

California Pest Rating Proposal for
***Anguina agrostis* (Steinbuch, 1799) Filipjev, 1936**

Bent grass seed gall nematode

Current Pest Rating: C

Proposed Pest Rating: B

Domain: Eukaryota, Kingdom: Metazoa,
Phylum: Nematoda, Class: Secernentea,
Order: Tylenchida, Family: Anguinidae

Comment Period: 12/01/2021 through 01/15/2022

Initiating Event:

A pest risk assessment of *Anguina agrostis* and a re-evaluation of its current pest rating in California is presented here.

History & Status:

Background:

The family Anguinidae includes both mycophagous and plant-parasitic nematodes. Members of the genus *Anguina* Scopoli, 1777 are obligate, specialized parasites of grasses and cereals that induce swellings and galls on plants. Three species of *Anguina*: *agrostis*, *tritici*, and *funesta*, induce seed galls on some cereals and grasses, and are considered of economic importance as agricultural and quarantine pests (Chizhov and Subbotin 1990; Krall, 1991). Several *Rathayibacter* species are vectored by *Anguina* nematodes and produce a bacterial toxin that causes annual ryegrass toxicity. The toxin is responsible for poisonings of grazing animals, especially sheep. When fed infected plants, intoxication leads to convulsions which are referred to as “staggers” and can result in animal death. It occurs only in parts of Australia (Murray et al., 2017). In the past, fresh galls of *A. agrostis* were associated with *Rathayibacter* spp. from bent grass, fescue and orchard grass and suspected in livestock poisonings (Jensen, 1961; Kurochkina and Chizhov, 1980). However, current research implicates only other *Anguina* spp. with the toxin producing *Rathayibacter* species, not *A. agrostis*. Additional bacteria from

Curtobacterium, *Microbacterium*, *Agreia* and *Leifsonia* have been isolated from *Anguina* nematode galls (Evtushenko et al., 1994, 2001). In some of these situations, the nematode is a required vector, while in others it is not. *Dilophospora alopecuri* is a plant pathogenic fungus able to directly infect a host. When the spores are carried into the apex of the plant by *Anguina* spp., the infection is much more effective and the impact can be severe, completely inhibiting any seed set (Subbotin and Riley, 2012).

Anguina spp. cause necrosis, swelling, deformation, distortion or galls on leaves, stems, inflorescences, or roots. The formation of galls is from intensive plant cell hypertrophy and proliferation that is triggered by the nematode feeding. The nematodes all start with vermiform bodies, but as they age the adult females become swollen and practically motionless. This group is known for having very effective survival stages. The J2 can enter a cryptobiotic (anabiotic) state that survives long periods of desiccation or freezing or both. Some can remain viable for more than 25 years in this cryptobiotic state. Thus, many species can parasitize above-ground plant parts and are found in semi-arid environments with hot, dry summers, as they are able to become quiescence under unfavorable conditions, later to be revived by seasonal rains to become an infective stage (Subbotin and Riley, 2012).

Anguina agrostis (Steinbuch, 1799) Filipjev, 1936 was first described from bent grass (*Agrostis capillaris*) in Germany. In previous decades, it was ascribed a length host list of additional grasses. An analysis of the ITS rRNA gene sequences made by Subbotin et al. (2004, 2020) showed that there is narrow specialization of seed gall nematodes and that *A. agrostis* was limited only to *Agrostis capillaris*. Other grasses previously known as hosts were parasitized by several other distinct described and still undescribed species of *Anguina*. *Anguina agrostis* sensu stricto causes characteristic elongate galls and abnormally elongated floral structures in *Agrostis* grasses. There is a recent report of this nematode from a new host, blue fowl grass, *Poa paulustris* in Wyoming (Roubtsova and Subbotin, 2020). *Anguina agrostis* is a serious and important nematode pest of bent grass grown for seed, especially in the Pacific Northwest of the United States and New Zealand (Pinkerton and Alderman, 1994; Southey, 1973).

Hosts: *Agrostis capillaris* (colonial bent grass), *Poa palustris* (fowl bluegrass) (Roubtsova and Subbotin, 2020). Colonial bent grass and fowl bluegrass are both non-native perennials. They are widespread in California, especially along the coast and in the Sierra Nevada (Calfora, 2021).

Symptoms: Symptoms include abnormal leaves (phyllody), lesions on glumes, twisting and distortion of the inflorescence, abnormal colors on the leaves or seeds, and seeds replaced by galls that may have abnormal pigments. This species forms characteristic cigar-shaped galls, at first green, later dark purple brown, in florets. Galled florets have the floral parts (glumes, lemma and palea) greatly elongated to three to five or more times normal length, with the lemma projecting beyond the glumes as a sharp point (Hooper and Southey, 1978).

Second state juveniles (J2) hatch and invade young grasses in early May in Europe or the end of August in Australia. J2s may feed as ectoparasites during the vegetative growth stage, migrating to areas of new growth or being carried up with the growing point of the plant. When the grass inflorescence

begins to form, the J2s invade the flower ovule and begin to feed as endoparasites. Maturation and oviposition begin in mid-June or mid-October, depending on the hemisphere, with only one generation per year (Pinkerton and Alderman, 1994; Riddle and Byrd, 1984; Krall, 1991).

Nematode feeding on floret primordia induces rapid cell division, cell enlargement, and subsequent cell degeneration and collapse. As this process continues, a large central cavity forms and is enveloped by a gall wall, and the nematodes reside inside. Gall size will increase rapidly as nematodes grow and reproduce. The gall wall is several cell layers thick with inner cells of the gall wall with dense cytoplasm with several mitochondria, and high levels of metabolic activity. These cells provide nutrients to the nematodes. Within the gall, nematodes go through three molts, J3, J4, and a final molt to become either male or female adults. Reproduction is amphimictic and females can lay up to 1000 eggs. The first molt occurs in the egg and the nematode hatches as a J2. These juveniles undergo anhydrobiosis and become the dormant dauer stage to withstand the summer heat. Winter or spring rains cause the seed galls to rupture when their mucoprotein takes up water and expels nematodes. This corresponds to favorable conditions for germination of host seeds. As the plant senesces, the galls desiccate, and the nematodes undergo anhydrobiosis, a state that can last for many years (Subbotin and Riley, 2012; Nemaplex, 2010).

Transmission: Galls containing nematodes can be harvested and accidentally shipped with seeds. The galls can be difficult to detect as they are covered by the chaffy scales or bractlets around the florets. Mechanical seed cleaning removes most galls, but control is more effective when combined with hot water treatment (Nemaplex, 2010). Movement with sand, soil or water is also possible (CABI-ISC, 2021).

Damage Potential: *Anguina agrostis* is considered as a serious or potentially important nematode pest of bent grass in the Pacific Northwest and New Zealand where populations were found in more than 40% of seed samples collected (Southey, 1973; Lehman, 1979; Subbotin and Riley, 2012). The detection on fowl bluegrass in Wyoming was from plants growing on the bank of a river, not in an agricultural setting (Roubtsova and Subbotin, 2020).

Worldwide Distribution: Africa: *South Africa*, Asia: *China, Georgia, Kyrgyzstan*. Europe: *Czechia, Estonia, Germany, Ireland, Netherlands, Norway, Poland, Russia, Slovakia, Sweden, Ukraine, United Kingdom*, North America: *Canada, United States* (Minnesota, Oregon, Virginia, Washington, Wyoming), Oceania: *Australia, New Zealand* (CABI-CPC, 2021).

Official Control: *Anguina agrostis* is on the USDA PCIT's harmful organism list for Argentina, Brazil, Chile, China, Colombia, Ecuador, Guatemala, Honduras, India, Japan, Korea, Republic of, Mexico, Panama, Paraguay, Peru, Thailand, Uruguay. (USDA, 2021). It is on the EPPO's A1 list for Argentina, Brazil, Chile, Comité de Sanidad Vegetal del Cono Sur, Paraguay and Uruguay, and a quarantine pest for Mexico (EPPO, 2021)

California Distribution: None

California Interceptions: None

The risk *Anguina agrostis* would pose to California is evaluated below.

Consequences of Introduction:

- 1) **Climate/Host Interaction:** This nematode can survive wherever its hosts are grown. There are records from cooler climates in the Willamette Valley of Oregon, and very hot, arid regions of Australia. They can withstand very dry conditions in a state of anhydrobiosis.

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:** There are only two proven hosts, colonial bent grass, and fowl bluegrass. Older literature lists many additional grass hosts, but with modern molecular techniques they have been shown to be species other than *A. agrostis*

Evaluate the host range of the pest.

Score: 1

- **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:** A single female nematode can produce 1000 eggs. They can form galls that take the place of grass seeds. The galls provide lasting safety for the eggs and J2 nematodes and have allowed them to contaminate seed lots and be moved.

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:**

This nematode impacts the yield of bent grass seed in infested fields. Infested seed lots need to be cleaned and treated.

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

Economic Impact: A, B

- 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:** There are no native hosts, and an environmental impact is not expected.

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: 1

- **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 *Anguina agrostis*: Medium

Add up the total score and include it here. **10**

- 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
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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 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 = 10

Uncertainty:

The recorded host range of this nematode has contracted with improvements in understanding of phylogenetic relationships. The host range may expand again in the future.

Conclusion and Rating Justification:

Based on the evidence provided above the proposed rating for *Anguina agrostis* is B.

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Responsible Party:

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***Comment Period: 12/01/2021 through 01/15/2022**

*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.
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- ❖ 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: B
