cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

# California Pest Rating Proposal for

## *Heterodera schachtii* A. Schmidt, 1871

## Sugarbeet cyst nematode

**Current Pest Rating: C**

**Proposed Pest Rating: C**

Domain: Eukaryota, Kingdom: Metazoa,
Phylum: Nematoda, Class: Secernentea,
Order: Tylenchida, Family: Heteroderidae

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**Comment Period: 10/05/2022 through 11/19/2022**

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## Initiating Event:

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

## History & Status:

**Background:** The sugarbeet cyst nematode was first recognized as a plant pathogen by Schacht in 1859, associated with stunted and declining sugarbeets in Germany. Subsequently it was observed as a serious pest in beet-growing areas of several European countries. *Heterodera schachtii* was first detected in California in 1907 in Los Angeles and Monterey counties (Caswell and Thomason, 1985). In 1920, surveys showed more than 1000 ha in California to be infested by this nematode (Thorne and Gidding 1922). By the 1970's, *H. schachtii* had been detected in 23 countries (Siddiqui et al., 1973) and is widespread in all former and present California sugarbeet growing areas, especially the Imperial Valley, central regions of the Central Valley, the Salinas Valley, and Monterey, Santa Barbara, and Ventura counties where sugarbeet production was most concentrated (Caswell and Thomason, 1985).

Schmidt (1871) established the genus *Heterodera* from Greek heteros = other, and deros = skin, the type and oldest genus for the family Heteroderidae, for those species having sexual dimorphism in which the mature females become swollen, and lemon-shaped, while the males remain vermiform. He named this species *H. schachtii* in honor of Hermann Schacht and is the type species for the genus (Subbotin et al., 2010).

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*Heterodera schachtii* is a sedentary endoparasite. After emerging from the egg, the J2s penetrate feeder roots, become sedentary, swell, and establish a permanent feeding site in the root stele. Adult females are swollen, and the posterior portions of their bodies protrude from the root. The female dies and becomes a cyst, each containing 500-600 embryonated eggs. Males are sedentary in the J3 and become active after reaching maturity (Subbotin et al., 2010).

The damage threshold for sugarbeets in the Imperial Valley is attained with only 1–2 nematode eggs/g soil (Cooke and Thomason, 1979). The optimum temperature for development is 25°C. In some climates, 3-5 generations may complete development on sugarbeet in one season (Franklin, 1972). In California, besides sugarbeet, *H. schachtii* is found parasitizing cole crops: Brussels sprouts, broccoli, cauliflower, and cabbage, especially on the central coast, from Ventura to Monterey.

Under continuous cultivation of susceptible hosts, some soils become naturally suppressive to *H. schachtii*. This has been documented to occur in California (Westphal and Becker, 1999). Although all the reasons for this are difficult to quantify, fumigation studies show that it is a biological process, presumably from micro- and macro-organisms that are parasitic or pathogenic on *H. schachtii* that build up over time.

*Hosts:* This nematode has a very large host range including multiple plant families, including crops, ornamentals, and weeds in the families Amaranthaceae (many species of *Beta* and *Chenopodium*), Amaryllidaceae, Apiaceae, Asteraceae, Boraginaceae, Brassicaceae (*Brassica oleracea, B. napus, B. rapa, Rhaphanus sativus* and many others), Caryophyllaceae, Chenopodiaceae, Euphorbiaceae, Fabaceae, Geraniaceae, Lamiaceae, Onagraceae, Papaveraceae, Phytolaccaceae, Plantaginaceae, Poaceae, Polygonaceae, Portulacaceae, Ranunculaceae, Resedaceae, Rubiaceae, Scrophulariaceae, Solanaceae, Tetragoniaceae, Tropaeolaceae, Urticaceae, Violaceae, and Vitaceae (Subbotin et al., 2010; Nemaplex, 2010).

*Symptoms*: There are no specific above ground symptoms in plants that can be attributed to infection by sugarbeet cyst nematode. General symptoms include stunting with leaves appearing yellowish-red then turning necrotic in the older parts. In fields, poor and patchy plant growth is apparent in small, circular areas which that extend to the entire field resulting in complete loss of crop. For cole crops, symptoms include patches of stunted or dying plants, yellowing of foliage, and reduction in head and curd size (Chitambar et al., 2018).

Seedlings infested by sugarbeet cyst nematode may have longer petioles than normal, with green or yellow leaves depending on the severity of infestation. Plants are likely to be stunted and wilted. Typically, storage roots such as beets will not be well developed and will have excessive fibrous roots. Mature female nematodes can be seen on the root surface as tiny, pinhead size, lemon-shaped bodies that are white in the earlier stages and turn into brown, egg-filled cysts on aging. These are distinct from the galls formed by root knot nematodes.

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

*Damage Potential:* In heavily infested soils, sugarbeet seedling emergence may be delayed, or seedlings may be killed before emergence, reducing the stand. Seedlings infested with sugarbeet cyst nematodes may be predisposed to secondary infection by soilborne fungi. Infestations of sugarbeet cyst nematode may be localized or spread over an entire field. This nematode can also severely damage cole crops in any type of soil. Sugarbeet cyst nematode is more widespread in California than cabbage cyst nematode, *H. cruciferae*, which is a close relative. High numbers of either species, particularly at seeding or transplanting, can stunt plants, reduce yields, and delay crop maturity (Westerdahl and Becker, 2005).

**Worldwide Distribution**: Africa: *Algeria, Cape Verde, Gambia, Libya, Morocco, Senegal*. Americas: *Canada, Chile, Mexico, Peru, United States of America* (California, Colorado, Florida, Hawaii, Idaho, Missouri, Nebraska, New York, North Dakota, Oregon, Utah, Wyoming), *Uruguay*. Asia: *China, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Kyrgyzstan, Pakistan, Syria*. Europe: *Albania, Azerbaijan, Croatia, Czechia, Estonia, Finland, Germany, Greece, Hungary, Ireland, Latvia, Moldova, Poland, Portugal, Romania, Russia, Serbia, Spain, Switzerland, Turkey, Ukraine, United Kingdom*. Oceania: *Australia, New Zealand* (EPPO, 2022).

**Official Control:** *Heterodera schachtii* is on the USDA PCIT's harmful organism list for Argentina, Brazil, China, Costa Rica, Egypt, French Polynesia, Guatemala, Honduras, India, Japan, Jordan, Republic of Korea, Madagascar, Mexico, Nicaragua, Panama, Saint Lucia, Sri Lanka, Taiwan, and Thailand. It is on the EPPO's A1 list for Argentina, Brazil, and the Inter-African Phytosanitary Council, on the A2 list for the Asia and Pacific Plant Protection Commission, China, Jordan, and a quarantine pest in Mexico (USDA PCIT, 2022; EPPO, 2022).

**California Distribution**: Official state detections are from 23 counties (Siddiqui, 1973; Chitambar et al., 2018; CDFA PDR database, 2022).

**California Interceptions:** None

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

## Consequences of Introduction:

1) **Climate/Host Interaction**: *Heterodera schachtii* favors temperate regions but also tolerates a broad range of climates. In California it has been established for decades in cooler coastal temperate areas and the Imperial Valley, which has very high summer temperatures (Baldwin and Mundo-Ocampo, 1991).

   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 main host crops of *H. schachtii* in California are in the families Chenopodiaceae (e.g., sugarbeets, garden beets, Swiss chard, spinach, marigold) and Brassicaceae (e.g., broccoli, radish, Brussels sprouts, rapini, cauliflower, kale, bok choy, mustard, canola, kohlrabi, and others). Several common weeds are also hosts such as common lambsquarters, shepherd's purse, pigweed, chickweed, dock, and others (Westerdahl and Becker, 2005).

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 nematode can have several generations per year. It spreads slowly in undisturbed sites but spreads easily with normal farming practices including flood irrigation and soil cultivation.

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:** When abundant, cyst nematodes can cause significant yield reductions. They are most prevalent and damaging in moist, coarse-textured soils (sandy, loamy sand, and sandy loam), warm interior valleys, and warm-season crops. However, sugarbeet cyst nematodes cause the most damage to cole crops in California. It is a quarantine pest in many countries.

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.
**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:** this nematode can significantly impact cultural practices, home/urban gardening, or ornamental plantings.

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

**Environmental Impact: 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: 2**

- 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 schachtii:* 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.

There are records of detections in 23 counties; this nematode is widespread in non-contiguous climate areas from the north coast to the desert

***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* ***= 10***

## Uncertainty:

None

## Conclusion and Rating Justification:

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

## References:

CABI Crop Production Compendium 2022. *Heterodera schachtii* https://www.cabi.org/cpc/datasheet/ 27036 Accessed 9/12/22

Caswell, E. P., and Thomason, I. J. 1985. Geographic distribution of *Heterodera schachtii* in the Imperial Valley of California from 1961 to 1983. Plant Disease, 69, 1075–1077.

Chitambar, J. J., Westerdahl, B. B., and Subbotin, S. A. 2018. Plant Parasitic Nematodes in California Agriculture. In Subbotin, S., Chitambar J., (eds) Plant Parasitic Nematodes in Sustainable Agriculture of North America. Sustainability in Plant and Crop Protection. Springer, Cham.

Cooke, D. A., and Thomason, I. J. 1979. The relationship between population density of *Heterodera schachtii*, soil temperature, and sugarbeet yields. Journal of Nematology, 11, 124–128.

EPPO Global database. *Heterodera schachtii*. https://gd.eppo.int/taxon/HETDSC accessed 10/5/22

Nemaplex UC Davis Nemabase 2010. http://Nemaplex.ucdavis.edu. Accessed 9/12/22

Siddiqui, I. A., Sher, S. A., & French, A. M. 1973. Distribution of plant parasitic nematodes in California. State of California Department of Food and Agriculture, Division of Plant Industry. 324 p.

Subbotin, S.A., Mundo-Ocampo, M., and Baldwin, J.G., 2010. Systematics of Cyst Nematodes (Nematoda: Heteroderinae), Part B. Brill.

Thorne, G., and Gidding, L. A. 1922. The sugar-beet nematode in the Western States. U.S. Dep. Agric., Farmers' Bull. 1248. 16 pp.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. *Heterodera schachtii* accessed 10/5/2022

Westphal, A. and Becker, J.O., 1999. Biological suppression and natural population decline of *Heterodera schachtii* in a California field. Phytopathology, 89(5), pp.434-440.

Westerdahl, B. B, and Becker, J. O., 2005. UC IPM Pest Management Guidelines: Sugarbeet UC ANR Publication 3469 http://ipm.ucanr.edu/PMG/r735200111.html

## Responsible Party:

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## *Comment Period: 10/05/2022 through 11/19/2022

## *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.

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## 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;

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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: C**

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