Nematode Investigations On Putting Green Turf

BY GENE C. NUTTER AND J. R. CHRISTIE

Associate Turf Technologist and Nematologist, respectively University of Florida, Agricultural Experiment Station, Gainesville, Fla.

Nematodes have been recognized as parasites on turf grasses only within the past decade. While these pests have been investigated for many years on other crops, it was not until 1951 that Tarjan and Ferguson (8) reported the first association of nematodes with turf decline. This report involved the stunt nematode (**Tylenchorhynchus** sp.) on bentgrass and was described as "yellow tuft" disease. In a recent paper Nutter (5) reviews development of the nematode problem in turf on a national scale.

In Florida, Prof. Erdman West, of Gainesville, and Dr. J. R. Christie, of Sanford (unpublished accounts) were among the first to suspect nematode damage on turf grasses. Kelsheimer and Overman (2) reported several nematodes associated with declining Bermuda and St. Augustine grasses in the Tampa Bay area in 1953. Christie et al (1) summarized quantitative and qualitative aspects of nematode samples collected throughout the state. Experiments by Overman (6) indicated the possibility of controlling certain species of nematodes in established turf without serious injury to the grass. Nutter et al (3) reported results of control experiments involving three nematode species on St. Augustine grass. Work was initiated in 1956 by Nutter and Whitton (4) to investigate the biological relationship between certain species of parasitic nematodes and four major turf grasses.

This paper reports nematodes population trends and results of nematocide treatments on an experimental putting green at the Florida Agricultural Experiment Station turf research nurseries during 1957 and 1958.

Experimental Procedure

The experimental green was built in the spring of 1955 to study the interaction of nitrogen source and thatch control on five putting green varieties of Bermudagrass. Activated sewerage sludge (A.S.), ammonium nitrate (A.N.) and urea-formaldehyde (U.F.) forms of nitrogen were applied in a factorial arrangement involving different rate-frequency combinations, all totaling 36 pounds of nitrogen per 1,000 square feet per year. A blanket application of an 0-12-12 fertilizer was made every four months at the rate of 500 pounds per acre. The turf was uniformly maintained under putting green conditions regarding mowing, irri-

A paper presented at the 1958 meetings of the Florida State Horticultural Society, Clearwater, Fla., Nov. 6, 1958.

Acknowledgment and appreciation are due Messrs. R. A. Lagasse, Turf Research Field Foreman, and W. H. Thames, Jr., Instructor in Soils (Nematology), University of Florida, for able assistance in this work.

1 This study partially conducted on grants from the USGA Green Section and the E. I. duPont de Nemours Company.

gation and pest control measures. Fertility treatments were initiated in the Fall of 1956 after the grass had become uniformly established.[1]

1957 Treatment: Early in the summer of 1957 decline in vigor and general chlorosis became pronounced on the green in a pattern not apparently associated with fertility treatments. Preliminary inspection indicated the presence of parasitic nematodes. All plots were sampled in early August and nematode analyses were conducted using the Baermann technique as modified by Christie. Nematode counts were made on an aliquot sample basis.

After sampling, the entire green was aerified and treated with 0-2-4-dichlorophenyl o, o-diethyl phosphorothioate (VC-13) at the rate of 20 gallons per acre using a spray boom which delivered approximately 50 gallons per acre of total liquid. Following treatment the green was irrigated with one acre-inch of water as a sealing agent. Some phytotoxicity was observed following treatment but the grass recovered and the condition of the green improved until the approach of the unusually cool winter when occasional frost damage occurred.

1958 Treatment: By mid-summer of 1958 turf decline and chlorosis again became evident. Nematode analyses were conducted in early August. On August 22, the green was aerified and half of every plot treated with 1,2-dibromo-3-chloropropane (Nemagon) at five gallons per acre (active). Application was with a hose attachment sprayer which applied approximately 2,200 gallons of solution per acre. A second workman followed immediately after the sprayman applying a water seal until no odor of the chemical could be detected. After this treatment, another half-inch of water was applied through the irrigation system.

Nematode counts were determined on both treated and untreated halves of 32 randomly selected plots three and eight

Table 1
The Population Trend from 1957 to 1958 of Four Species of Nematodes on an Experimental Bermudagrass Green.

Nematode Species	Average Nematode Count [1] August 1957	August 1958	% Increase 1957-1958
lance	71	223	213%
ring	26	106	316%
sting	27	65	145%
awl	19	33	76%
Average	36	107	200%

1 Based on average sample counts (150 cc. sample) from 32 randomly selected plots.

Table 2

The Effect of Three Nitrogen Sourses on the Population of Four Nematode Species on an Experimental Bermudagrass Green from August 1957 to August 1958 1/

	Nitrogen Source								
	Ammonium Nitrate			Activated Sludge			Urea-Form		
Nematode Species	Nematode Count 1957	1958	% Increase 1957-1958	Nematode Count 1957	1958	% Increase 1957-1958	Nematode Count 1957	1958	% Increase 1957-1958
lance	106	398	276%	39	111	185%	77	135	75%
ring	38	149	293%	49	88	77%	8	21	152%
sting	34	106	213%	39	52	33%	10	32	415%
awl	80	124	57%	0.5	9	1700%	0.6	0	−500%
Overall Average	64	195	202%	32	65	632%	24	47	36%
Overall Average Minus awl	60	218	261%	43	84	98%	32	62	214%

1/ Based on average nematode sample counts (150 c.c. sample) from eight randomly chosen replicates of each nitrogen source.

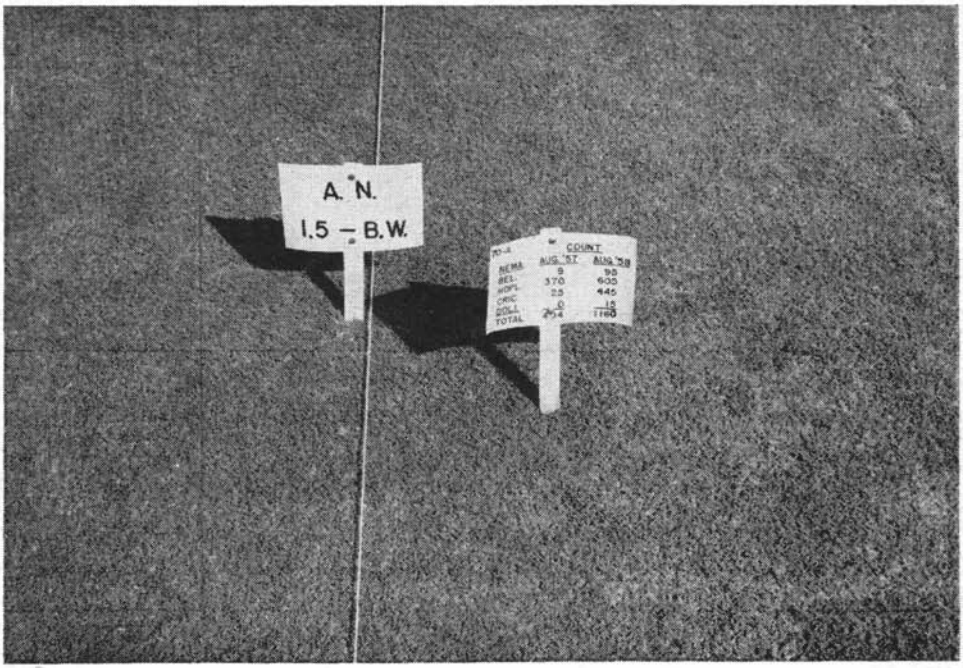
weeks after treatment. Turf quality evaluations (separate color and density ratings) were made after eight weeks.

Results and Discussion

The nematode population on the experimental green showed an overall 200 per cent increase from August, 1957 to August, 1958 (Table 1), despite the nematocide application in August, 1957 and the unusually cool winter which followed. Among the four principal species present, ring nematodes (**Criconemoides** spp.) showed the greatest increase—316 per cent; followed in order by lance (**Hoplolaimus tylenchiformis**)—213 per cent; sting (**Belonolaimus longicaudatus**)—145 per cent; and awl (**Dolicodorus** sp.)—76 per cent. The lance species exhibited the highest average sample count in 1958 followed in order by ring, sting and awl nematodes. Figure 1 shows a typical nematode count increase on one of the A.N. plots.

Table 2 summarizes the effect of nitrogen source upon the population behavior of the four species of nematodes involved. In this test complex interactions are evident between nitrogen source and nematode species. Disregarding awl nematode because of the low count—particularly on the A.S. and U.F. plots—the overall nematode population increase was notably less on the A.S. than on the A.N. or U.F. plots (an average of 98 as compared to 261 and 214 per cent respectively). In contrast, turf quality was highest on the A.S. plots (Table 4). Perhaps the activated sewerage sludge created soil conditions which were more favorable to the development of predators, thereby holding the build-up of parasitic nematodes more in check than in the case of other nitrogen sources. Apparently the soil environment created by the continuous application of the three nitrogen sources differentially affected population behavior both within and among nematode species.

Results of the 1958 Nemagon treatment on nematode population are given in Table 3. The figures show per cent nematode count reduction in treated versus untreated halves of the involved plots.



Typical increase in total nematode count and species distribution from August 1957 to August 1958. The Bermudagrass variety is Everglades; the fertility treatment ammonium nitrate.

Table 3

The Population Status of Five Species of Nematodes on Untreated Versus Plots Treated with Nemagon at Five Gallons Per Acre, Three and Eight Weeks After Treatment

Nematode Species	Average Nematode Count [1/] Three Weeks after Treatment			Eight Weeks after Treatment		
	Untreated	Treated	% Reduction	Untreated	Treated	% Reduction
lance	107	8	1237%	188	6	3033%
ring	79	4	1875%	278	11	2427%
sting	57	8	613%	151	2	7450%
awl	48	1—	6718%	49	1—	6323%
stubby-root	15	8	88%	5	103	—1960%
Overall Average	61	6	2106%	134	25	3455%
Overall Av. Minus stubby-root	73	5	2611%	167	5	4808%

1/ Based on average nematode sample counts (150 c.c. sample) from treated and untreated halves of fifteen randomly chosen plots.

Three weeks after treatment the reduction in nematode count was pronounced. Results were even more marked at the end of eight weeks. At this time, count reduction was greatest with sting nematodes, followed in order by awl, lance and ring nematodes.

The one striking exception to the excellent control involved stubby-root nematode (**Trichodorus** sp.). This species was not observed on the green until the sampling three weeks after treatment. The rapid build-up of this species following nematocidal treatment has been observed in several cases. Perry (7) reported such a build-up following fumigation with D.D. in vegetable beds. Nutter and Whitton (4) encountered the same behavior following sterilization with methyl bromide. Apparently, residual control of this nematode is not possible with the presently available materials.

Eight weeks after application of the nematocide, turf quality was improved to a marked degree on treated versus untreated areas. There was, however, an obvious interaction with nitrogen source as indicated in Table 4. The Nemagon treatment resulted in an average overall improvement in turf quality of 44 per cent on A.N. and U.F. plots compared to only a 12 per cent improvement on A.S. plots. However, it should also be noted from Table 4 that the turf on the A.S. plots was in better condition prior to the nematocide treatment than was the case with the other nitrogen sources. This fact may be associated with the slower rate of nematode build-up on the A.S. plots as discussed above. Turf color improved more rapidly following treatment than turf density. Both are combined in Table 4 to indicate overall turf quality improvement.

Summary

1. Nematode control studies were conducted in 1957 and 1958 on an experi-

Table 4

The Effect of Nematicide Treatment and Nitrogen Source on Turf Quality of an Experimental Bermudagrass Green Eight Weeks After Treatment with Nemagon at the Rate of Five Gallons per Acre (Active)

Nitrogen Source	Average Turf Quality 1/ Color Untreated	Color Treated	Color % Improvement	Density Untreated	Density Treated	Density % Improvement	% Overall Improvement (Color + Den.) ÷ 2
Ammonium Nitrate	1.44	2.34	62.5%	2.43	3.06	25.9%	44.2%
Activated Sludge	2.87	3.37	17.4%	3.81	4.06	6.6%	12.0%
Urea-Form	1.41	2.25	59.6%	2.31	3.00	29.9%	44.8%
Average	1.91	2.66	46.5%	2.85	3.71	20.8%	33.7%

1/ Turf Quality ratings: 1 — very poor, 2 — poor, 3 — fair, 4 — good, 5 — very good, 6 — excellent

mental putting green at the Florida Agricultural Experiment Station turf research nurseries. Nematode counts were taken before treatment in the fall of 1957 and before and after treatment in 1958. Turf quality was also evaluated.

2. Populations of sting, ring, lance and awl nematodes showed an average overall increase of approximately 200 per cent from August 1957 to August 1958 despite the 1957 nematocide treatment.

3. Under the conditions of this experiment nematode population behavior was influenced by nitrogen source, both within and among species.

4. In the 1958 test, Nemagon at five gallons per acre produced outstanding reduction in the overall nematode population eight weeks after treatment. The striking exception was stubby-root nematode which demonstrated rapid and severe population build-up following treatment.

5. Turf quality improved following treatment, but was influenced by nitrogen source.

6. The authors believe that close mowing, soil aeration, high gallonage application and an immediate water seal are essential techniques for successful nematocide treatment to established turf. The soil should be moist prior to application.

7. Much research is needed on both the ecological factors affecting nematode population behavior and aspects of economic control of principal species of nematodes parasitic to turf.

References

(1.) Christie, J. R., J. M. Good, Jr., and G. C. Nutter. Nematodes associated with injury to turf. Proc. Fla. Soil Sc. Soc. 14:167-169. 1954.

(2.) Kelsheimer, E. G. and A. J. Overman. Notes on some ectoparasitic nematodes found attacking lawns in the Tampa Bay area. Proc. Fla. Hort. Soc. 66:301-3. 1953.

(3.) Nutter, Gene C., J. M. Good, Jr., and J. R. Christie. Nematode investigations on Florida turf. Proc. Univ. of Fla. Turf Man. Conf. 3:133-41. 1955.

(4.) ————————and G. M. Whitton. Nematode investigations on turf grasses. Fla. Agricultural Exp. Sta. Ann. Rep't. :121-22. 1957.

(5.) ————————Nematode problems in turf. Golf Course Reporter 26 (7) 5-9. 1958.

(6.) Overman, A. J. Use of nematocides on established turf. Proc. Fla. Soil Sc. Soc. 14:170-73. 1954.

(7.) Perry, V. G. Return of nematodes following fumigation of Florida soils. Proc. Fla. St. Hort. Soc. 66: 112-14. 1953.

(8.) Tarjan, A. C. and M. H. Ferguson. Observation of nematodes in yellow turf of bentgrass. USGA Journal 4(2):28-30. 1951.