The Effects of Temperature on Pratylenchus scribneri and P. alleni Populations on Soybeans and Tomatoes[1]

O. J. DICKERSON[2]

Abstract: In soil temperature tests, rates of *Pratylenchus scribneri* and *P. alleni* reproduction were measured at various temperatures on 'Clark 63' and 'Cutler 71' soybeans and 'Rutgers' tomatoes. Recovered *P. scribneri* equaled or exceeded initial inoculum levels at temperatures of 27.5 C or higher on soybeans, and at 20 C or higher on tomatoes. Population increases were greatest at 35 C on both hosts. Populations increased on soybeans, but not on tomatoes, when soil temperature was raised from 25 to 35 C for either 3 or 9 days. Recovered *P. alleni* were less than the initial inoculum at 27.5 C but higher at 32 and 37.5 C and at 27.5 C on tomatoes, the lowest temperature tested for this nematode. In the field, soil temperatures 10 cm deep in eastern Kansas soybean growing areas reach 27.5 C only occasionally and for relatively short periods, which probably explains the relatively low and variable populations of *P. scribneri* and *P. alleni* on soybeans there. *Key Words:* Host-parasite relationships, resistance, lesion nematodes.

Pratylenchus scribneri Steiner is commonly associated with field crops in the north central United States (10). It reduces yields of several field crops (9, 13, 14) but yield losses have not been documented for soybeans (*Glycine max* (L.) Merr.). *Pratylenchus alleni* Ferris, more limited in distribution than *P. scribneri* (10), has been reported to damage roots of soybeans (6). Several soybean varieties, including 'Clark 63' and 'Cutler 71', have been reported to be resistant to either *P. scribneri* or *P. alleni* or both based on nematode reproduction (3).

Temperature is an important factor for nematode reproduction. *P. scribneri* reproduced best at 30–35 C on barley and sugarbeets (12). The optimum temperature for reproduction of *P. penetrans* was higher on corn than potatoes but population increases were not necessarily correlated with root damage (2). Fewer *P. penetrans* were required to damage onion seedlings at 7–13 C than at 16–26 C (5). The life cycle of *P. penetrans* on *Cryptomeria* spp. was completed in 86 days at 15 C but in 31 days at 30 C (8). Host susceptibility to nematodes also can be altered by high temperatures. The *Meloidogyne incognita*-induced necrotic reaction of resistant tomatoes was reduced drastically by elevating temperature from 24 to 36 C for 2 or 3 days (4) and Lahonton alfalfa susceptibility to *Ditylenchus dipsaci* was greater at 25 to 30 C than at 5 to 20 C (7).

This research was done to determine: 1) whether soil temperature is a principal factor in low populations of *P. scribneri* and *P. alleni* associated with soybeans in Kansas; and 2) whether altering soil temperature would change the susceptibility of soybeans to these nematodes.

MATERIALS AND METHODS

Nematodes for experiments were reared on *Lycopersicon esculentum* L. 'Rutgers' in a greenhouse, then collected from infected roots by a funnel spray method (11). Experimental plants were grown in steam-sterilized Haynie loam (45% silt, 40% sand, 15% clay) contained in 1800-cm^3 plastic pots. Plants were fertilized as needed with a 20-20-20 soluble fertilizer.

Inoculations were made at transplanting by pipetting 5,000 specimens in 5 ml of water into a 6-cm depression in the soil. The depression was then partially filled to 4 cm deep with soil, and a seedling was transplanted into each container. Ten replications/treatment were arranged in a completely randomized design in water-bath-type temperature tanks at 20, 25, 27.5, 30, 32.5, 35, or 37.5 C $\pm$ 1 C, and plants were grown for 90 days.

In a second experiment, *P. scribneri*-inoculated 'Clark 63' soybeans and 'Rutgers' tomatoes were grown for 28 days at 25 C, and the temperature was then raised to 35 C for either 3 or 9 days. Counts were made at either 60 or 90 days.

Light was provided for 12 h/day at ca. 22,000 lux. Fruit was removed from plants to prevent senescence.

Both soil and root populations were de-

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[1] Contribution No. 78-280-j, Department of Plant Pathology, Kansas Agricultural Experiment Station, Manhattan, Kansas 66506.

[2] Professor of Nematology.

termined. Three or four 2.5-cm-diameter soil plugs were taken from each pot and assayed for nematodes (1). Soil was washed from about the roots, which were then blotted dry and weighed. A 10-g root sample from each plant was used for nematode extraction (11).

Soil temperatures were obtained by averaging the maximum and minimum daily temperatures at 10-cm depths and were obtained from climatological data records kept in the Kansas Agricultural Experiment Station Weather Data Library.

RESULTS

At constant temperatures over the range 20–37.5 C, population increases of *P. scribneri* on soybean and tomato were correlated directly with temperature (Table 1). To exceed the 5000-nematode inoculum level in 90 days, 27.5 C or higher was required when soybeans were the host, but the inoculum level was exceeded at 20 C on tomato. When soil temperatures were raised from 25 to 35 C for 3 or 9 days to simulate intervals of peak field soil temperatures (Fig. 1), *P. scribneri* reproduction increased significantly ($P \leq 0.05$) in soybean roots but not in tomato roots (Table 2); 3- and 9-day treatments did not differ in total nematodes recovered, and far fewer nematodes were recovered than from roots grown continuously at more optimum temperatures (Table 1). Population changes in the two soybean varieties did not differ significantly.

At constant temperatures over the range 27.5–37.5 C, population increases of *P. alleni* on soybean and tomato were also correlated with temperature (Table 3). On soybeans, inoculation numbers were not maintained at 27.5 C but were exceeded at 32 and 37.5 C, with no significant difference between the two varieties. On tomato, inoculum numbers were exceeded at all three temperatures.

DISCUSSION

Pratylenchus scribneri and *P. alleni* did

TABLE 1. Numbers of *Pratylenchus scribneri* recovered from soybean and tomato plants grown 90 days after inoculation with 5,000 of these nematodes at constant temperatures.

Host	Soil temperature (C)	Total nematodes (roots + soil)[1]	Nematodes/g of dry root
Soybeans:			
'Clark 63'	20.0	764 e	181 d
	25.0	3,307 e	735 d
	27.5	18,499 d	7,273 c
	30.0	20,144 d	8,109 c
	32.5	81,513 b	24,284 b
	35.0	183,685 a	45,879 a
	37.5	49,853 c	17,900 b
'Cutler 71'	20.0	618 e	282 d
	25.0	2,864 de	1,685 cd
	27.5	13,871 cd	6,544 bc
	30.0	24,478 c	4,506 bcd
	32.5	84,057 b	49,209 a
	35.0	143,936 a	56,475 a
	37.5	21,972 c	14,319 b
Tomatoes:			
'Rutgers'	20.0	5,984 f	2,540 f
	25.0	163,320 cd	70,756 d
	27.5	242,010 bc	193,292 b
	30.0	243,540 b	188,178 b
	32.5	138,283 d	91,486 c
	35.0	374,795 a	276,523 a
	37.5	65,410 e	43,909 e

[1]Column means followed by the same letter do not differ ($P=0.05$) according to the F test with the transformation $\sqrt{N} + 0.5$. Each is the mean of 10 replications.

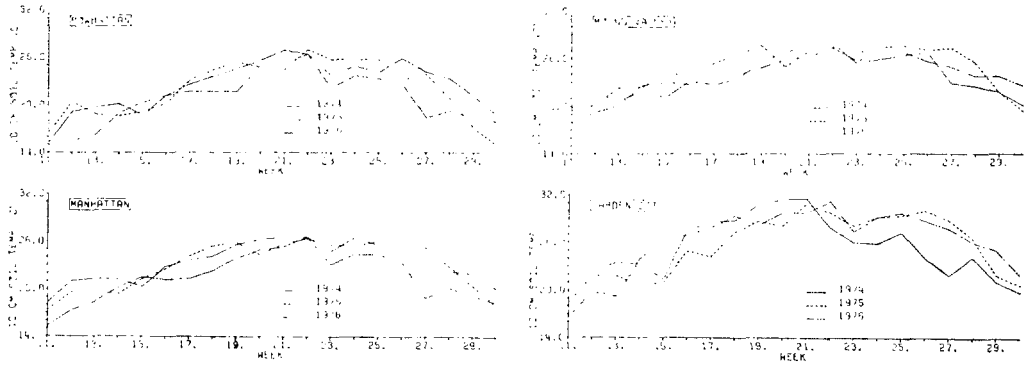

FIG. 1. Average weekly soil temperature at a 10-cm depth at four locations in Kansas, 1974–1976. Powhattan, Manhattan, and Mound Valley are in eastern Kansas; Garden City is in southwestern Kansas.

not reproduce at temperatures below 27.5 C on soybeans but reproduced at 20 C on tomatoes. The optimum temperature for reproduction was 35 C. Although *P. scribneri* is commonly associated with soybeans in Kansas, numbers are relatively low and numbers recovered from roots are below those reported to reduce growth on other hosts (9, 12, 13, 14). The relatively low field populations of *P. scribneri* in soybean-growing regions of eastern Kansas may be influenced by low soil temperatures (Fig. 1; Powhattan, Manhattan, Mound Valley) which reach 27.5 C 10 cm deep only for short periods in the latter part of July and early August. Either a 3- or 9-day increase in temperature to the optimum (35 C) increased *P. scribneri* populations, although not to greater levels than would be expected at a constant 27.5 C. Soybeans are not now a major crop in southwest Kansas, but if they were, soil temperatures there are high enough to support higher populations of *P. scribneri* and *P. alleni* (Fig. 1; Garden City). Soybean resistance to these two nematodes reported previously (3) was from greenhouse data where the temperature was variable.

Even though reproduction was best at 35 C on both tomatoes and soybeans, both

TABLE 2. Numbers of *Pratylenchus scribneri* recovered from soybean and tomato plants grown 60 and 90 days after inoculation with 5,000 of these nematodes at variable temperatures.

Host and growth period	Soil temperatures (c)	Total nematodes	Nematodes/g of dry root
Soybeans ('Clark 63')			
60 days	25 C	2,196 a[1]	—
	25 C + 3 days 35 C[2]	4,923 b	—
	25 C + 9 days 35 C	5,780 b	—
90 days	25 C	2,534 a	564 a
	25 C + 3 days 35 C	12,961 b	2,159 b
	25 C + 9 days 35 C	10,427 b	1,767 b
Tomatoes ('Rutgers')			
60 days	25 C	18,696 a	—
	25 C + 3 days 35 C	35,487 a	—
	25 C + 9 days 35 C	34,750 a	—
90 days	25 C	114,234 a	25,529 a
	25 C + 3 days 35 C	64,099 a	12,546 a
	25 C + 9 days 35 C	43,460 a	8,093 a

[1]Column means followed by the same letter do not differ (P=0.05) according to F test with the transformation $\sqrt{N + 0.5}$. Each is the mean of 10 replications.
[2]Temperature increased 28 days after planting.

TABLE 3. Numbers of *Pratylenchus alleni* recovered from soybean and tomato plants grown 90 days after inoculation with 5,000 of these nematodes at constant temperatures.

Host	Soil temperature (C)	Total nematodes (roots + soil)	Nematodes/g of dry root
Soybeans:			
'Clark 63'	27.5	3,394 a[1]	983 b
	32.0	38,734 a	8,236 ab
	37.5	352,963 a	23,878 a
'Cutler 71'	27.5	737 b	309 b
	32.0	7,142 b	2,937 b
	37.5	42,492 a	19,108 a
Tomatoes:			
'Rutgers'	27.5	80,834 b	18,845 b
	32.0	207,364 a	88,457 a
	37.5	133,812 ab	94,536 a

[1]Column means followed by the same letter do not differ ($P=0.05$) according to F test with the transformation $\sqrt{N}+0.5$. Each is the mean of 10 replications.

P. scribneri and *P. alleni* reproduced at relatively low temperatures on tomatoes, so that the temperature limitation depends on the nematode-host interaction and not on the nematode itself.

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