HOST CHECKLIST OF ROOT-KNOT NEMATODES ON BROAD-LEAVED LANDSCAPE TREES

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Abstract. A comprehensive review of the world literature dealing with root-knot nematodes (Meloidogyne spp.) on landscape trees is presented, including both natural occurrence and positive and negative results of controlled inoculations. Information is provided on more than 120 species in 56 plant genera.

Earlier this year, we published (65) the results of our rather extensive studies of root-knot nematodes (Meloidogyne spp.) on willows (Salix spp.). While we were surveying the world literature on this topic, it became obvious that although there had been numerous reports of root-knot nematodes on woody plants there were also great gaps in our knowledge of the exact identity of the pest and host species. Furthermore, it was apparent that there would be opportunities for significant observational and experimental research in this field if persons working with trees were aware of past investigations.

All of the root-knot nematodes are currently classified in the genus Meloidogyne. Although the genus had been established by E.A. Goeldi in 1887 for M. exigua (on coffee trees in Brazil), subsequent authors placed other root-knot nematodes under the genera Anguillula, Caconema, Heterodera, and Oxyuris. It was not until 1949 (14) that B.G. Chitwood re-established the genus, redescribing M. exigua (Goeldi) Chitwood, M. arenaria (Neal) Chitwood, M. incognita (Kofoid and White) Chitwood, and M. javanica (Treub) Chitwood and describing a new species (M. halpla Chitwood). These are still considered the most widespread and destructive root-knot nematodes throughout temperate zones around the world. Their host ranges include herbaceous and woody plants in field, orchard, and forest, but major research efforts have been restricted to important economic crops such as tobacco, tomato, potato, soybean, strawberry, and cotton.

Some morphological variants of these species have been described as subspecies or varieties, usually expressed as trinomials: M. arenaria thamesi, M. incognita acrita, and M. javanica bauriensis. In the 1976 compendium of Esser, et al. (20), these three subspecific taxa were elevated to species rank.

A somewhat more biologically important classification has been developed by Sasser (66), who distinguished "races" among these species based on their ability to infest and reproduce on different host plant cultivars. He recognized four races of M. incognita, two of M. arenaria, and only a single race of M. hapla and M. javanica. A further differentiation of two races of M. hapla was made by Triantaphyllou and Hirschmann (76) on the basis of chromosome numbers and mode of reproduction. Sasser (66) stated that the host races of M. arenaria and M. incognita were morphologically indistinguishable (within species). It is of some interest that the culture of M. arenaria that Chitwood (14) obtained from W.H. Thames (M. arenaria thamesi) did not infect peanut and, perhaps, could be equated with M. arenaria (Race 2) of Sasser (66). Despite these studies on morphology, cytology, and host preference, most of the current nematological research is concerned with the utilization or identification of these organisms at the species level.

Of the 35 Meloidogyne "species" listed by Esser et al. (20) in 1976, only three new species had been reported on woody host genera commonly grown in the United States. These were M. brevicauda Loos on tea (Camellia sinensis (L.) Kunze) in 1953 in Ceylon (41), M. ovalis Riffle on sugar maple and other trees in 1963 in Wisconsin (60), and M. mali Itoh, Ohshima, and Ichinohe on apple (Malus) and other trees in 1969 in Japan (34). Neither M. brevicauda nor M. mali have been found in the United States but M. ovalis has been subsequently reported from Iowa (57).

Since 1976, several new Meloidogyne species...
have been reported on woody hosts. Golden (24) described *M. camelliae* Golden on *Camellia japonica* L. imported from Japan and *M. querciana* Golden on pin oak (*Quercus palustris* Muenchh.) from Virginia (1979). Hirschmann (32), in 1982, described *M. platani* Hirschmann from sycamore (*Platanus occidentalis* L.) in Virginia and *M. christiei* Golden and Kaplan (25) was reported on *Quercus laevis* Walt. in Florida in 1986.

Based on inoculation studies conducted by the nematologists who described these new root-knot nematodes from woody plants, these *Meloidogyne* species have a restricted host range and do not parasitize many herbaceous crop plants. Thus, it is likely that more “new” nematode species will be discovered on woody plants. Some may be found on trees or shrubs previously reported as hosts of “unidentified” *Meloidogyne* species and some could be found on woody plants not previously noted as hosts of any root-knot nematodes.

The compendia issued by the Commonwealth Agricultural Bureaux and other agencies in England [(28)—1940; (26)—1959; (27)—1965] and that of Ruehle (62) in 1967 were invaluable in preparing this checklist. However, insofar as it was possible, all primary references were obtained and checked for accuracy, especially with regard to the nomenclature of host plants. Some original references could not be obtained and these are noted in “Literature Cited”.

This checklist is presented to stimulate arborists, horticulturists, and nurserymen to be more aware of the potential damage caused by root-knot nematodes, to “look underground” when investigating the causes of poor plant performance, and to help in extending our knowledge of the diversity and distribution of these plant pests.

In this checklist, the plant species are recorded as being “noted hosts” or “natural hosts” of identified or unidentified or unidentified root-knot nematodes. We have tried to restrict the use of “natural host” to those situations where a particular nematode was found to be capable of completing its life cycle (to reproduce) on the host. The term “noted host” denotes only that root galls were observed.
Camellia sp.—Noted host of Meloidogyne incognita acrita in South Carolina (5) and of unidentified Meloidogyne sp. in Texas and Georgia (5), and North Carolina (31).

Carpinus

C. betulus L.—Noted host of unidentified Meloidogyne sp. in Italy (77).

Carya

C. illinoensis (Wang.) K. Koch—Noted host of Meloidogyne incognita acrita in Alabama (5).

Castanea


C. mollissima Blume—Noted host of unidentified Meloidogyne sp. in Georgia (5).

C. sativa Mill.—Noted host of unidentified Meloidogyne sp. (77).

Catalpa

C. bignniodes Walt.—Noted host of unidentified Meloidogyne sp. in USSR (78) and Israel (49).

C. ovata G. Don—Noted host of unidentified Meloidogyne sp. in Maryland (46).

C. speciosa Warder—Noted host of unidentified Meloidogyne sp. (10, 13). Not susceptible to inoculation with M. ovalis (61).

Catalpa sp.—Noted host of M. incognita and M. incognita acrita in Alabama (5). Plants imported into Canada from Holland were infested with M. arenaria (6).

Celtis

Celtis sp.—Not susceptible to inoculation with M. ovalis (61).

Chaenomeles

C. speciosa (Sweet) Nakai—Noted host of unidentified Meloidogyne sp. (81).

Clerodendron

C. trichotomum Thunb.—Noted host of unidentified Meloidogyne sp. (13).

C. ugandense Prain—Natural host of M. incognita in Australia (17).

Clerodendron sp.—Natural host of M. arenaria in Africa (47). Many tropical species have been noted as host of unidentified Meloidogyne sp.

Cornus

C. alba L.—Noted host of unidentified Meloidogyne sp. on nursery stock imported into Finland (39).

C. florida L.—Noted host of M. hapla (70). Noted host of M. incognita in Georgia (36) and Florida (40). Symptoms included tip burn, premature leaf drop, and stunting. Considered resistant to M. incognita acrita (18). Not susceptible to inoculation with M. platani (1, 32).

Crataegus

C. pyracantha—Cited as such in Goodey (27) but original reference was to an unidentified Meloidogyne sp. on Pyracantha coccinea Roem. (4).

Cydonia

C. oblonga Mill. (=C. vulgaris Pers.)—Noted host of unidentified Meloidogyne sp. (10, 49).

Dalbergia

D. sisso Roxb.—Natural host of M. javanica bauruensis in Israel (51).

Diospyros

D. kaki L.—Noted host of unidentified Meloidogyne sp. in Georgia (36) and Florida (40). Symptoms included tip burn, premature leaf drop, and stunting. Considered resistant to inoculation with M. platani (1, 32).

Elaeagnus

E. alatus (Thunb.) Sieb.—Noted host of unidentified Meloidogyne sp. (54).

E. japonicus Thunb.—Noted host of unidentified Meloidogyne sp. in USSR (78). Cultivar 'Albo-marginatus' was noted host of M. javanica (48).

Fraxinus

F. americana L.—Natural host of M. ovalis in Wisconsin (60), but no egg masses were found following artificial inoculation (61). Susceptible to inoculation with M. platani showing moderate to high galling and moderate egg production (1, 32). Noted host of unidentified Meloidogyne sp. in USSR (78). F. mandshurica Rupr.—Noted host of unidentified Meloidogyne sp. (13).

F. nigra Marsh.—Noted host of unidentified Meloidogyne sp. (13).

F. oxycaipa Willd. (=F. oxyphylla Bieb.)—Natural host of M. javanica in Israel (50).

F. pennsylvanica Marsh.—Not susceptible to inoculation with M. ovalis; numerous galls were formed but no egg masses (61).

F. retusa Champ.—Noted host of M. incognita in Taiwan (79).

F. syrlaca Boiss.—Natural host of M. javanica in Israel (50).

F. velutina Torr.—Noted host of unidentified Meloidogyne sp. (16). Fraxinus sp.—Noted host of M. ovalis in Iowa (57). Noted host of unidentified Meloidogyne sp. in Oklahoma (5).

Ginkgo

G. biloba L.—Noted host of unidentified Meloidogyne sp. in Mississippi (72).

Gleditsia

G. triacanthos L.—Noted host of unidentified Meloidogyne sp. in USSR (78). Not susceptible to inoculation with M. ovalis (61).

Illex

I. cornuta Lindl. 'Dwarf Burford' and 'Rotunda'—Noted host of M. arenaria following artificial inoculation (8).

I. crenata Thunb.—Noted host of M. arenaria in Georgia (5), of M. hapla and M. incognita in North Carolina (31), of M. incognita acrita in North Carolina and Virginia (5), and of M.
sp.—Not susceptible to inoculation with Meloidogyne ovata (5).

l. opaca Ait.—Noted host of Meloidogyne arenaria following artificial inoculation (8).

Juglans

l. cinerea L.—Noted host of unidentified Meloidogyne sp. in Florida (13, 55).

l. nigra L.—Noted host of M. ovalis in Iowa (57). Noted host of unidentified Meloidogyne sp. (13).

l. regia L.—Noted host of M. javanica in Israel (53) and of M. arenaria in Czechoslovakia (74). Noted host of unidentified Meloidogyne sp. in Florida (55).

l. rupestris Engelm.—Noted host of unidentified Meloidogyne sp. in Arizona (10).

Koelreuteria

K. paniculata Laxm.—Noted host of unidentified Meloidogyne sp. in USSR (68).

Laburnum

l. anagyroides Medic.—Noted host of M. hapla in Maryland; based on soil samples, not galls (44).

Liquidambar

l. styraciflua L.—Not susceptible to inoculation with M. arenaria, M. hapla, M. incognita, M. javanica (64), or M. platani (1, 32). Noted host of unidentified Meloidogyne sp. in Mississippi (5, 81).

Liriodendron

l. tulipifera L.—Natural host of M. javanica in Georgia and susceptible to inoculation (64). Symptoms included wilting and stunted growth of seedlings. Not susceptible to inoculation with M. arenaria, M. hapla, M. incognita (64), or M. platani (1, 32).

Magnolia

M. grandiflora L.—Noted host of unidentified Meloidogyne sp. in Georgia (45).

Magnolia sp.—Noted host of unidentified Meloidogyne sp. in Florida, Georgia (5), and Arizona (11).

Malus

M. baccata (L). Borkh.—Noted host of unidentified Meloidogyne sp. on nursery stock imported into Finland (39).

M. x domestica Borkh.—Noted host of unidentified Meloidogyne sp. on nursery stock imported into Finland (39).

M. prunifolia (Willd.) Borkh.—Noted host of M. mali in Japan (34).

M. pumila Mill.—Noted host of M. mali in Japan (34).

M. sieboldii (Reg.) Rehd.—Noted host of M. mali in Japan (34).

M. sylvestris Mill.—Noted host of M. incognita and M. javanica on Norfolk Island, Australia (38); and as Malus mitis an unidentified Meloidogyne sp. in Israel (49).

Malus sp.—Not susceptible to inoculation with M. ovalis (61).

Melia

M. azedarach L.—Noted host of unidentified Meloidogyne sp. in USA (10, 11, 12).

Morus

M. alba L.—Natural host of M. javanica in Queensland, Australia (17). Noted host of M. incognita in Iraq (33) and an unidentified Meloidogyne sp. in Israel (49).

M. bombycis Koidz.—Noted host of M. mali in Japan (34).

M. indica L.—Noted host of M. javanica in northern India (56).

M. nigra L.—Noted host of unidentified Meloidogyne sp. (10, 13).

M. rubra L.—Noted host of unidentified Meloidogyne sp. (10, 13).

Morus sp.—Natural host of M. arenaria and noted host of M. hapla, M. incognita acrita (51) and M. javanica (52) in Israel.

Paulownia

P. fortunei Hemsl.—Susceptible to inoculation with M. incognita (80).

Pistacia

P. vera L.—Noted host of M. incognita in Iraq (33) and an unidentified Meloidogyne sp. in California (37).

Platanus

P. x acerifolia (Ait.) Wild.—Natural host of unidentified Meloidogyne sp. in Washington, DC (15); later identified as P. platani.

P. occidentalis L.—Natural host (nursery origin) of P. platani in Virginia and susceptible to inoculation (1, 32). Not susceptible to inoculation with M. arenaria, M. hapla, M. incognita, or M. javanica (64).

Populus

P. alba L.—Natural host of M. javanica in Israel (50).

P. deltoides Marsh.—Natural host of unidentified Meloidogyne sp. in South Carolina (63).

P. heterophylla L.—Not susceptible to inoculation with M. arenaria, M. hapla, M. incognita, or M. javanica (64).

Populus sp.—Noted host of M. incognita and M. Incognita acrita in Israel (51).

Prunus

P. amygdalus Batsch.—“Almond”—Noted host of M. hapla (52), M. incognita (50, 51), M. incognita acrita (43, 51), and M. javanica 21, 75).

P. armeniaca L.—“Apricot”—Noted host of M. incognita acrita and M. javanica (43).

P. avium L.—“Sweet Cherry”—Noted host of unidentified Meloidogyne sp. (12).

P. cerasifera Ehrh.—“Cherry Plum”—Noted host of unidentified Meloidogyne sp. (55).

P. cerasus L.—“Sour Cherry”—Noted host of M. hapla (44) and M. javanica (50).

P. davidiana (Carr.) Franch.—Noted host of unidentified Meloidogyne sp. (13).

P. domestica L.—“Plum”—Noted host of M. incognita in Iraq (33), and of unidentified Meloidogyne sp. (11, 55).

P. japonica Thunb. Noted host of unidentified Meloidogyne sp. (55).

P. mahaleb L.—Noted host of unidentified Meloidogyne sp. (58).

P. persica (L.) Batsch.—“Peach”—Abundant literature; not included here.

P. serotina Ehrh.—Not susceptible to inoculation with M. ovalis (61).
P. virginiana L.—Noted host of unidentified *Meloidogyne* sp. (10, 13).

P. yedoensis Matsum.—Natural host of *M. mall* in Japan (34).

**Pyrus**

*P. communis* L.—Noted host of unidentified *Meloidogyne* sp. (10, 13).

**Quercus**

*Q. agrifolia* Nee—Noted host of unidentified *Meloidogyne* sp. (12).

*Q. falcata* Michx.—Erroneously used as a synonym for *Q. laevis*, the host of *M. christiei* (25).

*Q. laevis* Walt.—Natural host of *M. christiei* in Florida (25); wild host of *M. ovalis* (80); not susceptible to inoculation with *M. incognita* (61).

*Q. palustris* Muenchh.—Natural host of *M. querciana* in Virginia; and susceptible to inoculation (24). Not susceptible to inoculation with *M. incognita incognita* or *M. incognita acrita* (24).

*Q. rubra* L.—Susceptible to inoculation with *M. querciana* (24), shoot growth was visibly affected. Not susceptible to inoculation with *M. in cognita incognita* or *M. incognita acrita* (24).

*Q. suber* L.—Noted host of unidentified *Meloidogyne* sp. in Southern Rhodesia (35).

**Robinia**

*R. pseudacacia* L.—Susceptible to inoculation with *M. incognita* (80); not susceptible to inoculation with *M. ovalis* (61). Noted host of unidentified *Meloidogyne* sp. in Oklahoma (5, 12) and Israel (49).

**Salix**

(See recent work of Santamour and Batzli (65)).

**Sambucus**

*S. nigra* L.—Noted host of unidentified *Meloidogyne* sp. (12, 29).

**Sapindus**

*S. saponaria* L.—Noted host of unidentified *Meloidogyne* sp. on oak seedlings in Arizona (11).

**Sophora**

*S. japonica* L.—Noted host of unidentified *Meloidogyne* sp. in USSR (78).

**Sorbus**

*S. americana* Marsh.—Noted host of *M. arenaria* on stock imported from Holland (7).

**Stewartia**

*S. malacodendron* L.—Noted host of unidentified *Meloidogyne* sp. (13).

**Styrax**

*S. dasyanthus* Perk.—Noted host of unidentified *Meloidogyne* sp. (12).

S. veitchilorum Hemsl.—Noted host of unidentified *Meloidogyne* sp. (12).

**Syringa**

*S. dilata* Nakai—Noted host of unidentified *Meloidogyne* sp. (13).

*S. sweginzowii* Koehne & Lingelsh.—Noted host of unidentified *Meloidogyne* sp. (3).

*S. vulgaris* L.—Mistakenly reported by Goodey (27) as a host of an unidentified *Meloidogyne* sp. Goodey's information came from Martin (48), which was erroneously referenced as Cobb (16). Martin (46) reported the unidentified nematode on *Philadelphus* sp., for which "syringa" is a common name.

**Tilia**

*Tilia cordata* Mill.—Noted host of unidentified *Meloidogyne* sp. on nursery stock imported to Finland (39).

**Ulmus**

*U. americana* L.—Natural host of *M. ovalis* in Wisconsin (60), and susceptible to inoculation with *M. ovalis* (61). Noted host of unidentified *Meloidogyne* sp. in Oklahoma (5).

*U. glabra* Huds.—Noted host of *M. hapla* on roots of trees from Holland (30). Small galls were uniformly distributed throughout root system.

*U. parvifolia* Jacq.—Noted host of unidentified *Meloidogyne* sp. (28).

*U. procera* Salisb.—Noted host of unidentified *Meloidogyne* sp. (10).

*U. pumila* L.—Noted host of unidentified *Meloidogyne* sp. in USSR (79).

*U. rubra* Michx. (=*U. fulva* Michx.)—Not susceptible to inoculation with *M. ovalis* (61).

*Ulmus* sp.—Noted host of *M. arenaria* and *M. incognita* in the Netherlands (59) and an unidentified *Meloidogyne* sp. in Oklahoma (12).

**Zelkova**

*Z. serrata* (Thunb.) Makino—Noted host of *M. incognita* and *M. javanica* in Taiwan (79).

**Zizyphus**

*Z. mucronata* Willd.—Noted host of unidentified *Meloidogyne* sp. in Southern Rhodesia (35).

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