PLANT-PARASITIC NEMATODES ASSOCIATED WITH SWITCHGRASS (*PANICUM VIRGATUM* L.) GROWN FOR BIOFUEL IN THE SOUTH CENTRAL UNITED STATES

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ABSTRACT

K. A. Cassida, T. L Kirkpatrick, R. T. Robbins, J. P. Muir, B. C. Venuto, and M. A. Hussey. 2005. Plant-parasitic nematodes associated with switchgrass (*Panicum virgatum* L.) grown for biofuel in the south central United States. Nematropica 35:1-10.

Switchgrass (*Panicum virgatum* L.) has attracted recent attention as a potential biofuel crop, but stand establishment can be difficult. Plant-parasitic nematodes, as well as other soil borne pathogens, may contribute to this problem in the South Central United States. In a survey of five-year-old switchgrass variety trials, plant-parasitic nematodes were identified from samples collected after fall biomass harvest. Plot locations included Clinton, LA, Hope, AR, College Station, TX, and Stephenville, TX. Twice as many nematode species were identified at Hope and Clinton as at College Station or Stephenville. *Xiphinema americanum* and *Tylenchorhynchus* spp. (*T. capitatus* and *T. ewingi*) were found at all locations. *Paratrichodorus minor* and *Criconemella ornata* were found in three of four sites. *Hoplolaimus magnistylus*, *Pratylenchus zeae*, *Helicotylenchus* spp. (*H. dihystera* and *H. digonicus*), *Meloidogyne* spp., and *Paratylenchus* spp. were identified from some sites. Upland morphological types of switchgrass supported greater densities of *Helicotylenchus* spp. than lowland types at Clinton and greater densities of *Pratylenchus*, *Helicotylenchus*, and *Tylenchorhynchus* spp. at Hope. Lowland types appeared to be better hosts for *Tylenchorhynchus* spp. at Stephenville and for *P. minor* at Hope. Differences in nematode population density among switchgrass genotypes were found for several nematode species, and in some cases, the nematodes were correlated with decreased stand persistence or dry matter yield.

Key words: biofuel, *Criconemella ornata*, dagger nematodes, *Helicotylenchus dihystera*, *H. digonicus*, *Hoplolaimus magnistylus*, lesion nematodes, *Meloidogyne*, *Panicum virgatum* L., *Paratrichodorus minor*, *Paratylenchus*, pin nematodes, *Pratylenchus*, ring nematodes, root-knot nematodes, *Tylenchorhynchus ewingi*, *T. capitatus*, spiral nematodes, stubby-root nematodes, stunt nematodes, switchgrass, *Xiphinema americanum.*

RESUMEN

K. A. Cassida, T. L Kirkpatrick, R. T. Robbins, J. P. Muir, B. C. Venuto, and M. A. Hussey. 2005. Nematodos fitoparásitos asociados con pasto aguja (*Panicum virgatum* L.) cultivado para biocombustible en la zona central del sur de Estados Unidos. Nematropica 35:1-10.

El pasto aguja (*Panicum virgatum* L.) recientemente ha despertado interés como fuente potencial de biocombustible, pero el establecimiento de su cultivo puede ser difícil. Los nematodos fitoparásitos y otras enfermedades pueden contribuir a este problema en la zona central del sur de Estados Unidos. En cultivos de cinco años de edad, sembrados para evaluar variedades, se identificaron los nematodos fitoparásitos en muestras recolectadas después de la cosecha de biomasa de otoño. Los lotes estaban ubicados en Clinton, LA, Hope, AR, College Station, TX, y Stephenville, TX. En Hope y Clinton se identificaron dos veces más especies que en College Station o Stephenville. *Xiphinema* *americanum* y *Tylenchorhynchus* spp. (*T. capitatus* and *T. ewingi*) se encontraron en todos los lugares. *Paratrichodorus minor* y *Criconemella ornata* estaban presentes en tres de cuatro sitios. *Hoplolaimus magnistylus*, *Pratylenchus zeae*, *Helicotylenchus* spp. (*H. dihystera* y *H. digonicus*), *Meloidogyne* spp. y *Paratylenchus* spp. estaban presentes en algunos sitios. Los tipos morfológicos de pasto aguja de las tierras altas albergaban densidades más altas de *Helicotylenchus* spp. que los tipos de las tierras bajas en Clinton, y más altas densidades de *Pratylenchus*, *Helicotylenchus*, y *Tylenchorhynchus* spp. en Hope. Los tipos de las tierras bajas parecen ser mejores hospedantes de *Tylenchorhynchus* spp. en Stephenville y de *P. minor* en Hope. Se encontraron diferencias en densidades de población entre diversos genotipos de pasto aguja para varias especies de nematodos, y en algunos casos, la presencia de los nematodos estaba correlacionada con menor persistencia del cultivo o con menor producción de materia seca.

Palabras clave: biocombustible, *Criconemella ornata*, *Helicotylenchus dihystera*, *H. digonicus*, *Hoplolaimus magnistylus*, *Meloidogyne*, nematodo alfiler, nematodo anillado, nematodo daga, nematodo de la lesión, nematodo del nudo radical, nematodo del raquitismo, nematodo espiral, *Panicum virgatum*, *Paratrichodorus minor*, *Paratylenchus*, *Pratylenchus*, *Tylenchorhynchus ewingi*, *T. capitatus*, *Xiphinema americanum*.

INTRODUCTION

Switchgrass (*Panicum virgatum* L.) is a native prairie species adapted to much of the United States. Historically, switchgrass has been used as livestock feed, for wildlife habitat, and in soil conservation programs (Moser and Vogel, 1995), but in recent years it has attracted attention as a crop with potential for biofuel production. This perennial grass species produces large quantities of biomass, requires relatively little fertilizer and water, and can be utilized for fuel either by burning or in ethanol generation (Sanderson *et al.*, 1996). However, slow and unpredictable establishment of switchgrass stands has proven to be a significant problem in some areas.

Switchgrass genotypes encompass a wide range of both physiological and morphological traits. Moser and Vogel (1995) cited response to photoperiod, precipitation, and humidity as most important in determining regional adaptation. When ecotypes from northern and southern regions are grown together, northern types flower earlier and are shorter in stature, produce lower yields, and have a longer winter dormant period with better winter survival than southern ecotypes. Switchgrass morphological types are categorized as either lowland or upland types (Moser and Vogel, 1995). Lowland types are taller and more coarse, and grow faster than upland types. The lowland types exhibit a classic bunch-type growth habit and are adapted to flood plains and wet areas. Upland types are better suited to well-drained sites. Most varieties that have been developed and released are upland types (Moser and Vogel, 1995).

Factors, including seed and seedling traits (Panciera, 1999), insect predation (McKenna and Wolf, 1990), and competition from weeds (Evers and Butler, 2000) have been suggested as contributing factors in poor stand establishment. Soil borne pathogens may also be involved in poor stand establishment, particularly in the humid southern regions where winters are mild. In Texas, soil fumigation with methyl bromide improved switchgrass seedling density and weight compared to control plots, suggesting that soil borne pathogens were involved in poor establishment (Evers and Butler, 2000).

The impact of nematodes on forage stands has been reviewed (Bernard *et al.*, 1998; Griffin *et al.*, 1996; Leath *et al.*, 1996). Nematodes are most likely to damage young plants or plants stressed by drought, poor drainage, or harvesting (Griffin *et al.*, 1996). In many cases, nematode damage may be mistakenly attributed to environmental or abiotic factors (Leath *et al.*, 1996). In prairie ecosystems where switchgrass occurs as a native species, nematode population densities are generally low (Griffin *et al.*, 1996). However, Ingham and Detling (1984) reported that nematodes in the order Tylenchida, and *Trichodorus*, *Longidorus*, and *Xiphinema* species in the order Dorylaimida consumed up to 16.4% of annual net root production of western wheatgrass [*Pascopyrum smithii* (Rydb.) A. Löve] and 8.9% of little bluestem [*Schizachyrium scoparium* (Michx.) Nash]. Aboveground net primary production in a mixed grass prairie consisting primarily of little bluestem was up to 51% higher when mixed populations of *Helicotylenchus*, *Tylenchorhynchus*, *Tetylenchus*, *Paratylenchus*, and *Criconemella* spp. were reduced with nematicides (Ingham and Detling, 1990). In rotation with peanut, switchgrass resulted in lower population densities of *Meloidogyne arenaria* than where peanut was grown in monoculture for three years (Kokalis-Burelle *et al.*, 2002).

Nematodes associated with established switchgrass stands in the south central United States have not been investigated. Therefore, at the conclusion of a cooperative five-year switchgrass variety testing program, a survey of plant-parasitic nematodes associated with the stands at each of four locations in Texas, Arkansas, and Louisiana was conducted to determine if nematodes could be implicated in stand decline or yield suppression.

MATERIALS AND METHODS

Switchgrass variety trials established during 1997 at four locations in the south central United States were sampled during fall 2001 to determine the identity and population density of plant-parasitic nematodes. The sites were located in Clinton, LA (Dextar silt loam [fine-silty, mixed thermic Ultic Hapludalf], 1576 mm average annual precipitation), Hope, AR (Bowie fine sandy loam [fine-loamy, siliceous, thermic Fragic Paleudult], 1367 mm average annual precipitation), College Station, TX (Weswood silty clay loam [fine silty, mixed thermic Fluventic Ustochrept], 993 mm average annual precipitation), and Stephenville, TX (Windthorst fine sandy loam [fine, mixed thermic Udic Paleustalfs], 778 mm average annual precipitation).

Plots at all locations were established using seedlings originating from a common source. Four replications of each of nine varieties or experimental lines were included at each site. Switchgrass entries included four southern lowland types ('Alamo', SL931, SL932, SL941), one southern upland type (SU941), two northern lowland types (NL931, NL942), and two northern upland types ('Caddo', NU942). A randomized complete block design was used at each site, and plot size was 6.1 ¥ 2.1 m, consisting of four rows spaced 53 cm apart with 30-cm plant spacing within rows. Plots were fertilized once per year in spring with 150 kg N/ha (except at the Hope site which received 134 kg N/ha), and P and K to meet local soil test recommendations. Biomass was harvested from all plots in the fall each year to determine dry matter yields. The fall harvest consisted of a full season of growth in Clinton, College Station and Stephenville, and re-growth following a June mowing in Hope.

Soil samples for nematode assay were collected at each site following the fall harvest in 2001. Sampling dates were: 31 October, Clinton; 10 November, Hope; 30 October, College Station; and 19 November, Stephenville. Twenty soil cores were collected from each plot to a depth of 15-20 cm using a 2.54-cm-diam. sampling tube. Cores were collected within the dripline area of surviving switchgrass crowns. Individual cores were bulked by plot, placed in plastic bags, and shipped by overnight courier to the University of Arkansas Nematode Diagnostic Clinic in Hope, AR, where they were held at 12°C ± 2°C until they were assayed within two weeks after they were received. Samples were mixed thoroughly and 250-cm^3 subsamples were processed by semi-automatic elutriation (Byrd *et al.*, 1976) and centrifugal flotation (Jenkins, 1964). Root material that was collected during elutriation was placed on Baermann funnels for 72 hr. Nematodes from each site were identified to genus using a dissecting microscope at 40-60¥ magnification. Species identifications were made using 500-1,000 ¥ by comparing the morphological characteristics of multiple specimens from each sample with those of existing described species. A *Meloidogyne* and a *Pratylenchus* species found at the Clinton site were not identified to species because no adults were obtained, and a *Paratylenchus* species found at the College Station site was not identified because the available specimens did not allow for conclusive identification.

Statistical analyses were conducted using PROC GLM in SAS (SAS Institute, Cary, NC). Nematodes extracted from both soil and roots were combined and are reported as the number of nematodes per 500 cm^3 soil. Nematode counts and herbage yields were subjected to log ($\log_{10}[x + 1]$) and stand survival to square-root transformation prior to analysis of variance. Means are presented as the original arithmetic data. Analysis of variance was conducted separately by sites because Bartlett's test (Gomez and Gomez, 1984) on both original and transformed data revealed heterogeneous variances for the four sites. Contrasts were used to compare upland vs. lowland morphological types and northern vs. southern ecotypes within sites. A correlation analysis was run across transformed nematode counts, herbage yield, and percent switchgrass survival to determine whether nematode populations were associated with stand yield and persistence.

RESULTS AND DISCUSSION

Plant-parasitic nematodes associated with switchgrass at the four sites are listed in Table 1. Approximately twice as many nematode species were identified at Clinton and Hope as at College Station and Stephenville. The higher diversity of species at the former two sites is likely related to higher rainfall (1637, 1366, 1161, and 722 mm in the 12 mo prior to harvest at Clinton, Hope, College Station, and Stephenville, respectively). Only the dagger nematode, *Xiphinema americanum,* and the stunt nematode, *Tylenchorhynchus capitatus,* were found at all sites. Several nematodes were identified in only a few plots. The lance nematode, *Hoplolaimus magnistylus,* was found only in a single plot in Hope, and second stage juveniles of an unidentified *Meloidogyne* species were found in three plots at Clinton.

Switchgrass genotypes differed in nematode population densities within every site (Table 2). In general, *Tylenchorhynchus* spp. were the dominant nematode type at all sites (Table 2). At Clinton, ring and stunt nematode densities were similar across all switchgrass genotypes. Relatively low densities of dagger and stubby-root nematodes were found associated with some, but not all, switchgrass genotypes. Low numbers of the spiral nematode, *H. dihystera,* were found in three of four plots of one upland genotype (SU941), and in only one plot each of two other genotypes. Low numbers of lesion nematodes were recovered from the three upland switchgrasses (Caddo, NU942, and SU941), but *Pratylenchus* spp. were not recovered from any lowland gen-

Table 1. Plant-parasitic nematode species associated with five-year-old stands of switchgrass at four sites.

Site	Number of species	Nematode species
Clinton, LA	7	*Xiphinema americanum, Tylenchorhynchus capitatus, Criconemella ornata, Paratrichodorus minor, Pratylenchus* sp.[z], *Helicotylenchus dihystera, Meloidogyne* sp.
Hope, AR	8	*Xiphinema americanum, Tylenchorhynchus capitatus, T. ewingi, Criconemella ornata, Paratrichodorus minor, Pratylenchus zeae, Helicotylenchus digonicus, Hoplolaimus magnistylus*
College Station, TX	3	*Xiphinema americanum, Tylenchorhynchus capitatus, Paratylenchus* sp.
Stephenville, TX	4	*Xiphinema americanum, Tylenchorhynchus capitatus, Criconemella ornata, Paratrichodorus minor*

[z]Some samples of *Pratylenchus*, *Meloidogyne*, and *Paratylenchus* could not be identified to species because of lack of adults.

otype. At College Station, densities of dagger, pin, and stunt nematodes were not statistically different across individual genotypes despite relatively large numeric differences. At Hope, densities of dagger, spiral, and stubby-root nematodes appeared high relative to the other sites, although heterogeneous variances precluded a direct comparison among sites. *Pratylenchus zeae* was found in all of the upland genotypes, but only half of the lowland genotypes. At Stephenville, only the stunt nematode was found associated with all switchgrass genotypes.

Contrasts between switchgrass genotype groups revealed more differences within sites than did the comparison of individual genotypes. There were few differences related to switchgrass ecotype. *Tylenchorhynchus* spp. were more numerous in northern than in southern ecotypes in Hope (860 vs. 438 nematodes/cm^3, respectively, $P < 0.05$), and spiral nematodes were more numerous in southern than in northern ecotypes in Clinton (1 vs. 46 nematodes/cm^3, respectively, $P < 0.05$). Most genotype differences were observed between switchgrass morphological types (Table 3). Lesion nematode numbers were greater in upland than in lowland switchgrass genotypes at Clinton and Hope ($P < 0.05$). Upland genotypes were associated with greater numbers of spiral nematodes at Hope ($P = 0.07$) and Clinton ($P < 0.01$), and lower numbers of *P. minor* ($P < 0.10$) at Hope. Relative population density of stunt nematodes in upland versus lowland switchgrasses was reversed in Hope compared to Stephenville. Soil moisture is the most likely reason for this result. Dry years reduced populations of plant-parasitic nematodes on crested wheatgrass [*Agropyron desertorum* (Fisch. ex Link) Shultes] (Griffin *et al.*, 1988). It is possible that under the limiting moisture conditions at Stephenville, canopy or root characteristics of lowland switchgrasses altered the soil environment in a favorable direction for stunt nematode populations compared to upland switchgrasses. At Hope, where 2001 precipitation was nearly twice that in Stephenville, switchgrass genotypes possibly had less impact on soil environment.

Stand survival and herbage yield of switchgrass genotypes varied within most sites (Table 2). Across all sites, densities of *Helicotylenchus* spp., *Pratylenchus* spp., *C. ornata*, and *X. americanum* were nega-

Table 2. Herbage yield, stand survival, and average nematode population densities per 500 cm³ of soil plus roots in five-year-old stands of nine switchgrass genotypes at four sites.

			Nematode type[x]						
Site/genotype	Yield	Survival	Dagger	Lesion	Ring	Spiral	Stubby	Stunt	Pin
Clinton, LA	kg DM[y]/ha	%	Nematodes/cm³ soil						
Alamo	16011	100	9	0	568	0	118	175	0
SL931	16041	100	84	0	171	5	66	57	0
SL932	15139	100	66	0	284	0	57	468	0
SL941	16781	100	57	0	852	0	0	341	0
NL931	13276	100	0	0	398	0	0	289	0
NL942	15667	100	66	0	739	0	57	459	0
Caddo	0	0	57	5	455	0	5	228	0
NU942	0	0	66	9	341	5	0	171	0
SU941	0	0	9	9	568	227	61	402	0
LSD[z]	2394	0	NS	NS	NS	91	NS	NS	NS
College Station, TX									
Alamo	19994	79	38	0	0	0	0	563	380
SL931	13601	71	56	0	0	0	0	400	1356
SL932	13105	88	0	0	0	0	0	675	1763
SL941	13242	78	18	0	0	0	0	225	525
NL931	11574	71	0	0	0	0	0	525	1055
NL942	14214	64	0	0	0	0	0	1763	42
Caddo	6869	72	5	0	0	0	0	563	225
NU942	6982	71	0	0	0	0	0	150	150
SU941	5746	70	80	0	0	0	0	788	263
LSD	4634	NS	NS	NS	NS	NS	NS	NS	NS
Hope, AR									
Alamo	3902	52	5	5	341	61	114	520	0
SL931	4284	46	227	0	57	0	229	293	0
SL932	3561	42	57	114	114	0	568	298	0
SL941	3098	31	114	0	227	114	118	193	0
NL931	3061	66	118	118	57	61	232	805	57
NL942	3041	42	9	0	114	61	170	512	0
Caddo	2502	16	5	127	284	227	171	1202	0
NU942	1801	33	66	27	284	114	236	923	0
SU941	916	21	171	184	114	232	61	888	0
LSD	NS	17	NS	NS	NS	NS	NS	777	NS

Table 2. (Continued) Herbage yield, stand survival, and average nematode population densities per 500 cm^3 of soil plus roots in five-year-old stands of nine switchgrass genotypes at four sites.

Site/genotype	Yield	Survival	Nematode type[x]						
			Dagger	Lesion	Ring	Spiral	Stubby	Stunt	Pin
Stephenville, TX	kg DM[y]/ha	%	---------- Nematodes/cm^3 soil ----------						
Alamo	10126	98	70	0	398	0	66	482	0
SL931	12124	99	0	0	402	57	66	1187	0
SL932	14746	100	0	5	0	0	57	1102	0
SL941	11447	100	0	0	0	0	9	543	0
NL931	9509	90	61	0	5	0	0	827	0
NL942	11101	89	0	0	180	0	61	1046	0
Caddo	4870	81	9	0	0	0	118	429	0
NU942	5515	75	0	0	227	0	0	307	0
SU941	4654	95	0	0	0	0	0	718	0
LSD	3179	17	NS	NS	NS	NS	NS	NS	NS

[x]Dagger nematode, *Xiphinema americanum*; lance nematode, *Hoplolaimus magnistylus*; lesion nematode, *Pratylenchus* spp.; ring nematode, *Criconemella ornata*; spiral nematode, *Helicotylenchus* spp.; stubby-root nematode, *Paratrichodorus minor*; stunt nematode, *Tylenchorhynchus* ssp.; root-knot nematode, *Meloidogyne* spp.; and pin nematode, *Paratylenchus* spp.

[y]DM = dry matter.

[z]Analysis of variance was conducted using log-transformed data for yield and nematode densities and square-root transformed data for stand survival. Genotype means were separated using Fisher's LSD ($P < 0.05$) with a protection level of $P < 0.05$ for the main effect. All means and LSDs are presented as original arithmetic data.

tively correlated with switchgrass stand survival (r = &0.42, &0.39, &0.24, and -0.17, respectively, df = 141, $P < 0.05$). *Helicotylenchus* spp., *Pratylenchus* spp., and *C. ornata* densities were also negatively correlated with herbage yield across sites (r = &0.28, -0.24, and &0.31, respectively, df =141, $P < 0.01$); however, across-site yield correlations should be interpreted cautiously because switchgrass harvest management was not identical across sites in 2001. Within-site correlation analysis may present a more accurate comparison of nematode/yield/survival relationships. In Clinton, *Helicotylenchus* and *Pratylenchus* spp. densities were negatively associated with stand survival (r = -0.44 and -0.56, respectively, df = 35, $P < 0.01$) and herbage yield (r = -0.44 and -0.57, df = 35, $P < 0.01$). In Hope, *Helicotylenchus* and *Pratylenchus* spp. densities were negatively associated only with stand survival (r = -0.37, $P < 0.05$ and r = -0.28, $P < 0.10$, respectively, df = 35), and *C. ornata* was negatively correlated with herbage yield (r = -0.29, df = 35, $P < 0.06$). Positive correlations were observed between *Tylenchorhynchus* spp. densities and herbage yield in Stephenville (r = 0.48, df = 35, $P < 0.01$) and between *P. minor* densities and herbage yield in Hope (r = 0.33, df = 35, $P < 0.06$).

Lesion nematodes were consistently found associated with upland switchgrass genotypes in Hope and Clinton, although

Table 3. Nematode population densities per 500 cm[3] of soil plus roots in five-year-old stands of switchgrass genotypes of upland (U) or lowland (L) morphological types at four sites.[y]

	Nematode type[z]							
	Dagger	Lance	Lesion	Ring	Spiral	Stubby	Stunt	Pin
Clinton, LA	Nematodes/cm[3] soil							
Upland	44	0	8 a	455	77 a	22	267	0
Lowland	47	0	0 b	502	1 b	50	298	0
Hope, AR								
Upland	80	0	113 a	227	191 c	156 d	1004 a	14
Lowland	88	19	39 b	152	50 d	239 c	437 b	9
College Station, TX								
Upland	31	0	0	0	0	0	532	218
Lowland	17	0	0	0	0	0	704	831
Stephenville, TX								
Upland	3	0	0	76	0	39	485 b	0
Lowland	22	0	1	164	9	43	864 a	0

[y]Analysis of variance was conducted using log-transformed data. Upland and lowland means within locations followed by different letters are significantly different by orthogonal contrast at $P < 0.05$ (a, b) or $P < 0.10$ (c, d). All means are presented as original arithmetic data.

[z]Dagger nematode, *Xiphinema americanum*; lance nematode, *Hoplolaimus magnistylus*; lesion nematode, *Pratylenchus* spp.; ring nematode, *Criconemella ornata*; spiral nematode, *Helicotylenchus* spp.; stubby-root nematode, *Paratrichodorus minor*; stunt nematode, *Tylenchorhynchus* ssp.; root-knot nematode, *Meloidogyne* spp.; and pin nematode, *Paratylenchus* spp.

relatively low nematode populations, coupled with poor condition of the stands, require cautious interpretation regarding cause and effect. In general, literature provides few references to pathogenicity of nematodes for forage grasses. Lesion nematodes have been associated with reduced yield and persistence in some grasses, including root-rot complexes in corn (Jordaan *et al.*, 1987), reduced shoot and root growth of crested wheatgrass (Griffin, 1994), and poor drought resistance of endophyte-free tall fescue (*Festuca arundinacea* Schreb) (West *et al.*, 1988).

Other nematode types that were associated with poor switchgrass persistence or yield in this trial were dagger, spiral, and ring nematodes. Spiral and ring nematodes can damage turfgrasses and cereals (Bernard *et al.*, 1998). Ingham and Detling (1990) reported that yield of little bluestem increased when *Helicotylenchus* and *Paratylenchus* spp. populations were reduced with nematicides, although Bernard *et al.* (1998) reported that some host plants can tolerate large populations of *Paratylenchus* spp. without damage. Root productivity was reduced in a mixed prairie when nematode populations included *X. americanum* (Ingham and Detling, 1984).

Stunt, lance, stubby-root, pin, and root-knot nematodes were not associated with stand decline or yield depression in this trial even when found in relatively large numbers. *Tylenchorhynchus* spp. generally cause little damage to grasses (Bernard *et al.*, 1998), but have been associated with reduced yield in sideoats grama [*Bouteloua curtipendula* (Michaux) Torrey] (Ingham and Detling, 1986), western wheatgrass, and buffalograss [*Buchloe dactyloides* (Nutt.) Engelm.] (Smolik, 1982). Pathogenicity of *Hoplolaimus magnistylus* to grass hosts is unknown, but *H. galeatus* reproduces on orchardgrass (*Dactylis glomerata* L.) and tall fescue (McGlohon *et al.*, 1961), and several grass species have been demonstrated as good hosts for *Meloidogyne* spp. (Griffin *et al.*, 1984).

In this survey, numerous species of plant-parasitic nematodes were found in association with switchgrass grown in the South Central region of the United States. Although in its native range this prairie grass species has generally been characterized by a lack of reported soil disease or nematode problems, environmental or edaphic conditions in the southern United States and more intensive management for maximum biomass production may increase its vulnerability to nematodes or other pathogens that are of only minor significance in cooler, drier environments. The possible relationship between plant-parasitic nematodes and switchgrass persistence and yield merits further research.

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