

Nematodes Parasitic on Forest Trees:

III. Reproduction on Selected Hardwoods

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Abstract: The host-parasite relationships of 13 species of plant parasitic nematodes and five species of hardwoods native to the southeastern United States were tested on greenhouse-grown tree seedlings for 6–10 months. Criteria for parasitism were completion of life cycle and population increase of nematodes. *Belonolaimus longicaudatus*, *Helicotylenchus dihystera*, *Scutellonema brachyurum* and *Tylenchorhynchus claytoni* parasitized and reproduced on three or more of the species tested. *Hoplolaimus galeatus* and *Pratylenchus brachyurus* parasitized two species, *Trichodorus christiei* and *Criconemoides xenoplax* parasitized only red maple. *Meloidogyne javanica*/*Liriodendron tulipifera* combination was the only positive root-knot nematode/hardwood host-parasite relationship. *Hemicycliophora silvestris*, *Meloidogyne arenaria*, *M. incognita*, and *M. hapla* were not parasites of the tree species tested. **Key Words:** Host-parasite relations, *Liquidambar styraciflua*, *Acer rubrum*, *Liriodendron tulipifera*, *Platanus occidentalis*, *Populus heterophylla*.

Greenhouse tests with plant-parasitic nematodes on pines have been previously reported (5, 8). Many of the nematodes which were tested are also associated with certain hardwood species important to the forest economy of southeastern USA (7).

This paper reports a greenhouse study in which the parasitism of 13 selected species of plant-parasitic nematodes occurring in forest plantations and in natural woodlands was tested on five hardwood species native to the southeastern United States. A tree species was classed as a host if nematodes completed their life cycle in or on its roots and populations actually increased during the experiment.

MATERIALS AND METHODS

The following plant-parasitic nematodes were freshly recovered from forest soils and reared in the greenhouse throughout the year (maintained at 24 to 30C): *Belonolaimus longicaudatus* Rau, reared on St. Augustine

grass (*Stenotaphrum secundatum* (Walt.) Kuntze); *Criconemoides xenoplax* Raski, on peach seedlings (*Prunus persica* [L.] Batsch var. 'Elberta'); *Helicotylenchus dihystera* (Cobb), on cotton (*Gossypium hirsutum* L. var. 'Coker 201'); *Hemicycliophora silvestris* Jenkins and Reed, on loblolly pine (*Pinus taeda* L.); *Hoplolaimus galeatus* (Cobb) on bent grass (*Agrostis palustris* Huds.); *Trichodorus christiei* Allen, on loblolly pine. *Scutellonema brachyurum* (Steiner) and *Pratylenchus brachyurus* (Godfrey), both recovered from agricultural soils, were reared on amaryllis (*Amaryllis vittata* Ait.) and cotton, respectively. Isolates of four species of root-knot nematodes (*Meloidogyne arenaria* (Neal), *M. hapla* Chitwood, *M. incognita* (Kofoid & White), and *M. javanica* (Treb)) were provided by Dr. J. N. Sasser, North Carolina State University, Raleigh, N. C. and reared on tomatoes (*Lycopersicon esculentum* Mill. var. 'Rutgers').

The hardwood species used were: red maple, *Acer rubrum* L.; sweetgum, *Liquidambar styraciflua* L.; yellow-poplar *Liriodendron tulipifera* L.; American sycamore, *Platanus occidentalis* L.; and swamp cottonwood, *Populus heterophylla* L.

Yellow-poplar and sweetgum were grown

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TABLE 1. Numbers of nematodes recovered from soil and root samples of southern (USA) hardwoods.^a

Nematodes	Cottonwood	Red maple	Sweetgum	Sycamore	Yellow-poplar
<i>Belonolaimus longicaudatus</i>	no test	100 ^b 9 284(3)	100 9 2,308(5)	no test	650 6 0(0)
<i>Criconemoides xenoplax</i>	1,000 9 282(0)	1,000 9 443(2)	1,000 9 17(0)	1,000 9 27(0)	1,000 9 30(0)
<i>Helicotylenchus dihystera</i>	1,000 7 7,722(5)	1,000 7 78(0)	1,000 6 0(0)	1,000 7 34,429(5)	1,000 6 6,048(5)
<i>Hemicycliophora silvestris</i>	no test	no test	1,000 10 0(0)	200 10 0(0)	500 8 0(0)
<i>Hoplolaimus galeatus</i>	900 8 1,032(3)	1,000 9 0(0)	1,000 6 323(0)	900 8 1,688(4)	1,000 9 213(0)
<i>Pratylenchus brachyurus</i>	no test	1,000 9 7,472(5)	1,000 9 42(0)	900 9 308(0)	1,000 9 3,014(5)
<i>Scutellonema brachyurum</i>	1,000 7 981(2)	1,000 7 3,874(4)	1,000 8 111(0)	1,000 7 17,058(5)	1,000 7 9,771(4)
<i>Trichodorus christiei</i>	1,000 8 395(1)	1,000 8 4,871(4)	1,000 7 0(0)	no test	1,000 7 190(0)
<i>Tylenchorhynchus claytoni</i>	500 7 4,718(2)	500 8 1,389(3)	500 8 0(0)	no test	950 9 774(3)

^a Means based on five replications for each nematode species. Counts from roots and soil were combined and used to estimate total nematodes per pot.

^b In each group for each species, the top number refers to inoculum, middle number to test period in months, bottom number to mean number of nematodes per pot at end of test, and number in parentheses to number of pots showing an increase above the inoculum level.

from seed and all other species were propagated from cuttings. All seedlings and rooted cuttings were greenhouse-grown in steam-pasteurized soil (80 C for 1 hr) for 3 to 5 months before being transplanted to 20-cm clay pots, each containing 2840 cc of steamed fine sandy loam.

The four *Meloidogyne* species, *H. galeatus*, and *P. brachyurus* were extracted from infested roots placed in a mist chamber (3). All other nematodes were obtained from soil in pot cultures by a combination elutriator-cottonwool filter method (4).

Seedlings and rooted cuttings were inoculated 5 to 8 weeks after potting with water suspensions of nematodes poured into two holes, each 10-cm deep in the soil, on opposite sides of the plants. Inoculum rates were from 900 to 1,000 for all but three nematodes. Sufficient inoculum for *T. claytoni*, *H. silvestris*, and *B. longicaudatus* was not available, thus fewer than 900 nematodes were used for these tests. Inoculations for all species were replicated five times. Ra-Pid-Gro® liquid fertilizer was added monthly

TABLE 2. Parasitism of nematodes on southern hardwoods.

Nematodes	Cottonwood	Red maple	Sweetgum	Sycamore	Yellow-poplar
<i>Belonolaimus longicaudatus</i>	0 ^a	+	+	+ ^b	-
<i>Criconemoides xenoplax</i>	-	+	-	-	-
<i>Helicorylenchus dihystra</i>	+	-	-	+	+
<i>Hemicycliophora silvestris</i>	0	0	-	-	-
<i>Hoplotaimus galeatus</i>	+	-	-	+	-
<i>Meloidogyne arenaria</i>	-	-	-	-	-
<i>M. hapla</i>	-	-	-	-	-
<i>M. incognita</i>	-	-	-	-	-
<i>M. javanica</i>	-	-	-	-	+
<i>Pratylenchus brachyurus</i>	0	+	-	-	+
<i>Scutellonema brachyurum</i>	+	+	-	+	+
<i>Trichodorus christiei</i>	?	+	-	0	-
<i>Tylenchorhynchus claytoni</i>	+	+	-	0	+

^a + = Positive host-parasite relationship; - = doubtful host-parasite relationship; 0 = not tested; ? = results too variable to permit a conclusion.

^b Reported by Ruehle in 1968 (6).

(150 ml of 0.3% solution per pot) and the pots were watered as needed.

After 6 months, seedlings inoculated with root-knot nematodes were removed from the pots; the roots were rinsed and examined under a 3× magnifier. After 6 to 10 months all seedlings or cuttings inoculated with the other nematode species were removed from the pots, and the soil was gently shaken from the roots. The roots from each pot were rinsed carefully in 4 liters of tapwater. A 100-cc aliquant was taken from the soil remaining in the pot after it had been thoroughly mixed. The root washings and soil aliquants were assayed separately for nematodes by Jenkins' centrifugal-flotation technique (2).

Nematodes were recovered from 15 g of root tissue (excluding large diameter main

roots) cut and placed in funnels in the mist extraction chamber for 48 hr. Nematode counts from roots were combined with soil assay counts to provide an estimate of the total nematodes per pot. Root samples (15 to 20 g) were randomly selected from each plant inoculated with root-knot nematodes and examined microscopically. Slightly swollen areas were dissected in an attempt to find females and egg masses.

RESULTS AND CONCLUSIONS

The pot-to-pot variation in final populations of each nematode species found in earlier tests with pines was also noted in these tests (Table 1). Thus, if more than one pot in a group yielded nematodes in excess of the original inoculum, a host-parasite relationship was considered positive.

Because of the considerable variation in many groups, no attempt was made to evaluate the relative susceptibility of each host to parasitism by a particular nematode.

In the test of stubby-root nematode and cottonwood, only one pot yielded nematodes in excess of the inoculum and this combination was rated questionable. Combinations in which no pots exceeded the inoculum level were classed as doubtful.

M. javanica on yellow-poplar was the only species of root-knot nematode that parasitized and completed its life cycle on any of the hardwoods tested. Numerous Type 2 reactions described by Dropkin and Nelson (1) were found on the roots in this test. In less than 20% of the galls examined, Type 3 and 4 reactions were observed with two to three females per gall. There was a surprising lack of egg masses, even after 6 months. Subsequent to this, however, wilting yellow-poplar seedlings have been examined in the experimental forest at University of Georgia, School of Forest Resources, and numerous *M. javanica* females and egg masses were observed on galled and stunted seedlings.

The compilation of hosts and nonhosts presented in Table 2 gives arbitrary designations as a guide only. Generally, the nematodes which are associated with hardwoods in nurseries, plantations, or natural woodlands also parasitized the same species in this study. However, there were some exceptions. It is difficult to explain some of the reported associations that failed to give a positive host-parasite relationship in this study, *i.e.*, *H. galeatus* × sweetgum or red maple, *H. dihystra* × sweetgum or red maple, *C. xenoplax* × sycamore, *P. brachy-*

urus × sycamore. Most of these combinations were tested twice, each time with the same results. Some of the factors such as temperature, pH, moisture, and nutritional variables may have been operating and should be tested.

On the other hand, several nematode-host combinations which have not been reported proved positive in this study. These findings emphasize the problems that may arise when tree species normally grown in forest areas are planted on agricultural lands infested with nematodes parasitic on agronomic crops.

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