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Population Fluctuations of Three Nematode Genera in Putting Greens in Northern Illinois[1]

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Abstract: Field experiments were conducted in 1989 and 1990 to examine the population fluctuation patterns of *Tylenchorhynchus nudus, Criconemella curvata,* and *Helicotylenchus cornurus* in mixed bentgrass and annual bluegrass putting greens on two golf courses near Chicago, Illinois, to determine if fluctuation patterns could be extrapolated to unsampled greens. Fenamiphos-treated and untreated plots were established on seven putting greens on two golf courses. Greens were sampled intensively five times during the growing season, and statistical comparisons of population levels per gram of root were made among dates for each green. Population levels per gram of root changed significantly on all greens in both years for each of the three nematode populations. Within a putting green in either year, population fluctuation patterns in fenamiphos-treated and untreated plots were similar. Population fluctuation patterns were different between years, however. Within a year, population fluctuation patterns among greens showed similarities indicating that carefully monitoring a few locations may allow extrapolation of population fluctuation data to other locations within that year.

Key words: Agrostis palustris, annual bluegrass, bentgrass, *Criconemella curvata,* golf course, *Helicotylenchus cornurus,* nematode, *Poa annua,* population dynamics, population fluctuation, putting green, turfgrass, *Tylenchorhynchus nudus.*

Cyclic (seasonal) fluctuations in nematode population densities occur when nematode communities are exposed to parasitism, competition, and seasonal climatic changes (21). These fluctuations may vary with geographical location (17). Temperature and moisture are the major controlling factors for nematode population fluctuations (1,9,10,12,15,21,22). Micro-climates, which can vary within very small areas due to different tillage systems (26) or edaphic factors (23), will influence plant-parasitic nematode populations. Temperature, a regulator of nematode metabolic rates, has been used as the primary parameter in simulations of nematode population changes (6,18). Temperature alone (25) and temperature plus moisture (15) have been correlated with egg production and nematode regeneration time. Irrigation reduces moisture fluctuations on golf course putting greens.

Nematode population dynamics studies may give insight into the basic ecology of nematodes (13,21) and may also be used in conjunction with damage functions to predict the potential for exceeding damage thresholds (5,7,16,19). If population dynamics are to be used for this purpose, then it is important to know if fluctuations can be extrapolated from one green to another and from one year to the next.

Wick (27,28) reported that nematode populations fluctuated differently among New England putting greens on the same golf course. Such asynchronous population changes precluded extrapolating the population fluctuations of a few carefully monitored greens to unsampled greens. The primary objective of this study was to examine the population fluctuation patterns of *Tylenchorhynchus nudus* Allen, *Criconemella curvata* (Raski) Luc and Raski, and *Helicotylenchus cornurus* Anderson in mixed bentgrass (*Agrostis palustris* Huds.) and annual bluegrass (*Poa annua* L.) putting greens near Chicago, Illinois, to deter-

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mine if data could be extrapolated to unsampled greens.

Materials and Methods

Tests were conducted during 1989 and 1990 on mixed bentgrass and annual bluegrass putting greens near Chicago, Illinois. Greens were selected for high numbers of nematodes and no previous history of nematicide application. Fungicides were applied as needed. Grass was mowed every day with a mower set to cut 0.3 cm high, and irrigation was applied as needed to minimize water stress.

Four putting greens were studied in 1989: greens 14 and 17 from a golf course in Homewood, Illinois (Ravisloe Country Club), and greens 5 and 9 from a golf course in Riverside, Illinois (Riverside Golf Club). In 1990, green 9 from the course in Homewood and greens 15 and 16 from the course in Riverside were studied. Different greens were used each year to avoid the possibility of residual effects of fenamiphos. Two treatments (fenamiphos treated and untreated) were arranged in randomized complete blocks with 10 replications per green in 1989 and eight in 1990. The plots used in 1989 on green 14 in Homewood and green 5 in Riverside were sampled again in 1990 to determine residual effects of fenamiphos application on population fluctuations, but only five replicates per green were sampled, and fenamiphos was not applied in 1990. Fenamiphos was applied at 0.11 kg a.i./100 m^2 on 30 May 1989 and 7 May 1990. Water (1.3 cm) was applied following nematicide application. Plots were 0.9 m × 3 m; a 30-cm-wide strip was sampled intensively within each plot to avoid interplot interference. Plots were sampled on 30 May, 26 June, 24 July, 11 September, and 6 November 1989. In 1990, plots were sampled on 7 May, 11 June, 23 July, 10 September, and 22 October. In addition, plots on green 14 at Homewood and green 5 at Riverside were also sampled on 16 April.

Plots were sampled by collecting approximately 30 soil cores per plot with a 1.3-cm-d probe. Foliage and thatch were removed, and each soil core was measured so that only the uppermost 5 cm of soil were included in the sample because we observed that approximately 99% of the root mass was in this zone. Nematodes and roots were extracted from a 50-cm^3 subsample by centrifugal-flotation (14). All roots present in this subsample were extracted by wet sieving and then dried at 70 C.

Population densities per 50 cm^3 soil and population densities per g dry root were plotted. The data for all greens are presented as nematodes per gram dry root. A split-plot in time analysis of variance was performed on root weight and nematode populations per gram of dry root for each of the locations. Least significant difference values were calculated (11) to compare subplots (dates) within whole plots (nematicide treatment).

Results

A significant fenamiphos × date interaction indicated that fenamiphos decreased the magnitude of differences among dates but generally did not eliminate differences among dates. The fenamiphos × date interaction was significant for nematodes per g dry root on green 14 in Homewood in 1989 (*T. nudus* and *H. cornurus*), green 17 in Homewood in 1989 (*T. nudus*), green 9 in Riverside in 1989 (*H. cornurus*), green 9 in Homewood in 1990 (*C. curvata*), greens 15 and 16 in Riverside in 1990 (*H. cornurus*), green 14 in Homewood in 1990 (*H. cornurus*), and green 5 in Riverside in 1990 (*T. nudus* and *C. curvata*).

The overall pattern of change in the population level for *C. curvata* over time was similar among plots within years, but not across years (Fig. 1). This trend also occurred with the other species. Within a green in either year, population fluctuation patterns of *C. curvata* in fenamiphos-treated and untreated plots tended to show general similarities, although population levels and the magnitude of fluctuations were reduced somewhat by fenami-

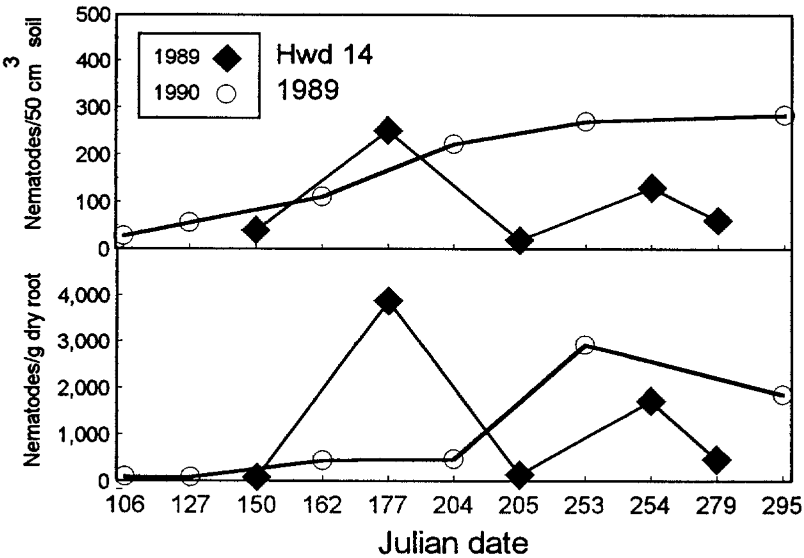

FIG. 1. Population fluctuations of *Criconemella curvata* in untreated plots in 1989 and 1990 in green 14 in Homewood, IL, expressed as nematodes/50 cm^3 soil and as nematodes/g dry root.

phos (Fig. 2). The population fluctuations of *T. nudus* in fenamiphos-treated and untreated plots were similar. The magnitude of population change of *H. cornurus* was

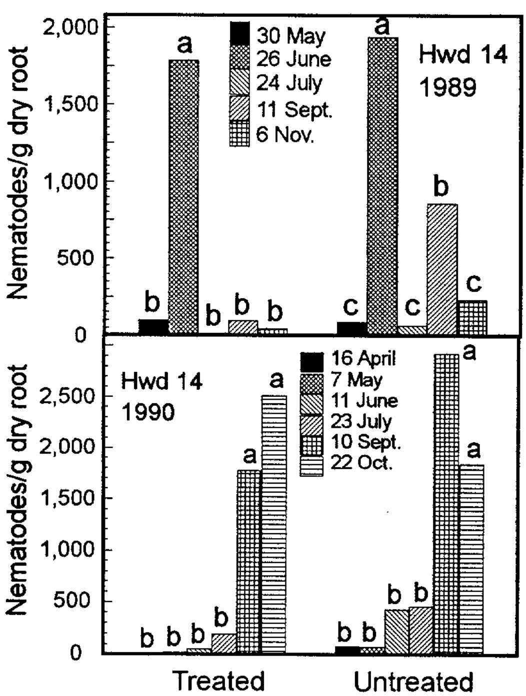

FIG. 2. Population densities of *Criconemella curvata* in fenamiphos-treated and untreated plots in 1989 and 1990 in green 14 in Homewood, IL. Least significant difference comparisons ($P = 0.05$) are among dates within a nematicide treatment at each location.

suppressed ($P \leq 0.05$) in fenamiphos-treated plots. Population fluctuation patterns of all three species were different between years, with population levels generally being highest early in 1989 and late in 1990.

Population fluctuation patterns of *T. nudus* in greens on the same course were similar, and generally similar population fluctuation patterns within a year occurred across golf courses (Fig. 3). In 1989, population fluctuation patterns of *C. curvata* showed similarities between greens on the course in Homewood, but fewer similarities occurred between greens on the course in Riverside (Fig. 4). The population fluctuation patterns were largely parallel in 1990 among all greens, with population peaks late in the season (Fig. 4). Population fluctuation patterns of *H. cornurus* were similar among all greens (numbers on green 9 on the course in Homewood were very small in 1990; therefore, the configuration of this graph cannot be compared with that of the others) (Fig. 5).

In 1989, root dry weight generally was highest at the end of the season, except for green 14 on the course in Homewood (Fig. 6). In 1990, root dry weight was generally higher early in the season. No differences in dry root weight due to fenamiphos

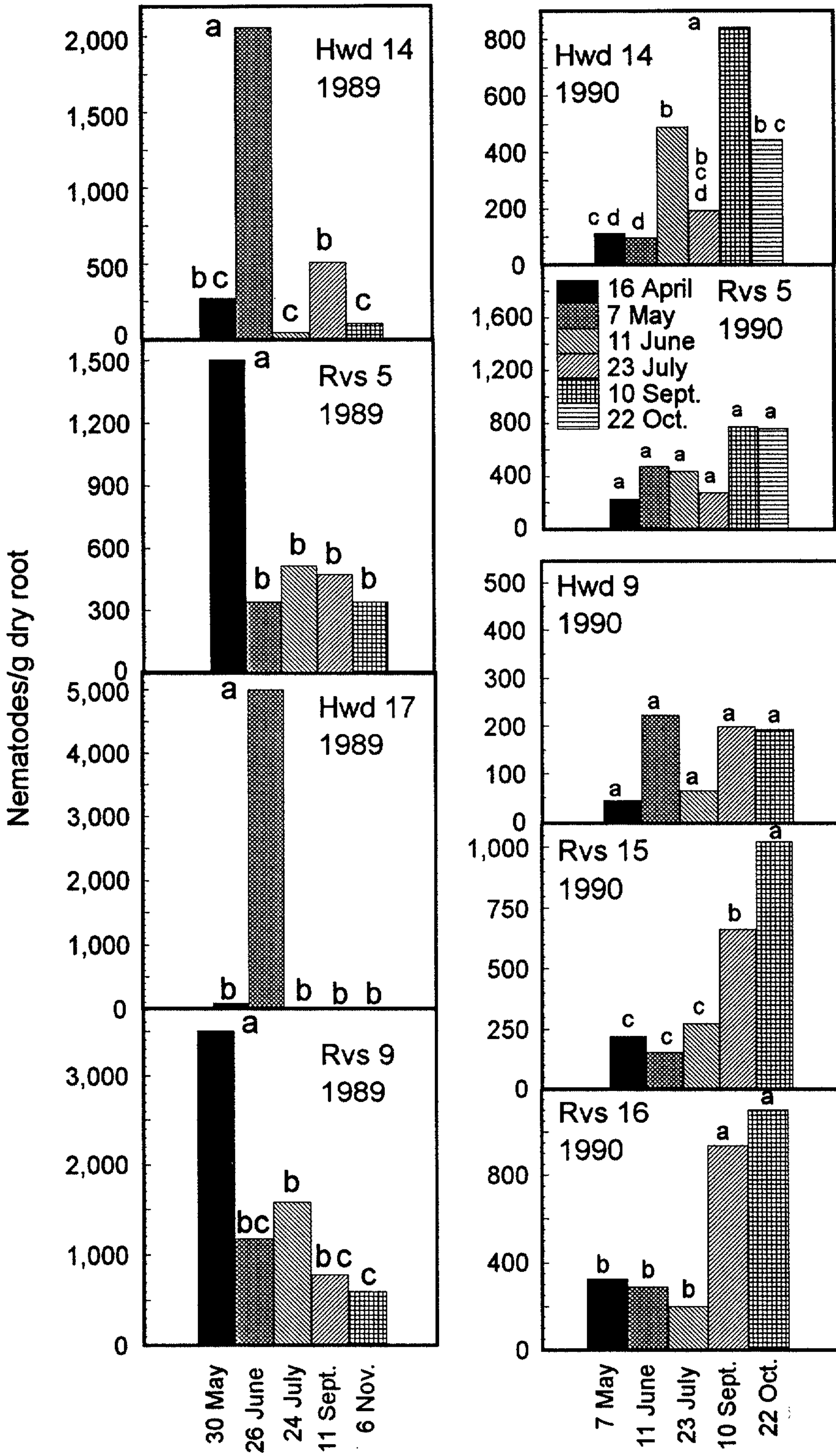

FIG. 3. *Tylenchorhynchus nudus* population levels per gram of dry root in untreated plots. Least significant difference comparisons ($P = 0.05$) are among dates at each location. Hwd = golf course in Homewood, IL. Rvs = golf course in Riverside, IL.

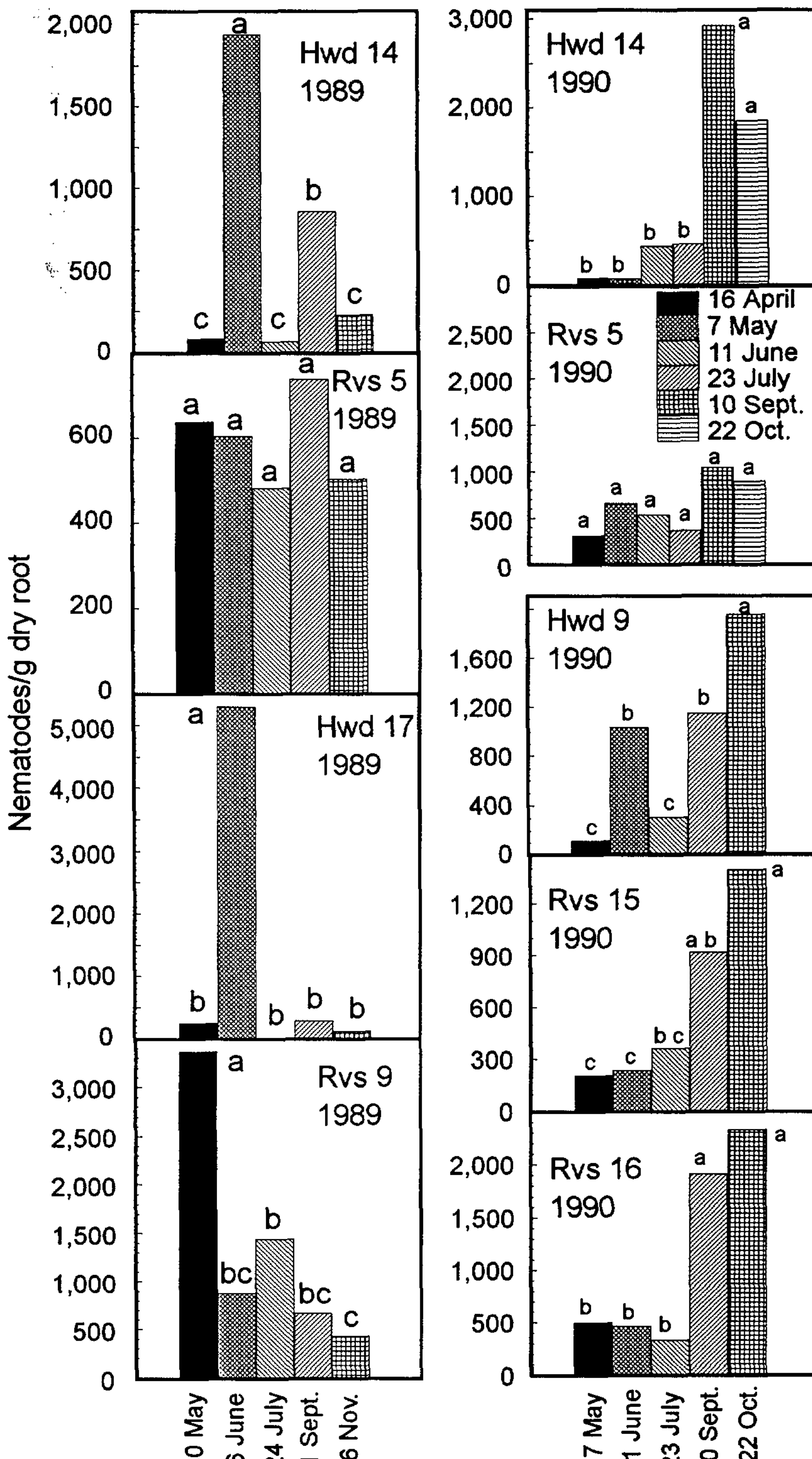

FIG. 4. *Criconemella curvata* population levels per gram of dry root in untreated plots. Least significant difference comparisons ($P = 0.05$) are among dates at each location. Hwd = golf course in Homewood, IL. Rvs = golf course in Riverside, IL.

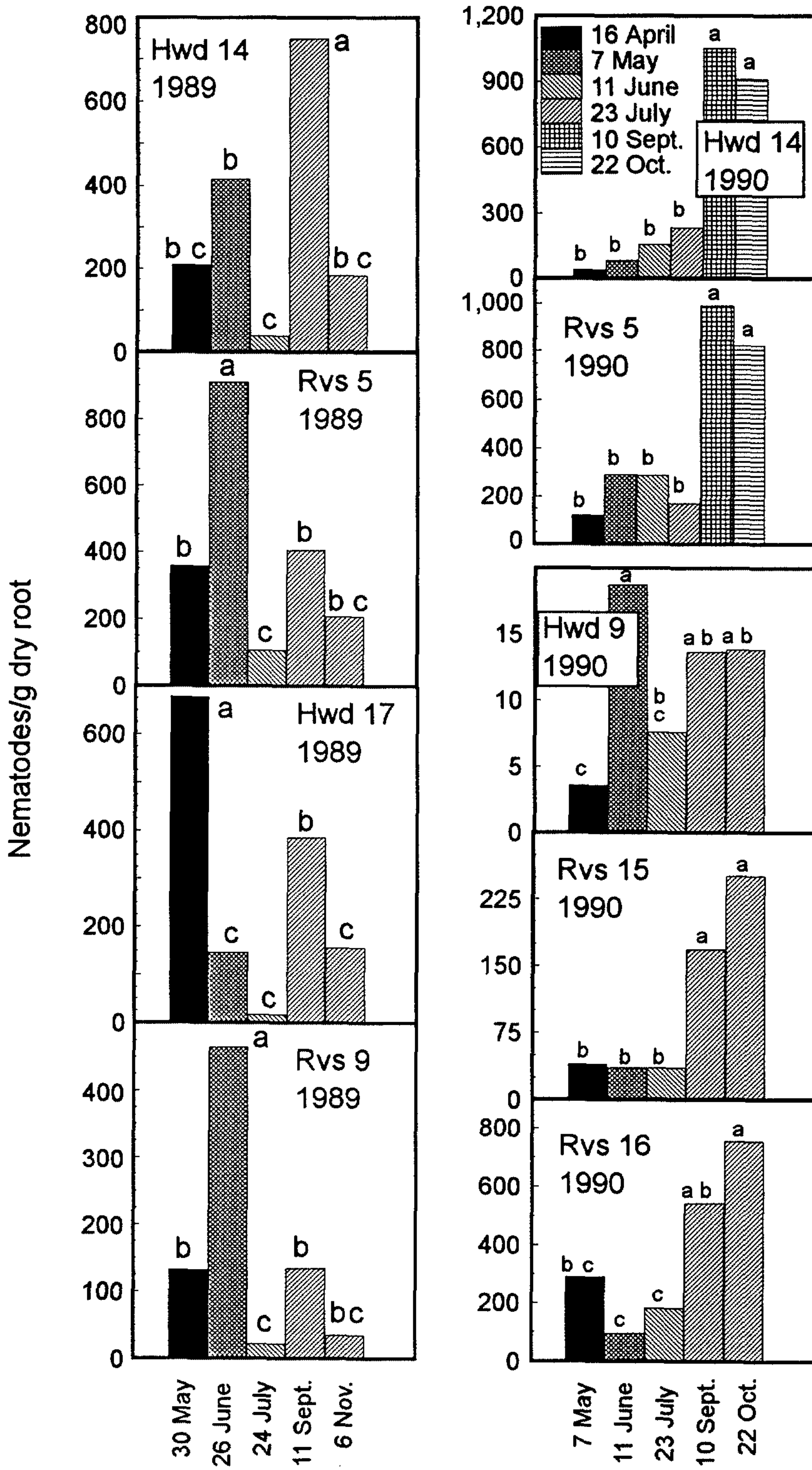

FIG. 5. *Helicotylenchus cornurus* population levels per gram of dry root in untreated plots. Least significant difference comparisons ($P = 0.05$) are among dates at each location. Hwd = golf course in Homewood, IL. Rvs = golf course in Riverside, IL.

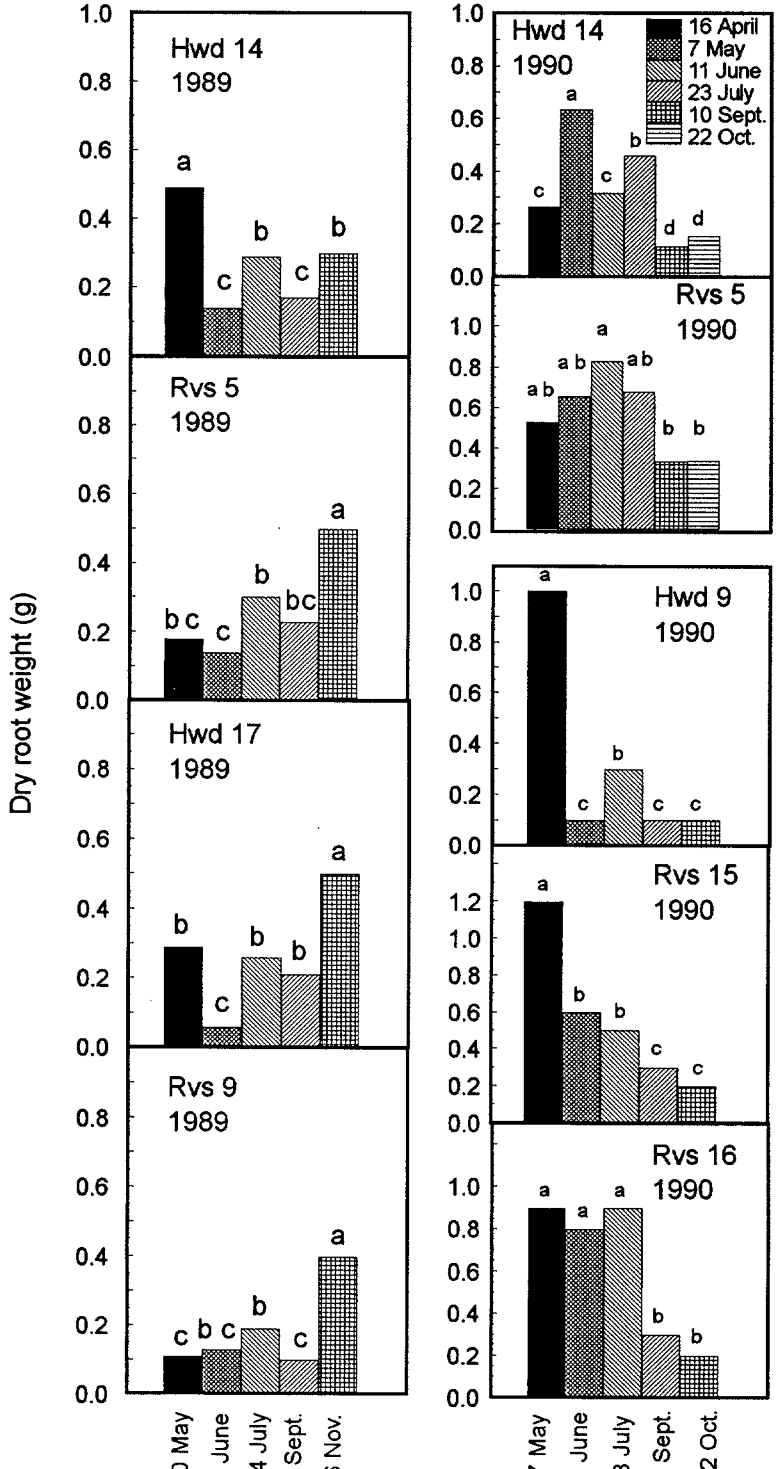

FIG. 6. Grams of dry root per 50 cm^3 of soil in untreated plots. Least significant difference comparisons (P = 0.05) are among dates at each location. Hwd = golf course in Homewood, IL. Rvs = golf course in Riverside, IL.

treatment were observed on any green on any sampling date during this study (data not presented). A separate test (Davis et al., unpubl.) detected no differences in dry clipping weights between fenamiphos-treated and untreated plots on any sampling date or combination of sampling dates (a measure of cumulative effects).

Discussion

Information on population fluctuations can be helpful in timing both sampling and nematicide application. To predict nematode damage, samples are sometimes collected in the fall (2) when population densities are expected to be highest during the year. If chemical control is most effective when population densities are at a minimum, nematicide application in early to mid-May on golf courses in the Chicago area would be most effective.

Numbers of nematodes per g of dry root and numbers per 50 cm^3 soil provide an equivalent measure of seasonal and annual population change. This relationship probably is a result of the obligate nature of parasitism of the nematodes recovered from the golf course greens. We believe that nematodes per gram of dry root are well suited for use as threshold levels because the amount of root weight should influence greatly the number of nematodes that a plant can tolerate without significant damage: a specific number of nematodes may cause no damage when root weight is high, but may cause serious damage when root weight is low. This view is an adaptation of Seinhorst's (24) definition of tolerance limit, but the basic concept is the same.

The root systems of annual plants expand throughout the growing season to provide an increasing food supply, which may allow nematode populations to increase until the root system dies at the end of the season. In contrast, the root systems of perennial plants persist, providing stability to the nematode's food supply—thus possibly influencing population fluctuations. Individual grass plants behave as annuals, but the turfgrass as a collective entity is perennial in nature. Because of this characteristic, nematode population fluctuations on turfgrass depend on the carrying capacity of the turfgrass (24).

Two parameters of the logistic growth curve, the intrinsic growth rate (r) and the asymptote or carrying capacity (K) (20,21), may be used to categorize nematodes. The r selected species have high reproductive rates and short life spans and are considered to be poor or weak competitors, but they are quick to exploit new substrates. In contrast, K selected species have lower reproductive rates, generally live longer, and may have a greater degree of specialization. In general, r selected organisms can dominate in an annual cropping system, and K selected organisms can dominate in perennial cropping systems (8,21); however, the r and K terminology is relative and differs among nematode–plant communities (3). Turf has elements of both annual and perennial crops, so both r and K selection may be important in nematode population dynamics (4). Because changes in population levels per g of root within a year generally appear similar among *T. nudus, C. curvata,* and *H. cornurus,* significant differences in the relative importance of r and K selection for these nematodes are not apparent.

Wick (27,28) reported that nematode populations in different putting greens, even on the same golf course, did not change synchronously. In contrast, our work demonstrates that it may be possible in the Chicago area to extrapolate to unsampled greens, but not from one year to the next.

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