Soil Temperature Effects on Onion Seedling Injury by *Pratylenchus penetrans*[1]

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Abstract: The effect of soil temperatures 7–25 C upon injury to seedling onions by *Pratylenchus penetrans* was investigated. At 7–13 C < 100 nematodes/g of root caused significant reduction in onion root weights by the fifth week. More than 400 nematodes/g were required to produce comparable injury at 16–25 C. *Key Words: Pratylenchus penetrans,* Pathogenicity, Onion seedlings, Soil Temperature.

Studies of *Pratylenchus penetrans* (Cobb) in onion fields in Indiana occasionally, but not consistently, show conspicuous damage caused by small numbers of the nematode (1, 2). Moisture and plant nutrients were not suspected to have limited plant growth or nematode pathogenicity in these situations. Soil temperature, however, was an uncontrolled variable which may have been influential in the field. The tests reported here were designed to determine the effect of soil temperature on the pathogenicity of *P. penetrans* to onions.

MATERIALS AND METHODS

A series of five tests were performed, in which soil temperatures of 7, 10, 13, 16, 19, and 25 C were maintained in six Cornell-type temperature tanks (4). The highest temperature (25 C) was maintained ±3 C; at the other temperatures, the deviation was ±1 C. Onion seeds (var. 'Downing Yellow Globe') were planted along a diameter line of a 4-inch plastic pot containing a steam sterilized mixture of soil, sand and perlite (2:1:1). Soon after germination, plants were thinned to six per pot. Inoculation of onions was accomplished by mixing thoroughly washed and finely chopped *P. penetrans* infected soybean roots (1g/4-inch pot) with the steam sterilized soil mixture prior to planting the onion seed. This inoculation technique resulted in an infestation of from 900 to 4000 *P. penetrans* per 4-inch pot in the five tests.

Each plastic pot was placed in moist sand in a water-tight, lidless can immersed in the water of the temperature tank (Fig. 1). A thermometer was inserted into the center of the 4-inch pot. Gravel was placed in the bottom of the can and a drainage tube inserted. During humid periods in the greenhouse, condensation, which accumulated in the cans maintained at the lower soil temperatures, was removed by inserting a wand connected to an aspirator pump down the drain tube.

Although the actual number of plants used varied slightly between experiments, in most cases sixteen 4-inch pots of onions were grown at each of the six temperatures, making a total of 96 pots in a test. Half of the pots at each temperature were infested with *P. penetrans*. During a test, half of the plants growing at each temperature were harvested at one intermediate time interval and the remainder when the test was terminated. An equal number of inoculated and check onion plants were included at each harvest. The earliest harvest date was 3 weeks after seed germination and the latest 12 weeks after germination. Other harvest intervals included 5 and 7 weeks, with different combinations of these intervals utilized in the experiments. At each harvest time the soil was washed

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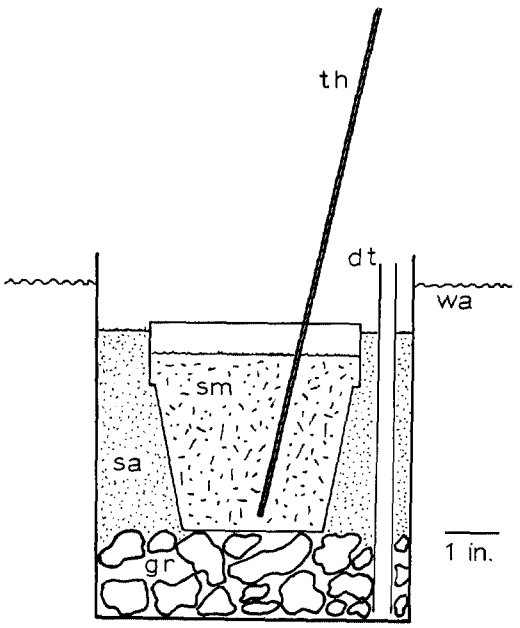

FIG. 1. Arrangement of 4-inch plastic pot inside water-tight can immersed in water of a Cornell-type temperature tank (dt = drainage tube; gr = gravel; sa = sand; sm = soil mixture; th = thermometer; wa = water of temperature tank).

from the roots of all plants in a pot. Roots were blotted dry with paper toweling and the fresh weight and top weight of the six plants recorded. A reduction in the root weight of the onion plants inoculated with *P. penetrans*, as compared to the root weight of the uninoculated check plants, was used as the criterion of injury. Roots of inoculated plants were incubated for 1 week in 150 ml of tap water through which air was bubbled constantly. The total number of nematodes emerged from the six plants in a pot was counted.

RESULTS

Mean root weight data obtained at different harvest intervals are presented in Table 1. Data from one test which included harvest intervals of 3 and 5 weeks, and from another test which included the harvest interval of 12 weeks, are shown. With harvest dates as early as 3 weeks, the reduction in root weight of inoculated plants was not statistically significant at any of the temperatures. However, with harvests from 5 to 12 weeks, significant reductions in root weights of inoculated plants were usually obtained at the lower soil temperatures (7–13 C). Statistically significant reductions in root weights at the higher (16–25 C) soil temperatures were infrequent.

TABLE 1. Root weights of six onion plants grown in 4-inch pots with and without *Pratylenchus penetrans* at different soil temperatures.

Soil temperature (C)	Length of growing period: 3 weeks[a] Fresh weight Check (g)	3 weeks[a] Fresh weight Inoculated (g)	3 weeks[a] *P. penetrans* per g of root	5 weeks[a] Fresh weight Check (g)	5 weeks[a] Fresh weight Inoculated (g)	5 weeks[a] *P. penetrans* per g of root	12 weeks[b] Fresh weight Check (g)	12 weeks[b] Fresh weight Inoculated (g)	12 weeks[b] *P. penetrans* per g of root
7	0.25	0.22	31	0.50	0.48	30	1.78	0.65**	5
10	0.27	0.25	63	0.71	0.57**	23	3.46	1.59**	1
13	0.43	0.35	38	1.00	0.66**	82	4.68	2.90**	7
16	0.36	0.33	83	0.92	0.81	104	8.96	7.24	22
19	0.38	0.32	382	0.83	0.58*	389	11.14	10.40	52
25	0.35	0.29	573	0.68	0.56	731	9.84	9.71	129

[a] Avg of four replicates; inoculum level 900 *P. penetrans*/4-inch pot.
[b] Avg of five replicates; inoculum level 2000 *P. penetrans*/4-inch pot.
* Difference between weights of check and inoculated plants significant at 5% level.
** Difference between weights of check and inoculated plants significant at 1% level.

TABLE 2. Top weights of six onion plants grown in 4-inch pots with and without *Pratylenchus penetrans* at different soil temperatures.

Soil temperature (C)	Length of growing period					
	3 weeks[a]		5 weeks[a]		12 weeks[b]	
	Fresh weight		Fresh weight		Fresh weight	
	Check (g)	Inoculated (g)	Check (g)	Inoculated (g)	Check (g)	Inoculated (g)
7	0.66	0.59	1.42	1.34	2.66	1.35
10	0.68	0.64	1.74	1.51	4.05	3.05
13	1.12	1.06	2.70	2.13*	5.60	4.88
16	1.12	1.05	2.80	2.59	13.20	10.87
19	1.52	1.41	3.37	2.41	20.83	19.97
25	1.53	1.44	3.12	3.30	39.68	37.09

[a] Avg of four replicates.
[b] Avg of five replicates.
* Difference between weights of check and inoculated plants significant at 5% level.

Mean top weights obtained in these same tests are presented in Table 2. Generally, there was a trend toward a reduction in top weight of inoculated plants as compared to the controls. However, in most instances the reduction was not statistically significant. Significant reduction in top weight was always accompanied by significant reduction in root weight.

DISCUSSION

The results of these tests help to explain a phenomenon occasionally observed in Indiana onion fields despite carefully executed fumigation schedules. In one documented case, only a small area of a very large field planted with onions showed characteristic symptoms of nematode injury. Damage was confined to that portion of the field which had been planted early (during March and April). Since the numbers of *P. penetrans* in the soil were fairly low throughout the field, the area having been treated with dichloropropene nematicides the previous fall, the hypothesis was proposed that soil temperature has a marked influence on the ability of this lesion nematode to cause injury to onion.

From the data presented, it can be seen that onion root systems growing at low soil temperatures (7–13 C) may be severely injured by *P. penetrans* when the density of nematodes is less than 100 per gram of root. At higher soil temperatures (16–25 C) considerably more *P. penetrans* per gram of root may be present without injuring the onion plant. It is postulated that low soil temperature slows growth of onion plants but does not restrict feeding and migration of *P. penetrans* altogether. This supposition also explains why a significant increase in yield was not obtained in one field test of several commercial dichloropropene fumigant formulations (3). In that experiment the density of *P. penetrans* in the check plant roots was only 30 per g. Soil temperatures during the growth of these plants were continually rising, reaching 12 C at 3 weeks and over 20 C at 7 weeks, the time root count data were taken. If the nematode density per g of root is low (less than 100) more than 3 weeks at the lower soil temperatures are necessary to cause significant injury to onion plants.

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