

RESEARCH/INVESTIGACIÓN

FIRST REPORT OF *MELOIDOGYNE ENTEROLOBII* IN *CAPSICUM* ROOTSTOCKS CARRYING THE *Me1* AND *Me3/Me7* GENES IN CENTRAL BRAZIL

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ABSTRACT

Pinheiro, J. B., L. S. Boiteux, M. R. A. Almeida, R. B. Pereira, L. C. S. Galhardo, and R. M. D. G. Carneiro. 2015. First report of *Meloidogyne enterolobii* in *Capsicum* rootstocks carrying the *Me1* and *Me3/Me7* genes in Central Brazil. *Nematropica* 45:184-188.

Meloidogyne enterolobii (= *M. mayaguensis*) has been reported as a potential threat to tomato (*Solanum lycopersicum*) and pepper (*Capsicum* spp.) crops in tropical and subtropical areas. Of particular concern with this nematode is its ability to overcome the resistance mediated by the tomato *Mi-1* gene as well as by some of the *Me* genes in *Capsicum*. In the present work, we report for the first time the occurrence of *M. enterolobii* infecting *Capsicum annuum* plants carrying the *Me1* and *Me3/Me7* genes under plastic house systems in Brasília-DF (Central Brazil). Plants of the commercial rootstock hybrid ‘Snooker’ (a pyramid of the genes *Me1* and *Me3/Me7*) infected by *M. enterolobii* (esterase phenotype M2) exhibited overall yellowing, severe wilt symptoms, premature defoliation, and root rot accompanied by profuse root galling. To our knowledge, this is the first report of *M. enterolobii* infection in root-knot resistant *Capsicum* rootstocks in Central Brazil, thus expanding the geographical distribution of this pathogen in this host species.

Key words: *Capsicum annuum*, *Meloidogyne mayaguensis*, resistance genes, root-knot nematodes, virulent populations.

RESUMO

Pinheiro, J. B., L. S. Boiteux, M. R. A. Almeida, R. B. Pereira, L. C. S. Galhardo, e R. M. D. G. Carneiro. 2015. Primeiro registro no Brasil Central de *Meloidogyne enterolobii* em porta-enxerto de *Capsicum* contendo os genes *Me1* e *Me3/Me7*. *Nematropica* 45:184-188.

Meloidogyne enterolobii (= *M. mayaguensis*) tem sido reportado como uma ameaça potencial ao cultivo de tomate (*Solanum lycopersicum*), pimentas e pimentão (*Capsicum* spp.) em regiões tropicais e subtropicais, especialmente devido a sua capacidade de infectar plantas de tomate com o gene de resistência *Mi-1* e plantas de *Capsicum* contendo genes da série *Me*. O presente trabalho constitui o primeiro registro da ocorrência de *M. enterolobii* em porta-enxertos de *Capsicum* contendo fatores de resistência *Me1* e *Me3/Me7* em condições de cultivo sob cobertura plástica na região de Brasília-DF (Brasil Central). As plantas do híbrido comercial ‘Snooker’ (uma pirâmide dos genes *Me1* e *Me3/Me7*) atacadas por *M. enterolobii* (fenótipo de esterase M2) apresentaram sintomas de amarelecimento, murcha intensa, desfolha e sistema radicular apodrecido com muitas galhas. Este é o primeiro relato da presença *M. enterolobii* infectando porta-enxertos de *Capsicum* resistentes aos nematoides-das-galhas no Brasil Central, expandindo a distribuição geográfica desse patógeno nessa hospedeira.

Palavras-chave: *Capsicum annuum*, *Meloidogyne mayaguensis*, nematoide-das-galhas, resistência, populações virulentas.

Production of high-yielding and high-quality bell peppers (*Capsicum annuum* L.) under plastic house systems has increased in Central Brazil during the last decades (Emater, 2012). The Federal District region is, at the present time, one of the major bell pepper-producing regions in Brazil, with more than 100 ha, under plastic house cultivation systems (Emater, 2012). The intensive and repeated use of these plastic houses over the past three decades has led to a widespread increase in the incidence and severity of root-knot nematodes, especially *Meloidogyne incognita*. In order to manage this problem in this production area, growers have used commercially available root-knot nematode resistant rootstocks.

Five distinct genes of the *Me* series were identified in the genus *Capsicum* controlling useful levels of resistance to *M. arenaria*, *M. incognita*, *M. javanica*, and *M. hapla* (Djian-Caporalino *et al.*, 1999; 2001; 2007). Three of these genes (*Me1*, *Me3*, and *Me7*) were characterized as having thermostability and effectiveness against a wide range of *M. incognita*, *M. arenaria*, and *M. javanica* populations (Djian-Caporalino *et al.*, 1999). The *Me1* gene (derived from the accession 'PI 201234' collected in the Meso-America region); the *Me3* gene (incorporated from the accession 'PI 322719'), and the *Me7* gene (identified in the *C. annuum* landrace 'Criollo de Morelos' = 'CM 334' from Mexico) were characterized as being highly effective against distinct *M. incognita* populations (Djian-Caporalino *et al.*, 2007; 2011). More recently, Fazari *et al.* (2012) demonstrated that *Me3* and *Me7* are likely allelic variants of a same gene. Therefore, it has been suggested that the name for the dominant resistant allele derived from either 'PI 322719' or 'CM 334' should be *Me3* rather than *Me7*.

The wide commercial deployment of these genes has been done only recently. However, resistance breakdown has already been reported where inoculum pressure was high (Castagnone-Sereno *et al.*, 1996; Djian-Caporalino *et al.*, 2011). *Meloidogyne incognita* populations that were virulent on *Me3* have been reported both in natural and experimental conditions, but the emergence of *Me1*-virulent *M. incognita* populations has not been reported thus far (Castagnone-Sereno *et al.* 1996; Djian-Caporalino *et al.*, 2011). Currently, the leading *C. annuum* rootstocks available in the Brazilian market are 'Silver' and 'AF 8253', both from Sakata SudaAmerica (with unspecified resistance genes) and 'Snooker' from Syngenta Seeds, which is a pyramid of *Me1* and *Me3/Me7* genes (Ros *et al.*, 2010). These rootstocks are marketed as having resistance to *M. incognita* host races 1, 2, 3, and 4 and to *M. javanica*.

In Brazil, *M. enterolobii* was first reported causing severe yield losses in guava orchards in

Pernambuco and Bahia States (Carneiro *et al.*, 2001). Since the initial report, *M. enterolobii* has been detected in virtually all geographic areas of the country, primarily affecting guava crops (Silva and Oliveira, 2010). This root-knot nematode species has been identified as a potential threat to tomato and bell pepper crops in tropical and subtropical areas, especially due to its ability to overcome the *Meloidogyne* spp. resistance mediated by the tomato *Mi-1* and certain *Me* genes in *Capsicum* (Yang and Eisenback, 1983; Brito *et al.*, 2004; 2007; Carneiro *et al.*, 2006; Kiewnick *et al.*, 2009). Recently, *M. enterolobii* was reported affecting 'Silver' rootstock under protected crop systems in São Paulo State, Southeast Brazil (Carneiro *et al.*, 2006; Siqueira *et al.*, 2009). Our present work is the first report of infection of *C. annuum* rootstocks containing the *Me1* and *Me3/Me7* genes by *Meloidogyne enterolobii*.

Samples of *Meloidogyne* spp. were collected from infected root systems of the commercial F₁ hybrid 'Snooker' during surveys carried out in plastic houses at four farms in the production areas of Taquara and Pípiripau in Brasília-DF (Federal District, Central Brazil) in 2014. Samples of *Meloidogyne* species were obtained from rootstock plants exhibiting typical root-knot symptoms. Female nematodes were analyzed for esterase isozyme phenotypes in the Nematology Laboratory at Embrapa Recursos Genéticos & Biotecnologia, using methods described by Carneiro and Almeida (2001).

A widespread occurrence of *M. enterolobii* was observed in plastic house systems throughout farms of two vegetable-producing areas (Taquara and Pípiripau) in Brasília-DF, Central Brazil. Plants of the scion/rootstock combination Margarita/Snooker infected by *M. enterolobii* displayed severe root necrosis and profuse root galling (Fig. 1A). Above-ground symptoms were characterized by an overall yellowing of the plant, severe wilt, and premature defoliation (Fig. 1B). These symptoms occurred on plants with the *C. annuum* rootstock 'Snooker', which is a pyramid of the genes/loci *Me1* and *Me3/Me7*.

The populations of *M. enterolobii* that were tested displayed an esterase phenotype M2 (Fig. 2) with two well-defined major bands (Rm: 0,7; 0,98) associated with two secondary bands (Rm: 0,8; 1,1), which are typical from this root-knot nematode species (Carneiro and Almeida, 2001). *Meloidogyne incognita* populations were also detected in these field surveys in both localities and displayed either esterase phenotype II (Rm:1.0) or phenotype I2 (Rm:0.9, 1.0) (Fig. 2). However, the infection levels and root damage caused by *M. incognita* populations were far less severe than that induced by *M.*



Fig. 1. Root systems of the F₁ hybrid Snooker infected by *Meloidogyne enterolobii* in production area of Taquara (Central Brazil), 2014. Affected plants displayed necrosis accompanied by a profuse production of galls (A). The above-ground symptoms were characterized by an overall yellowing, severe wilt and premature defoliation (B).

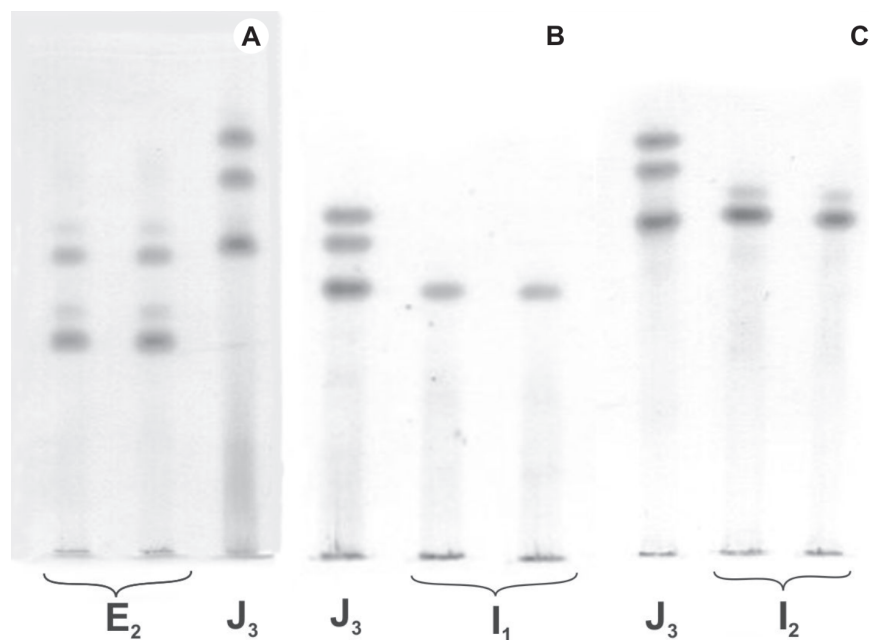


Fig. 2. Esterase phenotypes M2 of *M. enterolobii* (A); I1 (B) and I2 of *M. incognita* (C) and J3 of *M. javanica* (used as internal control). Samples described in A, B, and C were collected from infected *Capsicum annuum* 'Snooker' plants in two bell pepper production areas in Central Brazil, 2014.

enterolobii.

The introduction of *M. enterolobii* in bell pepper fields in Central Brazil could be due to contaminated commercial seedlings that are very often produced in polystyrene trays filled with domestically-produced substrate, which is neither pasteurized nor stem sterilized. These seedlings are then shipped to distant production areas throughout the country. In fact, the introduction of *M. enterolobii* in new production areas via contaminated commercial seedlings has been previously reported in bell pepper and tomato fields in São Paulo State, Southeast Brazil (Carneiro *et al.*, 2006). Once established, field-to-field contamination in the areas sampled in our present work may be due to the transit of machinery, which is shared by the farmer's cooperative in this region in Central Brazil. The present observations of severe root-knot infestations of the rootstock 'Snooker', which carries the resistant loci *Me1* and *Me3/Me7*, is in agreement with previous reports of the susceptibility of *Capsicum* rootstocks containing *Me1* and *Me3/Me7* to *M. enterolobii* (Brito *et al.*, 2007; Gonçalves *et al.*, 2014; Pinheiro *et al.*, 2014).

To our knowledge, this is the first report of *M. enterolobii* infection of *Capsicum* rootstocks in Central Brazil, thus expanding the geographical distribution of this pathogen in bell pepper crops. The widespread presence of *M. enterolobii*, which has a very wide host range, in bell pepper-producing areas represents a potential threat for the vegetable crop agribusiness in Central Brazil. It is vital that *Capsicum* breeding should include the search for new sources of resistance that are effective against *M. enterolobii*. Meanwhile, it will be necessary to establish more effective cultural management strategies in order to minimize the damage caused by this root-knot nematode in the plastic house production in Central Brazil.

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