CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Meloidogyne marylandi Jepson and Golden, 1987

Current Pest Rating: Z

Proposed Pest Rating: C

Comment Period: 09/18/2019 through 11/02/2019

Initiating Event:

Meloidogyne fallax, the false Columbia root-knot nematode, was first reported in North America in 2013 (Nischwitz et al., 2013). One of the locations where this species was found was a golf course in San Francisco, California. This species was initially described from the Netherlands in 1992 and was considered to be a race of the Columbia root-knot nematode, *M. chitwoodi.* These nematodes are important pest of potatoes and of quarantine significance (EPPO, 2019). In response to the 2013 report, CDFA conducted a survey. Hundreds of samples were collected from golf courses in 25 California counties leading to nearly 600 nematode detections. *Meloidogyne fallax* was not detected, but *M. chitwoodi* was detected from six samples from San Luis Obispo County. Another *Meloidogyne* species, *M. marylandi*, was found in multiple California counties during the survey and was assigned a temporary Z rating. An assessment of the status of *M. marylandi* in California is presented herein, and a permanent rating is proposed.

History & Status:

Background:

Root-knot nematodes (*Meloidogyne* spp.) have been found parasitizing the grass roots on golf courses, sports fields, and pastures, causing poor growth and yellowing of the leaves (Kimmons et al., 1990; Walker, 2014; Salazar et al., 2013). These symptoms are problematic on golf courses, especially on putting greens. On golf courses in the western United States, a variety of *Meloidogyne* species have been detected including *M. marylandi* (McClure et al., 2012; Nischwitz et al., 2013; CDFA PDR database).

Meloidogyne marylandi is a root knot nematode species with a life cycle and feeding behavior similar to other root knot nematode species. It is a sedentary endoparasite that feeds within host plant roots.

Adult females embedded in host roots produce eggs within a mass either on the surface of, or within roots. The first stage juvenile (J1) develops within the egg and molts to become the second stage, which is the infective stage. The second-stage juveniles (J2) hatch from eggs, migrate in rhizosphere soil, and invade host roots. Within roots, J2 establish a specialized feeding site made up of giant plant cells that are formed at the head end of the nematode in response to its feeding. The second stage juveniles become sedentary while feeding at the specialized site, increase in size, and molt twice going through two non-feeding stages before developing into mature adult females or males and completing the life cycle. Generally, the life cycle for root knot nematodes may take about 30 days at 25-28°C and longer at lower temperatures.

Hosts: Meloidogyne marylandi reproduces well on wild grasses, turfgrasses, and some grain crops. The original hosts described were Bermudagrass (*Cynodon dactylon × C. transvaalensis*), fescue grass (*Fescue* spp.), and Zoysiagrass (*Zoysia matrella)* (Araki, 1992; Jepson and Golden, 1987; Kimmons et al., 1990). A host range study was done with inoculations by Oka et al., 2003, who reported wheat (*Triticum aestivum*), barley (*Hordeum vulgare*), and pearl millet (*Pennisetum glucum*) as good reproductive hosts; maize (*Zea mays*) and oat (*Avena sativa*) as poor hosts; and tomato (*Solanum lycopersicum*), cucumber (*Cucumis sativus*), cotton (*Gossypium hirsutum*), and pepper (*Capsicum annuum*) as non-hosts. Faske and Starr (2009) added buffalograss (*Buchloe dactyloides*), jungle rice (*Echinochloa colona*), weeping lovegrass (*Eragostis curvula*), dallisgrass (*Paspalum dilatatum*), bahiagrass (*P. notatum*), indiangrass (*Sorghastrum nutans*), eastern gamagrass, (*Tripsacum dactyloides*), St. Augustine grass (*Stenotaphrum secundatum*), and another species of zoysiagrass (*Zoysia japonica*) to the list of reproductive hosts.

Symptoms: Small galls are produced on the roots of infected plants. Galls may occur singly or coalesce to form compounded root swellings. Aboveground symptoms are general and typical of an impaired root system caused by biotic or abiotic factors. Visible symptoms of infection usually include unthriftiness, yellowing of leaves, wilting, defoliation, and reduced growth. Symptoms are most pronounced on Bermuda grass (*Cynodon dactylon × C. transvaalensis*) putting greens with a high proportion of sand (Walker, 2014; Jagdale et al., 2019).

Transmission: Infected roots, infested soils, root debris, and irrigation water.

Damage Potential: Golf courses and sports fields report *Melodoigyne* feeding damage as an important problem, but identification to the species level is not always made, and often multiple species in addition to *M. marylandi* are found (McClure et al., 2012; Nischwitz et al., 2013). The host range of *M. marylandi* seems to be restricted compared to some other species in this genus, affecting mainly Poaceae (wild grasses, turfgrasses, and grains) but not dicots. Control options for turf and pastures are extremely limited (Starr et al., 2007; Oka et al., 2007).

Worldwide Distribution: Costa Rica (Salazar et al., 2013), Israel (Oka et al., 2004), Japan (Araki, 1992), United States (Arkansas, Arizona, California, Florida, Georgia, Hawaii, Maryland, Nevada, North Carolina, Oklahoma, Tennessee, Texas, Utah, South Carolina) (Jepson and Golden, 1987; Kimmons et

al., 1990; Elmi, 2000; Starr et al., 2007; McClure et al., 2012; Khanal et al., 2016; Walker, 2014; Sekora et al., 2012; Jagdale et al., 2019).

Official Control: None

California Distribution: Found in soil and root samples of turfgrass from golf courses in Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Yuba counties. (CDFA Pest and Damage Records; McClure et al., 2012)

California Interceptions: none.

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

Consequences of Introduction:

1) **Climate/Host Interaction:** *Melodoigyne marylandi* has been reported in seven California counties and 14 US states that cover a range of tropical, subtropical, temperate, and desert climates. Climate is not expected to be a limiting factor for this nematode in California.

   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 is limited to Poaceae, including wild grasses, turfgrasses, and grains.

   Evaluate the host range of the pest.

   Score: 1

   - **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:** Root knot nematodes can multiply very quickly and can produce highly adapted populations. They are dispersed by moving soil, plants, and water.

   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:** It is likely this nematode has been present in California for decades, and no specific economic impact has been reported for this species, but high-value turf could be damaged if populations are high (Chitambar et al., 2018).

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

Economic Impact: Low

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: **1**
- **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:** No environmental impacts have been reported and none are expected.

Environmental Impact: Low
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: 1
- **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 marylandi is Medium:*

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

6) **Post Entry Distribution and Survey Information**: From published research and a CDFA survey, this nematode is in multiple counties and climates.

***Evaluation is 'high'*-3**

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: **9-3**

Final Score: *Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information* ***= 6***

Uncertainty:

None

Conclusion and Rating Justification:

Based on the evidence provided above **the proposed rating for *Meloidogyne marylandi is C*.**

References:

Anonymous. 2016. *Meloidogyne chitwoodi* and *Meloidogyne fallax*. Bulletin OEPP/EPPO Bulletin(2016)46(2), 171–189
Araki, M. 1992. The first record of *Meloidogyne marylandi* JEPSON and GOLDEN, 1987 from *Zoysia* spp. in Japan. Japanese Journal of Nematology Vol. 22 pages 49-52
Chitambar J. J., Westerdahl B. B., 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
Faske, T., R, and Starr, J. L. 2009. Reproduction of *Meloidogyne marylandi* and *M. incognita* on several *Poaceae*. Journal of Nematology Vol 41 No 1 pp 2-4

Golden, A. M. 1989. Further Details and SEM Observations on *Meloidogyne marylandi* (Nematoda: Meloidogynidae) Journal of Nematology 21:453
Jagdale, G. B., Martinez-Espinoza, A. D., Ye, W., and Habteweld, A. 2019. First report of the root-knot nematode *Meloidogyne marylandi* infecting bermudagrass in Georgia. Plant Disease Vol 103, 5
Jepson, S. B., Golden, A. M. 1987. *Meloidogyne marylandi* n. sp. (Nematoda: Meloidogynidae), a root-knot nematode parasitizing grasses. In: Jepson, S. B. Ed. Identification of root-knot nematodes (*Meloidogyne* species) Wallingford, UK: CABI Publishing. pp. 263–265
Khanal, C., Robbins, R. T., Faske, T. R., Szalanski, A. L., McGawley, E. C., and Overstreet, C. 2016. Identification and haplotype designation of *Meloidogyne* spp. of Arkansas using molecular diagnostics. Nematropica 46:261-270.
Kimmons, C. A., Gwinn, K. D., and Bernard, E. C. 1990. Nematode reproduction on endophyte-infected and endophyte-free tall fescue. Plant Disease 74:757-761
McClure, M. A., Nischwitz, C., Skantar, A. M., Schmitt, M. E., and Subbotin, S. A. 2012. Root-knot nematodes in golf course greens of the western United States. Plant Dis. 96:635-647.
Nischwitz, C., Skantar, A., Handoo, Z. A., Hult, M. N., Schmitt, M. E, and McClure, M. A. 2013. Occurrence of *Meloidogyne fallax* in North America, and molecular characterization of *M. fallax* and *M. minor* from U. S. golf course greens. Plant Disease 97:1424-1430
Oka, Y., Karssen, G., Mor, M. 2004. First report of the root-knot nematode *Meloidogyne marylandi* on turfgrasses in Israel. Plant disease 88(3):309
Oka, Y., Tkachi, N., and Mor, M. 2007. Phosphite inhibits development of the nematodes *Heterodera avenae* and *Meloidogyne marylandi* in cereals. Phytopathology 97:396-404
Salazar, L., Gomez, M., Flores, L., and Gomez-Alpizar, L. 2013. First report of *Meloidogyne marylandi* infecting Bermudagrass in Costa Rica. Plant Disease Vol 97. No 7
Sekora, N. S., Crow, W. T., Mekete, T. 2012 First report of *Meloidogyne marylandi* infecting bermudagrass in Florida. Plant Dis 96: 1583–1584.
Starr, J. L., Ong, K. L., Huddleston, M., Handoo, Z. A. 2007. Control of *Meloidogyne marylandi* on bermudagrass. Nematropica 37: 43–49.
Walker, N. 2014. First report of *Meloidogyne marylandi* infecting bermudagrass in Oklahoma. Plant Disease Vol 98 No 9 p 1286-1287
Ye, W., Zeng, Y. and Kerns, J. 2015. Molecular characterization and diagnosis of root-knot nematodes (*Meloidogyne* spp.) from turfgrasses in North Carolina, USA. PLoS One 10(11): e0143556

Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, California Department of Food and Agriculture, 204 West Oak Ave, Lompoc, CA. Phone: 805-736-8050, plant.health[@]cdfa.ca.gov.

***Comment Period: 09/18/2019 through 11/02/2019**

***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 plant.health[@]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: C
