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Vertical Distribution of Three Nematode Genera in a Bentgrass Putting Green in Central Illinois[1]

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Abstract: A study was conducted to determine the vertical distribution of *Tylenchorhynchus nudus, Criconemella curvata,* and *Helicotylynchus cornurus* in the upper 5 cm of bentgrass (*Agrostis palustris* cv. Penncross) putting green turf. The effect of fenamiphos on the vertical distribution of these species also was examined. Experimental design was a split-plot in which whole-plots were fenamiphos treated (0.11 kg a.i./100 m^2) or untreated, and sub-plots were two strata (depths of 0–2.5 cm and 2.5–5.0 cm). Soil samples were collected during the growing season for 2 years after treatment to determine root weight and number of nematodes. Root weight was greater in the upper stratum on all sampling dates in both years. When differences between strata in population density were observed, *T. nudus, C. curvata,* and *H. cornurus* were more concentrated in the upper stratum. Vertical distribution of *T. nudus, C. curvata,* and *H. cornurus* was similar to the distribution of root weight. The difference in population density of *H. cornurus* between upper and lower strata was affected by fenamiphos on some dates, whereas differences between strata were unaffected for *T. nudus* and *C. curvata.* Double arcsine transformed proportions of the total populations of *T. nudus, C. curvata,* and *H. cornurus* in the upper stratum on each sampling date indicated no differences between fenamiphos treated and untreated plots in 1989 or 1990.
Key words: Agrostis palustris, bentgrass, *Criconemella curvata, Helicotylenchus cornurus,* nematode, stratification, turfgrass, *Tylenchorhynchus nudus,* vertical distribution.

Nematode populations can vary due to variation in soil conditions (13). Brodie (2) found that populations of *Belonolaimus longicaudatus* Rau, *Pratylenchus brachyurus* (Godfrey) Filipjev & Schuurmans Stekhoven, and *Paratrichodorus christiei* Allen in the same soils were not distributed uniformly among soil depths. These differences were attributed to factors such as soil temperature and soil composition. Vertical distribution (vertical stratification) of nematode populations under grape (1,4) was similar to root distribution as was *Globodera rostochiensis* Wollenweber distribution under potato (11).

Several studies have examined the vertical distribution of nematodes through time. MacGuidwin (8) determined that *Longidorus breviannulatus* Norton & Hoffman under corn and potato was concentrated at 0–15 cm deep early in the season but at 15–30 cm deep late in the season. *Pratylenchus scribneri* Steiner was in the top 15 cm in samples taken to 37.5 cm deep on most sampling dates over a 2-year period on corn and potato (9).

Wick (14,15) determined that nematode species tend to be distributed nonuniformly (vertically stratified) in New England golf greens. *Tylenchorhynchus* sp. and *Criconemella* sp. were usually most abundant in the upper 5 cm of soil, whereas *Pratylenchus* sp. was more evenly distributed throughout the upper 10 cm of soil. Nematodes were more abundant in the top 10 cm than deeper in the soil.

This study was performed to describe the vertical distribution of *Tylenchorhynchus nudus* Allen, *Criconemella curvata* (Raski) Luc & Raski, and *Helicotylenchus cornurus* Anderson in the top 5 cm of bentgrass putting green turf throughout the year in Illinois. The effect of an application of fenamiphos on the vertical distribution of these species also was evaluated.

MATERIALS AND METHODS

A field test was conducted during 1989 and 1990 on the University of Illinois

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Landscape Horticulture Research Facility in Urbana, Illinois. Bentgrass (*Agrostis palustris* Huds. cv. Penncross) was maintained 0.64 cm tall as a golf course putting green turf and was irrigated with 2.5 cm water/week. Fungicides were applied as needed, but insecticides were not applied during this study.

A split-plot experimental design with six complete blocks was used. Whole-plots, 1.5 × 3.7 m, either were treated with fenamiphos or untreated. Sub-plots were two soil strata, 0–2.5 cm and 2.5–5.0 cm deep. The two strata were chosen because of differences in root distribution and sand content of the soil. Soil particle size composition was 21% sand, 57% silt, and 22% clay in the 0–2.5 cm stratum, and 15% sand, 62% silt, and 23% clay in the 2.5–5.0 cm stratum. Approximately 99% of the root mass was in the 0–5 cm zone, and soil near the surface generally had a higher sand content than lower soil layers. Replicates were separated by 0.9-m buffer zones of untreated turf. Fenamiphos 10G was applied at 0.11 kg a.i./100 m^2 on 15 May 1989 with a push-type granular applicator.

Soil samples were collected from a 30 cm × 3.7 m strip in the center of each plot on 14 May, 20 June, 20 July, and 13 September 1989, and on 26 March, 28 April, 5 June, 12 July, 6 September, and 24 October 1990. Approximately 25 soil cores per whole-plot unit were collected with a 1.3-cm-diameter probe. Foliage and thatch were removed, the cores divided into the 0–2.5 cm and 2.5–5.0 cm strata, and then the cores from each stratum were composited. A 50-cm^3 subsample of the composite sample was used for extraction of nematodes and roots. Roots were extracted by wet sieving through an 850-μm pore opening screen. Nematodes were extracted by the centrifugal-flotation method (7) and counted. All recovered roots were placed in small paper bags and dried in an oven at 70 C for 24 hours, brought to room temperature, and weighed.

Variables analyzed were the number of nematodes per species, dry root weight, and number of nematodes per g dry root. A least significant difference (LSD) was calculated to make comparisons between subplot units (strata) within a whole-plot unit (nematicide treatment) (6) for each date. The double arcsine transformed proportions (5) of nematodes in upper stratum of whole-plot units were compared on each date.

Results and Discussion

When nonuniform distribution between strata was observed in either treated or untreated plots, *T. nudus, C. curvata,* and *H. cornurus* were more abundant in the upper 2.5 cm than in the lower 2.5 cm of soil (Fig. 1). Populations of *H. cornurus* were always distributed nonuniformly in untreated plots in 1989 and 1990, and populations of *T. nudus* were distributed nonuniformly between strata in untreated plots on all sampling dates in 1990. Root weight was greater in the 0–2.5 cm stratum than in the 2.5–5.0 cm stratum on all sampling dates in both fenamiphos-treated and untreated plots in both years (Fig. 2). When these data were computed as nematodes per g of dry root, values were greater in the lower stratum.

Even though more nematodes occurred in the top stratum, population levels per gram of dry root were higher in the lower stratum than in the upper stratum. Consequently, more damage to the roots caused by nematodes should occur in the 2.5–5.0 cm depth stratum than in the 0–2.5 cm depth stratum. Our study indicates that during much of the year less than 10% of the root weight is in the lower stratum, so even if roots in this region are damaged, the injury may not create enough stress to affect the foliar portion of the plant. Though undocumented, we believe it is unlikely that the depth of a root in the top 5.0 cm of the putting green profile affects that root's relative importance to the plant: a gram of root material in the lower stratum should supply the same amount of water and nutrients to the plant as a gram of root material in the upper stratum. Whether nematode damage in the lower

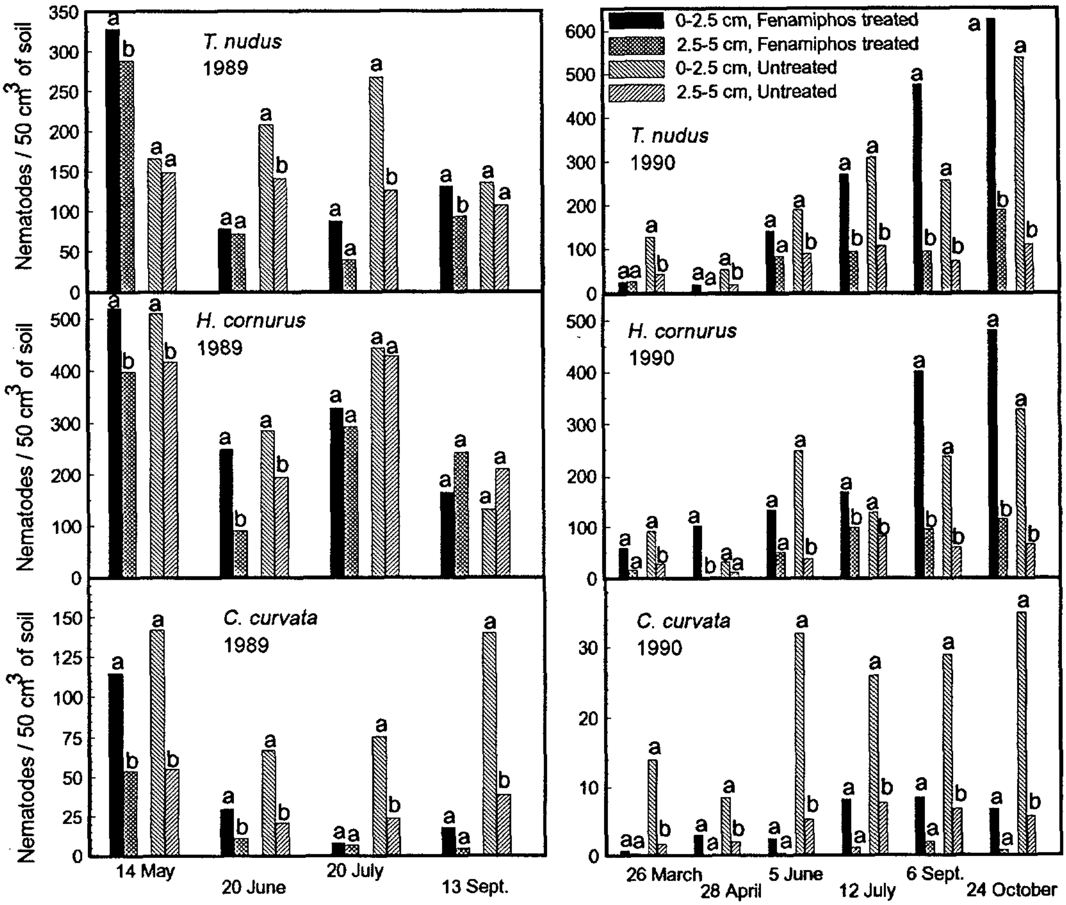

FIG. 1. Nematode population levels in two strata of soil in fenamiphos-treated and untreated plots. Comparisons by LSD (P = 0.05) are between strata within a nematicide treatment. Fenamiphos was applied following sample collection on 14 May 1989.

stratum seriously affects the foliar portion of plants should be influenced heavily by the sum of other stresses on the plant.

The nonuniform distribution of nematodes in this study is consistent with previous studies (1,4,8,9,11,14,15). *Tylenchorhynchus nudus, C. curvata, H. cornurus,* and dry root weight generally were more concentrated in the upper stratum than the lower stratum. Vertical distribution of nematodes has been reported previously to be similar to vertical distribution of roots (4,11). Knowing this distribution is important for sampling since sampling depth will influence both the number and species of nematodes recovered if nematode populations are distributed nonuniformly in the soil profile (14,15).

Dry root weight was significantly different between fenamiphos-treated and untreated plots only on 26 March 1990 when nematode population densities were at a minimum and both the grass and nematodes were dormant. Since symptoms of nematode damage are the result of either physical injury or physiological changes in the plant (3,12), it is unclear why symptoms of nematode damage (reduced dry root weight) were observed only when the grass and nematodes were dormant.

A non-zero depth × nematicide interaction effect in the analysis of variance indicates that the factors are not acting independently of each other (10); i.e., fenamiphos decreased population density (numerically) more in the upper stratum

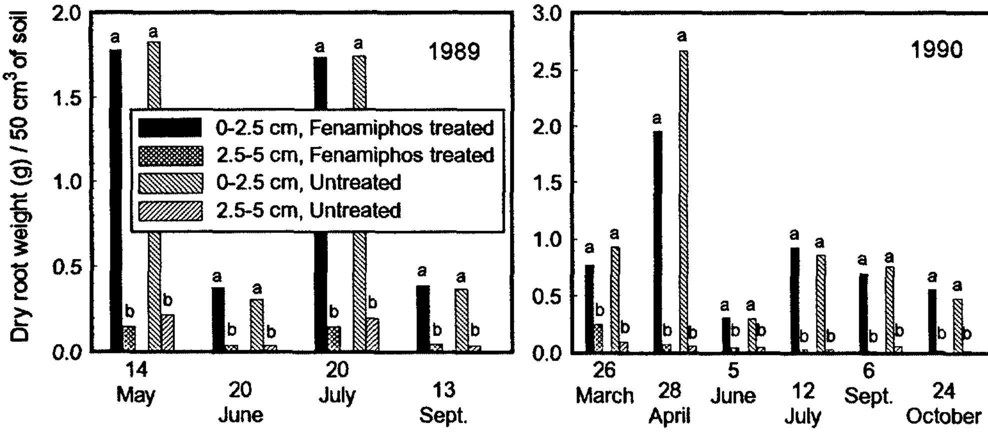

FIG. 2. Dry root weight in two strata of soil in fenamiphos-treated and untreated plots. Comparisons by LSD (P = 0.05) are between strata within a nematicide treatment. Fenamiphos was applied following sample collection on 14 May 1989.

than in the lower stratum, though the effects were proportional. Population densities of *H. cornurus* in the two strata were affected differentially by fenamiphos on 20 July in 1989 and on 26 March, 5 June, 6 September, and 24 October in 1990. Other variables in the two strata were not affected differentially by the nematicide treatment.

On each sampling date, a comparison between the upper stratum of fenamiphos-treated plots and the upper stratum of nontreated plots for the proportions of *T. nudus, C. curvata,* and *H. cornurus* indicated no significant differences. Fenamiphos reduced the number of nematodes present but did not affect the proportion of nematodes in the strata, which indicates that fenamiphos affected both strata proportionately.

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