cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Heterodera glycines Ichinohe, 1952

Soybean cyst nematode

Current Pest Rating: A

Proposed Pest Rating: A

Comment Period: 06/07/2021 through 07/22/2021

Initiating Event:

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

History & Status:

Background: The soybean cyst nematode (SCN) has not been detected in California soils, nor has it ever been intercepted on shipments coming into California. This may be in part to a history of national and state quarantines against this nematode. SCN likely originates from Japan where it was first reported more than 75 years ago (Ichinohe, 1952). The nematode was first detected in the United States in North Carolina in 1954 and it has spread to 30 additional states in the southeastern and central United States (Riggs, et al., 1988; CABI-CPC, 2021). Between 1966 and 1972, USDA maintained and enforced a Federal Domestic Quarantine against SCN. Under this federal quarantine, California was protected from the entrance of SCN into the State. When the federal quarantine was rescinded, there was little to no commercial acreage cultivated to soybean in California. In 1980, CDFA took protective action and prepared the Soybean Cyst Nematode Exterior Quarantine. Under this quarantine all states and districts of the United States were under quarantine for SCN and restriction was placed on entry into California of hosts and possible carriers of the pest from areas under quarantine. Based on the misunderstanding that soybean was the only host of SCN, CDFA found it inappropriate to restrict entrance of plant hosts and carriers of the nematode into California when we had little to no commercial acreage, and in 1994 the Soybean Cyst Nematode Exterior Quarantine was repealed. An "A" rating has been maintained but this nematode has not been through the pest rating process.

Hosts: Heterodera glycines attacks a wide range of Fabaceae. Members of Caryophyllaceae and Scrophulariaceae are also hosts. Nemaplex (2010) lists hosts from 19 plant families.

Symptoms: SCN penetration of and feeding on roots causes stunting of the host, and this may be combined with general chlorosis. Sometimes called 'yellow dwarf disease', the symptoms appear in the field about two months after sowing. Diseased plants may be stunted with yellowed foliage and have fewer and stunted lateral roots than healthy plants. There can be reduced *Rhizobium* nodulation, resulting in reduced nitrogen available to the plant. Yield is substantially reduced. In severe cases the plant may die. SCN infestation may increase susceptibility to soil-borne fungal infections, such as *Rhizoctonia* (CABI-ISC, 2021).

Transmission: SCN spreads easily via infested soil and contaminated machinery. Any method that spreads infested soil can be a means of dispersal, including wind, water, and migratory birds (Riggs and Niblack, 1993). *Heterodera glycines* is already widespread in most of the countries where soybeans are produced commercially. Cysts potentially can contaminate seed lots

The SCN has a life cycle like other cyst nematodes, with amphimictic reproduction that uses both males and females. Adult females are semi-endoparasites that live partially inside plant roots. While she is alive, the female lays numerous eggs in a gelatinous matrix that is exuded into the soil. After death, the female's body forms a brown, leathery cyst that serves to protect the retained eggs. Eggs may remain viable in the cyst for a decade or longer. After hatching from the egg, the infective second stage juvenile is vermiform and can swim to a host root and penetrates the cortex. The nematode then becomes sedentary and feeds via specialized trophic cells formed by the host in response to secretions from the nematode. The developing nematodes become increasingly obese and moult to the J3 and the J4 stages. The J4 either moults to the female, which remains in position within the root cortex, or moults to the vermiform male, which leaves the root and searches for females. The nematode may complete 6-7 generations per year in temperate growing areas (Noel, 1985; Riggs and Wrather 1992).

Damage Potential: It has been reported that more than 30% yield losses can occur due to SCN, and losses can occur without conspicuous above-ground symptoms (Wang et al., 2003). In a recent study that looked at 23 common soybean diseases in 28 soybean-producing states in the U.S., SCN caused the greatest total dollar loss (on a per hectare basis) during the period of 1996 to 2016 (Bandara et al., 2020). Furthermore, SCN was estimated to have caused more than twice as much yield loss than any other soybean disease studied. Savary et al. (2019) reported that SCN and the fungal disease charcoal rot are the top yield loss causing diseases in soybean on a global scale. The same was reported for the US and Canada by Allen et al. (2017).

There are increased yield losses due to SCN in years exacerbated by drought, and in drought years, yield loss estimates for SCN were far greater than any other disease (Bandara et al., 2020). There are some reports of losses on hosts other than soybean, include dry bean (*Phaseolus vulgaris*). Losses on non-soybeans appear to be increasing and will likely become a major yield-limiting threat, especially in highly susceptible kidney bean (Yan et al., 2016).

Worldwide Distribution: Asia: *China, India, Indonesia, Iran, Japan, Mongolia, Korea* (*Democratic People's Republic), Korea (Republic)*. Europe: *Italy, Russia*. North America: *Canada, United States* (Alabama, Arkansas, Connecticut, Delaware, Florida, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maryland, Michigan, Minnesota, Mississippi, Missouri, Nebraska, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Puerto Rico, South Carolina, South Dakota, Tennessee, Texas, Virginia, Wisconsin). South America: *Argentina, Brazil*, *Colombia*, *Ecuador*, *Paraguay* (EPPO, 2021; CABI ISC, 2021)

Official Control: *Heterodera glycines* is on the EPPO's A1 list for Chile, Comunidad Andina, Eurasian Economic Union, Georgia, Inter-African Phytosanitary Council, Paraguay, Russia, Turkey, Ukraine, and Uruguay. It is on the A2 list for Comite de Sanidad Vegetal del Cono Sur, Egypt, and the European plant protection organization. It is a quarantine pest in Canada, Morocco, Mexico, and Israel (EPPO, 2021).

Heterodera glycines is on the USDA's harmful organism list for Angola, Argentina, Bangladesh, Benin, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, Democratic Republic of the Congo, Cote d'Ivoire, Cuba, Ecuador, Egypt, Equatorial Guinea, Kingdom of Eswatini, Eurasian Customs Union, French Polynesia, Gabon, Gambia, Georgia, Ghana, Guatemala, Guinea, Guinea-Bissau, Honduras, India, Israel, Lesotho, Liberia, Madagascar, Mali, Mauritania, Mauritius, Mexico, Morocco, Mozambique, Namibia, New Caledonia, Nicaragua, Niger, Panama, Peru, Rwanda, Senegal, Sierra Leone, Somalia, South Africa, Taiwan, Thailand, Togo, Turkey, Uruguay, and Zimbabwe (USDA-PCIT, 2021).

In Idaho, *H. glycines* is a regulated pest and all seed of soybean (*Glycine max*), mung bean (*Vigna radiata*), and azuki bean (*Vigna angularis*), cowpeas (*Vigna unguiculata*), noodle beans (*Vigna unguiculata* subsp. *sesquipedalis*), faba bean (*Vicia faba*) and any other plant species capable of spreading a regulated pest as a contaminant or in a seed borne or seed transmitted manner is prohibited from any source and from being planted, unless otherwise exempted. Arizona lists *H. glycines* as a quarantine actionable nematode pest, having determined it to be an imminent threat to agriculture and horticulture within the state, requiring immediate action, and prohibiting entry (National Plant Board https://nationalplantboard.org/laws-and-regulations/).

California Distribution: None

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:** The nematode can develop within a temperature range of 15-34°C. Climatic conditions favorable for the growth of host plants in California would also be conducive for SCN development.

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:** SCN has a broad host range, especially among legumes including beans (green, snap, dry, red, lima, mung, bush and Adzuki), garden peas and cowpeas, and also attacks many non-legumes, including ornamentals and weeds. Some of these hosts, especially snap, dry, red and lima beans, are economically important crops cultivated in the State and may present possible reservoirs for establishment and increase of SCN. At the same time, biological races of SCN exist that vary in their parasitic ability of different hosts.

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:** A single female can produce 600 eggs in her lifetime, and some of these remain viable for years because her body forms a protective cyst around them after her death. Cysts can move with soil and water.

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.

5 **Economic Impact:** California ranks 5th in the US in dry bean production and has a large seed export industry. Dry beans are mainly produced in Stanislaus, Tulare, San Joaquin, Yolo, Fresno, and Sutter counties (Chitambar et al., 2018). SCN is a quarantine pest for many countries and other states. Cysts can be moved with soil and water.

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

Economic Impact: A, C, F, 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.

6 **Environmental Impact:** With a very large host range including dozens of species in 19 plant families, there are many hosts or potential hosts of SCN that are California natives or naturalized in non-crop areas.

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

Environmental Impact: A
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 glycines:* High

Add up the total score and include it here. **13**
-Low = 5-8 points
-Medium = 9-12 points
-High = 13-15 points

7 **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 no official or published reports of this nematode in California

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* ***= 13***

Uncertainty:

SCN exists in a number of races (Riggs and Wrather, 1992), which can be distinguished using differential host cultivars. Some races may be more (or less) pathogenic on the widely grown *Phaseolus* spp. in California than to soybeans.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for ***Heterodera glycines*** is **A**.

References:

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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.

***Comment Period: 06/07/2021 through 07/22/2021**

***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
