RESEARCH REPORT

PLANT-PARASITIC NEMATODES IN LOUISIANA SUGARCANE AND PLANT GROWTH RESPONSE TO NEMATICIDE APPLICATION

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ABSTRACT

Aguilar-Arevalo, I. M., J. S. Rezende, and T. T. Watson. 2025. Plant-parasitic nematodes in Louisiana sugarcane and plant growth response to nematicide application. Nematropica 55:73-83.

Plant-parasitic nematodes (PPN) have not been studied in Louisiana sugarcane for more than 20 years and may threaten this crop. A survey was conducted across 62 sugarcane fields in Louisiana to determine PPN present in fields and their relationship to soil texture and crop stage. Greenhouse studies were conducted using soil from multiple fields with PPN infestation. This study aimed to determine the impact of PPN on sugarcane growth and evaluate nematicides as a management strategy. Collected field soil was subjected to four treatments: (1) no treatment, (2) steam-sterilization, (3) ethoprop, and (4) fluensulfone. After 3 months, PPN population densities were quantified. Tillering and root weight were also measured. The survey revealed that *Tylenchorhynchus*, *Mesocriconema*, *Pratylenchus*, and *Helicotylenchus* are the predominant PPN genera in Louisiana sugarcane fields. Greenhouse trials showed sterilized soil enhanced sugarcane growth, suggesting PPN have a negative impact on sugarcane production. Ethoprop reduced the main PPN in sugarcane but also reduced plant growth. Fluensulfone potentially reduced *Pratylenchus* spp. in soil and improved plant growth. Findings suggest PPN influence sugarcane growth in Louisiana, and nematicides show potential for management.

Key words: Mesocriconema, nematicides, plant-parasitic nematodes, *Pratylenchus,* sugarcane, *Tylenchorhynchus*

RESUMEN

Aguilar-Arevalo, I. M., J. S. Rezende, y T. T. Watson. 2025. Nematodos fitoparásitos en caña de azúcar en Louisiana y respuesta en el crecimiento de la planta a la aplicación de nematicidas. Nematropica 55:73-83.

Los nematodos fitoparásitos no han sido estudiados desde hace más de 20 años en caña de azúcar en Louisiana y podrían representar una amenaza para este cultivo. Se muestrearon 62 campos de caña de azúcar de Louisiana para detectar nematodos fitoparásitos y su relación con la textura del suelo y etapa del cultivo. Se realizaron experimentos en invernadero con suelo de campos de caña de azúcar infestado con nematodos. Se evaluó el impacto de los nematodos fitoparásitos en el crecimiento de la caña de azúcar y los nematicidas como una estrategia de manejo. El suelo colectado fue expuesto a cuatro tratamientos: (1) sin tratar, (2) esterilizado, (3) ethoprop, (4) fluensulfone. Tres meses después, los nematodos fueron cuantificados. El número de rebrotes y el peso de la raíz también fueron evaluados. El muestreo reveló que *Tylenchorhynchus*, *Mesocriconema*, *Pratylenchus*, y *Helicotylenchus* predominan en los campos de caña de azúcar en

Louisiana. Los experimentos mostraron que el suelo esterilizado mejoró el crecimiento de la caña de azúcar, indicando un impacto negativo de los nematodos. Ethoprop redujo los nematodos, pero afectó negativamanete el crecimiento. Fluensulfone disminuyó *Pratylenchus* spp. y mejoró el desarrollo de la planta. Los resultados indican que los nematodos fitoparásitos influyen en el crecimiento de la caña de azúcar en Louisiana y los nematicidas mostraron potencial como estrategia de manejo.

Palabras clave: Caña de azúcar, *Mesocriconema*, Nematicidas, Nematodos fitoparásitos, *Pratylenchus*, *Tylenchorhynchus*.

INTRODUCTION

The United States is the tenth largest sugarcane producer worldwide, with 927,600 acres of cane harvested in 2024; of these acres, Louisiana harvested 519,400 (USDA, 2025). Sugarcane-producing countries, including Australia, Japan, and South Africa, have reported economic losses in sugarcane associated with nematodes (Blair & Stirling, 2007; Cadet & Spaull, 2003; Kawanobe et al., 2020). However, the impact of plant-parasitic nematodes (PPN) on sugarcane production in Louisiana has not been assessed in over 20 years.

In previous studies, PPN genera associated with sugarcane crops in Louisiana included *Pratylenchus*, *Tylenchorhynchus*, *Mesocriconema*, *Helicotylenchus*, *Paratrichodorus*, and *Meloidogyne* (Birchfield, 1969; Bond et al., 2000). However, the abundance and diversity of PPN genera may have changed due to factors such as the introduction of new sugarcane cultivars in Louisiana (Bond et al., 2004; Schmitz et al., 2020); other influences, including certain production practices like billet planting, harvest practices, and new pesticide chemistries, may also have impacted the abundance and diversity of the current PPN genera (Berry et al., 2007; Stirling et al., 2001).

There is minimal information about the extent of sugarcane yield loss caused by PPN in the United States; however, historic estimates have attributed a 5-10% yield loss associated with nematodes in Louisiana sugarcane production (Koenning et al., 1999). Symptoms associated with nematode damage in sugarcane are quite general and include a reduction in shoot and root biomass, reduced shoot production (i.e., tillering), and the appearance of red or brownish lesions on roots (Ricaud et al., 2012). All of these symptoms can collectively contribute toward an overall reduction in sugar yield (Ricaud et al., 2012). Aboveground, many of these symptoms are not obvious during the growing season and can often be mistaken for nutrient deficiencies or other abiotic problems.

Given that sugarcane is grown as a perennial grass in the same location for 3 to 4 years in Louisiana, opportunities to implement management tactics are limited. None of the sugarcane cultivars grown in Louisiana are known to be resistant to PPN, thus management primarily relies upon chemical strategies. For chemical management, aldicarb (Temik®), ethoprop (MOCAP®), and phorate (Thimet®) have shown efficacy toward nematodes parasitizing sugarcane (Bond et al., 2000); however, aldicarb and phorate are no longer registered for use on sugarcane in Louisiana. Ethoprop is still available to sugarcane growers in Louisiana, but opportunities for application are limited to field renovation events when new plant cane is being planted. A newer nematicide, fluensulfone (Nimitz®), is registered for use on sugarcane; however, minimal information is available regarding its efficacy as a nematode management option in sugarcane. Nimitz® is a liquid nematicide that offers more flexibility in application than previously registered products on sugarcane, allowing annual reapplication which may provide more prolonged nematode suppression.

Using a combination of a soil survey and subsequent potted greenhouse nematicide experiments, this study aimed to: (1) determine the PPN genera associated with sugarcane fields in Louisiana, (2) evaluate the relationship among soil texture and sugarcane crop stage and the density of PPN genera, and (3) evaluate early sugarcane plant growth response to nematicide application when grown in potted soil collected from nematode-infested sugarcane fields.

MATERIALS AND METHODS

Survey of Plant-Parasitic Nematodes in Louisiana Sugarcane Fields

In September 2020, soil samples were collected from 62 randomly chosen commercial sugarcane fields from six major sugarcane producing parishes in Louisiana (Ascension Parish (n = 6), Avoyelles Parish (n = 1), Iberville Parish (n = 22), Pointe Coupee Parish (n = 16), St. James Parish (n = 3), West Baton Rouge Parish (n = 14)). From each location, 20-25 soil cores were randomly collected from a 1- to 5-acre area of the field, mixed in a plastic bucket, placed in a plastic bag, and stored at 4°C for a maximum of 2 weeks until subsequent processing. Soil texture was determined by A & L Laboratories (A & L Western Agricultural Laboratory, Oregon). Nematodes were extracted from 250 ml of soil from each pot using an NC elutriator followed by a sucrose-centrifugation technique (Byrd Jr et al., 1976; Jenkins, 1964). Nematodes were collected using a 25-µm sieve, transferred into cups, and stored at 12°C prior to counting. PPN genera were counted and identified using an inverted light microscope. Data are presented as the number of nematodes per 500 ml of soil.

Greenhouse Nematicide Experiments

Establishment and plant material

Two experiments were conducted from September to December 2021 and from November 2022 to February 2023 under greenhouse conditions. Field soil naturally infested by PPN were collected from four commercial sugarcane fields located in Louisiana (West Baton Rouge, Pointe Coupee, Ascension, and Avoyelles parishes) where the predominant soil texture is silt loam and silty clay loam. Soil sites were selected based on the fields that showed the highest nematode densities in the previous survey. Six-inch pots were used and filled with the collected soil and others with sterilized soil (0.75 gallons of soil per pot). Stalks of sugarcane variety HoCP 96-540 were cut into single eyepieces and soaked in water heat treatment (50°C for 50 min) to prevent any fungal or bacterial infection. Eyepieces of sugarcane were planted in trays with potting mix (Miracle-Gro®, Scotts Miracle-Gro Company, Marysville, Ohio), and after 3 weeks of growing under greenhouse conditions, plants were transplanted into the pots. Plants were fertilized once a week and watered as needed.

Experimental design and treatment applications

The experimental design was a randomized complete block with four repetitions and four treatment combinations: (1) sterilized soil, (2) untreated soil, (3) ethoprop (MOCAP 15G, AVMAC, North Carolina), and (4) fluensulfone (Nimitz®, ADAMA, North Carolina). Nematicides were applied at planting using the broadcast application rate; the amount applied to each plant is equivalent to the surface area of the pot. Fluensulfone was applied by soil drenching with 25 ml of water with 14.9 µl of fluensulfone. Ethoprop (53 mg) was applied to each pot by mixing the granules into the soil by hand.

Measurements

To evaluate plant growth, the number of tillers and root weight were measured 3 months after planting. The number of tillers was also counted, data were presented as the number of tillers per plant, and roots were weighted in grams.

Nematode populations were extracted from 250 ml of soil from each pot using an NC elutriator followed by a sucrose-centrifugation technique (Jenkins, 1964). Nematodes were collected using a 25-µm sieve, transferred into cups, and stored at 12°C before counting. Nematodes were also extracted from roots using the entire root system of each plant using the modified Baermann pan technique (Oostenbrink, 1954). Roots were in the pan for seven days and nematodes were extracted using a 25-µm sieve. PPN were counted and identified using an inverted microscope. Data are presented as the number of nematodes per 500 ml of soil and the number of nematodes per gram of roots.

Statistical analysis

The survey data was analyzed using the Krustal-Wallis non-parametric test with Wilcoxon Z test for multiple comparison analysis. Greenhouse experiment data was subjected to a three-way ANOVA using R (Version 4.3.1) to

evaluate the effect of treatment, site, and experiment on root weight, tillering, and nematode densities. The experimental model was a randomized complete block with experiment, field soil, and soil treatment as main factors. Differences in treatment means were examined using Fisher's LSD test ($P < 0.05$).

RESULTS

Plant-Parasitic Nematode Genera in Louisiana Sugarcane Fields

Within the 62 sugarcane fields sampled in Louisiana the most recovered PPN genera included *Tylenchorhynchus* spp. (60% of fields), *Mesocriconema* spp. (56% of fields), *Pratylenchus* spp. (53% of fields), and *Helicotylenchus* spp. (32% of fields). Other PPN genera also recovered *Hoplolaimus* spp. (11% of fields) and *Paratylenchus* spp. (2% of fields), but at a lower frequency. When present in a field, average soil population densities for each genera were 395 nematodes per 500 cm^3 of soil for *Tylenchorhynchus* spp., 356 nematodes per 500 cm^3 of soil for *Mesocriconema* spp., 317 nematodes per 500 cm^3 of soil for *Pratylenchus* spp., 540 nematodes per 500 cm^3 of soil for *Helicotylenchus* spp., 160 nematodes per 500 cm^3 of soil for *Hoplolaimus* spp., and 320 nematodes per 500 cm^3 of soil for *Paratylenchus* spp. Soil texture had a significant effect on soil population densities of *Pratylenchus* spp. and *Mesocriconema* spp. (Table 1). Sugarcane fields with sandy loam and silt loam soil textures had higher population densities of *Pratylenchus* spp. than fields with silty clay loam and clay soil. For *Mesocriconema* spp., soil population densities were higher in fields with sandy loam, silt loam, and silty clay loam soil textures than clay soil. Crop stage had a significant effect on soil population densities of *Tylenchorhynchus* spp., *Pratylenchus* spp., and *Mesocriconema* spp., with a similar but not significant trend also observed with *Helicotylenchus* spp. (Table 2). On average, soil population densities of each genus were higher in sugarcane fields that were in the first ratoon, second ratoon, or third ratoon stage relative to fields that were in the fallow or plant cane stages.

Plant Growth Response to Nematicide Application in Greenhouse Experiments

For each plant growth parameter evaluated, there was an interaction effect between treatment, soil site, and experiment ($p < 0.05$); therefore, data were analyzed using a one-way ANOVA for each site and experiment independently. In experiment 1, no differences were observed in root weight among the soil treatments (Table 3). However, a significant impact was observed on the amount of tillering. The sterilization treatment increased the number of tillers in plants grown in soil from SC20, while the application of fluensulfone showed a similar response in soil from SC57. Ethoprop did not impact tillering in experiment 1.

In experiment 2, there was a significant effect of soil treatment on root weight at one site (Table 3). The application of ethoprop to soil from SC20 reduced root weight by 35% relative to untreated while application of fluensulfone increased root weight by 35% relative to the untreated. Similar results were observed with the sterilization treatment in this soil, which increased root weight by 39% relative to the untreated control. Conversely, no differences in the amount of tillering were observed among soil treatments in experiment 2.

Nematode Response to Nematicide Application in Greenhouse Experiments

For each nematode parameter evaluated, there was an interaction effect between treatment, site, and experiment ($p < 0.05$); therefore, data were analyzed using a one-way ANOVA for each soil site and experiment independently. Overall, *Pratylenchus* spp. densities in roots were higher in experiment 1; whereas in soil, *Pratylenchus* spp. densities were greater in experiment 2. In the first experiment, soil treatments significantly affected *Pratylenchus* spp. population densities in roots in all soils (Table 4). Ethoprop reduced population levels from 78 to 83% in three soils (SC49, SC51, and SC57). In contrast, fluensulfone did not impact the abundance of *Pratylenchus* spp. in roots compared to the untreated treatment. In this experiment, there was significant soil treatment effects on soil population densities of *Pratylenchus* spp. in soils from SC20, SC49, and SC57 (Table 4). Ethoprop reduced *Pratylenchus* spp. population

Table 1. Influence of soil texture on soil population density of common plant-parasitic nematode genera in Louisiana sugarcane fields.

		Nematodes by soil texture[y]			
Soil texture	n	*Tylenchorhynchus* spp.	*Pratylenchus* spp.	*Helicotylenchus* spp.	*Mesocriconema* spp.
Sandy Loam		400	250 a[z]	120	485 a
Silt Loam	3	265	217 a	133	214 a
Silty Clay Loam	1	151	54 b	282	216 a
Clay		200	40 b	93	17 b
P-value		*0.518*	*0.043*	*0.482*	*0.015*

[y] Number of nematodes per 500 cm^3 soil.
[z] Means with same letter are not significantly different.

levels in two soils by 49% and 89% in SC20 and SC57, respectively. Fluensulfone reduced the *Pratylenchus* spp. population level in SC20 by 71%. In experiment 2, there was a significant effect of soil treatment on *Pratylenchus* spp. root population densities across all four soils (Table 4). Ethoprop reduced population levels in soils SC49 and SC51 by 89% and 100%, respectively. Fluensulfone reduced densities of *Pratylenchus* spp. by 100% in SC51. However, *Pratylenchus* spp. densities in roots were low in all soils in this experiment. There was a significant effect of soil treatment on *Pratylenchus* spp. soil population densities in all soils except SC51 (Table 4). Ethoprop reduced *Pratylenchus* spp. population levels in SC49 by 62%, while fluensulfone reduced by 36% the *Pratylenchus* spp. population level in SC20.

In experiment 1, there was a significant effect of soil treatment on soil population densities of *Tylenchorhynchus* spp. in SC51 and SC57

Table 2. Influence of crop stage on soil population density of common plant-parasitic nematode genera in Louisiana sugarcane fields.

		Nematodes by crop stage[y]			
Crop stage	n	*Tylenchorhynchus* spp.	*Pratylenchus* spp.	*Helicotylenchus* spp.	*Mesocriconema* spp.
Fallow	11	15 b[z]	7 b	15	22 b
Plant Cane	9	133 ab	120 ab	0	80 ab
First Ratoon	6	309 a	175 a	36	185 a
Second Ratoon	19	265 a	292 a	236	194 a
Third Ratoon	17	344 a	107 ab	301	420 a
P-value		*0.009*	*0.014*	*0.231*	*0.010*

[y] Number of nematodes per 500 cm^3 soil.
[z] Means with same letter are not significantly different.

(Table 5). Ethoprop reduced the *Tylenchorhynchus* spp. density levels in soil in two soils, resulting in SC57, respectively. Fluensulfone did not impact the number of *Tylenchorhynchus* spp. relative to the untreated. In experiment 2, a significant effect of soil treatment was observed on soil population densities of *Tylenchorhynchus* spp. in three soils (SC20, SC51, and SC57). In this experiment, the application of ethoprop and fluensulfone did not

Table 3. Plant growth parameters in sugarcane after three months under greenhouse conditions.

		Plant growth parameters			
		Root weight (g)		Tillering (#)	
Site	Treatment	Exp 1	Exp 2	Exp 1	Exp 2
SC20	Untreated	14.10	20.40 b[z]	0.00 b	0.50
	Sterilized	21.97	28.45 a	2.25 a	0.50
	Ethoprop	10.30	13.18 c	0.25 b	0.00
	Fluensulfone	11.70	27.55 a	0.25 b	0.75
	P-value	*0.072*	*<0.001*	*<0.001*	*0.215*
SC49	Untreated	9.10	10.93	1.25	1.75
	Sterilized	11.40	12.93	2.00	1.50
	Ethoprop	10.60	11.65	0.00	0.25
	Fluensulfone	12.10	13.70	2.00	0.25
	P-value	*0.797*	*0.723*	*0.214*	*0.127*
SC51	Untreated	7.30	15.98	1.80	1.25
	Sterilized	8.80	18.93	1.50	0.25
	Ethoprop	6.60	15.13	0.80	0.75
	Fluensulfone	7.30	11.50	2.00	0.50
	P-value	*0.605*	*0.092*	*0.494*	*0.227*
SC57	Untreated	11.40	10.63	0.80 b	0.50
	Sterilized	9.70	14.30	0.00 b	0.00
	Ethoprop	12.00	10.35	0.50 b	0.50
	Fluensulfone	12.40	16.40	2.30 a	0.75
	P-value	*0.441*	*0.183*	*0.006*	*0.662*

[z] Means with same letter are not significantly different.

impact the number of *Tylenchorhynchus* spp. in the soil relative to the untreated across all soils.

In experiment 1, soils SC49 and SC57 showed an effect of soil treatment on soil population densities of *Mesocriconema* spp. (Table 5). Ethoprop reduced *Mesocriconema* spp. population levels in the soil by 86% in SC57 while fluensulfone showed no impact on the abundance of *Mesocriconema* spp. in the soil. In experiment 2, there was an effect of soil treatment on soil population densities of *Mesocriconema* spp. in three soils (SC20, SC51, and SC57). Ethoprop and fluensulfone reduced *Mesocriconema* spp. densities in one site (SC51) by 70% and 100%, respectively. However, *Mesocriconema* spp. densities were lower at this site.

DISCUSSION

Results from the survey conducted in this study provide an update on the major PPN genera currently present in sugarcane fields in Louisiana. The most common PPN genera detected in this study included *Tylenchorhynchus* spp., *Mesocriconema* spp., *Pratylenchus* spp., and *Helicotylenchus* spp., with *Hoplolaimus* spp., and *Paratylenchus* spp. detected less frequently. These nematode genera are also reported in fields from other sugarcane-producing countries (Blair & Stirling, 2007; Kawanobe et al., 2020; Martinha et al., 2022; Steven et al., 2014) and have previously been reported in Louisiana (Bond et al., 2000).

In this survey, sites that were in their second and third ratoon had the highest nematode population densities in soil compared to sites in their fallow, plant-cane year, or first ratoon. This suggests that increasing nematode soil population densities over time may lead to more nematode-associated damage in subsequent years. Overall, increasing nematode densities in soil during the crop cycle is likely a contributing factor to sugarcane yield decline (Blair & Stirling, 2007; Savario & Hoy, 2011; Stirling et al., 2001).

Table 4. Number of *Pratylenchus* spp. in roots and soil in experiment 1 and experiment 2.

		Pratylenchus spp.			
		Roots[x]		Soil[y]	
Site	Treatment	Exp 1	Exp 2	Exp 1	Exp 2
SC20	Untreated	35 b[z]	6 a	35 a	233 a
	Sterilized	0 b	0 b	3 b	0 c
	Ethoprop	32 b	2 a	18 b	158 ab
	Fluensulfone	113 a	4 a	10 b	150 b
	P-value	*0.005*	*0.004*	*<0.001*	*<0.001*
SC49	Untreated	178 a	9 a	28 a	105 a
	Sterilized	0 b	0 c	0 b	3 c
	Ethoprop	31 b	1 b	10 ab	40 bc
	Fluensulfone	104 ab	4 a	15 ab	78 ab
	P-value	*0.042*	*0.001*	*0.048*	*0.001*
SC51	Untreated	9 a	1 a	--	13
	Sterilized	0 c	0 b	--	0
	Ethoprop	2 bc	0 b	--	8
	Fluensulfone	6 ab	0 b	--	10
	P-value	*0.004*	*0.002*	--	*0.34*
SC57	Untreated	55 a	4 a	45 a	123 a
	Sterilized	1 b	0 b	3 b	0 b
	Ethoprop	12 b	2 ab	5 b	95 a
	Fluensulfone	51 a	3 a	45 a	108 a
	P-value	*0.002*	*0.02*	*0.037*	*<0.001*

[x] Number of nematodes per gram of root.
[y] Number of nematodes per 500 cm^3 soil.
[z] Means with same letter are not significantly different.

In our study, it was noted that soil texture influenced the abundance of PPN genera. The survey showed that *Pratylenchus* spp. and *Mesocriconema* spp. were more prevalent in sandy textured soils. In contrast, *Helicotylenchus* spp. and *Tylenchorhynchus* spp. were found at similar densities across all soil types, suggesting minimal preference in soil texture. The sites sampled predominantly consisted of silt loam soils, which may also explain the absence of *Meloidogyne* spp. as this nematode is typically found in coarser textured soils with higher sand contents. However, *Meloidogyne* spp. have previously been reported in sugarcane in Louisiana, primarily in parishes located near the Mississippi River Valley which often have a higher sand content (Bond *et al*., 2000). The inclusion of additional sugarcane fields along the Mississippi River may lead to the detection of *Meloidogyne* spp. in sugarcane fields.

The plant growth response to nematicide application in the greenhouse experiment varied among field soils and experiments, which may be related to the fact that soil was collected at different times and the sugarcane crops within each site were at different growth stages during each sampling event. Despite showing different results across experiments and sites, it was still evident that the sterilization treatment increased plant growth in most of the soils. Other studies have shown that soil sterilization eliminates nematodes and soil-borne pathogens and promotes plant growth in other crop systems (Katan, 1981; Li et al., 2019). The plant growth response to sterilization in the current greenhouse study suggests that PPN, as well as possibly other soilborne pathogens, contribute to reduced plant growth in sugarcane.

Ethoprop showed potential to reduce population densities of PPN in potted sugarcane

Table 5. Number of *Tylenchorhynchus* spp. and *Mesocriconema* spp. (number of nematodes/500 ml of soil) in experiment 1 and experiment 2.

		Ectoparasite nematodes[y]			
		Tylenchorhynchus spp.		*Mesocriconema* spp.	
Site	Treatment	Exp 1	Exp 2	Exp 1	Exp 2
SC20	Untreated	188	310 a[z]	85	125 a
	Sterilized	0	3 b	0	1 b
	Ethoprop	65	245 a	48	183 a
	Fluensulfone	225	260 a	50	108 a
	P-value	*0.171*	*<0.001*	*0.163*	*<0.001*
SC49	Untreated	265	888	48 ab	3
	Sterilized	3	0	0 b	0
	Ethoprop	110	490	25 b	3
	Fluensulfone	653	763	148 a	10
	P-value	*0.205*	*0.140*	*0.039*	*0.351*
SC51	Untreated	225 a	365 a	8	10 a
	Sterilized	0 b	8 b	0	0 b
	Ethoprop	13 b	310 a	3	3 b
	Fluensulfone	65 b	254 a	3	0 b
	P-value	*<0.001*	*0.003*	*0.642*	*0.037*
SC57	Untreated	508 a	548 a	815 a	228 ab
	Sterilized	10 b	3 b	0 c	0 c
	Ethoprop	70 b	420 a	118 bc	135 bc
	Fluensulfone	633 a	630 a	585 ab	415 a
	P-value	*<0.001*	*0.026*	*<0.001*	*<0.001*

[y] Number of nematodes per 500 cm^3 soil.
[z] Means with same letter are not significantly different.

field soils, but application also often resulted in a reduction in sugarcane growth. Ethoprop reduced the density of *Pratylenchus* spp. in roots and soil, as well as densities of *Mesocriconema* spp. and *Tylenchorhynchus* spp. in soil. Results in this greenhouse study suggested that ethoprop may suppress the three main nematodes in sugarcane, contrary to what was reported by Bond (2000) in a field experiment, where ethoprop did not reduce densities of *Pratylenchus* spp., *Mesocriconema* spp., and *Tylenchorhynchus* spp.. Several factors may affect the efficacy of nematicides application under field and greenhouse conditions, including temperature, irrigation or rainfall, and nematicide distribution in the soil profile, all of which may have contributed to the discrepancies and results observed in the current study. Temperature is a major factor influencing ethoprop degradation, with higher soil temperatures associated with accelerated degradation of this compound (Jones & Norris, 1998). This may have influenced the efficacy of ethoprop in the current greenhouse study relative to the field experiment conducted by Bond (2000) since temperatures could be higher and less controlled under field conditions. In the greenhouse, water application is regulated, which may reduce the potential of leaching of the compound in soil; whereas in the field, rainfall may lead to faster leaching (Rahi et al., 1992). Coverage is another important factor that may influence nematicide efficacy. In potted greenhouse experiments, the nematicide typically covers 100% of the pot, potentially enhancing its efficacy; whereas in the field, it is less likely to get the same level of root coverage. In the current experiment, ethoprop had no impact on plant growth parameters within each field soil; however, in the second potted greenhouse study, application of ethoprop

reduced root weight by 35%. Reduced plant growth after ethoprop application may be related to phytotoxicity as has been previously reported on lima bean and carrot seedlings (Jones et al., 2017; Sinclair et al., 1992). However, no obvious signs of phytotoxicity were observed on the sugarcane plants. Root weight reductions related to ethoprop application may have been a contributing factor in reductions in PPN densities in our study, as a smaller root system would presumably support less overall nematode reproduction.

Fluensulfone showed some potential to reduce densities of *Pratylenchus* spp. in soil and promoted a greater number of tillers, however, results were inconsistent across experiments and soil sites. In experiment 1, fluensulfone reduced densities of *Pratylenchus* spp. in soil collected at SC20. In experiment 2, fluensulfone also appeared effective at a site with low nematode pressure (SC51), reducing the density of *Pratylenchus* spp. in roots and *Mesocriconema* spp. in soil. The variability in the efficacy of fluensulfone toward *Pratylenchus* spp. has been previously observed in potato, as well as in in vitro and greenhouse studies on lettuce (Grabau et al., 2019; Oka, 2014). Fluensulfone has also shown efficacy in reducing *Mesocriconema* spp. nematode densities in peach (Shirley et al., 2019); however, in the current greenhouse experiment, it only reduced *Mesocriconema* spp. densities at one site where densities were initially low. In the study by Shirley et al. (2019) multiple applications of fluensulfone further reduced *Mesocriconema* spp. densities, suggesting that repeated applications may improve its efficacy. The phytotoxicity of fluensulfone has previously been reported (Giannakou & Panopoulou, 2019; Jones et al., 2017); however, these effects were not observed in the current experiments. In certain field soils, fluensulfone showed a similar level of plant growth stimulation as the sterilized treatment, suggesting that this compound may help to improve plant growth, which may lead to an increased yield in sugarcane. Overall, fluensulfone showed the potential to reduce PPN densities; however, further evaluation in a field setting is needed.

CONCLUSION

A survey conducted across 62 sugarcane fields revealed that *Tylenchorhynchus* spp., *Mesocriconema* spp., *Pratylenchus* spp., and *Helicotylenchus* spp. are the main PPN genera found in Louisiana sugarcane fields. The crop stage and soil texture have an impact on nematode population densities since a higher number of nematodes were found in the second and third ratoon. In the greenhouse experiment, the sterilization treatment led to greater plant growth, suggesting that nematodes, as well as possibly other soilborne pathogens, contribute negatively toward sugarcane growth in Louisiana. Application of ethoprop showed potential to reduce three main nematode genera in sugarcane; however, a plant growth reduction was also observed after application, which may have been associated with phytotoxicity. Although fluensulfone showed inconsistent efficacy in reducing PPN densities in some field soils, it showed potential to reduce *Pratylenchus* spp. in soil and the tendency to increase the number of tillers, which may have a positive impact on sugarcane yield. Overall, a diverse array of PPN genera were detected in Louisiana sugarcane fields, and application of nematicides to potted sugarcane plants showed potential to reduce nematode-associated damage; however, additional field-based nematicide efficacy trials are required to validate our initial findings under commercial production practices.

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LITERATURE CITED

Berry, S., Spaull, V., & Cadet, P. (2007). Impact of harvesting practices on nematode communities and yield of sugarcane. *Crop Protection, 26*(8), 1239–1250. https://doi.org/10.1016/j.cropro.2006.10.022

Birchfield, W. (1969). Nematicides for control of plant-parasitic nematodes on sugarcane in Louisiana. *The Plant Disease Reporter, 53*, 530–533.

Blair, B., & Stirling, G. (2007). The role of plant-parasitic nematodes in reducing yield of sugarcane in fine-textured soils in Queensland, Australia. *Australian Journal of Experimental Agriculture, 47*(5), 620–634.

Bond, J., McGawley, E., & Hoy, J. (2000). Distribution of plant-parasitic nematodes on sugarcane in Louisiana and efficacy of nematicides. *Journal of Nematology, 32*(4S), 493.

Bond, J., McGawley, E., & Hoy, J. (2004). The impact of nematodes on sugarcane cultivars. *Nematropica, 34*(2), 235–244.

Byrd Jr, D., Barker, K., Ferris, H., Nusbaum, C., Griffin, W., Small, R., & Stone, C. A. (1976). Two semi-automatic elutriators for extracting nematodes and certain fungi from soil. *Journal of Nematology, 8*(3), 206–212.

Cadet, P., & Spaull, V. W. (2003). Effect of nematodes on the sustained production of sugarcane in South Africa. *Field Crops Research, 83*(1), 91–100. https://doi.org/10.1016/S0378-4290(03)00066-2

Giannakou, I. O., & Panopoulou, S. (2019). The use of fluensulfone for the control of root-knot nematodes in greenhouse cultivated crops: Efficacy and phytotoxicity effects. *Cogent Food & Agriculture*, *5*(1), 1643819. https://doi.org/10.1080/23311932.2019.1643819

Grabau, Z. J., Noling, J. W., & Gine, P. A. N. (2019). Fluensulfone and 1, 3-dichloroprene for plant-parasitic nematode management in potato production. *Journal of Nematology, 51*(1), 1–12. https://doi.org/10.21307/jofnem2019-001

Jenkins, W. (1964). A rapid centrifugal-flotation technique for separating nematodes from soil. *Plant Disease Reporter, 48*, 692.

Jones, J. G., Kleczewski, N. M., Desaeger, J., Meyer, S. L., & Johnson, G. C. (2017). Evaluation of nematicides for southern root-knot nematode management in lima bean. *Crop Protection, 96*, 151–157. https://doi.org/10.1016/j.cropro.2017.02.015

Jones, R. L., & Norris, F. A. (1998). Factors affecting degradation of aldicarb and ethoprop. *Journal of Nematology, 30*(1), 45.

Katan, J. (1981). Solar heating (solarization) of soil for control of soilborne pests. *Annual Review of Phytopathology, 19*(1), 211–236. https://doi.org/10.1146/annurev.py.19.090181.001235

Kawanobe, M., Sugihara, S., Miyamaru, N., Yoshida, K., Nonomura, E., Oshiro, H., & Toyota, K. (2020). Distribution of root-lesion and stunt nematodes, and their relationship with soil properties and nematode fauna in sugarcane fields in Okinawa, Japan. *Agronomy, 10*(6), 762. https://doi.org/10.3390/agronomy10060762

Koenning, S., Overstreet, C., Noling, J., Donald, P., Becker, J., & Fortnum, B. (1999). Survey of crop losses in response to phytoparasitic nematodes in the United States for 1994. *Journal of Nematology, 31*(4S), 587.

Li, K., DiLegge, M. J., Minas, I. S., Hamm, A., Manter, D., & Vivanco, J. M. (2019). Soil sterilization leads to re-colonization of a healthier rhizosphere microbiome. *Rhizosphere, 12*, 100–176. https://doi.org/10.1016/j.rhisph.2019.100176

Martinha, D. D., Silva, M. C. C., Maceda, A., Hahn, M. H., Calegario, R., Ruaro, L., Oliveira, R. A. d., & Duarte, H. d. S. S. (2022). Survey of nematodes associated with sugarcane in the state of Paraná, Brazil. *Arquivos do Instituto Biológico, 89*, e00332021. https://doi.org/10.1590/1808-1657000332021

Oka, Y. (2014). Nematicidal activity of fluensulfone against some migratory nematodes under laboratory conditions. *Pest Management Science, 70*(12), 1850–1858.

Oostenbrink, M. (1954). Een doelmatige methode voor het toetsen van aaltjesbestrijdingsmiddelen in grond met *Hoplolaimus uniformis* als proefdier. *Mededelingen van de Landbouwhogeschool en de Opzoekingsstations van de Staat te Gent, 19*(3), 377–408.

Rahi, G., Rich, J., & Hodge, C. (1992). Ethoprop depletion from soil as influenced by simulated rainfall. *Journal of Nematology, 24*(4S), 642.

Ricaud, C., Egan, B., Gillaspie, A., & Hughes, C. (Eds.) (2012). *Diseases of sugarcane: Major diseases*. Elsevier.

Savario, C. F., & Hoy, J. W. (2011). Microbial communities in sugarcane field soils with and without a sugarcane cropping history. *Plant and Soil, 341*, 63–73. https://doi.org/10.1007/s11104-010-0622-9

Schmitz, A., Kennedy, P. L., & Zhang, F. (2020). Sugarcane and sugar yields in Louisiana (1911–2018): Varietal development and mechanization. *Crop Science, 60*(3), 1303–1312. https://doi.org/10.1002/csc2.20045

Shirley, A. M., Noe, J. P., Nyczepir, A. P., Brannen, P. M., Shirley, B. J., & Jagdale, G. B. (2019). Effect of spirotetramat and fluensulfone on population densities of and on peach. *Journal of Nematology, 51*(1), 1–10. https://doi.org/10.21307/jofnem-2019-012

Sinclair, P., Neeson, R., & Williams, P. (1992). Phytotoxicity of some organophosphate insecticides to onions and carrots during germination and emergence. *Plant Protection Quarterly, 7*(1), 23–25.

Steven, A., Sunday, S., & Fisayo, D. (2014). Biodiversity of plant-parasitic nematodes of sugarcane in Bacita, Nigeria. *Journal of Entomology and Nematology, 6*(6), 71–79. https://doi.org/10.5897/jen2014.0096

Stirling, G., Blair, B., Pattemore, J., Garside, A., & Bell, M. (2001). Changes in nematode populations on sugarcane following fallow, fumigation and crop rotation, and implications for the role of nematodes in yield decline. *Australasian Plant Pathology, 30*, 323–335. https://doi.org/10.1071/AP01044

U.S Department of Agriculture, National Agricultural Statistics Service (2025). Louisiana Crop Production https://www.nass.usda.gov/Statistics_by_State/Louisiana/Publications/Crop_Releases/Annual_Summary/2024/laannsum24.pdf

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