NEMATODES ASSOCIATED WITH *PENNISETUM PURPUREUM* AND *SACCHARUM* SP. IN FLORIDA[1]

R. McSorley, L. C. Hammond, and R. A. Dunn

Respectively, Departments of Entomology and Nematology, Soil Science, and Entomology and Nematology; Institute of Food and Agricultural Sciences, University of Florida, Gainesville, FL 32611, U.S.A.

Accepted:
7.III.1989
Aceptado:

ABSTRACT

McSorley, R., L. C. Hammond, and R. A. Dunn. 1989. Nematodes associated with *Pennisetum purpureum* and *Saccharum* sp. in Florida. Nematrópica 19:29–37.

During two growing seasons, the most abundant plant-parasitic nematodes found on crops of energy cane (*Saccharum* sp.) and napiergrass (*Pennisetum purpureum*) were *Belonolaimus longicaudatus* and *Criconemella ornata,* along with low numbers of *C. sphaerocephala.* Near the end of the 1986 growing season, populations of *B. longicaudatus* were negatively correlated with height of plants and length of leaves of energy cane. Although such negative correlations were not observed in the second season (first ratoon) of either host crop, in a few cases positive correlations ($P \leq 0.05$) were observed between plant growth parameters and population density of either *B. longicaudatus* or *Criconemella* spp. During the second season, similar initial (Pi) and final (Pf) populations of *B. longicaudatus* were maintained on both crops (energy cane: mean Pi = 32/100 cm^3 of soil; mean Pf = 30/100 cm^3 soil; napiergrass; mean Pi = 56/100 cm^3 soil; mean Pf = 34/100 cm^3 of soil). Population levels of *Criconemella* spp. were maintained on energy cane (Pi = 76/100 cm^3; Pf = 79/100 cm^3) but doubled on napiergrass (Pi = 213/100 cm^3; Pf = 421/100 cm^3).

Key words: Belonolaimus longicaudatus, biomass, *Criconemella ornata, C. sphaerocephala,* napiergrass, *Pennisetum purpureum,* ring nematodes, *Saccharum* sp., sting nematodes, sugarcane.

RESUMEN

McSorley, R., L. C. Hammond y R. A. Dunn. 1989. Nematodos asociados con *Pennisetum purpureum* y *Saccharum* sp. en Florida. Nematrópica 19:29–37.

Durante dos años, los nematodos que se encontraron con más frequencia en asociación con los cultivos del pasto elefante (*Pennisetum purpureum*) y de la caña para energía (*Saccharum* sp.) fueron *Belonolaimus longicaudatus* y *Criconemella ornata,* seguidos por bajas poblaciones de *C. sphaerocephala.* Al final del verano de 1986, las poblaciones de *B. longicaudatus* tuvieron una correlación negativa con la altura de las plantas y la longitud de las hojas de la caña para energía. Aunque éstas correlaciones negativas no se observaron en el segundo verano (primer retoño) en ninguno de los dos cultivos, en algunos casos se observaron correlaciones positivas ($P \leq 0.05$) entre los parámetros de crecimiento de las plantas y las densidades de las poblaciones de *B. longicaudatus* o de *Criconemella* spp. Durante el segundo verano, las poblaciones iniciales (Pi) y finales (Pf) de *B. longicaudatus* se mantuvieron al mismo nivel en ambos cultivos (caña: Pi = 32/100 cm^3 de suelo; Pf = 30/100 cm^3 de suelo; pasto elefante: Pi = 56/100 cm^3 de suelo; Pf = 34/100 cm^3 de suelo). Los niveles de

[1]Florida Agricultural Experiment Stations Journal Series No. 9303.

Criconemella spp. se mantuvieron en la caña para energía (Pi = 76/100 cm^3; Pf = 79/100 cm^3), pero se duplicaron en el pasto elefante (Pi = 213/100 cm^3; Pf = 421/100 cm^3).

Palabras claves: biomasa, *Belonolaimus longicaudatus,* caña de azucar, *Criconemella ornata, C. sphaerocephala,* nematodo de aguijon, nematodo de anillo, pasto elefante, *Pennisetum purpueum, Saccharum,* sp.

INTRODUCTION

There is increasing interest in cultivation of highly productive, low-maintenance, high-biomass crops both as a potential source of fuel (2) and as forage for livestock (14). Two crops that are particularly well-adapted for this purpose in subtropical and tropical regions are the sugar canes (*Saccharum* spp.) and napiergrass, also known as elephant grass (*Pennisetum purpureum* Schum.). As with any crop introduced into new locations for cultivation, the potential pests, including nematodes, should be anticipated.

The present study was undertaken to investigate the nematodes associated with *P. purpureum* and an "energy cane" (*Saccharum* sp.) in Florida. Of particular concern was the sting nematode, *Belonolaimus longicaudatus* Rau, which is common in sandy soils and known to damage other graminaceous crops such as corn (8). Numerous plant-parasitic nematodes are associated with sugar cane, including *Belonolaimus* spp. (7). Little information is available on the nematodes of *P. purpureum,* although it is the type host for several species collected in Malawi (3, 10–12). In the southeastern United States, a diverse nematode community consisting of *B. longicaudatus, Criconemella ornata* (Raski) Luc & Raski, *Paratrichodorus christei* (Allen) Siddiqi, *Pratylenchus* spp. and *Xiphinema americanum* Cobb, is found on pearl millet (*Pennisetum typhoides* (Burm. f.) Stapf & Hubbard; syn. = *P. americanum* (L.) K. Schum.), with yield suppression attributed to *B. longicaudatus* and *Pratylenchus* spp. (5). *Helicotylenchus dihystera* (Cobb) Sher was recovered from Kikuyu grass (*P. clandestinum* Hochst. ex. Chiov.) in Australia (13).

MATERIALS AND METHODS

The test site was located at the Irrigation Park on the University of Florida campus in Gainesville. The predominant soil type in the 0.5-ha field plot was Arredondo fine sand (loamy, siliceous, hyperthermic Grossarenic Paleudults, 92% sand, 3% silt, 5% clay). Cuttings of energy cane (*Saccharum* sp., #L79-1002) and napiergrass were planted in November–December 1985. The experiment was part of a larger study consisting of a four-replicate, split-plot design with main plots arranged as a randomized complete block. The two tropical grasses × three water management levels (rainfed, well irrigated to avoid stress, and irrigated 2–3 days after water stress) were main plots and two fertilizers at two rates were subplots (N applied at rates of 168 and 336 kg/ha and K applied at 69 and 139 kg/ha). Subplots were 6.9 × 6.9 m and consisted of seven rows planted 1 m apart. The present experiment used only the rainfed plots from the larger study.

During the summer of 1986, stunting and irregular growth became apparent in both crops. Therefore, on 3–4 September 1986, preliminary samples of each crop were collected from 10 random locations within selected rainfed plots. At each location (1.0-m length of row), the following measurements were made: plant height, length of the uppermost fully mature leaf, and stem diameter at 30 cm above ground level. Measurements were collected from 10 plants at each location, and mean values obtained for each location. In addition, a soil sample consisting of 10 cores of soil taken from within 15 cm of the plant base to a 15–20 cm depth, was collected from each location. A 100-cm^3 subsample was taken from each sample, and the nematodes extracted using a sieving and centrifugation procedure (4).

Plants were killed by frost during the winter of 1986–87, and were subsequently cut, leaving stubble less than 50 cm high. Regrowth began in early March 1987. Soil samples for nematode analysis were collected on 31 March, 27 May, 27 July, 16 September and 23 November 1987. The soil samples were collected from each fertilizer treatment from each crop, for a total of 16 samples per crop. Each sample consisted of 10 cores, two from each of the five middle rows of each plot, composited and extracted as described previously. Plant measurements were collected at three locations within each plot and averaged. Plant height was measured on 27 July, 16 September, and 23 November, but stem diameter and leaf length were measured on only the latter two dates. Yield was collected on 5–7 January 1988, by harvesting two 3-m sections of row from each plot. The number of stems and plant height also were measured in each section of row.

In both seasons, Pearson correlation coefficients were calculated between plant growth parameters and nematode populations. For the 1987 data, analysis of variance also was used to analyze for differences between hosts and fertilizer treatments.

RESULTS AND DISCUSSION

Plant-parasitic nematodes detected in this site during the September 1986 sampling included many *B. longicaudatus* and a mixture of *Criconemella* species consisting primarily of *C. ornata* but with some *C. sphaerocephala* (Taylor) Luc & Raski (Table 1). A range in plant growth was evident in the different plots for both crops. For energy cane, plant height and leaf length were negatively correlated ($r = -0.762$ and $r = -0.694$, respectively; $P \leq 0.05$) with *B. longicaudatus* density during

Table 1. Nematode densities per 100 cm³ of soil and plant growth parameters for energy cane and napiergrass in September 1986.

Nematode or plant growth parameter	Energy cane	Napiergrass
Belonolaimus longicaudatus	76 ± 13.0	78 ± 11.6
Criconemella spp.	17 ± 7.8	73 ± 10.3
Stem diameter (mm)	13.2 ± 0.40	15.2 ± 0.41
Plant height (m)	1.29 ± 0.14	1.76 ± 0.08
Leaf length (cm)	127 ± 6.5	116 ± 1.4

Data are means (± standard error) based on 10 replications for each parameter.

1986. No significant ($P \leq 0.05$) correlation was found between stem diameter of energy cane and *B. longicaudatus* density. No correlations were found between *B. longicaudatus* numbers and any plant measurement of napiergrass, or between numbers of *Criconemella* spp. and plant growth measurements of either crop.

During 1987, separate samples were collected from all fertilizer treatments on each of several different sampling dates. Among the rainfed plots sampled during the course of this study, the fertilizer level generally had no significant effect on nematode populations or plant growth parameters (data not shown). Exceptions occurred in the 23 November sample, when napiergrass plants were taller ($P \leq 0.01$) in plots receiving 336 kg N/ha (mean height = 3.4 m) than in those receiving 168 kg N/ha (mean height = 2.9 m), and harvest yield also was greater ($P \leq 0.05$) at 26 500 vs. 16 800 kg/ha.

The results of samplings averaged across fertilizer treatments are presented by host crop (Tables 2, 3). Although *B. longicaudatus* was more

Table 2. Densities of *Belonolaimus longicaudatus* and *Criconemella* spp. per 100 cm³ of soil on five sampling dates in 1987, compared by host crop.

Sampling date	Energy cane	Napiergrass	*F* value
	Belonolaimus longicaudatus		
31 March	32 ± 3.8	56 ± 6.4	10.83*
27 May	18 ± 3.1	22 ± 4.2	0.58
27 July	75 ± 9.9	94 ± 10.7	1.74
16 September	25 ± 2.9	33 ± 4.7	2.37
23 November	30 ± 5.6	34 ± 6.1	0.18
	Criconemella spp.		
31 March	76 ± 19	213 ± 61	4.63*
27 May	33 ± 7	301 ± 81	10.91**
27 July	87 ± 19	795 ± 129	29.42***
16 September	164 ± 23	708 ± 105	25.58***
23 November	79 ± 13	421 ± 49	45.27***

Data are means (± standard error) of 16 replications.
$*P \leq 0.05$. $**P \leq 0.01$. $***P \leq 0.001$.

abundant in napiergrass at the beginning of the second season (31 March), this difference disappeared in subsequent samplings (Table 2). Population densities of this nematode peaked in July, declining thereafter. *Criconemella* spp. were always more abundant on napiergrass than on energy cane (Table 2), reaching mean numbers in excess of 700/100 cm^3 of soil during the July and September samplings. Numbers of *Criconemella* spp. remained stable on energy cane, but doubled during the second season (March–November) on napiergrass.

Ranges in nematode populations (Table 2) and plant growth parameters (Table 3) provided a basis for examining correlations between the two types of variables. Results are summarized for energy cane (Table 4) and napiergrass (Table 5). Contrary to results achieved during the first season (1986), no significant negative correlations between plant growth and densities of *B. longicaudatus* were observed in 1987. However, significant negative correlations between plant growth parameters and numbers of *Criconemella* spp. were observed in one instance on energy cane (Table 4) and twice on napiergrass (Table 5) during the 1987 season. In a number of cases, nematode numbers and plant growth were positively correlated in 1987. One possible explanation for these positive correlations may be that stunted plants entering the second season would have reduced root systems and thus be capable of supporting few nematodes, whereas the large root systems may support larger nematode populations.

Traditional approaches toward the development of damage functions have worked well when relating yield of short-lived annual crops to initial nematode populations (1,9). Long-term changes in growth cycles of nematodes and hosts in perennial systems may require breakdown into multiple-point models for each growth cycle before appropriate damage functions can be developed (1), if at all. Even in a long-lived

Table 3. Means and standard errors of plant growth parameters during the 1987–88 season.

Plant growth parameter	Measurement date	Energy cane	Napiergrass
Plant height (m)	27 July	1.7 ± 0.06	2.0 ± 0.09
	16 September	2.3 ± 0.09	2.6 ± 0.06
	23 November	2.5 ± 0.11	3.1 ± 0.11
Stem diam (mm)	16 September	15.0 ± 0.33	17.7 ± 0.50
	23 November	16.1 ± 0.27	18.6 ± 0.38
Leaf length (cm)	16 September	116 ± 2.33	100 ± 0.80
	23 November	108 ± 2.26	79 ± 2.43
Stalks/3 m of row	5–7 January	62.6 ± 3.09	39.7 ± 1.64
Plant height (m)	5–7 January	2.5 ± 0.10	3.1 ± 0.11
Yield (kg/ha)	5–7 January	18 600 ± 1 704	21 600 ± 1 779

Data are means (± standard error) based on 16 plots for each parameter.

Table 4. Correlation coefficients between populations of either *Belonolaimus longicaudatus* (BL) or *Criconemella* spp. (C) per 100 cm^3 of soil and plant growth measurements for energy cane during 1987.

Nematode sample date[z]	Plant height				Leaf length	
	27 July	16 September	23 November	5–7 January	16 September	23 November
BL, 27 May	0.124	0.195	0.194	0.011	0.312	0.522*
BL, 16 September	0.308	0.633**	0.504*	0.278	0.576*	0.378
C, 23 November	−0.303	−0.605*	−0.374	0.525*	−0.364	−0.423

Coefficients computed over 16 plots (n = 16). $^*P \leq 0.05$. $^{**}P \leq 0.01$.

[z]No significant ($P \leq 0.05$) correlations of plant growth measurements with BL populations sampled on 31 March, 27 July, or 23 November, or with C populations sampled on 31 March, 27 May, 27 July, or 16 September.

Table 5. Correlation coefficients between populations of either *Belonolaimus longicaudatus* (BL) or *Criconemella* spp. (C) per 100 cm^3 of soil and plant growth measurements for napiergrass during 1987.

Nematode and	Plant height				Stem diameter		Leaf length	
sample date[z]	27 July	16 September	23 November	5–7 January	16 September	23 November	23 November	Yield
BL, 31 March	−0.229	−0.225	−0.043	−0.221	−0.088	−0.065	0.520*	−0.040
BL, 27 July	0.135	0.080	0.458	−0.020	−0.003	0.396	0.546*	−0.057
BL, 16 September	0.538*	0.415	0.209	0.525*	0.115	0.442	−0.268	0.615*
BL, 23 November	0.480	0.124	0.405	0.298	−0.162	0.540*	0.345	0.376
C, 23 November	0.410	0.522*	0.498*	−0.545*	0.524*	−0.064	−0.454	0.670**

Coefficients computed over 16 plots (n = 16). $*P \leq 0.05$. $**P \leq 0.01$.

[z]No significant ($P \leq 0.05$) correlations of plant growth measurements with BL populations sampled on 27 May, or with C populations sampled on 31 March, 27 May, 27 July, or 16 September.

annual crop such as cassava, relationships between yield and initial nematode density may no longer be evident by harvest (6). The present study illustrates the practical difficulty of attempting to develop damage functions in the perennial system, in which even the direction (positive vs. negative) of nematode-host relationships may change from season to season.

Aside from these theoretical implications, this study provides practical information on some potential problems that could occur when growing these high-biomass crops in Florida. The negative correlations obtained during the first season suggest that sites should be checked for *B. longicaudatus* before attempting to cultivate energy cane or related *Saccharum* spp. on sandy soils in Florida. This report may be the first evidence of suppressed growth in *Saccharum* spp. attributed to a *Belonolaimus* species (7).

Although no negative relationships were found between densities of *B. longicaudatus* and growth of napiergrass, the inconclusive nature of these relationships suggests that further study of this system is warranted. Furthermore, in a few instances, negative correlations between plant growth and high populations of *Criconemella* spp. were noted. Either napiergrass or energy cane could support substantial populations ($> 30/100$ cm^3 of soil) of *B. longicaudatus*, which could cause severe damage to subsequent crops, such as corn or soybean.

LITERATURE CITED

1. FERRIS, H., and J. W. NOLING. 1987. Analysis and prediction as a basis for management decisions. Pp. 49–85 *in* R. H. Brown and B. R. Kerry, eds. Principles and Practice of Nematode Control in Crops. Academic Press: Sydney.
2. GARDNER, C. S., and G. M. PRINE. 1987. Phytomass yield of elephantgrass as affected by fertilizer nitrogen and cool-season legume intercrop. Soil and Crop Science Society of Florida Proceedings 46:46–51.
3. JAIRAJPURI, M. S., and M. R. SIDDIQI. 1977. Observations on the nematode genera *Orientylus* and *Calvatylus* (Rotylenchoidinae: Hoplolaimidae) with descriptions of three new species. Indian Journal of Nematology 7:101–111.
4. JENKINS, W. R. 1964. A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Disease Reporter 48:692.
5. JOHNSON, A. W., and G. W. BURTON. 1973. Comparison of millet and sorghum-sudangrass hybrids grown in untreated soil and soil treated with two nematicides. Journal of Nematology 5:54–59.
6. McSORLEY, R., and J. L. PARRADO. 1985. Relative performance of two cassava cultivars in a field infested with *Meloidogyne incognita*. Soil and Crop Science Society of Florida Proceedings 44:180–183.
7. PRASAD, S. K. 1972. Nematode diseases of sugar-cane. Pp. 144–158 *in* J. M. Webster, ed. Economic Nematology. Academic Press: New York.
8. RHOADES, H. L. 1985. Effects of separate and concomitant populations of *Belonolaimus longicaudatus* and *Dolichodorus heterocephalus* on *Zea mays*. Nematrópica 15:171–174.
9. SEINHORST, J. W. 1965. The relation between nematode density and damage to plants. Nematologica 11:137–154.
10. SIDDIQI, M. R. 1971. On the plant-parasitic nematode genera *Histotylenchus* gen. n.

and *Telotylenchoides* gen. n. (Telotylenchinae), with observations on the genus *Paratrophurus* Arias (Trophurinae). Nematologica 17:190–200.

11. SIDDIQI, M. R. 1979. Seven new species in a new nematode subfamily Duosulciinae (Tylenchidae), with proposals for *Duosulcius* gen. n., *Zanenchus* gen. n., and *Neomalenchus* gen. n. Nematologica 25:215–236.
12. SIDDIQI, M. R. 1980. Taxonomy of the plant nematode superfamily Hemicycliophoroidea, with a proposal for Criconematina, new suborder. Revue de Nématologie 3:179–199.
13. SMITH, A. D. M., and H. R. WALLACE. 1976. Fluctuations in the distribution and numbers of *Helicotylenchus dihystera* in Kikuyu turf (*Pennisetum clandestinum*). Nematologica 22:145–152.
14. SOLLENBERGER, L. E., G. M. PRINE, W. R. OCUMPAUGH, S. C. SCHANK, R. S. KALMBACHER, and C. S. JONES, Jr. 1987. Dwarf elephantgrass: A high quality forage with potential in Florida and the tropics. Soil and Crop Science Soceity of Florida Proceedings 46:42–46.

Received for publication: *27.IX.1988*
Recibido para publicar:

ACKNOWLEDGEMENTS

This study was supported in part from a co-funded program between the Gas Research Institute and the Institute of Food and Agricultural Sciences, University of Florida.