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Susceptibility of Eight Herbs to Common Root-Knot Nematodes[1]

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Abstract

Eight herb species were inoculated with two common species of root-knot nematode and grown for 2 months in a greenhouse. Root systems were examined for galls and egg mass production. All herb species were susceptible but developed fewer galls and had lower gall indices than Rutgers tomato. Burnet, chives, valerian and winter savory had few galls or low gall indices. Eggs were produced on all. Chamomile had a high gall index. Chicory, parsley, and sorrel had intermediate indices. Herbs were equally susceptible to the southern (*Meloidogyne incognita*) and peanut root-knot nematodes (*M. arenaria*), particularly at the highest inoculum densities. Mean dry weights of inoculated herbs were not always significantly less than the non-inoculated plants, suggesting that some herbs may be tolerant to root-knot nematodes.

Index words: host plants, perennials, home gardens, plant disease, root-galling, egg masses, peanut root-knot nematode, southern root-knot nematode.

Species used in this study: *Meloidogyne arenaria* (Neal) Chitwood, peanut root-knot nematode, *Meloidogyne incognita* (Koford S White) Chitwood, Southern root-knot nematode, burnet (*Sanguisorba minor* L.), chamomile (*Chamaemelum nobile* L.), chicory (*Cichorium intybus* L.), chives (*Allium schoenoprosum* L.), parsley (*Petroselinum crispum* (Mill.) Airy-Shaw, sorrel (*Rumex acetosa* L.), valerian (*Valeriana officinalis* L.), winter savory (*Satureja montana* L.), tomato (*Lycopersicon esculentum* L. cv. 'Rutgers').

Significance to the Nursery Industry

Herbs can be produced more economically if growers know in advance what diseases and pests are likely to attack their crops. This investigation examined the susceptibility of eight herbs to two common root-knot nematode species. All herbs evaluated were considered hosts because nematode reproduction occurred, although the level of reproduction on many species was much lower than was noted on the susceptible 'Rutgers' tomato, and may be considered tolerant to both root-knot nematodes.

Introduction

Interest in herbs for culinary, fragrance and medicinal purposes dates from ancient times (7, 17). Now there is a resurgence of interest in the potential of herbs and plant products for human and animal medicine (3, 8, 12) as well as emphasis on 'natural' products for control of plant diseases and pests (2, 6, 9, 10, 11).

Herbs generally are considered fairly resistant to many diseases (14). Information on their susceptibility to nematodes is somewhat limited, especially with regard to inoculation with specific species. In the late 1950s and 1960s , field surveys for plant feeding nematodes were common on major crops and landscape plants throughout the world. A number of herb species were included in this activity and were reported as hosts (4).

Nematodes decreased the growth of basil in Florida (15) and have resulted in decline of thyme in Mauritius (1). Dry weights of balm, dill, oregano, peppermint, tansy and thyme decreased after inoculations with *Meloidogyne incognita* in greenhouse experiments (18).

The expanding production and sales of herbs to the gardening public (7, 13) and use in international cuisines (5, 16) suggest that we should learn more about the susceptibility of herbs to plant parasitic nematodes. Hence, the purpose of this investigation was to examine a few herb species not included in prior studies for their susceptibility to two common root-knot nematode species.

Materials and Methods

Spring planting. Seeds of chicory, *Cichorium intybus L.*; chives, *Allium schoenoprasum*; parsley, *Petroselinum crispum (Mill.) Nym*.; valerian, *Valeriana officinalis L.* were planted in a pasturized soil-Promix BX (Premier Horticulture Inc., Red Hill, PA) — vermiculite medium (2:1:1 by vol), and two weeks after germination four to six seedlings of each species were transplanted into 10 cm (4 in) diam. plastic pots 380 cm^3 (23 in^3) containing the same medium. Herbs germinated at slightly different rates, but all were transplanted three weeks after seeding.

Herb seedlings were inoculated with 0, 760, and 5700 eggs of *Meloidogyne incognita*, obtained from root-galls of 'Black Beauty' eggplant (*Solanum melongena L*), by pipetting a suspension of eggs into the center of each pot. Plants were placed in a greenhouse with daytime temperatures ranging from 20–32C (68–89F) and nighttime minimums of 16C (61F). There were twelve replications with four to six plants per replication for each inoculum density in a randomized block design.

Plant roots were washed and the number of root-galls counted and the presence or absence of egg masses noted on each replica by a score of one or zero, respectively, two months after inoculation. Plant heights and dry weights were recorded. Data were analyzed by analysis of variance using the General Linear Model Procedure (SAS).

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Table 1. **Mean height, dry weights, number of root-galls and egg mass score on four herbs inoculated at two egg densities of Meloidogyne *incognita* compared with Rutgers tomato.**

Herbs	Height (cm)			Dry wt (g)			Number galls/plant		Egg mass score	
	Egg density/380 cm³									
	0	760	5700	0	760	5700	760	5700	760	5700
Chicory	10.6bc[z] (A)[x]	6.5cd (B)	7.0c (A)	3.1b (A)	1.9c (B)	1.5c (B)	3.7b (A)	21.5b (B)	1.0[y]	0.6
Chives	7.4cd (A)	7.2c (A)	8.0c (A)	0.5c (A)	0.4d (A)	0.2e (B)	0.3b (A)	0.9d (B)	0.5	0.7
Parsley	4.3d (A)	3.8d (A)	4.0d (A)	1.4c (A)	1.1cd (B)	0.9d (B)	4.6b (A)	10.9c (B)	1.0	1.0
Valerian	13.6b (A)	11.1b (AB)	9.9b (B)	3.8b (A)	3.5b (A)	2.5b (B)	0.9b (A)	3.5d (B)	0.3	0.8
Tomato	48.3a (AB)	52.0a (A)	47.3a (B)	6.2a (A)	6.7a (A)	7.6a (A)	40.5a (A)	109.0a (B)	1.0	1.0

[z]Mean of 12 replications with 4–6 plants in each replication. Dissimilar letters within columns represent significant differences at P = 0.05 for LSD of each variable by General Linear Model procedure.

[y]Egg mass score: 0 = no egg masses observed; 1 = numerous egg masses. Values represent mean of twelve replications.

[x]Dissimilar letters across means represents significant differences at P = 0.05 for LSD.

Fall planting. Seeds of four additional herb species (burnet, *Sanguisorba minor* L; chamomile, *Anthemis nobilis* L.; sorrel, *Rumex acetosa* L.; winter savory, *Satureja montana* L.) were planted in the fall, and transplants inoculated with either *M. arenaria* or *M. incognita* separately at the rate of 0, 600, and 5400 eggs per 10 cm (4 in) diam pot with six replications per treatment. *M. arenaria* eggs were obtained from coleus (*Coleus blumei L.*); *M. incognita* eggs from eggplant. Following inoculation, the herbs grew for two months at temperatures ranging from 12–29C (54–84F). The experiment was repeated with one inoculum density of 6800 eggs. Plants were watered daily and fertilized at three intervals with liquid fertilizer (Peters 20N–20P–20K [50 g/19 liters (1.8 oz/5 gal)]). Roots were examined for root-galls and given an index of 1 to 5 with 5 representing more than 100 galls per root system. Roots were stained with phloxine B to enhance the detection of egg masses. The presence of egg masses on each replicate was designated with a 1.0, their absence by zero and the mean for all replicates was calculated. Plant heights and dry weights were measured; all data were subjected to analysis of variance. Tomato 'Rutgers' transplants were included in all experiments to verify nematode infectivity on a susceptible host at each inoculum density.

Results and Discussion

Spring planting. Chicory, chives, parsley, and valerian supported some reproduction of *M. incognita*, yet had significantly fewer root-galls at both infestation levels than did tomato (Table 1). A highly significant interaction between the infestation level and herb species for galling and plant dry weight parameters was also noted at the lowest infestation level of 760 eggs (2 eggs/cm³). No statistical difference in number of galls among these four herbs was observed. At the higher infestation level of 5700 eggs (15 eggs/cm³), significantly more galls were present on chicory than on parsley, while gall counts were higher on parsley than on either chives or valerian. Within each herb species and tomato, significantly more galls were present at the highest infestation level than at the lowest infestation level.

Little difference occurred between the height of inoculated and noninoculated plants. The dry weights of noninoculated herbs varied by species as expected, but weight of nemotode inoculated herbs was affected by the rate of inoculum (P = 0.0001), with those at the highest inoculum rate weighing less than the controls. For example, infected chicory and chives weighed 50 and 60 percent less than the noninoculated plants. When ratios of gall numbers per gram to herbal dry weight were calculated at the highest inoculum rate, chives and valerian had values of 4.5 and 1.4; the ratios for chicory and tomato were identical at 14.3 and for parsley, 12.1.

Egg masses were observed on all herbs at both infestation levels, with slightly lower scores recorded for chives and valerian than for the other herbs.

Fall planting. In the first fall experiment neither nematode species had any effect on plant height, dry weight or gall indices, but there was a significant effect of inoculum density on the gall index with the highest gall indices present on herbs inoculated with 5400 eggs per container.

In the repeat experiment at the inoculum density of 6800 eggs/container, no difference in gall indices or egg mass scores resulted on a specific herb between inoculations with the southern root-knot nematode or with the peanut root-knot nematode. Because of this nonspecificity (no interaction between herbs and nematode species), the mean values for the dependent variables of gall indices and egg mass score are provided in Table 2. Tomato data were excluded from the analysis.

Table 2. **Root-gall indices and egg mass scores of herbs inoculated with 6800 eggs/pot of root-knot nematodes, (*M. arenaria* and *M. incognita*).**

Herb	Gall index[z]	Egg mass score[y]
Burnet	1.50de[x]	0.33c
Chamomile	3.17a	0.65a
Chicory	2.27b	0.46abc
Chives	1.33de	0.61ab
Parsley	1.94c	0.56ab
Sorrel	2.22bc	0.50abc
Valerian	1.60d	0.47abc
Winter Savory	1.22e	0.39bc

[z]Gall index: 1 = no galls, 2 = 1–50 galls, 3 = 51–75 galls; 4 = 76–100 galls, 5 = >100 galls. Based on six replications for each of two nematode species.

[y]Egg mass score: 0 = no egg masses observed, 1 = numerous egg masses observed in each replicate. Mean values represent six replications for each of two nematode species.

[x]Dissimilar letters indicate significant differences at P = 0.05 for LSD by General Linear Model procedure.

Table 3. **Effect of root-knot nematodes (M. *arenaria* and M. *incognita*) on mean height, dry weights, gall indices (GI) and egg mass scores (EMS) of eight herbs.**

Nematode	Height (cm)	Dry weight (g)	GI[z]	EMS[y]
M. arenaria	11.9a[x]	51.1b	2.9a	0.7a
M. incognita	10.3b	50.4b	2.9a	0.8a
Control	12.7a	70.9a	0.0b	0.0b

[z]Gall index: 1 = no galls, 2 = 1–50 galls, 3 = 51–75 galls; 4 = 76–100 galls, 5 = >100 galls/plant. Mean values of six replications for each herb.

[y]Egg mass score: 0 = no egg masses observed, 1 = numerous egg masses observed. Mean values of six replications for each herb.

[x]Dissimilar letters within columns signify differences at P = 0.05 for LSD by General Linear Model procedure.

As expected, the dry weights varied between herb species. These data are not presented in their entirety because there was no interaction between nematodes and species of herbs for dry weight, but are provided in Table 3. This could be interpreted that herbs are tolerant to these nematodes rather than susceptible, yet in the spring experiment, the interaction between herbs and inoculum density for dry weight was significant. The warmer greenhouse temperatures and longer day lengths in the spring planting were more conducive for herb growth and nematodes than environmental conditions in the fall.

The presence of egg masses confirmed that nematode reproduction occurs on all the herbs species tested and therefore, they must be considered as hosts. If greater differences in galling and egg mass scores had been observed between herbs, then a reproductive factor (Pi/Pf) may prove more appropriate for detecting any differences between herb species in their response to the common root-knot nematodes.

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