CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Meloidogyne haplanaria Eisenback et al. 2003

Texas peanut root-knot nematode

Current Pest Rating: Q

Proposed Pest Rating: A

Domain: Eukaryota; Kingdom: Metazoa;
Phylum: Nematoda; Family: Meloidogynidae

Comment Period: 07/01/2021 through 08/15/2021

Initiating Event:

In February 2021, a Los Angeles County plant pathologist submitted a sample of American pitcher plant, *Sarracenia* sp. with symptoms of galling on the roots to CDFA's Plant Pest Diagnostics lab at Meadowview. Nematologist Sergei Subbotin isolated and identified the Texas root knot nematode, *Meloidogyne haplanaria*, by morphological and molecular methods. The sample was collected at a private botanical garden from plants growing in pots. This was the first detection of this nematode in California. In May 2021, a second *Sarracenia* sample that was at one time on the same greenhouse bench as the first was submitted with galled roots, and *M. haplanaria* was identified for a second time. Subsequent mitigative action taken by CDFA Pest Exclusion resulted in the eradication of *M. haplanaria* from the greenhouse. The risk to California from *M. haplanaria* is described herein and a permanent pest rating is proposed.

History & Status:

Background: *Meloidogyne haplanaria* was described by Eisenback et al. in 2003 from specimens they found parasitizing peanuts in Texas. They gave it the common name "Texas peanut root-knot nematode". The species name *haplanaria* reflects its relatedness to two other root knot nematodes that attack peanuts. *Meloidogyne hapla* has similar punctations in the tail tip region of the perineal pattern and *M. arenaria* has a similar shape of the perineal pattern, shape of the male head and stylet, and shape of the stylet of the female. *Meloidogyne haplanaria* reproduces mainly on tomato, peanut, pepper, eggplant, soybean, and common bean (Bendezu et al. 2004; Eisenback et al. 2003). Resistance in commercial tomato cultivars to several root knot species including *M. arenaria, M. javanica*, and *M.*

incognita is conferred by the Mi gene (Williamson 1998). *Meloidogyne haplanaria* is able to overcome this resistance gene, leaving tomatoes vulnerable to significant damage and heavy root galling (Bendezu et al. 2004; Joseph et al., 2016).

Hosts: The most important hosts identified to date are peanut (*Arachis hypogaea*) and tomato (*Solanum lycopersicum*). Additional moderately susceptible hosts are pepper (*Capsicum annuum*), eggplant (*Solanum melongena*), soybean (*Glycine max*), common bean (*Phaseolus vulgaris*), Garden pea (*Pisum sativum*), and radish (*Raphanus sativus)* (Bendezu et al. 2004; Eisenback et al. 2003). This species was found in rhizosphere soil of Indian hawthorn, okra, ash, oak, cherry laurel, maple, tomato, willow, rivercane, elm, bermudagrass, and birch in Arkansas (Khanal et al., 2016a; Ye et al., 2019). Joseph et al. (2016) described the host range for this nematode as similar to several other root knot nematodes in that it is likely to successfully parasitize a large and diverse number of hosts across a large range of plant families.

Symptoms: Nematode feeding causes cell enlargement and proliferation and leads to the primary symptom of a galled root systems. On some hosts such as tomatoes, galls are obvious and can be up to one inch in diameter (Ploeg, 2013). Galled root systems should not be the only diagnostic test, as galls are not always formed, or can be very small, spindle shaped, or in spirals. Galls can also resemble nodules caused by nitrogen-fixing bacteria. Sometimes the primary symptom is a proliferation of lateral root branches rather than galls. Numerous aboveground symptoms can also be observed, but these are also not diagnostic. Severely affected plants wilt readily, even when soil moisture is sufficient, because galled roots have less ability to absorb and transport water. Nutrient deficiency symptoms including chlorosis can also be observed because of a reduced ability of galled roots to absorb and transport nutrients, even when levels are adequate in the soil. Stunting is a frequent symptom. At high densities or with highly sensitive crops, root-knot nematodes can kill host plants, particularly if the high populations occur early in the growing season when root systems are small. Above ground, symptoms usually appear in clusters of plants or in patches of the field. (Mitkowski and Abawi, 2003; Chitambar et al., 2018).

Transmission: Root-knot nematodes move slowly through undisturbed soil, and in perennial crops, infestations will gradually radiate outward from an initial point of infection. Cultivation and other practices that move soil and plants will spread root-knot nematodes over longer distances. The length of a root-knot nematode life cycle varies with species and climate but can be as short as two weeks. Nematodes in cooler regions typically have longer life cycles. Eggs may remain inside root tissue or may be released into the soil matrix. Eggs hatch at random and hatching does not require exposure to root exudates. Second-stage juveniles move within the film of water that lines soil pores and are the infective stage. Stylets are used to penetrate root tips at the elongation zone. Once inside the plant root, nematodes migrate towards the vascular cylinder where they establish a feeding site. Once feeding is initiated, they become sedentary and undergo three additional moults to become pear-shaped or nearly spherical adults. The adult female lays 150–250 eggs in a gelatinous matrix on or below the surface of the root. The proportion of males in a population are typically low but may be found toward the end of the growing season, when populations are dense and host plants are under stress (Mitkowski and Abawi, 2003).

Long distance spread occurs with the movement of plants with soil, especially with infected nursery stock. Anything that can move infested soil or water, including vehicles, people, containers, or animals, can spread nematodes.

Damage Potential: This nematode is a major pest of peanut in Texas (Eisenback et al., 2003). Infected plants show typical root-knot nematode symptoms such as stunting and extensive root galls. *Meloidogyne* infection in general causes a decrease in the size of the plant root systems. Depending upon the host and the number of nematodes present, galls vary in size from minute to extremely large.

Meloidogyne haplanaria has been shown to overcome the resistance in tomato conferred by the Mi gene (Bendezu et al., 2004). In 2016 it was been reported in Florida, where it caused heavy galling and severe yield reduction (Joseph et al., 2016).

Worldwide Distribution: United States (*Arkansas, Florida, Texas*) (Eisenback et al., 2003, Churamani et al., 2015; Joseph et al., 2016).

Official Control: *Meloidogyne* spp. are on the USDA's harmful organisms list for Australia, Canada, Chile, China, Colombia, Egypt, French Polynesia, Iceland, Jordan, Mexico, Morocco, Namibia, Nauru, Qatar, South Africa, Tunisia, Turkey, and Venezuela.

California Distribution: There were two detections made from pitcher plants at a botanic garden in Los Angeles County. *Sarracenia* spp. are non-native, and the plants and all associated materials were destroyed. Mitigative action taken by CDFA Pest Exclusion resulted in the eradication of *M. haplanaria*.

California Interceptions: none

The risk *Meloidogyne haplanaria* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Meloidogyne* spp. are generally more common in hotter areas with sandy soils, such as California's inland valleys, but have been detected in many climates. This one is likely to establish wherever its hosts are grown.

   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 host range include plants in multiple families, and many *Meloidogyne* spp. have hundreds of known 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:** Female root knot nematodes produce large numbers of eggs into rhizosphere soils. Movement over long distances requires transport of infected plants, movement of infested soils or movement of water off infested soils.

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:**

The risk to California is from the ability of this nematode to overcome the Mi resistance gene in commercial tomato cultivars and cause heavy galling and significant root galling as has occurred in Florida tomato production. Severe infestations can dramatically reduce yields and eventually kill plants. Damage from root-knot nematode feeding may also increase the incidence of other pathogens like Fusarium wilt, a severe wilt disease of tomato. While either the nematode or the fungus is capable of causing damage individually, much more severe losses are caused when they co-occur.

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

Economic Impact: A, D, 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:** With a wide host range, it is likely that *M. haplanaria* could move out of crop fields. It has been reported on diverse woody and grass hosts in Arkansas, including oak, willow and bermudagrass.

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 *Meloidogyne haplanaria:* 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.

This nematode has only been isolated from one botanic garden in Los Angeles County, with non-native American pitcher plants. The plants were destroyed.

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:

The known host range of this nematode is likely to increase with future studies.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Meloidogyne haplanaria* is A.

References:

Bendezu, F., Morgan, E., and Starr, J. L. 2004. Hosts for Meloidogyne haplanaria. Nematropica 34:205-209.

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Churamani, R., McGawley, R. T., and Overstreet, E. C. 2015. Meloidogyne spp. reported from Arkansas: Past and Present. Page 60 in: (Abstr.) Proc. 54th Annu. Meet. Soc. Nematol. East Lansing, MI.

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Ye, W., Robbins, R.T. and Kirkpatrick, T., 2019. Molecular characterization of root-knot nematodes (*Meloidogyne* spp.) from Arkansas, USA. Scientific reports, 9(1), pp.1-21.

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.

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*Comment Period: 07/01/2021 through 08/15/2021

*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
