

California Pest Rating Proposal for *Meloidogyne javanica* (Treub, 1885) Chitwood, 1949

Javanese root-knot nematode

Current Pest Rating: C

Proposed Pest Rating: C

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

Comment Period: 11/09/2022 through 12/24/2022

Initiating Event:

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

History & Status:

Background:

Root-knot nematodes (*Meloidogyne* spp.) were first reported in California by E. A. Bessey in 1911. *Meloidogyne* is a name of Greek origin, meaning "apple-shaped female." It is one of the most extensively studied nematode genera in the state with six species of significant economic concern: *M. incognita*, *M. javanica*, *M. arenaria*, *M. hapla*, *M. chitwoodi*, and *M. naasi*. The host ranges of different species are variable but encompass most of the economically important agronomic and ornamental crops grown in California. Most, including *M. javanica*, are distributed widely in California's agricultural areas but show some differences in distribution and crop preferences.

Meloidogyne javanica was originally described from Java, Indonesia and now occurs widely in warm regions around the world. It is a sedentary endoparasite of plant roots. The type host is sugarcane (*Saccharum officinarum*), but it has a very broad host range with close to 800 host plants recorded. It is one of the most serious pests of crops in central Africa and is considered second only to *M. incognita* in importance worldwide, being widespread in sub-tropical and tropical regions (Sasser et al., 1985).

In California, *M. javanica* is most often associated with beet, citrus, tomato, olive, potato, grape, and peach (Chitambar et al., 2018; CDFA PDR database, 2022). 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. The females are globose and sedentary at maturity. They establish a feeding site as juveniles and permanently remain within the plant root, exuding eggs out into the soil. The feeding site is a group of 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 serious nutrient sinks, producing large amounts of proteins that the nematode can use. Increases in the production of plant growth regulators from nematode feeding also plays 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.

Meloidogyne spp. generally reproduce by mitotic parthenogenesis, meaning that males are not necessary and viable eggs can be produced by females alone in the absence of fertilization. Vermiform males are rare and are only found when the population is subjected to an environmental stress, but they can mate with females. Eggs hatch in the soil and vermiform juveniles (mostly female sometimes male) swim to new roots (Mitkowski and Abawi, 2003).

Hosts: Goodey et al. (1965) list a total of 770 host species or varieties, including many weeds as well as crop plants. In addition to those crops in the list of hosts, there are many others of economic importance, including many vegetables, fruit trees, cereals, and ornamentals.

Symptoms: Nematode feeding causes cell enlargement and proliferation and leads to the primary symptom of a galled root system. On some hosts such as tomatoes, galls are obvious and can be up to one inch in diameter. However, 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. Carrots can suffer severe forking with galling mostly found on the lateral roots. On lettuce roots, galls are beadlike. On grasses and onions, galls are usually small swellings and barely noticeable (Chitambar et al., 2018; Mitkowski and Abawi, 2003).

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. Heavily infected roots are often badly discolored and rotted. This is due to the invasion of roots by fungi such as *Rhizoctonia*, *Fusarium* and *Pythium* which cause necrosis, and due to the breakdown of galled tissue by bacteria (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 among species 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 or nearly spherical-shaped 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 (McClure and Viglierchio, 1966).

Damage Potential: *Meloidogyne javanica* infection causes a decrease in the size of the root system. Depending upon the host and the number of nematodes present, galls vary in size from minute to extremely large. Galls on trees and vines, are typically smaller than those on herbaceous plants. Infections can also be an aesthetic problem; in carrots, attack causes disfiguration with galling and splitting of the tap root, rendering the carrot unmarketable. Aboveground symptoms include stunting, loss of quantity and quality of yield, wilting during hot periods of the day, and increased susceptibility to foliage and wilt diseases (Mitkowski and Abawi, 2003). Reproduction is probably always parthenogenetic, done almost exclusively without males. Under stress conditions such as overcrowding, food shortage, high temperature, or unsuitable host plants, a higher percentage of males and intersexes are produced (Triantaphyllou, 1973).

Worldwide Distribution: Africa: *Algeria, Angola, Botswana, Burundi, Comoros, Congo, Democratic Republic of the, Côte d'Ivoire, Egypt, Eritrea, Ethiopia, Gabon, Gambia, Ghana, Kenya, Liberia, Libya, Madagascar, Malawi, Mauritania, Mauritius, Morocco, Mozambique, Nigeria, Réunion, Rwanda, Senegal, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zambia, Zimbabwe.* Asia: *Armenia, Bangladesh, Brunei, China, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Kazakhstan, Lebanon, Malaysia, Myanmar, Nepal, Oman, Pakistan, Philippines, Saudi Arabia, Singapore, South Korea, Sri Lanka, Syria, Taiwan, Tajikistan, Thailand, Turkey, Turkmenistan, Uzbekistan, Vietnam, Yemen.* Europe: *Bosnia and Herzegovina, Bulgaria, Cyprus, France, Germany, Greece, Hungary, Iceland, Italy, Malta, Moldova, Montenegro, North Macedonia, Poland, Portugal, Russia, Serbia, Spain, Ukraine.* North America: *Costa Rica, Cuba, El Salvador, Guadeloupe, Guatemala, Honduras, Jamaica, Martinique, Mexico, Nicaragua, Panama, Puerto Rico, Trinidad and Tobago, United States (Alabama, Arizona, California, Florida, Georgia, Hawaii, Louisiana, Mississippi, New Mexico, North Carolina, South Carolina, Tennessee, Texas, Virginia).* Oceania: *Australia, Cook Islands, Fiji, Kiribati, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga.* South America: *Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Suriname, Uruguay, Venezuela (CABI-CPC, 2022).*

Official Control: *Meloidogyne javanica* is on the USDA PCIT's harmful organism list for Canada, Jordan, and Mexico. It is on the EPPO's A2 list for Jordan, and it is a Quarantine pest in Mexico and a regulated non quarantine pest in the United Kingdom

California Distribution: There are official records of *M. javanica* found from surveys, phytosanitary certification samples, nursery samples, and diagnostic samples from Alameda, Fresno, Imperial, Kern, Kings, Los Angeles, Monterey, Riverside, Sacramento, San Bernardino, San Diego, Santa Barbara, Solano, Stanislaus, Tulare, and Yolo counties (Siddiqui et al., 1973; Nemaplex, 2010; CDFA PDR Database, 2022).

California Interceptions: none

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

Consequences of Introduction:

- 1) Climate/Host Interaction:** *Meloidogyne javanica* is widespread in tropical and sub-tropical areas. It is more common in hotter areas, such as California's inland valleys, but it has been detected in many climates, 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 of this nematode is extremely large.

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:** This species can reproduce with females only, and populations can increase exponentially. They disperse slowly on their own, with juveniles moving through soil.

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.
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- 4) **Economic Impact:** Damage can be direct, from nematode feeding and gall formation on the roots, or indirect, as plants become more susceptible to attack from other types of pathogens. They can be moved with irrigation water.

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

Economic Impact: A, B, 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:** *Meloidogyne javanica* is an exotic nematode species with an extremely large host range, including weeds and native plants. Once established in the soil, they are very difficult to eradicate. It is a quarantine pest for Canada and Mexico, both of which are important trading partners.

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 *Meloidogyne javanica*: 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.

This nematode is already widespread in California, likely moving with infected planting material and infested soils in the major agricultural areas along the Coast and in the Inland Valleys

Evaluation is 'High'.

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: (Score)**

Final Score: Score of Consequences of Introduction – Score of Post Entry Distribution and Survey Information = 11

Uncertainty:

Distinguishing between the species of *Meloidogyne* can be a difficult challenge and many species can co-occur. Cultural management techniques such as crop rotation and trap cropping, rely on knowing the species present in a field. The ability to analyze DNA has progressively led to more advanced and accurate methods of species identification and this is likely to continue to improve in the future.

Conclusion and Rating Justification:

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

References:

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Responsible Party:

Heather J. Scheck, Primary Plant Pathologist/Nematologist, CDFA/PHPPS ECOPERS, 1220 N St Rm 221, Sacramento, CA 95814 Phone: (916) 654-1017, [permits@\[cdfa.ca.gov](mailto:permits@[cdfa.ca.gov).

***Comment Period: 11/09/2022 through 12/24/2022**

***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](mailto: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.
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Proposed Pest Rating: C
