

Plant-parasitic Nematodes in Maine Agricultural Soils

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Abstract: In a survey of plant-parasitic nematodes associated with agricultural crops in nine Maine counties, 744 soil samples from 26 potential host plants were analyzed between November 1987 and January 1989. The most commonly encountered nematode genus was *Pratylenchus*, occurring in 85% of the samples from most crops, except blueberries and onions. *Pratylenchus penetrans* and *P. crenatus* were found commonly as species mixtures, with *P. penetrans* composing 40–80% of the mixture. *Meloidogyne hapla* was encountered in 16% of the samples in four counties, generally in potato rotations. Other nematodes encountered were *Aphelenchoides* spp., *Criconebella curvatum*, *Ditylenchus* spp., *Helicotylenchus pseudorobustus*, *H. digonicus*, *Heterodera trifolii*, *Paratylenchus projectus*, *Trichodorus* spp., *Tylenchorhynchus maximus*, and *Xiphinema americanum*. Potato fields were the most heavily sampled and thus weighted the statewide results.

Key words: *Aphelenchoides* sp., *Criconebella curvatum*, *Helicotylenchus digonicus*, *Helicotylenchus pseudorobustus*, *Heterodera trifolii*, *Meloidogyne hapla*, survey, *Pratylenchus crenatus*, *Pratylenchus penetrans*, *Pratylenchus projectus*, *Trichodorus* sp., *Tylenchorhynchus maximus*, *Xiphinema americanum*.

A survey of potatoes (*Solanum tuberosum* L.) grown in the New Brunswick and Prince Edward Island areas of northeastern Canada indicated that several plant-parasitic nematode species were associated with potatoes in northern climates (6,7). This survey prompted the Division of Plant Industry, Maine Department of Agriculture, to request a survey to determine if similar genera also occurred in the major agricultural areas of Maine.

Early surveys conducted in the state identified some species of plant-parasitic nematodes and their host associations (8,9). A later survey identified plant-parasitic nematodes only to genus (12). This study was undertaken to provide more extensive information on the distribution of genera and species of plant-parasitic nematodes now occurring in agricultural soils of Maine.

MATERIALS AND METHODS

Counties were sampled by personnel from the Division of Plant Industry, USDA, University of Maine Cooperative Extension Service, and the Soil and Water Con-

servation Service. The suggested sample size was 10–12 soil cores taken at random from the sampled area. Agents sampled fields of interested growers and areas with undiagnosed plant health problems. The size of the sampled area varied, depending upon the crop and field size. A survey form supplied with each sample kit requested information on name, date, location, present and previous crops and cultivars, and soil-applied insecticide usage. Soil samples were put into plastic bags and sealed in boxes for shipment by private carrier to the Nematology Laboratory, USDA ARS, Beltsville Agricultural Center, Beltsville, Maryland. Samples were discarded if the time from collection to processing was more than 26 days.

Samples were collected in October 1987 and between May and November 1988. Samples were processed promptly upon receipt by centrifugation–flotation (5) of a 100-g subsample. Identification to genus and nematode counts were made on a stereomicroscope. Species identifications were verified by Dr. A. M. Golden, USDA ARS, Beltsville, Maryland. *Meloidogyne* spp. were propagated in the greenhouse on tomato (*Lycopersicon esculentum* Mill. cv. Rutgers) for 45 days to obtain perineal patterns for species verification. Representative samples of nematodes from each county were preserved in 3% formalin and deposited in the USDA Nematode Collection in Beltsville.

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TABLE 1. Mean number and highest count (both per 100 cm³) and frequency of occurrence (% of samples containing the nematode) of genera of plant-parasitic nematodes in agricultural soils of Maine classified by county.

County	Samples (N)	<i>Pratylenchus</i>			<i>Meloidogyne</i>			<i>Paratylenchus</i>		
		Mean	High	%	Mean	High	%	Mean	High	%
Aroostook	693	64	798	85	7	448	17	3	123	15
Penobscot	15	25	88	87	0	0	0	2	18	13
Lincoln	10	136	441	100	2	18	10	1	7	10
Cumberland	8	28	84	100	0	0	0	9	32	50
Androscoggin	6	33	63	83	0	0	0	0	0	0
Sagadahoc	5	58	105	100	0	0	0	0	0	0
York	4	14	53	50	2	6	25	1	4	25
Kennebec	2	24	28	100	0	0	0	37	42	100
Oxford	1	0	0	0	42	42	100	7	7	100
Total	744	63	798	86	6	448	16	3	123	15

† Trace (mean < 0.5 nematodes/100 cm³).

In addition to potato, other crops sampled were apple (*Malus domestica* Borkh.), oat (*Avena sativa* L.), raspberry (*Rubus strigosus* Michaux), strawberry (*Fragaria chiloensis* L. Duchesne × *F. virginiana* Duchesne), pea (*Pisum sativum* L.), cabbage (*Brassica oleracea* var. *capitata* L.), rutabaga (*Brassica napus* var. *napobrassica* L.), corn (*Zea mays* L.), tomato, clover (*Trifolium pratense* L.), radish (*Raphanus sativus* L.), onion (*Allium cepa* L.), parsnip (*Pastinaca sativa* L.), cucumber (*Cucumis sativus* L.), pumpkin (*Cucurbita pepo* L.), cantaloupe (*Cucumis melo* L.), zucchini (*Cucurbita pepo* L.), squash (*Cucurbita pepo* L.), pepper (*Capsicum annuum* L.), rye (*Secale cereale* L.), blueberry (*Vaccinium angustifolium* Ait.), and iris (*Iris* sp. L.). Also sampled were mixed conifers (species unknown), hardwoods (species unknown), and forage grasses. The nine counties sampled were Aroostook, Penobscot, Lincoln, Cumberland, Androscoggin, Sagadahoc, York, Kennebec, and Oxford (Fig. 1). The agricultural soil catenas in Aroostook county consist of mainly Caribou-Conant associations, which have a gravelly loam to silt loam texture, with some Easton-Perham-Diagle soil associations (13,14).

RESULTS AND DISCUSSION

The mean number of nematodes per sample, highest individual counts, and fre-

quency of occurrence of plant-parasitic nematodes in Maine counties are summarized (Table 1). Potato fields were the most heavily sampled and thus weighted the statewide results. The mean numbers of nematodes collected are also summarized by sampling time and crop (Table 2). All samples outside of Aroostook county were collected in June 1988. Since May and June samples were taken relatively early in the season, frequency of occurrence and population density may have been influenced by cropping history.

Pratylenchus spp. were the most common plant-parasitic nematodes in agricultural soils (Table 1). They were found in soil samples from all crops sampled, except blueberry and onion, and in all counties, except Oxford which was sampled in only one location. Mixed populations of *P. penetrans* (Cobb) Filipjev & Schuurmans-Stekhoven and *P. crenatus* Loof occurred in most samples, with *P. penetrans* constituting 40–80% of the individuals. Together with *Verticillium dahliae* Kleb., *P. penetrans*, but not *P. crenatus*, causes the potato early dying syndrome (10), which may be a threat in the potato growing areas of Maine. This *Pratylenchus* spp. complex is similar to those associated with potato in Prince Edward Island and New Brunswick (1,6,7).

Meloidogyne hapla Chitwood was found in four counties in potato rotations, in apple orchards, and in one sample from Lincoln

TABLE 1. Extended.

<i>Helicotylenchus</i>			<i>Criconebella</i>			<i>Tylenchorhynchus</i>			<i>Xiphinema</i>		
Mean	High	%	Mean	High	%	Mean	High	%	Mean	High	%
1	123	3	1	168	7	T†	32	2	0	0	0
0	0	0	3	18	27	7	67	27	1	18	7
24	238	10	1	7	20	0	0	0	7	67	10
16	53	38	44	140	75	16	67	50	20	112	62
21	98	33	224	686	100	40	182	83	16	98	20
0	0	0	1	7	20	3	14	20	0	0	0
6	21	50	6	11	75	4	18	25	12	28	50
7	14	50	107	172	100	11	18	100	0	0	0
214	214	100	0	0	0	0	0	0	18	18	100
2	238	4	4	686	10	1	182	4	1	112	1

county, a corn-corn-rye rotation sequence. Although not as widespread as *P. penetrans*, this nematode causes concern because of its high degree of pathogenicity (11).

Paratylenchus projectus Jenkins and an un-

described *Paratylenchus* species were widespread throughout the agricultural soils of the state. The highest count was 123/100 cm³ on potato in July. *Paratylenchus projectus* is widespread in northeastern Canada

TABLE 2. Mean number (per 100 cm³) of plant-parasitic nematode genera in agricultural soils of Maine categorized by date and crop.

Crop	Samples (N)	<i>Pratylenchus</i>	<i>Meloidogyne</i>	<i>Paratylenchus</i>	<i>Helicotylenchus</i>	<i>Criconebella</i>	<i>Tylenchorhynchus</i>	<i>Xiphinema</i>
October 1987								
Potato	241	36	6	1	T†	T	T	0
May 1988								
Potato	23	87	4	1	T	1	0	0
June 1988								
Potato	135	47	2	2	2	2	T	0
Apple	14	39	3	9	51	122	28	25
Oat	8	23	0	1	0	2	0	0
Raspberry	5	28	0	11	1	3	3	7
<i>Curcubita</i> spp.	5	21	0	0	0	2	1	1
Strawberry	4	38	0	1	0	2	0	0
Hay, clover	4	43	0	6	31	42	0	0
<i>Brassica</i> spp.	4	26	0	0	8	26	12	4
Pea	3	41	0	0	0	7	4	0
Tomato, pepper	3	25	0	0	0	0	0	0
July 1988								
Potato	31	69	1	21	0	4	1	0
August 1988								
Potato	19	98	8	1	0	0	0	0
October 1988								
Potato	202	104	13	3	1	1	T	0
Oat	5	244	6	4	0	0	0	0
November 1988								
Potato	21	44	0	2	0	0	0	0
Oat	3	139	0	0	0	0	0	0

† Trace (mean < 0.5 nematodes/100 cm³).

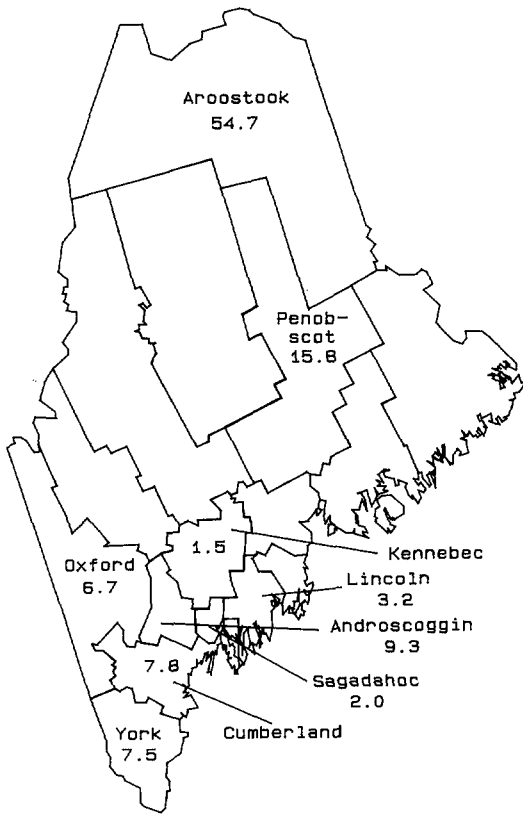


FIG. 1. Map of Maine showing the nine counties sampled for plant-parasitic nematodes. The number associated with each sampled county represents the number of hectares ($\times 1,000$) in crop production excluding pasture land (2).

(Ontario, Quebec, New Brunswick) where it generally is associated with forage crops, grasses, and some legumes (16,17). It was associated with apple, clover, hardwood trees, hay, oat, potato, raspberry, and strawberry in Maine.

Several nematode species—including *Helicotylenchus digonicus* Darling & Thorne, *H. pseudorobustus* (Steiner) Golden, *Criconebella curvatum* Raski, *Tylenchorhynchus maximus* Allen, and *Xiphinema americanum* Cobb—were found only occasionally (Tables 1, 2). Generally, these species infested relatively undisturbed soils in perennial crops, hardwood trees, and conifers, but a field of rutabagas that had been in timothy (*Phleum pratense* L.) for at least the previous 2 years was infested with relatively large numbers of *T. maximus* (35/100 cm³). Even

though it was in only 1% of all samples, 38% of apple orchards sampled were infested with *X. americanum*. This nematode is of particular concern because it is the vector of several viruses, most notably tomato ringspot (4,15).

Several other nematodes were detected at very low frequencies. *Aphelenchoides* sp. was identified from iris in Cumberland County and *Trichodorus* sp. was found in one sample from apples. *Heterodera trifolii* Goffart was detected in turf mixed with clover in Aroostook County, but it was not detected in potato fields sampled in clover rotations (3). *Ditylenchus* spp. were found in nine samples from potato in Aroostook county; however, *D. destructor* Thorne was not verified.

The results of this study indicate that plant-parasitic nematodes are widely distributed in Maine. Species identification was important to determine the possible threat to crops in these areas because several of the species encountered are capable of causing severe damage to host crops. In particular, the population dynamics of *Pratylenchus* spp. and *Meloidogyne hapla* on potatoes and the association of *V. dahliae* and *P. penetrans* deserve further study. Also, damage thresholds need to be established for these crops in the soil types and under the growing conditions of Maine. This survey provides important background information for planning and administering nematode management strategies in Maine.

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