cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Globodera rostochiensis Wollenweber 1923

Golden 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 rostochiensis* is described herein and a permanent pest rating is proposed.

History & Status:

Background: The golden nematode *Globodera rostochiensis*, also called the yellow potato cyst nematode, is a major pest of potato crops, other solanaceous hosts including tomatoes, eggplants, peppers, tomatillos, and some weeds, in cool-temperature areas. Golden nematode 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 golden nematode in the United States was made in 1941 in a potato field on Long Island in New York. The field was used a staging area for military equipment returning from World War 1, and it's thought the nematodes were accidentally transported from Europe with soil on truck tires. It was found in Delaware in 1968 but no cysts were recovered since the first report in several surveys (Spears, 1969). It has also been found in several Canadian provinces. G. rostochiensis has been reported from many countries and is probably the most economically important nematode pest of potato (Subbotin et al., 2010). High populations can cause 100% yield loss in potatoes (Brodie and Mai, 1989).

Some fields in New York remain infested and under regulation in 2021. Following a 2006 detection in Idaho of pale cyst nematode (*G. pallida*), 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 examined represented certified seed and production (commercial 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 golden nematodes or pale cyst nematodes were found (Chitambar, 2007).

Unmitigated infestations of golden nematode can cause substantial potato yield loss. Golden nematode 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. Once a nematode infests a field; it is practically impossible to eradicate it because its eggs survive in cysts in the soil for more than 30 years.

Globodera rostochiensis (formerly *Heterodera rostochiensis*) is closely related to *G. pallida* (pale cyst nematode), another serious threat to potatoes. Collectively, they are often called "potato cyst nematodes" and were once considered a single species. In 1959, Skarbilovich formed the subgenus *Globodera* to accommodate the round cyst nematode species and made *G. rostochiensis* the type species. From Latin, globus = globe, and from Greek, (δερος) deros=skin. Behrens (1975) raised *Globodera* to generic level, and Mulvey and Stone (1976) moved *H. rostochiensis* and named it *G. rostochiensis* n. comb. *Globodera rostochiensis* has yellow females, not white or cream like *G. pallida*. Egg-laden cysts are environmentally resistant and easily transportable with soil particles, on host roots, stolons and tubers. Contaminated machinery, tools, boots, wind, rain, and flood water also move cysts and create new infestations.

Hosts: The primary host is potato, Solanum tuberosum. Other agronomic hosts include tomato, *S. lycopersicum*, eggplant, *S. melongena,* and peppers, *Capsicum annuum*. Many other *Solanum* spp. are also hosts.

Chenopodium album var. *centrorubrum*, *Datura ferox* (long-spined thorn apple), *D. inoxia* (thorn apple), *D. meteloides* (thorn apple), *D. stramonium* (Jimson weed), *Hyoscyamus niger* (henbane), *Ipomoea batatas* (sweet potato), *Nicandra physalodes* (broadleaf-nightshade), *Nicotiana acuminata*, *N. glauca* (wild tobacco), *N. tabacum* (tobacco), *N. X sanderae*, *Oxalis tuberosa* (New Zealand yam), *Phaseolus sp.*, *Physalis* spp., *Physalis philadelphica* (tomatillo), *P. viscosa* (grape ground cherry), *Physochlaina orientalis*, Polygonum nepalense, *Salpiglossis sinuate*, *Saracha jaltomata Solanum acaule*, *S. aethiopicum* (Chinese scarlet eggplant), *S. ajanhuiri*, *S. andigenum* (potato), *S. anomalocalyx*, *S. antipoviczii* (Fendler's nightshade), *S. armatum*, *S. ascasabii* (potato), *S. asperum*, *S. auriculatum* (wild tobacco), *S. aviculare* (kangaroo apple), *S. berthaultii*, *S. blodgettii*, *S. boergeri*, *S. brevimucronatum*, *S. bulbocastanum* (ornamental nightshade), *S. calcense*, *S. caldasii*, *S. canasense*, *S. capsicastrum* (winter cherry), *S. capsicibaccatum*, *S. cardiophyllum*, *S. chacoense* (wild potato), *S. chauca*, *S. cheesmanii*, *S. chilense*, *S. coeruleiflorum* (potato), *S. commersonii* (Commerson's nightshade), *S. curtilobum*, *S. curtipes*, *S. demissum* (dwarf wild potato), *S. dulcamara* (climbing nightshade), *S. elaeagnifolium* (silverleaf nightshade), *S. famatinae*, *S. galenii*, *S. garciae*, *S. gibberulosum*, *S. giganteum* (African holly), *S. gigantophyllum*, *S. gilo* (Chinese scarlet eggplant), *S. glandulosum* (tomato), *S. glaucophyllum*, *S. goniocalyx* (potato), *S. gracile*, *S. hirsutum*, *S. humboldii*, *S. integrifolium* (tomato fruit eggplant), *S.*

jamesii (wild potato), *S. jujuyense*, *S. juzepczukii*, *S. kesselbrenneri* (Andean potato), *S. kurtzianum*, *S. lanciforme* (heart-leaf nightshade), *S. lapazense*, *S. lechnoviczii*, *S. leptostygma*, *S. ligustrinum* (Natri tomatillo), *S. longipedicellatum* (Fendler's nightshade), *S. lycopersicum* (tomato), *S. maculae*, *S. maglia*, *S. mamilliferum* (potato), *S. marginatum* (purple African nightshade), *S. melongena* (eggplant), *S. mexicanum*, *S. miniatum* (red nightshade), *S. multidissectum*, *S. muricatum* (pepino melon), *S. nigrum* (European nightshade), *S. nitidibaccatum* (hairy nightshade), *S. pampasense*, *S. parodii*, *S. parviflorum*, *S. peruvianum* (wild tomato), *S. phureja* (potato), *S. pimpinellifolium* (currant tomato), *S. pinnatisectum* (Tansy-leave Nightshade), *S. pinnatum* (tomatillo), *S. platypterum*, *S. polyacanthos*, *S. polyadenium*, *S. pseudocapsicum* (Jerusalem cherry), *S. pyriforme*, *S. racemigerum*, *S. radicans*, *S. rostratum* (buffalo berry), *S. rybinii* (potato), *S. salamanii*, *S. saltense*, *S. sambucinum*, *S. sanctae-rosae*, *S. sarrachoides* (hairy nightshade), *S. schenkii*, *S. schickii*, *S. semidemissum*, *S. simplicifolium*, *S. sisymbriifolium* (sticky nightshade), *S. soukupii*, *Solanum sp.*, *S. stenotomum* (potato), *S. stoloniferum* (Fendler's nightshade), *S. subandigenum*, *S. sucrense*, *S. tarijense*, *S. tenuifilamentum* (potato), *S. tomentosum*, *S. topiro* (cocona), *S. toralopanum*, *S. triflorum* (cut-leaved nightshade), *S. utile*, *S. vallis-mexicae*, *S. vernei* (purple potato), *S. verrucosum*, *S. villosum* (yellow nightshade), *S. wittmackii*, *S. xantii* (purple nightshade), *S. yabari* (potato), *S. zuccagnianum* (Chinese scarlet eggplant) (CABI- ISC, 2021; Nemabase, 2021; Subbotin et al., 2010).

Symptoms: *Globodera rostochiensis* 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: 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.

In temperate regions, *G. rostochiensis* usually completes only one generation although a second generation may be initiated but not completed. In subtropical regions two generations might occur. Development of one generation requires 6-10 weeks. Cysts can survive unfavorable environmental conditions for years to decades with a hard cuticle protecting the eggs. The J2 can go into diapause and remain viable for many years, hatching continuing for 25 or more years (Subbotin et al., 2010).

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 golden nematodes 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, it could stop commerce in potatoes and nursery stock and seriously harm U.S. agricultural production, the environment, and our economy" (USDA Pest Alert, 2015). These could be direct losses from potato yield reduction, and loss of markets for seed potatoes if fields are regulated.

The damaging effect of potato cyst nematodes is determined by nematode density, and also by such factors as cultivar, crop management and environmental conditions (Mulder et al., 1997). 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, golden nematodes can significantly reduce tuber size (USDA Pest Alert). Eradication programs over 70 years in New York to prevent the spread of golden nematode to other potato-growing areas has cost tens of millions of dollars.

Worldwide Distribution: Golden nematode is widely distributed in potato-growing regions, including the temperate zones down to sea level and in the tropics at higher elevations. Africa: *Algeria, Egypt, Kenya, Libya, Rwanda, South Africa, Tunisia, Uganda.* Asia: *India, Indonesia, Iran, Japan, Kazakhstan, Kyrgyzstan, Lebanon, Oman, Pakistan, Philippines, Sri Lanka, Tajikistan.* Europe: *Albania, Armenia, Austria, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Faroe Islands, Federal Republic of Yugoslavia, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Russia, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom.* North America: *Canada, Mexico, Panama, United States* (Delaware, New York). Oceania: *Australia, New Zealand, Norfolk Island.* South America: *Bolivia, Chile, Colombia, Ecuador, Falkland Islands, Peru, Venezuela* (EPPO, 2021; CABI-CPC, 2021).

Official Control: Golden nematode is on the USDA's harmful organism list for the following countries: Albania, Algeria, Angola, Antigua and Barbuda, Argentina, Azerbaijan, Belize, Benin, Bosnia and Herzegovina, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Democratic Republic of the Congo, Costa Rica, Cote d'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Eurasian Customs Union, European Union, French Polynesia, Gabon, Gambia, Georgia, Ghana, Grenada, Guatemala, Guinea, Guinea-Bissau, Holy See (Vatican City State), Honduras, Iceland, Indonesia, Israel, Jamaica, Japan, Jordan, Lesotho, Liberia, Madagascar, Mali, Mauritania, Mauritius, Mexico, Republic of Moldova, Monaco, Morocco, Mozambique, New Caledonia, Nicaragua, Niger, Norway, Oman, Pakistan, Paraguay, Qatar, Republic of North Macedonia, Rwanda, Saint Lucia, San Marino, Saudi Arabia, Senegal, Serbia, Sierra Leone, Somalia, Svalbard and Jan Mayen, Taiwan, Tajikistan, Thailand, The Kingdom of Eswatini, Timor-Leste, Togo, Tunisia, Turkey, Turkmenistan, Ukraine, United Arab Emirates, United Kingdom, Uruguay, Uzbekistan, Viet Nam, and Zimbabwe (USDA-PCIT, 2021). Golden nematode is on the EPPO's A1 for Argentina, Azerbaijan, Bahrain, Brazil, China, Egypt, Jordan, Moldova, Paraguay, Uruguay, Uzbekistan; A2 list for Asia and Pacific Plant Protection Commission (APPPC), Chile, Comite de Sanidad Vegetal del Cono Sur (COSAVE), Eurasian Economic Union, European and Mediterranean Plant Protection Organization (EPPO), European Union (EU), Georgia, Inter-African Phytosanitary Council (IAPSC), Kazakhstan, Pacific Plant Protection Organization (PPPO), Russia, Turkey, Ukraine; and on the

quarantine pest list for Belarus, Canada, Israel, Mexico, Morocco, Norway, Tunisia, and United States (EPPO, 2021).

The USDA has a federal domestic quarantine against golden nematode which places restrictions on the movement of regulated articles out of the quarantine areas. These articles include soil, compost, humus, muck, peat, and decomposed manure, separately or with other things; plants with roots, except soil-free aquatic plants; grass sod; plant crowns and roots for propagation, true bulbs, corms, rhizomes, and tubers of ornamental plants; Irish potatoes for seed; and Irish potatoes unless each is at least 1 and 1⁄2 inches in diameter, substantially free of soil, under a compliance agreement, moved in an approved container; or substantially free of soil as a result of washing or fluming under a compliance agreement and moved in an approved container; or Irish potatoes harvested from a field tested and found by an inspector to contain an identifiable population of viable golden nematodes, unless such field had been subsequently treated with an approved nematicide; root crops other than Irish potatoes; small grains and soybeans; hay, straw, fodder, and plant litter, of any kind; ear corn, except shucked ear corn, used crates, boxes, and burlap bags, and other used farm products containers; used farm tools; used mechanized cultivating equipment and used harvesting equipment; used mechanized soil-moving equipment; any other products, articles, or means of conveyance of any character whatsoever, when it is determined by an inspector that they present a hazard of spread of golden nematode.

The current regulated area covers 186,534 acres in eight counties in New York. APHIS considers 5,945 acres to be infested with golden nematode and has an active control and mitigation program in place to prevent its spread (USDA golden nematode website). These states have exterior quarantines against *Globodera rostochiensis*: Arizona, Florida, Idaho, Iowa, Mississippi, and New Jersey (National Plant Board, 2021).

California Distribution: None

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:**

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

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 golden nematodes are members of the genus *Solanum*, and 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 is especially difficult because the female 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.
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 rostochiensis:* 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 rostochiensis*** is **A.**

References:

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***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.

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: A
