PLANT-PARASITIC NEMATODES ASSOCIATED WITH HYBRID BERMUDAGRASS AND CREEPING BENTGRASS PUTTING GREENS IN ALABAMA

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RESUMEN

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Se condujo un censo para determinar los géneros de nematodos fitoparásitos más comúnmente asociados con los híbridos del pasto bermuda (*Cynodon dactylon* × *C. transvaalensis*) y el pasto rastreo bent (*Agrostis palustris*) cultivados como putting greens en los campos de golf de Alabama, e identificar los niveles de infestación. Muestras de suelos se colectaron de putting greens cultivados con 1-3 híbridos de pasto bermuda o del pasto rastrero bent en 70 campos de golf. Nueve géneros de nematodos fitopárasitos se identificaron en 157 putting greens de pasto bermuda de 70 campos de golf. *Mesocriconema, Helicotylenchus, Hoplolaimus, Meloidogyne, Tylenchorhynchus, Hemicycliophora, Belonolaimus, Paratrichodorus, y Pratylenchus* spp. se encontraron en 96, 61, 46, 37, 23, 21, 9, 5 y 2% de los campos y en 80, 39, 31, 16, 10, 10, 4, 2 y 1% de los putting greens censados, respectivamente. Densidades poblacionales por encima de los niveles del umbral de acción para aplicación de nematicida se encontraron en cinco putting greens infestados con Hoplolaimus y solamente en uno por cada uno de los siguientes géneros: Helicotylenchus, Hemicycliophora, y Belonolaimus. Cinco géneros de nematofos fitoparásitos se identificaron en 36 putting greens de pasto bent en 13 campos de golf. *Helicotylenchus, Mesocriconema, Tylenchorhynchus, Hoplolaimus* y *Meloidogyne* spp. se encontraron en 77, 69, 46, 15, y 8% de los campos censados y en 56, 53, 28, 11, y 6% de putting greens muestreados respectivamente. Densidades poblacionales por encima de los niveles del umbral de acción se observaron en dos putting greens para *Helicotylenchus* y en uno para *Tylenchorhynchus*.

Palabras claves: Agrostis palustris, Belonolaimus, Cynodon dactylon × *C. transvaalensis, Helicotylenchus, Hemicycliophora, Hoplolaimus, Meloidogyne, Mesocriconema*, nematodo, nematodo agallador de raíz, nematodo anular, nematodo atrofiador, nematodo lanceta, nematodo lesionador de raíz, nematodo de la vaina, nematodo espiral, nematodo pinchador, nematodos de las raíces regordetas, Paratrichodorus, pasto bermuda, pasto rastreo bent, *Pratylenchus,* putting greens, *Tylenchorhynchus*.

There are currently over 300 golf courses in Alabama. Putting greens on these courses are comprised of either hybrid bermudagrass (*Cynodon dactylon* × *C. transvaalensis* (L.) Pers.) or creeping bentgrass (*Agrostis palustris* Huds.). At least 10 genera of plant parasitic nematodes have been recovered in routine assays of soil from putting greens of both turfgrasses in Alabama including *Belonolaimus*, *Helicotylenchus*, *Hemicycliophora*, *Hoplolaimus*, *Meloidogyne*, *Mesocriconema*, *Paratrichodorus*, *Pratylenchus*, *Tylenchorhynchus*, and *Xiphinema* (Mullen, 1998). High population levels of many of these genera can cause severe damage to turfgrass putting greens (DiEdwards, 1963; Dunn and Noling, 1997; Johnson and Powell, 1968; Johnson, 1970; Lucas, 1982; Lucas *et al.*, 1974; Todd and Tisserat, 1990; and Winchester and Burt, 1964). Detailed information concerning the distribution, population levels, and economic importance of plant-parasitic nematodes associated with putting greens in Alabama is lacking.

The purpose of this study was to determine which plant-parasitic nematode genera were most commonly associated with

hybrid bermudagrass and creeping bentgrass putting greens in Alabama. We also intended to ascertain their infestation levels to determine the percentage of putting greens with nematode populations above action threshold levels, where the use of a nematicide may be warranted.

Soil samples were collected from one to three putting greens randomly selected on each of 70 golf courses throughout Alabama in 1996. Fifty-seven courses had hybrid bermudagrass putting greens and 13 had creeping bentgrass putting greens. Soil type varied greatly among putting greens due to the wide range of native soils found in the State. Courses in the southern, central, and northern counties of the state were sampled in June, July, and August, respectively. A total of 29 courses were sampled in the southern counties, 19 in the central counties, and 22 in the northern counties. Due to the Alabama climate, bentgrass putting greens were located only in central and north Alabama. Each green was sampled by removing 20 soil cores (2.5-cm diam. × 8-cm deep) at roughly equal intervals in a zig-zag pattern across the green. Nematodes were extracted from a 100-cm^3 subsample with a centrifugal flotation technique (Jenkins, 1964). Plant-parasitic nematodes were identified to genus and counted.

Population levels of individual genera were compared to action threshold levels (minimum levels of nematodes that may justify nematicide treatment) used by the Alabama Cooperative Extension Service (Austin Hagan, pers. comm.) for making nematicide recommendations for commercial golf courses. For both bermudagrass and bentgrass greens in Alabama, the threshold levels per 100 cm^3 soil are: *Helicotylenchus* = 300, *Hoplolaimus* = 60, *Meloidogyne* = 80, *Mesocriconema* = 500, *Tylenchorhynchus* = 1 000, *Hemicycliophora* = 80, *Belonolaimus* = 10, *Paratrichodorus* = 100, per 100 cm^3 soil.

From the 57 hybrid bermudagrass courses, nine genera of plant-parasitic nematodes were extracted from soil cores collected from a total of 157 putting greens (Table 1). The genera most frequently found were *Mesocriconema*, *Helicotylenchus*, *Hoplolaimus* and *Meloidogyne,* which were found on 96, 61, 46 and 37% of the golf courses surveyed and on 80, 39, 31 and 16% of the putting greens sampled, respectively. *Tylenchorhynchus, Hemicycliophora*, *Belonolaimus*, *Paratrichodorus* and *Pratylenchus* spp. were found on less then 23% of the golf courses surveyed and on fewer than 10% of the putting greens sampled. *Hoplolaimus* populations were found above action threshold levels in five of the putting greens sampled. Population densities above action threshold levels were found on one putting green each for *Helicotylenchus*, *Hemicycliophora* and *Belonolaimus*.

Five genera of plant-parasitic nematodes were extracted from soil samples collected from 36 creeping bentgrass putting greens collected from 13 golf courses (Table 2). *Helicotylenchus*, *Mesocriconema* and *Tylenchorhynchus* were the most frequently occurring genera found on 77, 69 and 46% of the golf courses surveyed and on 56, 53 and 28% of the putting greens sampled, respectively. *Hoplolaimus* and *Meloidogyne* spp. were found on 15 and 8% of the golf courses surveyed and on 11 and 6% of the putting greens sampled, respectively. Population densities above action threshold levels were observed on two putting greens for *Helicotylenchus* and on one green for *Tylenchorhynchus*.

Nematode genera that occurred in 5% or more of the putting greens sampled were distributed throughout the state. Plant-parasitic nematodes were found in a higher proportion of hybrid bermudagrass than on creeping bentgrass greens with the exception of *Hoplolaimus* and *Tylenchorhynchus* spp. (Tables 1 and 2). Four genera found on hybrid bermudagrass (*Belonolai-*

Table 1. Frequency of occurrence and population density of plant parasitic nematodes in soil samples from hybrid bermudagrass putting greens in Alabama, 1996.

Nematode genus	Golf courses with nematode (%)[v]	Greens with nematode (%)[w]	Nematodes per 100 cm^3 soil		Populations above threshold levels[z]
			Mean[x]	Maximum[y]	
Mesocriconema	96.4	80.2	34	306	0
Helicotylenchus	61.4	39.4	34	664	1
Hoplolaimus	45.6	30.5	26	126	5
Meloidogyne	36.8	15.9	11	58	0
Tylenchorhynchus	22.8	9.5	16	58	0
Hemicycliophora	21.0	9.5	26	204	1
Belonolaimus	8.7	3.8	4	12	1
Paratrichodorus	5.2	1.9	2	4	0
Pratylenchus	1.7	1.2	3	4	0

[v]Percentage of golf courses with at least one nematode-infested putting green. Percentage based on 57 golf courses with one to three putting greens sampled on each golf course.
[w]Percentage based on a total of 157 bermudagrass putting greens.
[x]Mean population density from bermudagrass putting greens in which the nematode was found.
[y]Maximum population found in soil samples from individual bermudagrass putting greens.
[z]Threshold levels (minimum levels of nematodes that may justify nematicide treatment): *Mesocriconema* = 500, *Helicotylenchus* = 300, *Hoplolaimus* = 60, *Meloidogyne* = 80, *Tylenchorhynchus* = 1,000, *Hemicycliophora* = 80, *Belonolaimus* = 10, *Paratrichodorus* = 100 (Austin Hagan, pers. comm.).

mus, *Hemicycliophora*, *Paratrichodorus* and *Pratylenchus*) were not found on creeping bentgrass. However, average population density for four of the five genera associated with both turfgrass species was higher on bentgrass than on hybrid bermudagrass putting greens (Tables 1 and 2).

Our results agree with previous reports that indicate a variety of nematode genera are associated with turfgrass in the southeastern region of the United States (DiEdwards, 1963; Good *et al.*, 1959; Lucas *et al.*, 1974; Parris, 1957). *Mesocriconema* and *Helicotylenchus* spp. were both found in a high percentage of hybrid bermudagrass and creeping bentgrass putting greens in Alabama, which is similar to what had been observed in the other states. *Hoplolaimus* and *Tylenchorhynchus* spp. also were relatively common, with *Hoplolaimus* occurring more frequently on hybrid bermudagrass and *Tylenchorhynchus* more frequently on creeping bentgrass. The genus *Meloidogyne* was much more common on bermudagrass greens then on creeping bentgrass as was observed in North Carolina (Lucas *et al.*, 1974). *Belonolaimus*, *Hemicycliophora*, *Paratrichodorus* and *Pratylenchus* spp., which were only found on hybrid bermudagrass in this study, have all been previously reported on creeping bentgrass (Riedel, 1979; Robbins and Barker, 1973). The low occurrence of *Belonolaimus* could be expected since it is only found in very sandy soils, which are not common in the state (Brodie and Quattlebaum, 1970; Dunn and Noling, 1997). *Paratrichodorus* was relatively common in other turfgrass surveys conducted in the southeast but not in this study (Good *et al.*, 1959; Lucas *et al.*, 1974).

Table 2. Frequency of occurrence and population density of plant parasitic nematodes in soil samples from creeping bentgrass putting greens in Alabama, 1996.

Nematode genus	Golf courses with nematode (%)[v]	Greens with nematode (%)[w]	Nematodes per 100 cm³ soil		
			Mean[x]	Maximum[y]	Populations above threshold levels[z]
Helicotylenchus	76.9	55.5	146	1 318	2
Mesocriconema	69.2	52.7	132	366	0
Tylenchorhynchus	46.1	27.7	350	1 608	1
Hoplolaimus	15.3	11.1	10	32	0
Meloidogyne	7.6	5.5	27	36	0

[v]Percentage of golf courses with at least one nematode-infested putting green. Percentage based on 13 golf courses with one to three putting greens sampled on each golf course.
[w]Percentage based on a total of 36 creeping bentgrass putting greens.
[x]Mean population density from creeping bentgrass putting greens in which the nematode was found.
[y]Maximum population found in soil samples from individual bentgrass putting greens.
[z]Threshold levels (minimum levels of nematodes that may justify nematicide treatment): *Mesocriconema* = 500, *Helicotylenchus* = 300, *Hoplolaimus* = 60, *Meloidogyne* = 80, *Tylenchorhynchus* = 1 000, *Hemicycliophora* = 80, *Belonolaimus* = 10, *Paratrichodorus* = 100 (Austin Hagan, pers. comm.).

The greater number of nematode genera isolated and the higher percentage of hybrid bermudagrass putting greens infested, compared to creeping bentgrass greens, is likely due to the period when soil samples were obtained. Golf courses in the southern, central, and northern counties of Alabama were sampled in June, July, and August, respectively, coinciding with the warmest months of the year for the State. The optimum time to take samples for nematode assay in the southeastern United States for warm-season grasses such as bermudagrass is June through August, whereas, the optimum months for sampling a cool-season turfgrass such as creeping bentgrass are September, October, or April (Davis *et al.*, 1996). Time constraints and the considerable distance between golf courses restricted the time of year when courses could be surveyed and the number of greens sampled per course. Sampling of bentgrass greens at the optimum time probably would not have significantly increased the frequency of genera identified but may have increased the number of individual populations above action threshold levels.

Nematode populations were above threshold levels in 11 of the 193 (5.7%) hybrid bermudagrass or creeping bentgrass putting greens sampled (Tables 1 and 2). *Hoplolaimus* and *Helicotylenchus* were the only genera found above threshold levels on more than one green in this survey. Species of both genera have been shown to suppress turfgrass growth (Perry *et al.*, 1971; Todd and Tisserat, 1990; Vargas, 1994). Todd and Tisserat (1990) reported that foliar damage and/or decreased growth of bentgrass was correlated with high numbers of *Hoplolaimus galeatus* (Cobb) Thorne and *Helicotylenchus pseudorobustus* (Steiner) Golden; however, damage or growth reduction was not observed in the second year of their study, indicating that damage thresholds for bentgrass may fluctuate from year to year depending on envi-

ronmental factors. It is believed that golf greens that are well maintained through a proper fertility and water management program may withstand higher nematode populations than the action thresholds reported by individual states.

This study showed that a wide variety of plant-parasitic nematode genera are associated with hybrid bermudagrass and creeping bentgrass putting greens in Alabama. It also found that population densities were high enough to warrant treatment with a nematicide in nearly 6% of the putting greens sampled. We estimate that less then 10% of the golf courses in Alabama check for nematodes on a regular basis mainly due to a lack of an understanding of the pest and the symptoms they cause.

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