HOST STATUS OF PETUNIA CULTIVARS TO ROOT-KNOT NEMATODES

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Summary. The host status of 26 cultivars of petunia (*Petunia hybrida*) to *Meloidogyne mayaguensis* and *M. incognita* race 4 was evaluated under glass-house conditions. The experiment was carried out in a completely randomized design with six replicates. A tomato cultivar was included as a susceptible host to both nematode species. The inoculum consisted of 3,000 eggs and/or second-stage juveniles of *M. mayaguensis* or *M. incognita* per plant. Sixty-four days after inoculation, the plants were harvested and the numbers of galls and egg masses per root system were recorded. All petunia cultivars were highly susceptible to both nematodes and no differences were observed between the two nematode species ($P \leq 0.05$). However, fewer galls were formed by both nematodes on cv. Supertunia Lemon Plume and by *M. incognita* on cv. Supertunia Lavender Pink, and fewer egg masses were formed by *M. mayaguensis* on cv. Supertunia Lavender Pink and by *M. incognita* on cv. Supertunia Lemon Plume. The size of the galls induced by *M. mayaguensis* was unusually larger than that of galls induced by *M. incognita* ($P < 0.05$). The largest galls of *M. mayaguensis* were observed on Easy Wave Red and Sweet Sunshine 5, whereas the largest galls of *M. incognita* were found on Easy Wave White, Sweet Sunshine 5 and Mini Blue. The gall sizes of both nematodes were significantly larger on tomato than on petunia cultivars ($P \leq 0.05$).

Key words: *Meloidogyne incognita*, *M. mayaguensis*, *Petunia hybrida,* susceptibility.

Ornamental crops represent the sixth largest agricultural commodity in the United States (NASS, 1999; University of Florida-IFAS Extension, 2006). Floriculture and environmental agriculture is the fastest growing segment in this country's agriculture and includes bedding plants, cut flowers and greens, tropical foliage, potted flowering plants, nursery crops, and turfgrass sod (Hodges and Haydu, 2000).

In Florida, ornamental crop production is a rapidly expanding industry and the state is the second ranked producer of ornamental plants in the United States (University of Florida-IFAS Extension, 2006). The gross wholesale value for U.S.-grown floriculture and nursery crops in 2001 reached $13.3 billion, of which $1.6 billion was produced in Florida alone (Hodges and Haydu, 2003).

Petunia [*Petunia hybrida* (Hook.) Vilm.] is one of the most popular bedding plants. Offering a broad variety of flower colors, from white through purple to two-color cultivars, they are used in landscaping for filling borders. The fact that they are so widely grown has encouraged breeders to improve them, resulting in the release of new cultivars every year. However, the appearance of these colorful annual plants in the landscape can be diminished by pests and diseases, including plant-parasitic nematodes and especially root-knot nematodes, *Meloidogyne* spp. So far, there is relatively little information regarding to the response of petunia cultivars to plant-parasitic nematodes. Root-knot nematodes are the most widespread and destructive of plant nematodes (Walker *et al.*, 1994; Dunn, 1997; Brito *et al.*, 2004a).

Some petunia cultivars have been reported as hosts for different root-knot nematode species. Goff (1936) was the first scientist to investigate the reaction of annual bedding plants, including a petunia cultivar, to root-knot nematodes; however, the plant cultivars and nematode species were not identified. According to McSorley and Frederick (1994), petunia cv. Dwarf Bedding was susceptible to *M. javanica* (Treub) Chitw. and *M. arenaria* (Neal) Chitw. race 1, and petunia cv. Color Parade Hybrid Mix was susceptible to *M. incognita* (Kofoid *et* White) Chitw. race 1. McSorley (1994) also found petunia cv. Fire Chief susceptible to *M. arenaria* race 1, with severe galling. In a microplot study under field conditions in India, Khan *et al.* (2005) state that *M. incognita* (race not specified) had led to a 37% decrease in flower production in petunia cv. Silver Spring.

In Florida, *M. arenaria, M. incognita* and *M. javanica* are the most common root-knot nematodes (Dunn, 1997; Inserra *et al.*, 2003). In addition to these species, *M. mayaguensis* Rhamma *et* Hirschman was discovered in 2001 (Brito *et al.*, 2003; Inserra *et al.*, 2003), representing a new challenge to growers. Since then, *M. mayaguensis* has been found in 10 counties infecting many important agronomic crops, such as soybean and guava, vegetables, ornamentals grown in nurseries and greenhouses, and many other plant species, including weeds, belonging to several botanical families (Brito *et al.*, 2003; Brito *et al.*, 2004a; Levin *et al.*, 2004; Cetintas

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et al., 2005; Mendes *et al.*, 2005). This nematode is of particular importance due to its ability to reproduce on root-knot nematode resistant cultivars of crops such as pepper and tomato (Brito *et al.*, 2004b).

While *P. hybrida* is already a known host of the common species of root-knot nematodes, the host status of new cultivars had not yet been evaluated. Likewise, information about the reaction of petunia to *M. mayaguensis* is also lacking. Similarly, information about susceptibility of petunia to race 4 of *M. incognita* is also unknown. Therefore, this study was designed to evaluate the reaction of new petunia cultivars to these particular root-knot nematodes.

MATERIALS AND METHODS

The responses of twenty-six cultivars of petunia (*P. hybrida*) to *M. mayaguensis* and *M. incognita* race 4 were checked under glass-house conditions. The experiment was carried out in a completely randomized design with six replicates. Tomato (*Lycopersicon esculentum* Mill.) cv. Rutgers was included as a susceptible host to both nematode species.

The petunia seedlings were provided by the Environmental Horticulture Department, University of Florida, Gainesville, FL. Thirty-two-day-old seedlings were transplanted singly to 10 cm diameter clay pots containing a mixture (1:3) of steam-pasteurized sand soil and potting soil (Fafard No. 3 – Conrad Fafard, Inc., Agawam, MA, USA). Ten days after transplanting, each plant was inoculated with 3,000 eggs and/or second-stage juveniles of *M. mayaguensis* or *M. incognita*. Nematode inocula for both species were obtained from single egg mass populations maintained on tomato cv. Rutgers in a glass-house. The eggs were extracted from the root systems in 0.25% sodium hypochlorite solution using the technique of Hussey and Barker (1973) modified by Bonetti and Ferraz (1981).

Inoculated plants were maintained under glass-house conditions at an average temperature of 27 °C. The ambient temperature ranged from 23 °C to 31°C. Plants were watered daily and fertilized twice a week with NPK Peter's fertilizer (20-20-20) according to the manufacturer's instructions. At 64 days after inoculation the plants were harvested; the root systems were removed from the pots, carefully washed to remove the soil, and rated for galls and egg masses per root system using the 0 - 5 scale proposed by Taylor and Sasser (1978). Because visual observation showed that gall sizes varied considerably, one plant of eight selected cultivars (Table II) and one of tomato infected either by *M. mayaguensis* or *M. incognita* were chosen to determine the diameters of the galls. Five galls on each plant were measured.

The analysis of variance (ANOVA) of the data was performed using SAS software (SAS Institute, Care, NC) and mean separation ($P \leq 0.05$) for root gall and egg mass indices was with Waller-Duncan's multiple range.

RESULTS AND DISCUSSION

All petunia cultivars evaluated in this study were highly susceptible to *M. mayaguensis* and *M. incognita* race 4. The great majority of the petunia genotypes had more than 100 galls and egg masses per root system induced by both nematodes, and the infestation of petunia cultivars was similar to that of tomato cv. Rutgers used as control (Table I). The gall index ranged from 3.2 to 5.0 for *M. mayaguensis* and 4.5 to 5.0 for *M. incognita* race 4, whereas the egg mass index ranged from 4.0 to 5.0 for *M. mayaguensis* and from 4.3 to 5.0 for *M. incognita*, respectively. The cultivars Supertunia Lemon Plume, Supertunia Lavender Pink and Surfinia Red Petunia exhibited lower gall and/or egg mass indices than other genotypes (Table I). However, the cultivar Supertunia Lemon Plume had significantly smaller gall indices caused by both nematodes and Supertunia Lavender Pink a lower gall index induced by *M. incognita*. The size of the galls induced by *M. mayaguensis* both on petunia cultivars and tomato was usually larger than that of the galls induced by *M. incognita*. The gall diameter of *M. mayaguensis* ranged from 0.10 cm to 0.60 cm on petunia and from 0.10 cm to 1.1 cm on tomato. For *M. incognita* the gall size varied from 0.05 cm to 0.30 cm on petunia and from 0.05 cm to 0.60 cm on tomato. The difference in mean gall size ($P < 0.05$) between *M. mayaguensis* (0.48 cm) and *M. incognita* (0.20 cm) was significant. The largest galls of *M. mayaguensis* were observed on Easy Wave Red and Sweet Sunshine 5, whereas for *M. incognita* they were found on Easy Wave White, Sweet Sunshine 5 and Mini Blue. The gall sizes of both nematodes were larger on tomato than those on petunia cultivars and the difference was significant ($P \leq 0.05$) (Table II).

Many bedding plants have been tested for their responses to root-knot nematodes (McSorley, 1994; Wang and McSorley, 2005). However, prior to our test, just a few petunia cultivars had been evaluated against *M. javanica*, *M. incognita* and *M. arenaria* (McSorley, 1994; McSorley and Frederick, 1994; Khan *et al.*, 2005) and resistance was not found. Different cultivars of many species of annual plants react differently to root-knot nematodes (Dunn, 1997). A difference in reaction of two white dill cultivars to *M. incognita* re-emphasizes that variability in susceptibility within a plant species does exist (Wang and McSorley, 2005). Such differences were not observed in petunia in this study. No petunia cultivar had previously been tested against *M. mayaguensis*. Our findings showed that many *P. hybrida* genotypes are highly susceptible to this root-knot nematode species. This is not surprising since *M. mayaguensis* has a wide host range, including plants in several botanical families (Brito *et al.*, 2007).

Meloidogyne mayaguensis and *M. incognita* are important pathogens and probably the most damaging nematodes to petunias and many other ornamental plants. The suitability of different cultivars as hosts must be

Table I. Host status of 26 petunia cultivars, compared to tomato cv. Rutgers, to *Meloidogyne mayaguensis* and *M. incognita* race 4 in a glass-house trial.

Cultivar	Gall index[1]		Egg mass index[1]	
	M. mayaguensis	*M. incognita* race 4	*M. mayaguensis*	*M. incognita* race 4
Easy Wave Red[2]	5.0 a	5.0 a	5.0 a	5.0 a
Easy Wave Rose Down	5.0 a	5.0 a	5.0 a	5.0 a
Easy Wave White[2]	5.0 a	5.0 a	5.0 a	5.0 a
Madness Midnight 288[2]	5.0 a	4.6 a	5.0 a	4.6 ab
Milliflora Prostrate (Whisper Purple)[2]	5.0 a	5.0 a	5.0 a	5.0 a
Miniflora Prostrate (Whisper White)	5.0 a	5.0 a	5.0 a	5.0 a
Petunia Mini Blue[2]	5.0 a	5.0 a	5.0 a	5.0 a
Petunia Suncatcher (Lavender Imperator)	5.0 a	5.0 a	5.0 a	5.0 a
Petunia Pink Vein (Florida)	5.0 a	5.0 a	5.0 a	5.0 a
Suncatcher Dark Lavender	5.0 a	5.0 a	5.0 a	5.0 a
Suncatcher Saphire	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Blushing Princess	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Lavender Morn	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Lavender Pink	5.0 a	4.0 b	4.5 b	5.0 a
Supertunia Lemon Plurne	3.2 b	4.2 b	5.0 a	4.3 b
Supertunia Mini (Blue Veined)	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Mini (Bright Pink)	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Mini (Pastel Pink)	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Mini Purple	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Mystic Pink	5.0 a	5.0 a	5.0 a	5.0 a
Supertunia Red	5.0 a	5.0 a	5.0 a	5.0 a
Surfinia Baby Compact (Amethyst Petunia)	5.0 a	5.0 a	5.0 a	5.0 a
Surfinia Red Petunia	4.8 a	4.8 a	5.0 a	4.8 a
Surfinia Sugar Plum[2]	5.0 a	5.0 a	5.0 a	5.0 a
Sweet Sunshine 5[2]	5.0 a	5.0 a	5.0 a	5.0 a
Tidal Wave Silver[2]	5.0 a	5.0 a	5.0 a	5.0 a
Tomato 'Rutgers' (control)	5.0 a	5.0 a	5.0 a	5.0 a

Data are means of six replications. Means within a column followed by a common letter are not different according to Waller-Duncan's multiple-range test ($P \leq 0.05$).
[1]Gall Index/ Egg mass Index: 0 = no galls or egg masses; 1 = 1 - 2 galls or egg masses; 2 = 3 - 10 galls or egg masses; 3 = 11 - 30; 4 = 31 - 100 galls or egg masses; 5 = more than 100 galls or egg masses (Taylor and Sasser, 1978).
[2]Cultivars selected for gall size measurement.

Table II. Gall size induced by *Meloidogyne mayaguensis* and *M. incognita* race 4 on eight petunia cultivars compared to that on tomato cv. Rutgers in a glass-house trial.

Cultivar	Gall diameter (cm)	
	M. mayaguensis	*M. incognita* race 4
Easy Wave Red	0.53 b	0.20 bc
Easy Wave White	0.49 bc	0.22 b
Madness Midnight 288	0.49 bc	0.08 c
Milliflora Prostrate (Whisper Purple)	0.29 c	0.20 bc
Petunia Mini Blue	0.37 bc	0.23 b
Surfinia Sugar Plum	0.47 bc	0.09 bc
Sweet Sunshine 5	0.53 b	0.22 b
Tidal Wave Silver	0.43 bc	0.19 bc
Tomato 'Rutgers' (control)	0.76 a	0.40 a

Data are means of five replications. Means within a column followed by a common letter are not different according to Waller-Duncan's multiple-range test ($P \leq 0.05$).

recognized to avoid damage. If susceptible cultivars are successively planted in the same area it can led to an increase of nematode population to levels that will affect plant growth, flower production and flower quality. Potted plants and transplants should be free of plant-parasitic nematodes. Thus, it is important to know the nematode species, and races if possible, that are present in a location before any landscape planting begins. If root-knot nematode is found, bedding plants others than petunia should be considered for inclusion.

ACKNOLEDGMENTS

The authors thank Dr. Ramandeep Kaur and Joey Orajay for critically reviewing the manuscript and Mr. Luis Collazo for technical assistance.

This research was supported by the TSTAR grant USDA-CSREES 2005-34135-15895.

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Accepted for publication on 23 April 2007.