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Species abundance and influence of nematodes in urban turfgrass ecosystems in East Baton Rouge Parish, Louisiana

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SPECIES ABUNDANCE AND INFLUENCE OF NEMATODES IN URBAN TURFGRASS ECOSYSTEMS IN EAST BATON ROUGE PARISH, LOUISIANA

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ABSTRACT

In 2011 and 2012, 100 residential lawns in the Baton Rouge, Louisiana area were sampled to document the incidence of plant-parasitic nematodes, in addition four full-season microplot experiments and four 71-day duration greenhouse experiments were conducted to evaluate their pathogenicity on St. Augustine and centipede turfgrasses. Nematode genera associated with both turfgrasses included *Criconemella, Helicotylenchus*, *Meloidogyne*, *Pratylenchus*, *Tylenchorynchus* and *Tylenchus* spp. In microplot trials in 2012, nematodes did not cause significant damage to either turfgrass, but soil exhibited an effect on plant growth parameters. In 2013, when there was significant nematode related injury to both turfgrasses, there were no significant effects of soil on plant growth parameters. Greenhouse based pathogenicity trials were conducted separately with *Meloidogyne incognita* and *Pratylenchus zeae*. Across two levels of nematode infestation, reductions below controls for St. Augustine and centipede averaged 24% and 28% for *M. incognita* and 37.0% and 39.3% for *P. zeae*; indicating that overall, *P. zeae* was more damaging than *M. incognita* to both turfgrasses.

INTRODUCTION

Approximately 60 million acres in the U.S. are residential properties supporting the expanding population (Lubowski et al., 2002). Most residences allocate approximately half their property to landscape; much of which is turfgrass, the most widely grown ornamental crop in the United States (Bruneau et al., 2007). The use of turfgrasses in urban areas increases the aesthetic quality of the landscape as well as helps to mitigate heat, provides proper water drainage and contributes to soil carbon sequestration (Milesi et al., 2005). Turfgrass species grown for residential lawns in the southern U.S. include centipede (*Eremochloa ophiuroides*), St. Augustine (*Stenotaphrum secundatum*) and zoysia (*Zoysia japonica*). Bermudagrass (*Cynodon dactylon*) and creeping bentgrass (*Agrostis stolonifera*) are most commonly used for recreational turf, such as sports fields and golf courses (Dunn and Diesburg, 2004). According to Milesi et al. in 2005, half of Louisiana's estimated 3,377 km^2 of turfgrass is utilized in residential environments; the other half for state, commercial, and recreational properties.

By infecting the root system, plant parasitic nematodes (PPN) influence the physiological processes of the entire plant, either directly or indirectly. Nematodes affect plant growth by disrupting cell structure, removing cell contents, altering metabolism and modifying the genetic expression of the host (Bongers and Bongers, 1998; Milesi et al., 2005; Cheng et al., 2008). As PPN feed on plant parts, subsequent damage reduces the ability of root systems to uptake water and nutrients from the soil solution (Khan, 1993). Infestations of PPN frequently cause turfgrasses to become more susceptible to environmental stresses. Parasitized roots may be shortened and appear darkened or rotted (Crow and Welch, 2004). Roots may also exhibit knots or galls and/or display excessive branching (Blake, 1999). When nematode population densities become high enough, and/or environmental stresses such as high temperatures or drought occur, above ground symptoms usually become detectable as a result of this stunted growth and discoloration. Foliar symptoms include yellowing, wilting, browning, thinning out, poor response to fertilization and irrigation, or death of grass. Damage often occurs as irregularly shaped chlorotic patches that may enlarge in diameter over time (Crow and Grewal, 2009).

More than 20 genera of PPNs are known to actively parasitize and cause damage to turfgrasses (Dunn and Diesburg, 2004). The most common of these twenty nematode genera include lance (*Hoplolaimus galeatus*; Giblin-Davis et al., 1995), ring (*Criconemella* 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, 2000ab), stubby-root (*Paratrichodorus* and *Trichodorus* spp.; Crow and Welch, 2004) and stunt (*Tylenchorhynchus* spp.; Mai and Lyon, 1975). Of these nematodes, sting and stubby-root tend to cause the most severe damage to turfgrass (Schwartz et al., 2010; Wetzel, 2010). Turfgrasses that are 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, 2005), as well as the two grasses used in this research, St. Augustine (Kelsheimer and Overman, 1953; Good et al., 1959; Rhoades, 1962; Di

Edwardo and Perry, 1964; Dickerson, 2000; Inserra, 2005; Faske, 2009) and centipede (Good et al., 1959; Ratanaworabhan and Smart, 1969; Dickerson, 2000; Ye et al., 2012; Davis, 2013).

The damage severity as a result of nematode infection on turfgrasses varies with genus and species. This variation in damage potential is used to establish genus-specific damage and economic thresholds. For example, nematodes such as sting and lance, in quantities exceeding 20 nematodes per 100 cc of soil (Dickerson, 2013), can cause economically important loss in sod farms and destruction of entire putting greens on golf courses, whereas spiral and ring usually only cause a significant amount of damage to turfgrasses when nematode levels exceed 500 nematodes per 100 cc of soil.

A relationship between nematode densities, subsequent damage to crops and soil texture has been established. For example, embers of the genus *Helicotylenchus* occur in much greater density in soils with higher clay content while those in *Pratylenchus* occur in higher densities in soils with more silt or sand (Ferris and Bernard, 1971). Also, field trials have shown that in the presence of *Meloidogyne incognita*, there is a 9.85, 12.81 and 8.74 kg/ha decrease in lint yield of cotton for every percentage increase in soil sand content in 2001, 2002 and 2003, respectively (Monfort, 2007).

Most research on the impact of nematodes on turfgrass to date pertains to recreational ecosystems including golf courses and sports fields (Crow et al., 2003; Pontif and McGawley, 2007; Starr et al., 2007; Crow and Grewal, 2009). Very few studies have evaluated the influence of nematode genera on turfgrass species used in residential environments. Of 34 articles on turfgrass pathology published in three major nematological journals, seven pertain to *B. longicaudatus*, 10 focus on golf course turf such as creeping bentgrass and bermudagrass and 11 are studies of soil food webs. Only six articles (Ratanaworabhan, 1969; Johnson, 1970; Giblin-Davis et al., 1992, 1995; Crow and Welch, 2004; Brito et al., 2010) contain information on the effects of nematodes on St. Augustine and centipede turfgrasses, the two most widely utilized in residential landscapes in the southeastern U.S. Despite the apparent impact nematodes have on the overall health of lawns, few reports have attempted to quantify this impact in any state in the Southern United States.

Objectives of the Research

1) Survey populations and communities of plant parasitic nematodes that infest residential lawn ecosystems in the greater Baton Rouge, Louisiana area.
2) Assess the impact of individual and combined populations of plant parasitic nematodes on the growth of St. Augustine and centipede turfgrasses.
3) Evaluate the impact of soil texture on nematode reproduction and damage to St. Augustine and centipede turfgrasses.

MATERIALS AND METHODS

Survey

An urban area of Baton Rouge, which encompassed low, middle and high-income residences, having a total area of 12,646 ha was selected for sampling using a digital map (Google maps). A grid composed of 256 squares (sample areas), each 49.4 ha in size, was superimposed over this map with horizontal and vertical designations of 1-16 and A-P, respectively. Twenty of these squares were randomly selected for sampling. Preliminary work indicated that each 484-acre square contains an average of 66 residences with lawns suitable for sampling. Five lawns in each of the 20 sample areas, referred to hereafter as "sites," were chosen for the collection of soil and root samples. Twenty-five soil cores (2.5-cm-diam. X 15-cm-deep) and a sample of roots was collected from each site. Samples were collected from 65 residences with St. Augustine and 35 with centipede. Soil cores from each site were bulked and homogenized. A 250 g subsample of soil was utilized for nematode community analysis and a 20 g subsample was used to determine soil texture. Soil type and texture (percentages of sand, silt and clay) for each sample was determined utilizing the soil hydrometer method (American Society for Testing and Materials, 1985; Day, 1965). Root material from each site was visually inspected for galling by *Meloidogyne spp.* and a 3 g subsample was placed on Baerman funnels (Hooper et al., 2005) and inspected after 24 hours for endoparasitic nematode species.

Nematodes were extracted from soil samples by wet-sieving through nested 250-µm-pore (60 mesh) and 38-µm-pore (400 mesh) sieves followed by sugar floatation and centrifugation technique (Jenkins, 1964). Nematodes recovered from soil samples were enumerated and sorted according to genus (Mai and Lyon, 1975) at 40X using an inverted microscope.

Populations of *Pratylenchus* and *Meloidogyne* were identified in both soil and root samples and were established in axenic cultures in a greenhouse environment for subsequent identification to the species level. Dichotomous keys for speciation of root-knot (Esser et al., 1976; Eisenback, 1991) and lesion (Handoo and Golden, 1989) nematodes were used in conjunction with the Spot Image Analysis System (http://www.spotimaging.com/software/) for Macintosh to determine the root-knot nematode was *Meloidogyne incognita* and the lesion nematode was *Pratylenchus zeae*. Also, populations of this root-knot nematode readily infected tomato plants and reproduced abundantly.

Microplot Experiments

Grass species used 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 seconds and rinsed. Washings were analyzed for nematodes to ensure adequate control criteria were met, and none 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 capacity of 10 kg of soil sterilized by steaming at 116°C for eight hours. Soils used in these trials 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 (LSU School of Plant, Environmental and Soil Sciences) as they reflected the range of coarse to fine textured soils encountered during the survey. Field soil from two locations at the Ben Hur Research Farm in Baton Rouge, Louisiana were collected. One soil lot 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. The three soils are referred to hereafter, respectively, as clay, loam and sandy loam. During the course of these experiments, turf was 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.

The microplot area is bounded by a 17-meter-long by 9-meter-wide aluminum Quonset hut skeletal frame 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 (Pontif and McGawley, 2008).

Two weeks after establishment of St. Augustine and centipede sod squares, populations of nematodes recovered from stock cultures 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 seven days. The first infestation was made in the center of each sod square and the second and third infestations were made 10 cm north and south of the first. For the 2012 experiment, nematode infestations included a nematode-free control: suspending fluid minus nematodes; a low level of infestation (LOI): 1,009 juveniles and adults (15 lesion, 664 ring, 12 root-knot, 64 spiral, 163 stunt and 88 stylet); and a high LOI: 10,076 juveniles and adults (150 lesion, 6,646 ring, 121 root-knot, 645 spiral, 1638 stunt and 876 stylet). The low LOI was based on survey data for nematode genera and densities present in the spring. The high LOI was used to evaluate whether or not these communities were pathogenic to the two turfgrass species. Microplot experiments in 2012 were established on 11 April, infested with nematodes on 25 April, 27 April and 2 May and harvested 15 November.

Foliage in each microplot was trimmed to a height of 5 cm every two weeks, placed into paper bags, dried at 30°C for 72 h and weighed to determine biomass. A 100 g subsample of soil was collected from each microplot at 111 and 198 days after infestation by collecting 10 soil cores in a star-shaped pattern utilizing a 2-cm-diameter x 15-cm-deep soil probe. At 198 days after infestation, the final clippings were collected, root systems were rinsed free of soil, dried and weighed as described for clippings. Mass (g) of dry roots plus those of final clippings were used to determine final plant mass.

Treatments were replicated five times for a total of 90 microplots separated physically according to turfgrass type in two adjacent microplot areas, 45 microplots per area. Within each area, microplots were spaced 1-meter apart and arranged as a 5-by-9 randomized block design.

All aspects of the experiment for 2013 were as described above for the 2012 experiment with the exceptions that that soil samples were 250 g, the experiment was terminated after 162 days and there were only two LOI. The control was as described for the 2012 experiment and the level of nematode infestation was 19,959 vermiform stages (308 lesion, 10,076 ring, 1,286 root-knot, 1,100 spiral, 5,049 stunt and 2,140 stylet). The 60 microplots (30 per area) in the 2013 experiment were established 18 April, infested with nematodes 1 May, 3 May and 6 May and harvested 15 October.

Weight of clippings (g), roots and plants were examined by analysis of variance (ANOVA) for a 3 x 3 (soil type x LOI) and 3 x 2 (soil type x LOI) factorial design for the 2012 and 2013 experiments, respectively, using the “Fit Model” module of SAS JMP, version 10.0 (SAS Institute, Cary, NC). Nematode data was examined by analysis of variance (ANOVA) for a 3 x 3 x 2 (soil type x LOI x grass) and 3 x 2 x 2 (soil type x LOI x grass) factorial design, for the 2012 and 2013 experiments, respectively. Means of data were separated by Tukey’s HSD ($P \leq 0.05$).

Greenhouse Experiments

Four 71-day duration experiments, two with the root-knot nematode, *Meloidogyne incognita* and two with the root-lesion nematode, *Pratylenchus zeae*, were conducted to evaluate their impact on the growth of St. Augustine or centipede turfgrasses. Each experiment had three LOI (0, 200 and 2,000 vermiform nematodes), three soils (clay, loam and sandy loam types as described for microplot experiments), two turfgrasses and were replicated four times for a total of 72 pots (terra-cotta, 10.2 cm top diam, each holding 1.2 kg of steam-sterilized soil) per trial. Each experiment was arranged as a randomized block and repeated once. Sod was obtained and 5 cm x 5 cm squares were prepared as described for microplots. Fertilizer (same as described for microplots, 0.25 g) was applied every two weeks. For all experiments, populations of nematodes recovered from axenic stock cultures were pipetted from water slurry into a 5.0 cm deep hole at the center of each turfgrass square at 11 days after establishment.

Data for plants and nematodes were collected as described for microplot experiments, but there were six clipping intervals. At 71 days after infestation, a 150 g soil subsample was collected from each pot and used to estimate levels of nematodes in soils. A three g subsample from each root system were placed on Baerman funnels for 24 hours and used to estimate levels of endoparasitic nematodes. Root systems were examined for galling and root lesions typical of the two nematode species. Experiments were established 26 July, infested with nematodes 6 August and harvested 20 October, 2013.

Weight of clippings (g), roots and plants were examined by analysis of variance (ANOVA) for a 3 x 3 factorial design (soil x LOI) using the “Fit Model” module of SAS JMP, version 10.0. Nematode data from both greenhouse experiments were examined by analysis of variance (ANOVA) for a 3 x 3 x 2 (soil x LOI x turfgrass) factorial design.

Means of data were separated by Tukey's HSD ($P \leq 0.05$) in all greenhouse experiments. There were no significant differences between trials, so data from like experiments were combined.

RESULTS

Survey

Nematodes in 13 genera, with community totals ranging from 6-2,673 and from 45-2,185 per 250 g of soil were found in soils from lawns of St. Augustine and centipede turfgrasses, respectively (Table 1). Community densities were similar for both turfgrasses and averaged 496 for St. Augustine and 618 per 250 g of soil for centipede.

Nematodes in the genera *Criconemella* spp., *Helicotylenchus* spp. and *Tylenchus* spp. were very commonly associated with both turfgrasses, with frequencies ranging from 91-94% for St. Augustine and from 78-92% for centipede. Similarly, densities per 250 g ranged from 150-180 for St. Augustine and from 132-290 for centipede. Genera less frequently encountered, with frequencies ranging from 25-69%, included *Meloidogyne* spp., *Pratylenchus* spp. and *Tylenchorhynchus* spp. for St. Augustine and *Meloidogyne* spp., *Pratylenchus* spp. *and Hoplolaimus* spp. for centipede. Densities for these genera were approximately equal on both turfgrasses and ranged from 8-59 per 250 g of soil. *Xiphinema* spp. was found in only 15% of the samples from St. Augustine while *Trichodorus* spp. and *Tylenchorhynchus* spp. were found in 14% and 19% of the samples from centipede. Densities for these genera were low and averaged 11, 9 and 32 per 250 g, respectively. *Aphelenchoides* spp., *Gracilicus* spp., *Hemicycliophora* spp. and *Scutellonema* spp. were rarely detected, occurring at frequencies of less than 10% and densities ranging from 6-26 individuals.

Table 1. Nematode incidence and density in residential lawns of St. Augustine and centipede turfgrasses in East Baton Rouge Parish, Louisiana.

Nematode genera (spp.)	St. Augustine[u]			Centipede[u]		
	Freq.[w]	Density[x]	Range[y]	Freq.	Density	Range
Aphelenchoides	2	6	6	6	26	26
Criconemella	91	159	6-1,760	86	290	6-2,052
Gracilicus	3	20	17-22	0	0	0
Helicotylenchus	94	180	6-2,585	78	186	6-836
Hemicycliophora	2	11	11	0	0	0
Hoplolaimus	5	8	6-11	25	18	6-61
Meloidogyne	46	54	6-220	25	52	6-303

(Table 1 continued)

Nematode genera (spp.)	St. Augustine[u]			Centipede[u]		
	Freq.[w]	Density[x]	Range[y]	Freq.[w]	Density[x]	Range[y]
Pratylenchus	35	29	6-127	69	59	6-297
Scutellonema	2	11	11	3	25	25
Trichodorus	3	14	6-22	14	9	6-17
Tylenchorhynchus	25	28	6-88	19	32	6-88
Tylenchus	92	150	6-804	92	132	33-386
Xiphinema	15	11	6-22	6	14	5-22
Community[z]	100	496	6-2,673	94.4	618	45-2,185

[u]Soil samples (250 g) were collected from 65 and 35 lawns containing St. Augustine and centipede, respectively. Root samples (3 g) were collected from each site. Data is not presented as only *Meloidogyne* spp. and *Pratylenchus* spp. were recovered at very low densities ranging from 6-28 and 6-22 for St. Augustine and centipede, respectively.
[v]The majority of samples were collected between March and October, 2011.
[w]Frequency is the number of times each genus was identified for each turfgrass expressed as a percentage.
[x]Density is the average density for each genus.
[y]Range is the minimum and maximum densities for each genus.
[z]Refers to plant parasitic nematodes only.

Microplot Experiment – 2012

Soil had a significant impact on all plant growth parameters for both turfgrasses (Table 2). Final weight for St. Augustine plants averaged 80.6 g in clay, 19.4% less in loam and 43% less in sandy loam. For centipede, final plant weight averaged 36 g in clay, 4.2% less in loam and 54% less in sandy loam. Weights of dry clippings and roots followed a similar pattern. There was no significant effect of LOI and there was no soil by LOI interaction.

Table 2. Main and interaction effects (P values) of soil and level of infestation on St. Augustine and centipede turfgrasses at 198 DAI[t] in a microplot environment – 2012[u].

Source	DF	Clipping wt.[u] (g)		Root wt.[v] (g)		Plant wt.[w] (g)	
		St. Aug.[t]	Cent.[t]	St. Aug.	Cent.	St. Aug.	Cent.
S[y]	2	<0.001**	<0.001**	0.039*	0.032*	0.008**	0.024*
LOI[z]	2	0.949	0.766	0.822	0.713	0.81	0.691

(Table 2 continued)

Source	DF	Clipping wt.[u] (g)		Root wt.[v] (g)		Plant wt.[w] (g)	
		St. Aug. [t]	Cent. [t]	St. Aug.	Cent.	St. Aug.	Cent. [t]
S x LOI	4	0.981	0.966	0.396	0.791	0.62	0.851

[t]Days after infestation; St. Aug. is St. Augustine and Cent. is centipede.
[u]Data are means of five replications per treatment.
[v]Data are cumulative weights of clippings collected at twelve intervals and dried at 30°C for 72 hours.
[w]Data are weights of roots at 198 DAI obtained by drying at 30°C for 72 hr.
[x]Data are weights of roots plus weights of clippings at the 198 DAI interval.
[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]Levels of infestation (LOI) were 0, 1,009 or 10,074 nematodes (mixed genera) per microplot.
Data analyzed as a 3 x 3 factorial with ANOVA (P≤0.05) separately for each turfgrass; * and ** indicate P values significant at 0.05 and 0.01% levels, respectively.

Soil, however, did not significantly influence the density of the nematode community at either 111 or 198 days after infestation (DAI) (Table 3). There was a significant influence of turfgrass on the density of the nematode community at 111 DAI, resulting in 41% more nematodes being recovered from St. Augustine than from centipede. The significant main effect for LOI reflected the difference between the three LOI. No nematodes were recovered from the non-infested controls at either sampling interval. Individual treatment means for the Soil x Turfgrass x Infestation interactions at 111 DAI are presented in Figure 1. This provides for comparisons between treatments within the low and high LOI, while figures for S x LOI and T x LOI interactions would reflect only differences in LOI. Also, the significant S x T interaction is illustrated in Figure 1. Inspection of individual treatment means showed that the absolute greatest number of nematodes, 2,450 per 250 g of soil, was recovered from St. Augustine turfgrass grown in sandy loam soil that received the high LOI. This number of nematodes was not significantly different from the number, 1,476 per 250 g, recovered from St. Augustine grown in loam that also received the high LOI, but numbers of nematodes recovered from all other soil, turfgrass and LOI combinations were significantly lower.

Table 3. Main and interaction effects (P values) of soil, turfgrass and level of infestation on nematode community densities at 111 and 198 DAI[v] in a microplot environment – 2012[w].

Source	DF	Community at 111 DAI [v]	Community at 198 DAI[v]
S[x]	2	0.250	0.119
T[y]	1	<0.001**	0.064
LOI[z]	2	<0.001**	<0.001**
S x T	2	0.037*	0.059
S x LOI	4	<0.001**	0.685

(Table 3 continued)

Source	DF	Community at 111 DAI [v]	Community at 198 DAI [v]
T x LOI	2	0.014*	0.325
S x T x LOI	4	0.387	0.536

[v]Days after infestation.
[w]Data are means of five replications per treatment.
[x]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).
[y]Turfgrasses (T) were St. Augustine or centipede.
[z]Levels of infestation (LOI) were 0, 1,009 or 10,074 nematodes (mixed genera) per microplot.
Data analyzed as a 3 x 2 x 3 factorial with ANOVA ($P \leq 0.05$) separately for each time interval; * and ** indicate P values significant at 0.05 and 0.01% level, respectively.

Data for individual nematode genera that comprised the community at both 111 and 198 DAI were very similar with respect to relative abundance of genera and therefore only data for 198 DAI is presented (Table 4). At 198 DAI, the total nematode community density was 26.2% greater on St. Augustine than on centipede. Across LOI and soils, individual populations of ring and stunt nematodes accounted for 89% of the total nematode community (Table 4). Within LOI, populations of these two nematodes were not significantly different across soils and turfgrasses. Similarly, within LOI, population densities of spiral, root-knot and lesion nematodes did not differ significantly across soils and turfgrasses. Within low and high LOI, the absolute greatest numbers of stylet nematodes were recovered from St. Augustine turfgrass grown in loam soil. Within the low LOI, the St. Augustine-loam combination resulted in significantly higher densities of stylet nematode than other combinations except St. Augustine-clay and centipede-loam. Conversely, within the high LOI, the St. Augustine-loam combination resulted in significantly higher populations of stylet nematode than the St. Augustine-clay and centipede-loam combinations.

Microplot Experiment – 2013

Soil significantly influenced the dry weight of clippings from centipede at 162 DAI (Table 5). Clippings from centipede turfgrass grown in loam soil averaged 81.4 g whereas those in sand and clay averaged 73.7 and 61.3 g, respectively.

Level of infestation significantly influenced all plant growth parameters except weight of roots for centipede. Across all soils, dry weights of St. Augustine plants infested with nematodes averaged 68.1 g and were reduced by 25% compared with that of the non-infested control that averaged 90.7 g at 162 DAI. Similarly, dry weights of centipede plants at 162 DAI infested with nematodes averaged 53.6 g and were reduced by 30% compared with that of the non-infested control that averaged 76.1 g. Weights of dry clippings and roots followed a similar pattern. There were no significant interactions between main effects.

Unlike results for 2012, soil had a significant influence on nematode community density at 162 DAI in 2013. Across both turfgrasses, 45% more nematodes were recovered from sandy loam than clay soils, with nematode density in loam intermediate between the two (Table 6). The turfgrass main effect was not significant at 162 DAI. The significant main effect for LOI reflected the difference between the presence and absence of nematodes in the inoculum since none were recovered from the no-nematode control. There was a significant S x T x LOI interaction in this experiment. Individual treatment means for this interaction are presented in Figure 2 and include means for the significant S x T and S x LOI interactions. The absolute greatest number 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 the number, 1,640 per 250 g, recovered from centipede grown in loam, but numbers of nematodes recovered from all other soil and turfgrass combinations were significantly lower.

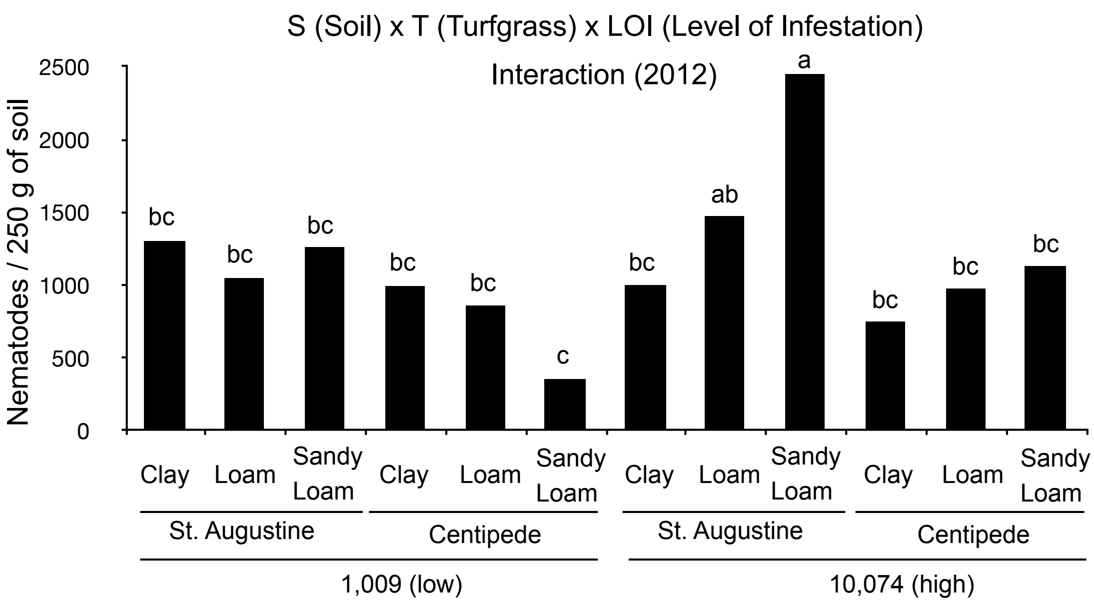

Figure 1. Vermiform stages of nematode community recovered from soil (10 kg) of St. Augustine and centipede turfgrasses grown in clay (25% sand, 35% silt, 40% clay), loam (50% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay) soils infested with 1,009 (low) or 10,074 (high) nematodes of mixed genera. No nematodes were recovered from the non-infested controls; and, data is therefore not presented as a part of this figure. Data are means of five replications per treatment over a 198-day-duration experiment conducted in a microplot environment in 2012. Bars with common letters are not significantly different based on Tukey's HSD (P≤0.05).

Table 4. Densities of six nematode genera from St. Augustine and centipede turfgrasses in three soils with three infestation levels at 198 DAI[t] in a microplot environment - 2012[u].

Nematode Genera[w]	Vermiform life stages / 250 g of soil[v]											
	Low level of infestation[x]						High level of infestation[x]					
	Clay[y]		Loam[y]		Sandy Loam[y]		Clay[y]		Loam[y]		Sandy Loam[y]	
	St. Aug.[t]	Cent.	St. Aug.	Cent.	St. Aug.	Cent.	St. Aug.	Cent.	St. Aug.	Cent.	St. Aug.	Cent.
Ring	890a[z]	160a	558a	956a	611a	37a	1,349a	709a	903a	1,783a	1,181a	843a
Spiral	4a	0a	0a	4a	0a	0a	17a	0a	58a	0a	0a	0a
Root-knot	8a	33a	21a	0a	0a	0a	4a	25a	0a	53a	4a	8a
Lesion	0a	25a	0a	62a	4a	25a	0a	62a	0a	107a	0a	29a
Stunt	267a	225a	242a	262a	160a	127a	452a	517a	328a	422a	385a	135a
Stylet	95ab	29b	197a	54ab	45b	16b	29b	45ab	160a	24b	46ab	37ab
Total	1,264a	472a	1,018a	1,338a	820a	205a	1,851a	1,358a	1,449a	2,389a	1,616a	1,052a

[t]Days after infestation; St. Aug. is St. Augustine and Cent. is centipede.
[u]Data are means of five replications per treatment.
[v]Nematodes were extracted from 100 g of soil and converted to densities per 250 g of soil for comparison with 2013 data (Table 7).
[w]Nematode genera are (top to bottom): *Criconemella* spp., *Helicotylenchus* spp., *Meloidogyne* spp., *Pratylenchus* spp., *Tylenchorhynchus* spp. and *Tylenchus* spp., respectively.
[x]Infestation levels were 0 (data not shown as no nematodes were recovered from the control at 198 DAI), 1,009 nematodes (low: 15 lesion, 665 ring, 12 root knot, 65 spiral,164 stunt and 88 stylet) or 10,074 nematodes (high: 150 lesion, 6,646 ring, 121 root knot, 645 spiral, 1,636 stunt and 876 stylet).
[y]Soil types 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]Within infestation level and individual nematode genera, means followed by the same letter are not significantly different according to Tukey's HSD ($P \leq 0.05$).

Table 5. Main and interaction effects (P values) of soil and level of infestation on St. Augustine and centipede turfgrasses at 162 DAI[t] in a microplot environment – 2013[u].

Source	DF	Clipping wt.[v] (g)		Root wt.[w] (g)		Plant wt.[x] (g)	
		St. Aug.[t]	Cent.	St. Aug.	Cent.	St. Aug.	Cent.
S[y]	2	0.062	0.010*	0.083	0.245	0.103	0.256
LOI[z]	2	<0.001**	0.009**	0.009**	0.053	0.006**	0.048*
S x LOI	4	0.318	0.605	0.537	0.738	0.467	0.717

[t]Days after infestation; St. Aug. is St. Augustine and Cent. is centipede.
[u]Data are means of five replications per treatment.
[v]Data are cumulative weights of clippings collected at ten intervals and dried at 30°C for 72 hours.
[w]Data are weights of roots at 162 DAI obtained by drying at 30°C for 72 hr.
[x]Data are weights of roots plus weights of clippings at the 162 DAI interval.
[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]Levels of infestation (LOI) were 0 or 19,959 nematodes (mixed genera) per microplot. Data analyzed as a 3 x 2 factorial with ANOVA (P≤0.05) separately for each turfgrass; * and ** indicate P values significant at 0.05 and 0.01% level, respectively.

Table 6. Main and interaction effects (P values) of soil, turfgrass and level of infestation on nematode community density at 162 DAI[v] in a microplot environment – 2013[w].

Source	DF	Community at 162 DAI[v]
S[x]	2	0.008**
T[y]	1	0.759
LOI[z]	1	<0.001**
S x T	2	0.009**
S x LOI	2	0.008**
T x LOI	1	0.759
S x T x LOI	2	0.009**

[v]Days after infestation.
[w]Data are means of five replications per treatment.
[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]Levels of infestation (LOI) were 0 or 19,959 nematodes (mixed genera) per microplot. Data analyzed as a 3 x 2 x 2 factorial with ANOVA (P≤0.05); * and ** indicate P values significant at 0.05 and 0.01% level, respectively.

For each of the six nematode genera comprising the community, final population densities associated with St. Augustine were generally highest on sandy loam, lowest on clay and intermediate on loam (Table 7). Population density of ring nematode from St. Augustine grown in sandy loam soil was significantly greater than that associated with both turfgrasses in clay soil and St. Augustine in loam; and, population densities recovered from centipede in loam and sandy loam were significantly greater than those from St. Augustine in clay. The population density of lesion nematode did not differ significantly across soils or turfgrass species. The only significant difference in final population densities for both root-knot and stunt nematodes was that the St. Augustine-sandy loam combination had significantly higher population densities than did the St. Augustine-clay combination. Final populations of spiral and stylet nematodes were below detectable levels. As was the case in 2012, ring and stunt nematode populations composed the majority (81%) of the final nematode community in 2013 (Table 7). However, in 2013, final populations contained 11.4x and 4.2x more vermiform stages of root-knot and lesion (148 and 108 per 250 g, respectively), as were present in final communities in the 2012 microplot experiment.

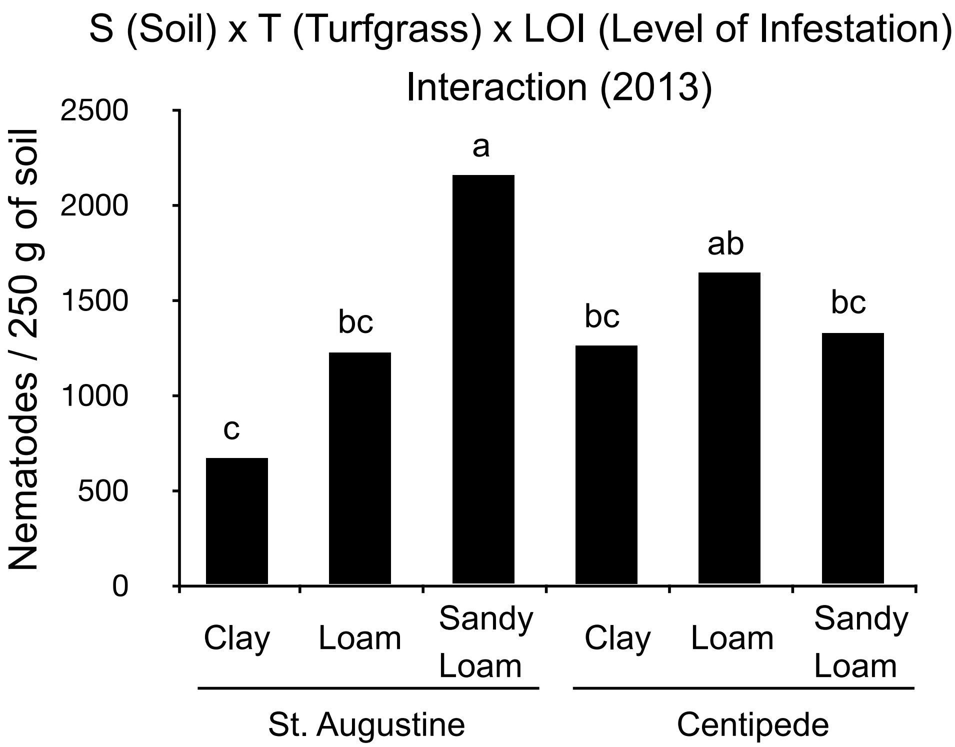

Figure 2. Vermiform stages of nematode community recovered from soil (10 kg) of St. Augustine and centipede turfgrasses grown in clay (25% sand, 35% silt, 40% clay), loam (45% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay) soils infested with 19,959 nematodes of mixed genera. No nematodes were recovered from the non-infested controls; and, data is therefore not presented as a part of this figure. Data are means of five replications per treatment over a 162-day-duration experiment conducted in a microplot environment in 2013. Bars with common letters are not significantly different based on Tukey's HSD ($P \leq 0.05$).

Table 7. Densities of six nematode genera from St. Augustine and centipede turfgrasses in three soils with two levels of infestation at 162 DAI[t] in a microplot environment - 2013[u].

Nematode Genera[w]	Vermiform Stages / 250 g of soil[v]					
	Clay		Loam		Sandy Loam	
	St. Aug. [t]	Cent. [t]	St. Aug.	Cent.	St. Aug.	Cent.
Ring	280c [z]	525bc	517bc	731ab	955a	714ab
Spiral	0a	0a	0a	0a	0a	3a
Root-knot	76b	136ab	167ab	169ab	238a	100ab
Lesion	67a	121a	103a	150a	140a	69a
Stunt	245b	477ab	434ab	580ab	821a	438ab
Stylet	0a	0a	0a	10a	0a	0a

[t]Days after infestation; St. Aug is St. Augustine and Cent. is centipede.
[u]Data are means of five replications per treatment.
[v]Nematodes were extracted from 250 g of soil.
[w]Nematode genera are (top to bottom): *Criconemella* spp., *Helicotylenchus* spp., *Meloidogyne* spp., *Pratylenchus* spp., *Tylenchorhynchus* spp. and *Tylenchus* spp., respectively.
[x]Levels of infestation were 0 (data not shown as no nematodes were recovered from the control at 162 DAI) or 19,959 nematodes (308 lesion, 10,076 ring, 1,286 root knot, 1,100 spiral, 5,049 stunt and 2,140 stylet).
[y]Soil types were clay (25% sand, 35% silt, 40% clay), loam (45% sand, 30% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay).
[z]Within individual nematode genera, means followed by the same letter are not significantly different according to Tukey's HSD ($P \leq 0.05$).

Greenhouse Experiment 1

Soil significantly impacted weights of dry clippings of both turfgrasses at 71 DAI (Table 8). The clipping weight of St. Augustine grown in clay soils, 25.2 g, was significantly greater than those for loam and sand, which averaged 22.6 g and 21.4 g, respectively. Similarly, weight of clippings of centipede grown in clay and loam, 27.1 g and 25.7 g respectively were significantly greater than that for sandy loam, 25.5 g. Level of infestation also significantly influenced weights of dry clippings, roots and plants. There was a significant and stepwise reduction in final weights of plants of both turfgrass species as the LOI increased from 0 to 2,000 nematodes per pot. Final weights of plants for the 0, 200 and 2,000 LOI averaged 43.9 g, 38.9 g and 28.2 g for St. Augustine and 45.0 g, 37.3 g and 27.3 g for centipede. Weights for clippings and roots of both turfgrasses followed a similar pattern. There were no significant soil by LOI interactions which influenced plant growth parameters.

Table 8. Main and interaction effects (P values) of soil and *Meloidogyne incognita* on St. Augustine and centipede turfgrasses at 71 DAI[t] in a greenhouse environment[u].

Source	DF	Clipping wt.[v] (g)		Root wt.[w] (g)		Plant wt.[x] (g)	
		St. Aug. [t]	Cent.	St. Aug.	Cent.	St. Aug.	Cent.
S[y]	2	<0.001**	<0.001**	0.111	0.888	0.169	0.913
LOI[z]	2	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
S x LOI	4	0.963	0.475	0.263	0.370	0.232	0.346

[t]Days after infestation; St. Aug is St. Augustine and Cent. is centipede.
[u]Data are combined over two trials with four replications per treatment.
[v]Data are cumulative weights of clippings collected at six intervals and dried at 30°C for 72 hours.
[w]Data are weights of roots at 71 DAI obtained by drying at 30°C for 72 hr.
[x]Data are weights of roots plus weights of clippings at the 71 DAI interval.
[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]Levels of infestation (LOI) were 0, 200 or 2,000 nematodes per pot.
Data analyzed as a 3 x 3 factorial with ANOVA ($P \leq 0.05$) separately for each turfgrass; * and ** indicate P values significant at 0.05 and 0.01% level, respectively.

Soil had no significant effect on the combined density of populations of *M. incognita* from soil and roots (Table 9). Turfgrass and LOI did, however, significantly influence population density (totals for nematodes recovered from soil plus roots) of the nematode. Across soils and LOI, population density at 71 DAI averaged 11,505 and 7,566 per pot for St. Augustine and centipede, respectively. The significant main influence of LOI resulted from numbers of nematodes in the inoculum. The turfgrass by LOI interaction was significant and demonstrated that at the high, but not at the low LOI, significantly more nematodes were associated with St. Augustine than with centipede. Figure 3 illustrates the numbers of root-knot nematodes recovered from soil and roots across all soil-turfgrass-LOI treatment combinations in this experiment (except those for controls). Within turfgrasses, at each LOI, the numbers of nematodes from the three soils were not significantly different. Across soils, turfgrasses and LOI, there were no significant differences in numbers of nematodes per root system, which averaged 1,416 (analysis not presented).

Table 9. Main and interaction effects (P values) of soil, turfgrass and level of infestation on density of *Meloidogyne incognita* at 71 DAI[v] in a greenhouse environment[w].

Source	DF	Nematodes at 71 DAI[v]
S[x]	2	0.532
T[y]	1	<0.001**
LOI[z]	1	<0.001**
S x T	2	0.967
S x LOI	2	0.800

(Table 9 continued)

Source	DF	Nematodes at 71 DAI[v]
T x LOI	1	<0.001**
S x T x LOI	2	0.9917

[v]Days after infestation.
[w]Data are combined over two trials with four replications per treatment.
[x]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).
[y]Turfgrasses (T) were St. Augustine or centipede.
[z]Levels of infestation (LOI) were 0, 200 or 2,000 nematodes per pot.
Data analyzed as a 3 x 2 x 3 factorial with ANOVA (P ≤ 0.05); * and ** indicate P values significant at 0.05 and 0.01% level, respectively.

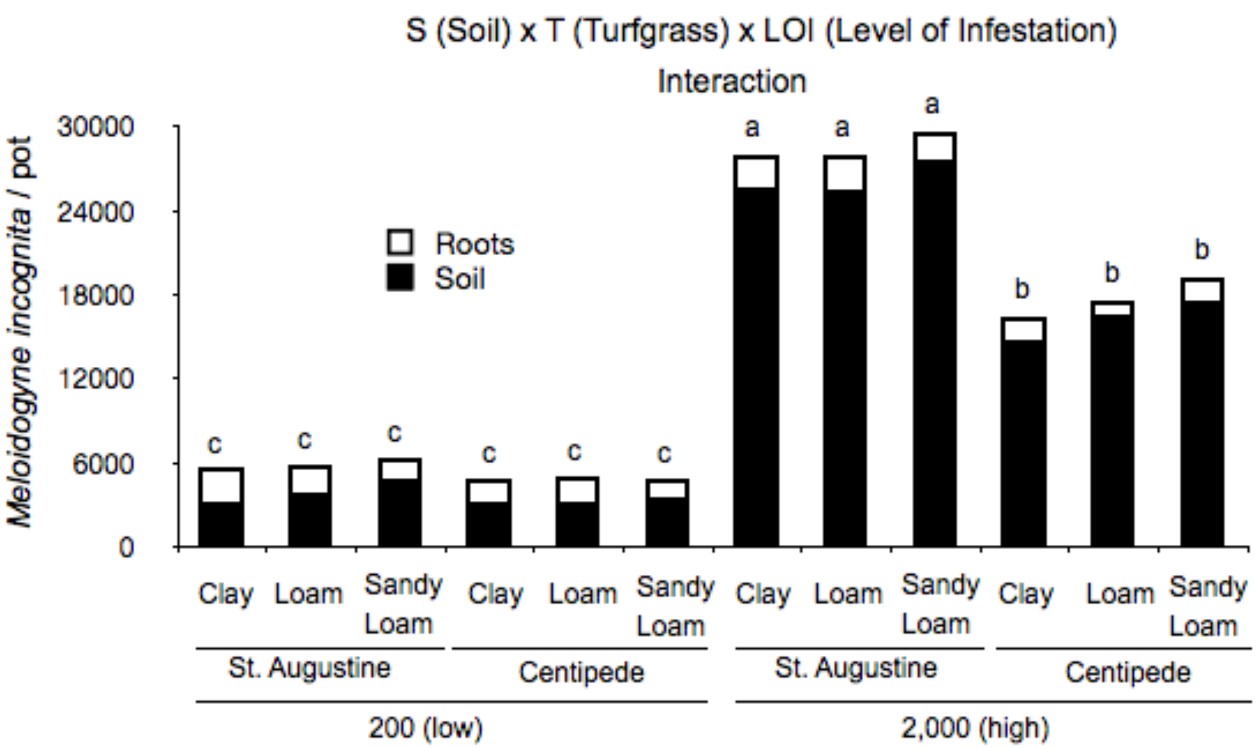

Figure 3. Vermiform life stages of root-knot nematode (*Meloidogyne incognita*) recovered from soil (1.2 kg) and roots of St. Augustine and centipede turfgrasses grown in clay (25% sand, 35% silt, 40% clay), loam (45% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay) soils infested with 200 (low) or 2,000 (high) levels of nematodes. No nematodes were recovered from the non-infested controls; and, data is therefore not presented as a part of this figure. Data are means of eight replications per treatment combined over two 71-day-duration trials conducted in a greenhouse environment. Bars with common letters are not significantly different based on Tukey's HSD (P≤0.05).

Greenhouse Experiment 2

At 71 DAI, soil significantly impacted the weights of dry clippings from St. Augustine which, across the three LOI, averaged 26.4 g in clay and 5%-6.5% less in loam and sandy loam soils (Table 10). For centipede, weights of all plant parameters, clippings, roots and plants, were influenced significantly. Weights for plants in clay were greatest, and averaged 26.2 g, while those for sandy loam were least, and averaged 23.0 g. Weights for clippings and roots of centipede followed a similar pattern.

Table 10. Main and interaction effects (P values) of soil and *Pratylenchus zeae* on St. Augustine and centipede turfgrasses at 71 DAI[t] in a greenhouse environment[u].

Source	DF	Clipping wt.[v] (g)		Root wt.[w] (g)		Plant wt.[x] (g)	
		St. Aug. [t]	Cent.	St. Aug.	Cent.	St. Aug.	Cent.
S[y]	2	<0.001**	0.030*	0.172	<0.001**	0.229	<0.001**
LOI[z]	2	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**	<0.001**
S x LOI	4	0.717	0.753	0.561	<0.001**	0.646	<0.001**

[t]Days after infestation; St. Aug. is St. Augustine and Cent. is centipede.
[u]Data are combined over two trials with four replications per treatment.
[v]Data are cumulative weights of clippings collected at six intervals and dried at 30°C for 72 hours.
[w]Data are weights of roots at 71 DAI obtained by drying at 30°C for 72 hr.
[x]Data are weights of roots plus weights of clippings at the 71 DAI interval.
[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]Levels of infestation (LOI) were 0, 200 or 2,000 nematodes per pot.
Data analyzed as a 3 x 3 factorial with ANOVA ($P \leq 0.05$) separately for each turfgrass; * and ** indicate P values significant at 0.05 and 0.01% level, respectively.

As was noted for root-knot, the LOI significantly influenced all plant parameters for both St. Augustine and centipede. Except for dry weights of clippings of centipede, there were significant and stepwise reductions in final weights as LOI increased from 0 to 2,000 nematodes per pot. Respectively, final weights for clippings, roots and plants of St. Augustine averaged 28.7, 45.6 and 49.8 g for the control, 24.4, 31.0 and 34.2 g for the 200 LOI, and 21.3, 25.7 and 28.2 g for the 2,000 LOI. Similarly, those for centipede averaged 27.7, 42.3 and 46.7 g for the control, 24.0, 30.1 and 33.4 g for the 200 LOI, and 24.7, 20.6 and 23.5 g for the 2,000 LOI. The significant S x LOI interaction for weights of dry plants, that separates means by soil and LOI, is presented in Figure 4. This figure illustrates that, at both the 200 and 2,000 LOI, weights of plants grown in sandy loam were reduced significantly below that of those grown in either loam or clay soils. A similar figure presenting weights of roots would present an identical pattern.

Nematode data (totals for nematodes recovered from soil plus roots) for this trial showed only significant LOI and S x LOI interactions (Table 11). The significant LOI main effect and the S x LOI interaction both resulted from the difference in levels of nematodes, 0, 200 or 2,000, in the inoculum. The S x T x LOI interaction approached significance ($P = 0.056$) and is presented as Figure 5; and, includes means for both LOI and S x LOI. At the 200 nematode per pot LOI, there were no significant differences in the numbers of nematodes across the six turfgrass-soil combinations, which ranged from 2,904 to 4,018 per 1.2 kg of soil and from 1,627 to 2,303 per root system. At the 2,000 nematode per pot LOI, however, the centipede-loam combination had significantly lower levels of nematodes, which averaged 11,837 individuals in soil and 1,735 individuals from roots, than all combinations, except the centipede-clay one. Population densities across these treatment combinations ranged from 17,219 to 22,430 individuals in soil and 1,216 to 2,968 individuals per root system. Across soils, turfgrasses and LOI, there were no significant differences in numbers of nematodes per root system, which averaged 1,886 (analysis not presented).

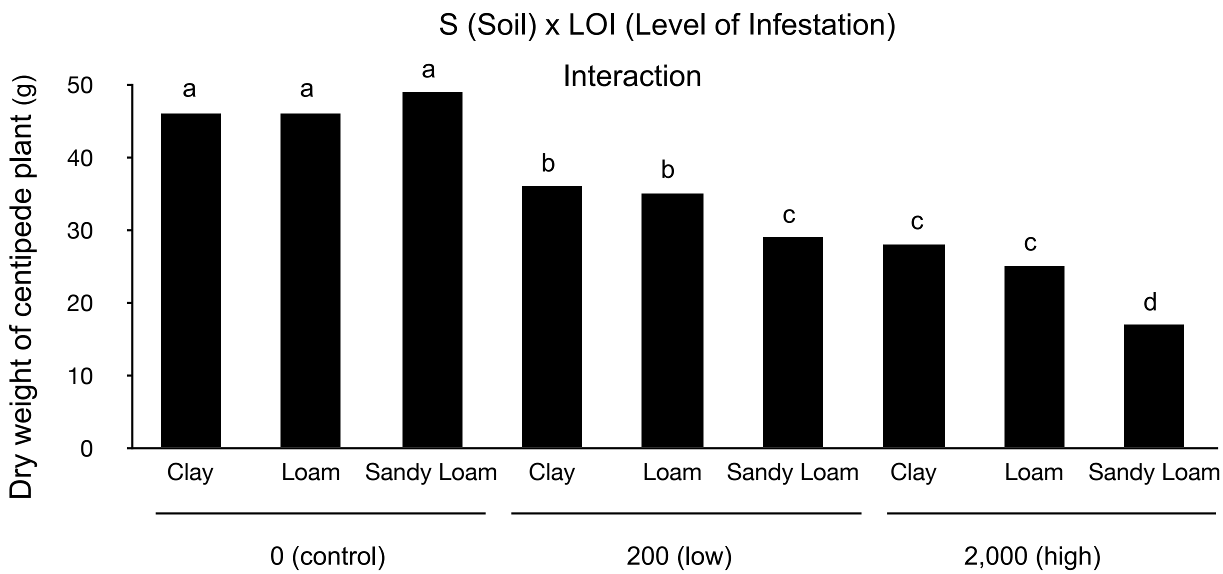

Figure 4. Weights of dry plants of centipede turfgrass grown in clay (25% sand, 25% silt, 40% clay), loam (45% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay) soils infested with 0 (control), 200 (low) or 2,000 (high) lesion nematodes (*Pratylenchus zeae*). Data are means of eight replications per treatment combined over two 71-day-duration trials conducted in a greenhouse environment. Bars with common letters are not significantly different based on Tukey's HSD (P≤0.05).

Table 11. Main and interaction effects (P values) of soil, turfgrass and level of infestation on density of *Pratylenchus zeae* at 71 DAI[v] in a greenhouse environment[w].

Source	DF	Nematodes at 71 DAI[v]
S[x]	2	0.053
T[y]	1	0.378
LOI[z]	1	<0.001**
S x T	2	0.263
S x LOI	4	0.022*

(Table 11 continued)

Source	DF	Nematodes at 71 DAI [v]
T x LOI	2	0.143
S x T x LOI	4	0.056

[v]Days after infestation.
[w]Data are combined over two trials with four replications per treatment.
[x]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).
[y]Turfgrasses (T) were St. Augustine or centipede.
[z]Levels of infestation (LOI) were 0, 200 or 2,000 nematodes per pot.
Data analyzed as a 3 x 2 x 3 factorial with ANOVA ($P \leq 0.05$); * and ** indicate P values significant at 0.05 and 0.01% level, respectively.

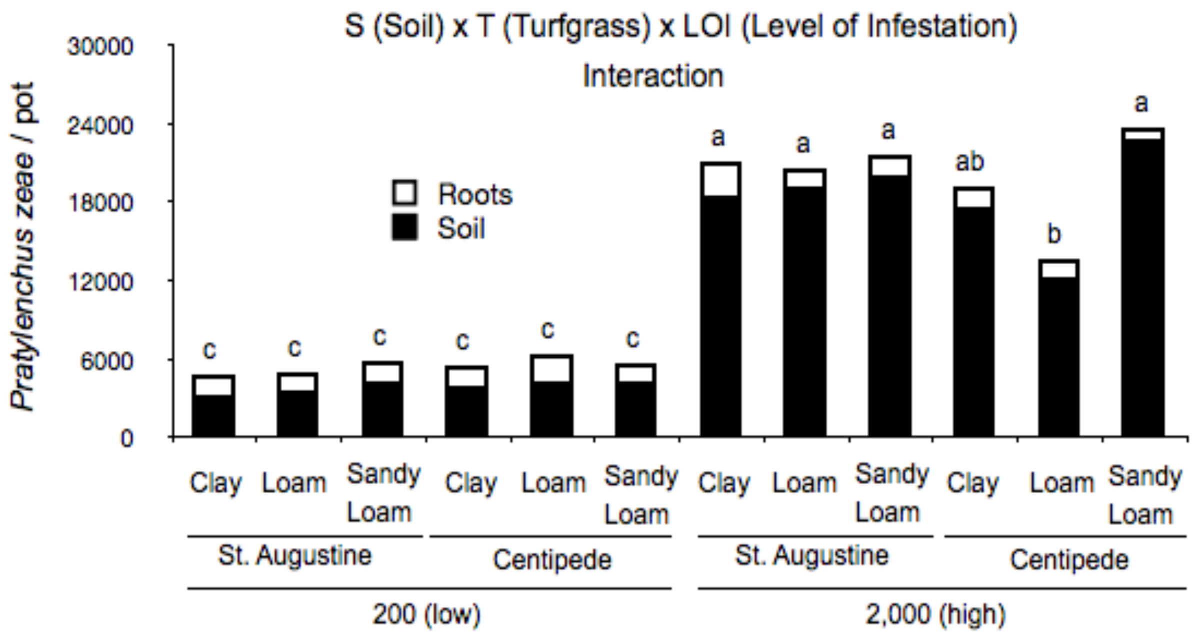

Figure 5. Vermiform life stages of lesion nematode (*Pratylenchus zeae*) recovered from soil (1.2 kg) and roots of St. Augustine and centipede turfgrasses grown in clay (25% sand, 35% silt, 40% clay), loam (45% sand, 25% silt, 25% clay) or sandy loam (75% sand, 15% silt, 10% clay) soils infested with 200 (low) or 2,000 (high) levels of nematodes. No nematodes were recovered from the non-infested controls; and, data is therefore not presented as a part of this figure. Data are means of eight replications per treatment combined over two 71-day-duration trials conducted in a greenhouse environment. Bars with common letters are not significantly different based on Tukey's HSD ($P \leq 0.05$).

DISCUSSION

Criconemella spp. and *Helicotylenchus* spp. were the genera identified most frequently and in the greatest abundance in home lawns in Baton Rouge, Louisiana, during 2011 and 2012. Ye et al. (2012) indicated that ring and spiral nematodes were among the most commonly encountered on centipede in North and South Carolina; and, Kelsheimer and Overman (1953) found that ring was frequently associated with St. Augustine in Florida. Stylet nematodes were found with great frequency, 92%, and in high relative densities, averaging 141 per 250 g of soil during the survey phase of this research. Only one report (Good et al., 1959) indicates stylet nematode as being associated with residential lawns. Since nematodes in this genus were found so commonly, further studies to evaluate the potential impact of this nematode on these two grasses seems warranted. Both the incidence and density of populations for individual genera of nematodes as well as the community structure as a whole were remarkably similar for both St. Augustine and centipede turfgrasses.

Soils, known to influence nematode populations, were one of the primary focuses of this research. Soils exhibited a significant influence on plant growth in 2012 and nematode reproduction in 2013. Griffin (1996), who studied the importance of soil texture and other edaphic factors on rangeland grasses under greenhouse conditions, found that dry weights of shoots and roots were negatively correlated with increasing percent of sand. Similarly, the significant main effects of soil on plant growth parameters in the 2012 microplot experiment indicated that plant growth parameters were significantly lowest when plants were grown in sandy loam soils. In 2013, however, there was no significant reduction in plant growth parameters due to soil, except that clippings of centipede in clay were reduced compared to those in loam soil. A significant main effect of soil on plant growth in 2013 was likely masked by the damage that the nematode community caused to roots of both turfgrasses in this experiment.

In 2013, but not in 2012, soil type had a significant influence on the density of individual nematode populations as well as the entire community of nematodes. Nematode densities were highest in the soil type with the highest percent of sand, especially with St. Augustine. Other researchers have evaluated the influence of soil type on nematode reproduction and pathogenicity in both microplot (Koenning et al., 1996; Moore and Lawrence, 2013) and field (Jordaan et al., 1989; Jaraba et al., 2009) environments with similar results. Likewise, subsequent damage due to nematode feeding was often greatest in the coarser soil.

The composition of the nematode inoculum utilized in the 2012 microplot experiment had the objective of mirroring the genera and levels of the six nematode genera found with greatest frequency and abundance completed in the survey portion of the research. The low LOI for 2012 reflected the genera and densities required to establish a level of nematodes in the upper one-third of the microplot soil comparable to the average densities across both turfgrasses found in the survey, 113 nematodes per 250 g. The objective of the high LOI of 2012 was to evaluate pathogenicity of this nematode community on both turfgrasses. Densities of *Helicotylenchus* included in the inoculum were less than this justification would require as a result of poor reproduction in greenhouse cultures. The LOI in 2012 were inadequate for evaluation of effects of nematodes on the two turfgrasses and were therefore increased for the 2013 experiment.

The total nematode community densities that resulted from the high LOI were similar in both years, averaging 64,720 per microplot in 2012 and 55,080 in 2013. However, there were marked and significant differences in the densities of populations comprising the community in these two years. Most importantly were populations of root-knot and lesion nematodes, which were 11.4 and three times greater in 2013 than in 2012, together comprising 19.0% of the community total in 2013 and only 3.2% in 2012. Plant growth data from the 2013 microplot experiment strongly suggested damage to both turfgrasses was related to the augmented population densities of root-knot and lesion nematodes since populations of other nematodes were comparable to those of the high LOI of 2012 experiment.

The greenhouse trials with *Meloidogyne incognita* and *Pratylenchus zeae* tested the hypothesis that these two nematodes were pathogens of St. Augustine and centipede turfgrasses. Although *M. graminis, M. graminicola* and *M. marylandi* have been more commonly reported from and associated with turfgrasses, there is a report indicating the association of *M. incognita* (Faske and Starr, 2009) with St. Augustine and indicating that its reproduction on St. Augustine was equal to that of *M. marylandi*. *Pratylenchus zeae* has also been reported from St. Augustine (Inserra et al., 2005). Addition of 0, 200 and 2000 individuals of the respective two nematode species caused significant and stepwise reductions in weights of plants of both turfgrass species at 71 DAI in research reported herein. Across both nematode infestation levels, reductions below controls for St. Augustine and centipede averaged 24% and 28% for *M. incognita* and 37.0% and 39.3% for *P. zeae*; indicating that overall, *P. zeae* was more damaging than *M. incognita* to both turfgrasses. Nematode population densities associated with this damage followed a similar stepwise pattern. Across all soils, densities of *M. incognita* from soil and roots averaged 6,033 and 28,483 from the low and high LOI on St. Augustine and 4,960 and 17,737 from the low and high LOI on centipede. Similarly, across all soils, densities of *P. zeae* from soil and roots averaged 5,175 and 21,067 from the low and high LOI on St. Augustine and 5,788 and 18,802 from the low and high LOI on centipede. Overall, in these trials with *M. incognita* and *P. zeae*, more nematodes were recovered from soil than from roots. It is likely that damage due to nematode feeding reduced the root mass to the point where there was not enough to support the nematode density, rendering the root systems unsuitable and the populations increased in the soil at 71 DAI. This greenhouse-based and relatively short duration research provides impetus for further investigation and confirmation of the pathogenicity of *Meloidogyne incognita* and *Pratylenchus zeae* on St. Augustine and centipede turfgrasses.

SUMMARY AND CONCLUSIONS

Notable conclusions from the research reported herein include:

1) Communities composed of 12-13 populations of nematodes are associated with residential lawns of St. Augustine and centipede turfgrasses in the area of Baton Rouge, Louisiana.
2) These nematode communities have the potential to cause significant injury to both turfgrass species under microplot conditions.
3) Pathogenicity of populations of *Meloidogyne incognita* and *Pratylenchus zeae* on St. Augustine (*Stenotaphrum secundatum*) and centipede (*Eremochloa ophiuroides*) were demonstrated under greenhouse conditions. For both nematode species on both turfgrasses, there was a significant and stepwise reduction in weight of plants as the level of inoculum was increased from 0 to 2,000 nematodes per 1.2 kg of soil.
4) Generally, over both turfgrass species and environmental conditions, nematode reproduction was greatest in sandy loam, least in clay and intermediate in loam soil.
5) Generally, under microplot but not greenhouse conditions, there were significant soil by turfgrass interactions that resulted in significantly greater of numbers of nematodes being recovered from St. Augustine grown in sandy loam soil than from all other soil-turfgrass combinations.

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