parthenogenetic species (reproducing asexually without males), a polyploid, and a sedentary endoparasite. After emerging from the egg, the J2s penetrate

roots, become sedentary, swell, and establish a permanent feeding site in the root stele. Adult females become swollen, and the posterior portions of their bodies protrude from the root. At the end of her life, she becomes a cyst, each containing 500-600 embryonated eggs. Cysts can be extremely long-lived in the soil, surviving decades of adverse conditions (Subbotin et al., 2010).

While working on cereal cyst nematodes in 1932, H. Goffard, a German Nematologist, identified a *Heterodera* sp. parasitizing white clover (*Trifolium repens*). It was similar to *H. schachtii*, the sugar beet cyst nematode. Initially, he considered it a subspecies of *H. schachtii* and named it var. *trifolii*. In 1959 Goffard revised his work and elevated *H. trifolii* to a species, with the type locality in Germany. A neotype and a redescription were provided later by Wouts and Sturhan (1978). Today *H. trifolii* is a cosmopolitan species found in all continents, widely occurring throughout northern Europe and Spain, Italy, southern France, Russia, Canada, the U.S., Israel, India, Australia, and New Zealand (Subbotin et al., 2010; Nemaplex, 2010). White clover (*Trifolium repens*) fixes nitrogen and provides high-quality feed. It is a key contributor to grazed pasture systems worldwide.

Until the mid-1970s, all cyst nematodes were considered as belonging to a single genus, *Heterodera*. As new species were described, the genus *Heterodera* was informally divided into morphological groups, with each group named after a typical species. There are seven groups within *Heterodera* recognized by Subbotin et al., (2010). *Heterodera trifolii* belongs to the Schachtii group and is a member of the *H. trifolii* species complex which includes *H. betae*, *H. lespedezae*, and *H. galeopsidis*. Their hosts are dicotyledons.

In California, *H. trifolii* was first reported by Raski and Hart (1953) from white clover in the lawn of a private residence in Camarillo, Ventura County. The nematode is noted as being able to develop on carnation (*Dianthus caryophyllus*), Golden Wax bush bean (*Phaseolus vulgaris*), and *Sesbania macrocarpa* (bigpod sesbania). Subsequently, this nematode has been collected from other hosts in California, but its pathogenicity was not always confirmed (Chitambar et al., 2018; CDFA PDR database, 2023).

Hosts: Isolates collected from clovers at different locations have been intensively tested to determine their ability to support nematode reproduction. Many good reproductive hosts are found within the family Fabaceae including *Trifolium* spp., *Lotus oroboides*, *Medicago falcata*, *Melilotus officinalis*, *M. albus*, *Kummerowia stipulacea*, *K. striata*, *Vicia villosa*, *Phaseolus vulgaris* and *Sesbania macrocarpa*. Additional recorded hosts include *Brassica juncea*, *Chenopodium glaucum*, *Cleome spinosa*, *Desmodium canum*, *D. uncinatum*, *Dianthus deltoides*, *D. caryophyllus*, *Geranium dissectum*, *Lathyrus tingitanus*, *Pisum sativum*, *Rumex crispus*, *R. obtusifolius*, *Sesbania grandiflora*, *Solanum lycopersicum*, and *Spinacia oleracea* (Nemaplex, 2010; Subbotin et al., 2010).

Symptoms: There are no specific above-ground symptoms in plants that can be attributed to infection by the clover cyst nematode. General symptoms include abnormally branching rootlets stimulated near the point of infection, along with a general debilitation and reduction in the efficiency of the root system. There may be chlorosis, with leaves first appearing yellowish red and then turning necrotic in

the older parts, stunted growth, or wilted plants. In fields, poor and patchy plant growth is apparent in circular areas (Chitambar et al., 2018).

Transmission: Infected nursery stock, infected plants, soil contaminated with cysts, cysts moving with wind, nematode-infested soil, or irrigation water.

Damage Potential: *Heterodera trifolii* infection reduces plant growth and nutrition (Mercer et al., 2008). Roots of germinating clover seedlings or mature plants may both be invaded by *H. trifolii*, provided they are actively growing. In New Zealand, *H. trifolii* is active in the roots of white clover in the field during the autumn and spring growth periods. Poor autumn growth of clover and a lack of vigor was observed with high populations of clover cysts in areas that are subject to drought (Yeates, 1973). In Costa Rica, *Trifolium repens* and *Rumex obtusifolius* were found with cysts but were otherwise asymptomatic. The occurrence of the cysts on weed species can be a source of inoculum for economically important crops (Núñez-Rodríguez et. al., 2021).

Worldwide Distribution: Africa: *Egypt, Tunisia*. Asia: *India, Iran, Israel, Japan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkey, Turkmenistan, Uzbekistan*. Europe: *Belgium, Bulgaria, Denmark, France, Germany, Italy, Latvia, Lithuania, Netherlands, Poland, Russia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom*. North America: *Canada, Costa Rica, United States (Arkansas, California, Florida, Hawaii, Illinois, Iowa, Kentucky, Minnesota, Pennsylvania)*. Oceania: *Australia, New Zealand*. South America: *Argentina, Chile, Colombia* (CABI, 2023).

Official Control: *Heterodera trifolii* is on the EPPO's A1 list for Argentina and Brazil (EPPO, 2023). It is on the USDA PCIT's harmful organisms list for Brazil, Indonesia, Nicaragua, Thailand, The Republic of Korea, and Timor-Leste (USDA, 2023).

California Distribution: Due to its rating of a 'D', it is possible that *Heterodera trifolii* was not always identified as species. There are records from Mendocino and Sacramento counties, but it's likely to be more widespread.

California Interceptions: none

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

Consequences of Introduction:

- 1) **Climate/Host Interaction:** This nematode is likely to survive wherever its hosts can grow.

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.**
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- High (3) likely to establish a widespread distribution in California.

- 2) Known Pest Host Range:** The host range includes multiple hosts in the family Fabaceae, and some in other families.

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:** *Heterodera* spp. produce eggs in cysts. These cysts can withstand very adverse, very dry conditions for many years, sometimes decades. The cysts are easily moved with soil and water.

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 yield losses have been reported in white clover, and *H. trifolii* is regulated as a quarantine pest by some trading partners.

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 (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: 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.**
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- 5) Environmental Impact:** None have been reported and this nematode has been present in California for over 70 years.

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

Environmental Impact:

- 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: 1

- **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 trifolii*: Medium

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

-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 = 8*

Uncertainty:

none

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Heterodera trifolii* is **C**.

References:

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Responsible Party:

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

***Comment Period: 08/14/2023 through 09/28/2023**

*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).

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.
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❖ 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
