Plant-Parasitic and Beneficial Nematode Distribution in Michigan Vegetable Soils

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Background

Plant-parasitic nematodes can be serious pathogens of Michigan vegetable crops particularly root crops such as carrots. Symptoms of nematode infection vary by crop and plant-parasitic nematode type, but include forked, stunted roots and stunted, chlorotic shoots. Different types of plant-parasitic nematodes also have different capacities to infect and damage crops. Lesion nematode and northern root-knot nematode (the type of root-knot nematode in Michigan) can infect and damage a wide range of vegetable crops. Cyst nematodes have narrow host ranges and carrot cyst nematode can only infect carrots. The host ranges of pin and stunt nematodes are not well-defined, but carrots, celery, and corn may be damaged by pin nematode. More information about plant-parasitic nematodes of vegetables is contained in Chapter 8 "Nematode Management" of "Vegetable Crop Pest Management" (Extension Bulletin E-2160).

Only a portion of soil nematodes infect and damage plants (plant-parasitic nematodes). The other types of nematodes (free-living or beneficial nematodes) fill important functions in the soil and are grouped by what they feed on. Bacteria-feeding nematodes feed on bacteria, are important in nutrient cycling, and increase rapidly in the presence of abundant, simple resources such as sugars. Fungal-feeding nematodes feed on fungi, increase relatively rapidly with abundant resources, and are involved in break-down of recalcitrant materials such as fibrous plant material. Predators feed on other nematodes, and omnivores feed on multiple food sources. Omnivores and predators can be involved in limiting plant-parasitic nematode densities and do better in a more stable (fewer changes) soil environment.

Procedures

During the growing season or shortly after harvest in 2015, 276 soil samples from 32 Michigan vegetable fields (primarily carrot at sampling) were collected to assess nematode populations. Fields had prior crop quality issues indicating possible nematode infestation. The major carrot producing regions were sampled including 15 fields (11 mineral and four muck soils) in the West-Central region (Mason, Oceana, Newaygo, and Kent Counties), nine mineral soil fields in the Southwest region (Berrien County), six muck soil fields in the East region (Lapeer County), and two fields in Allegan County. At each field, between 4 and 16 soil samples (6" depth, 6 points within 2 acres) were collected.

All free-living and plant-parasitic nematodes were extracted from the soil then identified and quantified. For root-knot nematode (RKN), only the juvenile stage—immature, mobile, worm-shaped stage—was extracted from the soil. For cyst nematodes, the juvenile and cyst (enlarged egg-producing female) stages were extracted. An additional series of bioassays were conducted to detect root-knot nematode based on the presence of RKN galls on tomato seedlings grown in a subsample of each soil sample collected

Table 1. West-central region vegetable fields: Population densities (per 100 cm soil) of plant-parasitic nematodes detected. Maximum population density for each nematode is in bold text.

Field	Soil Type	Lesion Nematode	RKN Juveniles	RKN detected in bioassay?	Pin Nematode	Stunt Nematode	Cyst Juveniles	Spiral Nematode	Dagger Nematode
1	Mineral	40	0	no	0	0	0	0	0
2	Mineral	20	0	no	0	0	0	0	0
3	Mineral	8	2	yes	0	0	0	0	2
4	Mineral	7	0	no	0	1	0	0	0
5	Mineral	16	0	no	0	**58**	**2**	0	0
6	Mineral	17	0	no	0	3	0	0	0
7	Mineral	20	0	no	0	0	0	0	0
8	Mineral	32	0	yes	0	0	0	**4**	0
9	Mineral	96	20	no	0	0	0	**8**	0
10	Mineral	**264**	4	no	0	0	0	0	0
11	Mineral	44	0	no	0	0	0	0	0
12	Muck	0	0	yes	2	0	0	0	0
13	Muck	4	0	no	28	0	0	0	0
14	Muck	0	18	yes	0	0	0	0	0
15	Muck	40	**44**	yes	**40**	0	0	0	0
	Mean	41	6	5	4	<1	<1	<1	<1
# Fields Infested		13	5	5	3	4	1	2	1
% Fields Infested		87%	33%	33%	20%	27%	7%	14%	7%

Plant-Parasitic Nematode Distribution

Plant-parasitic nematodes were detected in all fields--except for 2 fields in the southwest. Overall (32 fields), lesion nematode was the most prevalent plant-parasitic nematode (23 fields, 72% of fields sampled, 31 nematodes/100 cm^3 soil average). Root-knot nematode (juveniles in soil or galls in bioassay) was the next most common (14 fields, 44% of fields, 12 juveniles/100 cm^3 soil average) followed by pin nematode (9 fields, 28%, 25 nematodes average), stunt nematode (9 fields, 28%, 4 nematodes average), and cyst nematode (6 fields, 19%, 4 cysts and 2 juveniles average). Spiral (2 fields), stubby-root, lance, and dagger nematodes (1 field each) were also detected. Based on these results, plant-parasitic nematode infestation is common in Michigan vegetable fields and economic loss due to nematodes may be widespread in Michigan.

In the **West-Central region** (Table 1), lesion nematode was the most prevalent plant-parasitic nematode (87% of fields sampled) followed by root-knot nematode (detected in 47% of fields sampled in soil or bioassay), stunt nematode (27%), pin nematode (20%), and spiral nematode (14%). Cyst and dagger nematodes were detected in 1 field each. In the **Southwest region** (Table 2), lesion nematode was most prevalent (67% of fields sampled) followed by stunt (56%) and root-knot nematodes (33%). Stubby-root and lance nematodes were each detected in 1 field. In the **East region** (Table 3), pin (100% of fields), cyst (83%), root-knot (50%), and lesion nematodes (33%) were detected.

Table 2. Southwest region (all mineral soils): Population densities (per 100 cm soil) of plant-parasitic nematodes detected.

Field	Lesion Nematode	RKN Juveniles	RKN detected in bioassay	Stunt Nematode	Lance Nematode	Stubby-root Nematode
1	**56**	0	no	20	0	0
2	52	0	no	**36**	**8**	**16**
3	14	2	yes	2	0	0
4	10	**6**	yes	4	0	0
5	12	0	no	4	0	0
6	8	0	no	0	0	0
7	0	0	no	0	0	0
8	0	4	no	0	0	0
9	0	0	no	0	0	0
Mean	17	1		7	1	2
# Fields Infested	6	3	2	5	1	1
% Fields Infested	67%	33%	22%	56%	11%	11%

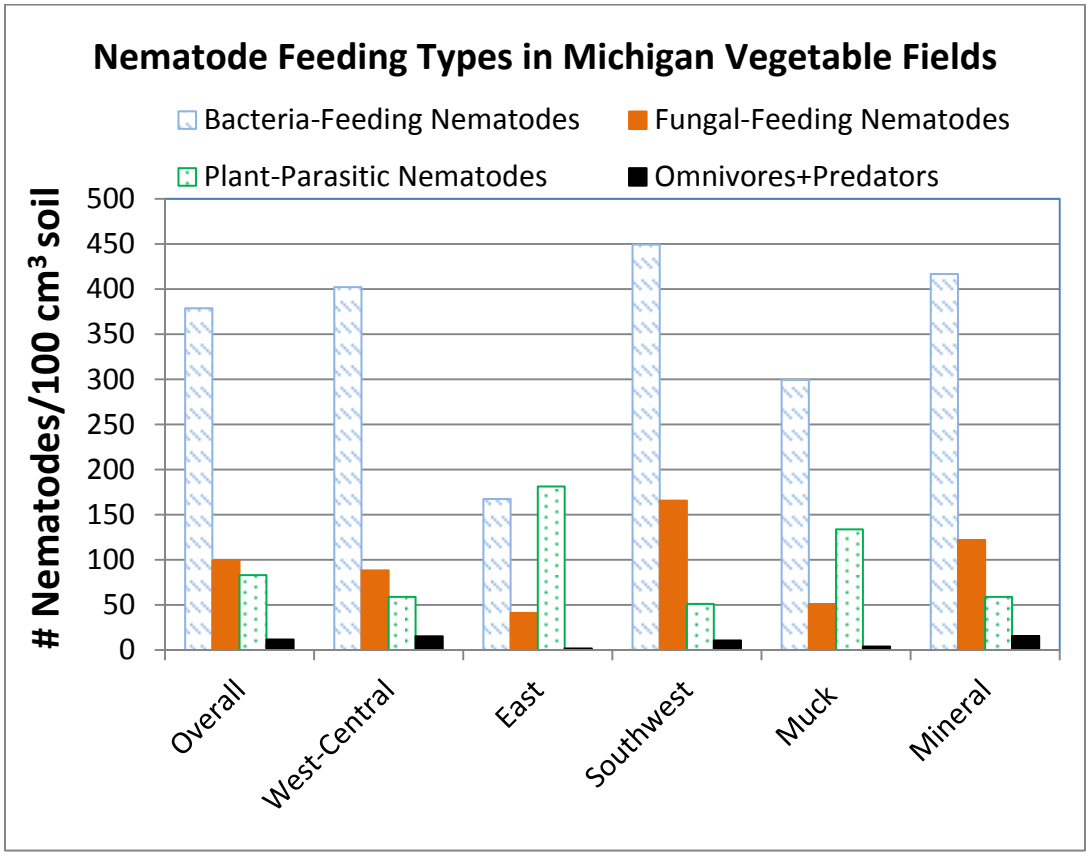
In **mineral soils** (21 fields sampled), the most prevalent plant-parasitic nematodes were lesion (18 fields, 86% of fields sampled, 34 nematodes/100 cm^3 soil average), stunt (9 fields, 43%, 6 nematodes/100 cm^3 soil average), root-knot (8 fields, 38%, 2 juveniles on average), and spiral nematodes (2 fields, 10%, 1 nematode average). Cyst, stubby-root, lance, and dagger nematodes were each detected in 1 field (5% of fields). In **muck soils** (11 fields sampled), pin nematode was most prevalent (9 fields, 82% of fields sampled, 74 nematodes/100 cm^3 soil average) followed by root-knot (7 fields, 62%, 30 juveniles average), lesion (5 fields, 45%, 23 nematodes average), and cyst nematode (5 fields, 45%, 6 juveniles and 11 cysts average).

Table 3. East region (all muck soils): Population densities (per 100 cm soil) of plant-parasitic nematodes detected.

Field	Lesion Nematode	RKN Juveniles	RKN detected in bioassay	Pin Nematode	Cysts	Cyst Juveniles
1	0	2	yes	43	14	9
2	**10**	**261**	yes	**693**	**93**	**43**
3	0	0	no	3	0	0
4	0	1	no	2	10	13
5	0	0	no	2	6	2
6	1	0	no	3	1	1
Mean	2	44		124	20	11
# Fields Infested	2	3	2	6	5	5
% Fields Infested	33%	50%	33%	100%	83%	83%

Free-Living Nematode Population Densities

Averaged across regions and soil types (Figure 1), bacteria-feeding nematodes had the highest density with 67% relative abundance (percent of total nematode abundance) followed by fungal-feeding nematodes (16% relative abundance), plant-parasitic nematodes (14% relative abundance), and omnivore-predators (3% relative abundance). These relative proportions are typical of agricultural soils and reflect a soil food web that is nutrient-rich but relatively basic. These proportions were different in the East region as plant-parasitic nematodes constituted a greater proportion (46%), but bacteria- and fungal-feeding nematodes constituted a smaller proportion of nematodes (43% and 10%) than in other regions. Muck soils had a higher proportion of plant-parasitic nematodes (27%) and lower proportion of fungal-feeding nematodes (10%) than mineral soils.



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