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SHORT COMMUNICATION / *COMUNICAÇÃO*

Pathogenicity of *Meloidogyne* spp. (Tylenchida: Meloidogynidae) from Brazil and Central America on two genotypes of *Coffea arabica*

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ABSTRACT

Among the most damaging root-knot nematode species*, Meloidogyne exigua*, *M. paranaensis*, *M. incognita*, *M. arabicida, M. izalcoensis* and *M. mayaguensis* are major agronomic constraints in coffee-growing areas in Brazil and other Latin American countries. The resistance reaction to those six species was studied for the H 419-5-4-5-2 progeny, derived from the artificial hybridization between Catuaí Amarelo 'IAC 30' x Timor Hybrid UFV 445-46 selection. The Catuaí Vermelho IAC 144 genotype was used as susceptibility control for *Meloidogyne* spp. The genotypes were inoculated with 6,000 eggs/plant and the experiment was set up in a completely randomized design, replicated 10 times for each *Meloidogyne* species and genotype. The evaluation was performed at 240 days after inoculation and the reproduction factor (RF= Final population/6000) was used as the variable to evaluate resistance. *M. exigua* caused typical rounded galls mostly on new roots, and egg-masses were produced mostly in the cortex under the root epidermis. *M. incognita, M. paranaensis* and *M. arabicida* caused swollen roots, peeling and cracking of cortical root tissue. No symptoms were observed for *M. mayaguensis*. *M. izalcoensis* induced very small galls, mostly on the extremity of new roots. Egg-masses were produced outside the roots in large quantities. The genotype IAC 144 was susceptible (FR>1.0) to all *Meloidogyne* spp. studied, except to *M. mayaguensis*. The nematode isolate used in this experiment seems to be a weak parasite for coffee. The H 419-5-4-5-2 progeny was resistant to *M. exigua* (FR<1) and susceptible to *M. incognita*, *M. paranaensis*, *M. arabicida* and *M. izalcoensis*.
Key words: *Meloidogyne exigua*, *M. paranaensis*, *M. incognita*, *M. arabicida, M. izalcoensis*, *M. mayaguensis*, resistance, coffee.

RESUMO

Patogenicidade de *Meloidogyne* spp. (Tylenchida: Meloidogynidae) originárias do Brasil e América Central a dois genótipos de *Coffea arabica*

Entre as espécies de nematóides de galhas mais danosas ao cafeeiro, *Meloidogyne exigua*, *M. paranaensis*, *M. incognita*, *M. arabicida, M. izalcoensis* e *M. mayaguensis* são as que causam os maiores problemas em áreas de cultivo de café no Brasil e países da América Latina. A reação de resistência a essas seis espécies foi estudada na progênie H 419-5-4-5-2, obtida do cruzamento artificial entre a cultivar Catuaí Amarelo IAC 30 com a seleção de Híbrido de Timor UFV 445-46. As genótipos foram inoculados com 6.000 ovos/planta e o experimento foi conduzido no delineamento inteiramente ao acaso, com 10 repetições para cada espécie de *Meloidogyne* e cada genótipo de cafeeiro. A avaliação foi realizada 240 dias após a inoculação. O Fator de Reprodução (FR= População Final/6000) foi usado como variável para se avaliar a resistência. *M. exigua* causou galhas arredondadas típicas, sobretudo nas raízes novas. *M. incognita, M. paranaensis* e *M. arabicida* causaram engrossamento nas raízes, descolamento cortical e rachaduras em várias partes do sistema radicular. Nenhum sintoma foi observado para *M. mayaguensis*. *M. izalcoensis* causou galhas pequenas, a maioria na extremidade das raízes novas. As massas de ovos foram produzidas externamente e em grande número. O genótipo IAC 144 (testemunha) foi suscetível (FR>1.0) a todas espécies de *Meloidogyne*, exceto a *M. mayaguensis*. Esse isolado mostrou-se um parasita fraco para o cafeeiro. A progênie H 419-5-4-5-2 foi resistente a *M. exigua* e *M. mayaguensis* (FR<1) e suscetível a *M. incognita*, *M. paranaensis*, *M. arabicida* e *M. izalcoensis*.
Palavras chaves*: Meloidogyne exigua*, *M. paranaensis*, *M. incognita*, *M. arabicida, M. izalcoensis*, *M. mayaguensis*, resistência, café.

Meloidogyne spp. have a substantial economic impact on production in almost all coffee-producing regions in many countries. In Brazil and Central America six species are known to cause serious damage: *M. exigua* Goeldi, 1887 in Brazil and Costa Rica (Campos & Vilain, 2005), *M. paranaensis* Carneiro *et al.*, 1996 in Brazil and Guatemala, *M. incognita* (Kofoid & White, 1919) Chitwood, 1949 in Brazil, Guatemala, El Salvador, Costa Rica, Nicaragua and Cuba, *M. arabicida* López & Salazar, 1989 in Costa Rica, *M. mayaguensis* Rammah & Hirschmann, 1988 in Cuba (Campos & Villain, 2005) and *M. izalcoensis* Carneiro *et al.*, 2005 in El Salvador.

Resistance to *M. incognita* races, *M. exigua*, *M. paranaensis*, and *M. coffeicola* has been found in many

Brazilian coffee germplasm lines, which makes it possible in the future to obtain resistant cultivars for either rootstock or direct planting in the field. Several lines of *C. canephora* and *C. congensis* have shown resistance to race 3 of *M. incognita,* and some progenies of Sarchimor (derived from crossing Villa Sarchi and Timor Hybrid) and 'Icatu' (an advanced line derived from crossing *C. arabica* x *C. canephora*), have shown moderate resistance to *M. paranaensis* (Campos & Villain, 2005).

In coffee trees, several *C. arabica* lines have been previously identified as derived from the interspecific Timor Hybrid (wild *C. arabica* x *C. canephora*) that displayed resistance to *M. exigua.* This resistance has been confirmed to come from the *C. canephora* progenitor (Bertrand *et al.*, 2001). Resistance to *M. exigua* is controlled by a simple inherited major gene, called the *Mex*-1 locus (Noir *et al.,* 2003).

Considering the great diversity of *Meloidogyne* species (Carneiro *et al.*, 2004), it is of prime importance to assess the pathogenicity of *Meloidogyne* spp. on coffee genotypes. The present study investigated the pathogenicity of those six species of *Meloidogyne* on two selected *C. arabica* genotypes: Catuaí Vermelho IAC 144 (susceptible) and a new progeny H 419-5-4-5-2 (Catuaí Vermelho IAC 30 x Timor Hybrid UFV 445-46).

Six species of *Meloidogyne* were assessed in this work, four from Brazil: *M. exigua* (Lavras, MG, coffee), *M. paranaensis* (Londrina, PR, coffee), *M. incognita* race 1 (Avilândia, SP., coffee) and *M. mayaguensis* (Petrolina, PE, guava) and two from Central America: *M. arabicida* (Costa Rica, coffee) and *M. izalcoensis* (El Salvador, coffee).

The C. *arabica* genotypes came from the Instituto Agronômico de Campinas ('IAC 144', Catuaí Vermelho) and Empresa de Pesquisa Agropecuária de Minas Gerais - EPAMIG (H 419-5-4-5-2, a progeny derived from Catuaí Vermelho' x Timor Hybrid. The Timor Hybrid is the result of natural hybridization between *C. arabica* and *C. canephora*, which occurred in Timor island.

One experiment was undertaken in a greenhouse at 25-30°C. The plant arrangement was completely randomized, replicated 10 times for each *Meloidogyne* species and genotype. Two months after transplanting i.e. when they had at least two pairs of leaves, coffee plants were inoculated with 6,000 eggs/plant extracted by Hussey & Baker's method (1973) and counted on Peters slides. The evaluation was done 240 days after inoculation; the plant development measurements were taken, and the reproduction factor (RF= Final population/6,000) was used as the variable to evaluate resistance. The galling and egg-mass index (Taylor & Sasser, 1978) was used as a second variable.

There was no significant difference between the six *Meloidogyne* species for plant height. The roots' fresh weight was significantly higher when coffee 'Catuaí' was infected with *M. exigua,* which caused several elongated or round galls mostly on new roots; egg masses were produced generally in the cortex under the root epidermis. *M. incognita, M. paranaensis* and *M. arabicida* caused swollen roots, peeling and cracking of cortical root tissue; such symptoms could not be quantified. The egg masses were produced outside the roots in *M. incognita* parasitized plants and outside and under the root epidermis in *M. paranaensis* and *M. arabicida*. *M izalcoensis* caused very small galls, mostly on the extremity of new roots. Egg-masses were produced outside the roots and in large quantities (Figure 1). No galls and egg masses were observed in plants inoculated with *M. mayaguensis.*

The galling and egg-mass indexes were not reliable indicators of nematode multiplication rates (data not included) because the symptoms of damage caused by different species of *Meloidogyne* on coffee were variable and difficulty to quantify. Based on these findings, the best variable is the number of eggs/g of roots or the reproduction factor (RF). This result disagrees with observations made by Hernandez *et al*. (2004), who considered galling index as a relatively good indicator of nematode multiplication rate. Our results showed this variable is suitable for quantifying *M. exigua* and *M. izalcoensis* only.

M. mayaguensis from guava was unable to develop on genotype Catuaí and progeny H 419-5-4-5-2 (Table 1). This confirms that coffee is not a good host of *M. mayaguensis* from guava. This species is one of the main coffee pests in Cuba (Rodriguez *et al.,* 1995), indicating that the isolate

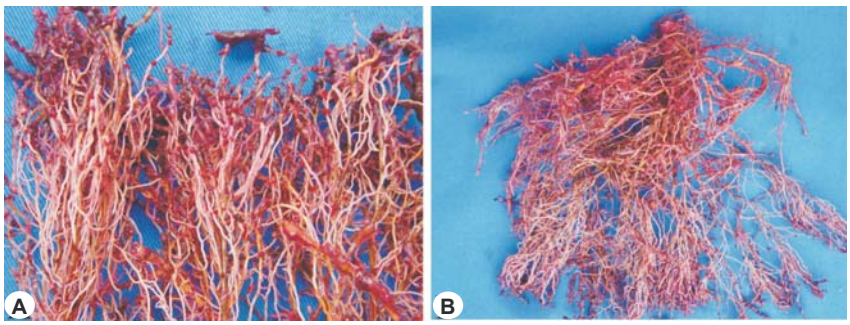

FIG. 1 - Symptoms caused by *Meloidogyne izalcoensis* on roots of *Coffea arabica* 'Catuaí Vermelho' stained with Phloxine B.

TABLE 1 - Host reaction and development variables of two genotypes of *Coffea arabica* 240 days after being inoculated by *Meloidogyne* spp. under greenhouse conditions

Species of root-knot nematode and esterase phenotype (Est)	Catuaí Vermelho IAC 144			Progeny H 419-5-4-5-2		
	Height of plants	Fresh Root weight	RF*	Height of plants	Fresh Root weight	RF *
M. exigua (Est E2)	49.0	81.0 b **	98.2 d (S)	54.2	43.8 b	0.9 a (R)
M. incognita (Est I1)	43.2	15.0 a	16.1 b (S)	44.8	49.2 b	67.2 c (S)
M. paranaensis (Est P1)	47.5	16.1 a	17.3 b (S)	42.3	35.1 a	47.3 b (S)
M. arabicida (Est Ar2)	48.0	16.4 a	19.8 b (S)	54.8	52.1 c	86.3 d (S)
M. izalcoensis (Est S4)	44.6	20.3 a	30.6 c (S)	50.5	38.8 a	71.9 c (S)
M. mayaguensis (Est M2)	43.7	13.3 a	0.5 a (R)	54.0	45.1 b	0.9 a (R)

*Reproduction Factor, RF = Final population/6000 eggs. The plants with RF>1 were considered susceptible (S) and RF< 1.0, resistant (R). ** lower different case letters indicate that arithmetical means differ according to the Scott and Knott (1974) test at P<0.05

from guava is probably different from the Cuban isolate from coffee.

M. exigua reproduced very well on 'Catuaí Vermelho' (RF=98.2), but no galls and a low reproduction were observed on the progeny H 419-5-4-5-2 (RF=0.9). Different levels of resistance to *M. exigua* have been found on progenies derived from crossing *C. arabica* and *C. canephora* (Ribeiro *et al.,* 2001). Forty–two progenies of Timor Hybrid derived from crossing *C. arabica* and *C. canephora* were resistant to *M. exigua*. In some of them, eggs were not produced, showing the same behavior as the parent *C. canephora,* and were also resistant to coffee rust (*Hemileia vastatrix*) (Gonçalves & Pereira, 1998). Resistance to *M. exigua* is controlled by a simply inherited major gene, denominated the Mex-1 locus in the 'IAPAR 59' and other Timor Hybrid introgressed lines with, possibly, incomplete dominance (Noir *et al*., 2003). Mex-1 is the first identified gene of nematode resistance in coffee, and it represents an important starting point to enhance backcross breeding programs and thus to perform early marker–assisted selection of resistant seedlings (Campos & Vilain, 2005). No information about resistant gene was available for the progeny H 419-5-4-5-2.

The other four species assessed, *M. incognita*, *M. paranaensis*, *M. arabicida* and *M. izalcoensis,* reproduced very well in both genotypes (Table 1). Hernandez *et al.* (2004) demonstrated that *M. incognita* from Brazil did not multiply on Sarchimor or genotype from Ethiopia ('ET 28'). *M. paranaensis* from Guatemala multiplied at relatively low rates on Sarchimor, but did not multiply on genotypes ET15 and ET28. *M. arabicida* did not multiply at all on genotype ET15. However, resistance in these Ethiopian genotypes is apparently not effective against some isolates of *M. exigua* from Costa Rica and *M. izalcoensis* (Hernandez *et al*., 2004). Different resistance genes are involved according to the *Meloidogyne* species considered. This explains why some Sarchimor accessions are resistant to *M. exigua* and other Ethiopian accessions to *M. paranaensis* (Hernandez *et al*., 2004).

Other studies have pointed out the large diversity of *Meloidogyne* species that are able to parasitize coffee in Brazil and Central America. These populations have a high genetic diversity (Carneiro *et al*, 2004) and in terms of pathogenicity (Hernandez *et al*., 2004), which increases the need for accurate characterization of species or types correlating with pathogenicity studies on different coffee genotypes.

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