Effect of Certain Environmental Factors and Host Plants on Reproduction of *Hoplolaimus galeatus*

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ABSTRACT

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The effects of soil texture and host plants on the reproduction of *Hoplolaimus galeatus* were investigated under greenhouse conditions. A three-way interaction among soil, crop, and pH existed. Sandy loam soil was more suitable for nematode reproduction than silty loam or loamy sand soil. The pH effect varied with the host plant; population increases were greatest at pH 7 for bean and pH 5 for barley. The rate of reproduction of *H. galeatus* was significantly higher on rye, barley, wheat, oats, soybean, corn, cabbage, and bean than on pepper, eggplant, lettuce, tobacco, and pea.

The lance nematode *Hoplolaimus galeatus* has a wide geographic distribution and is reported to be associated with decline in plants (8). The host-parasite relationships of *H. galeatus*, however, have been established for only a few hosts. In view of the frequency of occurrence of *H. galeatus* on many crops in New Jersey and the limited information on its biology, studies were conducted on the influence of environmental factors and host plants on the reproductive potentials of this nematode.

MATERIALS AND METHODS

Nematodes were obtained from a stock culture of *H. galeatus* maintained in the greenhouse on bent grasses. The soil and roots from the stock culture were washed, and the nematodes were extracted from the soil suspensions with a modified Baerman funnel method (Cornell pie-pan method). The nematodes were counted in a 5-ml aliquot under ×30 magnification.

Nineteen plant varieties were tested for suitability as hosts for *H. galeatus*. Five replicates of each plant were grown in 12.5-cm clean pots filled with pasteurized sandy loam soil, pH 5.5. Four plants 5–7.5 cm high were inoculated with 200 adult nematodes; the fifth plant served as a control. Nematode inoculation was done by pouring the inoculum (200 nematodes/pot) into three holes about 1–2 in. deep next to the base of the plant. The pots were then watered lightly. Four months after inoculation, the nematodes were extracted and counted. Average numbers with four replicates per plant were used for statistical analysis. The root systems were examined for general appearance, discoloration, and nature and extent of feeder root growth.

The effects of soil texture, pH, and host on population changes of *H. galeatus* were studied in a combined experiment to allow assessment of interactions. Design of the experiment included two hosts (bean and barley) at three different pH levels for each of three different soils, with three replicates of each treatment (two hosts × three soils × three pH values × three replicates = 54 pots). Three natural soil textures were collected from areas in New Jersey: silty loam (Piscataway), pH 4.9; sandy loam (Bridgeton), pH 5.4; and loamy sand (Bridgeton), pH 6.1. The desired pH level was obtained by treating each soil with appropriate amounts (g amendment/kg soil) of pulverized limestone and powdered sulfur. After a 2-wk adjustment period to allow the soil chemistry to stabilize, the pH was checked and readjusted to 5, 6, and 7. The soils were pasteurized with dry heat, examined for the presence of nematodes before use, and placed in pots (2 kg/pot). All plants were irrigated with tap water and inoculated with 100 nematodes per plant. After 2 mo, the nematodes were extracted and counted and the data analyzed.

RESULTS

Statistical analysis of the number of nematodes recovered showed significant differences among the increases of nematode populations on different plants (Table 1). The observed F value 13.78 for the differences among the plants was significant ($P = 0.01$). *H. galeatus* populations were significantly higher on barley, wheat, soybean, cabbage, bean, corn, and rye than on other plants tested. Populations were higher on onion, tomato, oats, and sorghum than on squash, cucumber, okra, pea, tobacco, and eggplant. No increases occurred on lettuce or pepper.

The root systems of cereals (rye, barley, oats, and wheat), soybean, common bean, cabbage, and corn were discolored and had fewer feeder roots than the noninfested controls. The root systems of control plants appeared healthy, with large numbers of white normal roots and

Table 1. Effect of different host plants on the population increase of *Hoplolaimus galeatus*[y]

Serial no.	Host plant: Scientific name	Host plant: Common name	Mean nematodes per 12.5-cm pot[z]	Grouping
1	*Capsicum frutescens*	Pepper	174	a
2	*Lactuca sativa*	Lettuce	204	ab
3	*Solanum melongena*	Eggplant	270	ab
4	*Nicotiana tabacum*	Tobacco	276	ab
5	*Pisum sativum*	Pea	314	ab
6	*Hibiscus esculentus*	Okra	465	abc
7	*Cucumis sativus*	Cucumber	406	abc
8	*Cucurbita maxima*	Squash	405	abc
9	*Sorghum vulgare*	Sorghum	658	bcd
10	*Avena sativa*	Oats	789	cd
11	*Lycopersicon esculentum*	Tomato	821	cde
12	*Allium cepa*	Onion	856	cdefg
13	*Hordeum vulgare*	Barley	1,018	defg
14	*Triticum aestivum*	Wheat	1,081	defg
15	*Glycine max*	Soybean	1,099	defg
16	*Brassica oleracea* var. *capitata*	Cabbage	1,120	defg
17	*Phaseolus vulgaris*	Bean	1,298	efg
18	*Zea mays*	Sweet corn	1,380	fg
19	*Secale cereale*	Rye	1,494	g

[y] Duration of test, 4 mo; number of nematodes inoculated, 200 per plant.
[z] Means with the same letters are not significantly different (α 0.05).

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Table 2. Effect of soil texture, crop, and pH, on the population of *Hoplolaimus galeatus*[a]

Soil texture	Crop	Nematode numbers per pot at three pH levels[b]		
		pH 5	pH 6	pH 7
Sandy loam	Bean	100	100	190
	Barley	177	100	101
Silty loam	Bean	128	130	130
	Barley	160	117	99
Loamy sand	Bean	100	145	120
	Barley	125	100	102

[a]Duration of experiment, 2 mo; number of nematodes inoculated, 100 per plant.
[b]ANOVA test: crop-soil-pH interaction ($Pr > F$ 0.0001).

no discoloration. No differences were noted between noninfested and infested root systems of all other species. Because of considerable variation in root growth even among plants in the same treatment, expression of nematode population in terms of gram-weight of root would not present an accurate picture of the results.

No differences were noticeable in top or root growth among the plants grown in the three different soils. Final population was considered an adequate measure of the effects of pH and soil texture on *H. galeatus*. The ANOVA (analysis of variance) showed significant $Pr > F$ 0.0001 three-way interactions among soil, crop, and pH (Table 2). Sandy loam and silty loam had significantly higher numbers of *H. galeatus* than loamy sand at α 0.05 level. However, there were no significant differences between sandy loam and silty loam soils.

The population of *H. galeatus* was significantly higher at pH 7 than at pH 6 or pH 5 (α 0.05) on bean and at pH 5 than at pH 7 or pH 6 (α 0.05) on barley.

DISCUSSION

The rate of reproduction of *H. galeatus* was high in some of the 19 plant species evaluated as hosts but negligible in others. Apparently, the nematode prefers particular plant species. Duggan (2) reported that root diffusate of many plant species may increase or decrease the hatching of nematode eggs. The resistance of many plant species may also restrict reproduction of a particular nematode (7). In addition, biochemical interaction between nematode and host plant may result in production of toxic substances injurious to the nematode species (6).

Statistical analysis of the data in our study showed that significant differences existed among different plant species as a suitable host for lance nematode reproduction and development. Analysis also revealed, however, that plant species were not significantly different within the same treatment, although the number of nematodes recovered from different plants within the group varied considerably. Previous workers have interpreted host suitability for lance nematode reproduction only on the basis of differences in the number of nematodes on different plants (3,4).

We found pepper, lettuce, eggplant, tobacco, and pea to be poor hosts for *H. galeatus* and tomato to be a good host. Tobacco and pea were reported to be poor hosts for *H. indicus* (4) and pepper to be a poor host for *H. columbus* (3) whereas tomato was an excellent host for *H. indicus* but a poor host for *H. columbus*. Our study indicated that cereals, corn, soybean, and common bean are favorable hosts for *H. galeatus*.

The maximum number of *H. galeatus* occurred in sandy loam and silty loam soils. Porous soil (loamy sand) is more conducive to water movement than fine-textured soils (silty loam and sandy loam), which may prevent adherence of the large and sluggish lance nematodes to soil particles. Soil with 10–20% clay content (sandy loam) appears to provide the optimal environment for nematode reproduction.

The optimal pH giving the maximal increase in numbers of *H. galeatus* was pH 7 for the legume (bean) and pH 5 for the cereal (barley) on all soils. Burns (1) noted that *H. galeatus* numbers in soybean were lower at pH 4 than at pH 6, that soil pH alters mineral uptake in soybean, and that potassium uptake was less at pH 6 than at pH 4. Potassium deficiencies are known to decrease the amount of carbohydrates stored in plants, and the resulting morphological changes, such as thinning of the epidermal cell walls, could affect the degree of invasion by the lance nematode. Similarly, Lewis and Smith (5) observed that the number of *H. columbus* recovered from soybean soils increased as pH rose to 6.8. Higher numbers associated with barley at pH 5 may be attributed to a more suitable host metabolism or to improved plant growth at the lower pH level.

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