ENY-061

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Susceptibility of Flowers and Bedding Plants to Root-Knot Nematodes[1]

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Introduction

Root-knot nematodes can cause serious problems on flowers and bedding plants. Root-knot, which is characterized by swelling of the root (Fig. 1), is caused by the feeding activities of root-knot nematodes (*Meloidogyne* spp.). Different species of root-knot nematodes may be present in the soil, and different races may occur within these species. These root-knot nematode races may differ in their ability to infect some plant species and cultivars. Different species or cultivars of flowers may have different susceptibilities to these species and/or races. Selecting the right flower or bedding plant for a site may help to prevent losses due to root-knot nematodes. This publication summarizes some recently published work on this subject and provides an overview of flower cultivars and their susceptibility to different species and races of root-knot nematodes, particularly *M. incognita*, *M. javanica*, and *M. arenaria*, all of which are common in Florida.

Figure 1. Root symptoms caused by root-knot nematodes

Selecting a bedding plant – Identifying a possible root-knot problem

Before selecting any bedding plant, it is beneficial to obtain a soil nematode sample to determine which nematodes are present in the soil. More information on how to take a soil nematode sample and where to submit it can be found here: http://edis.ifas.ufl.edu/sr011. However, identification of root-knot nematode species is difficult and often requires molecular techniques and is not performed on routine nematode samples. Submission of a soil

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sample will only help to clarify if root-knot nematodes are present in the soil. If root-knot nematodes were a problem in the site before, selecting the right plant may be easier, but it is still often based on trial and error, eliminating or selecting flower species and cultivars according to the degree of damage observed in the previous crop. Eventually it might be possible to identify which root-knot nematode is present or if there is a mixture of species and races. As techniques for root-knot nematode identification improve, new species and races might be found. For example, *M. mayaguensis* and *M. floridensis* have only recently been identified from Florida (Mendes et al. 2007, Stanley et al. 2006). Relatively little is known about the susceptibility of flowers and bedding plants to these species.

An important tool in managing root-knot nematodes is rotation of plants that are susceptible, but are desired plants, with plants that are resistant. Root-knot nematodes, which are plant parasites and require a host for long-term survival, will be either unable to reproduce on these resistant plants or may only produce relatively small numbers of offspring. As numbers of offspring decrease, so does the potential for damage to a following susceptible flower planted in the site. Once the susceptible flowers are planted, nematode numbers build up again. Successful use of rotation requires knowledge about the degree of susceptibility of different plants. Tables 2 and 3 below might be useful in making the decision about which bedding plant to select. It can also serve as a guideline for choosing more suitable plants for sites that are infested with root-knot nematodes.

How Tables 2 and 3 were prepared

These tables combine and summarize the research efforts of several researchers over a number of years (McSorley 1994, McSorley and Frederick 1994, McSorley and Frederick 2001, Mendes et al. 2007, Om et al. 2008, Wang and McSorley 2005, Wang et al. 2004). In all of these studies, the researchers used similar methods, so it is possible to compare results among the different studies. An older study from the 1930s used different methods and the identification of the root-knot nematode species was not clear at that time. Crow (2007) gives a good summary of this older study as well as some other work: http://edis.ifas.ufl.edu/in470.

In the studies used to prepare Tables 2 and 3, all researchers used a root gall index to rate the severity of root-knot infestation on the roots of a plant. Several studies also reported number of nematode eggs produced per plant, and/or numbers of hatched mobile juveniles (J2) that were produced per plant. We wanted to develop a rating scale for flower cultivars that included root gall indices as well as numbers of eggs or juveniles produced per plant. Ratings were assigned based on the categories shown in Table 1. A rating was given in each category (gall index, eggs per plant produced, and J2 per plant) for each species/race of nematode and each plant cultivar. In most cases ratings were identical or similar in all categories, so the corresponding descriptive term was used in Tables 2 and 3. If ratings were close they were averaged, but if they were far apart, the result was described as “variable”. If a nematode has not been tested on a particular cultivar, then the result is listed as “unknown”.

Explanation of different susceptibilities

A wide range in susceptibility is seen among the flower species and cultivars (Tables 2 and 3). Some of these results come from single tests while others were averaged across several studies. Snapdragon is consistently one of the most susceptible flower crops (Fig. 2). Marigolds (Fig. 3) generally show good levels of resistance. The use of resistant marigolds against root-knot nematodes is well known, and additional information can be found here: http://edis.ifas.ufl.edu/ng045. Cultivars designated as “high” or “susceptible” could be expected to develop problems if root-knot nematodes are present, but even cultivars designated as “intermediate” or “variable” should be used with much caution. Several different cultivars were classified as “variable”, such as Periwinkle cultivars, Dianthus 'Baby Doll Mix', and 'Qis White' larkspur. 'Qis White' was inconsistent, making its responses difficult to predict. Because dianthus 'Baby Doll Mix' is technically a mixture of different cultivars, it also has a variety of susceptibilities, and therefore variable results are expected, unless all the cultivars

Table 1. Rating numbers and descriptions used to summarize data for Tables 2 and 3.

Rating	Description	No. of eggs or J2	Root gall index
5	high susceptibility	> 10,000	> 4
4	susceptible	5,000-10,000	3-4
3	intermediate susceptibility	1,000- 4,999	2-3
2	low susceptibility	100- 999	1-2
1	resistant	>0- 99	>0-1
0	immune	0	0

contained in the mix respond similarly to root-knot nematodes. Periwinkle, which produces high galling indices, does not support a high degree of egg production. The same is true to some extent for 'Scarlet' Zinnia. This indicates that although the plant is subject to infection, it has some degree of tolerance to root-knot nematodes. It may initially produce galls, but possibly will grow out of it because future egg production on that plant will be low. On the other hand, a plant that has little galling, but high egg production, is not a good candidate for rotation. Even if this type of plant can tolerate some damage, it does not minimize nematode numbers in the soil, which is the purpose of a rotational plant. Nematode population density will continue to increase on this plant, and will threaten the next crop planted if that plant is susceptible. Ratings of Lisianthus in response to *M. incognita* are favorable but should be used with caution. Although it showed little galling in greenhouse tests, considerable galling can be observed in the field. It is possible that galling in the field resulted from another species of root-knot nematode that was not evaluated in those greenhouse tests. For example, *M. mayaguensis* is a relatively newly discovered species in Florida soils, as is *M. floridensis*. Recent work by Mendes et al. (2007) evaluated the susceptibility of many petunia cultivars to *M. incognita* race 4 and *M. mayaguensis*. All of the petunia cultivars in Table 3 received a rating of "high" for susceptibility to *M. mayaguensis* and all cultivars except for 'Supertunia Lavender Pink' were rated "high" for susceptibility to *M. incognita* race 4. 'Supertunia Lavender Pink' was rated "susceptible". From these findings it becomes clear that most petunia cultivars should be avoided if *M. incognita* race 4 or *M. mayaguensis* are present. Greenhouse pots from the tests summarized in Tables 2 and 3 were inoculated with reared root-knot nematodes whose identity was firmly established, and not with nematodes found in the soil of field plots or gardens. Nematodes found in the soil from a sampled site might not be accurately identified for root-knot nematode species or races, or could be a mixture of different species and races. For this reason, plant cultivars that show resistance to multiple types of root-knot nematodes are generally more useful than those showing resistance to only one species or race.

Figure 2. Snapdragon (*Antirrhinum majus*)

Figure 3. Marigold (*Tagetes* spp.)

Closing remarks

Because of the difficulties mentioned above in identifying root-knot nematodes, it is highly unlikely that anyone planting flowers or bedding plants will

know which species they will have. *Meloidogyne incognita* is very common throughout Florida, but other species, even *M. mayaguensis*, could occur throughout the state as well. It is interesting that whenever more than one nematode species or race were tested, relatively similar results were obtained for the species and cultivars summarized in Table 2, rarely differing by more than one rating classification. It is hoped that the table will provide some general guidelines about which plants are typically quite susceptible to root-knot nematodes and which ones tend to show high levels of resistance. In practice, growers, landscapers, and home gardeners should carefully check to verify that these responses are consistent in their own sites, recognizing that in some cases results could be very different in the event of unusual responses to other root-knot nematode species.

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Table 2. Bedding plant cultivars and their susceptibility to different species of root-knot nematodes.

Species	*M.arenaria*	*M.incognita*		*M.javanica*
	race 1	race 1	race 2	
Ageratum				
-Blue Mink	resistant	immune	*unknown*	immune
Alyssum				
-Rosie O'Day	resistant	*unknown*	*unknown*	immune
Blue Lace				
-Madonna Blue	*unknown*	susceptible	high	*unknown*
Carnation				
-Chabaud Giant	*unknown*	*unknown*	resistant	resistant
Celosia				
-Century Mix	susceptible	susceptible	*unknown*	intermediate
Coleus				
-Rainbow	susceptible	intermediate	*unknown*	intermediate
Delphinium				
-Butterfly Blend	*unknown*	*unknown*	resistant	low
Dianthus				
-Baby Doll Mix	variable	low	*unknown*	resistant
Gypsophila				
-Covent Garden	susceptible	*unknown*	*unknown*	*unknown*
Larkspur				
-Qis Dark Spur	*unknown*	intermediate	*unknown*	*unknown*
-Qis White	*unknown*	variable	intermediate	*unknown*
Lisianthus				
-Avila Rose Rim	*unknown*	low	low	*unknown*
-Balboa Purple	*unknown*	resistant	*unknown*	*unknown*
-Balboa White	*unknown*	resistant	*unknown*	*unknown*
-Catalina White	*unknown*	resistant	*unknown*	*unknown*
-Echo Blue	*unknown*	resistant	*unknown*	*unknown*
-Echo Pink	*unknown*	intermediate	low	*unknown*
-Malibu Blue Blush	*unknown*	low	*unknown*	*unknown*
-Ventura Blue Rim	*unknown*	resistant	*unknown*	*unknown*
-Ventura Purple	*unknown*	resistant	*unknown*	*unknown*
-Laguna Pink Rim	*unknown*	resistant	*unknown*	*unknown*
Marigold				
-Dwarf Primrose	resistant	immune	*unknown*	immune
-Snow Drift	*unknown*	*unknown*	resistant	resistant
-Petite	*unknown*	*unknown*	resistant	low
-Jaguar	*unknown*	*unknown*	resistant	resistant
Nasturtium				
-Dwarf Jewel Blend	*unknown*	*unknown*	intermediate	low
Pansy				
-Jolly Joker	susceptible	*unknown*	*unknown*	*unknown*

Table 2. Bedding plant cultivars and their susceptibility to different species of root-knot nematodes.

Species	***M.arenaria***	***M.incognita***		***M.javanica***
	race 1	**race 1**	**race 2**	
Periwinkle (Vinca)				
-Grape Cooler	*unknown*	resistant	*unknown*	resistant
-Blush Cooler	*unknown*	variable	*unknown*	variable
-Little Bright Eyes	intermediate	variable	*unknown*	variable
-Little Mixed Colors	immune	high	*unknown*	variable
-Peppermint Cooler	*unknown*	low	*unknown*	resistant
Petunia				
-Dwarf Bedding	intermediate	low	*unknown*	low
-Fire Chief	variable	low	*unknown*	resistant
Poppy				
-Oriental Red Perennial	susceptible	*unknown*	*unknown*	*unknown*
Salvia				
-Sea Breeze	*unknown*	resistant	*unknown*	resistant
-Oxford Blue	*unknown*	susceptible	*unknown*	susceptible
-Flare	*unknown*	resistant	*unknown*	resistant
-Lady in Red	*unknown*	immune	*unknown*	resistant
-Victoria	*unknown*	immune	*unknown*	resistant
-Blue Bedder	*unknown*	unknown	resistant	resistant
-Bonfire	*unknown*	resistant	*unknown*	low
Shasta Daisy				
-Alaska	intermediate	*unknown*	*unknown*	*unknown*
-Silver Princess	*unknown*	low	susceptible	susceptible
Snapdragon				
-Dwarf Magic Carpet	*unknown*	*unknown*	susceptible	intermediate
-First Ladies	high	high	*unknown*	high
-Potomac Rose	*unknown*	susceptible	*unknown*	*unknown*
-Potomac Pink	*unknown*	high	susceptible	susceptible
-Potomac Royal	*unknown*	susceptible	susceptible	*unknown*
Verbena				
-Florist	high	low	*unknown*	high
White Dill				
-Green Mist	*unknown*	high	high	*unknown*
-Queen of Africa	*unknown*	high	high	*unknown*
Zinnia				
-Scarlet	resistant	low	*unknown*	intermediate
-Thumbelina	*unknown*	*unknown*	resistant	resistant
-Envy	*unknown*	*unknown*	immune	resistant

Table 3. Susceptibility of selected Petunia cultivars to *M. incognita* race 4 and *M. mayaguensis.*

Species	*M.incognita* race 4	*M.mayaguensis*
Petunia		
-Easy Wave Red	high	high
-Easy Wave Rose Down	high	high
-Easy Wave White	high	high
-Madness Midnight 288	high	high
-Milliflora Prostrate	high	high
-Miniflora Prostrate	high	high
-Petunia Mini Blue	high	high
-Petunia Suncatcher	high	high
-Petunia Pink Vein (Florida)	high	high
-Suncatcher Dark Lavender	high	high
-Suncatcher Saphire	high	high
-Supertunia Blushing Princess	high	high
-Supertunia Lavender Morn	high	high
-Supertunia Lavender Pink	susceptible	high
-Supertunia Lemon Plume	high	high
-Supertunia Mini (Blue Veined)	high	high
-Supertunia Mini (Bright Pink)	high	high
-Supertunia Mini (Pastel Pink)	high	high
-Supertunia Mini Purple	high	high
-Supertunia Mystic Pink	high	high
-Supertunia Red	high	high
-Surfinia Baby Compact	high	high
-Surfinia Red Petunia	high	high
-Surfinia Sugar Plum	high	high
-Sweet Sunshine 5	high	high
-Tidal Wave Silver	high	high