2003-2004 Progress Report for Slosson Foundation

Management of plant parasitic nematodes on turf in the urban landscape

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Introduction:

Plant parasitic nematodes are microscopic roundworms that can be a major problem in turfgrass maintenance. The University of California publication Turfgrass Pests (Radewald and Westerdahl, 1988) identifies the following nematodes as causing damage in California turf: root knot (Meloidogyne sp.) (Figures 1 and 2), ring (Criconemella sp.) (Figure 3), dagger (Xiphinema sp), lesion (Pratylenchus sp.), stubby root, (Trichodorus sp.), and pin (Paratylenchus sp.). The UC Pest Management Guidelines for turfgrass (Westerdahl et al., 2000) add the seed and leaf gall (Anguina pacificae) (Cid del Prado Vera and Maggenti, 1984; Winterlin et al, 1986) and sting nematode (Belonolaimus longicaudatus) to this list. In addition, we have recovered large numbers of spiral nematode (Helicotylenchus sp.) from problem turfgrass locations.

There are currently no control measures available to California homeowners. Over the past several years, a large variety of soil amendments have become available that have potential to reduce nematode damage to turf. We have tested a number of these on various crops and seen reductions in nematode populations, and/or increases in growth and yield (Westerdahl et al. 1992, 1995). As a result of these trials, the first biological nematicide DiTera (which is a toxin produced by a fungus in fermentation and marketed by Valent) has achieved California registration on a variety of crops (Westerdahl et al., 1997).

Unlike many deep rooted agricultural crops, a significant portion of turf roots are within the top 5 cm (2 inches) of soil making them accessible by conventional application methods such as drenching, or spraying followed by irrigation. Although our trials are planned for Northern California, the control measures developed should have statewide application.

During the past year, a nematode management trial was completed, and the population cycling of three common turfgrass nematodes (root-knot, spiral, and ring) was monitored in two locations on a biweekly basis. Information on the population cycling of nematodes should help us to advise home gardeners on optimum times to apply treatments.

Materials and Methods

<u>Nematode Management Trial:</u>
A trial with 10 treatments was conducted in a randomized complete block design with four replicates per treatment. Each replicate was 2.25 sq meters (1.5 meters x 1.5 meters). The treatments were: untreated, Nemacur 10G at 75 kg/ha, DiTera DF (Valent) at 112 kg/ha, A-1641 (mustard bran, Uniroyal/Crompton) at 872 and 654 kg/ha, Quillaja 35% (an extract of the Soap Bark tree, Desert King) at 14 and 23 liters/ha, XRM 5053 at 11 1iters/ha, Fore (mancozeb, Dupont) at 28 liters/ha and fosthiazate (Syngenta) at 3.4 kg ai/ha.

Plot boundaries were delineated by placing metal stakes 0.5 cm below the soil surface in the turf surrounding the green. Prior to each treatment and sampling, strings were run between stakes to delineate the replicates. Strings were removed following applications and sampling. A metal stud detector was used to locate the metal stakes.

Nemacur and A-1641 were granular products that were applied with a shaker bottle. DiTera and the liquid products were applied with a sprinkler can in 0.5 liter of water per replicate. Applications were followed by 1 cm of irrigation via overhead sprinklers. Each treatment was applied a total of three times at 4 to 6 week intervals. Turf quality was evaluated and nematode samples were taken 6 weeks following the final application.

To sample for nematodes, cores were taken to a 10 cm depth from the center of each replicate. Nematodes were extracted from soil around roots via elutriation followed by sugar centrifugation. The number of galls per 2.54 cm were counted. Ten galls were individually removed from the cores, and dissected under a dissecting microscope. From each dissected gall, the number of adult males and females, immature adults, juveniles, and eggs was determined.

Turf quality was visually determined based on standards acceptable for that location. Digital photos were taken from a slope over looking the plot and a representative photo in which all replicates were visible in full sun was selected for digital analysis of turf quality. The digital analysis was conducted with the histogram function of Adobe Photoshop set for RGB analysis. Within each replicate, two100 pixel areas were randomly selected and the following data was recorded: RGB, Red, Green, Blue, and Luminosity.

Data on nematodes and digital turfgrass quality was analyzed by ANOVA followed by contrast means comparisons compared to the untreated control (SuperAnova). Prior to analysis, nematode counts were transformed by $\log_{10}(x+1)$ to stabilize variances.

Nematode Population Cycling:
Two sites were selected, one in San Mateo County (Location A) and one in Monterey County (Location B) to monitor the population cycling of three plant-parasitic nematodes. Three samples were taken biweekly from each location. Nematodes were extracted from soil around roots via elutriation followed by sugar centrifugation and from roots via Baermann funnel extraction. Extracted nematodes were identified to genus and counted under a dissecting microscope. Data was analyzed with Analysis of Variance (ANOVA) followed by Fisher's Protected Least Significant Difference Test.

Results and Discussion

Nematode Management Trial:
By visual observation, it was evident that turfgrass quality in Nemacur and fosthiazate treated plots was superior to all other treatments. Some improvement in quality was visible in the DiTera treated plots compared to the untreated while the remaining treatments could not be visibly distinguished from the untreated. The digital photograph analysis conducted using the histogram function of Adobe Photoshope supported the visual analysis (Table 1). The Red analysis indicated that Nemacur and fosthiazate were different from the untreated at $P = 0.05$.

Several treatments reduced ($P = 0.05$) populations of *Anguina* (Table 2). Nemacur reduced the number of males, females, eggs, total adults, and total nematodes. Fosthiazate reduced the number of galls, females, males, immature adults, and total adults. DiTera reduced the number of eggs.

None of the treatments reduced populations of root-knot, spiral or ring nematode (Table 3). For several treatments, populations of spiral nematode were significantly higher than for the untreated. Increased nematode populations could occur if the treatments permitted the development of a healthier root system that could sustain higher populations of nematodes. This was also the case for one treatment with ring nematode.

This study indicates that the biological nematicide DiTera should receive further consideration for nematode management on turfgrass in California.

Nematode Population Cycling:
Spiral and ring (Figure 3) nematodes are ectoparasites of turf, always being found outside of roots in the soil. Root-knot nematode (Figure 2) is an endoparasitic nematode. Juvenile nematodes penetrate roots, take up a feeding site, and the body swells as the nematode matures and lays eggs. Populations of all three nematodes fluctuated throughout the year. Levels of spiral nematode (Figure 4) were similar at both locations. Populations were highest at Location A in mid-August and at Location B in early November and these populations were significantly higher than when populations were at their lowest levels ($p = 0.05$). Ring nematode populations (Figure 5) were considerably higher at Location A than at Location B. Populations at Location A were highest in September and at Location B in November and these populations were higher than when populations were at their lowest levels ($p = 0.05$). As with ring nematode, populations of root-knot nematode (Figure 6) were typically higher at Location A than at Location B. At Location A, populations in April and September were higher than at the lowest times of the year ($p = 0.05$). Peak populations at Location B were reached in September and in November ($p = 0.05$).

Conclusion

Every year, we hear from home gardeners who are devastated to learn that their once beautiful lawns have become infested with plant parasitic nematodes. At the present time, we have no solutions to offer. While eradication of plant parasitic nematodes is not feasible, it is very likely that one or more of the treatments we will develop will be able to reduce nematode numbers and provide improved growth. Since the treatments we will be using are classified as biological nematicides, natural products, or are currently registered for use on turf against other pests, they should be readily available to the home gardener.

Literature cited:

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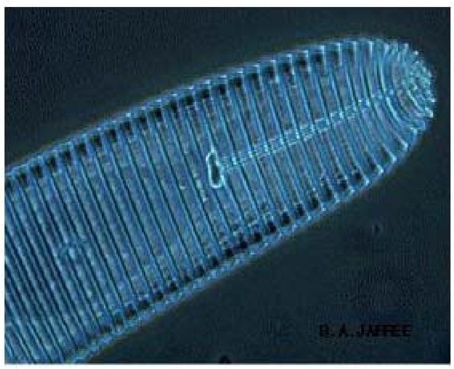
Figure 1. Damage to lawn caused by root-knot nematode.

Figure 2. Adult female of root-knot nematode within root (right). The head of the nematode is within the root. At the left in the picture is the swollen body of the nematode and an egg mass containing several hundred eggs.

Figure 3. Head of ring nematode.



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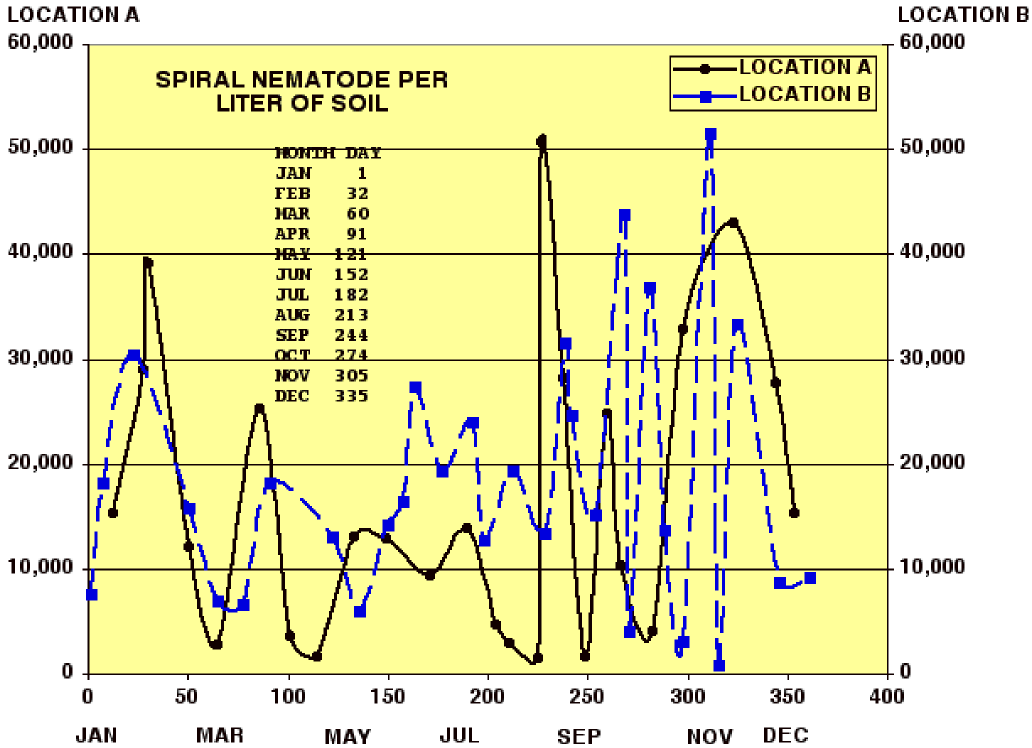

Figure 4. Population cycling of spiral nematode on turfgrass.

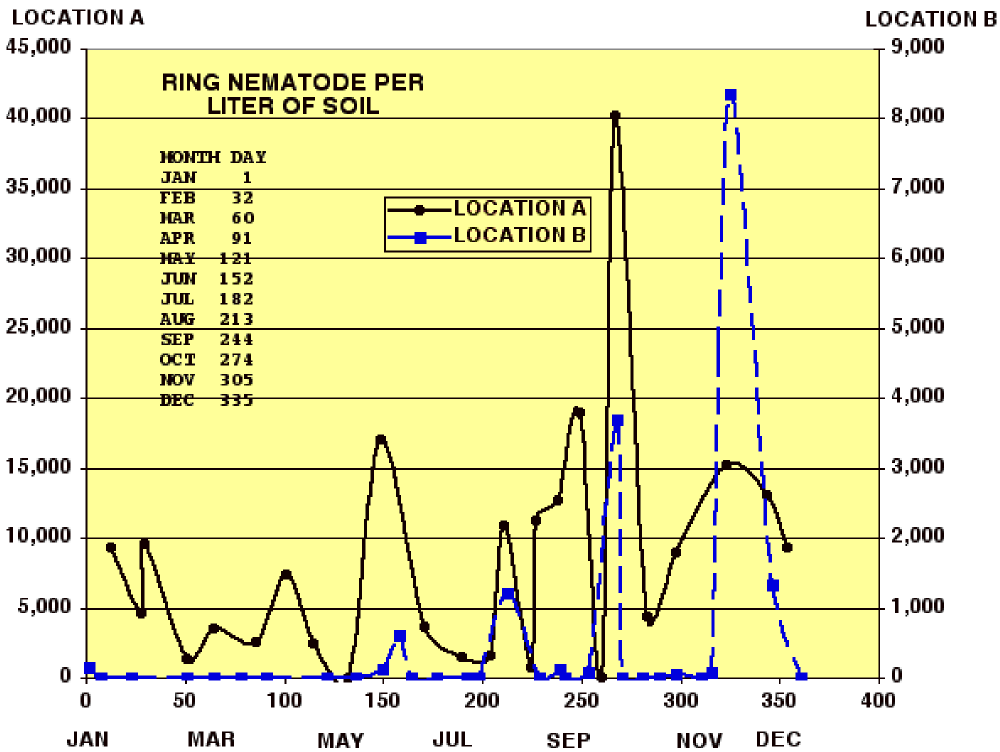

Figure 5. Population cycling of ring nematode on turfgrass.

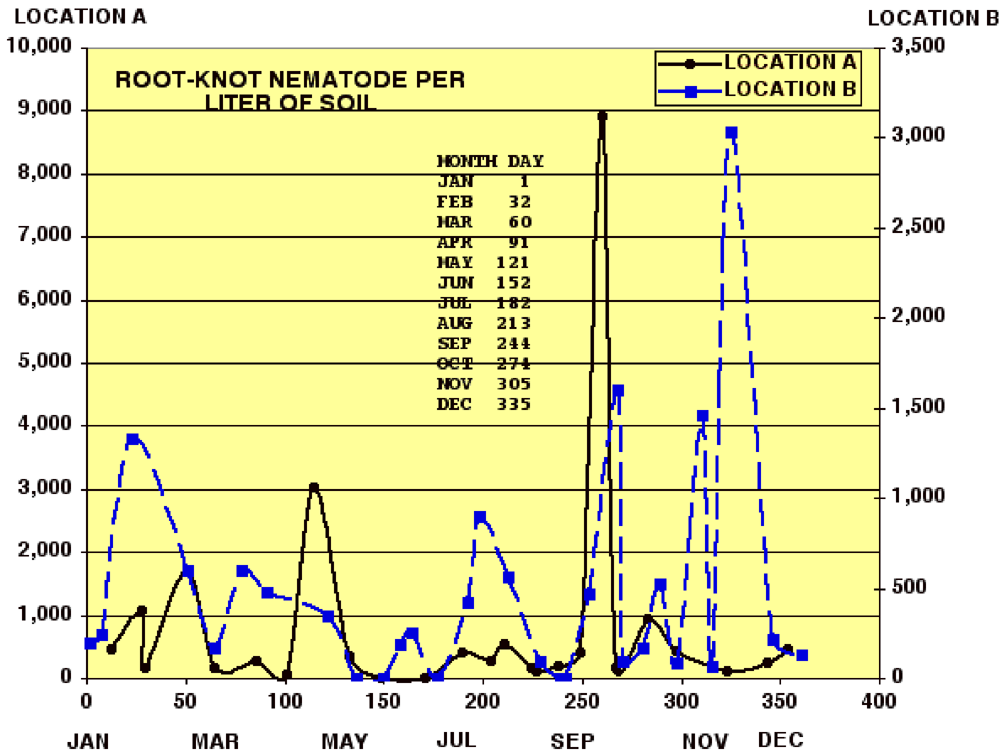

Figure 6. Population cycling of root-knot nematode on turfgrass.

Table 1. Turfgrass quality as determined by RGB color measurements from a digital photograph.

Treatment	Rate/Ha	RGB		Red		Green		Blue		Luminosity	
Untreated		165.9		166.9		202.65		128.3		183.6	
Nemacur 10G	75 kg	159.9	0.07	159.4	0.05	198.87	0.26	121.5	0.06	178.4	0.12
Ditera DF	112 kg	161.3	0.16	162.1	0.21	198.75	0.25	122.9	0.13	179.5	0.21
A-1641	872 kg	164.1	0.58	164.7	0.56	202.08	0.86	125.5	0.44	182.3	0.68
A-1641	654 kg	164.2	0.59	164.7	0.56	203.18	0.87	124.7	0.31	182.9	0.82
Quillaja 35%	14 liters	167.6	0.61	168.6	0.65	203.83	0.72	130.4	0.54	185.1	0.65
Quillaja 35%	23 liters	164.6	0.69	165.7	0.75	200.60	0.54	127.6	0.85	182.0	0.62
XRM 5053	11 liters	165.0	0.78	164.1	0.46	203.54	0.79	127.5	0.83	183.2	0.90
Fore	28 liters	167.1	0.72	169.5	0.49	204.66	0.55	127.1	0.75	185.4	0.58
Fosthiazate	3.4 kg ai	160.9	0.13	159.4	0.05	199.58	0.36	123.8	0.21	179.1	0.17

Each figure is the mean of 4 replicates.

Each mean is followed by the probability that it is statistically different from the untreated.

Rate indicates amount of product applied for each of 3 applicatioons at 4 to 6 week intervals.

Table 2. Number of *Anguina* galls and nematode populations within galls following nematicde applications.

Treatment	Rate/Ha	Galls		Females		Males		Immature Adults		Juveniles		Eggs		Total Adults		Total Nematodes	
Untreated		13.0		13.3		8.5		19.0		105.5		1,745.3		40.8		146.3	
Nemacur 10G	75 kg	2.8	0.09	2.5	0.02	1.3	0.03	12.3	0.13	0.5	0.35	63.0	0.01	16.0	0.01	16.5	0.03
Ditera DF	112 kg	17.3	0.77	14.0	0.68	8.8	0.98	8.0	0.34	12.5	0.74	1,422.3	0.01	30.8	0.64	43.3	0.55
A-1641	872 kg	11.8	1.00	8.0	0.74	4.3	0.44	15.0	0.74	1.3	0.46	2,486.3	0.20	27.3	0.58	28.5	0.39
A-1641	654 kg	17.0	0.67	16.5	0.56	6.5	0.73	7.8	0.11	123.3	0.90	902.3	0.29	30.8	0.75	154.0	0.92
Quillaja 35%	14 liters	12.8	0.72	4.3	0.17	1.8	0.10	17.5	0.69	12.0	0.62	940.0	0.46	23.5	0.09	35.5	0.33
Quillaja 35%	23 liters	16.5	0.97	7.5	0.27	5.0	0.22	13.0	0.64	1.0	0.40	1,697.8	0.71	25.5	0.47	26.5	0.35
XRM 5053	11 liters	14.5	0.78	15.0	0.66	3.8	0.25	10.8	0.08	124.0	0.89	2,554.5	0.99	29.5	0.70	153.5	0.92
Fore	28 liters	25.7	0.41	20.5	0.40	14.0	0.80	12.8	0.35	62.5	0.72	2,700.5	0.98	47.3	0.73	109.8	0.92
Fosthiazate	3.4 kg ai	1.5	0.03	0.5	0.01	0.0	0.01	4.8	0.01	238.5	0.51	0.0	0.67	5.3	0.01	243.8	0.21

Each figure is the mean of 4 replicates.

Each mean is followed by the probability that it is statistically different from the untreated.

Rate indicates amount of product applied for each of 3 applicatioons at 4 to 6 week intervals.

Galls indicates galls counted per 2.54 cm of soil core.

Other figures are total counts per 10 galls per replicate.

Total adults is the sum of females plus males plus immature adults.

Total nematodes is the sum of total adults plus juveniles.

Table 3. Nematode populations per liter of soil following nematicide applications.

Treatment	Rate/Ha	Root-knot		Spiral		Ring	
Untreated		4,550		7,713		11,775	
Nemacur 10G	75 kg	3,475	0.28	62,175	0.07	59,400	0.13
Ditera DF	112 kg	3,000	0.90	18,375	0.07	10,950	0.85
A-1641	872 kg	2,775	0.83	70,125	0.11	28,950	0.21
A-1641	654 kg	8,100	0.79	32,250	0.03	83,025	0.02
Quillaja 35%	14 liters	8,575	0.68	19,800	0.03	25,238	0.68
Quillaja 35%	23 liters	3,825	0.88	19,725	0.10	42,525	0.44
XRM 5053	11 liters	3,675	0.27	18,900	0.05	12,150	0.58
Fore	28 liters	5,175	0.35	30,900	0.01	46,725	0.12
Fosthiazate	3.4 kg ai	7,125	0.78	13,800	0.09	20,175	0.32

Each figure is the mean of 4 replicates.

Each mean is followed by the probability that it is statistically different from the untreated.

Rate indicates amount of product applied for each of 3 applicatioons at 4 to 6 week intervals.