Host-parasite Interactions of Pratylenchus scribneri on Selected Crop Plants[1]

J. R. RICH, I. J. THOMASON, and F. C. O'MELIA[2]

Abstract: Greenhouse tests were conducted to determine the effects of soil temperature and texture on development of *Pratylenchus scribneri* and the pathogenicity and reproductive rates of this nematode on selected crop plants. In a sandy loam soil, greatest numbers of *P. scribneri* were found at 30 and 35 C on sudangrass and sugarbeet, respectively. In a silty clay loam, the nematode reproduced best at 35 C on sugarbeet. Higher populations of *P. scribneri* were found in the sandy loam than silty clay loam soil at corresponding temperatures. In a pathogenicity test, top and root growth of sudangrass and barley were suppressed by the nematode, whereas no significant growth inhibition was found on wheat and alfalfa. Tests with other vegetable and field crops indicated wide variance in nematode reproduction. *Key Words:* Lesion nematode, pathogenicity, soil temperature, soil type, sudangrass, sugarbeet, barley, wheat, and alfalfa.

In a review of the literature, seven plant species were found to be good hosts, one species a moderate host, and seven were poor hosts of *Pratylenchus scribneri* (1, 2, 3, 5, 6, 8, 11, 12). Of 14 plants tested, 6 plants were heavily damaged by *P. scribneri*. The nematode has been found associated with 22 plant species in California alone and is widely distributed in many areas (10). Greenhouse studies were initiated to determine: *(i)* soil temperature and texture preferences of the nematode and *(ii)* its pathogenicity and host range. A preliminary report on soil temperature and texture preferences has been published (12).

MATERIALS AND METHODS

Soil temperature and texture test: Plastic containers (1-liter) were filled with a sandy loam soil from Chino, California (67% sand, 21% silt, 12% clay, pH 7.7) or silty clay loam soil from Tustin, California (8% sand, 54% silt, 38% clay, pH 7.9). The soil was steamed prior to use, and 1 gm of $CaNO_3$ was added to each container. Seeds of sugarbeet (*Beta vulgaris* L. 'U. S. 75') and sudangrass (*Sorghum vulgare* var. *sudanense* (Piper) Hitchc. '23') were surface sterilized for 10 min. in a 0.5% solution of sodium hypochlorite. Sudangrass seeds were planted in the sandy loam soil and sugarbeet seeds planted in both soil types. The three treatments of eight replicates each were placed in a completely randomized design in temperature tanks maintained at 15, 20, 25, 30, or 35 C. After emergence, plants were thinned to one/container; 41 days after seeding, the soil in each container was infested with 862 $\pm$ 25 *P. scribneri* recovered from greenhouse grown sudangrass. Plant roots and soil from four replicates were analyzed for *P. scribneri* 6 weeks after inoculation, and from the remaining four replicates after 12 weeks. Soil was washed through a 44-μm screen and placed on a Baermann funnel for 24 h. Roots were placed in water and aerated for 48 h. Roots were oven-dried and weighed after nematode extraction.

Pathogenicity: Alfalfa (*Medicago sativa* L. 'Mesa Sirsa'), barley (*Hordeum vulgare* L. 'Atlas'), sudangrass, and wheat (*Triticum aestivum* L. 'Ramona') seeds were each planted into 15-cm diam plastic pots filled with steam-pasteurized sandy loam soil (75% sand, 24% silt, and 1% clay). After emergence, the sudangrass was thinned to two plants/pot, and the remaining test species were thinned to three/pot. Eighteen days after planting, six replicate pots of each plant species were inoculated with 2,500 *P. scribneri* extracted from corn roots. Inoculated and control pots were placed on a heated greenhouse bench in a completely randomized design and maintained at a soil temperature of 25-28 C. A complete Hoagland's solution was added biweekly, and the duration of the test was 4.5 months. Top growth was clipped to 10 cm above the soil at 3-4 week intervals; the clippings were oven-dried (80 C for 48 h) and then

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[2] Respectively, former Graduate Assistant, now Assistant Professor, University of Florida (IFAS), Department of Entomology and Nematology, ARC P. O. Box 657, Live Oak, Fl. 32060; Professor, Department of Nematology, University of California, Riverside, California 92507; and Dow Chemical Company, P. O. Box 1706, Midland, Michigan 48640.

weighed. Nematode reproduction was determined at the end of the test by randomly removing two 2.5-cm soil cores (100 cm^3 soil) from each replicate and placing them on a Baermann funnel for 3 days. Total soil nematode populations were estimated by using an average of 1,750 cm^3 soil/pot. Roots were washed from the soil, damp dried, weighed, and placed in a mist chamber for 6 days. Nematodes were removed at 3 and 6 days.

Host range: Seeds of broccoli (*Brassica oleracea* var. *botrytis* L. 'Neptune'), cabbage (*Brassica oleracea* var. *capitata* L. 'Copenhagen'), carrot (*Daucus carota* L. 'Imperator'), onion (*Allium cepa* L. 'Yellow Bermuda'), pepper (*Capsicum fructescens* L. 'Red Hot Chili'), and table beet (*Beta vulgaris* L. 'Detroit Dark Red') were planted in vermiculite and allowed to grow for 30 days. Four replicates of two seedlings each were transplanted into 15-cm diam pots filled with a steam-pasteurized sandy loam soil. Nine days after they were transplanted, seedlings were inoculated with 1,800 *P. scribneri* extracted from corn roots, and the plants were placed on a heated greenhouse bench in a completely randomized design. Soil temperature ranged from 25-28 C, and a complete Hoagland's solution was applied biweekly. Plant roots and soil were analyzed for nematodes 73 days after inoculation by the method described previously. Macroscopic root symptoms were recorded by comparison with two controls/treatment.

In a second host range test, cotton (*Gossypium hirsutum* L. 'Delta Pine'), grain sorghum (*Sorghum vulgare* Pers. 'Meloland'), and sweet corn (*Zea mays* L. 'Honeycross') were seeded and thinned to one plant/pot after emergence. Fifteen-day-old tomato seedlings (*Lycopersicon esculentum* Mill. 'Pearson') grown in vermiculite were transplanted at the time of seeding the other plant species. Unless stated otherwise, materials and procedures were similar to those in the pathogenicity experiment. Five replicates of each plant species were inoculated with 5,000 *P. scribneri* extracted from sudangrass roots 21 days after being planted. Soil temperatures ranged from 25-30 C, and plants were removed 47 days after inoculation.

RESULTS

Soil temperature and texture: No significant differences in nematode numbers were found among any of the plant-soil-temperature combinations 6 weeks after inoculation. Twelve weeks after inoculation, greatest numbers of *P. scribneri* were found on sugarbeet in both soil types at 35 C (Table 1). Of all temperatures, 30 and 35 C gave the lowest root weights of sugarbeet, but nematodes/gm of root and total nematode populations were greatest at these temperatures. On sugarbeet, higher nematode populations were found in the sandy loam soil than the silty clay loam soil at all corresponding temperatures. No differences in the numbers of *P. scribneri* on sugarbeet were found in the sandy loam soil between 30 and 35 C, whereas an increase in nematode populations occurred at 35 C in the silty clay loam. Nematode reproduction was limited by temperatures of 15, 20, and 25 C in either soil type. In the sandy loam soil, nematode reproduction on sudangrass was greater at 30 C than at the other soil temperatures, but it was also high at 35 C. A decline in *P. scribneri* numbers occurred at 15 and 20 C.

Pathogenicity: Pratylenchus scribneri suppressed top and root growth of sudangrass and barley, but no significant growth inhibition was found in wheat or alfalfa (Table 2). Significant repression in top growth occurred as early as 4 weeks after inoculation in sudangrass and after 8 weeks in barley. Highest *P. scribneri* populations/gm of root were found in barley, and the next highest in sudangrass, wheat, and alfalfa, in descending order. The three grasses produced abundant *P. scribneri,* but few nematodes were recovered from alfalfa roots. A few *P. scribneri* were recovered from the controls, an occurrence indicating some contamination during 4.5 months' growth in the greenhouse. During the course of the experiment, inoculated sudangrass also frequently exhibited symptoms of nutrient deficiency.

Host Range: Variation in host suitability was found in two further tests (Table 3). In a test with vegetables, highest numbers of nematodes were found on onion, and the next highest, in descending order, on broccoli, cabbage, table beet, pepper,

TABLE 1. Effects of soil temperature and two soil types on populations of *Pratylenchus scribneri* grown on sudangrass and sugarbeet.

	Sandy loam				Silty clay loam	
	Sugarbeet		Sudangrass		Sugarbeet	
Temperature of soil (C)	Oven-dry root wt. (gm)	Nematodes/gm of root	Oven-dry root wt. (gm)	Nematodes/gm of root	Oven-dry root wt. (gm)	Nematodes/gm of root
15	22.4 a[x]	2 x	7.6 c	15 x	20.2 ab	3 x
20	15.0 bc	27 x	11.3 abc	134 x	25.0 a	3 x
25	20.8 ab	180 x	8.2 bc	1,510 y	18.5 ab	14 x
30	9.0 c	13,780 y	15.1 ab	14,310 z	13.1 bc	146 x
35	9.2 c	17,440 y	18.4 c	10,190 xy	6.4 c	8,220 y

[x]Each figure is an average of four replicates (12 weeks after inoculation of 41-day-old seedlings with 850 *P. scribneri*/pot), and column means followed by the same letter are not different ($P = 0.05$) according to Duncan's multiple range test.

TABLE 2. Pathogenicity and populations of *Pratylenchus scribneri* grown on four crop plants.

Treatment	Dry wt./four clippings (gm)	Damp-dry root wt. (gm)	Nematodes/gm of root	Nematodes/ replicate (in 1,000's)
Sudangrass				
Control	34.5 a[y]	100.8 a	—	0.2[z]
Inoculated	21.5 b	59.4 b	8,040	477.8
Barley				
Control	7.1 a	18.8 a	—	0.1
Inoculated	4.4 b	9.0 b	11,390	102.5
Wheat				
Control	4.8 a	9.8 a	—	0.3
Inoculated	4.0 a	8.8 a	3,740	32.9
Alfalfa				
Control	7.5 a	24.9 a	—	0.1
Inoculated	10.8 a	19.9 a	9	0.2

[y]Each figure is an average of six replicates (4.5 months after inoculation with 2,500 *P. scribneri*/pot), and grouped means followed by the same letter are not different ($P=0.01$) according to the analysis of variance.
[z]Minor contamination in some controls.

and carrot. Low numbers of *P. scribneri* were found on carrot and pepper, a fact indicating little, if any, nematode reproduction. Cabbage, onion, and beet roots exhibited macroscopic symptoms of nematode parasitism, whereas the remaining three vegetables species roots showed no obvious symptoms. Onion roots appeared water soaked; cabbage roots showed light gray to black necrotic areas; and table beet roots exhibited a light brown to red discoloration.

In the final test, large numbers of *P. scribneri* were found in roots and in soil around sweet corn and tomato (Table 3). Some nematode reproduction occurred on sorghum but little occurred on cotton. Highest total nematode numbers were found on sweet corn but greatest numbers/gm of root were found in tomato.

DISCUSSION

In the soil temperature and texture test, sugarbeets provided adequate root development at the lower end of the temperature range and sudangrass at the upper end of the range. Thus, root growth was not the principal factor limiting nematode development. The nematode, however, probably

TABLE 3. Host range and comparative reproduction of *Pratylenchus scribneri* on 10 plants.

Treatment	Nematodes/gm of root	Total nematodes/ replicate (in 1,000's)
Test with vegetables[y]		
Carrot	10	0.1
Pepper	63	0.5
Table Beet	880	6.9
Cabbage	2,030	30.2
Broccoli	2,740	41.7
Onion	6,600	56.1
Test with General Crops[z]		
Sweet Corn	2,110	90.1
Tomato	2,760	63.9
Sorghum	300	10.9
Cotton	24	0.2

[y]Data are means of four replicates (two seedlings each) removed 73 days after inoculation of 39-day-old seedlings with 1,800 *P. scribneri*.
[z]Data are means of five replicates removed 47 days after inoculation of 21-day-old seedlings with 5,000 *P. scribneri*.

reproduced at temperatures higher than optimum for sugarbeet and best at temperatures similar to the optimum for sudangrass. Nematode numbers from both sudangrass and sugarbeet were greatest at 30 and 35 C, respectively. These temperatures suggest a higher temperature optimum for *P. scribneri* than for *P. penetrans* (4) but one similar to those reported for *P. coffeae* (7) and *P. vulnus* (9). Like many other *Pratylenchus* spp., *P. scribneri* preferred a coarser textured soil, as was shown by differences in reproduction in the sandy loam and silty clay loam soils. An interaction between soil type and temperature was suggested. At 35 C, *P. scribneri* increased to 8,224 nematodes/gm of root tissue on sugarbeet in the silty loam, whereas at 30 C, only 146 nematodes/gm of root were found. In the sandy loam, greatest numbers/gm of root were found on this host at 35 C with slightly lower numbers at 30 C. These data indicate that, given an appropriate host and suitable soil temperature, the nematode may increase to large numbers in a silty clay loam soil. Soil moisture may have been an influencing factor in population development between the two soil types.

A comparison of nematode numbers 6 and 12 weeks after inoculations suggests the importance of timing the termination of an experiment. After 6 weeks, soil temperatures had no effect on nematode numbers. Six weeks later, however, large differences were noted.

The pathogenic potential of *P. scribneri* was demonstrated on sudangrass and barley. These two plants and wheat proved to be good hosts for the nematode. Wheat and barley, however, are planted during cooler periods of the year in California and less reproduction and damage would probably occur than on sudangrass which is grown during the summer months. Residual populations resulting from any of these three crops, however, could affect subsequent crops. Reproductive data on alfalfa were similar to those reported by Minton (5), and it appears to be a good rotation crop for control of *P. scribneri*. Further studies, however, are necessary to confirm this observation.

Wide differences in host preferences were observed in the host-range tests. Nematode populations on broccoli, cabbage, and onion suggest that these plants are good hosts. Table beet can be classed as intermediate, and pepper and carrot as poor hosts. Growth of these plants, however, was relatively poor during the experiment, probably because of high soil (28 C) and air temperatures (24-32 C). These data and previous results from temperature studies indicate that *P. scribneri* reproduces poorly on these crop plants which are normally grown in cool coastal areas of California. The potential for reproduction and damage is present since these crops may be planted in soil at 25-30 C in some growing areas. Reproduction could also occur if some plants were left in the field after harvest when soil temperatures are rising, and residual populations could affect subsequent crops. On some crops, i.e. carrots, onions, and table beet, root and/or bulb quality could also be affected by presence of the nematode.

Data for nematode reproduction on sweet corn and tomato in our test agree with earlier observations (3, 12). Both plants are good hosts for *P. scribneri*. Sorghum is an intermediate host, and cotton is a nonhost or poor host.

We have shown that *P. scribneri* is capable of reproducing on a large number

of plants although its reproductive ability on different plants varies widely. Few data on soil temperature and texture preferences are available (12), but evidence supports high temperature optimum and a preference for coarse-textured soils. The high reproduction rate of *P. scribneri* and evidence of pathogenicity in these experiments indicate the need for further tests to ascertain populations and damage in the field. Data reported here, however, suggest some reasons why there have been few reports of field damage by *P. scribneri*. High temperature optimum, preference for coarse-textured soil, and availability of suitable hosts appear to be factors limiting nematode reproduction and damage in California. High soil temperatures may occur only over a relatively short period of time, and soil texture may be less than optimum in some areas of California. In some plants, tolerance to the presence of large numbers of *P. scribneri* in the root system may explain the lack of reports of damage. From our experience, sweet corn appears to be such a plant.

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