cdfa CALIFORNIA DEPARTMENT OF FOOD & AGRICULTURE

California Pest Rating Proposal for

Nanidorus spp. Siddiqi, 1974

Stubby root nematode

Current Pest Rating: D

Proposed Pest Rating: C

Kingdom: Animalia, Phylum: Nematoda,
Class: Enoplea, Subclass: Enoplia,
Order: Triplonchida, Suborder: Diphtherophorina,
Superfamily: Diphtherophoroidea, Family: Trichodoridae

Comment Period: 02/03/2022 through 03/20/2022

Initiating Event:

During the 1950-60s, several genera of plant parasitic nematodes were given a 'D' rating as they were regarded as parasites, predators, or organisms of little or no economic importance that did not require State-enforced regulatory action. However, these nematode species were inaccurately assigned a 'D' rating as most, if not all, are plant parasitic and therefore capable of damaging plant production and causing significant economic losses especially at the county and local residential/grower level. Furthermore, the detection of plant parasitic nematodes in nursery stock may be an indication of contamination in violation of the State's standard of pest cleanliness required for nurseries. Multiple genera of stubby-root nematodes were originally rated 'D'. The risk of infestation and permanent rating of the genus *Nanidorus* is proposed here.

History & Status:

Background:

Generally, pest risk assessments and assignment of pest ratings are conducted per individual pest species and not per genus group primarily due to differing pest biologies, geographical distributions, host ranges, damage potentials, and risk mitigation requirements. However, an exception to this rule is made here for the genus *Nanidorus* largely because of historical practice. Over the past several decades, stubby root nematodes in the genera *Paratrichodorus*, *Trichodorus,* and *Nanidorus* were

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seldom differentiated to species level by CDFA Nematologists mainly due to 1) the common occurrence and wide distribution of important member species within California, 2) no state-enforced regulatory action required subsequent to their detection, and 3) prioritizing diagnosis of other nematode species in other genera considered to be of greater economic importance than those belonging to *Nanidorus*.

Members of the genera *Nanidorus, Paratrichodorus*, and *Trichodorus* have the common name of "stubby-root nematodes". Stubby-root nematodes have a unique (among plant-parasitic nematodes) type of stylet, called an onchiostylet, that is used to punch holes in cells, allowing the contents to drain out. The stubby root nematode then secretes from its mouth salivary material into the punctured cell. This hardens which allows the nematode to withdraw and ingest the cell contents. This contrasts with other plant-parasitic nematodes, which have hollow stylets that function more like straws (Christie and Perry, 1951). Species reproduce mainly by parthenogenesis; unmated females produce eggs, juvenile stages, and adults. Males are rare. These nematodes usually inhabit the soil-root region of the plant and feed as obligate, migratory ectoparasites of roots using a stylet to feed on epidermal cells. All motile juvenile and adult stages feed (Mai et al., 1996; Maggenti, 1981). They have an additional adverse impact on crops when they vector viruses in the Tobravirus group (Brown et al., 2004).

Historically, species descriptions were based on morphological and morphometric features. The family Trichodoridae contains over one hundred valid species in six genera. The largest genus is *Trichodorus* Cobb, 1913, which holds approximately half of the species, followed by *Paratrichodorus* Siddiqi, 1974 with a quarter of the species, and *Nanidorus* Siddiqi, 1974 with six species. Only these three genera contain known virus vectors. There are 3 additional genera, *Monotrichodorus, Allotrichodorus* and *Ecuadorus*. Molecular analyses based mainly on nuclear ribosomal RNA genes (D2-D3 expansion segments of 28S and partial 18S rRNA gene) have been used to characterize and validate trichodorid species. The best studied species is Christie's stubby root nematode, that for many years was classified as *Paratrichodorus minor*, and today is *Nanidorus minor* (Subbotin et al., 2019).

Hosts: Stubby root nematodes are associated with the roots of a wide range of plants including tobacco, cotton, oats, corn, other agricultural crops, fruit trees, ornamentals, nursery stock, forest trees and shrubs, desert shrubs, grasses, and weeds (Siddiqi et al., 1973; Nemaplex, 2022; CABI, 2022). Database records show the widespread occurrence in soil and in plant rhizospheres, but plant parasitism has not always been supported by other research or observations, and the severity has not often been quantified.

Symptoms: General plant damage associated with subby root nematodes includes stunting of the root system, which is expressed aboveground by yellowing of foliage, stunted top growth, and sometimes wilt and defoliation (Maggenti, 1981). Symptomatic plants often occur as irregularly shaped patches within a field. Impacts are generally more severe in sandy and light soils. Seedlings are the most seriously damaged. As the seedling roots develop, the tips are attacked, and growth stops. The roots will appear "stubby" and shortened because feeding by the nematode causes the root tips to fail to grow as it inhibits root elongation. The roots will branch at the points of nematode feeding and then the new root tips can also be attacked (Christie and Perry, 1951). The damaged roots are less able to take up water and nutrients from the soil and the plants may show nutrient deficiency symptoms.

Affected plants may fall over more easily in the wind (MacGowan, 1983). Plant roots usually show little or no necrosis or discoloration (Christie and Perry, 1951; Brodie, 1984). Stubby root nematodes are vectors of tobraviruses including tobacco rattle tobravirus that causes corky ringspot disease of potato, plus Pea early-browning virus and Pepper ringspot virus (Decraemer, 2011).

Transmission: The main mode of long and short distance spread through artificial means is movement of nematode-contaminated water (run-off and irrigation), soil (movement of tools and equipment), and infested planting materials

Damage Potential: Christie's stubby root nematode was the first ectoparasitic nematode shown to damage plants (Christie and Perry, 1951). On most hosts, feeding by *Nanidorus* on cells of root tips causes growth and elongation of roots to cease, and results in stubby-root symptoms. The damaged roots are less capable of supplying the plant with adequate water and nutrients from soil. Affected plants suffer yield losses.

Generally, stubby root nematodes. are considered mild pathogens of plants and are common associates of several plants (Siddiqi et al., 1973). However, plant damage caused by high populations may be more significant in small-area plant productions and/or containerized crops in nursery, residential, and local situations than in large acreages and environments such as, pastures, parks, and cultivated fields. Crop losses under field conditions are not reported. Greatly increased damage occurs when *Nanidorus* spp. vector viruses. Several stubby nematode species are known to vector tobraviruses, which cause economically important diseases in several crops (Decraemer, 1995). Viruses that can be transmitted by stubby-root nematodes belong to the genus *Tobravirus* and include Tobacco rattle virus, Pea early-browning virus and Pepper ringspot virus. There is a highly specific relationship between virus and nematode vector, so that virus isolates are transmitted only by certain nematode species. Tobacco rattle tobravirus, the cause of corky ringspot disease of potato, is vectored by *N. minor*. Corky ringspot causes noticeable brown rings on the surface and/or brown arcs or flecking of the inside of infected potatoes. These symptoms make symptomatic tubers unmarketable. As few as 5% of tubers with corky ringspot symptoms can cause rejection of the entire lot of potatoes (Zwieg and Hudelson, 2010). It is common to find multiple species of stubby root nematodes living together, which makes it difficult to attribute damage to a single species (CDFA pest and damage records, 2022).

Worldwide Distribution: *Nanidorus* spp. are distributed worldwide in tropical, sub-tropical, and temperate areas (CABI-CPC, 2022)

Official Control: *Nanidorus minor* is on the EPPO's A1 list for Argentina and on the A2 list for Jordan, (EPPO, 2022) and on the USDA's harmful organism list for Honduras, Jordan, Korea (Republic of), Peru and Taiwan (USDA, 2022).

California Distribution: Fresno, Imperial, Kern, Kings, Los Angeles, Madera, Merced, Monterey, Sutter, Riverside, Sacramento, San Bernardino, San Diego, San Francisco, San Joaquin, San Luis Obispo, San Mateo, Santa Barbara, Santa Cruz, Solano, Sonoma, and Stanislaus counties (PDR database, 2022).

California Interceptions: Stubby root nematodes are detected occasionally on imported nursery stock and at the border stations (PDR database, 2022).

The risk *Nanidorus* spp. would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** These nematodes inhabit agricultural production areas worldwide and are already widely distributed 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 of *Nanidorus* spp. is very large including important agronomic crops.

   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:** These nematodes spread with human activities and with infested planting materials such as potato tubers. It is parthenogenic with a high reproductive potential.

   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:** Reports of serious damage from stubby root nematode feeding are limited. However, under high population levels in residences, nurseries, and other small-area plantings, infestations could result in lowered crop yield. Species able to vector Tobraviruses can cause greater economic loss.

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

Economic Impact: A, E

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: **2**
- 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: The impact of *Nanidorus* on natural environments are most likely not very significant as the genus has been widespread in California for decades without causing apparent detriment to ecological balances and processes (Chitambar et al., 2018).

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

Environmental Impact: 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: 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 *Nanidorus* spp*:* 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.

   CDFA records show detections stubby-root nematodes in 20 counties, including those along the south and central coast, the Monterey Bay area, the San Francisco Bay area, the Central Valley, and southern deserts. The most common hosts are grapes, plums and turfgrass.

   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* ***= Medium (10)***

Uncertainty:

None

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Nanidorus* spp. are C.

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Responsible Party:

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***Comment Period: 02/03/2022 through 03/20/2022**

***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