Nematodes Associated with Sorghum in Mississippi

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ABSTRACT

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Soil and root samples were collected in 16 Mississippi counties from fields with a cropping history to sorghum. Species of 14 free-living and nine plant-parasitic genera were found. *Pratylenchus zeae* and *Quinisulcius acutus* were the most commonly recovered plant-parasitic nematodes from sorghum. A significant negative correlation occurred between *P. zeae* populations and soil pH and percent base saturation. A highly significant positive correlation occurred between *P. zeae* and total nematode populations. Correlations of soil phosphorus and potassium were both positive and highly significant in relation to population levels of *Q. acutus*.

Sorghum (*Sorghum bicolor* (L.) Moench) is one of the five most important grains worldwide. It is grown on about 44 million hectares throughout the world in areas where the average summer temperature is higher than 22 C. Grain production is estimated at 69 million metric tons per year (12,17).

Grain production in the United States has increased during the past decade. Sorghum grain production in Mississippi was about 315,000 t in 1983, a 79% increase over 1982 production. Harvested area was 89,000 ha in 1983; average yield was 0.58 t/ha (1). Forecasts indicate that sorghum acreage will continue to increase.

Increased planting of grain sorghum in Mississippi has increased insects, nematodes, and bacterial and fungal pathogens. Stand failure caused by seedborne and soilborne fungi is a problem. Plant-parasitic nematodes cause irregular plant stands and limit grain sorghum production (2–4,10,11,18, 19,21,24). Estimated losses caused by nematodes on grain sorghum throughout the United States were 6% in 1970 (23). Mississippi sorghum value losses caused by diseases and nematodes were estimated at $1 million in 1982 (D. J. Blasingame and C. C. Baskin, *personal communication*). Little is known, however, about the number and kinds or economic importance of nematodes on sorghum in the state. This study is part of an effort to determine the distribution and frequency of occurrence of nematodes in sorghum-producing areas of Mississippi.

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MATERIALS AND METHODS

Twenty-seven fields comprising 125 ha in 16 Mississippi counties were assayed for nematodes between August and October 1982 (Fig. 1). Large fields were divided into sections (6–7 ha) for sampling. Four root and soil subsamples taken at random within each section per field were combined to form one sample. Each subsample consisted of 10–15 g of roots and 200–300 cc of soil from the root zone of an individual plant. Samples were collected from fields where sorghum had grown for at least two consecutive years.

Nematodes were extracted from 250 cc of soil by a combination of sieving and screening methods (8). The shaker-incubation method described by Bird (5) was used to extract endoparasitic nematodes from 4 g of root tissue. Nematode species were identified with a compound microscope and counted with a stereomicroscope. Soil analyses were made at the Soil Testing Laboratory, Mississippi Cooperative Extension Service. Correlations were determined for soil pH, cation exchange capacity, percent base saturation, phosphorus

Table 1. Plant-parasitic nematodes recovered from 27 grain sorghum fields in Mississippi

Nematode	Absolute frequency (%)		Absolute density[a]		Absolute density[b]		Relative density (%)[c]	
	Soil	Root	Soil	Root	Soil	Root	Soil	Root
Pratylenchus zeae	93[d]	78[d]	465	1067	430	830	40	98
Quinisulcius acutus	78	4	467	133	363	5	33	1
Helicotylenchus dihystera	70	7	249	25	175	2	16	0
Tylenchorhynchus martini	30	4	219	17	65	1	6	0
Xiphinema americanum	19	4	113	17	20	1	2	0
Hoplolaimus galeatus	26	22	64	54	14	8	1	1
Meloidogyne spp.	26	7	55	34	14	3	1	0
Criconemella xenoplax	4	4	33	33	7	1	1	0
Rotylenchulus reniformis	4	0	50	0	2	0	0	0

[a] Average number of each nematode in samples in which found.
[b] Average number of each nematode found in all samples.
[c] Number of a particular species relative to mean number for all species.
[d] Numbers represent extractions from 250 cc of soil or 4 g of roots.

Table 2. Correlation matrices for pH, cation exchange capacity, percent base saturation, phosphorus, potassium, *Pratylenchus zeae, Quinisulcius acutus*, and total nematode populations in sorghum production fields surveyed in Mississippi in 1982[a]

	CEC	% BS	P	K	*P. zeae*	*Q. acutus*	TN
pH	−0.51*[b]	0.92**	0.11	0.01	−0.47*	0.10	−0.30
CEC	...	−0.32	−0.09	0.05	0.10	−0.10	−0.10
% BS	...	...	0.26	0.07	−0.45*	0.30	−0.21
P	...	...	...	0.83**	−0.16	0.89**	0.31
K	...	...	...	...	−0.06	0.65**	0.41
P. zeae	...	...	...	...	...	−0.23	0.81**
Q. acutus	...	...	...	...	...	...	0.22

[a] CEC = cation exchange capacity, % BS = percent base saturation, P = phosphorus, K = potassium, and TN = total nematode populations.
[b] * = Significant at $P = 0.05$ and ** = significant at $P = 0.01$.

concentration, potassium concentration, and nematode populations.

RESULTS

Twenty-three nematode genera were associated with grain sorghum from the 16 Mississippi counties surveyed. Free-living nematodes included *Acrobeles* sp., *Aphelenchoides* sp., *Aphelenchus avenae, Diplogaster* sp., *Diphtherophora* sp., *Dorylaimus* sp., *Malenchus* sp., *Mononchus* sp., *Nothotylenchus* sp., *Pseudhalenchus* sp., *Psilenchus* sp., *Rhabditis* sp., *Tylencholaimus* sp., and *Tylenchus* sp.

Nine plant-parasitic nematode genera were recovered (Table 1). *Pratylenchus zeae* and *Quinisulcius acutus* were the most abundant and commonly recovered. *P. zeae* was the only nematode with a higher relative density in root samples (98%) than in soil samples (40%); populations averaged 430 nematodes per 250 cc of soil and 830 nematodes per 4 g of root. *P. zeae* was found in all 16 counties surveyed. *Q. acutus* populations averaged 363 nematodes per 250 cc of soil and five nematodes per 4 g of root tissue. *Q. acutus* was found in all counties except Panola and Pearl River.

Numbers of *P. zeae* and *Q. acutus* extracted from soil and roots appeared to be related to severity of disease development. Disease symptoms included poor root system development and a reddish discoloration of the cortex and vascular tissue. Most of the finer roots were destroyed and a stubby root condition developed. Stunted plants were easily pulled from the ground.

The seven remaining plant-parasitic nematode genera were not recovered in all counties. *Helicotylenchus dihystera* was not found in Jefferson, Panola, and Pearl River counties. *Tylenchorhynchus martini* was identified in Calhoun, Hinds, Jasper, Jefferson Davis, Leake, Newton, Oktibbeha, and Rankin counties. *Xiphinema americanum, Hoplolaimus galeatus, Meloidogyne* spp., and *Criconemella xenoplax* were all recovered from samples taken in Tate County. *Meloidogyne* spp. were also present in Carroll, Hinds, Jefferson Davis, Leake, and Rankin counties. *X. americanum* and *C. xenoplax* were present in isolated Pearl River County samples, with the former occurring also in Calhoun and Panola counties and the latter in Jefferson Davis County. Carroll County was the only other county from which *H. galeatus* was recovered, and *Rotylenchus reniformis* was found only in Hinds County.

Highest nematode population densities were found in soils in Hinds, Newton, Tate, and Noxubee counties that were characterized by pH values of 5.5, 7.1, 5.1, and 5.7, respectively. *P. zeae* was found most frequently in acid and neutral soils. There was a significant negative correlation between soil pH and *P. zeae* populations (Table 2). This same relationship existed in the case of percent base saturation, whereas a highly significant positive correlation occurred between total nematode and *P. zeae* populations. Correlations of soil phosphorus and potassium were both positive and highly significant in relation to population levels of *Q. acutus*.

Fig. 1. Sorghum production fields by county surveyed for nematodes in 1982 in Mississippi.

DISCUSSION

Many sorghum plants in fields infested with *P. zeae* and *Q. acutus* were reduced in growth. These results are similar to those reported previously for sorghum (4) and for such related crops as sugarcane (22), maize (13), and wild grasses (15); however, previous studies have not reported the high incidence of concomitant populations of *P. zeae* and *Q. acutus* reported in this paper. The other phytoparasitic nematodes isolated from sorghum in this study may be responsible for additional crop pressure.

Analyses of soil samples from the various counties revealed a number of relationships between soil characters and nematode populations. Other investigators have reported that *Pratylenchus* spp. prefer acid soils (4,6,14). *P. zeae*, considered one of the more virulent nematodes recovered, was negatively correlated with soil pH in this study.

The high frequency of occurrence of *Q. acutus* where phosphorus and potassium levels were high indicates that these elements may favor increased population densities. Conditions favorable for development of the plant root system may enhance the capability of this nematode to attack the host, or such conditions may provide abundant, readily available food for the nematode (16). Another possible explanation for high nutrient levels in soils heavily infested with nematodes is decreased efficiency of nutrient utilization by infected plants (7). Rodríquez-Kábana and Collins (20) found populations of *H. dihystera* and *Trichodorus christei* were favorably influenced by fertilizer application of major elements. Eguiguren et al (9) reported decreased populations of *Criconemoides* sp. and *Trichodorus* sp. for 60 days after application of high organic nitrogen (urea) and phosphorus. Reported differences in nematode populations in response to soil fertility may be due to several factors acting alone or in combination, such as crop condition, physical environment, time of sampling, and/or competing organisms.

The widespread and frequent occurrence of *P. zeae* and *Q. acutus* in Mississippi sorghum fields suggests that these nematodes are involved in an observed sorghum root disorder. Pathogenicity studies are under way to determine the relationship between these two nematodes and their relative impact on grain sorghum production.

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