Pakistan J. Zool., vol. 43(2), pp. 337-342, 2011.

Meloidogyne incognita Infecting Two Perennial Ornamentals

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Abstract.- The plants of *Iresine herbstii* cv. Brilliantissima, and, *Alternanthera dentata* cv. Brazilian-Red-Hot planted as edging plants in fourteen lawns on the campus of University of Agriculture, Faisalabad were sampled to assess the infestation of root-knot nematodes. *Meloidogyne incognita* was identified by using perineal patterns of adult females and morphology of adult males. The nematode infected plants were severely stunted and lacking in vigor with pale green foliage. Root galling was evident on roots but galls on the two cultivars differed in number and size. The nematode infested plants were rated for root galling and egg mass production per root system using a 0-5 scale and second stage juvenile (J2) population in roots and soil. Only two out of seven lawns having Brazilian-Red-Hot plants exhibited light root galling (mean rating = 3), however all Brilliantissima plants from all seven lawns exhibited heavy root galling (mean rating = 5) in response to *M. incognita* infection. Root and soil J2 populations indicated that *M. incognita* reproduced efficiently on roots of Brilliantissima plants (mean egg mass rating = 4.8) compared to that on roots of Brazilian-Red-Hot plants (mean egg mass rating = 1.0). This study has identified that *M. incognita* is a damaging pest of these ornamentals and it is also apparent that preference of bedding plant can impact root-knot nematode population and subsequent plant damage in a planting site.

Keywords: *Alternanthera dentata* cv. Brazilian-Red-Hot, *Iresine herbstii* cv. Brilliantissima, *Meloidogyne incognita,* gardening.

INTRODUCTION

Iresine herbstii cv. Brilliantissima, and *Alternanthera dentata* cv. Brazilian-Red-Hot Family Amaranthaceae are short-lived perennials originally from tropical and subtropical rainforests throughout the West Indies and Brazil. These two bedding perennials are attractive as tall edging plants for garden beds or as containerized specimen plants. They also make excellent cut flowers. Their flowers display a variety of sizes, shapes, and colors but pest infestation reduces their aesthetic quality and marketability (Higley and Pedigo, 1996). Nematodes are the most destructive pests of several ornamentals (Walker and Melin, 1998; Williams-Woodward and Gray, 1999; Walker *et al.*, 1994). The plant grouping of seasonal ornamentals includes many selections highly susceptible to and less productive in the presence of root-knot nematodes (Sasser, 1989; Khan *et al.*, 1987). Brilliantissima and Brazilian-Red-Hot ornamentals were investigated for their host status to *Meloidogyne incognita*.

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0030-9923/2011/0002-0337 $ 8.00/0

Brilliantissima and Brazilian-Red-Hot ornamentals are widely used in outdoor plantings in Pakistan. They are produced in containers but also seeded or transplanted directly into planting beds. There has been minimal quantification of its association with plant parasitic nematodes, particularly root-knot nematode, *Meloidogyne* spp. This group of nematodes is a major pathogen of agricultural crops in the Punjab (Anwar and McKenry, 2010a, b; Anwar *et al.*, 2007) so there is a likelihood of their presence in landscaping area.

Lists of other root-knot nematode susceptible bedding plants are worthy of attention and include coleus, *Coleus blumei*, impatiens, *Impatiens* spp., cock's comb, *Celosia argentea*, dahlia, *Dahlia imperialis,* snapdragon, *Antirrhinum majus*, lisianthus, *Eustoma grandiflorum*, sunflower, *Helianthus* spp. and gladiolus, *Gladiolus* spp. (Anwar and Javed, 2010; Anwar *et al.*, 2009; McSorley and Frederick, 1994). *Coleus* and *celosia* can be so severely damaged by root-knot nematodes that chemical control has been considered as an option (Anwar *et al.*, 2009; Caveness and Wilson, 1977; Acosta, 1976). Ziannia, *Zinnia elegans*, showed root galling, but galling incidence increased when it was infected with Zinia mosaic virus (Jabri *et al.*, 1985). Snapdragon is a good host for root-knot nematodes and showed wilting or other damage symptoms (Tarjan, 1952; Goff, 1936). Cape jasmine, *Gardenia* is highly susceptible to root-knot nematode resulting in poor survival, the preferred scion has been recommended to be grafted onto the nematode resistant rootstock *G. thunbergia* (Plant Files, 2009; Davis and Jenkins, 1960). Golden dewdrop, *Duranta erecta* and showy baby's-breath, *Gypsophila elegans* have been found susceptible to *M. arenaria* (Burgos, 2010; McSorley, 1994). Spriggs (2009) found *M. mayaguensis* infecting roots of crape-myrtle, *Lagerstroemia indica*. Stunting of night–blooming jasmine *Cestrum nocturnum* has been associated with the presence of root-knot nematode species (Top Tropical Plant Catalog, 2010). *Meloidogyne incognita* is also associated with galling on roots of paper flower, *Bougainvillea glabra* (Ibrahim *et al.*, 2000).

Limited nematode information is available on plants of Brilliantissima and Brazilian-Red- Hot planted in the Punjab or other provinces. The objective of this research was to assess associations of root-knot nematodes with *I. herbstii* cv. Brilliantissima, and *A. dentata* cv. Brazilian-Red-Hot planted at various locations on the campus of University of Agriculture, Faisalabad.

MATERIALS AND METHODS

During 2009 and 2010, fourteen separate lawns at the campus of University of Agriculture, Faisalabad were planted with Brilliantissima, and Brazilian-Red-Hot. Each of these fourteen was sampled to quantify root-knot nematode presence. Sites of lawns 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, and 14 were located at Institute of Food Science and Technology, Dean's Office, Department of Animal Breeding and Genetics, Institute of Horticulture Sciences, Faculty of Live Stock Management, Iqbal Auditorium, Mosque, Senior Tutor Office, VC House, Institute of Soil Science, Directorate of Research, Power House, Habib Bank, and Department of Resource Economics, respectively. At least 5 plants from each lawn were randomly selected and sampled. A composite sample was collected into a plastic bag and transferred to $5^{O}C$ refrigerator prior to extraction. Each sample consisted of roots with adhering soil collected between 5 and 30-cm deep. All root samples were carefully washed under tap water to remove adhering soil particles and fine entangled grass roots. Root systems of the plants were stained with Phloxine B (Holbrook *et al.*, 1983) and assessed for presence of egg masses. Root galling and egg mass indices were assessed on a 0 to 5 scale, where 0 = no gall, 1 = 1-2, 2 = 3-10, 3 = 11-30, 4 = 31-100, and 5 = >100 galls per root system (Quesenberry *et al.*, 1989). Nematodes were extracted from a composite fresh root sample by placing 20 g of diced roots onto a screen fitted atop a glass funnel then placed into a mist-chamber for 5 days (McKenry and Roberts, 1985). Soil of each sample was thoroughly mixed and a $100cm^3$ sub-sample was collected for nematode extraction. Nematodes were extracted from soil through a combined sieving/Baermann funnel technique that involved 3 days of mist extraction (McKenry and Roberts, 1985). Nematode population levels were identified and quantified under a stereo microscope.

Root knot nematodes present in these samples were identified using perineal patterns of adult females as well as morphology of adult males (Jepson, 1987).

Data analysis

Data were subjected to analysis of variance using SAS (SAS Institute, Cary NC). Significant differences in means of nematode reproduction were separated using Duncan's Multiple Range Test at ($P = 0.05$).

RESULTS

Identification of Meloidogyne *spp.*

Shape of female perineal patterns and morphology of males from galled roots of Brilliantissima and Brazilian-Red-Hot plants were notably similar to that of *Meloidogyne incognita* (Hartsman and Sassaer, 1985).

Symptoms

Root-knot nematode infected plants were severely stunted and lacking in vigor. Foliage of infected plants of Brilliantissima and Brazilian-Red-Hot was pale green. Nematode infected plants exhibited symptoms of wilt and ultimately necrosis.

Characteristic root galling was evident on feeder as well as secondary roots but galls on the two cultivars differed in number and size (Fig. 1). Greater numbers of galls were recorded on roots of Brilliantissima compared to Brazilian-Red-Hot at all locations sampled (Tables I, II). Size of galls on roots of Brilliantissima was significantly greater than that on roots of Brazilian-Red-Hot (Fig. 1). Nematode infected plants exhibited noticeably reduced root systems and particularly sparse development of secondary roots and root hairs.

Nematode development on Brazilian-Red-Hot:

Seven lawns planted with Brazilian-Red-Hot as border plants were sampled for nematode presence. Plants sampled from two lawns located at sites 5 and 6 exhibited light root galling (mean rating = 3) in response to *M. incognita* infection (Table I). Five other lawns including those located at sites 1, 2, 3, 4, and 7 were found free from root galling. Roots of plants collected from site 5 carried 1.4, 1.7, 1.2 and 1.3 times more root galls, more egg masses per root system, more J2 per g of root and more juveniles in soil, respectively compared to counts from the site 6.

Nematode development on Brilliantissima

All Brilliantissima plants from seven lawns exhibited heavy root galling (mean rating = 5) in response to *M. incognita* infection (Table II). Greatest gall intensity was recorded from roots with 313, 253 and 225 galls collected from sites 13, 12, and 9, respectively. Roots collected from sites 10 and 11 carried intermediate galling. The other two sites including 8 and 14 exhibited significantly reduced galling (Table II). At all seven sites galling and egg mass development were similar but roots collected from site 8 exhibited a lower egg mass rating than gall rating (Table II).

Nematode root and soil populations

Meloidogyne incognita reproduced efficiently on roots of Brilliantissima plants collected from all seven sites (mean egg mass rating = 4.8). The greatest number of J2 populations per gram was noticed on roots sampled from sites 9 and 12 with intermediate numbers from sites 13, 10, and 11. Lowest numbers of infective juveniles occurred on roots of plants near sites 8 and 14 (Table II). Soil population densities of *M. incognita* were highest in soil from lawn of site 11 and lowest from soil of lawns located at sites 8 and 14. Three other sites had intermediate J2 populations (Table II).

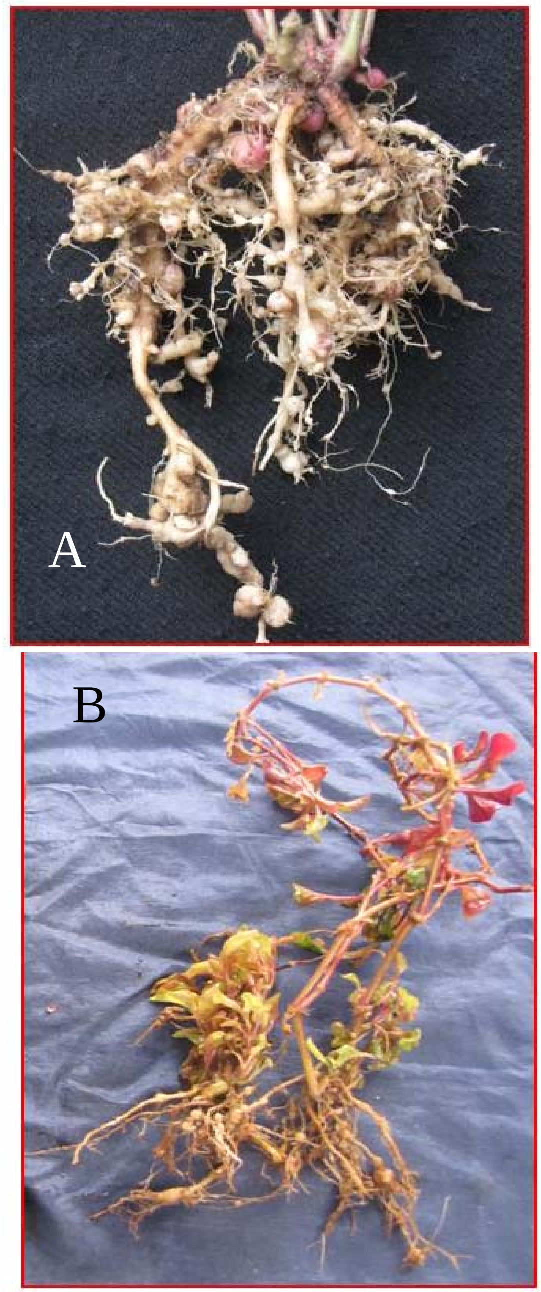

Fig. 1. Root galling: A. *Iresine herbstii* cv Brilliantissima, and B. *Alternanthera dentata* cv Brazilian-Red-Hot.

Table I.- **Root galling and egg masses per root system and J2 root and soil populations of *Meloidogyne incognita* on *Alternantera dentata* cv. Brazilian Red-Hot.**

Lawns sampled	Galls per root system	Egg masses per root system	Gall index*	Egg mass index*	J2-population**	
					per g of root	250cm^3 of soil
					0.0c	0.0c
2	0.0c	0.0c	0.0	0.0	0.33c	6.7c
3	0.0c	0.0c	0.0	0.0	0.0c	0.0c
4	0.0c	0.0c	0.0	0.0	0.0c	0.0c
5	21.0a	33.0a	3.0	4.0	17.0a	260.0a
6	15.0b	19.0b	3.0	3.0	14.0b	206.0b
7	0.0c	0.oc	0.0	0.0	0.0c	0.0a

*Gall and egg mass indices were rated on 0-5 scale; where 0 = no galls or egg masses, 1 = 1-2 galls or egg masses; 2 = 3-10 galls or egg masses; 3 = 11-30 galls or egg masses; 4 = 31-100 galls or egg masses, and 5 = > 100 galls or egg masses per root system (Quesenberry *et al.,* 1989).
** Means within a column followed by the same letter are not significantly different according to Duncan's multiple Range Test at *P* = 0.05.

Table II.- **Root galling and egg masses per root system and J2 root and soil populations of *Meloidogyne incognita* on** *Iresine herbstii* **cv. Brilliantissima.**

Lawns sampled	Galls per root system	Egg masses per root system	Gall index*	Egg mass index*	J2-population**	
					per g of root	250cm^3 of soil
8	106c	89e	5	4	43c	1197d
9	225ab	186b	5	5	88a	2065c
10	166bc	123c	5	5	67b	2522b
11	162bc	114cd	5	5	66b	3146a
12	313a	215 a	5	5	94a	2353bc
13	253ab	199ab	5	5	74b	2453b
14	111c	98de	5	5	36c	1418d

*Gall and egg mass indices were rated on 0-5 scale; where 0 = no galls or egg masses, 1 = 1-2 galls or egg masses; 2 = 3-10 galls or egg masses; 3 = 11-30 galls or egg masses; 4 = 31-100 galls or egg masses, and 5 = > 100 galls or egg masses per root system (Quesenberry *et al.,* 1989).
** Means within a column followed by the same letter are not significantly different according to Duncan's multiple Range Test at *P* = 0.05.

DISCUSSION

The sedentary, vascular endoparasite, *M. incognita* displays a broad host range. It is also the most common species world-wide and can be found in approximately 75% of agricultural soils of Pakistan. (Anwar, 1989; Maqbool *et al*., 1992). This nematode species is an important pest of field crops and vegetables and can result in dramatic yield losses (Anwar and McKenry, 2010a, b; Anwar *et al.*, 2007, Shurley and Kemerait, 2005; Koenning *et al.,* 1999). *Meloidogyne incognita* has been found damaging ornamentals in USA and other countries of the world (Anwar and Javed, 2010; Anwar *et al.*, 2009; Ibrahim *et al.* 2000; McSorley *et al.* 1994). *Meloidogyne incognita* has been found infecting roots of many flowering and bedding plants including snapdragon, lisianthus, sunflower, gladiolus, coleus, impatiens, cock's comb, zinnia and dhalia *(*Anwar and Javed, 2010; Anwar *et al.*, 2009; McSorley and Frederick, 1994; Jabri *et al.*, 1985). This is the first report on the association of *M. incognita* with Brilliantissima and Brazilian-Red-Hot in Pakistan.

Development of root-knot galls is a response to stimulation by a secretory protein injected from esophageal glands of infective junvenile (Hussey *et al*., 1994). Susceptible plants respond with the formation of giant cells and galls. The nematode responds with rapid juvenile growth and abundant egg production upon maturity. By contrast, the responses in resistant plants include poorly developed galls, undersized juveniles, and fewer eggs (Anwar and McKenry, 2002). Presence of few egg masses and smaller galls on roots of Brazilian Red-Hot in response to *M. incognita* infection suggests that it is a relatively poor host. Whereas production of abundant egg masses by adult females and development of large galls on roots of Brilliantissima in response to *M. incognita* infection suggests that it is an excellent host. The development of eggs is directly proportionate to the size of giant cells developed by J2 (Anwar and McKenry, 2002). We did not examine the giant cells in this experiment. Possibly the development of larger-sized giant cells by J2s on roots of Brilliantissima compared to Brazilian-Red-Hot resulted in the finding of more eggs on roots of Brilliantissima plants. Plant damage caused by nematodes could not be assessed in this study. It was observed that severely galled plants were stunted, appeared relatively unthrifty and some had actually died. Feeding by J2 and females within roots causes a disruption of the roots vascular system and reduction of plant growth. Root development and elongation can actually cease as high populations of J2 damage meristematic cells at the root tip (Fig 1). Inadequate uptake of water and nutrients by limited root systems can result in chlorotic foliage and foliar wilt with an overall stunting of growth leading to death associated with other pathogenic agents. In addition to the direct damage it causes, *M. incognita* has also been shown to increase the susceptibility of plant roots significantly to attack by bacteria and fungi, even by species they could otherwise resist, which can cause extensive secondary decay and rotting. This effect is based less on the physical damage than on the nematode's physiological impacts (Abawi and Chen, 1998)

This investigation has identified the association of *M. incognita* with Brilliantissima and Brazilian-Red-Hot. Evaluation of germplasm for resistance or tolerance to nematode feeding is an important feature of nematode management (Young, 1998). Until that time Brazilian-Red-Hot or other choices provide a better planting choice than Brillinatissima if root-knot nematodes and coarser textured soils are present.

REFERENCES

ABAWI, G.S. AND CHEN, J., 1998. Concomitant pathogen and pest interactions. In: *Plant and nematode interactions* (eds. K.R. Barker, G.A. Pederson, and G.L. Windham), pp. 135-158. Agronomy Monograph **36**. American Society of Agronomy, Madison, WI.

ACOSTA, N., 1976. Control of *Meloidogyne incognita* on *Coleus blumei* by drench application of fensulfothion. *Nematropica*, **6**: 23-26.

ANWAR, S.A. AND MCKENRY, M.V., 2002. Developmental response of a resistance-breaking population of *Meloidogyne arenaria* on *Vitis* spp. *J. Nematol*., **34**:28–33. 2002.

ANWAR, S.A. AND JAVED, N., 2010. *Meloidogyne incognita* infecting Dahlia. *Pakistan J. Zool*., **42**: 348-350.

ANWAR, S.A. AND. MCKENRY, M.V., 2010a. Incidence and population density of plant-parasitic nematodes infecting vegetable crops and associated yield losses in the Punjab, Pakistan. *Pakistan J. Zool*., [submitted]

ANWAR, S.A. AND. MCKENRY, M.V., 2010b. Incidence and reproduction of *Meloidogyne incognita* on vegetable crop genotypes. *Pakistan J. Zool*., **42**:135-141.

ANWAR, S.A., 1989. Investigations on nematodes associated with field, vegetable and fruit crops. *Tech. Bull. Barani Agric. Coll., Rawalpindi, Pakistan*.

ANWAR, S.A., ZIA, A. AND SHAKEEL, Q., 2009. A root knot nematode pathogenic to cock's comb, *Celosia argentea. Pak. J. Nematol.,* **27**:309-315.

ANWAR. S.A., ZIA, A., HUSSAIN , M. AND KAMRAN, M., 2007. Host suitability of selected plants to *Meloidogyne incognita* in the Punjab, Pakistan. *Int. J. Nematol.*, **17**:144-150.

BURGOS, F.A., 2010. *Meloidogyne arenaria* infecting the root system of an ornamental plant, *Duranta erecta* (eds. J.A. Brito, M.N. Maria and J.D. Stanley) *Triology*, **49**: 1.

CAVENESS, F.E. AND WILSON, G.F., 1977. Effect of root-knot nematodes on growth and development of *Celosia argentea* L. *Acta Hort*., **53**: 71-73.

DAVIS, R.A. AND JENKINS, W.R., 1960. Histopathology of Gardenia (*Gardenia Jasminoides Veitchi*), infected with three species of *Meloidogyne*. *Nematologica,* **5**: 228-230.

HARTMAN, K.M. AND SASSER, J.N., 1985. Identification of *Meloidogyne* species on the basis of differential host tests and perineal pattern morphology. In: *An Advanced* *treatise on* Meloidogyne. Vol.2. *Methodology* (eds. K.R. Barker, C.C. Carter, and J.N. Sasser), Raleigh: North Carolina State University Graphics. pp. 69-77.

HIGLEY, L.G. AND PEDIGO, L.P., 1996. *Economic thresholds for integrated pest management*. University of Nebraska Press, Lincoln, NE.

HOLBROOK, C.C., KNAUFT, D.A. AND DICKSON, D.W., 1983. A technique for screening peanut for resistance to *Meloidogyne incognita*. *Pl. Dis*., **57**:957-958.

HUSSEY, R.S., 1985. Host-parasite relationships and associated physiological changes. In: *An advanced treatise on* Meloidogyne (eds. J.N. Sasser and C.C. Carter), Vol. 1, Biology and control, North Carolina State University Graphics, Raleigh, pp. 143–153.

HUSSEY, R.S., DAVIS, E.L. AND RAY, C., 1994. *meloidogyne* stylet secretion. In: *Advances in molecular plant nematology* (eds. F. Lamberti, C. DiGiorgio and D. McK. Bird), Plenum Press, New York, pp. 233-249.

GOFF, C.C., 1936. Relative susceptibility of some annual ornamentals to root-knot. Bulletin 291, University of Florida Agricultural Experiment Station, Gainesville.

IBRAHIM, I.K.A., HANDOO, Z.A. AND EL-SHERBINY, A.A., 2000. A survey of pyhtonematodes on cultivated and non-cultivated plants in northern Egypt. *J. Nematol*., **32**: 478-485.

JABRI, M.A., KHAN, T.A., HUSSAIN, S. AND MAHMOOD, 1985. Ineration of Zinnia virus with rit knot nematode, *Meloidogyne ingognita* on *Zinia elegens*. *Pakistan J. Nematol*., **3**: 17-21.

JEPSON, S.B., 1987**.** *Identification of root-knot nematodes* (*Meloidogyne* species). CAB International. Wallingford, UK.

KHAN, M.R., SIDDIQUI, M.B., KUMAR, R. AND SINGH, S.K., 1987. Effect of *Meloidogyne incognita* on three seasonal ornamental plants. *Inter-national Nematol. Netw. Newsl.,* **4**:5–7.

KOENNING, S.R., OVERSTREET, C.J., NOLING, W., DONALD, P.A., BECKER, J.O. AND FORTNUM, B.A., 1999. Survey of crop losses in response to phytoparasitic nematodes in the United States for 1994. *J. Nematol*., **31**:567–618.

MAQBOOL, M.A., 1992. *Distribution and host association of plant parasitic nematodes in Pakistan*. National Nematological Research Center, University of Karachi, Karachi, Pakistan, pp. 215.

MCKENRY, M.V. AND ROBERTS, P.A., 1985. *Phytonematology study guide*. ANR Publications, University of California, Oakland CA, Pp. 56.

MCSORLEY, R. AND FREDERICK, J.J., 1994. Response of some common annual bedding plants to three species of *Meloidogyne*. *J. Nematol*., **26**:773-777.

MCSORLEY**,** R., 1994. Susceptibility of common bedding plants to root-knot nematodes. *Proc. 17a State I-Loot. Soc*., 107:430-432**.**

PLANT FILES, 2009. Gardenia, Cape Jasmine, Gandharaj, *Gardenia jasminoides* 'Mystery'. http://davesgarden.com/guides/pf/go/83493/.

QUESENBERRY, K.H., BALTENSPERGER, D.D., DUNN, R.A., WILCOX, C.J. AND HARDY, S.R., 1989. Selection for tolerance to root-knot nematodes in red clover. *Crop Sci*., **29**:62-65.

SASSER, J.N., 1989. Plant-parasitic nematodes, the farmer's hidden enemies. Raleigh, North Carolina State University Graphics.

SHURLEY, W.D. AND KEMERAIT, R.C., 2005. Efficacy and economic analysis of nematode control strategies in Georgia. Pp. 401–405. In: Proceedings of the Beltwide Cotton Conference. New Orleans, LA: National Cotton Council and the Cotton Foundation.

SPRIGGS, C.L., 2009. *Meloidogyne mayaguensis* infecting the root system of an ornamental plant, *Lagerstroemia indica***.** (eds. J.A. Brito and J.D. Stanley) *Triology,* **49**: 1.

TARJAN, A.C., 1952. Comparative studies of some root-knot nematodes infecting the common snapdragon, *Antirrhinum majus* L. *Phytopathology*, **42**:641-644.

TOP TROPICAL PLANT CATALOG., 2010. http://toptropicals.com/catalog/uid/cyphomandra_abutiloides.htm.

WALKER, J.T. AND MELIN, J.B., 1998. Host status of herbaceous perennials to *Melodogyne incognita* and *M. arenaria*. *J. Nematol*., **30**(4S):607-610.

WALKER, J.T., MELIN, J.B. AND DAVIS, J., 1994. The sensitivity of bedding plants to southern root knot nematode, *Meloidogyne incognita,* race 3. *.J. Nematol*., **26**:778-781.

WILLIAMS-WOODWARD, J.L. AND DAVIS, R.F., 1999. Season fluctuations of soil and tissue population of *Ditylenchus dipsaci* and *Aphelenchoides ritzemabosi* in alfalfa. *J. Nematol*., **31**: 27-36.

YOUNG, L.D., 1998. Breeding for nematode resistance and tolerance. In: *Plant and nematode interactions* (eds. K.R. Barker, G.A. Pederson, and G.L. Windham), Agronomy Monograph **36**. pp 187-207. American Society of Agronomy, Madison, WI.

(Received 18 August 2010, revised 3 September 2010)