RESEARCH/INVESTIGACIÓN

TEMPORAL DISTRIBUTION OF PLANT-PARASITIC NEMATODES ON SELECT BERMUDAGRASS SITES IN ALABAMA

W. Groover, K. S. Lawrence*, and P. Donald

Department of Entomology and Plant Pathology, Auburn University, Auburn, AL, 36849, USA; *Corresponding author: lawrekk@auburn.edu

ABSTRACT

Groover, W., K. S. Lawrence, and P. Donald. 2020. Temporal distribution of plant-parasitic nematodes on select bermudagrass sites in Alabama. Nematropica 50:77-85.

Plant-parasitic nematodes are a major pest of hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) in the southern United States. In this study, six bermudagrass locations in Alabama were selected for monthly or bimonthly sampling of plant-parasitic nematodes throughout 2018 and 2019. Five plant-parasitic genera were recovered in 2018: *Criconemoides*, *Belonolaimus*, *Helicotylenchus*, *Hoplolaimus*, and *Meloidogyne*. Only *Belonolaimus* was recovered at action thresholds that may warrant the use of a nematicide. *Belonolaimus* was recovered at highest levels in April and October. In 2019, seven genera were recovered from these locations: *Criconemoides*, *Belonolaimus*, *Helicotylenchus*, *Hemicycliophora*, *Hoplolaimus*, *Meloidogyne*, and *Tylenchorhynchus*. Of these genera, *Belonolaimus* and *Meloidogyne* were found at a population density that may require a nematicide application. Again, highest population density for *Belonolaimus* was found in April and October. However, *Meloidogyne* population density peaked during midsummer (June through September). These results indicate that nematode genera behave differently based upon climate season and demonstrate a need for turfgrass managers to sample for nematodes throughout the year and not rely on one sample date for management decisions.

Key words: Belonolaimus longicaudatus, bermudagrass, *Meloidogyne* spp., nematode management, root-knot nematode, temporal distribution, turfgrass, sting nematode

RESUMEN

Groover, W., K.S. Lawrence, and P. Donald. 2020. Distribución temporal de nematodos fitoparásitos en sitios selectos con bermudagrass en Alabama. Nematropica 50:77-85.

Los nematodos fitoparásitos son una plaga importante en los híbridos de bermudagrass (*Cynodon dactylon* x *C. transvaalensis*) en el Sur de los Estados Unidos. En este estudio, seis sitios con bermudagrass en Alabama se seleccionaron para muestreos mensuales o bimensuales de nematodos fitoparásitos durante el 2018 y 2019. Cinco géneros de nematodos fitoparásitos se identificaron en el 2018: *Criconemoides*, *Belonolaimus*, *Helicotylenchus*, *Hoplolaimus*, y *Meloidogyne*. Solo *Belonolaimus* se identificó en altos niveles en Abril y Octubre. En el 2019, siete géneros se identificaron en estos sitios: *Criconemoides*, *Belonolaimus*, *Helicotylenchus*, *Hemicycliophora*, *Hoplolaimus*, *Meloidogyne*, y *Tylenchorhynchus*. De estos géneros, *Belonolaimus* y *Meloidogyne* se encontraron en densidades poblacionales que puedan requerir de una aplicación de nematicida. De nuevo, altas densidades poblacionales de *Belonolaimus* se encontraron en Abril y Octubre. Sin embargo, la densidad poblacional de *Meloidogyne* alcanzó su punto máximo durante el pleno verano (junio a septiembre). Estos resultados indican que los géneros de nematodos se comportan de manera diferente en función de la temporada climática, y demuestran una

necesidad de que los administradores de bermudagrass muestreen nematodos durante todo el año y no dependan de una fecha de muestreo para tomar decisiones de manejo.

Palabras clave: Belonolaimus longicaudatus, Bermudagrass, *Meloidogyne* spp., manejo de nematodos, nematodos agalladores, distribución temporal, cesped, nematodo de aguijón

INTRODUCTION

The turfgrass industry is extremely economically relevant to the state of Alabama. Alabama is third highest in number of sod farms in the United States (behind Florida and Texas) at an estimated 89 operating farms (USDA, 2017). In 2010, there were also approximately 250 golf facilities in the state with an estimated total revenue of > $808 million, providing an added 20,000 jobs to the state (SRI International, 2010). In the southern United States, hybrid bermudagrass (*Cynodon dactylon* x *C. transvaalensis* (L.) Pers.) is the primary grass used for putting greens on golf courses. The warm and humid weather of this temperate to subtropical region makes it an ideal location for bermudagrass growth and production.

Plant-parasitic nematodes are one of the main pest issues faced by turfgrass managers in the southern United States. Nematodes cause issues by feeding on the root system of the turfgrass plant, leading to chlorosis, wilting, and thinning of the turf canopy (Crow and Han, 2005). The most significant damage occurs when plant-parasitic nematodes reach high population density in the soil, and excessive feeding leads to a reduction in root biomass, water uptake, and nutrient absorption (White and Dickens, 1984; Luc *et al.*, 2006). Plant-parasitic nematodes are common in the southern United States. A recent survey in Florida found that plant-parasitic nematodes infested over 80% of sampled golf courses at potentially damaging levels (Crow, 2005a; Aryal *et al.*, 2017). In a survey of 111 golf courses throughout North and South Carolina, Zeng *et al.* (2012) found a wide diversity of plant-parasitic nematodes, with over 24 unique nematode species, belonging to 19 genera and 11 families.

In the state of Alabama, previous studies have found a wide range of plant-parasitic nematode genera present on golf courses. Mullen (1998) reported recovering the genera *Belonolaimus*, *Helicotylenchus*, *Hemicycliophora*, *Hoplolaimus*, *Meloidogyne*, *Mesocriconema*, *Paratrichodorus*, *Pratylenchus*, *Tylenchorhynchus*, and *Xiphinema*. A more recent study by Sikora *et al.* (2001) identified nine plant-parasitic genera in Alabama on hybrid bermudagrass, with four of these genera (*Helicotylenchus*, *Hoplolaimus*, *Hemicycliophora*, and *Belonolaimus*) reported on golf courses at or above threshold levels that may require a nematicide application. While these previous studies provided important insight into the specific plant-parasitic nematodes that are present in Alabama, it has been almost 20 years since the last nematode survey, and detailed information on modern distribution and population levels of plant-parasitic nematodes in Alabama is lacking.

With production of fenamiphos (Nemacur; Bayer CropScience, St. Louis, MO), a previous chemical standard for nematode management on turfgrass, halting in 2007 (Keigwin, 2014), multiple other nematicides have become available. These nematicides include abamectin (Divanem; Syngenta Crop Protection, Greensboro, NC), fluopyram (Indemnify; Bayer CropScience, St. Louis, MO), and fluensulfone (Nimitz Pro G; Adama, Pasadena, TX). Recent studies have shown each of these products to have success for a wide range of plant-parasitic nematodes (Crow *et al.*, 2017). However, no nematode survey has been conducted in Alabama since this change in nematicide chemistry for nematode management on turfgrass.

Knowing that plant-parasitic nematodes are a significant pest of turfgrass in Alabama, six bermudagrass locations were selected for monthly or bimonthly (every other month) sampling of plant-parasitic nematodes. The primary objective of this study was to determine what plant-parasitic nematodes are present in Alabama and if seasonal climate has any impact on population densities of nematode genera.

MATERIALS AND METHODS

Soil samples were collected from five golf courses in Alabama and the Auburn University

Turfgrass Research Unit over the 2018 and 2019 growing season. All locations consisted of hybrid bermudagrass. All golf courses sampled requested to have their name redacted from the study for privacy reasons, thus locations are reported as the county in which the golf course is located. One course was located in Shelby County, two were located in Barbour County, and two were located in Lee County, AL. For each golf course, one green with a known history of plant-parasitic nematodes was chosen for sampling and was repeatedly sampled at each sample interval. If the golf course did not report a previous issue with plant-parasitic nematodes, the green sampled was selected at random. For each green, 10 soil cores (2.5 cm-diam. x 10 cm-deep) were taken at roughly equal intervals in a zigzag pattern across the green. Samples were collected from April to October of both 2018 and 2019. In 2018, two locations were sampled monthly, three locations were sampled bimonthly, and one location was sampled monthly starting in August through October. In 2019, three locations were sampled monthly, and three locations were sampled bimonthly.

Nematode soil samples for each location were thoroughly mixed, and a 100-cm^3 soil subsample was processed to determine plant-parasitic nematode population density. Nematodes were extracted by gravity sieving followed by sucrose centrifugation following the methodology of Jenkins (1964). Nematodes were confirmed and enumerated via a Nikon TSX 100 inverted microscope at 40-x magnification, and morphologically identified to genus or species if possible based upon "Pictoral Key to Genera of Plant-Parasitic Nematodes, 4th Edition" (Mai and Lyon, 1975) and "Identification Guides for the Most Common Genera of Plant-Parasitic Nematodes" (Eisenback, 2002). Nematode population density for each genus was also compared to action thresholds (minimum level of each plant-parasitic nematode genus possible to justify nematicide treatment) used by the Alabama Cooperative Extension Service. These levels were as follows: *Criconemoides* = 500, *Helicotylenchulus* = 300, *Hoplolaimus* = 60, *Meloidogyne* = 80, *Tylenchorhynchus* = 1,000, *Hemicyliophora* = 80, *Belonolaimus* = 10, *Paratrichodorus* = 100, per 100 cm^3 of soil (Sikora *et al.* 2001).

RESULTS

2018

In 2018, five genera of plant-parasitic nematodes were recovered across all locations sampled. These include *Belonolaimus longicaudatus* (sting nematode), *Criconemoides* spp. (ring nematode), *Hoplolaimus galeatus* (lance nematode), *Meloidogyne* spp. (root-knot nematode), and *Helicotylenchus* spp. (spiral nematode). Nematode occurrence across all locations ranged from *H. galeatus* (found on 17% of locations) to *Criconemoides* spp. (found on 100% of locations) (Table 1). However, neither of these nematodes were ever at action threshold levels. *Belonolaimus longicaudatus* was found above threshold levels in three samples and was the

Table 1. Frequency of occurrence of plant-parasitic nematodes in hybrid bermudagrass soil samples in central and southern Alabama, 2018.

Scientific name	Common name	Locations with this nematode (%)[x]	Samples with this nematode (%)[y]	Samples above threshold levels[z]
Criconemoides spp.	Ring nematode	100	87	0
Belonolaimus longicaudatus	Sting nematode	50	23	3
Helicotylenchus spp.	Spiral nematode	33	37	0
Hoplolaimus galeatus	Lance nematode	17	10	0
Meloidogyne spp.	Root-knot nematode	83	70	0

[x]Percentage of turfgrass locations with at least one nematode identified during the 2018 growing season. Percentage based upon six bermudagrass locations.

[y]Percentage based on 30 bermudagrass soil samples.

[z]Minimum levels of nematodes that indicate need for nematicide application: *Criconemoides* = 500, *Belonolaimus* = 10, *Helicotylenchus* = 300, *Hoplolaimus* = 60, *Meloidogyne* = 80 nematodes per 100 cm^3 of soil (Sikora *et al*., 2001).

only nematode that reached this level (Table 1). This high population density was found at Lee County, Golf Course 1 in April (Fig. 1B) and at Barbour County, Golf Course 2 in April and October (Fig. 1E).

2019

In 2019, seven plant-parasitic nematode genera were identified from the same six turfgrass locations. These include *Criconemoides* spp., *B. longicaudatus*, *Helicotylenchus* spp., *Hemicycliophora* spp., *H. galeatus*, *Meloidogyne* spp., and *Tylenchorhynchus* spp. (Table 2). *Criconemoides* spp. was identified at all locations sampled, with 97% of soil samples throughout 2019 having this nematode (Table 2). However, no samples were ever above threshold levels. *Belonolaimus longicaudatus* was identified on 67% of the locations sampled, with 52% of soil samples in 2019 confirming presence (Table 2). There were four soil samples from 2019 with above threshold levels for *B. longicaudatus*: Lee County Golf Course 1 in April (Fig. 2B), Barbour County Golf Course 2 in April and October (Fig. 2E), and the Shelby County Golf Course in October (Fig. 2F). *Meloidogyne* spp. was recovered from 83% of locations sampled in 2019, with 88% of total soil samples confirming *Meloidogyne* spp. presence (Table 2). Of these samples, five individual soil samples had *Meloidogyne* spp. above threshold levels. These samples were in Barbour County Golf Course 1 in June and August (Fig. 2D), Barbour County Golf Course 2 in August (Fig. 2E), and the Shelby County Golf Course in July and August (Fig. 2F).

DISCUSSION

This study confirms other previous reports of plant-parasitic nematode genera found on turfgrass in the southern United States (Sikora *et al.*, 2001; Crow, 2005b; Zeng *et al.*, 2012). *Criconemoides* spp. was the most commonly found nematode in both years, occurring in all locations sampled regardless of sampling date. However, this nematode was never found at levels above action thresholds. *Helicotylenchus* spp. was only found at 33% of sampled locations in 2018, but that rose drastically in 2019 to 67%, though none of the samples containing *Helicotylenchus* spp. were ever at damaging levels.

Belonolaimus longicaudatus was found most often in both years above action thresholds, with 10% (3 out of 30) of samples above threshold in 2018, and 12% above threshold in 2019 (4 out of 33). *Belonolaimus longicaudatus* has been reported to cause significant damage to hybrid bermudagrass throughout the southern United States (Laughlin and Williams, 1971; Luc *et al.*; 2006). The locations with densities above thresholds of *B. longicaudatus* were Lee County Golf Course 1 and Barbour Golf Course 2. After receiving the initial April report with above threshold levels, Lee County Golf Course 1 implemented a year-long nematicide program and successfully managed *B. longicaudatus* throughout 2018. Barbour County Golf Course 2 did not implement a nematode management program, and while the *B. longicaudatus* population density dropped below treatment thresholds during the summer, it rose back to above threshold levels in October. This trend repeated in 2019. Lee County Golf Course 1 and Barbour County Golf Course 2 both had above threshold levels of *B. longicaudatus* in April of 2019. Lee County Golf Course 1 implemented a nematicide program, and Barbour County Golf Course 2 did not. This, again, lead to lowering nematode population density below action thresholds later in Lee County Golf Course 1. Barbour County Golf Course 2, however, saw an initial decline in population density during the peak of summer but a rise in population density as temperatures cooled in the fall.

The other plant-parasitic nematode found above the action threshold was *Meloidogyne* spp. *Meloidogyne* spp. was present in 83% of sampled locations at some point during the growing season in 2018 and 2019, and 70% of total soil samples had *Meloidogyne* spp. present in 2018. However, none of the 2018 samples were above the action threshold. In 2019, 88% of soil samples confirmed the presence of *Meloidogyne* spp. Five of these 2019 samples (out of 33) also had *Meloidogyne* spp. population densities at or above treatment thresholds. Similar to *B. longicaudatus*, *Meloidogyne* spp. is historically known to be a major pest of hybrid bermudagrass (Christie *et al.*, 1954; Crow, 2005b; Ye *et al.*, 2015). Two locations had *Meloidogyne* spp. at action threshold levels: Barbour County Golf Course 1 and Shelby County Golf Course 2. Neither of these locations applied a nematicide in 2019, and interestingly, the populations behaved in a similar fashion at both

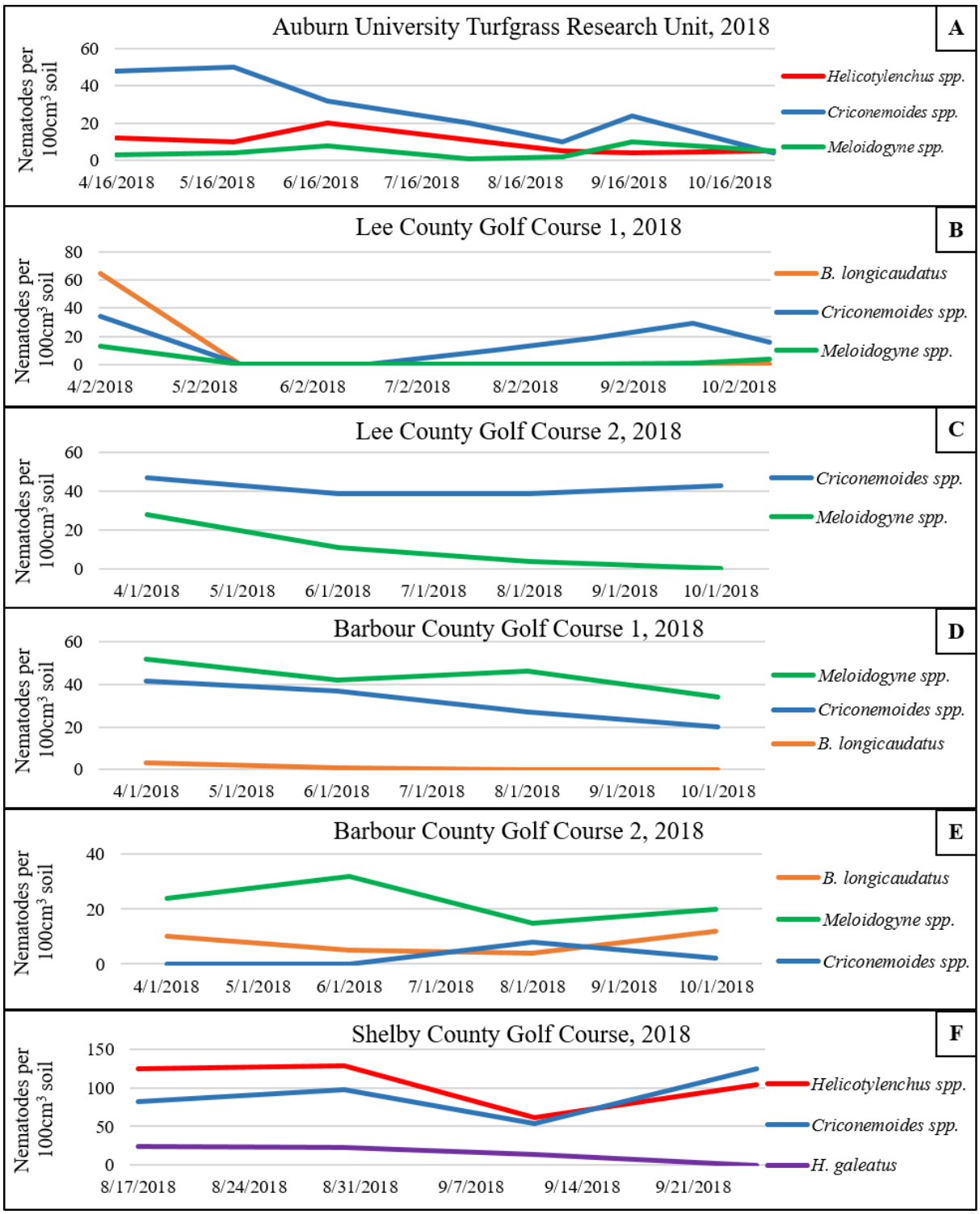

Figure 1. Plant-parasitic nematode population densities for the Auburn University Turfgrass Research Unit (A), Lee County Golf Course 1 (B), Lee County Golf Course 2 (C), Barbour County Golf Course 1 (D), Barbour County Golf Course 2 (E), and Shelby County Golf Course (F) in 2018. Nematode population densities are reported per 100 cm^3 of soil in 2018.

locations. *Meloidogyne* spp. population densities peaked for both locations during the middle of summer (June through September). This trend was inverse to that observed for *B. longicaudatus* during this study. In fact, at the Shelby County Golf Course, as the *Meloidogyne* spp. population density declined from above threshold levels to below threshold levels from September to October, the *B. longicaudatus* population density increased from below threshold levels to above threshold levels. Previous studies have shown that the optimal temperature for *B. longicaudatus* is 30°C, so seeing population density decline as temperatures exceed this is not surprising (Smart and Nguyen, 1991).

This study is relevant for plant-parasitic nematode management on hybrid bermudagrass, because it emphasizes the importance of season-long nematode sampling. This is especially true for highly maintained bermudagrass with a history of multiple nematode genera previously reported at high population densities. These results are similar to studies conducted in Florida, where McGroary *et al.* (2009) found that while *B. longicaudatus* population density can be highly variable based on numerous factors, population density tended to peak from March to May. Bekal and Becker (2000) found that in a temperate region of California, *B. longicaudatus* population density consistently increased in early spring as grass exited dormancy and began to grow and declined rapidly shortly after. They also found one location where *B. longicaudatus* population density consistently peaked during October. For *Meloidogyne* spp. in Alabama, the highest population density occurred primarily in late summer around August. Laughlin and Williams (1971) found *Meloidogyne* spp. population density highest in May on bermudagrass in Virginia. Starr *et al.* (2007) found the highest population density of *M. marylandi* in a nematicide trial during March in Texas, which has a semi-arid climate. Westerdahl and Harivandi (2007) found *Meloidogyne* spp. population density was highest in September and November in central coastal California. Morris *et al.* (2013) reported M. minor population density on bentgrass in Ireland was highest from June through August. Overall, *Meloidogyne* spp. peak population density is largely dependent on geographic location, as various times throughout the year have been reported for highest population density.

While this study largely confirms previous reports that population dynamics can vary significantly based on seasonal timing of nematode sampling; this is the first report of seasonal population variability on turfgrass in Alabama. It is extremely important for a turfgrass manager to understand the importance of consistent nematode sampling. Relying on only one sample date for yearlong nematode management can lead to a misinformed decision. This research focused on six turfgrass sites in Alabama and found plant-parasitic nematode population densities that warranted a nematicide application on half of the locations. Sikora *et al.* (2001) estimated that less than 10% of golf courses in Alabama check for nematodes on a consistent basis. This number has

Table 2. Frequency of occurrence of plant-parasitic nematodes in hybrid bermudagrass soil samples in central and southern Alabama, 2019.

Nematode genus	Common name	Locations with this nematode (%)[x]	Samples with this nematode (%)[y]	Samples above threshold levels[z]
Criconemoides spp.	Ring nematode	100	97	0
Belonolaimus longicaudatus	Sting nematode	67	52	4
Helicotylenchus spp.	Spiral nematode	67	67	0
Hemicycliophora spp.	Sheath nematode	17	9	0
Hoplolaimus galeatus	Lance nematode	17	18	0
Meloidogyne spp.	Root-knot nematode	83	88	5
Tylenchorhynchus spp.	Stunt nematode	17	6	0

[x]Percentage of turfgrass locations with at least one nematode identified during the 2019 growing season. Percentage based upon sixotal of 33 bermudagrass soil samples.

[z]Minimum levels of nematodes that can indicate need for nematicide application: *Criconemoides* = 500, *Belonolaimus* = 10, *Helicotylenchus* = 300, *Hoplolaimus* = 60, *Meloidogyne* = 80 nematodes per 100 cm^3 of soil (Sikora *et al*., 2001).

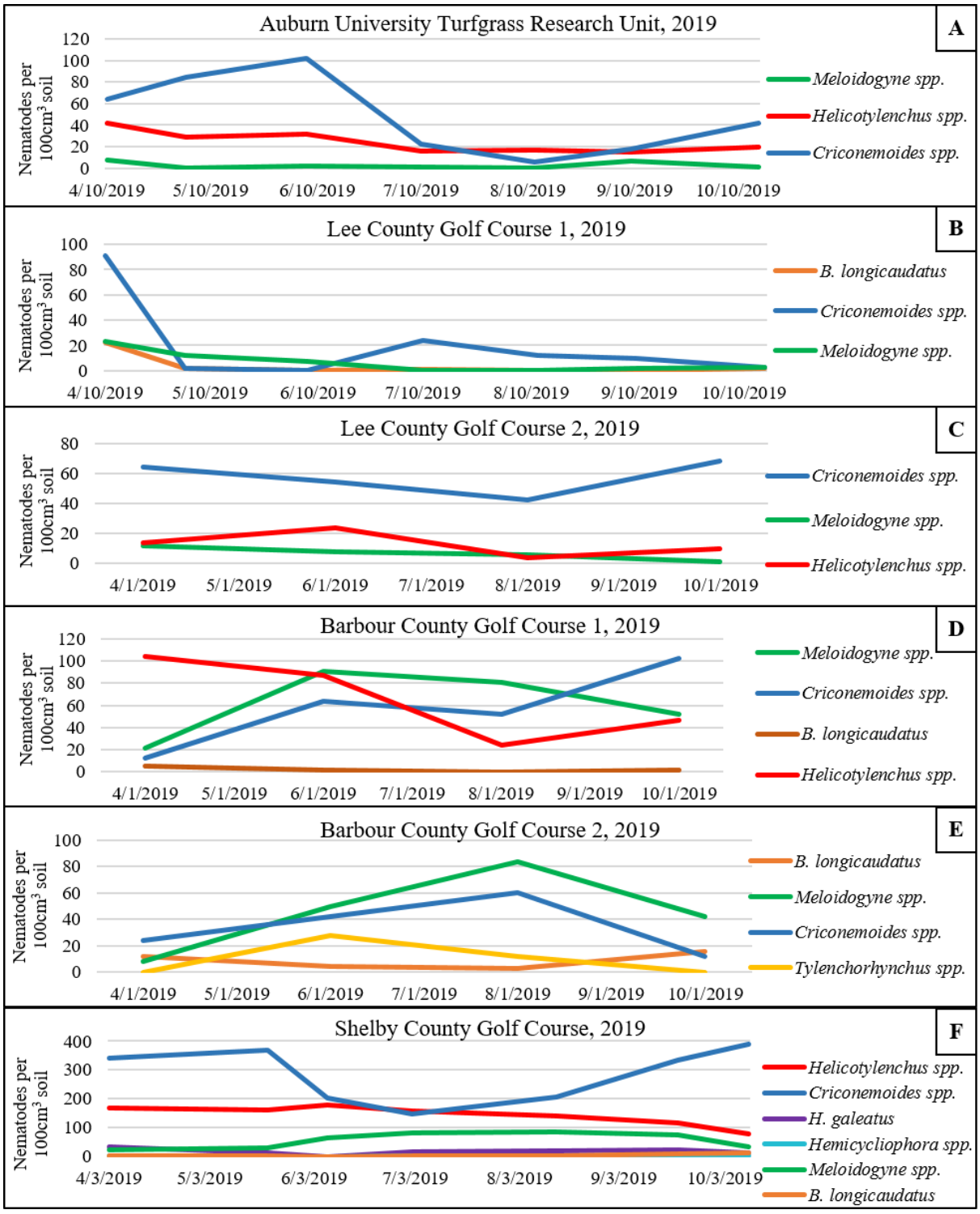

Figure 2. Plant-parasitic nematode population densities for the Auburn University Turfgrass Research Unit (A), Lee County Golf Course 1 (B), Lee County Golf Course 2 (C), Barbour County Golf Course 1 (D), Barbour County Golf Course 2 (E), and Shelby County Golf Course (F). Nematode population densities are reported per 100 cm^3 of soil in 2019.

certainly increased in recent years, but it is still important to help turfgrass managers understand the importance of consistent nematode sampling in spring, summer, and fall seasons.

ACKNOWLEDGMENTS

We would like to thank the Auburn University Turfgrass Research Unit and the five unnamed golf courses for allowing us to take nematode samples throughout 2018 and 2019.

LITERATURE CITED

Aryal, S. K., W. T. Crow, R. McSorley, R. M. Giblin-Davis, and K. E. Kenworthy. 2017. Integrated pest management of nematodes on bermudagrass turf. Crop, Forage and Turfgrass Management 2: doi:10.2134/cftm2015.0144.

Bekal, S., and J. Ole Becker. 2000. Population dynamics of sting nematode in California turfgrass. Plant Disease 84:1081-1084.

Christie, J. R., J. M. Good, and G. C. Walter. 1954. Nematodes associated with injury to turf. Proceedings of the Soil and Crop Science Society of Florida 14:167-169.

Crow, W. T. 2005a. Alternatives to fenamiphos for management of plant-parasitic nematodes on bermudagrss. Journal of Nematology 37: 477-482.

Crow, W. T. 2005b. Plant-parasitic nematodes on golf course turf. Outlooks on Pest Management 16:10-15.
doi:10.1564/16feb04.

Crow, W. T., and H. Han. 2005. Sting nematode. St. Paul, MN: American Phytopathological Society. The Plant Health Instructor
doi:10.1094/PHI-I-2005-1208-01.

Crow, W. T, J. O. Becker, and J. H. Baird. 2017. New golf course nematicides. Golf Course Management 7:66-71.

Eisenback, J. 2002. Identification guides for the most common genera of plant-parasitic nematodes. Department of Plant Pathology, Physiology, and Weed Science, Virginia Polytech Institute and State University. Mactode Publications, Blacksburg, Virginia. ISBN: 1-893961-22-2.

Keigwin, R. P., Jr. 2014. Fenamiphos: Amendment to existing stocks provision of use deletion and product cancellation order. Federal Registration 79:59261-59262.

Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Report 48:692.

Laughlin, C. W., and A.S. Williams. 1971. Population behavior of *Meloidogyne graminis* in field-grown 'Tifgreen' bermudagrass. Journal of Nematology 3:386-389.

Luc, J. E., W. T. Crow, J. L. Stimac, J. B. Sartain, and R. M. Giblin-Davis. 2006. Influence of *Belonolaimus longicaudatus* on nitrate leaching in turf. Journal of Nematology 38:461-465.

Mai, W. F., and H. H. Lyon. 1975. Pictorial Key of Plant-Parasitic Nematodes, 4th edition. Ithaca and London: Cornell University Press.

McGroary, P. C., W. T. Crow, R. McSorley, R. M. Giblin-Davis, and J. L. Cisar. 2009. Seasonal fluctuations of *Belonolaimus longicaudatus* in bermudagrass. Nematropica 39:99-110.

Morris, K., F. G. Horgan, and C. T. Griffin. 2013. Spatial and temporal dynamics of *Meloidogyne minor* on creeping bentgrass in golf greens. Plant Pathology 62:1166-1172.

Mullen, J. 1998. 1997 Annual Report of the Plant Diagnostic Laboratory. Plant Pathology Services Timely Information, Alabama Cooperative Extension System, Auburn University, AL.

Sikora, E. J., E. A. Guertal, and K. L. Bowen. 2001. Plant-parasitic nematodes associated with hybrid bermudagrass and creeping bentgrass putting greens in Alabama. Nematropica 31:301-306.

Smart, G. C., and K. B. Nguyen. 1991. Sting and awl nematodes: *Belonolaimus* spp. and *Doliochodorus* spp. Pp. 627-667 *in* Manual of Agricultural Nematology. New York: Marcel Dekker, Inc.

SRI International. 2010. The Alabama Golf Economy: Summary Report. Golf 20/20. http://wearegolf.org/wp-content/uploads/2019/01/Alabama-Golf-State-Report.pdf.

Starr, J. L., K. L. Ong, M. Huddleston, and Z. A. Handoo. 2007. Control of *Meloidogyne marylandi* on bermudagrass. Nematropica 37:43-49.

USDA. 2017. 2017 Census of Agriculture: United States Summary and State Data. Vol. 1, Geographic Area Series. Part 51. Washington, D.C.: USDA.

https://www.nass.usda.gov/Publications/AgCEnsus/2017/Full_Report/Volume_1,_Chapter_1_US/st99_1_0039_0039.pdf.

Westerdahl, B. B., and M. A. Harivandi. 2007. Variability in populations of plant parasitic nematodes on turfgrass. Proc. XXVII IHC – Horticulture Plants in Urban and Peri-Urban Life. Acta Horticulturae 762:139-142.

White, R. H., and R. Dickens. 1984. Plant-parasitic nematode populations in bermudagrass as influenced by cultural practices. Agronomy Journal 76:41-43.

Ye, W., Y. Zeng, and J. Kerns. 2015. Molecular characterization and diagnosis of root-knot nematodes (*Meloidogyne* spp.) from turfgrasses in North Carolina, USA. PLoS One10: DOI:10.1371/journal.pone.0143556.

Zeng, Y., W. Ye, S. B. Martin, M. Martin, and L. Tredway. 2012. Diversity and occurrence of plant-parasitic nematodes associated with golf course turfgrasses in North and South Carolina, USA. Journal of Nematology 44:337-347.

Received: 8/II/2020

Recibido:

Accepted for publication: 4/V/2020

Aceptado para publicación: