SUSCEPTIBILITY OF MAPLES TO ROOT-KNOT NEMATODES

by Frank S. Santamour, Jr.

Abstract. Seedlings of 19 maple (*Acer*) species, representing 11 of the 23 botanical sections recognized in the genus, were inoculated with the common root-knot nematodes *Meloidogyne arenaria* (two races), *M. hapla, M. incognita* and *M. javanica*, and 10 species with *M. querciana*, the oak root-knot nematode. Some major landscape species, such as *A. saccharum* and *A. pseudoplatanus*, were tolerant or resistant to all nematodes. Most of the other widely grown maples were susceptible to at least one of the common nematodes. Susceptibility to *M. hapla* appeared to be related to the sectional classification of maples. None of the maple species tested was susceptible to the oak root-knot nematode.

Maples (*Acer* spp.) have frequently been noted as hosts of root-knot nematodes (*Meloidogyne* spp.) but, with some notable exceptions, the nematode species have not been identified (12). Among the maples reported to be hosts of unidentified *Meloidogyne* sp. were *A. japonicum* (15), *A. macrophyllum* (1), *A. negundo* (16), *A. platanoides* (6), and *A. rubrum* (10). *Acer palmatum* was noted as a host of *M. mali* in Japan (5) and *A. saccharum* was a natural host of *M. ovalis* in Wisconsin (8, 9). Several other maples (*A. negundo, A. platanoides, A. rubrum*) were also susceptible to inoculation with *M. ovalis* (9). On the other hand, *A. rubrum* was reported as not susceptible to inoculation with the common nematodes *M. arenaria, M. hapla, M. incognita*, and *M. javanica* (11) or *M. platani*, the sycamore root-knot nematode (4).

Meloidogyne mali has not been found in the United States and our attempts to obtain *M. ovalis* from Wisconsin or Iowa (7) were unsuccessful. However, preliminary studies on several maples in 1989 (discussed below) showed that some species were susceptible to the common nematodes. This observation prompted a more extensive investigation of the susceptibility of a wide range of maple species to these nematodes. In addition, we wanted to test the susceptibility of selected maples to the oak root-knot nematode, *M. querciana* (3).

Materials and Methods

Our work in 1989 utilized one-year-old seedlings of *A. campestre, A. mono, A. truncatum*, and *A. velutinum* and two-year-old rooted cuttings of two different unnamed clones of *A. rubrum*. Two plants of each species or clone were inoculated with nematodes (*M. arenarina*-Race 1 and Race 2, *M. incognita* and *M. javanica*) taken from infested willows (13) on 27 June 1989. The root systems of these plants were examined 90 days after inoculation.

Seedlings of fall-fruiting maples used in the 1990 tests were grown from seed collected in 1989 by the author or cooperators and stratified for 90 days. Seed of the spring-fruiting *A. rubrum* and *A. saccharinum* were collected on 23 April 1990 and sown immediately. Seedlings were potted after two pairs of leaves had developed and inoculated at the 4- to 5- leaf-pair stage. Inoculations were made with root galls and soil from infested plants as described for willows (13).

The nematode inoculum of *M. arenaria* (both races), *M. incognita*, and *M. javanica* was from susceptible willows (13) inoculated in 1989 and the inoculum of *M. hapla* was from infested tomato roots. Galled roots of *Quercus rubra* were used as inoculum (14) of the oak root-knot nematode (*M. querciana*). From two to five seedlings of each maple species were inoculated with each of the nematodes and assessments of root galling and egg masses were made between 80 and 90 days after inoculation.

Results and Discussion

The 1989 studies showed that all of the maple species tested were susceptible to at least one species or race of nematodes, and these results stimulated the more extensive testing in 1990. All of the maples related to *A. platanoides* in Section Platanoidea (*A. campestre, A. mono, A. truncatum*) were highly susceptible to all of the nematodes, with more than 100 root galls and numerous viable egg masses on each root system. *Acer velutinum* was highly susceptible to *M. arenaria*-Race 1 and *M. javanica* but appeared tolerant of *M. arenaria*-Race 2 and *M. incognita*. One clone of *A. rubrum* was highly susceptible to *M. arenaria*-Race 1 but resistant to the other nematodes. The other *A. rubrum* clone was susceptible to all of the nematodes, with moderate galling (3 to 30 galls per plant) and viable egg masses.

Results of the nematode inoculations in both

Table 1. Response of maple (Acer) taxa to inoculation with root-knot nematiodes (Meloidogyne spp.) [1]

Section Species	M. arenaria Race 1	 Race 2	M. hapla	M. incognita	M. javanica	M. querciana
Macrantha Pax						
A. davidii Franch.	S (4-+)	S (5-+)	S (5-+)	S (4-+)	S (3-+)	---
A. grosseri Pax	S (5-+)	S (5-+)	S (5-+)	S (5-+)	T (2-0)	---
Negundo (Boehm.) Maxim.						
A. negundo L.	S (3-+)	S (4-+)	T (1-0)	S (3-+)	T (2-0)	R (0-0)
Palmata Pax						
A. palmatum Thunb.	S (4-+)	S (5-+)	T (2-0)	S (4-+)	T (2-0)	R (0-0)
Ginnala Nakai						
A. tartaricum L.	S (5-+)	S (5-+)	S (4-+)	S (5-+)	S (5-+)	R (0-0)
Rubra Pax						
A. rubrum L.	S (4-+)	S (4-+)	R (0-0)	S (5-+)	R (0-0)	---
A. saccharinum L.	S (5-+)	S (5-+)	R (0-0)	S (4-+)	T (2-0)	R (0-0)
Pentaphylla Hu & Cheng						
A. pentaphyllum Diels	T (1-0)	---	R (0-0)	R (0-0)	R (0-0)	---
Platanoidea Pax						
A. campestre L.	S (5-+)[2]	S (5-+)[2]	---	S (5-+)[2]	S (5-+)[2]	---
A. mono Maxim.	S (5-+)[2]	S (5-+)[2]	---	S (5-+)[2]	S (5-+)[2]	---
A. platanoides L.	S (2-+)	S (3-+)	S (5-+)	S (2-+)	R (0-0)	R (0-0)
A. truncatum Bunge	S (5-+)[2]	S (5-+)[2]	S (5-+)	S (5-+0[2]	S (5-+)[2]	R (0-0)
Acer						
A pseudoplatanus L.	T (1-0)	T (4-0)	T (1-0)	R (0-0)	T (2-0)	R (0-0)
A. velutinum Boiss.	S (4-+)	T (2-0)	R (0-0)	T (1-0)	S (5-+)	R (0-0)
Saccharina Pax						
A grandidentatum Torr. & Gr.	T (3-0)	---	R (0-0)	T (3-0)	R (0-0)	---
A. saccharum Marsh.	T (1-0)	T (3-0)	R (0-0)	T (2-0)	R (0-0)	R (0-0)
Lithocarpa Pax						
A. franchetii Pax	T (2-0)	---	R (0-0)	R (0-0)	R (0-0)	---
Macrophylla Momotani						
A. macrophyllum Pursh	S (5-+)	S (5-+)	S (5-+)	S (2-+)	S (5-+)	R (0-0)

1. Key to table. S = susceptible, galls and egg masses noted; T = tolerant, some galls but no egg masses; R = resistant, no galls and no egg masses. First figure in parentheses refers to gall rating: 0 = no galls; 1 = from one to two galls; 2 = three to 10 galls; 3 = 11 to 30 galls; 4 = 31 to 100 galls; 5 = more than 100 galls per root system. (+) denotes that two or more egg masses with potentially viable eggs were found. (0) denotes that no egg masses were found.

2. 1989 data

years are presented in Table 1, with those tested only in 1989 clearly marked. The sectional classification of the species follow that of Delendick (2). As in our previous report on oaks (14), the numbers of egg masses were not quantified. Generally, the discovery of 30 or more galls (categories 4 and 5 in Table 1) on a root system was indicative of successful nematode reproduction on that host species and an intensive search would disclose a number of viable egg masses—but there were exceptions. One seedling of *A. pseudoplatanus* that had been inoculated with *M. arenaria*-Race 2 had 68 root galls, but no eggs were found. The other seedlings inoculated with the same nematode, and with other nematodes, likewise had no egg masses and *A. pseudoplatanus* could be considered as at least highly tolerant of all nematodes. On the other hand, *A. macrophyllum* was highly susceptible to all of the common nematodes except *M. incognita*. No more than 10 galls were found on any of the three seedlings inoculated with this nematode, but the few egg masses found on two root systems indicated a low level of susceptibility.

The resistance of 10 maple species (representing eight botanical sections) to galling by the oak root-knot nematode (*M. querciana*) is indicative of the presumed specificity of this nematode to oaks and perhaps several other genera of the Fagaceae (3, 14).

Six of the 16 maple species inoculated with *M. hapla* were highly susceptible to this nematode. This result was rather surprising since we did not find any willows or oaks that were susceptible to *M. hapla* were highly susceptible to this nematode. This result was rather surprising since we did not find any willows or oaks that were susceptible to *M. hapla* (13, 14) and our literature survey (12) had found that *Acer rubrum*, *Liquidambar styraciflua*, *Liriodendron tulipifera*, *Platanus occidentalis*, and *P. heterophylla* were not susceptible to artificial inoculation. Susceptbility of maples to *M. hapla* appeared to follow the sectional classification of species, but more taxa would have to be tested to determine if this relationship were absolute. The galls produced by *M. hapla* were smaller than those of the other nematodes, but this is true of herbaceous hosts as well.

It is difficult to reconcile the earlier report of the non-susceptibility of *A. rubrum* to inoculation with the common nematodes (11) with our data. Although our 1989 results suggested that clonal differences in susceptibility might exist, a future paper will also deal with different clones of *A. rubrum*.

Perhaps the most perplexing results of the 1990 inoculations relate to Norway maple (*A. platanoides*). Because of the high susceptibility of other species of sect. *Platanoidea* to 1989 inoculations with the common nematodes, we expected that Norway maple would also be susceptible. The data in Table 1 do indicate a low level of susceptibility of Norway maple to the two races of *M. arenaria* and to *M. incognita*, but these are "worst case" situations. The fact is that only one or two of the five seedlings inoculated with each of these nematodes produced viable egg masses. Apparently, there was a wide range of susceptibility even among the progeny of a single tree. Clonal differences in nematode susceptibility of Norway maples will be discussed in a future paper.

Conclusions

Many of the landscape maples widely planted in the United States are susceptible to parasitism by one or more of the common root-knot nematodes. At this juncture, it is problematical whether nematode control practices would be justified. There is definitely a need for further research with the elusive maple root-knot nematode (*M. ovalis*) and the potential synergism between these nematodes and Verticillium wilt should be explored.

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Résumé. Des semis de 18 espèces d'érable (*Acer*), représentant 11 des 23 sections botaniques reconnues de ce genre, étaient inoculés avec les nématodes communs des racines que sont *Meloidogyne arenaria* (deux races), *M. hapla*, *M. incognita* et *M. javanica*, et 10 espèces avec *M. querciana*, le nématode des racines du chêne. Certaines espèces ornementales majeures, tel *Acer saccharum* et *A. pseudoplatanus*, étaient tolérantes ou résistantes à tous les nématodes. La plupart des autres érables largement rencontrés dans la réalité étaient susceptibles à au moins un des nématodes communs cités. La susceptibilité à *M. hapla* apparaissait être reliée à la classification sectionnelle des érables. Aucune des espèces d'érable testée était susceptible au nématode des racines du chêne.

Zusammenfassung. Sämlinge von 18 Ahornarten (*Acer*), die 11 der 23 anerkannten botanischen Gruppen der Gattung repräsentieren, wurden mit den gemeinen Wurzelnematoden *Meloidogyne arenaria* beimpft (zwei Rassen), *M. hapla, M. incognita* und *M. javanica,* und 10 Arten mit *M. querciana*, der Wurzelnamatode der Eiche. Einige bedeutende Landschaftsbaumarten, wie *A. saccharum* und *A. pseudoplatanus* waren gegenüber alle Nematoden tolerant oder resistent. Der Großteil der anderen weitverbreiteten Ahornbäume war anfällig für mindestens eine der üblichen Nematoden. Eine Anfälligkeit für *M. hapla* schien mit der Gruppenklassifikation des Ahorns zusammenzufallen. Keine der getesteten Ahornarten war gegenüber den Wurzelnematoden der Eichen empfindlich.