California Pest Rating Proposal for

Belonolaimus longicaudatus Rau, 1958

Sting nematode

Pest Rating: A

Domain: Eukaryota, Kingdom: Metazoa

Phylum: Nematoda, Family: Belonolaimidae

Comment Period: 12/17/2020 through 01/31/2021

Initiating Event:

None

History & Status:

Background: *Belonolaimus longicaudatus* was discovered in California for the first time in 1992, associated with dying turfgrasses from a golf course in Riverside County. Intensive delimiting surveys in the Coachella Valley were conducted by CDFA and County inspectors and by late 1993, this nematode was detected on eight golf courses (Chitambar 2008). Cherry et al. (1997) hypothesized from DNA characterization that it was accidentally introduced from the Eastern United States. There had been earlier detections of sting nematodes in few interstate plant shipments that were intercepted on entry and destroyed by state regulatory action under external quarantine regulations (Chitambar et al., 2018). Surveys of several major golf courses in California were conducted in 2012–2013 by the CDFA and sponsored by the USDA APHIS Cooperative Agricultural Pest Survey (CAPS) Program. These surveys showed that the distribution of sting nematode in California was still restricted to ten golf courses in the Coachella Valley. This limited distribution supports the continuation of the external quarantines against *B. longicaudatus* and ongoing regulation of greenwaste and biosecurity to prevent spread from the affected golf courses.

Hosts: Abelmoschus esculentus (okra), *Acer* (maples), *Acer pseudoplatanus* (sycamore), *Agrostis stolonifera* var. *palustris* (bent grass), *Allium cepa* (onion), *Apium graveolens* (celery), *Arachis hypogaea* (peanut), *Baccharis halimifolia* (groundsel-bush), *Beta vulgaris* (beetroot), *Brassica oleracea* (cabbages, cauliflowers), *Brassica oleracea* var. *botrytis* (cauliflower), *Brassica oleracea* var. *capitata* (cabbage),

Brassica rapa subsp. *oleifera* (turnip rape), *Capsicum annuum* (bell pepper), *Casuarina equisetifolia* (casuarina), *Chrysanthemum* (daisy), *Citrullus lanatus* (watermelon), *Citrus sinensis* (navel orange), *Cucumis melo* (melon), *Cucumis sativus* (cucumber), *Cynodon dactylon* (Bermuda grass), *Daucus carota* (carrot), *Desmodium tortuosum* (Florida beggarweed), *Digitaria decumbens* (pangolagrass), *Digitaria sanguinalis* (large crabgrass), *Diospyros kaki* (persimmon), *Eremochloa ophiuroides* (centipedegrass), *Festuca arundinacea* (tall fescue), *Fragaria* (strawberry), *Glycine max* (soyabean), *Gossypium hirsutum* (Bourbon cotton), *Helianthus annuus* (sunflower), *Hordeum vulgare* (barley), *Ilex* (Holly), *Ipomoea batatas* (sweet potato), *Ipomoea purpurea* (tall morning glory), *Lactuca sativa* (lettuce), *Liquidambar styraciflua* (sweet gum), *Lolium multiflorum* (Italian ryegrass), *Mentha spicata* (spearmint), *Ocimum basilicum* (basil), *Oxalis* (wood sorrels), *Paspalum notatum* (bahia grass), *Pennisetum glaucum* (pearl millet), *Pennisetum purpureum* (elephant grass), *Phaseolus vulgaris* (common bean), *Pinus palustris* (longleaf pine), *Pinus taeda* (loblolly pine), *Pisum sativum* (pea), *Pittosporum tobira* (Japanese pittosporum), *Poaceae* (grasses), *Rumex crispus* (curled dock), *Saccharum officinarum* (sugarcane), *Schinus terebinthifolius* (Brazilian pepper tree), *Secale cereale* (rye), *Sesbania exaltata* (coffeeweed), *Solanum lycopersicum* (tomato), *Solanum melongena* (aubergine), *Solanum tuberosum* (potato), *Sorghum sudanense* (Sudan grass), *Stenotaphrum secundatum* (buffalo grass), *Trifolium* (clovers), *Triticum aestivum* (wheat), *Ulmus parvifolia* (lacebark elm), *Vaccinium corymbosum* (blueberry), *Vigna unguiculata* (cowpea), *Vitis rotundifolia* (muscadine grape), and *Zea mays* (maize) (CABI-CPC, 2020).

Symptoms: *Belonolaimus longicaudatus* is an ectoparasite that spends its entire life in soil, moving freely. It feeds by inserting its long stylet into epidermal cells of root tips, injecting enzyme-containing saliva and breaking down the cell contents, and then sucking the plant cell contents through the stylet (Agrios, 2005). *Belonolaimus* feeding kills the root meristems, halting root growth. When plants are fed upon when they are young, they grow poorly and then stop growing altogether. When older plants are fed upon, they develop short, stubby roots that have dark, shrunken lesions, especially near the root tips. Lateral roots will develop, but nematodes will migrate out to the lateral roots and damage them as well. The symptoms usually appear aboveground as enlarging patches of discolored, stunted, and dead plants. Because the roots are damaged, they are unable to supply the plant with water and nutrients. Plants with impaired root systems may show symptoms of nutrient deficiency and subsequently remain stunted and may wilt. At high nematode populations, plants can die.

This nematode suppresses turfgrass root growth and causes stunting and chlorosis (Mundo-Campo et al., 1994). Turfgrass roots may stop just below the thatch and plants may wilt easily. Corn and cane plants may lodge (fall over) as the nematodes damage the brace-roots. Annuals can be stunted, wilt, and die. Young fruit may be delayed in beginning to fruit. *Belonolaimus longicaudatus* typically occurs in patches because the nematodes are generally clumped in distribution.

Transmission: Belonolaimus longicaudatus is an amphimictic and gonochoristic species, meaning sexual reproduction is required and occurs between distinct males and females. Depending on soil conditions and populations, development from an egg to an egg-laying adult takes between 18 and 24 days. Large numbers of eggs are laid in the soil and the second stage juveniles begin to feed on plant roots immediately. Nematodes will gradually move short distances in expanding patches in perennial

plantings. Long distance spread is with movement of infested soil or with irrigation water, and with the movement of infected nursery stock or contaminated planting materials (Agrios, 2005).

Damage Potential: Belonolaimus longicaudatus has a high reproductive fitness and is considered a major threat for most agricultural and horticultural crops grown in sandy soils (>80% sand) (Bekal and Becker 2000a). It is associated with chlorotic and dying turfgrass on several golf courses in the Coachella Valley, an inland desert. Turfgrasses in this arid area provide a suitable ecosystem for the sting nematode because it thrives in warm, sandy soil with frequent irrigation.

Belonolaimus longicaudatus is also capable of parasitizing a wide range of crops including grapes, citrus, cantaloupes, lettuce, tomatoes, cotton, ornamentals, and weeds (Bekal and Becker 2000a,b). In Florida, *B. longicaudatus* is considered the most damaging nematode to turfgrasses, forage grasses, strawberry, potato, sugarcane, and cantaloupe (Crow, 2015). Devastating losses to cotton can occur, particularly when it occurs in association with Fusarium wilt (Davis et al., 2006).

Worldwide Distribution: Bahamas, Bermuda, Costa Rica, Mexico, Pakistan, Puerto Rico, Saudi Arabia, Turkey, United States (*Alabama, Arkansas, California, Connecticut, Delaware, Florida, Georgia, Kansas, Louisiana, Mississippi, Missouri, Nebraska, New Jersey, North Carolina, Oklahoma, South Carolina, Texas, Virginia*) (CABI- CPC, 2020)

Official Control: It is on the EPPO A1 list for Brazil and Jordan (EPPO, 2020) and on the USDA-PCIT harmful organism list for Antigua and Barbuda, Bermuda, Brazil, Colombia, Ecuador, Guatemala, Honduras, India, Indonesia, Jordan, Republic of Korea, Nicaragua, Panama, Peru, Taiwan, and Thailand (USDA, 2020). Arizona classifies it as an actionable nematode pest and maintains a state exterior quarantine for it as a pest that would require immediate action and is prohibited from entry into the state (National Plant Board, 2020).

California Distribution: There is a limited distribution in the Coachella Valley, Riverside County (CDFA PDR Database)

California Interceptions: None

The risk *Belonolaimus longicaudatus* would pose to California is evaluated below.

Consequences of Introduction:

1) **Climate/Host Interaction:** *Belonolaimus longicaudatus* is native to the sandy coastal plains of the southeastern United States. It is limited to soils with high sand content (>80% sand) is found near the coast from Texas to Virginia. It has been spread to sandy areas inland and has been found as far north as southern Ohio (Crow, 2015).

   Evaluate if the pest would have suitable hosts and climate to establish in California.

Score: **2**
- 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:** *Belonolaimus longicaudatus* is a major parasite of grasses and is also capable of parasitizing a wide range of crops including grapes, citrus, cantaloupes, lettuce, tomatoes, cotton, ornamentals, and weeds.

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:** Depending on conditions and population, development from an egg to an egg-laying adult takes between 18 and 24 days. Eggs are laid in pairs by the female at a rapid rate of 10 eggs per 10-15 hours. After a few days, the second-stage juvenile hatches from the egg and begins to feed. They move small distances by swimming. Long distance spread is with irrigation water and movement of contaminated planting material, including turf.

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:** *Belonolaimus longicaudatus* is a very damaging nematode on many agronomic, horticultural, forage, and tree crops. Chemical nematicides or crop rotations are used in places where it is established to reduce its damage. It is a quarantine pest in California and Arizona, as well as other countries, which impacts movement of plant and soil.

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

Economic Impact: A, B, C,
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:** In addition to the ability to parasitize many grasses (exotic and native), weeds, such as *Euphorbia glyptosperma, Sisymbrium irio, Paspalum dilatatum, Portulaca oleracea, Sorghum sudanense*, and *Cyperus esculentus*, can serve as hosts for *B. longicaudatus*. Infested golf courses must practice biosecurity to prevent movement of the nematodes off site.

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 *Belonolaimus longicaudatus* is 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 'Low'. *Belonolaimus longicaudatus* is established on some golf courses in the Coachella Valley, in Riverside County

Score: -1
-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* **= 13**

Uncertainty:

Belonolaimus longicaudatus is polyphyletic; suggesting that multiple species are being grouped artificially into a single species. Future taxonomic work may resolve them into separate species or subspecies**.**

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Belonolaimus longicaudatus* is A.

References:

Agrios, G. N. 2005. Plant Pathology, 5th Edition. Elsevier Academic Press. 922 pg

Bekal, S., and Becker, J. O. 2000a. Host range of a California string nematode population. Hortscience, 35, 1276–1278.

Bekal, S., and Becker, J. O. 2000b. Population dynamics of the sting nematode in California turfgrass. Plant Dis. 84, 1081–1084.

CABI Crop Production Compendium 2020. *Belonolaimus longicaudatus*. https://www.cabi.org/cpc/datasheet/ 8892 Accessed 11/18/2020

Cherry, T., Szalanski, A.L., Todd, T.C. and Powers, T.O., 1997. The internal transcribed spacer region of *Belonolaimus* (Nemata: Belonolaimidae). Journal of Nematology, 29(1), p.23.

Chitambar, J. J. 2008. Status of ten quarantine “A” nematode pests in California. California Plant Pest and Damage Report., (January through December 2007), 24, 62–75.

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.

Crow, W.T. 2015. Sting nematode. Featured creatures, University of Florida FDACS/DPI. Http://entnemdept.ufl.edu/creatures/nematode/sting_nematode.htm

Davis, R.M., Colyer, P.D., Rothrock, C.S. and Kochman, J.K., 2006. Fusarium wilt of cotton: population diversity and implications for management. Plant Disease, 90(6), pp.692-703.

EPPO Global Database. 2020. https://gd.eppo.int/taxon/BELOLO. Accessed 11/18/2020

Mundo-Ocampo, M. J., Becker, J. O., and Baldwin, J. 1994. Occurrence of *Belonolaimus longicaudatus* on bermudagrass in the Coachella Valley. Plant Disease, 78, 529.

USDA Phytosanitary Certificate Issuance and Tracking System, Phytosanitary Export Database (PExD) Harmful Organisms Database Report. *Belonolaimus longicaudatus*. Accessed 11/18/2020

Responsible Party:

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*Comment Period: 12/17/2020 through 01/31/2021

*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: A