PLANT-PARASITIC NEMATODES ASSOCIATED WITH HORSERADISH IN ILLINOIS

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ABSTRACT

Walters, S. A., J. P. Bond, M. Babadoost, D. I. Edwards, and Z. A. Handoo. 2004. Plant-parasitic nematodes associated with horseradish in Illinois. Nematropica 34:191-197.

Eight genera of plant-parasitic nematodes (with seven identified to species) were identified from Illinois horseradish production fields in 1999, 2000, 2001, and 2003 and included *Helicotylenchus pseudorobustus*, *Hoplolaimus galeatus*, *Meloidogyne* spp., *Paratylenchus projectus*, *Pratylenchus sefaensis*, *Quinisulcius acutus*, *Tylenchorhynchus annulatus*, and *Xiphinema americanum*. *Pratylenchus sefaensis* is reported in Illinois for the first time. *Helicotylenchus pseudorobustus*, *P. sefaensis*, *T. annulatus*, and *X. americanum* are the most prevalent plant-parasitic nematodes associated with horseradish in southern Illinois at the present time, as these nematodes respectively occurred in 70%, 63%, 56%, and 39% of samples collected from horseradish fields during the four growing seasons. Other nematode genera identified usually occurred at low population densities. There are no established damage threshold levels for plant-parasitic nematodes in horseradish, but it appears that population densities are currently not high enough to be considered a threat to horseradish production in Illinois.

Key words: Armoracia rusticana, *Helicotylenchus pseudorobustus*, *Hoplolaimus galeatus*, horseradish, *Meloidogyne* spp., *Paratylenchus projectus*, *Pratylenchus sefaensis*, *Quinisulcius acutus*, survey, *Tylenchorhynchus annulatus*, *Xiphinema americanum*.

RESUMEN

Walters, S. A., J. P. Bond, M. Babadoost, D. I. Edwards, y Z. A. Handoo. 2004. Nemátodos parásitos de plantas asociados con rábano picante en Illinois. Nematropica 34:191-197.

Ocho genera de nemátodos parasíticos de plantas fueron identificados (con siete a nivel de especie) de campos de producción de rábano picante en Illinois en 1999, 2000, 2001 y 2003, e incluyeron *Helicotylenchus pseudorobustus*, *Hoplolaimus galeatus*, *Meloidogyne* spp., *Paratylenchus projectus*, *Pratylenchus sefaensis*, *Quinisulcius acutus*, *Tylenchorhynchus annulatus* y *Xiphinema americanum*. Se reporta *Pratylenchus sefaensis* en Illinois por la primera vez. Presentemente, *Helicotylenchus pseudorobustus*, *P. sefaensis*, *T. annulatus* y *X. americanum* son los nemátodos parasíticos de plantas más prevalecientes asociados con rábano picante en el Sur de Illinois, ocurriendo en 70%, 63%, 56% y 39%, respectivamente, de las muestras colectadas de campos de rábano picante durante las cuatro estaciones de cultivo. Otras genera de nemátodos normalmente ocurrieron a densidades de población más bajas. No hay umbrales de daño establecidos para nemátodos parásitos de plantas en rábano picante, pero parece que las densidades de las populaciones actuales no son bastante altas para ser consideradas como una amenaza a la producción de rábano picante en Illinois.

Palabras clave: Armoracia rusticana, *Helicotylenchus pseudorobustus*, *Hoplolaimus galeatus*, *Meloidogyne* spp., muestreo, *Paratylenchus projectus*, *Pratylenchus sefaensis*, *Quinisulcius acutus*, rábano picante, *Tylenchorhynchus annulatus*, *Xiphinema americanum*.

INTRODUCTION

Horseradish (*Armoracia rusticana* Gaertn., Mey., Scherb.) is grown for its white, fleshy, and pungent roots. Illinois is the leading producer of horseradish grown in the U.S., supplying over 50% of the U.S. demand (Eastburn and Chang, 1994; Rhodes, 1977), with the majority of the horseradish sold to and utilized by commercial condiment processors. Most of the horseradish production in Illinois can be found in the Mississippi River Valley region adjacent to East St. Louis. Approximately 600 ha are grown with annual farm gate value exceeding $5 million (Eastman, 2001). Little is known about the association of plant parasitic nematodes with horseradish. Although Kadow and Anderson (1940) discussed diseases caused by nematodes in horseradish, there is no recently published report on the association of plant-parasitic nematodes and horseradish. The purpose of this study was to determine the plant-parasitic nematodes that are associated with horseradish in Illinois.

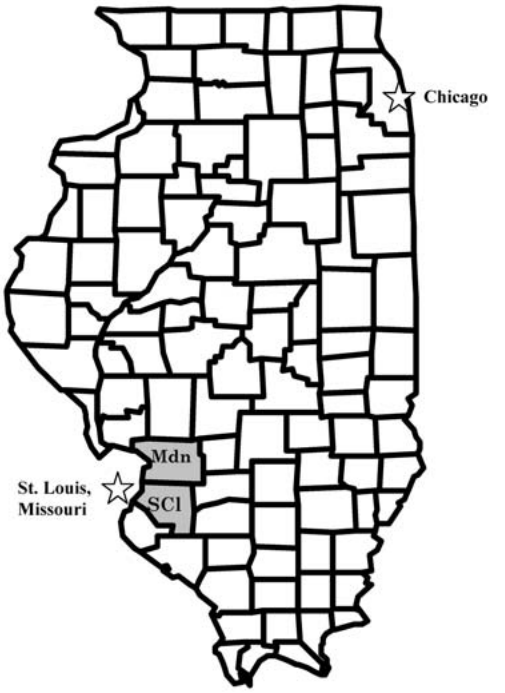

Fig. 1. Counties sampled that include most of commercial horseradish production in Illinois. Mdn = Madison County and SCl = St. Claire County.

MATERIALS AND METHODS

Soil samples were collected from various horseradish fields in southern Illinois during 1999 (10 collected in August), 2000 (seven collected in July), 2001 (seven collected in July and 10 collected in September), and 2003 (10 collected in October). Most of the same fields that were sampled in 1999, 2000, and 2001 were again sampled in 2003 to determine the predominant nematode species. Soil types on the selected fields varied in texture with sandy loam, silt loam, silty clay loam, and clay loam soils being represented (Goddard and Sabata, 1986; Wallace, 1978). Madison and St. Claire counties have most of the horseradish production in Illinois and were included in the survey (Fig. 1).

The collected soil samples were placed in plastic bags, and stored at 4 C until processed. Each sample was a composite of 20 soil cores (2.5-cm-dia. × 30-cm long) randomly collected from each field. Nematodes were extracted from 100 cc subsamples by wet sieving through nested 250-µm-pore and 37-µm-pore sieves followed by sugar flotation and centrifugation (Jenkins, 1964). Plant-parasitic nematodes from the soil samples were identified to genus (1999, 2000, and 2001) or species (2003) and enumerated using an inverted compound microscope.

In 2003, nematodes were fixed in hot 3% formaldehyde solution, with some fixed specimens processed to anhydrous glycerine (Seinhorst, 1959) and examined under a compound microscope for species

identification. Nematode identifications were based on the morphology of adult and larval forms and their identities were confirmed with recent taxonomic keys (Eisenback *et al.*, 1981; Handoo, 2000; Handoo and Golden, 1989, 1992; Mullin *et al.*, 1996; Raski, 1975; Sher, 1966).

RESULTS

1999 Survey

Helicotylenchus spp., *Hoplolaimus* spp., *Pratylenchus* spp., *Tylenchorhynchus* spp., and *Xiphinema* spp. were identified in soil samples and averaged 62, 2, 44, 107, and 3 per 100 cc soil, respectively (Table 1). However, only three genera, *Helicotylenchus*, *Pratylenchus* and *Tylenchorhynchus* were identified in all samples collected (Table 1).

2000 Survey

Only *Helicotylenchus* spp. and *Xiphinema* spp. were identified from soil samples (Table 1). Most samples had low densities, and only one, a sample from Caseyville, Ill., had a relatively high density of *Helicotylenchus* spp. (394/100 cc soil).

2001 Survey

Seven genera of plant-parasitic nematodes were identified from soil samples: *Helicotylenchus*, *Hoplolaimus*, *Meloidogyne*, *Paratylenchus*, *Pratylenchus*, *Tylenchorhynchus*, and *Xiphinema*. Population densities of *Helicotylenchus* spp. and *Tylenchorhynchus* spp. were the highest, although *Pratylenchus* spp. were found with greater frequency (Table 1). Two fields at Caseyville, Ill. and one at Washington Park, Ill. had >250 *Tylenchorhynchus* spp. per 100 cc of soil. Four fields (one at Collinsville, Ill. and three at Caseyville, Ill.) had >150 *Helicotylenchus* spp. per 100 cc of soil. *Xiphinema* spp. population densities were low in most fields, except for a field at Caseyville, Ill. that had 189 nematodes per 100 cc soil. Three fields had low densities of *Meloidogyne* spp.; however, plant symptoms diagnostic of root-knot infection (e.g., root galling) were not observed. *Paratylenchus* spp. and *Hoplolaimus* spp. were also identified in several fields at low population densities.

2003 Survey

Seven species and one genus of plant-parasitic nematodes were documented from soil samples: *Helicotylenchus pseudorobustus*, *Hoplolaimus galeatus*, *Meloidogyne* spp., *Paratylenchus projectus*, *Pratylenchus sefaensis*, *Quinisulcius acutus*, *Tylenchorhynchus annulatus*, and *Xiphinema americanum* (Table 2). *Helicotylenchus pseudorobustus* and *Pratylenchus sefaensis* were detected at the highest population densities, while all other species identified were <10 nematodes per 100 cc soil. *Tylenchorynchus annulatus* was identified in all fields sampled although at relatively low population densities. Other species identified included *H. galeatus*, *Meloidogyne*, *P. projectus*, *Q. acutus*, and *X. americanum* and population densities of these nematode species were very low in most fields.

DISCUSSION

Helicotylenchus pseudorobustus, *P. sefaensis*, *T. annulatus*, and *X. americanum* are the most prevalent plant-parasitic nematodes associated with horseradish in southern Illinois at the present time, as these nematodes respectively occurred in 70%, 63%, 56%, and 39% of samples collected from horseradish fields over the four growing seasons (data not presented).

Population densities of *T. annulatus* were often the highest among the nematodes identified from the horseradish fields. However, it is common to find high populations of *T. annulatus* in soil types

Table 1. Population densities of plant parasitic nematode genera associated with horseradish in Illinois during 1999, 2000, and 2001 growing seasons.[y]

Year/Location[z]	*Helicotylenchus* spp.	*Hoplolaimus* spp.	*Meloidogyne* spp.	*Paratylenchus* spp.	*Pratylenchus* spp.	*Tylenchorhynchus* spp.	*Xiphinema* spp.
1999							
Edwardsville	19	0	0	0	14	99	11
Granite City	8	0	0	0	36	131	0
Granite City	113	12	0	0	22	39	4
St. Jacob	11	0	0	0	19	198	0
Collinsville	15	0	0	0	135	34	7
Collinsville	13	0	0	0	38	266	0
Caseyville	54	0	0	0	28	52	0
Washington Park	6	1	0	0	72	64	1
Fairview Heights	371	2	0	0	36	31	4
Collinsville	8	0	0	0	40	156	0
Mean	62	2	0	0	44	107	3
2000							
East St. Louis	0	0	0	0	0	0	0
East St. Louis	10	0	0	0	0	0	0
Washington Park	0	0	0	0	0	0	19
Washington Park	0	0	0	0	0	0	38
Caseyville	0	0	0	0	0	0	0
Caseyville	48	0	0	0	0	0	10
Caseyville	394	0	0	0	0	0	0
Mean	65	0	0	0	0	0	10
2001							
East St. Louis	25	0	0	0	0	0	0
East St. Louis	25	0	8	0	0	0	0
East St. Louis	41	0	0	0	0	0	0
East St. Louis	0	0	0	8	8	0	0
East St. Louis	0	0	0	0	0	0	0
East St. Louis	0	0	0	8	0	0	0
Collinsville	0	0	0	0	25	0	0
Collinsville	0	0	0	0	8	0	0
Collinsville	173	0	25	8	25	16	8
Washington Park	0	33	16	8	16	25	0
Washington Park	0	0	8	0	57	254	8
Washington Park	8	0	0	131	25	0	0
Caseyville	0	0	0	0	16	328	0
Caseyville	0	0	0	0	16	385	0
Caseyville	230	0	0	0	0	98	0
Caseyville	205	0	0	0	0	0	189
Caseyville	287	0	0	0	0	0	57
Mean	58	2	3	10	12	65	15

[y]Plant-parasitic nematodes were identified to genus. Numbers represent nematodes per 100 cc soil.
[z]Collinsville, Edwardsville, Granite City, and St. Jacob are in Madison County, Ill.; and Caseyville, Washington Park, Fairview Heights, and East St. Louis are in St. Claire County, Ill.

Table 2. Plant parasitic nematode species associated with horseradish in Illinois during 2003.[y]

Location[z]	*Helicotylenchus pseudorobustus*	*Hoplolaimus galeatus*	*Meloidogyne* spp.	*Paratylenchus projectus*	*Pratylenchus sefaensis*	*Quinisulcius acutus*	*Tylenchorhynchus annulatus*	*Xiphinema americanum*
East St. Louis	35	3	0	4	23	0	12	5
East St. Louis	20	31	10	0	15	0	12	0
East St. Louis	133	0	0	22	70	2	0	3
East St. Louis	0	0	0	20	90	0	5	0
East St. Louis	25	0	0	0	21	0	11	11
East St. Louis	25	0	0	0	31	32	17	12
Caseyville	25	0	0	0	65	13	12	0
Caseyville	10	0	0	0	33	4	7	0
Caseyville	5	0	0	0	18	6	5	0
Caseyville	13	0	0	3	18	8	20	0
Mean	28	3	1	5	38	7	10	3

[y]Plant-parasitic nematodes were identified to species. Numbers represent nematodes recovered per 100 cc soil.
[z]Caseyville and East St. Louis are in St. Claire County, Ill. Identical fields were sampled as in previous years (1999, 2000, and 2001).

typical of those collected from horseradish fields, as horseradish is generally included in a corn and/or soybean rotation. In Illinois, damage thresholds for *T. annulatus* have not been established; however, in South Carolina, damage threshold densities for *Tylenchorhynchus* spp. per 100 cc of soil are >500 and >700 for corn and soybean, respectively (Dickerson *et al.*, 2000). The population densities in all fields were well below what is needed to damage corn or soybeans (Table 1). However, the damage threshold levels are much lower for other root crop vegetables such as turnip, which is closely related to horseradish. Greater than 150 to 200 *Tylenchorhynchus* per 100 cc soil will inflict severe damage to this vegetable crop (Dickerson *et al.*, 2000), and several horseradish fields had densities above this threshold (Tables 1 and 2).

Helicotylenchus pseudorobustus was found in a greater percentage of horseradish fields as compared to *T. annulatus* over the four years (data not presented). However, in most instances, populations of *H. pseudorobustus* rarely exceeded the damage thresholds given for many other crops (Dickerson *et al.*, 2000; Anonymous, 2004).

Pratylenchus sefaensis was detected in 63% of the horseradish fields sampled (data not presented). This is the first report of *P. sefaensis* in Illinois. In most instances, densities of *Pratylenchus sefaensis* in the soil were below 100 juveniles per cc of soil (Tables 1 and 2). However, accurate root populations were not determined. Crop damage to other related Brassicaceae crops, such as turnip, occurs when populations of *Pratylenchus* spp. are >100 per 100 cc soil (Dickerson *et al.*, 2000; Anonymous, 2004).

Population densities of *Xiphinema americanum* in most instances were low (Tables 1 and 2); although, this nematode was found in 39% of fields over the four years (data not presented). For many crops, population densities exceeding 100 per 100 cc soil has the potential to inflict severe damage (Anonymous, 2003), as *Xiphinema americanum* transmits several plant viruses (Dickerson *et al.*, 2000; Hewett *et al.*, 1958; Jones *et al.*, 1991).

The other plant-parasitic nematodes identified from soil samples had relatively

low population densities. Although low population densities of *Meloidogyne* spp. were found at the time of sampling, this nematode has potential to cause severe damage to horseradish (Kadow and Anderson, 1940). *Paratylenchus projectus*, *Hoplolaimus galeatus*, and *Quinisulcius acutus* were also identified in several fields at low population densities, and probably do not pose a threat to horseradish production. There are no established quantitative levels to determine damage thresholds for nematodes in horseradish. However, based on the generalized population thresholds for damage by nematodes for other crops (Dickerson *et al.*, 2000 Anonymous, 2004), it appears that nematode densities are currently not high enough to be considered a direct threat to horseradish production in Illinois.

Even though most nematodes were found at low densities, they still have potential to cause yield loss via interactions with other pathogens (Powell, 1971). The interactions of plant-parasitic nematodes with other organisms in plant disease complexes such as soil-borne fungi, particularly *Verticillium* species, which has been shown to cause internal root discoloration of horseradish (Chen *et al.*, 2001; Eastburn and Chang, 1994) needs to be investigated. Further studies may reveal interactions of plant-parasitic nematodes with other soil-borne pathogens that play some role in the root discoloration of horseradish.

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