

California Pest Rating Proposal for *Globodera pallida* (Stone 1973) Behrens

Pale cyst nematode

Current Pest Rating: A

Proposed Pest Rating: A

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

Comment Period: 06/10/2021 through 07/25/2021

Initiating Event:

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

History & Status:

Background: The pale cyst nematode (PCN) (*Globodera pallida*), also called the potato cyst nematode, is a major pest of potato crops and other solanaceous hosts including tomatoes, eggplants, peppers, tomatillos, and some weeds in areas with temperate climates. PCN is thought to have originated in Andean regions of Peru and Bolivia and is now widely distributed in many potato-growing regions of the world. The first detection of PCN in the United States was made in 2006 in eastern Idaho (Hafez et al., 2007). Today portions of two counties in Idaho remain infested and under regulation. CDFA participated in USDA's national survey plan for the detection of potato cyst nematodes in California's potato production acreage. During 2006-2007, a total of 1,531 soil samples were examined, representing certified seed and production (conventional and organic) potato fields in 14 counties, namely, Fresno, Kern, Los Angeles, Madera, Marin, Modoc, Monterey, Riverside, San Benito, San Joaquin, Siskiyou, Sonoma, Yolo and Yuba. No potato cyst nematodes were found (Chitambar, 2007).

Unmitigated infestations of PCN can cause substantial potato yield loss. PCN infestations manifest in fields as patches of poor growth with affected potato plants showing yellowing, wilting, or death of foliage. Even with only minor symptoms on the foliage, potato tuber size can be affected. It is

practically impossible to eradicate this nematode because its eggs survive in cysts in the soil for more than 20 years

Globodera pallida (formerly *Heterodera pallida*) is closely related to *G. rostochiensis* (golden nematode), another serious threat to potatoes (Subbotin et al., 2010, 2020). Collectively, they are often called potato cyst nematodes and were once considered a single species. *Heterodera pallida* was first described by Stone in 1972 (published in 1973) and was originally considered to be a pathotype of *H. rostochiensis* Wollenweber 1923. Both species were moved out of *Heterodera* and into the new genus *Globodera* by Behrens in 1975 along with other related species with round cysts. *Globodera pallida* has white or cream (not yellow) females, as does *G. rostochiensis*. Egg-laden cysts are environmentally resistant and easily transportable with soil particles and on host roots, stolons and tubers. Cysts can also move with contaminated machinery, tools, boots, wind, rain, and flood water, leading to new infestations.

Hosts: The primary hosts are potato, *Solanum tuberosum*, eggplant, *S. melongena*, and tomato *S. lycopersicum*, plus black henbane, *Hyoscyamus niger*. Additional species in the genus *Solanum* including: *S. acaule*, *S. americanum*, *S. aviculare* (kangaroo apple), *S. canasense*, *S. cardiophyllum*, *S. dulcamara* (climbing nightshade), *S. ehrenbergii*, *S. gilo* (*gilo*), *S. indicum* (tomato), *S. marginatum* (white-edged nightshade), *S. mauritanum* (tobacco tree), *S. multidissectum*, *S. muricatum* (melon pear), *S. nigrum* (black nightshade), *S. oplocense*, *S. peruvianum* (tomato), *S. physalifolium*, *S. quitoense* (naranjilla), *S. sarrachoides* (hairy nightshade), *S. sisymbriifolium* (sticky nightshade), *S. scabrum*, *S. spegazzinii*, *S. triflorum* (cut-leaved nightshade), *S. vernei* (purple potato) (CABI- ISC, 2021; Nemabase, 2021; Subbotin et al., 2010).

Symptoms: *Globodera pallida* does not cause specific or diagnostic symptoms on above ground parts of its hosts. The diagnostic features are the presence of cysts on the roots, proliferation of roots and production of small, shallow, bushy root systems. Infected plants grow poorly and may show chlorosis and wilting, with weak top growth. The leaves may wilt and die. Small to large areas of infected plants in the field appear as patches of shorter yellowish plants that have fewer and smaller tubers. Other than reduced size, tubers of infected plants show no symptoms and the nematodes do not feed on the tubers (CABI-ISC, 2021).

Transmission: *Globodera pallida* develops one generation for a vegetation season. This species is adapted to cool temperatures. Natural dispersal is generally slow as cyst nematodes are only moved by soil disturbance. Dispersal can occur with run-off from flooded fields, with water carrying cysts to adjoining fields. Wind during dust storms can lift soil and cysts and deposit them into new areas. They can also be distributed with machinery, animal movement from field to field, and any other way that moves soil or plant roots. Cysts can survive unfavorable environmental conditions for years to decades with a hard cuticle protecting the eggs.

Because the cysts are very small, they are easily dispersed with the movement of seed potatoes, locally and internationally. Inspection and testing of seed potato is particularly important to stop the spread of PCN to “clean” areas and countries (CABI-ISC, 2021).

Damage Potential: Due to PCN feeding on their roots, affected plants suffer yield loss and tubers are smaller. The USDA in a pest alert describes the damage potential as follows: “Potato cyst nematodes are a major threat for agricultural industries. If these pests were to spread unchecked in the United States, they could stop commerce in potatoes and nursery stock and seriously harm U.S. agricultural production, the environment, and our economy” (USDA Pest Alert, 2015). There could be direct losses from potato yield reduction, and loss of markets for seed potatoes if fields are regulated.

Continuous cropping of susceptible potato cultivars on land heavily infested with *G. pallida* and *G. rostochiensis* in Europe resulted in an average yield loss of 50-60% (Oeydvin, 1978). The potential yield losses in areas of high infestation were 70-80% or more by Vasyutin and Yakoleva (1998). Even with only minor symptoms showing on leaves, PCN can significantly reduce tuber size (USDA Pest Alert). Eradication programs run over 15 years in Idaho to prevent the spread of PCN to other potato-growing areas has cost tens of millions of dollars.

Worldwide Distribution: Africa: *Algeria, Kenya, Morocco, Tunisia*. Asia: *India, Iran, Japan, Pakistan, Turkey*. Europe: *Austria, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Romania, Serbia, Spain, Sweden, Switzerland, Turkey, United Kingdom*. North America: *Canada, Costa Rica, Panama, United States (Idaho)*. Oceania: *New Zealand*. South America: *Argentina, Bolivia, Chile, Colombia, Ecuador, Falkland Islands, Peru, Venezuela* (EPPO, 2021).

Official Control: EPPO’s A1 list for: *Argentina, Azerbaijan, Bahrain, Brazil, China, Egypt, Eurasian Economic Union, Georgia, Jordan, Kazakhstan, Moldova, Russia, Ukraine, Uruguay, and Uzbekistan*; A2 list for the Asia-Pacific Plant Protection Commission, *Chile, Comite Regional de Sanidad Vegetal del Cono Sur, European Plant Protection Organization, European Union, Pacific Plant Protection Organization and Turkey*, and on the quarantine pest list for *Belarus, Canada, Israel, Mexico, Morocco, Norway, Tunisia, and the United States* (EPPO, 2021). It is on the USDA’s harmful organisms list for *Albania, Algeria, Antigua and Barbuda, Argentina, Azerbaijan, Belize, Bosnia and Herzegovina, Brazil, Cambodia, Canada, Chile, China, Costa Rica, Dominican Republic, Egypt, Ethiopia, Eurasian Customs Union, European Union, French Polynesia, Georgia, Grenada, Guatemala, Holy See (Vatican City State), Honduras, Iceland, Indonesia, Israel, Japan, Jordan, Mauritius, Mexico, Republic of Moldova, Monaco, Morocco, New Caledonia, Nicaragua, Norway, Oman, Paraguay, Republic of Qatar, North Macedonia, Saint Lucia, San Marino, Serbia, Svalbard and Jan Mayen, Taiwan, Tajikistan, Thailand, Timor-Leste, Tunisia, Turkey, Turkmenistan, Ukraine, United Arab Emirates, United Kingdom, Uruguay, and Uzbekistan* (USDA-PCIT, 2021).

The USDA has a federal domestic quarantine against PCN which places restrictions on interstate movement of regulated articles. These articles include: Pale cyst nematodes, PCN host crops including eggplant (*Solanum melongena*), pepper (*Capsicum* spp.), potato (*Solanum tuberosum*), tomatillo (*Physalis philadelphica*), tomato (*Lycopersicon esculentum*), and anything else that could move PCN including all root crops, garden and dry beans (*Phaseolus* spp.), peas (*Pisum* spp.), all nursery stock, soil, compost, humus, muck, peat, manure, products on or in which soil is commonly found, including

grass sod and plant litter, hay, straw, fodder, any equipment or conveyance used in an infested or associated field that can carry soil if moved out of the field, and any other product, article, or means of conveyance not listed that an inspector determines presents a risk of spreading the pale cyst nematode. The current regulated area is currently 7,354 acres, of which 3,446 acres are infested fields. The infested fields are in an 8.5-mile radius that spans a portion of northern Bingham County and southern Bonneville County in Idaho (USDA PCN website).

These states have exterior quarantines against *Globodera pallida*: Arizona, Florida, Iowa, and Mississippi (National Plant Board).

California Distribution: None

California Interceptions: None

The risk *Globodera pallida* would pose to California is evaluated below.

Consequences of Introduction:

1) Climate/Host Interaction:

PCN is a cool temperature pest and is better adapted to temperatures below 20° C, but it can survive at 30° C for lengthy periods. In general, PCN will survive in environments where potatoes or its other hosts can grow. Cooler areas in California are expected to favor PCN.

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:

Primary hosts for PCN include potato, tomato and eggplant, all of which are grown in California.

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 nematode lays hundreds of eggs and the eggs are protected in a cyst that can survive decades in a dormant, dry state. They do not move very far without the movement of soil or infected host plants.

However, with the international movement of seed potatoes they have moved from the Andes mountains to at least 50 countries around the world, including the United States.

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:

The primary impact is to the yields of potato tubers. Losses on other hosts are more difficult to estimate. There is also a serious impact to the seed potato industry from quarantines from trading partners which includes other states.

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:

Several solanaceous weed hosts of which some such as, Jimson weed, hairy nightshade, black nightshade, and heartleaf horse nettle are present in California.

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

Environmental Impact: A, D, 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.**
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- 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 *Globodera pallida*: 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 '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 = 14*

Uncertainty:

None

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Globodera pallida* is **A**.

References:

Behrens E, 1975. Taxonomically useful characters for the differentiation of Heterodera species. Probleme der Phytonematologie. Vortrage anlässlich der 10 Tagung über Probleme der Phytonematologie im Institut für Pflanzenzüchtung Gross-Lusewitz der Deutschen Akademie der Landwirtschaftswissenschaften zu Berlin am 11 Juni 1971., 122-142

CABI Datasheet, 2021. Pale cyst nematode. <https://www.cabi.org/isc/datasheet/27033>

Chitambar, J. 2007. Status of ten quarantine “A” nematode pests in California. Potato cyst nematodes. California Plant Pest and Disease Report. California Department of Food and Agriculture. Volume 24 – January through December 2007 pg. 66-67.

Durham S, 2007. ARS Scientists, Cooperators Identify Potato Pest., 1. <https://www.ars.usda.gov/news-events/news/research-news/2007/ars-scientists-cooperators-identify-potato-pest/#:~:text=The%20pale%20potato%20cyst%20nematode,processing%20plant%20in%20eastern%20Idaho.>

EPPO 2021. *Globodera pallida*. <https://gd.eppo.int/taxon/HETDPA>

Hafez, S.L., Sundararaj, P., Handoo, Z.A., Skantar, A.M., Carta, L.K. and Chitwood, D.J., 2007. First report of the pale cyst nematode, *Globodera pallida*, in the United States. Plant Disease, 91(3), pp.325-325.

Oeydvin J, 1978. Studies on potato cyst-nematodes, *Globodera* spp. (Skarbilovich), and the use of plant resistance against *G. rostochiensis* (Woll.) in Norway. Vaxtskyddsrapporter. Avhandlingar, No. 2:37 pp

Stone, A.R. 1973. *Heterodera pallida* n.sp. (Nematoda: Heteroderidae), a second species of potato cyst nematode. Nematologica, 18:591-606

Subbotin S.A., Mundo-Ocampo M. & Baldwin J.G. 2010. Systematics of Cyst Nematodes (Nematoda: Heteroderinae). Nematology Monographs and Perspectives, Volume 8A (Series Editors: Hunt, D.J. & Perry, R.N.). Leiden, The Netherlands, Brill, 351 pp.

Subbotin, S.A., Franco, J., Knoetze, R., Roubtsova, T.V., Bostock, R.M. & Cid del Prado Vera, I. 2020. DNA barcoding, phylogeny and phylogeography of the cyst nematode species from the genus *Globodera* (Tylenchida: Heteroderidae). Nematology 22: 269-297

USDA Pest Alert, 2015. Potato Cyst Nematodes. https://www.aphis.usda.gov/publications/plant_health/2015/alert_pcn.pdf

USDA Pale Cyst Nematode quarantine information. 2021. <https://www.aphis.usda.gov/aphis/ourfocus/planthealth/plant-pest-and-disease-programs/pests-and-diseases/Nematode/PCN>

Vasyutin, A. S., and Yakovleva, V. A. 1998. *Globodera* in potatoes in Russia. Kartoffel' i Ovoshchi, No. 6:29, 32

Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, CDFA/PHPPS ECOPERS, 2800 Gateway Oaks Suite 200, Sacramento, CA 95833 Phone: (916) 654-1017, [permits\[@\]cdfa.ca.gov](mailto:permits[@]cdfa.ca.gov).

***Comment Period: 06/10/2021 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).

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.
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Proposed Pest Rating: A
