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Anguina pacificae – seed and leaf gall nematode

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Anguina pacificae (AP) – the seed and leaf gall nematode - is the most threatening plant disease of *Poa annua* (poa) greens in California. It is currently restricted to central and northern coastal California golf courses. The high threat is the result of several factors:

1) **The likelihood of developing a poa variety that is resistant to AP is remote.** Poa is not a turfgrass variety that has been developed for commercial use. It is a variable weed with unknown genetic potential for development of AP resistant varieties. There is only one commercial variety of poa and we doubt that it has been screened for resistance to AP.
2) **The genus *Anguina* is thoroughly studied for crop plants but little is known about AP biology in low mown poa.** Based upon what is known for the rest of the genus *Anguina*, eradication will be impossible without host free periods or methyl bromide fumigation. When dry, the some *Anguina* galls are resistant to heat and methyl bromide fumigation
3) **Chemical and biological controls are very limited.** There is only one registered chemical, Nemacur that can control the nematode without killing the poa plant. Unfortunately, Nemacur is a highly toxic organophosphate nematicide that requires a golf course to be closed for 24 hrs following application. The insecticide/veterinary nematicide abamectin (Avid) has been evaluated but it was found to be ineffective at the rate tested. In addition, there are no known biological or cultural controls for the genus Anguina that could be implemented in a golf course environment.

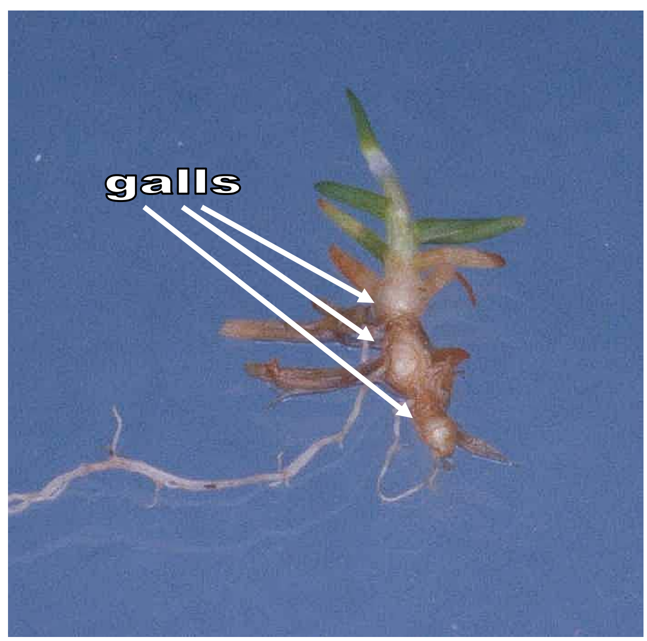
Background: In 1979, Larry Costello, University of California Farm Advisor, found poa plants with swollen stems at Pebble Beach (Prado Vera and Maggenti, 1984). The swollen stems released plant parasitic nematodes when they were dissected (Figure 1). Since that time, several studies have been conducted but few have been published that describe the biology and control of this nematode. The information below will summarize the published data and information that we have developed at the PACE Turfgrass Research Institute.

Biology: The most difficult to manage plant disease problems are caused by organisms that are not well understood. *Anguina pacificae* is one of those organisms. Only the most basic descriptive work has been conducted on this pathogen.

Prado Vera and Magenti (1984) reported the morphology of AP. Various measurements of the nematode anatomy suggested that the poa gall nematode was a new species within the genus *Anguina*. The nematode was assigned the name *Anguina pacificae*. The biology of AP is essentially unknown.

Samples of AP collected in 1998 were shipped Dr. Mike McClure at the University of Arizona for study. Dr. McClure subsequently shipped the nematodes to Dr. Tom Powers, University of Nebraska for DNA analysis and comparison with other *Anguina* species. DNA analysis is the most reliable and accurate method of identification of most organisms. Dr. Powers's assessment was that the nematode is probably *A. pacificae* but he did not have a known *A. pacificae* to compare the results to. In his letter, Dr. Powers noted that AP has been synonymized with *A. agropyri*. At this point, the nematode found attacking galls in poa plants is most likely the same *A. pacificae* species that was described by Prado Vera and Magenti in 1984 and first observed by Costello in 1978.

Figure 1. Illustration of a poa plant with three nematode galls on the stem. The three galls are probably the result of three separate infection events. Each gall contains nematodes.



Based upon preliminary findings and the lifecycle of other Anguina species, the following has been proposed for AP.

1. Starting with the eggs inside a gall, the nematode molts once and the second stage larvae emerges from the eggs within the stem gall. The sex of the

nematode has not yet been determined. The gall can be ruptured by a variety of methods, for example by mowing, vertical mowing, or natural decomposition to release the second stage larvae. It is likely that the second stage larvae can not exit the gall under their own power.

2. Once released from the gall, the second stage larvae must find their way to a new plant and enter the plant by a mechanism that has yet to be studied. However, based upon the location of the galls on the stem suggests entry may be in the proximity of new roots emerging from the stem. The nematode will require a film of water to move between plants. In a golf course green, the surface of the plant probably has a thin but continuous coating of water for the nematodes to move through.

3. Once inside the plant, the nematodes feed and begin to control the metabolism and morphology of the cells that are to become the components of the gall. As the nematodes develop they will differentiate into either male or female adults. At least one adult male and female will be needed for a successful paring but multiple adults of both sexes can frequently be found within a gall. The adult female can produce many eggs within the gall completing the lifecycle.

In order to evaluate the population dynamics of this nematode, samples were provided by several courses in addition to the samples collected at San Francisco Golf Club that will be described below in the Chemical Control section. Ten 3/4 inch diameter soil core samples were submitted by each course. Galls were frequently present in ten out of the ten cores. When galls were cut open to determine the contents, all nematode developmental stages were present in some of the galls. The highest egg count from a single gall was 897 eggs. In some cases, galls contained only a few juvenile nematodes, indicating that they were only recently infected. In other cases, there were numerous second stage larvae, a few eggs, and several adults indicating that most of the eggs had hatched into infective second stage larvae waiting to be released into the environment. These results, although preliminary, indicate that the nematodes are present in all stages at all times.

Control: *Anguina pacificae* can be controlled using fenamiphos (Nemacur). The activity of nemacur and residual levels in plant tissue and soil has been described by Peterson et. al (1986). Anecdotal evidence of the performance of Nemacur has been provided by several superintendents in the Bay Area who use the product to successfully manage AP. There are no alternatives, chemical or biological, that have been reported to be effective for control of this nematode.

Avid field trial San Francisco Golf Club, Robert Klinesteker Cooperator

Based upon research conducted by LaMondia (1996) on foliar nematodes of ornamental plants using abamectin (Avid), a field trial was established on the practice putting green at San Francisco Golf Club.

Objective: Evaluate a single rate of Avid that could be used under a Special Local Need registration for control of AP. Following discussions with Novartis representatives, the rate was identified as most likely to successful under the current label was 0.37 oz Avid 1.5 EC/1000 sq ft applied in 4-gal water/1000 sq ft.

Materials and methods: Plots were 4 x 4 ft square (16 sq ft). Six plots were treated with Avid at 0.37 oz/1000 sq ft and six plots were left non-treated. All applications were made using 8008VS flat fan nozzles to uniformly apply 250 ml per plot (4.1 gal/1000 sq ft). Treatments were randomized. Five 3/4 inch diameter cores were removed from each plot prior to each of two monthly treatments and the number of plugs containing plants with nematode galls were recorded. Applications and ratings were made on 5/27/98, 6/18/98, and 7/30/98.

Results: There were no significant differences in number of cores with galls in the treated versus non-treated plots after one or two applications of Avid. Moreover, there were no significant differences between pre-count and the two subsequent rating times using analysis of variance (Fisher's LSD $P<0.05$). Table 1 reports the average values for each rating time.

In addition to analysis of variance (Anova), Pearson Chi-square analysis of the data collected on 6/18/98 and 7/30/98 was also conducted. As with the Anova, there were no significant differences in the treated and non-treated.

Future research recommendations:

- Evaluate the performance of Avid insecticide at a high rate of 11 ppm delivered in 4 gal water/1000 sq ft for control of AP before abandoning this potential control product.
- Identify other control options if they exist. Searches have been conducted but a more exhaustive search is needed.
- Because bentgrass has never been observed to be damaged by AP, resurface poa greens to bentgrass when genetically-engineered herbicide-resistant varieties become available within the next five years. This will allow maintenance of pure bentgrass stands using herbicides to prevent poa invasion.

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Figure 2. Lifecycle of *Anguina pacificae*. Note that the nematode spends only a sort time outside of the host in the process of moving from a broken gall to a new plant.

Anguina pacificae Life Cycle

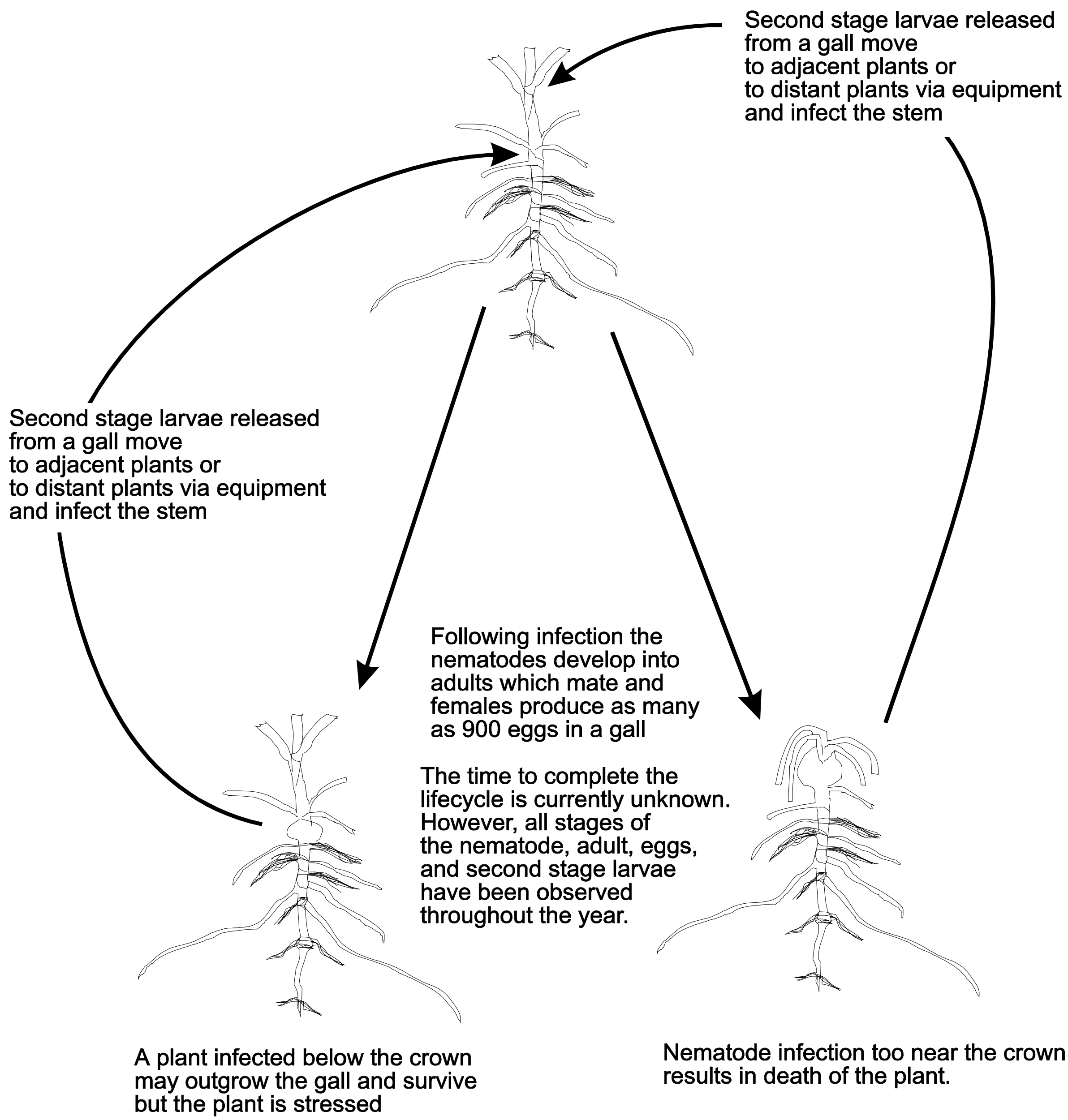

Table 1. Average number of 3/4 inch diameter plugs out of five plugs per plot that exhibit nematode galls. Analysis of variance and Pearson Chi-square analysis of the data indicates that there is no significant difference between the non-treated and Avid treated plots.

	Pre-count 5/27/1998	After one application 6/18/1998	After two applications 7/30/1998
Non-treated	2.3	2.2	2.8
Avid Treated	2.5	2.0	3.3

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