CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Profile for

Meloidogyne minor Karssen et al. 2004

Pest Rating: A

Kingdom: Animalia, Phylum: Nematoda,
Class: Chromadorea, Order: Rhabditida,
Family: Meloidogynidae

Comment Period: 07/19/2024 through 09/02/2024

Initiating Event:

This pathogen has not been through the pest rating process. *Meloidogyne minor* is a potentially dangerous plant-parasitic nematode capable of infecting many mono- and dicotyledonous plants. The risk to California from *M. minor* is described herein and a permanent rating is proposed.

History & Status:

Background:

Meloidogyne spp. are obligate, sedentary endoparasites that feed within host plant roots. The effect of root-knot nematodes on plants can be dramatic. As a result of their feeding, large galls or “knots” are formed on the root systems, which impairs the plant’s ability to take up water and nutrients from the soil (Chitambar et al., 2018). *Meloidogyne* is a name of Greek origin, meaning "apple-shaped female." Adult females, globose and sedentary, are found embedded in their host’s roots. They produce eggs within a mass either on the surface of, or within roots. Many *Meloidogyne* spp. can reproduce by mitotic parthenogenesis, meaning that males are not necessary and viable eggs can be produced by females alone in the absence of fertilization. *Meloidogyne minor* does have vermiform males, and it can be presumed that reproduction is by amphimixis (Karssen et al., 2004). Eggs hatch in the soil and vermiform juveniles swim to new roots (Mitkowski and Abawi, 2003).

The first-stage juvenile develops within the egg and molts to develop into the second stage. The second-stage juveniles (J2) are the infective stage that hatch from eggs and migrate through rhizosphere soil to host roots. The J2s penetrate the host roots and establish a specialized feeding site that is formed at the head end of the nematode in response to its feeding. They become sedentary while feeding at the specialized site, increasing in size, and undergoing two more molts and non-

feeding stages before developing into mature adult females or vermiform males and completing the life cycle. A feeding site is a group of plant cells, known as "giant cells", created when the nematode injects secretory proteins that stimulate changes within the parasitized cells. The injected cells rapidly become multinucleate when division occurs without cell wall formation. Giant cells can be very large and act as significant nutrient sinks, producing large amounts of proteins that the nematodes can use. Increases in the production of plant growth regulators from nematode feeding also play a role in this increase in cell size and division. Root cells next to the giant cells enlarge and divide rapidly, resulting in gall formation. Once a female establishes a feeding site as a juvenile, she permanently remains within the plant root, exuding her eggs out into the soil (Perry and Moens, 2013).

Meloidogyne minor n. sp. was described in the Netherlands by Karssen et al. in 2004 on potatoes in the Netherlands and on several golf courses in the British Isles. Since then, it has been associated with yellow patch disease of turf, specifically on creeping bentgrass (*Agrostis stolonifera* var. *stolonifera*). It can co-occur with other nematodes, often with *M. naasi* (Karssen et al., 2004). The differences in the morphology of *M. minor* exclude it from the 'graminis-group' of nematodes that include other typical golf-grass nematodes such as *M. graminis* and *M. Maryland* (Karssen et al., 2004). In a large survey of U.S. golf course greens, *M. minor* was isolated from a golf course in King County, WA in 2010 (McClure et al., 2012). This detection was confirmed by Nischwitz et al. (2013), based on an analysis of sequences for the large ribosomal subunit, the internal transcribed spacers 1 and 2, the intergenic spacer region 2, and the nuclear protein-coding gene Hsp90. There have been no California detections.

Hosts: Grasslands and dune areas are the presumed natural habitat of *M. minor*. It has been reported to infest a wide range of grasses, broadleaved weeds, and crops including scarlet pimpernel (*Anagallis arvensis*), creeping bentgrass (*Agrostis stolonifera* var. *stolonifera*), oat (*Avena sativa*), carrot (*Daucus carota*), fescue (*Festuca* sp.), lettuce (*Lactuca sativa*), Italian ryegrass (*Lolium multiflorum*), perennial ryegrass (*L. perenne*), black medick (*Medicago lupulina*), alfalfa (*M. sativa*), bluegrass (*Poa* sp.), timothy (*Phleum pratense*), tomato (*Solanum lycopersicum*), potato (*S. tuberosum*), red clover (*Trifolium pratense*), white clover (*T. repens*), clover (*Trifolium* sp.) and vetch (*Vicia sativa*) (Karssen et al., 2004; Mackesy et al., 2013).

Symptoms: On potato tubers, symptoms include numerous small pimple-like raised areas on the tuber surface with egg-laying females present just below the skin. This causes small dots of necrotic and brownish tissue. In comparison with other *Meloidogyne* spp., the pimple-like raised areas caused by *M. minor* are corkier. On potato roots, galls were formed at the beginning of the lateral roots leading to a thickened root base with an overall reduction in plant growth observed (Thoden et al., 2011; Mackesy et al., 2013).

In golf greens with creeping bentgrass, yellow patch disease has been observed. The patches of chlorotic grass appear after heavy spring rainfall and persist through the summer into the fall (Karssen et al., 2004). McClure et al., 2012, observed symptoms on golf courses and attributed them to multiple nematode species, including *M. minor*.

Transmission: Meloidogyne minor has a limited ability to move in the field. Only second-stage juveniles and males can travel within the soil, and their range is typically restricted to tens of centimeters per

year at most. The most probable way for *M. minor* to be introduced to a new area is through the transportation of infested or contaminated planting materials. Nematodes can easily be carried by infested host plants or host products. Additionally, the movement of non-host plants intended for planting, like seedling transplants or nursery stock, as well as non-host plant products such as bulbs, tubers, corms, and rhizomes, can contribute to the spread of *M. minor* if they are contaminated with soil infested by the nematode. Another potential pathway for its spread is through the movement of bulk soil. Contaminated irrigation water can also facilitate nematode movement (Chitambar et al., 2018; CABI, 2023). Specific to golf courses and turf fields, soil can be moved with players' shoes and equipment.

Damage Potential: Meloidogyne minor is causing increasing concern in temperate agriculture and horticulture (Subbotin et al., 2021). It is primarily reported as a pest of creeping bentgrass on golf course greens and other turf, where it causes yellow patch disease within a few years of new greens being planted (Elling, 2013). It also causes damage to potato plant growth and directly to potato tubers (Karssen et al., 2004; Thoden et al., 2011). In greenhouse experiments, potatoes were the only host tested that supported significant reproduction of *M. minor.* Damage to potato tubers is similar to that caused by other *Meloidogyne* species (Karssen et al., 2004).

Worldwide Distribution: Europe: *Belgium, Ireland, Netherlands, Portugal, Sweden*, and the *United Kingdom*. Oceania: *New Zealand*. North America: *United States* (Washington), South America: *Chile*

Official Control*: Meloidogyne minor* is on the USDA PCIT's harmful organisms list for Peru and The Republic of Korea (USDA PCIT 2024). It is not a regulated pest in the United States.

California Distribution: None

California Interceptions: None

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

Consequences of Introduction:

1) **Climate/Host Interaction:** This nematode is likely to occur wherever its hosts can grow.

   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 be established 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 includes mono- and dicotyledonous plants in several families.

   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:** Each female can produce hundreds of eggs, but the natural movement of soil-borne nematodes is very limited in undisturbed soils. They are spread easily with agricultural operations that move soil, equipment, and plant materials.

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:** Damage to potato growth and tuber yield has been reported as well as yellow patch disease which damages golf greens.

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

Economic Impact: A, B, G
A. The pest could lower crop yield.
B. The pest could lower crop value (including increasing crop production costs).
C. The pest could trigger the loss of markets (including 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:** Once established, root-knot nematodes are very difficult to eradicate. It has the potential to infect native grasses.

Evaluate the environmental impact of the pest on California using the criteria below.

Environmental Impact: A, 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 *Meloidogyne minor:* 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 the 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:

Meloidogyne minor is recently described and its host range and damage potential are not completely known. *Meloidogyne minor* may be confused with numerous other species of root-knot nematodes. Morphologically, *M. minor* is also very similar to *M. chitwoodi* and *M. microtyla*. Research by McClure et al. (2012) showed that many infested turf samples contained a mixture of *Meloidogyne* spp., and

molecular analysis was required to distinguish the species in the samples. It is then difficult to assess the damage they are causing as individuals.

Conclusion and Rating Justification:

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

References:

Chitambar, J. J., Westerdahl, B. B., and 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.

Elling, A.A., 2013. Major emerging problems with minor *Meloidogyne* species. Phytopathology, 103(11), pp.1092-1102.

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Karssen, G., Bolk, R.J., Van Aelst, A., Van Den Beld, I., Kox, L., Korthals, G., Molendijk, L., Zijlstra, C., Van Hoof, R. and Cook, R., 2004. Description of *Meloidogyne minor* n. sp.(Nematoda: Meloidogynidae), a root-knot nematode associated with yellow patch disease in golf courses. Nematology, 6(1), pp.59-72.

Mackesy, D., Robinson, A., and Sullivan, M. 2013. CPHST Pest Datasheet for *Meloidogyne minor*. USDA-APHIS-PPQ-CPHST

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 USA. Plant Dis. 96:635-647.

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USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. *Meloidogyne minor*. Accessed 6/24/2024.

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***Comment Period: 07/19/2024 through 09/02/2024**

***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.

Pest Rating: A