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Response of Additional Herbaceous Perennial Ornamentals to *Meloidogyne hapla*

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Abstract: Twenty-nine herbaceous perennial ornamentals were evaluated for root galling after 2 months in soil infested with *Meloidogyne hapla* under greenhouse conditions. Plants such as *Asclepias, Epimedium, Liriope, Lithospermum, Myosotis, Penstemon, Sidalecea,* and *Solidago* did not have galls or egg masses present on the root system and were rated as resistant. *Astrantia, Boltonia, Centranthus,* and *Miscanthus* had more than 100 galls on the roots (similar to 'Rutgers' tomato controls) and were rated susceptible. The remaining plants were intermediate in response. The identification of additional *M. hapla*-resistant perennial ornamentals will aid in nematode management in nurseries and landscapes.

Key words: Meloidogyne hapla, nematode, nonhost, ornamental, perennial, resistance, root-knot nematode.

The northern root-knot nematode *Meloidogyne hapla* is the most important nematode pathogen affecting a wide range of flowering herbaceous perennial ornamentals in the major market area of the northern United States and Canada. The lack of nematicide management options requires nursery and landscape nematode management programs based on sanitation and rotation. Previous research had demonstrated that 21 of 69 perennial herbaceous ornamentals tested were resistant to *M. hapla* (no galls detectable on roots), 20 were susceptible (more than 100 galls per plant), and the remainder were intermediate (5). While species in several widely grown genera such as *Achillea, Aster, Dianthus, Monarda, Primula,* and others were resistant, the host status of many of the more than 500 genera of herbaceous perennial ornamentals to *M. hapla* is unknown (7). The objective of this research was to evaluate the host suitability of additional common perennial ornamentals to *M. hapla.*

Materials and Methods

Perennial ornamentals were supplied as 1 to 2 year-old potted plants or bare root plants. Potted plants were grown in extra drainage mix (41% sand, 22% vermiculite, 22% perlite, and 15% peat) or a blend of 25% compost, 20% perlite, 20% peat, 15% bark, 15% sand, and 5% stone dust. Bare-root plants were potted in a 2:1 mix of pasteurized Merrimac fine sandy loam (73.4% sand, 21.4% silt, 5.2% clay) and Sunshine mix no. 3 (Fisons Western Corp., Downers Grove, IL). Perennials were grown in pots containing 700 or 1,400 cm^3 mix, depending on plant size. 'Rutgers' tomato (*Lycopersicon esculentum*) plants were grown for 2 months from seed and used as nematode-susceptible controls.

Inoculum consisted of a mixture of *M. hapla* isolates recovered from lettuce in New York and strawberries and cranes-bill geranium in Connecticut. Inoculum was recovered from greenhouse-grown 'Rutgers' tomato (4). A suspension of 10,000 or 20,000 eggs and second-stage juveniles was placed in four holes per pot for 700 and 1,400 cm^3 pots, respectively. Five to seven pots of each plant species were infested; uninfested plants served as controls.

Plants were grown on a greenhouse peat bed for 2 months. Roots of test plants were washed free of soil and rated when galls and egg masses were apparent on nematode-susceptible tomato controls. Root galling was rated on a 1–4 scale, as follows: 1 = no galls, 2 = 1–10 galls, 3 = 11–100 galls, and 4 = >100 galls per root system. The uninoculated plants were generally not galled and were used to compare root morphology with inoculated plants. When

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both inoculated and uninoculated plants had swollen roots or unusual root morphology, roots were dissected and examined for root-knot nematodes. In some cases, such as when small root galls were present on fine roots, the roots were soaked in dilute phloxine B to aid in the identification of egg masses (2).

Gall ratings were subjected to the nonparametric Kruskal-Wallis test and analysis of variance. Means were separated by the LSD technique.

Results and Discussion

The gall ratings of 29 species of flowering perennials varied ($P = 0.001$) and ranged from resistant (rating of 1.0 to 1.2) to susceptible (rating of 3.7 to 4.0) (Table 1). *Asclepias, Epimedium, Liriope, Lithospermum, Myosotis, Penstemon, Sidalecea,* and *Solidago* species were resistant to *M. hapla* in these experiments, adding to the 21 species previously identified as resistant (5).

All but two of the species found to be hosts of *M. hapla* in this report were listed previously as nonhosts (1,3,8) or not reported in the literature. Alternatively, *Penstemon digitalis* and *Sidalecea hybrida,* found to be resistant to *M. hapla* in the present study, had been previously reported as hosts of the southern root-knot nematode *M. incognita* or other *Meloidogyne* species (1,

Table 1. Galling response of perennial ornamentals grown in media infested with *Meloidogyne hapla* after 2 months under greenhouse conditions.

Genus species	Cultivar	Common name	Gall rating[a]	Literature[b]
Adenophora confusa	—[c]	Ladybells	3.6	NT
Anchusa azurea	Dropmore	Alkanet	3.8	–
Anemone sylvestris	Queen Charlotte	Windflower	4.0	–
Asclepias tuberosa	—	Butterfly Weed	1.0	–
Astrantia major	Rose Symphony	Masterwort	4.0	NT
Boltonia asteroides	Pink Beauty	Bolton's Aster	4.0	–
Centranthus ruber	Albus	Valerian	4.0	–
Echinacea purpurea	Bright Star	Purple Coneflower	1.0	–
Echinops bannaticus	Taplow Blue	Globe Thistle	1.5	–
Epimedium versicolor	Sulphureum	Yellow Barrenwort	1.0	NT
Gentiana sp.	Benichidori	Gentian	3.6	–
Geranium x magnificum	—	Cranes-bill	3.8	–
Geranium x oxonianum	Thurstonianum	Cranes-bill	3.7	–
Helicotrichon sempervirens	—	Blue Oat Grass	2.0	NT
Hemerocallis sp.	Bright banner	Daylily	1.5	+
Liriope muscari	Variegata	Lilyturf	1.0	NT
Lithospermum diffusa	Grace Ward	Lithodora	1.0	–
Lycopersicon esculentum	Rutgers	Tomato	4.0	+
Lysimachia clethroides	—	Circle Flower	3.2	+
Malva alcea	Fastigiata	Rose Mallow	2.4	–
Miscanthus sinensis	Silberfeder	Silver Feather	4.0	NT
Myosotis alpestris	Indigo Blue	Forget-Me-Not	1.0	–
Penstemon digitalis	Husker Red	Beard Tongue	1.0	+
Perovskia atriplicifolia	—	Russian Sage	3.8	NT
Physostegia virginiana	Summer Snow	False Dragonhead	1.2	–
Sanguisorba obtusa	—	Japanese Burnet	3.4	–
Sidalecea hybrida	Party Girl	Miniature Holleyhock	1.0	+
Solidago sphacelata	Golden Fleece	Goldenrod	1.0	–
Thymus serpyllum	Album	Thyme	3.2	–
Trollius hybrida	Lemon Queen	Globe Flower	3.0	–

Kruskal-Wallis Results: T = 123.1; df = 29; Prob. T > Chi square = 0.0001
ANOVA: MSE = 0.241; df = 140; F = 32.84; $P = 0.0001$; LSD = 0.26

[a]Gall ratings: 1 = no galls; 2 = 1–10 galls; 3 = 11–100 galls; 4 = >100 galls per root system. Numbers are the mean of five or six observations.
[b]Host status in the literature: + = reported as a host; – = not reported as a host; NT = not reported or not tested.
[c]No cultivar name given.

3,8). A previous study reported that several flowering annuals responded with great variability to the *Meloidogyne* species tested (6). Plant species may respond differently to other *Meloidogyne* species, explaining these discrepancies.

In the absence of nematicides, the identification of perennial herbaceous ornamental species or cultivars resistant to *M. hapla* is an important first step in nematode control by sanitation and rotation. The inspection of planting stock for galls can be labor intensive and expensive. Inspecting only those species known to be hosts of *M. hapla* can increase efficiency and reduce costs. A considerable percentage of perennial ornamentals are field-grown in nurseries. Rotation with *M. hapla*-resistant species can be an important means of control in field-grown nurseries, landscapes, and home gardens infested with *M. hapla*.

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