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Effect of *Criconemella onoensis* on Potato[1]

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Abstract: *Criconemella onoensis* (Luc) Luc and Raski increased to high (458–1,290/100 cm³) soil population densities in four fields planted to cover crops of sorghum-sudangrass (*Sorghum bicolor* (L.) Moench × *S. arundinaceum* (Desv.) Stapf var. *sudanense* (Stapf) Hitchc. 'Funk FP-4') during the summer of 1984 in southeastern Florida. Three pathogenicity tests conducted in the greenhouse with *C. onoensis* on potato (*Solanum tuberosum* L. 'La Rouge') using three different methods (inoculation, chemical treatment of infested soil, or pasteurization of infested soil) revealed no significant ($P = 0.10$) differences in plant growth, despite significant ($P = 0.05$) differences in population densities of *C. onoensis* between treated and control pots in each test. In these three tests, the maximum initial density of *C. onoensis* used was 720/100 cm³ soil and the maximum final density was 686/100 cm³ soil. Application of 933 liters/ha of Vapam to a field site with a pretreatment density of 1,120 *C. onoensis*/100 cm³ soil significantly ($P = 0.05$) reduced populations compared with untreated control plots, but yields remained higher in control plots. Apparently *C. onoensis* has no significant effect on potato growth at the population densities tested.

Key words: *Criconemella onoensis*, pathogenicity, potato, ring nematode, *Solanum tuberosum*, *Sorghum* spp.

Plant-parasitic nematodes vary in importance and occurrence on potatoes (*Solanum tuberosum* L.) throughout the United States (1,13). Even in Florida, the nematodes responsible for damage to potatoes in the northeast part of the state (12) are, for the most part, different from those found on the crop in southeastern Florida (9). In the southeast part of the state, the recent withdrawal of ethylene dibromide soil fumigant has raised growers' concern about damage from nematodes, including *Meloidogyne incognita* (Kofoid and White) Chitwood and *Rotylenchulus reniformis* Linford and Oliveira, both known pathogens of potato (1,10) on the Perrine marl soils (2) where potatoes are grown. *Criconemella* spp., however, apparently are much more common on Perrine marl soils than *M. incognita* or *R. reniformis* (11), but their effect on potato is not known (1). In one study (9), an inverse relationship was found between potato yield and density of *C. onoensis* (Luc) Luc and Raski, but the nature of this relationship is unclear, since potato yield was highly correlated with weed control, and *C. onoensis* population density was directly related to weeds and other cover crops. This nematode is known to build up on sorghum (*Sorghum bicolor* (L.) Moench), sorghum-sudangrass (*S. bicolor* × *S. arundinaceum* (Desv.) Stapf var. *sudanense* (Stapf) Hitchc.), and related hosts grown as summer cover crops in rotation with potatoes (9). Therefore, serious damage to a winter potato crop could occur if this nematode is pathogenic and widespread.

The objectives of this study were to determine the relative abundance of *C. onoensis* and other plant-parasitic nematodes on a sorghum-sudangrass cover crop and to investigate the possible pathogenicity of this nematode to potatoes in greenhouse and field experiments.

Materials and Methods

Survey: Four fields located 9–10 km north of Homestead, Florida, were monitored. All had Perrine marl soil (Typic Fluvaquent) and had been planted to potato during the previous winter. The sorghum-sudangrass hybrid 'Funk FP-4' (*Sorghum bicolor* (L.) Moench. × *S. arundinaceum* (Desv.) Stapf var. *sudanense* (Stapf) Hitchc.) was planted on all fields as a cover crop on

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TABLE 1. Population densities of *Criconemella onoensis, Helicotylenchus dihystera,* and *Rotylenchulus reniformis* in four fields planted to sorghum-sudangrass, 1984.

Field	Field size (ha)	Number of samples	Mean number of nematodes per 100 cm³ soil			
			C. onoensis		*H. dihystera*†	*R. reniformis*†
			11 June	11 Sept.	11 Sept.	11 Sept.
A	2.4	6	372	1,290	0	0
B	2.4	6	90	458	10	0
C	3.2	8	73	619	2	16
D	1.2	3	170	497	93	0

† Initial populations of *H. dihystera* and *R. reniformis* were near zero on 11 June; low populations (< 4/100 cm³) of *Tylenchorhynchus* spp. were also recovered on 11 September.

5–6 June and maintained until mid-September.

Initial and final samples for plant-parasitic nematodes were collected from these fields on 11 June and 11 September. The four fields varied in size from 1.2 to 3.2 ha. Because a single soil sample was collected from each 0.4 ha, the total number of samples collected varied among fields. Each sample consisted of 15 cores (2.0 cm d × 20 cm deep) collected in a systematic pattern from the 0.4 ha. The 15 cores were combined and the nematodes extracted from a 100-cm³ subsample using a modification (7) of Jenkins' sieving and centrifugation technique (5).

Greenhouse experiments: In Experiment 1, a nematode-free soil mix (two parts sand : one part peat moss : one part coarse vermiculite, v/v) was placed in 7.6-liter plastic pots. Seed pieces of 'La Rouge' potato (*Solanum tuberosum* L.) were dipped in a solution of Manzate 200 and gibberellic acid and planted on 20 December 1984. On 26 December, seven pots were inoculated with 700 *C. onoensis* in 80 ml water by pouring the suspension into a small depression in the soil directly above the seed piece. The remaining seven pots were treated with 80 ml supernatant water to serve as controls. The *C. onoensis* had been obtained by sieving heavily infested Perrine marl soil which was free of other nematodes except for *Rhabditis* spp. and *Acrobeloides* spp. Pots were maintained in a greenhouse and fertilized and watered as needed. On 27 March 1985, all pots were harvested and fresh top and root weights as well as tuber numbers and weight were determined for each plant. The soil from each pot was mixed well, and a 100-cm³ subsample processed for nematodes by the methods described previously. Data from inoculated and control treatments were compared by a *t*-test.

In Experiment 2, a Perrine marl soil naturally infested with 720 *C. onoensis*/100 cm³ soil was spread in 10-cm-deep flats and drenched with Vapam (32.7% sodium N-methyldithiocarbamate) at a rate equivalent to 933 liters/ha on 7 January 1985. A similar amount of untreated soil served as the control. There were six replications per treatment. Seven days after treatment, the soil was transferred to 7.6-liter plastic pots and planted with La Rouge seed pieces as in Experiment 1. Other practices were as in Experiment 1, except the soil was not inoculated and the harvest date was 23 April.

Criconemella onoensis-infested soil used in Experiment 3 was pasteurized by heating in plastic containers in a hot water bath until the internal temperature of the soil remained at 55–65 C for at least 2 hours. On 5 February 1985, pots of treated and untreated soil (six replications) were planted and maintained as in the other experiments. Plants were harvested on 29 April, although tubers had not yet formed on that date.

Field test: Located on Perrine marl soil east of Homestead, Florida, this test consisted of plots with four rows 96 cm apart and 12.2 m long. Paired Vapam-treated and untreated control plots were repli-

TABLE 2. Plant yields and *Criconemella onoensis* population densities at harvest in three greenhouse experiments, 1984–85.

Parameter measured	Experiment 1		Experiment 2		Experiment 3	
	Control	Inoculated†	Control	Treated‡	Control	Pasteurized§
Plant top weight (g)	50.1	26.1	47.5	61.3	48.7	75.2
Plant root weight (g)	11.8	6.7	17.7	11.2	30.8	32.5
Number of tubers	8.4	9.6	3.3	3.8	0.0	0.0
Weight of tubers (g)	375.7	393.3	69.3	94.5	0.0	0.0
C. onoensis per 100 cm³ soil	0.0	42.8*	685.8	13.3***	573.3	6.7***

Asterisks (*, ***) indicate significant differences from control at $P = 0.05$ and $P = 0.001$, respectively, according to a *t*-test; other differences not significant ($P = 0.10$).

† Inoculated with 700 *C. onoensis* (9.2/100 cm³ soil); seven replications.

‡ Treated with 933 liters/ha of Vapam; six replications.

§ Soil heated at 55–65 C for 2 hours; six replications.

cated eight times. On 24 October 1985, 933 liters/ha of Vapam in 28 kl water/ha were drenched onto the treated plots; control plots were drenched only with the water. All plots were planted with La Rouge potato 7 days later and maintained using cultural practices typical for the area. Soil samples for nematode analysis were collected before treatment on 24 October and periodically thereafter. Each sample consisted of 20 cores per plot (five per row), processed as described for the survey. On 4 December, 7 January, and 5 February, four plants from the outside rows of each plot were harvested to determine fresh top weight and number and weight of tubers per plant, and to rate fungal lesions on main roots using Horsfall and Barratt's 1–12 scale (4). Two 6.1-m sections from each center row of each plot were harvested and graded (3) on 24 February.

RESULTS AND DISCUSSION

Survey: Populations of *C. onoensis* increased to very high levels in all four fields planted with sorghum-sudangrass cover crops (Table 1). Final populations were 2.9–8.5 times greater than initial levels. Much lower levels of *R. reniformis*, *Helicotylenchus dihystera* (Cobb) Sher, and *Tylenchorhynchus* spp. were found following the sorghum-sudangrass cover crop. Results were in agreement with previous observations (9,11) of the relative abundance of *Criconemella* spp. compared with other nematodes in marl soils.

Greenhouse experiments: Results from all three greenhouse experiments were similar, despite differences in methodology among the tests (Table 2). In all tests, differences in *C. onoensis* populations between treatments were great and statistically sig-

TABLE 3. Population densities of *Criconemella onoensis*, *Rotylenchulus reniformis*, and *Tylenchorhynchus martini* in a field experiment, 1985–86.

Sampling date	Mean number of nematodes per 100 cm³ soil					
	C. onoensis		*R. reniformis*		*T. martini*	
	Control	Treated†	Control	Treated†	Control	Treated†
24 October	1,095	1,145	55	35	40	0
12 November	499	36***	18	2***	3	1*
25 November	1,079	120***	145	17***	33	1***
7 January	379	319	95	1***	99	1***
3 February	1,018	1,013	11	0***	24	9*
20 February	1,054	802*	1	2	15	14

Asterisks (*, ***) indicate significant differences from control at $P = 0.05$ and $P = 0.001$, respectively, according to a *t*-test; data are means of eight replications. No asterisks within a pair indicates no significant difference ($P = 0.05$).

† Treated with 933 liters/ha of Vapam on 24 October.

TABLE 4. Plant data and yields in a field experiment, 1985–86.

Parameter measured	Sampling date	Control	Treated†
Fresh top weight per plant (g)	4 December	105.2	88.4*
	7 January	261.0	251.2
	5 February	167.9	214.5*
Fresh root weight per plant (g)	4 December	12.1	13.7
	7 January	14.6	14.5
	5 February	13.2	13.8
Tubers per plant (no.)	7 January	3.6	4.7**
	5 February	4.1	4.6
Weight of tubers per plant (g)	7 January	266.8	293.8
	5 February	566.9	624.4
Total yield (kg/12.2 m)	24 February	26.7	22.8***
Marketable yield (kg/12.2 m)	24 February	22.3	18.9***
Lesions on main roots‡	4 December	3.0	2.4
	7 January	3.9	2.4*
	5 February	2.0	1.8

Asterisks (*, **, ***) indicate significant differences from control at $P = 0.05$, $P = 0.01$, and $P = 0.001$, respectively, according to a *t*-test; no asterisks within a pair indicate differences not significant ($P = 0.05$); data are means of eight replications.
† Treated with 933 liters/ha of Vapam on 24 October.
‡ Horsfall and Barratt 1–12 rating scale (4).

nificant ($P = 0.05$) even at harvest; however, differences in plant growth parameters were not significantly different at $P = 0.05$, nor were significant differences apparent even at $P = 0.10$. The low final population density of *C. onoensis* in Experiment 1 apparently resulted from an initial inoculum of 700 *C. onoensis* per plot, which was equivalent to only 9.2/100 cm³ soil. Initial populations in Experiments 2 and 3 (720/100 cm³) were much higher.

Field test: The test site had an average initial density of 1,120 *C. onoensis*/100 cm³ soil, as well as low populations of *R. reniformis* and *Tylenchorhynchus martini* Fielding. Soil treatment with Vapam significantly reduced population levels of all three nematode species, although *C. onoensis* populations recovered later in the season (Table 3). Disease incidence, monitored as lesions on roots, was affected little by treatment and was relatively low (Table 4). Although many plant growth parameters were similar, significant trends were inconsistent, and untreated control plots outyielded Vapam-treated plots (Table 4). This yield suppression with treatment may have been due to phytotoxicity, since only 7 days elapsed between treatment and planting. Similar responses, however, were not observed in most other plant growth parameters (Table 4) nor in the second greenhouse experiment (Table 2) in which an identical treatment-planting interval was used. As in the greenhouse tests, high populations of *C. onoensis* failed to suppress yields.

A related species, *C. xenoplax* (Raski) Luc and Raski has been shown to increase severity of certain diseases of fruit trees (6,8). Thus the possibility that *C. onoensis* could interact with high inoculum levels of other soilborne plant pathogens could not be ruled out. In several of our experiments, use of field soil, presumably containing low levels of pathogenic fungi and bacteria, suggests that synergistic interactions at high nematode–low pathogen densities may not be occurring in this system.

In summary, although *C. onoensis* builds up to high population levels on a summer cover crop of sorghum-sudangrass, there is no evidence tht this nematode is detrimental to a subsequent winter potato crop.

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