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SUSCEPTIBILITY OF COMMON BEDDING PLANTS TO ROOT-KNOT NEMATODES

ROBERT McSORLEY
Entomology and Nematology Department
IFAS University of Florida
Gainesville, FL 32611-0620

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Abstract. Several common ornamental bedding plants were each inoculated with 1,000 juveniles of the root-knot nematode, Meloidogyne arenaria race 1. After nearly three months, plants were rated for root galling, egg mass production, and numbers of nematodes produced per plant. Nematode populations multiplied by >3.9 times on 'Covent Garden' gypsophila (Gypsophila elegans), 'Jolly Joker' pansy (Viola tricolor), 'Oriental Red Perennial' poppy (Papaver orientale), 'First Ladies' snapdragon (Antirrhinum ma/us), and 'Florist' verbena (Verbena x *hybrida), and* these plants were heavily galled. Nematode reproduction was lower but galling was fairly severe on 'Baby Doll Mix' dianthus *(Dianthus chinensis),* 'Fire Chief' petunia (Petunia x ***hybrida),*** *and* 'Alaska' Shasta daisy (Chrysanthemum maximum). 'Blue Mink' ageratum (Ageratum houstonianum and 'Scarlet' zinnia (Zinnia elegans) were nearly free of galling and few nematodes were recovered from these plants. No galling was observed and no nematodes recovered from 'Dwarf Primrose' marigold (Tagetes patula). Results are compared with those of previous tests with M. arenaria race 1, M. javanica, and M. incognita race 1. It is evident that the choice of a bedding plant can greatly affect the root-knot nematode numbers in a site.

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Annual bedding plants arc widely used in outdoor plantings in many parts of Florida particularly during the winter months. Little is known about their susceptibility to plant-parasitic nematodes, such as the root knot nematodes (*Meloidogyne spp*.), which arc serious pests of agricultural crops and home gardens throughout the state. Certain cultivars of marigolds (*Tagetes spp*.) can reduce population densities of root-knot nematodes (Lehman, 1979; Motsinger et al., 1977; Rickard and Dupree, 1978), bill other bedding plants, such as snapdragon *(Antirrhinum majus* L.), celosia (Celosia argentea L.), and coleus (Coleus blumei Benth.), are very susceptible and increase nematode populations (Acosta, 1976; Caveness and Wilson, 1977; Tarjan, 1952). Goff (1936) conducted several large tests on tile susceptibility of bedding plants to root-knot nematodes, but unfortunately his work was conducted at a time when the species and races of root-knot nematodes were unknown.

To avoid damage or unintentional buildup of high nematode population densities in the landscape, the susceptibility of common bedding plants to root-knot nematodes must be known and considered. The objective of this research was to determine the response of several bedding plants to race I of the "peanut root-knot nematode," M. arenaria (Veal) Chitwood which is common in north Florida. Data for other root-knot species from other experiments (McSorley and Frederick, 1994) arc summarized as well.

Materials and Methods

Eleven different bedding plants were included ill this experiment: 'Blue Mink' ageratum *(Ageratum houstonianum Mill.)*, `Baby Doll Mix' dianthus *(Dianthus chinensis L.),* Covent Garden' gypsophila *(Gyposophila elegans Bieb.)*, `Dwarf Primrose' marigold *(Tagetes patula L.)*, 'Jolly Joker' pansy *(Viola tricolor L.),* 'Fire Chief' petunia *(Petunia x hybrida)*, `Oriental Red Perennial' poppy (Papaver orientale L.) `Alaska' Shasta daisy *(Chrysanthemum maximum Raymond)*, `First Ladies' snapdragon *(Antirrhinum majus L.),* `Florist' verbena *(Verbena x hybrida), and* `Scarlet' zinnia *(Zinnia elegans Jacq.)*. Individual seeds were planted ill 5 cm x 5 cm plastic trays in a mixture of 2/3 sand and 1/3 steam-sterilized soil (92 % sand, 3% silt, 5% clay). When they were c 3-5 cm in height, seedlings were transplanted (one per pot) into the same soil mix in 12.5-cm-diameter plastic pots.

On 10 February 1994 (one week after transplanting), each seedling teas inoculated with 1,000 second-stage juveniles (J2) of M. arenaria race 1. Previously, the nematode population had been maintained in a greenhouse on `Rutgers' tomato (*Lycopersicon esculentum Mill*.). Four days before inoculation, nematode eggs were extracted from tomato roots ill 0.525% NaOCl (Hussey and Barker. 1973). Extracted eggs were incubated at 22°C oil modified Baermann trays (Rodriguez-Kabana and Pope, 1981) for collection of J2, which were inoculated into two holes (2 cm deep) in the soil at the base of the plant.

Each of the 11 bedding plants was replicated six times, and pots were arranged in a randomized complete block design on raised benches in a temperature-controlled (24±1°C) growth room. Light intensity was 9,700 lux, on a 14-hr light/10-hr dark photoperiod. Plants were watered as needed and fertilized every two weeks with 3.8g/liter of a 20:20:20 (N:P:K) soluble fertilizer

On 5 May, root systems of each plant were washed free of soil, and galls, and egg masses were rateed oil a 0-5 scale: 0 = 0, 1=1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, 5 = > 100 galls or egg masses per root system (Taylor for and Sasser, 1978). Data were subjected to analysis of variance, followed by mean separation rising the Student-Newman-Keuls test (Freed el al., 1991). After determination of root ratings, root systems from three plants (replications) of the same genus were pooled, and eggs extracted in 0.525% Na0Cl (Hussy and Barker. 1972). Extracted eggs were incubated as before, and hatched J2 were counted.

Results and Discussion

Seen of the bedding plants tested had heavy galling (mean rating > 4.0) in response to M. arenaria (table I). These included plants which are often used as ornamental bedding plants in Florida, as well as plants such as Shasta daisy, and poppy which are occasionally used in gardens. For most plant species, gall and egg mass levels were similar, but in petunia and Shasta daisy, egg mass ratings were much lower than the gall ratings (Table 1). Eggs were produced on most plant species, and these hatched into viable juveniles capable of infecting plant roots. On five plant species, ≥3,900 juveniles per plant were obtained (Table 1). Based on the initial inoculum level of 1,000 J2 per plant, the M. arenaria population on these five plant species multiplied by 3.9 to 12 times, in a little less than three months. Two bedding plants, ageratum and zinnia, showed almost no evidence of M. arenaria infection, and marigold had no evidence of galling or reproduction.

Tests with other root-knot nematode species, using similar experimental methods and conditions (McSorley and Frederick, 1994), gave results similar to the present study for some of the bedding plants (Table 2). Snapdragon was susceptible to the three *Meloidogyne spp*. tested, but marigold and ageratum were not. Celosia and coleus varied in their galling response to the *Meloidogyne spp*. (Table 2), but consistently produced large (> 1,500 per plant) amounts of eggs (McSorley and Frederick, 1994). Alyssum (Lobularia maritima Dew.)

Table 1. Root gall ratings, egg mass ratings. and numbers of juveniles (J2) produced per plant on bedding plants grown in soil infested with *Meloidoavne arenaria* race 1. Spring. 1994.

Bedding plant	Root gall rating[z]	Egg mass rating[z]	J2 per plant[y]
Ageratum	0.11 d	0.11 e	<1
Dianthus	4.22 bc	3.83 b	840
Gypsophila	4.89 a	4.67 a	4,967
Marigold	0 d	0 e	0
Pansy	5.00 a	5.00 a	3,900
Petunia	3.89 c	1.83 d	418
Poppy	4.50 ab	4.39 ab	5,400
Shasta Daisy	4.61 ab	2.50 c	521
Snapdragon	5.00 a	5.00 a	12,000
Verbena	4.94 a	4.72 a	9,267
Zinnia	0.44 d	0.17 e	42

[z]Root galling and egg masses rated on a 0 - 5 scale: 0 = 0, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, 5 = >100 galls (or egg masses) per root system (Taylor and Sasser, 1978).
Data are means of six replications. Mean separations (in columns) by the Student-Newman-Keul's test (5% level).
[y]J2 numbers are totals extracted from three replications together, divided by 3 (one plant per replication).

Table 2. Root gall ratings on bedding plants grown in soil infested with isolates of *Meloidogyne incognita* race 1, *M. javanica*, or *M. arenaria* race 1 in three separate experiments[z] conducted during 1993.

Bedding plant	*M. incognita*	*M. javanica*	*M. arenaria*
Ageratum	0 d[y]	0 d	0.04 d
Alyssum	—	0 d	0 d
Celosia	2.80 b	1.50 c	3.13 b
Coleus	0.60 d	3.00 b	2.08 c
Dianthus	1.20 cd	0.20 d	0.04 d
Marigold	0 d	0 d	0.04 d
Periwinkle	0 d	0.20 d	2.04 c
Petunia	2.00 bc	0.80 cd	1.63 c
Salvia	0 d	0.10 d	—
Snapdragon	4.20 a	4.95 a	4.25 a
Verbena	0.20 d	4.06 a	4.42 a
Zinnia	0.20 d	2.90 b	0.04 d

[z]Methods and conditions of these experiments are presented in detail elsewhere (McSorley and Frederick, 1994).
[y]Root galling was rated on a 0 - 5 scale: 0 = 0 galls, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, 5 = >100 galls per root system (Taylor and Sasser, 1978). Mean separation (in columns) by the Student-Newman-Keul's test (5% level).

was a poor host for M. arenaria race I and *M. javanica* (Treub) Chitwood (Table 2). Dianthus, periwinkle (*Vinca rosea L.*), and salvia *(Salvia splendens Ker-Gawl)*. were generally poor hosts, but showed some variation depending on the root-knot nematode species (McSorley and Frederick, 1994). Verbena was slightly susceptible to *M. arenaria* race 1 and *M. javanica*, but not to *M. incognita* (Kofoid and White) Chitwood race 1. Zinnia, a poor host of *M. arenaria* and *M. incognita*, was infected by *M. javanica.*

Because zinnia and verbena are poor hosts of some root-knot nematode species, but susceptible to others, it would be necessary to know the root-knot nematodes species present in a site before using these bedding plants. If the root-knot species present is unknown, or a mixture of species are present, then plants such as marigold, ageratum, or alyssum could he used, because they are very poor hosts to the range of *Meliodogyne spp.* tested.

Although the present study provides somc guidelines for choosing plants that in minimize buildup of root-knot nematodes, the information is limited only to the specific plant cultivars tested here. Data are needed oil other cultivars (which may react differently to *Meloidogyne spp.*) and on many other species of bedding plants as well. As more information of this type becomes available, it will become easier to choose bedding plants that are compatible with the root-knot nematodes present in a particular site.

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