Impact of Plant Parasitic Nematodes On the Quality of Golf Course Greens

A survey of 22 California golf courses conducted September, 1992

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Contents

Overview

Plant-parasitic nematodes can be devastating pests under certain conditions. Unfortunately, little is known about the influence of nematodes upon golf-course-green turf quality. In order to better understand the impact of nematodes on turf quality in southern California golf course greens, a survey of 22 courses was conducted. The preliminary results of that study are reported in this document.

Objectives

1. Survey Southern California golf course greens and describe the range of genera and populations of plant-parasitic nematodes.

2. Determine the relationship between green quality (good or poor) and nematode populations.

3. Compare southern California nematode populations to the populations reported from Washington by Chastagner and McElroy (1985).

4. Based upon information available, estimate an economic threshold level of nematodes that would trigger a nematicide application to reduce populations to a level that would not cause significant damage.

Results

1. Six genera of nematodes were found in southern California samples. They were: *Criconemoides*, *Helicotylenchus*, *Meloidogyne*, *Paratylenchus*, *Trichodorus* and *Tylenchorhynchus*. The predominant genera were *Helicotylenchus* , *Criconemoides* and *Meloidogyne*.

2. There was no significant correlation between poor green quality and nematode populations. Nematode populations were dependent upon the location from which the sample was collected, probably as a result of environmental conditions at the site (temperature, sand composition, soil moisture, turf variety, soil microbiology, etc.). In other words, courses that had high nematode populations in the poor green also tended to have high nematode populations in the good green.

3. California nematode populations were lower than populations reported from Washington. However, the trend in nematode populations and

green quality was similar to that reported from Washington (Chastagner and McElroy 1985).

4. Economic threshold populations of nematodes that would trigger a nematicide application could not be identified.

5. While nematodes may cause damage under certain conditions, the data presented here indicates that nematodes are not the primary cause of poor green quality in southern California. Application of nematicides would therefore not be expected to improve poor greens. Similar sampling experiments conducted throughout the year will be necessary to confirm these conclusions.

Background

Plant-parasitic nematodes feed by penetrating root cells with a dagger-like stylet. Once the root cell has been penetrated, the cell contents can be sucked out through the stylet. The damage caused by nematodes may be as minor as the loss of a few root cells to as dramatic as stopping root growth entirely or capturing control of the root cell physiology to make knots or giant cells. Symptoms of nematode damage include galls, stubby roots, excessive root branching, rots, necrotic lesions or general root surface necrosis (Couch, 1973). Unfortunately, the role of nematodes in turfgrass systems is largely unknown at this time. For a description of the genera of nematodes identified during this study, refer to Appendix A (extracted from Southey, 1982).

According to Chastagner and McElroy (1985), nematodes are a factor in summer decline of poa greens in Washington. However, they were unable to determine the relationship between nematode population levels and turf damage. In a more recent study by Davis et. al. (1992), *Tylenchorhynchus nudus* (stunt nematode) and *Magnaporthe poae* (summer patch) were used to determine the interaction between nematodes and a fungal root pathogen. The fungus by itself decreased root length of bentgrass and annual bluegrass only at the highest temperature, 30° C. The nematode alone reduced root length in both the bentgrass and the annual bluegrass at all temperatures tested. However, the nematode in combination with the fungus reduced root length only on bentgrass, not on the bluegrass. This data indicates that nematodes may enhance summer patch on bentgrass which is normally not considered to be a host to the fungus. However, the nematode did not enhance summer patch disease on its more typical annual bluegrass host.

This study did not reveal higher nematode populations from poor greens when compared to the good greens from each of the courses. Under stressful conditions during hot summer months when nematodes are active, the equivalent population of nematodes will likely cause more damage to the stressed plant in a poor green than the healthy plant in a good green. Likewise, the good green with a more extensive root system is probably more capable of supporting higher nematode populations without evidence of nematode induced stress.

Although we were unable to quantify the damage caused by nematodes in southern California golf courses, we did reveal the importance of site characteristics and resultant nematode populations. With further study, the parameters of the environment that encourages high and low nematode populations may be identified. Some of these factors might be related to soil texture and management practices that could be used in future nematode abatement programs. For example, if a green-mix of a specific sand mesh composition is found to reduce the level of nematodes and the mix also falls within USGA specifications, new construction projects and rebuilds should use the new sand specifications to limit nematode populations if economical. As in this example, once identified, the parameters that favor high nematode populations can be avoided.

The remainder of this report represents the first rough draft of a publication that is being prepared for submission to Plant Disease. The information is necessarily technical to accurately describe the experiment and results to meet refereed journal standards. If you have questions, feel free to call Larry Stowell at (619) 272-9897.

Stowell, L.J. and M. A. McClure. 1992. Distribution of plant-parasitic nematodes in putting green soils in southern California. Plant Disease. 76: (in preparation).

Abstract

Soil samples were collected from 22 golf-courses in southern California. One sample was collected from a poor quality green and a second sample was collected from a good quality green at each course based upon the golf course superintendents perception of good and poor turf quality. Six genera of plant-parasitic nematodes were identified: *Criconemoides, Helicotylenchus, Meloidogyne, Paratylenchus, Trichodorus* and *Tylenchorhynchus*. The predominant genera were *Helicotylenchus* , *Criconemoides* and *Meloidogyne*. Nematode populations were not significantly higher in poor quality greens. Significant correlations between the population of nematodes in good and poor greens from the same course revealed that the sampling site is the major factor influencing nematode populations found in the samples. Environmental conditions at each course, for example, temperature, sand composition, turf variety, soil moisture, soil microbiology, etc. influenced nematode populations more than the conditions that caused the green to be rated as either good or poor.

Key Words: Nematode, turf, turfgrass, golf course, *Criconemoides, Helicotylenchus, Meloidogyne, Paratylenchus, Trichodorus, Tylenchorhynchus*

Materials and Methods

Root and soil samples were collected from 22 golf courses in southern California between September 18 and 24, 1992. Approximately ten sub-samples each three-inches deep were collected from each golf course green using a 1 inch diameter soil probe. Samples were collected from one good and one poor green at each course. The superintendent classified the quality of the greens based upon the historical performance of the green.

Samples were processed by dispersing 250 cc soil/roots into tap water in a bucket. The suspension was then concentrated on a 500 mesh screen and the concentrate backwashed from the screen using distilled water (DW) into a beaker and the volume adjusted to approximately 100 cc. The sample suspension was then distributed evenly into two centrifuge tubes. The suspension was centrifuged at 3,000 rpm for 5 min and the supernatant was discarded. The nematode-soil pellet was resuspended using 47% sucrose. The sucrose and nematode suspension was centrifuged for 2 min at 2,000 rpm followed by rapidly decanting the supernatant through a 500 mesh screen and immediately rinsing with DW to wash the sucrose solution away from the nematodes. Nematodes were washed off the screen using DW and transferred to a modified Baermann funnel to eliminate organic matter that interferes with counting. After approximately 24 hours on the Baermann funnels, the suspension was concentrated on a 500 mesh screen and backwashed into a beaker and the volume adjusted to 20 cc. The suspension was thoroughly mixed and one cc of suspension was transferred onto a counting slide for observation.

Results

The summary of nematode populations found in the 44 samples (22 good greens and 22 poor greens) can be found in Table 1. The following abbreviations are used throughout the results and discussion section to represent the nematode genera:

CR	*Criconemoides*	(ring nematode)
HE	*Helicotylenchus*	(spiral nematode)
ME	*Meloidogyne*	(root knot nematode)
PA	*Paratylenchus*	(pin nematode)
TR	*Trichodorus*	(stubby root nematode)
TY	*Tylenchorhynchus*	(stunt nematode)

In addition to statistical analysis of nematodes identified in this study, statistical analyses was also conducted on data collected in Washington by Chastagner and McElroy (Appendix B). The data collected in this study will be referred to as California. The Chastagner and McElroy data will be referred to as Washington.

Descriptive statistical analysis of the California and Washington data sets revealed that the sample population mean for each nematode genus was not normally distributed (kurtosis > 3 or kurtosis < -3 or skewness >1 or skewness <-1). However, $\log_{10}$ transformation of the nematode counts resulted in a more normally distributed variable with kurtosis and skewness falling into acceptable ranges for both data sets allowing analysis of variance assumption of normality to be met. The $\log_{10}$ transformed data was therefore used in analysis of variance between populations of nematodes in good and poor greens. The results are reported in Table 2.

No statistical differences were observed between populations of each nematode genus in the California data set . With the exception of *Criconemoides* and *Paratylenchus*, the trend was toward lower nematode populations in the poor greens compared to the good greens. Unlike the California data set, the Washington data revealed significantly higher populations of CR, HE and TY in poor greens compared to the good greens (Table 2).

In addition to analysis of variance of the population of nematodes, the prevalence of nematodes across locations was evaluated by determining the percent of samples containing each genera. Figures 1 and 2 provide a summary of the prevalence information for the California and Washington data respectively. The predominant genera found in California were HE, CR and ME. In Washington, the predominant genera were HE, CR and PA.

Table 1. Summary of nematode populations found in samples from southern California golf courses. All values are reported in nematodes per 100 cc soil.

Course	G/P[1]	CR	HE	ME	PA	TR	TY	TOTAL
1	G	208	1072	0	0	0	0	1280
1	P	208	288	0	0	0	0	496
2	G	0	432	0	64	20	0	516
2	P	0	1040	0	352	0	0	1392
3	G	0	0	560	0	0	0	560
3	P	0	0	304	0	0	0	304
4	G	0	544	96	0	0	0	640
4	P	16	112	16	0	0	0	144
5	G	0	672	0	0	0	0	672
5	P	0	336	0	0	0	0	336
6	G	0	40	0	0	0	704	744
6	P	8	48	0	0	0	160	216
7	G	0	0	0	0	64	0	64
7	P	0	0	0	0	0	0	0
8	G	96	400	0	0	0	0	496
8	P	160	240	80	0	0	24	504
9	G	0	0	128	0	0	0	128
9	P	0	0	320	112	0	0	432
10	G	0	0	0	0	0	24	24
10	P	0	0	0	0	0	0	0
11	G	64	16	80	0	0	16	176
11	P	64	16	0	0	0	16	96
12	G	160	0	40	96	0	0	296
12	P	272	24	0	20	16	32	364
13	G	32	48	96	0	0	0	176
13	P	80	640	192	0	0	0	912
14	G	16	80	128	0	0	0	224
14	P	0	0	16	0	0	0	16
15	G	0	0	112	0	0	0	112
15	P	0	0	0	0	0	0	0
16	G	272	1920	0	0	0	0	2192
16	P	224	832	0	0	0	0	1056
17	G	48	208	0	0	0	0	256
17	P	32	0	0	0	0	0	32
18	G	0	0	304	0	0	0	304
18	P	0	0	64	0	32	0	96
19	G	80	320	16	0	0	0	416
19	P	64	40	0	0	0	0	104
20	G	128	176	0	0	0	0	304
20	P	96	176	0	0	0	0	272
21	G	0	608	0	0	0	0	608
21	P	0	2496	0	0	0	0	2496
22	G	0	672	192	0	0	736	1600
22	P	8	320	80	0	0	480	888

[1] G/P refers to the golf course superintendents classification of the green as a good performing green (G) or a poor performing green (P).

Table 2. Mean nematode counts for each genus from good and poor greens. Data represents the de-transformed mean ($antilog_{10}$) computed during analysis of variance. California data are from this study. Washington data are from Chastagner and McElroy (1985). Numbers represent nematodes per 100 cc soil.

	California		Washington	
Genus	Good	Poor	Good	Poor
Criconemoides (Ring)	99	108	172	622*
Helicotylenchus (Spiral)	288	234	373	1119*
Meloidogyne (Root Knot)	175	82	110	204
Paratylenchus (Pin)	78	84	164	188
Trichodorus (Stubby Root)	ID[1]	ID	ID	ID
Tylenchorhynchus (Stunt)	202	107	71	416*

* Poor-green nematode counts are significantly higher than corresponding good-green nematode counts (Fisher protected LSD P=0.05)

1 Insufficient data for analysis of variance (ID)

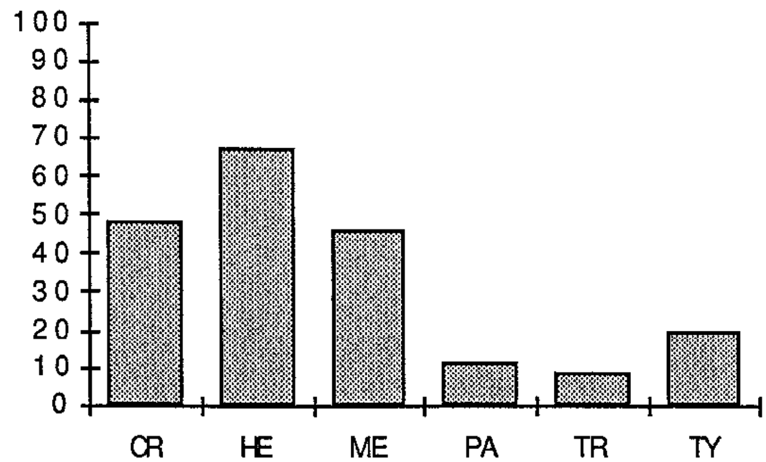

Figure 1. Percentage of samples containing at least one of each nematode genus. Data from California.

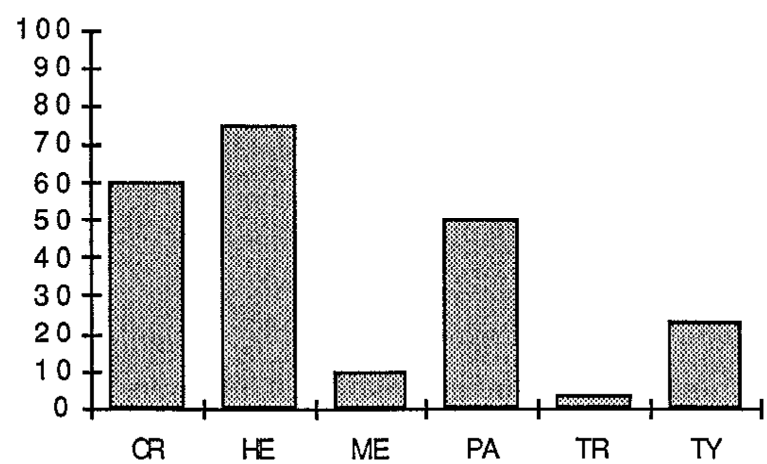

Figure 2. Percentage of samples containing at least one of each nematode genus. Data from Washington.

In addition to analysis of variance to determine whether the mean nematode populations were significantly different in good and poor greens, regression analysis was used to evaluate the dependency of the sample data. Tables 3 and 4 report the significant correlations found in the California and Washington data sets. In both instances, HE populations were highly correlated with total nematode populations in both the good and poor greens. Significant correlations were also found between the populations of HE, CR, ME, PA and TY in good and poor greens in California and HE, CR, ME and PA in Washington. This analysis reveals the lack of independence of data collected from good and poor greens and suggests that the analysis of variance assumption of independence has not been met. Therefore, sampling site has a greater influence on nematode population than the classification of the green into the categories of good and poor. These results also support the predominant position of HE within the population of nematodes as the major component within a sampling location and also between sampling locations.

Table 3. Correlation matrix indicating dependency of data. Significant interactions are noted by printing the correlation coefficient (p=0.05). Non-significant interactions are left blank. Data are from California.

	G CR	P CR	G HE	P HE	G ME	P ME	G PA	P PA	G TR	P TR	G TY	P TY	G TOT
P CR	.92	1											
G HE	.63	.46	1										
P HE			.43	1									
G ME					1								
P ME					.67	1							
G PA							1						
P PA							.53	1					
G TR									1				
P TR										1			
G TY											1		
P TY											.89	1	
G TOT	.54		.90										1
P TOT				.96									

Table 4. Correlation matrix indicating dependency of data. Significant interactions are noted by printing the correlation coefficient (p=0.05). Non-significant interactions are left blank. Original data from Washington.

	G CR	P CR	G HE	P HE	G ME	P ME	G PA	P PA	G TR	P TR	G TY	P TY	G TOT
P CR	.76	1											
G HE	.51	.66	1										
P HE				1									
G ME					1								
P ME					.76	1							
G PA							1						
P PA							.76	1					
G TR									1				
P TR										1			
G TY											1		
P TY												1	
G TOT	.57	.67	.99										1
P TOT				.99									

Discussion

Nematodes have been implicated in turf damage for almost 40 years (Couch, 1973). However, evaluation of soil population levels and resultant plant damage has been difficult to quantify. The data presented here reveals that nematode populations are more intimately related to the environmental conditions at a particular site than they are to the classification of golf course greens as either good or poor performing. Unfortunately, the good and poor rating assigned by golf course superintendents is probably too subjective to provide useful information regarding the impact of nematodes. For example, a poor green may be plagued with inadequate drainage that results in low green performance that is not related to nematode population. Likewise, a good green with healthy root systems will support higher nematode populations without obvious damage to the turf host. The real question lies in determining the impact of different nematode populations upon turf grown under a range of stressful conditions. Plant stress levels and nematode population levels need to be evaluated together to determine conditions that result in severe turf damage. Only then can a recommendation be made with confidence that treatment to control nematodes will result in improved turf quality.

In addition to the subjective nature of the good and poor ratings used in this study and in the Washington study, the time of sampling may have influenced the outcome of the results. For example, if nematode populations peak in mid summer and the nematode-damaged turf declines through September, nematode populations that induced the turf decline may drop as the roots are killed. The result would be lower nematode populations in a green that only a few weeks before was capable of supporting high nematode populations. This may be the explanation for the difference in population trends observed in the California and Washington studies. In California, poor greens tended to have the same number of nematodes as the good greens. Alternatively, in Washington, poor greens tended to have higher nematode levels than those found in the good greens (Table 2). The samples in the Washington study were collected between July and September and the samples used in this study were collected at the end of September. In addition to the later sampling time used in this study, temperatures in southern California are generally warmer than Washington and population declines might be expected to be earlier in the year. Routine sampling throughout the year will be needed to determine population fluctuations and the optimum time for sampling.

Regardless of the impact of population fluctuations throughout the year, this study and the Washington study both revealed significant correlations between nematode populations in good and poor greens. This information highlights the importance of the environmental conditions at each of the sampling sites. Further study of these environmental conditions (temperature, sand composition, soil moisture, soil microbiology etc.) may reveal conditions that can be used in a nematode abatement program. Currently, nematodes alone do not appear to be the primary cause of poor green performance in southern California.

References

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