RESEARCH/INVESTIGACIÓN

EVALUATION OF DAMAGE POTENTIAL OF URBAN TURF-ASSOCIATED NEMATODE COMMUNITIES UNDER MICROPLOT CONDITIONS AND INFLUENCE OF SOIL TYPE ON NEMATODE REPRODUCTION

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ABSTRACT

Plaisance, A. P., E. C. McGawley, C. Overstreet, and D. M. Xavier-Mis. 2017. Evaluation of damage potential of urban turf-associated nematode communities under microplot conditions and influence of soil type on nematode reproduction. Nematropica 47:8-17.

Two full-season microplot experiments were conducted to evaluate the damage potential of a plant-parasitic nematode community on St. Augustine and centipede turfgrasses grown in three soil types and to assess the influence of soil type on reproduction of the nematode populations comprising the community. Genera of nematodes associated with both turfgrasses included *Criconemella*, *Helicotylenchus*, *Meloidogyne*, *Pratylenchus*, *Tylenchorynchus*, and *Tylenchus* spp. In 2012, nematodes did not cause significant damage to either turfgrass, but soil type affected plant growth parameters. In 2013, there was significant nematode-related injury to both turfgrasses, but there were no significant effects of soil type on plant growth parameters.

Key words: centipede, *Criconemella* spp., *Eremochloa ophiuroides*, *Helicotylenchus* spp., *Meloidogyne incognita*, pathogenicity, *Pratylenchus zeae*, soil texture, St. Augustine, *Stenotaphrum secundatum*, turfgrass, *Tylenchorynchus* spp.

RESUMO

Plaisance, A. P., E. C. McGawley, C. Overstreet and D.M. Xavier-Mis. 2017. Evaluación del potencial de daño de nematodos asociados a céspedes urbanos en condiciones de microparcelas y la influencia del tipo de suelo en la reproducción. Nematropica 47:8-17.

Se evaluó el potencial de daño de nematodos asociados a los pastos *Stenotaphrum secundatum* y *Eremochloa ophiuroides en dos experimentos de microparcelas utilizando tres tipos de suelo. Los géneros asociados con ambos pas*tos incluyeron *Criconemella*, *Helicotylenchus*, *Meloidogyne*, *Pratylenchus*, *Tylenchorynchus*, y *Tylenchus* spp. En el 2012, los nematodos no causaron daño significativo en ninguna de las dos especies de pastos, pero el tipo de suelo afectó los parámetros de crecimiento de las plantas. En el 2013, se observó daño asociado con los nematodos en ambos pastos, pero no se observaron efectos significativos de los tipos de suelo sobre los parámetros de crecimiento de las plantas.

Palavras chave: céspedes, *Criconemella* spp., *Eremochloa ophiuroides*, *Helicotylenchus* spp., *Meloidogyne incognita*, patogenicidad, *Pratylenchus zeae*, textura del suelo, *Stenotaphrum secundatum*, *Tylenchorynchus* spp.

INTRODUCTION

The research detailed herein is the continuation of a previous report (Plaisance *et al.*, 2015) that described the composition and densities of plant-parasitic nematode communities associated with urban lawn ecosystems and detailed the individual damage potentials of *Meloidogyne incognita* and *Pratylenchus zeae*.

More than 20 genera of plant-parasitic nematodes are known to parasitize and damage turfgrasses (Dunn and Diesburg, 2004). The most common of these genera include lance (*Hoplolaimus galeatus*; Giblin-Davis *et al.*, 1995), ring (*Mesocriconema* spp.; Crow *et al.*, 2009), root-knot (*Meloidogyne* spp.; Starr *et al.*, 2007), spiral (*Helicotylenchus* spp.; Subbotin *et al.*, 2011), sting (*Belonolaimus longicaudatus*; Bekal and Becker, 2000a; 2000b), stubby-root (*Paratrichodorus* and *Nanidorus* spp.; Crow and Welch, 2004), and stunt

(*Tylenchorhynchus* spp.; Mai and Lyon, 1975). Of these nematodes, sting and stubby-root generally cause the most severe damage (Schwartz *et al.*, 2010; Wetzel, 2000). Turfgrasses known to be hosts for these nematodes include bermudagrass (Good *et al.*, 1959), bentgrass (Sikora *et al.*, 1999), zoysia (Patton *et al.*, 2013), tall fescue (Nyczepir, 2011), seashore paspalum (Ye *et al.*, 2012), bluegrass (Coates-Beckford and Malek, 1982), ryegrass (Griffin *et al.*, 1984), and switchgrass (Cassida *et al.*, 2005), as well as the two grasses employed in this research, St. Augustine (Kelsheimer and Overman, 1953; Good *et al.*, 1959; Rhoades, 1962; Di Edwardo and Perry, 1964; Dickerson *et al.*, 2000; Inserra *et al.*, 2005; Faske and Starr, 2009) and centipede (Good *et al.*, 1959; Ratanaworabhan and Smart, 1969; Dickerson *et al.*, 2000; Ye *et al.*, 2012; Davis *et al.*, 2013).

The severity of damage that results from nematode infection of turfgrasses varies both with nematode genus and turfgrass species. For example, sting and lance nematode populations exceeding 20 per 100 cm^3 of soil (Dickerson *et al.*, 2000), usually cause economically important losses in sod farms, whereas levels of spiral and ring nematodes must usually exceed 500 per 100 cm^3 of soil to cause significant damage. Despite the apparent impact nematodes have on the overall health of urban turfscapes, few reports have attempted to quantify this impact in any state in the southern United States. The objectives of this research were to: 1) assess the impact of a plant-parasitic nematode community on the growth of St. Augustine and centipede turfgrasses and 2) evaluate the impact of soil type on nematode reproduction and damage potential.

MATERIALS AND METHODS

Grass species employed in this research were St. Augustine [*Stenotaphrum secundatum* (Walter), Kuntze] and centipede [*Eremochloa ophiuroides* (Munro), Hack] obtained from a local commercial sod distributor. In order to establish nematode-free turfgrass mats, 10 cm x 10 cm squares were cut from sod mats, washed, dipped in a 0.8% NaOCl solution for 20 s, and rinsed. Sod mat washings were analyzed for nematodes, and a root sample was examined for endoparasitic nematodes. No nematodes were found. Sod squares were established in autoclaved terra cotta containers, referred to hereafter as microplots, having a top inside diameter of 30.5 cm and a capacity of 10 kg of soil. Three soils were used in these trials that were representative of the most common types present in Louisiana urban turfscapes. The soils ranged from fine textured to coarse and included steam-sterilized clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) and sandy loam (75% sand, 15% silt, 10% clay). Soils having these percentages of sand, silt and clay were prepared following consultation with Dr. B. S. Tubana of the LSU School of Plant, Environmental and Soil Sciences. Soil from two locations at the LSU AgCenter Ben Hur Research Farm were collected. One lot of soil was 25% sand, 35% silt, and 40% clay and the other was 75% sand, 15% silt, and 10% clay. These soils were used individually as clay and sandy loam and were mixed 1:1 to produce sandy clay loam. These three soils are referred to hereafter, respectively, as clay, loam, and sandy loam.

The microplot area was formed by a 17-meter-long by 9-meter-wide aluminum Quonset hut skeletal frame that was open at both ends and covered with one layer of clear, 6-mm thick polyethylene greenhouse film and one layer of 20% reflective foil cloth. This cover, necessary to protect plants in microplots from excessive summer rainfalls that are common in southern Louisiana, is equipped with overhead fans and automated micro-misting irrigation system that prevents splashing during irrigation and allows for the maintenance of near-natural air and soil temperature and moisture conditions (McGawley *et al.*, 2011). Treatments consisted of two turfgrass types, three infestation levels, and three soil types replicated five times for a total of 90 microplots. Microplots were spaced 1-meter apart, and treatments were arranged as a randomized block design.

Two weeks after establishment of St. Augustine and centipede sod squares, populations of nematodes recovered from greenhouse stock cultures via the centrifugal-floatation technique (Jenkins, 1964) were pipetted from water slurry into 5.0-cm deep depressions within each microplot. In order to utilize inoculum immediately after extraction, microplot soils were infested three times over a period of 7 d. The first inoculation was made in the center of each sod square, and the second and third inoculations were made 10 cm north and south of the first. In the 2012 experiment, treatments included a nematode-free control, suspending fluid minus nematodes; a low level of inoculum that simulated the composition and density of early spring communities (Plaisance *et al.*, 2015), 1,009 juveniles and adults (15 *Pratylenchus zeae*, 664 *Criconemella* spp., 12 *M. incognita*, 64 *Helicotylenchus* spp., 163 *Tylenchorhynchus* spp., and 88 *Tylenchus* spp.), and a high inoculum level to evaluate the damage potential of this community, 10,076 juveniles and adults (150 *P. zeae*, 6,646 *Criconemella* spp., 121 *M. incognita*, 645 *Helicotylenchus* spp., 1638 *Tylenchorhynchus* spp., and 876 *Tylenchus* spp.). The 2012 microplot trial was established on 11

April, inoculated with nematodes on 25 and 27 April and 2 May, and harvested 15 November.

During the course of these experiments, turf were fertilized twice monthly with 1.25 g of water-soluble Scotts Turf Builder fertilizer (12% urea nitrogen, 4% available phosphate, 8% soluble potash, 0.10% chelated iron, 0.05% chelated manganese, and 0.05% chelated zinc) and watered daily. Foliage in each microplot was trimmed to a height of 5 cm every 2 weeks, placed into paper bags, dried at 30°C for 72 h and weighed. At 111 and 198 d after establishment of the experiment, 10 soil cores, 2-cm-diameter x 15-cm deep, were collected in a star-shaped pattern from each microplot. Samples from each microplot were bulked, and a 250 g subsample was used to estimate the density of nematode communities. At 198 d, final clippings were collected, root systems were rinsed free of soil, dried, and weighed as described for clippings. Weights of dry roots, plus those of cumulative clippings, were used to determine final plant weight.

All aspects of the 2013 trial were the same as 2012 with the exceptions that there were two levels of inoculum, nematodes, and water controls, and soil samples were collected when the experiment was terminated after 162 d. The nematode infestation level in 2013 was 19,959 vermiform stages (308 *Pratylenchus zeae*, 10,076 *Criconemella* spp., 1,286 *M. incognita*, 1,100 *Helicotylenchus* spp., 5,049 *Tylenchorhynchus* spp., and 2,140 *Tylenchus* spp.). Microplots were established 18 April, infested with nematodes 1, 3, and 6 May and harvested 15 October.

Plant and nematode data were examined by analysis of variance using the "Fit Model" module of SAS JMP, version 10.0 (SAS Institute, Cary, NC) and means were separated using Tukey's HSD ($P \leq 0.05$).

RESULTS

At 111 d in the 2012 microplot trial, populations of *Criconemella* spp. that resulted from both the low and high inoculum levels were numerically, but not statistically, greater on St. Augustine than on Centipede grass (Table 1). The density of populations of *Helicotylenchus* and *Meloidogyne* in soil was very low at this time. *Helicotylenchus* was below detectable levels on centipede grass and *Meloidogyne* was just above 100 per 250 cc of loam soil in centipede grass. Populations of *Pratylenchus* that resulted from both levels of inoculum were numerically higher on centipede than on St. Augustine. Populations of *Tylenchorhynchus* and *Tylenchus* did not differ in density at this time on either grass species or from either level of inoculum.

When the 2012 trial was terminated after 198 d, population density estimates for individual genera were similar to those observed at 111 d (Table 2). There were no statistical differences in the soil population totals that resulted from level of inoculum, turfgrass species, or soil types.

The main effects of soil, turfgrass and inoculum level, and their interactions are presented as Table 3. At 111 d, both turfgrass and level of inoculum were significant at the 1%. There was also a significant (5%) interaction between soil and turfgrass type as well as soil and inoculum level (1%), and turfgrass type and inoculum level (5%) (Fig.1). At 198 d, only inoculum level was significant (1%).

At 111 d, the greatest number of nematodes (2,450 per 250 g of soil) was recovered from St. Augustine grown in sandy loam soil that received the high level of inoculum. This density was greater than all other soil, turfgrass and inoculum levels except for the community associated with St. Augustine growing in sandy loam soil infested with the high level of inoculum.

The 2013 microplot experiment was terminated after 162 d. For each of the six nematode genera, final population densities associated with St. Augustine were generally highest in sandy loam soil, lowest in clay and intermediate in loam (Table 4). Population density of *Criconemella* from St. Augustine grown in sandy loam soil was greater than those associated with either turfgrass in clay soil and with St. Augustine in loam. Population densities of *Criconemella* recovered from centipede in loam and sandy loam were greater than those from St. Augustine in clay. Populations of *Helicotylenchus* were below detectable levels in all combinations except for the centipede-sandy loam one where the density averaged 3 per 250 g of soil. *Meloidogyne* populations were comparable across all turfgrass and soil combinations except those on St. Augustine in clay soil where they were lower than on St. Augustine in sandy loam. The density of *Pratylenchus* populations did not differ across either soils or turfgrasses at 162 d. The St. Augustine-sandy loam soil combination had higher population densities of *Tylenchorhynchus* than did the St. Augustine-clay combination. Populations of *Tylenchus* were below detectable levels in all combinations except for the centipede/loam one where the density averaged 10 per 250 g of soil.

The main and interaction effects of soil, turfgrass, and inoculum level on nematode community totals at 162 d for the 2013 experiment are presented as Table 5. Main effects for both soil and inoculum as well as 2-way interaction effects for soil by turfgrass and soil by inoculum and 3-way interactive effects of soil by turfgrass by inoculum were significant at the

Table 1. Densities of six nematode genera per 250 g of soil from St. Augustine and centipede turfgrasses grown in three soil types with three inoculum levels after 111 d in a microplot environment in 2012.

	Vermiform life stages/250 g of soil[w]											
	Low inoculum level[x]						High inoculum level					
	St. Augustine			Centipede			St. Augustine			Centipede		
Nematode Genera	Clay[y]	Loam	Sandy Loam	Clay	Loam	Sandy Loam	Clay	Loam	Sandy Loam	Clay	Loam	Sandy Loam
Criconemella	944 ab[z]	665 ab	864 ab	246 b	472 b	213 b	618 b	1034 ab	1835 a	459 b	746 ab	706 ab
Helicotylenchus	19 a	97 a	3 a	0 a	0 a	0 a	8 a	11 a	0 a	0 a	0 a	0 a
Meloidogyne	4 a	8 a	21 a	66 a	144 a	12 a	17 a	8 a	37 a	13 a	8 a	45 a
Pratylenchus	8 b	0 a	0 a	353 a	127 ab	29 b	8 b	4 b	11 b	111 ab	45 b	74 ab
Tylenchorhynchus	314a	264a	341a	275a	103 a	74 a	271a	304a	396a	127 a	152 a	258 a
Tylenchus	17 a	17 a	33a	58a	17a	29 a	81a	115a	171a	41 a	28 a	49 a

[w]The soil capacity of microplots, terra cotta containers having a top inside diameter of 30.5 cm, was 10 kg. Density of nematodes per microplot may be estimated by using a conversion factor of 40.

[x]Inoculum levels were 0 (nematode suspending fluids minus nematodes; no nematodes recovered at 111 d), 1,009 nematodes (low inoculum level: 665 *Criconemella*, 65 *Helicotylenchus*, 12 *Meloidogyne*, 15 *Pratylenchus*, 164 *Tylenchorhynchus*, and 88 *Tylenchus*) or 10,074 nematodes (high inoculum level: 6,646 *Criconemella*, 645 *Helicotylenchus*, 121 *Meloidogyne*, 150 *Pratylenchus*, 1,636 *Tylenchorhynchus*, 876 *Tylenchus*).

[y]Soils were clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt,10% clay).

[z]Data are means of five replications and were analyzed by analysis of variance using the "Fit Model" module of JMP, Version 10.0. Means were separated using Tukey's HSD test ($P \leq 0.05$). Within inoculum levels and individual genera, means followed by the same letter are not significantly different according to Tukey's HSD ($P \leq 0.05$).

Table 2. Densities of six nematode genera per 250 g of soil from St. Augustine and centipede turfgrasses grown in three soil types with three inoculum levels after 198 d in a microplot environment in 2012.

	Vermiform life stages/250 g of soil[w]											
	Low inoculum level[x]						High inoculum level					
	St. Augustine			Centipede			St. Augustine			Centipede		
Nematode Genera	Clay[y]	Loam	Sandy Loam	Clay	Loam	Sandy Loam	Clay	Loam	Sandy Loam	Clay	Loam	Sandy Loam
Criconemella	944 ab[z]	665 ab	864 ab	246 b	472 b	213 b	618 b	1034 ab	1835 a	459 b	746 ab	706 ab
Helicotylenchus	19 a	97 a	3 a	0 a	0 a	0 a	8 a	11 a	0 a	0 a	0 a	0 a
Meloidogyne	4 a	8 a	21 a	66 a	144 a	12 a	17 a	8 a	37 a	13 a	8 a	45 a
Pratylenchus	8 b	0 a	0 a	353 a	127 ab	29 b	8 b	4 b	11 b	111 ab	45 b	74 ab
Tylenchorhynchus	314a	264a	341a	275a	103 a	74 a	271a	304a	396a	127 a	152 a	258 a
Tylenchus	17 a	17 a	33a	58a	17a	29 a	81a	115a	171a	41 a	28 a	49 a

[w]The soil capacity of microplots, terra cotta containers having a top inside diameter of 30.5 cm, was 10 kg. Density of nematodes per microplot may be estimated by using a conversion factor of 40.

[x]Inoculum levels were 0 (nematode suspending fluids minus nematodes; no nematodes recovered at 111 d), 1,009 nematodes (low inoculum level: 665 *Criconemella*, 65 *Helicotylenchus*, 12 *Meloidogyne*, 15 *Pratylenchus*, 164 *Tylenchorhynchus*, and 88 *Tylenchus*) or 10,074 nematodes (high inoculum level: 6,646 *Criconemella*, 645 *Helicotylenchus*, 121 *Meloidogyne*, 150 *Pratylenchus*, 1,636 *Tylenchorhynchus*, 876 *Tylenchus*).

[y]Soils were clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt,10% clay).

[z]Data are means of five replications and were analyzed by analysis of variance using the "Fit Model" module of JMP, Version 10.0. Means were separated using Tukey's HSD test ($P \leq 0.05$). Within inoculum levels and individual genera, means followed by the same letter are not significantly different according to Tukey's HSD ($P \leq 0.05$).

Table 3. Main and interaction effects (*P* values) of soil, turfgrass, and inoculum level on nematode community densities at 111 and 198 d after infestation in a microplot environment in 2012.

Source	DF	Community at 111 d	Community at 198 d
S[w]	2	0.250[x]	0.119
T[y]	1	<0.001**	0.064
I[z]	2	<0.001**	<0.001**
S x T	2	0.037*	0.059
S x I	4	<0.001**	0.685
T x I	2	0.014*	0.325
S x T x I	4	0.387	0.536

[w]Soils (S) were clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay).

[x]Data are means of five replications and were analyzed separately for each time interval by analysis of variance using the "Fit Model" module of JMP, Version 10.0. Single and double asterisks indicate *P* values significant at the 0.05 and 0.01% levels, respectively.

[y]Turfgrasses (T) were St. Augustine and Centipede.

[z]Inoculum (I) levels were 0 (nematode suspending fluids minus nematodes), 1,009 nematodes (low inoculum level: 665 *Criconemella*, 65 *Helicotylenchus*, 12 *Meloidogyne*, 15 *Pratylenchus*, 164 *Tylenchorhynchus*, and 88 *Tylenchus*) or 10,074 nematodes (high inoculum level: 6,646 *Criconemella*, 645 *Helicotylenchus*, 121 *Meloidogyne*, 150 *Pratylenchus*, 1,636 *Tylenchorhynchus*, 876 *Tylenchus*).

Table 4. Densities of six nematode genera per 250 g of soil from St. Augustine and centipede turfgrasses grown in three soil types with two inoculum levels after 162 d in a microplot environment in 2013.

	Vermiform life stages / 250 g of soil[x]					
	St. Augustine			Centipede		
Nematode genera	Clay[y]	Loam	Sandy Loam	Clay	Loam	Sandy Loam
Criconemella	280 c [z]	517 bc	955 a	525 bc	731 ab	714ab
Helicotylenchus	0 a	0 a	0 a	0 a	0 a	3 a
Meloidogyne	76 b	167 ab	238 a	136 ab	169 ab	100 ab
Pratylenchus	67 a	103 a	14 0a	121 a	150 a	69 a
Tylenchorhynchus	245 b	434 ab	821 a	477 ab	580 ab	438 ab
Tylenchus	0 a	0 a	0 a	0 a	10 a	0 a

[x]Soil capacity of microplots was 10 kg. Density of nematodes per microplot may be estimated by using a conversion factor of 40.

[y]Soils were clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay).

[z]Data are means of five replications and were analyzed by analysis of variance using the "Fit Model" module of JMP, Version 10.0. Means were separated using Tukey's HSD test ($P \leq 0.05$). Within individual genera, means followed by the same letter are not significantly different according to Tukey's HSD ($P \leq 0.05$). Inoculum levels were 0 (nematode suspending fluids minus nematodes, no nematodes recovered at 162 d) or 19,959 vermiform stages (308 *Pratylenchus zeae*, 10,076 *Criconemella* spp., 1,286 *M. incognita*, 1,100 *Helicotylenchus* spp., 5,049 *Tylenchorhynchus* spp., and 2,140 *Tylenchus* spp.).

Table 5. Main and interaction effects (*P* values) of soil, turfgrass and inoculum level on nematode community density at 162 d after inoculation in a microplot environment in 2013.

Source	DF	Community at 162 d[w]
S[x]	2	0.008**
T[y]	1	0.759
I[z]	1	<0.001**
S x T	2	0.009**
S x I	2	0.008**
T x I	1	0.759
S x T x I	2	0.009**

[w]Data are means of five replications and were analyzed separately by analysis of variance using the "Fit Model" module of JMP, Version 10.0. Double asterisks indicate *P* values significant at the 0.05 and 0.01% levels, respectively.

[x]Soil (S) were clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay).

[y]Turfgrasses (T) were St. Augustine or centipede.

[z]Inoculum (I) levels were 0 (nematode suspending fluids minus nematodes) or 19,959 nematodes (308 *Pratylenchus zeae*, 10,076 *Criconemella* spp., 1,286 *M. incognita*, 1,100 *Helicotylenchus* spp., 5,049 *Tylenchorhynchus* spp., and 2,140 *Tylenchus* spp.) per microplot.

1% level. Individual treatment means at 162 d in this experiment are presented as Figure 2. The highest population density of nematodes (2,153 per 250 g of soil), was recovered from St. Augustine grown in sandy loam soil. This number of nematodes was not significantly different from 1,640 per 250 g of soil recovered from centipede grown in loam soil. The nematode community density recovered from all other soil and turfgrass combinations were significantly lower.

Soil had a significant influence on weights of both turfgrasses in the 2012 and nematode inoculum had a significant influence on final weights of both turfgrasses in 2013 (Table 6). There were no significant interactions affecting plant weight in either year. Individual treatments means at 162 d relating to nematode inoculum influence on plant weights are presented as Figure 3. Plant weights of St. Augustine and centipede were reduced 13 and 25%, respectively, by the nematode communities.

DISCUSSION

Soil type is known to influence nematode population dynamics under greenhouse (Griffin *et al.*, 1984; Xavier *et al.*, 2014), microplot (Koenning *et al.*, 1996; Moore and Lawrence, 2013), and field conditions (Jordaan *et al.*,1989). In these microplot experiments, soil type exhibited a significant influence on plant growth in 2012 and a significant influence on nematode reproduction in 2013. The absence of a soil type-related impact on plant growth in 2013 was likely masked by the damage that the nematodes caused to the root systems of both turfgrasses.

Table 6. Main and interaction effects (*P* values) of soil and nematode inoculum on turfgrass plant weights at 198 and 162 d in a microplot environment in 2012 and 2013, respectively.

		Plant weight[x]			
		2012		2013	
Source	DF	St. Augustine	Centipede	St. Augustine	Centipede
S[y]	2	0.008**	0.003*	0.381	0.140
I[z]	2	0.806	0.727	<0.01**	0.011*
I x S	4	0.618	0.943	0.404	0.806

[x]Cumulative weights of foliar clippings collected at twelve intervals plus roots. Plant material was dried at 30°C for 72 hours. Data are means of five replications and were analyzed by analysis of variance using the "Fit Model" module of JMP, Version 10.0. Single and double asterisks indicate *P* values significant at the 0.05 and 0.01% levels, respectively.

[y]Soils (S) were clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay), or sandy loam (75% sand, 15% silt, 10% clay).

[z]Inoculum (I) levels per microplot were 0 (nematode suspending fluids minus nematodes), and 10,074 nematodes in 2012 (6,646 *Criconemella*, 645 *Helicotylenchus*, 121 *Meloidogyne*, 150 *Pratylenchus*, 1,636 *Tylenchorhynchus*, 876 *Tylenchus*) or 19,959 in 2013 (10,076 *Criconemella*, 1,100 *Helicotylenchus*, 1,286 *Meloidogyne*, 308 *Pratylenchus*, 5,049 *Tylenchorhynchus*, and 2,140 *Tylenchus*).

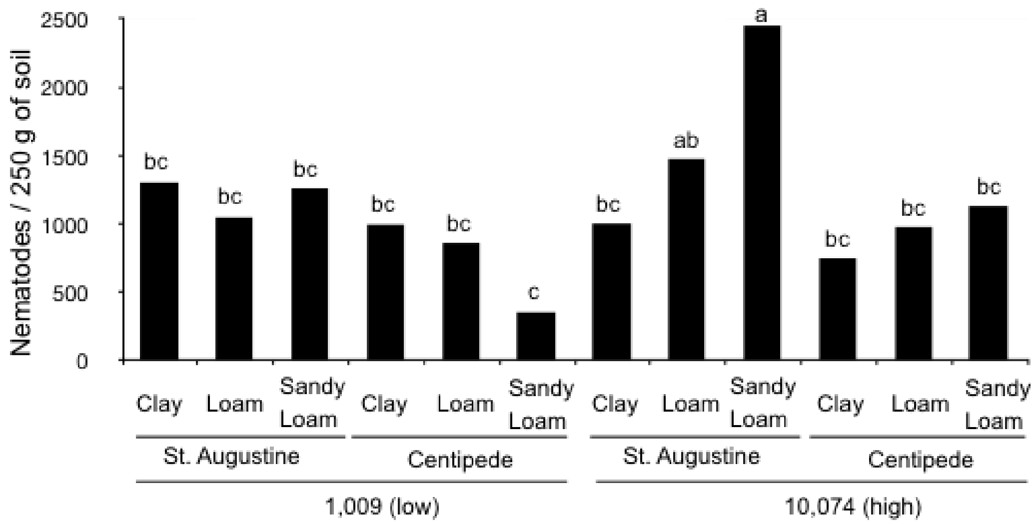

Fig. 1. 2012 microplot experiment: Vermiform stages of nematode community recovered from soil of St. Augustine and centipede turfgrasses at 111 d after inoculation in clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay), or sandy loam (75% sand, 15% silt, 10% clay) soils. Inoculum levels were 0 (nematode suspending fluids minus nematodes), 1,009 nematodes (low inoculum level: 665 *Criconemella*, 65 *Helicotylenchus*, 12 *Meloidogyne*, 15 *Pratylenchus*, 164 *Tylenchorhynchus*, and 88 *Tylenchus*) or 10,074 nematodes (high inoculum level: 6,646 *Criconemella*, 645 *Helicotylenchus*, 121 *Meloidogyne*, 150 *Pratylenchus*, 1,636 *Tylenchorhynchus*, 876 *Tylenchus*). Soil capacity of microplots was 10 kg. Density of nematode communities per microplot may be estimated by using a conversion factor of 40. Data are means of five replications per treatment. Bars with common letters are not significantly different based on Tukey's HSD ($P \leq 0.05$) test.

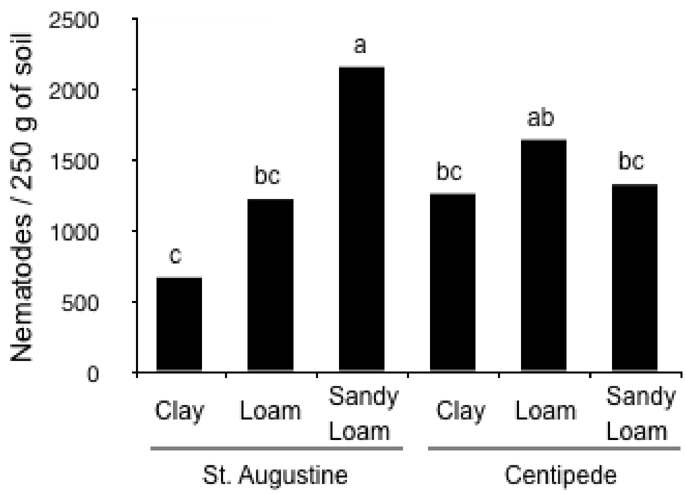

Fig. 2. 2013 microplot experiment: Vermiform stages of nematode community recovered from soil of St. Augustine and centipede turfgrasses at 162 d after inoculation in clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay) soils infested with 19,959 nematodes (308 *Pratylenchus zeae*, 10,076 *Criconemella* spp., 1,286 *M. incognita*, 1,100 *Helicotylenchus* spp., 5,049 *Tylenchorhynchus* spp., and 2,140 *Tylenchus* spp.). Soil capacity of microplots was 10 kg. Density of nematode communities per microplot may be estimated by using a conversion factor of 40. Data are means of five replications per treatment. Bars with common letters are not significantly different based on Tukey's HSD ($P \leq 0.05$) test.

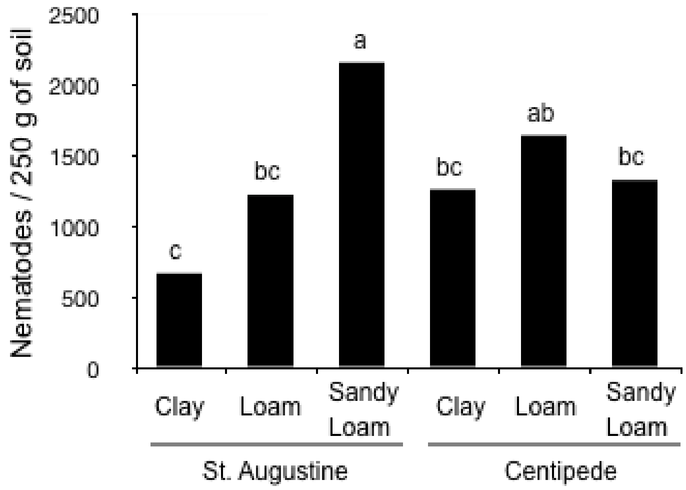

Fig. 3. . Effects of soil and nematode inoculum on turfgrass plant weights at 162 d in a microplot environment in 2013. Inoculum levels per microplot were 0 (nematode suspending fluids minus nematodes), and 19,959 nematodes (10,076 *Criconemella*, 1,100 *Helicotylenchus,* 1,286 *Meloidogyne*, 308 Pratylenchus, 5,049 *Tylenchorhynchus*, and 2,140 *Tylenchus*). Data are cumulative weights of foliar clippings collected at twelve intervals plus roots and are means of five replications per treatment. Plant material was dried at 30°C for 72 hours. Within turfgrass types, bars with common letters are not significantly different based on Tukey's HSD ($P \leq 0.05$) test.

In 2013, but not in 2012, soil type had a significant influence on the density of individual nematode populations as well as on the entire nematode community. Nematode population densities, especially for St. Augustine, were highest in the sandy loam soil, which was 75% sand. Edaphic factors such as temperature and moisture probably had minimal effects on either plant growth or nematode reproduction under the microplot conditions where plants were watered daily and daytime soil temperatures stayed within the range of 31 to 34°C.

The total nematode community densities that resulted from the high inoculum levels were similar in 2012 and 2013, averaging 64,720 individuals per microplot in 2012 and 55,080 in 2013. However, there were marked differences in the densities of individual nematodes comprising the community in both years. Populations of root-knot and lesion nematodes were eleven and three times greater in 2013 than in 2012. Axenic populations of *M. incognita* and *P. zeae* were derived from these communities and studied in greenhouse based experiments where they were shown to be pathogenic on these two turfgrasses (Plaisance *et al.*, 2015).

Notable conclusions from the research herein include: 1) Nematode communities composed of six to eight genera have the potential to cause significant injury to St. Augustine and centipede turfgrass species under microplot conditions; 2) On both St. Augustine and centipede turfgrass, nematode reproduction was greatest in sandy loam soil, least in clay soil and intermediate in loam soil; and 3) A soil type by turfgrass interaction resulted in significantly greater numbers of nematodes in St. Augustine turfgrass grown in sandy loam soil than from five other soil-turfgrass combinations.

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