RESEARCH NOTE - NOTA DE INVESTIGACION

HOST SUITABILITY OF CALADIUM VARIETIES TO *MELOIDOGYNE INCOGNITA*

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ABSTRACT

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Eight commercial varieties of caladium (*Caladium* × *hortulanum*) were evaluated for resistance or susceptibility to the root-knot nematode, *Meloidogyne incognita*, in tests conducted in greenhouse and growth room. Relative levels of resistance among varieties was evaluated in terms of nematodes present in soil and second-stage juveniles hatched from eggs extracted from roots at 4-5 months after nematode inoculation. Lowest numbers of nematodes were produced on 'White Christmas' and 'Pink Glow'. 'Crimson Wave' and 'Autumn Beauty' appeared to be the most susceptible varieties, usually supporting consistently high numbers of nematodes. Nematode numbers on 'Avalon Rose', 'Fire Nymph', 'Dawn', and 'Fire Chief' were generally intermediate, but often not different ($P \leq 0.05$) from those present on the most susceptible varieties. Results demonstrate the existence of differing levels of relative resistance against *M. incognita* in caladium germplasm.

Key words: Caladium × *hortulanum*, host plant resistance, ornamental crops, pest management, resistant cultivars, root-knot nematodes.

RESUMEN

McSorley, R., K.-H. Wang y J. J. Frederick. 2003. Idoneidad de variedades de caladium como huesped de *Meloidogyne incognita*. Nematropica 34:97-101.

Ocho variedades comerciales de caladium (*Caladium* × *hortulanum*) fueron evaluadas para su resistencia o sensibilidad al nemátodo de agalla, *Meloidogyne incognita*, en ensayos llevados a cabo en el invernadero y en una cámara de clima controlado. Niveles relativos de resistencia entre variedades fueron evaluados en términos de números de nemátodos presentes en el suelo, y números de juveniles de segundo estado nacidos de sus huevos extraidos de las raices 4-5 meses después de inoculación. Los números mas bajos de nemátodos fueron producidos por 'White Christmas' y 'Pink Glow'. 'Crimson Wave' y 'Autumn Beauty' aparentemente fueron las variedades más sensibles, normalmente mostrando números consistentemente altos de nemátodos. Números de nemátodos en 'Avalon Rose', 'Fire Nymph', 'Dawn', y 'Fire Chief' eran generalmente intermedios, pero en muchos casos no eran significativamente diferentes ($P \leq 0.05$) de los números presentes en las variedades más sensibles. Los resultados demostran la existencia de niveles diferentes de resistencia relativa contra M. incognita en germoplasma de caladium.

Palabras claves: Caladium × *hortulanum*, resistencia de planta huésped, cultivos ornamentales, manejo de plagas, cultivares resistentes, nemátodos agalladores.

INTRODUCTION

Caladium (*Caladium* × *hortulanum* Birdsey) is a popular ornamental foliage plant, but the majority of the world's production is in Florida, centered in Highlands County near Lake Placid. Soilborne pest problems due to nematodes (particularly *Meloidogyne* spp.), diseases (particularly *Fusarium* spp.), and weeds are important constraints to cal-

adium production, and sites are routinely fumigated with methyl bromide to minimize impact of these pests (Gilreath *et al.*, 1999; Overman and Harbaugh, 1982; 1983). However, due to pending limitations on use of methyl bromide (Gilreath *et al.*, 1999), interest in nonchemical alternatives for pest management has increased.

The root-knot nematode *Meloidogyne incognita* (Kofoid & White) Chitwood is the key nematode pest of caladium (Brcka *et al.*, 2000), but relatively little effort has been directed toward nonchemical methods for management. Hot water treatment can be used to kill root-knot nematodes on caladium corns and provide healthier planting material, resulting in improved growth in the field (Brcka *et al.*, 2000; Rhoades, 1961; 1964). However, caladium production sites are limited geographically, have been used for continuous production for many years, and are generally infested with root-knot nematodes (Gilreath *et al.*, 1999). Therefore, even if nematode-free planting material is used, the caladium crop will eventually become infected from the resident soil populations of nematodes.

Many varieties of caladiums are available, but it is unknown whether varieties differ in host suitability to root-knot nematode. Most nematologists define resistance as the ability of the plant to suppress nematode development or reproduction; susceptibility is the opposite of resistance (Cook and Evans, 1987; Roberts *et al.*, 1998; Trudgill, 1991). Many different criteria may be used in evaluating resistance to root-knot nematodes. In a practical sense, production of viable eggs and juveniles is critical for future nematode population development and infection/reinfection of plant roots. In this regard, root galling or egg mass ratings are not as useful as actual egg production in assessing resistance. However, *Meloidogyne javanica* (Treub) Chitwood produced eggs on *Dracaena marginata* Lam., but eggs were not viable (McSorley and Dunn, 1990). Therefore some means of assessing egg viability is also crucial in evaluating resistance.

If a source of resistance were available in caladium, it may have potential for development into an important nematode management tool. The objective of the current study is to determine the relative level of resistance/susceptibility of selected caladium varieties to *M. incognita*. This is accomplished by comparing nematode population development among the varieties evaluated.

MATERIALS AND METHODS

In February 2002, corms of 8 caladium varieties were received from a commercial caladium grower (Hendry Enterprises, Inc., Lake Placid, FL). Examination of randomly-selected corms (McSorley *et al.* 1999) revealed no root-knot nematodes present. In mid-March, corms were planted (one/pot) at a depth of 2.5 cm into 12.5-cm-diam plastic pots with a capacity of approximately 1100 cm^3 of soil. The soil used was a nematode-free 4:1 (v:v) mixture of sand:potting soil (Greenleaf Products, Inc., Haines City, FL), providing a final mix containing 97.0% sand, 0.5% silt, and 2.5% clay, with 3.0% organic matter.

On 5 April 2002, shortly after the first caladium shoots had emerged, all pots were inoculated with 800 second-stage juveniles (J2) of *Meloidogyne incognita* race 1. The nematode isolate used had been maintained in a greenhouse on 'California Wonder' pepper (*Capsicum annuum* L.) and previously verified by a differential host test (Brcka *et al.*, 2000; Taylor and Sasser, 1978). One week before nematode inoculation, eggs of *M. incognita* were extracted from pepper roots in 0.394% NaOCl using the method of Hussey and Barker (1973). Eggs were incubated at 23-24°C for seven days on modified Baermann trays (Rodriguez-Kabana and Pope,

1981) containing two pieces of standard tissue paper (Kimwipes, Kimberly Clark Corp., Roswell, GA) for collection of J2. Nematode inoculum was delivered into three holes (2 cm deep) near the corm.

Two separate experiments were established on the same day at the University of Florida in Gainesville, FL (29°39'N, 82°22'W). One experiment was conducted in a greenhouse with daily mean temperatures ranging between 21-29°C. The other experiment was conducted in a temperature-controlled growth room at 24 ± 1°C, where plants were maintained on a 14-hr light and 10-hr dark photoperiod regime at a light intensity of 9,700 lux. Each experiment consisted of 8 different caladium varieties, each replicated 6 times in a randomized complete block design. A three-week-old seedling of 'California Wonder' pepper was transplanted, inoculated with nematodes as described above, and maintained with each replication of caladiums as a control to confirm viability of inoculum. Plants were watered daily and fertilized weekly with 50 ml/pot of a 0.54 g/L solution of 15-30-15 ($N:P_2O_5:K_2O$) Miracle-Gro (Scotts Miracle-Gro Product Inc., Marysville, OH) fertilizer. No pesticides were applied, except for an occasional application of Safer Brand Insecticidal Soap (Safer, Inc., Bloomington, MN) for management of whiteflies.

The greenhouse experiment was harvested by replication from 19 July to 1 August and the growth room experiment was harvested from 20 August to 3 September. Plants were cut at the soil surface, and below-ground plant parts were removed, washed, and the root system rated for galling on a 0 to 5 scale, where 0 = 0 galls, 1 = 1-2 galls, 2 = 3-10 galls, 3 = 11-30 galls, 4 = 31-100 galls, and 5 = more than 100 galls per root system (Taylor and Sasser, 1978). Roots were then removed from any below-ground corms, extracted in 0.394% NaOCl (Hussey and Barker, 1973), and extracted eggs were incubated on Baermann trays as described previously, to determine viable J2 hatched per root system. Nematodes were also extracted from a 100-cm^3 sample of soil collected from each pot, using a sieving and centrifugation procedure (Jenkins, 1964). Eggs were not extracted from corms, since numbers present on corms are typically very low compared to numbers present in roots (McSorley *et al.*, 1999). Data were subjected to analysis of variance and means were compared by Duncan's new multiple-range test using MSTAT-C software (Freed *et al.*, 1991). Nematode count data (nematodes/g root or nematodes/100 cm^3 soil) were transformed by $\log_{10}$ (x+1) prior to analysis. Data for pepper plants (controls to confirm viability of inoculum) are not included in the analyses, since the objective of the data analyses was to determine differences among caladium cultivars.

RESULTS AND DISCUSSION

The nematode inoculum used was viable and very productive, as indicated by the pepper control plants, which had an average gall index of 5.0 (maximum) and 8328 hatched J2 per gram of root. Root galling was present on all caladium varieties but difficult to evaluate and not indicative of the nematode population levels present (Tables 1 and 2). Viable egg masses of *M. incognita* were present on all caladium root systems, but sometimes were difficult to see since they were partially embedded in the fleshy root cortex. Nematode production, evaluated as numbers in soil or hatched J2 from roots, varied among caladium varieties (Tables 1 and 2). Results of the two experiments were fairly consistent. In both tests, the lowest numbers of nematodes were produced on 'White Christmas' or 'Pink Glow'. 'Crimson Wave' and 'Autumn Beauty' appeared to be the most susceptible varieties, usually

Table 1. Root gall ratings and numbers of second-stage juveniles (J2) of *Meloidogyne incognita* on caladium varieties in greenhouse test, 2002.

Variety	Gall rating[y]	J2 per 100 cm^3 soil	J2 per g fresh root wt
Crimson Wave	4.0 a	24.2 abc[z]	334.7 a[z]
Fire Nymph	4.2 a	89.8 a	63.9 ab
Autumn Beauty	4.5 a	53.1 ab	254.3 a
Dawn	4.8 a	6.2 cde	50.6 ab
Fire Chief	3.8 a	9.4 bcd	39.2 ab
Avalon Rose	4.5 a	6.3 cde	16.1 ab
Pink Glow	3.2 a	2.3 de	5.3 b
White Christmas	4.2 a	0 e	23.5 ab

[y]Gall rating on 0 (none) to 5 (very high) scale of Taylor and Sasser (1978).
[z]Data are antilogs of means of $\log_{10}(x+1)$ transformed values. Data in columns followed by the same letter are not different ($P \leq 0.05$) according to Duncan's new multiple-range test.

having consistently high numbers of nematodes. Nematode numbers on 'Fire Nymph', 'Avalon Rose', 'Dawn', and 'Fire Chief' were generally intermediate, but often the numbers present on these varieties were not significantly different ($P \leq 0.05$) from numbers present on the most susceptible varieties (Tables 1 and 2).

Results of the current experiments are encouraging in that a range of relative resistance and susceptibility to *M. incognita* occurs within existing caladium varieties. The varieties tested represent only a small portion of commercially available varieties, so there may be potential to discover additional sources of resistance in caladium, as

Table 2. Root gall ratings and numbers of second-stage juveniles (J2) of *Meloidogyne incognita* on caladium varieties in growth room test, 2002.

Variety	Gall rating[y]	J2 per 100 cm^3 soil	J2 per g fresh root wt
Crimson Wave	2.1 bc	294.8 a[z]	499.0 a
Fire Nymph	1.5 c	40.6 ab	82.0 ab
Autumn Beauty	3.0 ab	51.7 ab	200.4 a
Dawn	2.2 abc	48.6 ab	133.2 ab
Fire Chief	2.7 abc	77.0 ab	305.9 a
Avalon Rose	3.3 a	18.9 bc	87.1 ab
Pink Glow	1.8 bc	4.6 bc	8.7 bc
White Christmas	2.5 abc	1.2 c	4.3 c

[y]Gall rating on 0 (none) to 5 (very high) scale of Taylor and Sasser (1978).
[z]Data are antilogs of means of $\log_{10}(x+1)$ transformed values. Data in columns followed by the same letter are not different ($P \leq 0.05$) according to Duncan's new multiple-range test.

well as to improve root-knot nematode resistance in the production of this important ornamental crop. Plant damage and nematode tolerance were not evaluated in the current experiments, because noninoculated plants of each variety were not included. Evaluation of germplasm for tolerance is an important feature of nematode management programs (Young, 1998), and should be explored further with caladium, in addition to studies of resistance.

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