cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Tylenchulus semipenetrans (Cobb, 1913)

Citrus nematode

Current Pest Rating: C

Proposed Pest Rating: C

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

Comment Period: 07/19/2022 through 09/02/2022

Initiating Event:

Tylenchulus semipenetrans has been assigned an informal C-rating by the California Department of Food and Agriculture (CDFA), Plant Health and Pest Prevention Services, but has not previously gone through the current pest risk analysis process. The risk to California from *Tylenchulus semipenetrans* is described herein and a permanent rating is proposed.

History & Status:

Background: *Tylenchulus semipenetrans* was discovered on citrus roots in Los Angeles County in 1912, and subsequently described by Cobb (1913, 1914). Within a few months of its discovery, it was found in many other citrus growing areas around the world. Its broad distribution is probably due to distribution on infested nursery stock (Cobb, 1914; Duncan, 2005). It is commonly referred to as the "citrus nematode" because of its historical association with citrus, but it does have other important agronomic hosts. In 1939, Johnston and Thorne examined more than 100 samples from citrus orchards in various parts of California and found all but one to be infested with *T. semipenetrans* (Thorne, 1961).

This is the only major nematode pathogen in California citrus and the disease it causes is called "slow decline" (Chitambar et al., 2018). In addition to citrus, *T. semipenetrans* commonly parasitizes grape, lilac, olive, and persimmon. It is common in table grape vineyards in the Coachella Valley (Riverside County) where Thompson Seedless is a susceptible variety (McKenry and Anwar 2006). It has also been found in peach and almond orchards on Lovell rootstocks in the San Joaquin Valley (Duncan et al.,

1992), and on ponderosa pine (Viglierchio, 1979). Baines et al. (1974) found four biotypes of *T. semipenetrans* in California that could be differentiated by means of a host range test utilizing four citrus rootstocks.

A detailed study on the life history and morphology of citrus nematode was conducted by Van Gundy (1958). Eggs are laid in a gelatinous matrix deposited by the female nematode onto the root surface. The life cycle from egg to egg takes between 6 and 8 weeks. Juveniles penetrate the root 2–3 weeks after hatching, burrowing their anterior end deep inside the root cortex while the posterior end remains outside in the soil. Feeding occurs on six to ten so-called "nurse cells," which are cortical parenchyma cells around the nematode anterior regions. Reproduction occurs over a wide range of temperatures, soil types, and pH values (Kirkpatrick et al., 1965), with maximum population growth occurring between 28 and 31 °C. Some reproduction occurs as low as 21 °C, but there is little above 31 °C.

Hosts: The preferred hosts of *T. semipenetrans* are citrus species, although related species, such as *Poncirus trifoliata* and its hybrids, are hosts. Other hosts are: *Beta vulgaris* (beet), *Citrus* spp., *Citrus aurantiifolia* (lime), *Citrus aurantium* (sour orange), *Citrus x clementina* (tangor), *Citrus limon* (lemon), *Citrus reticulata* (mandarin), *Citrus sinensis* (sweet orange), *Citrus x paradisi* (grapefruit), *Cydonia oblonga* (quince), *Diospyros* spp. (malabar ebony), *Justicia adhatoda* (Malabar nut), *Lantana camara* (lantana), *Olea europaea*, *Olea europaea* subsp. *europaea* (European olive), *Philadelphus coronarius* (mock orange), *Piper nigrum* (black pepper), *Poncirus trifoliata* (trifoliate orange), *Punica granatum* (pomegranate), *Syringa vulgaris* (lilac), *Toona ciliata* (toon), and *Vitis vinifera* (grapevine) (CABI, 2022).

Symptoms: The symptoms of *T. semipenetrans* infection on citrus trees develop slowly, and because of this, the disease is commonly called "slow decline". If susceptible trees are planted in lightly infested soil, they may grow for many years without apparent problems and only decline slowly over years.

Typical above ground signs consist of reduced vigor, the death of terminal buds, chlorosis and dying of leaves, early wilting under moisture stress, and twig dieback. Fruit is reduced in size, quantity, and quality. Symptom severity and speed of the tree decline depend on tree age and vigor, nematode biotype's parasitic ability, nematode population density, and the susceptibility of the rootstock. The leaves of infected trees are smaller than normal. Wilting is more pronounced in infected trees than in healthy trees during conditions of water stress. The fibrous roots of host trees are more often infected and appear thicker than healthy roots because soil particles adhere to the gelatinous egg masses of the nematode and are retained on the root surface. Infected fibrous roots decay because of the lesions and because secondary organisms infect them at the sites of nematode penetration and feeding. Heavy root infections result in root lesions and cortical sloughing (Cohn, 1965).

Transmission: This nematode has moved around the world with infected nursery stock. A low level of nematode infection may not be detected without a citrus nursery nematode certification program, leading infected trees to be transplanted into new orchards, thus spreading the nematode. Anything that moves soil or water, including machinery and irrigation water, can move this nematode (CABI-CPC, 2022).

Damage Potential: Yield losses to citrus due to *T. semipenetrans* are in the range of 10–30% depending on the level of infestation (Verdejo-Lucas and McKenry, 2004). Resistant rootstocks generally do well even in heavily infested soils. Some rootstock hybrids are not only resistant or tolerant against *T. semipenetrans*, but also against *Phytophthora* spp. and Tristeza disease. In general, trifoliate orange and its hybrids have performed well against the citrus nematode in California and are widely used in orchards. In resistant plants, juveniles penetrate epidermal and hypodermal cells. These cells and the first row of cortical parenchyma cells then collapse and often become necrotic. A wound periderm forms in the parenchyma, effectively isolating the area of penetration. Nurse cells don't develop and nematodes neither mature nor reproduce. In addition to this mechanical resistance, there appears to be a toxic chemical associated with nonhost plants (Verdejo-Lucas and McKenry 2004).

If, however, a highly infested orchard site is replanted with a susceptible rootstock, the roots of the young trees will soon be heavily parasitized, tree growth will be stunted, and fruit production will be reduced (Becker and Westerdahl, 2018). For grape rootstocks, Ferris et al. (2012) reported that of 13 tested, eight were susceptible, three were resistant, one was moderately resistant, and one was moderately susceptible. Two newly released grape rootstocks, GRN-1 and GRN-3 were resistant, and a third, GRN-2, was susceptible.

Damage is greater when trees are predisposed by other factors such as *Phytophthora* root rot and water stress. The potassium concentration in citrus leaves and roots is inversely related to the level of nematode infection. In saline conditions, excessive sodium accumulates in the leaves of infected trees aggravating the salinity problems (Mashela et al., 1992). Work done by Van Gundy and Martin (1961) found a relationship between nematode injury and plant nutrition. The greatest damage to growth occurred in soils that were deficient or nearly deficient in calcium, sodium, and potassium. Higher population densities of *T. semipenetrans* were found in alkaline than in acid soils. Soil moisture also affects reproduction with a dry soil being more favorable than a wet one, probably due to an oxygen deficiency when soil moisture is high (Van Gundy and Tsao, 1963; Van Gundy et al., 1964).

Worldwide Distribution: Africa: *Algeria, Central African Republic, Congo, Democratic republic of, Cote d'Ivoire, Egypt, Ethiopia, Guinea, Kenya, Libya, Malawi, Morocco, Mozambique, Nigeria, Senegal, South Africa, Sudan, Tanzania, Tunisia, Uganda, Zimbabwe*. America: *Argentina, Belize, Bermuda, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominica, El Salvador, Grenada, Guadeloupe, Honduras, Jamaica, Martinique, Mexico, Panama, Peru, Puerto Rico, Saint Lucia, St Vincent and the Grenadines, Trinidad and Tobago, United States of America, Uruguay, Venezuela*. Asia*: Afghanistan, Bahrain, Brunei Darussalam, India, Indonesia, Iran, Iraq, Israel, Japan, Jordan, Korea, Republic, Lebanon, Malaysia, Oman, Pakistan, Philippines, Saudi Arabia, Sri Lanka, Syria, Taiwan, Thailand, Uzbekistan, Vietnam, Yemen*. Europe: *Albania, Azerbaijan, Cyprus, France, Georgia, Greece, Italy, Malta, Portugal, Spain, Turkey*. Oceania: *Australia, Cook Islands, Fiji, French Polynesia, Niue, Papua New Guinea, Samoa, Tonga* (EPPO, 2022).

Official Control: A2 list for Jordan and Uruguay, quarantine pest in Tunisia and regulated non-quarantine pest in Bahrain (EPPO, 2022). It is on the USDA PCIT's harmful organisms list for Jordan,

Madagascar, Qatar, Timor-Leste, Uruguay, and the Bolivarian Republic of Venezuela (USDA_PCIT, 2022).

California Distribution: Fresno, Glenn, Imperial, Kern, Kings, Madera, Orange, Placer, Riverside, San Benito, San Bernardino, San Diego, San Luis Obispo, Santa Barbara, Stanislaus, Tehama, Tulare, and Ventura counties (CDFA PDR Database, 2022).

California Interceptions: Interceptions have been made at the border on grapefruit, orange, Norfolk Island pine, and bamboo, from Texas and Florida

The risk *Tylenchulus semipenetrans* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** This nematode has become widespread in California in all major grape and citrus growing areas.

   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 mainly woody plants and includes plants in multiple families.

   Evaluate the host range of the pest.

   Score: 2
   - 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 nematode has a short life cycle but no highly resistant life stages. It is dispersed with infested plants, soil, and irrigation 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.

4) **Economic Impact:** On susceptible root stocks, this nematode can cause significant yield decline, especially if trees are co-infected with *Phytophthora* or Tristeza. It is a quarantine pest in several countries.

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

Economic Impact: A, 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:** Orchardists are encouraged to test soils for nematode populations prior to planting. Discovery of significant levels of *T. semipenetrans* could affect the choice of rootstock for citrus and grape (Becker and Westerdahl, 2018).

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

Environmental Impact:

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 *Tylenchulus semipenetrans:* Medium

Add up the total score and include it here. **12**
-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 '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* ***= 9***

Uncertainty:

None

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Tylenchulus semipenetrans* is C.

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Responsible Party:

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***Comment Period: 07/19/2022 through 09/02/2022**

***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.

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