



Short Communication

Reaction of wild solanaceae species to *Meloidogyne incognita*¹

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ABSTRACT

The quest for resistance sources against *Meloidogyne incognita* as a control measure is essential in tomato. Thus, this study aimed to evaluate the reaction of six species of wild solanaceae to *M. incognita*. The species of wild solanaceae studied were *Solanum capsicoides*, *S. asperolanatum*, *S. americanum*, *S. viarum*, *S. palinacanthum* and *Nicandra physaloides*. Seedlings of wild solanaceae species were transplanted and inoculated with *M. incognita*. The experiment was performed in a completely randomized design with eight replicates. The analyzed variables were: height of the aerial portion, fresh weight of the aerial portion, fresh weight and length of the root system, gall index, number of galls/g of root, number of egg masses/g of root, number of eggs/g of root and the nematode reproduction factor. Based on gall index and reproduction factor criteria the species *S. capsicoides*, *S. americanum*, *S. palinacanthum* and *N. physaloides* were classified as resistant against *M. incognita*. These species also showed a significant increase in height and fresh weight of the aerial portion, length of the root system and fresh weight of the root system. Therefore, these species of wild solanaceae may contribute to the management of *M. incognita* in future applications.

Keywords: *Solanum* spp.; Solanaceae; tomato; root-knot nematodes.

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the main vegetables produced and marketed in Brazil, a country which is placed tenth in world production (FAO, 2018). Among the main phytosanitary problems jeopardizing tomato crops are the nematode species *Meloidogyne incognita* (Kofoid & White) Chitwood and *M. javanica* (Treb) (Chitwood), the first being widely disseminated (Pinheiro *et al.*, 2014a). In tomato, *M. incognita* causes losses that vary between 44.3 to 70% of the production (Charchar *et al.* 1998; Sharma & Sharma, 2015), reaching 100% depending on the susceptibility of the cultivar and the soil and climate factors.

Planting resistant cultivars is one of the main approaches for the management of *Meloidogyne* spp. in tomato, due to

its efficiency, cost and less environmental impact. The *Mi* gene confers resistance to *M. incognita*, *M. javanica*, *M. arenaria* (Neal) Chitwood (Cook, 1991), but there are few resistant commercial cultivars and the *Mi* gene does not confer resistance to new species such as *M. brasiliensis* Charchar & Eisenback and *M. enterolobii* Yang & Eisenback (formerly *M. mayaguensis* Rammah & Hirschmann) (Charchar *et al.* 2010; Pinheiro *et al.*, 2014b). Thus, the identification of new resistance sources similar to *Mi* gene in the Solanaceae family are fundamental for the management of *Meloidogyne* in tomato.

The use of rootstocks, mainly from the Solanaceae family, resistant to *Meloidogyne* species is an efficient and promising technique (Peil, 2003; Pinheiro *et al.*, 2014a), allowing cultivation in infested areas and making tomato

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production feasible. Species of wild solanaceae have been reported as resistant against *M. javanica*, *M. incognita* race 1 and *M. enterolobii* (Mattos *et al.*, 2011; Cardoso *et al.*, 2019). Therefore, the search for new wild resistant solanaceae against *M. incognita* contributes as a strategy to develop resistant rootstocks and genetic sources of resistance for tomato. Thus, the objective of this work was to evaluate the reaction of six species of wild solanaceae to *M. incognita*.

MATERIAL AND METHODS

The experiment was performed in a greenhouse at the Federal Institute of Northern Minas Gerais (IFNMG), Campus Almenara-MG, with geographical coordinates 16°13'52"S, 40°44'30"W and altitude of 270 m, from September to October 2019. The following wild solanaceae species were studied: Joá-de-capote (*Nicandra physaloides* (L.) Gaertn.), Jurubeba (*Solanum palinacanthum* Dun.), Joá-Vermelho (*S. capsicoides* All.), Jurubeba-grande (*S. asperolanatum* Ruiz & Pav.), Maria-pretinha (*S. americanum* Mill.) and Joá-bravo (*S. viarum* Dun.). Seeds of the first and second species were collected in the municipalities of Montes Claros and Almenara, state of Minas Gerais, respectively, and the others were acquired from the company Agro Cosmos. The identification of wild solanaceae was carried out based on specific literature (Lorenzi, 2008).

To obtain the seedlings, seeds were placed in plastic cups with 180 mL capacity, containing substrate composed of plaster sand (coarse washed river sand) and soil (Oxisol) at a proportion of 2:1 (v/v) and autoclaved at 121 °C for 1 hour to eradicate any plant-parasitic nematodes. Analyses of a composite soil sample of the studied site showed the following physico-chemical characteristics: 33% clay, 13% silt, 54% sand, pH in water of 4.5 and 0,54% organic matter. The cups were kept in a greenhouse at 28 ± 2 °C temperature and irrigated manually. Seedlings for transplanting and carrying out the experiment were obtained 36 days after sowing. Seedlings of the wild solanaceae were transplanted to plastic pots with a 2 L capacity, containing a mixture of the same substrate mentioned above. Single seedlings were transplanted to pots after being selected by size and development of root system.

Twenty-four hours after transplanting, seedlings were inoculated with a suspension containing eggs of *M. incognita*. The suspension of *M. incognita* eggs was obtained from pure tomato root cv. Kada, infected with *M. incognita* and grown in a greenhouse from the Phytopathology Research Laboratory (PRL) at Federal University of Minas Gerais-UFGM. The identification of *M. incognita* was performed by the perineal configuration of females under light microscope and α -esterase phenotyping performed according to Taylor & Sasser (1978),

Esbenshade & Triantaphyllou (1985) and Hartman & Sasser (1985). The eggs were obtained according to Hussey & Barker (1973), modified by Bonetti & Ferraz (1981). The eggs were cleaned according to Coolen & D'Herde (1972). The eggs suspension was kept at room temperature to stimulate the hatching of second-stage juveniles (J2) of *M. incognita* and to verify the quality of the inoculum (Rocha *et al.*, 2015). Then, with the aid of a light microscope, the suspension was calibrated (569 eggs/mL + 384 J2/mL), obtaining the inoculum concentration used in the experiment. To carry out the inoculation, 2.6 mL of the suspension were distributed in three 1.5 cm deep holes, made with the aid of a glass rod around the seedlings, in the rhizosphere projection. After inoculation, the pots were kept in a greenhouse under the same conditions mentioned above, keeping the soil at field capacity. The experiment consisted of seven treatments, six species of wild solanaceae and the susceptible tomato Santa Cruz cv. Kada (Control). A completely randomized design was used with eight replicates, totaling 56 plots.

Thirty-eight days after inoculation, the height of the aerial portion (HAP) of the plants was measured from the ground level until the last internode with the aid of a tape measure. Then, the aerial portion was cut and the root system was collected, washed in a bucket containing water and placed in a plastic bag with a capacity of three liters, previously identified, according to each treatment. Subsequently, the fresh weight of the aerial portion (FWAP), the length of the root system (LRS) and the fresh weight of the root system (FWRS) were evaluated with a precision electronic scale. The LRS was determined with a tape measure, evaluating the length of the pivoting root. Infectivity and reproduction evaluations were carried out in the PRL at UFGM. The percentage of infection severity was estimated by the following gall index criteria: Gall Index 1 (¹GI) in a scale of 0 to 10 (Bridge & Page, 1980), where 0 = no galls; 1 = few small, almost imperceptible galls; 2 = small but noticeable galls; 3 = some large galls; 4 = greater number of large galls; 5 = 50% of the infested roots and some main roots with galls; 6 = galls on the main roots; 7 = almost all roots with galls; 8 = all roots with galls; 9 = all roots with large galls; 10 = all roots with large galls, without root system, dead plant. Gall Index 2 (²GI) was also based on a scale of grades from 0 to 5, but based on the percentage of the root system with galls according Taylor & Sasser (1978), where 0 = no galls; 1 = 1 to 2; 2 = 3 to 10; 3 = 11 to 30; 4 = 31 to 100; and 5 = more than 100 galls. Next, egg masses in the root systems were colored red, in a solution containing artificial stain used in food manufacturing, according to the technique of Rocha *et al.* (2005). After staining, the roots were placed on paper towels for 10 minutes, and the number of egg masses and number of galls was counted in the root system.

To quantify the number of eggs per root system, the roots were cut into pieces of approximately 2 cm in length and the eggs obtained by extraction according to Hussey & Barker (1973), modified by Bonetti & Ferraz (1981). Under light microscope, the number of *M. incognita* eggs was quantified in the root system using a Peters slide to estimate the number of eggs per gram of root. The calculation of the Reproduction factor (Rf) was achieved by dividing the final (Pf) and initial (Pi) population densities for each treatment ($Rf = Pf/Pi$), as proposed by Oostenbrink (1966). The classification of plants according to the resistance reaction to *M. incognita* was based on the criteria of Oostenbrink, (1966) and Taylor & Sasser (1978). Plants with $Rf \geq 1.0$ were considered susceptible, with $Rf < 1$ resistant and $Rf = 0$ immune (Oostenbrink, 1966). Based on gall index at a scale of 0 to 5 (Taylor & Sasser, 1978), plants with a number of galls ≤ 10 (grades 0 to 2) were considered resistant and the number of galls > 10 (grades 3 to 5) were susceptible. The correlation between gall indexes (1GI and 2GI) and the number of galls per root system and between 2GI and Rf was evaluated.

Infectivity and reproduction data were transformed in order to attain homogeneity of variances and normality of data. The averages were subjected to analysis of variance and compared by Scott-Knott test at 5% probability by the SISVAR software (Ferreira, 2007). To calculate the Pearson correlation coefficient between gall indexes and the number of galls per gram of root and Rf, the statistical software GENES (Cruz, 2016) was used. All analyzes of mean comparison between treatments were performed with SISVAR and Pearson's correlations by GENES.

RESULTS AND DISCUSSIONS

The studied wild solanaceae showed some variable behaviors in relation to the reaction to *M. incognita* (infectivity and reproducibility) and to the development of the aerial part and the root system (Tables 1 and 2).

Among the studied wild solanaceae, the species *S. capsicoides*, *S. americanum*, *S. palinacanthum* and *N. physaloides* inoculated with *M. incognita* were considered resistant (Table 1). With the exception of *S. americanum*, the resistant species showed less infectivity and reproduction, expressed by the number of galls and masses of eggs per gram of root and the number of eggs per gram of root, respectively, in comparison with *S. lycopersicum*, control (Table 1). Similar behavior to infectivity was verified through the evaluation of 2GI , but according to 1GI *S. asperolanatum* and *S. americanum* also showed a lower percentage of infestation of the root system. *Nicandra physaloides* and *S. palinacanthum* also showed greater height and fresh weight of the aerial portion (Table 2). The species *S. palinacanthum*, *S. viarum* and *S. capsicoides* had higher fresh weight of the root system, while higher length of the root system occurred in these last two species and in *S. asperolanatum* and *S. americanum* (Table 2).

The species *S. capsicoides*, *S. americanum*, *S. palinacanthum* and *N. physaloides* showed Rf of 0.07, 0.86, 0.23 and 0.25, respectively, being considered resistant to *M. incognita* by the criteria of Oostenbrink (1966). Cardoso *et al.* (2019) previously verified the species *S. capsicoides*, *S. palinacanthum* and *Solanum* spp. were resistant to *M. javanica*. Mattos *et al.* (2011) also reported resistance from *S. asperolanatum*, *S. stramonifolium*, *Solanum* sp. against *M. incognita* race 1 and the species *S. stramonifolium*, *S. paniculatum* and *S. subinerme* against *M. enterolobii*. In another study, Mónico *et al.* (2008) verified resistance of *S. americanum* to *M. paranaensis*. Therefore, it seems that the species studied, *S. capsicoides*, *S. americanum* and *S. palinacanthum*, have sources of resistance to the aforementioned *Meloidogyne* species and *M. incognita*, and *S. asperolanatum* only to *M. incognita* race 1. In addition to the species reported in the literature, we demonstrate

Table 1: Infectivity and reproduction expressed by gall indexes (GI), number of galls per gram of root (NG), number of egg masses per gram of root (NEM), number of eggs per gram of root (NE), reproduction factor (Rf) and classification of the reaction of wild solanaceae species to *Meloidogyne incognita*

Species	1GI	2GI	NG	NEM	NE	Rf	Reaction	
							2GI	3Rf
<i>S. capsicoides</i>	0.75b	2.37b	2.73b	2.13b	8.90a	0.07b	S	R
<i>S. asperolanatum</i>	1.25b	4.62a	10.03a	9.62a	9.62a	4.11a	S	S
<i>S. americanum</i>	1.12b	3.12a	6.83a	5.62a	5.62a	0.86b	S	R
<i>S. viarum</i>	2.25a	4.25a	11.95a	10.99a	10.98a	4.50a	S	S
<i>N. physaloides</i>	0.75b	1.50b	1.49b	1.08b	1.08b	0.25b	R	R
<i>S. palinacanthum</i>	0.38b	1.50b	0.42b	0.19b	0.20b	0.23b	R	R
<i>S. lycopersicum</i>	2.63a	4.63a	7.35a	7.20a	7.19a	4.27a	S	S

Averages followed by the same lowercase letter within the column do not differ statistically from each other by the Scott-Knott test at 5% probability. 1GI : gall index based on a scale of 0 to 10 (Bridge & Page, 1980). 2GI : gall index based on a scale from 0 to 5 and reaction classification (Taylor & Sasser, 1978). 3Rf : Classification of the reaction based on the Rf (Oostenbrink, 1966). S: susceptible; R: resistant.

resistance from *S. americanum* and *N. physaloides* to *M. incognita*.

The primary purpose for grafting is the control of soil-borne diseases, such as bacterial wilt, Fusarium wilt and root-knot nematodes, which have been selected by screening tomato cultivars and resistant wild species (Yamakawa, 1982; King *et al.*, 2010). Genes for *Meloidogyne* spp. have been identified from solanaceous, such as tomato (Barbary *et al.*, 2015) and pepper (*Capsicum annuum* L.) (Changkwian *et al.*, 2019). However, no study has been reported on the identification of resistant genes from the wild solanaceous plants tested in the present study against root-knot nematodes.

The studied species of wild solanaceae showed different behavior when we observed the resistance classification criteria, with the four species *S. capsicoides*, *S. americanum*, *S. palinacanthum* and *N. physaloides* classified as resistant by the Rf, while only two species (*S. palinacanthum* and *N. physaloides*) were resistant according to the gall index criterion according to Taylor & Sasser (1978). Considering both criteria, *S. palinacanthum* and *N. physaloides* were the most promising species to be investigated as rootstocks for tomato in further studies. Similar behavior was also observed when we compared the evaluation of the percentage of infestation severity of the root system of the species *S. asperolanatum* and *S. americanum* by the gall index of Bridge & Page (1980), that resulted in scores of 1.2 and 1.1 (few small galls, almost imperceptible), but according to Taylor & Sasser (1978) scale of scores 4.6 and 3.1, which are considered susceptible (Table 1). We also observed that there was no correlation between the ²GI and the Rf, and between the ¹GI and the number of galls per root system, which partially explains the results obtained. The lack of correlation between the ¹GI and the number of galls per root system may be related to the scale of grades that varies from 0 to 10, which makes the precision/accuracy difficult to the evaluator, in relation to the scale of grades 0-5 proposed by Taylor & Sasser (1978). In addition, the parasitism of *M. incognita* in the host plant induces gall formation, but

the reaction of the plant due to the attack of the nematode may express differently in relation to the reproduction factor (number of eggs), which can classify it as susceptible or resistant according to the method used in the evaluation. Thus, the reaction estimation must be evaluated by the Rf and/or gall index.

The ²GI correlated positively with the number of galls per root system ($r = 0.94$) and with the ¹GI ($r = 0.79$). That is to say, the choice of the method to evaluate the severity of plant infestation by *M. incognita* by gall index of Taylor & Sasser (1978) and Bridge & Page (1980), or by direct quantification of the number of galls per root system and *vice versa*, showed similar results.

The quality, level and type of inoculum and the evaluation period and the development of the plants can interfere with the evaluation results concerning the plant reaction to the nematode. Dong *et al.* (2007) evaluated peanut (*Arachis hypogaea* L.) genotypes with three levels of resistance to *M. arenaria*, the type and concentration of the inoculum and the evaluation period, verifying that inoculation with 8,000 eggs or 2,000 J2 of *M. arenaria* per plant does not differ statistically by the gall index method when evaluated in the period of 2 and 10 weeks after inoculation, with similar results for the type of inoculum in relation to the classification of resistance. The same authors also found that the three levels of resistance can be separated based on gall indexes from four weeks with inoculum ranging from 1,000 to 6,000 eggs per plant. In our study, we used a suspension at a concentration of 2,478 eggs and J2 of *M. incognita* per plant and resistance evaluation period of five weeks after inoculation. In addition, we evaluated the quality of the inoculum by hatching and the dark color of the J2's body related to infectivity (Rocha *et al.*, 2015), demonstrating that the factors mentioned above did not affect negatively the reaction classification of the species studied.

Another factor that can interfere in the process of infection and infectivity is the growth and development of the root system due to the chances of the infective juvenile to find the root. Only *N. physaloides* showed

Table 2: Average height of the aerial portion (HAP), fresh weight of the aerial portion (FWAP), length of the root system (LRS) and fresh weight of the root system (FWRS) of wild solanaceae inoculated with *Meloidogyne incognita*

Species	HAP (cm)	FWAP (g)	LRS (cm)	FWRS (g)
<i>S. capsicoides</i>	9.75 c	12.38 c	60.50 a	19.63 a
<i>S. asperolanatum</i>	8.13 c	9.13 c	52.75 a	12.00 b
<i>S. americanum</i>	25.13 b	7.38 c	47.13 a	6.50 b
<i>S. viarum</i>	12.75 c	11.63 c	49.25 a	18.50 a
<i>N. physaloides</i>	39.63 a	14.50 b	23.50 c	8.25 b
<i>S. palinacanthum</i>	24.75 b	16.63 b	35.88 b	17.13 a
<i>S. lycopersicum</i>	42.88 a	21.63 a	40.38 b	15.50 a

Averages followed by the same lowercase letter, within the column, do not differ statistically from each other by the Scott-Knott test at 5% probability.

lower fresh weight and length of the root system, while *S. asperolanatum* and *S. americanum* showed only lower fresh weight of the root system, when compared to tomato (Table 2). However, *S. asperolanatum* and *S. americanum* were susceptible by the criterion of 2GI , with significant values in the number of galls per gram of root, yet by the criterion of Rf only *S. americanum* was resistant, but with Rf of 0.86, close to 1.0 (susceptible plant). Therefore, the selection of seedlings of the studied species was important so that growth and development did not interfere in the process of infection by the infective juvenile of *M. incognita*. However, some species considered resistant showed less development of the aerial portion, requiring future studies to verify their viability and compatibility as resistant rootstocks in tomato against *M. incognita*.

CONCLUSION

The wild species joá-vermelho (*Solanum capsicoides*), maria-pretinha (*S. americanum*), jurubeba (*S. palinacanthum*) and joá-de-capote (*Nicandra physaloides*) were considered resistant to *M. incognita*.

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The authors declare that there is no conflict of interests in carrying the study and publishing this manuscript.

REFERENCES

- Barbary A, Djean-Caporalino C, Palloix A & Castagnone-Sereno P (2015) Host genetic resistance to root-knot nematodes, *Meloidogyne* spp., in Solanaceae: from genes to the field. *Pest Management Science*, 71:1591-1598.
- Bonetti JIS & Ferraz S (1981) Modificações do método de Hussey & Barker para extração de ovos de *Meloidogyne exigua* em raízes de cafeeiro. *Fitopatologia Brasileira*, 6:553.
- Bridge J & Page SLM (1980) Estimation of root-knot nematode infestation levels on roots using a rating chart. *Tropical Pest Management*, 26:296-298.
- Cardoso J, Tonelli L, Kutz TS, Brandelero FD, Vargas TO & Giaretta RD (2019) Reaction of wild solanaceae rootstocks to the parasitism of *Meloidogyne javanica*. *Horticultura Brasileira*, 37:17-21.
- Changkwan A, Venkalesh J, Lee JH, Han JW, Kwon JK, Siddique MI, Solomon AM, Choi GJ, Kim E, Seo Y, Kim YH & Kang BC (2019) Physical localization of the root-knot nematode (*Meloidogyne incognita*) resistance locus Me7 in pepper (*Capsicum annuum*). *Frontiers in Plant Science*, 10:886.
- Charchar JM, Giordano LB, Gonzaga V & Reis NB (1998) Perda de produtividade de tomateiro por infecção de população mista de *Meloidogyne incognita* raça 1 e *M. javanica*. *Pesquisa em Andamento da Embrapa Hortaliças*, 12:01-06.
- Charchar JM, Fonseca MEN, Pinheiro JB, Boiteux LS & Eisenback JD (2010) Epidemics of *Meloidogyne brasiliensis* in central Brazil on processing tomato hybrids that have the root-knot nematode *Mi* resistance gene. *Plant Disease*, 94:781.
- Cook R (1991) Resistance in plants to cyst and root-knot nematodes. *Agricultural Zoology Reviews*, 04:213-240.
- Coolen WA & D'Herde CJ (1972) A method for the quantitative extraction of nematodes from plant tissue culture. Ghent, State Agriculture Research Centre. 77p.
- Cruz CD (2016) Genes Software - extended and integrated with the R, Matlab and Selegen. *Acta Scientiarum. Agronomy*, 38:547-552.
- Dong W, Holbrook CC, Timper P, Brenneman TB & Mullinix B (2007) Comparison of methods for assessing resistance to *Meloidogyne arenaria* in peanut. *Journal of Nematology*, 39:169-175.
- Esbenshade PR & Triantaphyllou AC (1985) Use of enzyme phenotype for identification of *Meloidogyne* species. *Journal of Nematology*, 17:06-20.
- FAO - Food and Agriculture Organization of the United Nations (2018) Available at: <http://www.fao.org/faostat/en/#data/QC/visualize>. Accessed on: March 7th, 2020.
- Ferreira DF (2007) Sisvar: sistema de análise de variância para dados balanceados. Available at: <https://des.ufla.br/~danielff/programas/sisvar.html>. Accessed on: October 25th, 2019.
- Hartman KM & Sasser JN (1985) Identification of *Meloidogyne* species on the basis of differential host test and perineal-pattern morphology. In: Barker KR, Carter CC & Sasser JN (Eds.) *An advanced treatise on Meloidogyne*, Volume II: Methodology. Raleigh, North Carolina State University Graphics. p.69-77.
- Hussey RS & Barker KR (1973) A comparison of methods for collecting inocula of *Meloidogyne* spp. including a new technique. *Plant Disease Reporter*, 57:1025-1028.
- King S, Davis AR, Zhang X & Crosby K (2010) Genetics, breeding and selection of rootstocks for Solanaceae and Cucurbitaceae. *Scientia Horticulturae*, 127:106-111.
- Lorenzi H (2008) *Plantas daninhas do Brasil: terrestres, aquáticas, parasitas e tóxicas*. Nova Odessa, Instituto Plantarum. 640p.
- Mattos LM, Pinheiro JB, Mendonça JL & Santana JP (2011) Wild Solanaceae: potential for the use as rootstocks resistant to root-knot nematode (*Meloidogyne* spp.). *Acta Horticulturae*, 917:243-247.
- Mônaco APA, Carneiro RG, Kranz WM, Gomes JC, Scherer A, Nakamura KC, Moritz MP & Santiago DC (2008) Reação de espécies de plantas daninhas a *Meloidogyne paranaensis*. *Nematologia Brasileira*, 32:279-284.
- Oostenbrink M (1966) Major characteristics of the relation between nematodes and plants. *Mededelingen Landbouwhogeschool Wageningen*, 66:01-46.
- Peil RM (2003) A enxertia na produção de mudas de hortaliças. *Ciência Rural*, 33:1169-1177.
- Pinheiro JB, Pereira RB & Suinaga FA (2014a) Manejo de nematoides na cultura do tomate. Brasília, Embrapa Hortaliças. 12p. Circular técnica, 132).
- Pinheiro JB, Mendonça JL, Rodrigues CS, Pereira RB & Suinaga FA (2014b) Avaliação de *Solanum stramonifolium* para reação a *Meloidogyne enterolobii*. Brasília, Embrapa Hortaliças. 20p. (Boletim de Pesquisa e Desenvolvimento, 124).
- Rocha FS, Muniz MFS & Campos VP (2005) Coloração de fitonematóides com corantes usados na indústria alimentícia brasileira. *Nematologia Brasileira*, 29:293-297.
- Rocha FS, Catão HCRM, Muniz MFS, Campos VP & Civil N (2015) Correlations among methods to estimate lipid reserves of second-stage juveniles and its relationships with infectivity and reproduction of *Meloidogyne incognita*. *Nematology*, 17:345-352.

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- Sharma IP & Sharma AK (2015) Effects of initial inoculum levels of *Meloidogyne incognita* J2 on development and growth of tomato cv. PT-3 under control conditions. African Journal of Microbiology Research, 09:1376-1380.
- Taylor AL & Sasser JN (1978) Biology, identification, and control of root-knot nematodes (*Meloidogyne*) species. Raleigh, North Carolina State University Press. 111p.
- Yamakawa K (1982) Use of rootstocks in solanaceous fruit-vegetable production in Japan. Japan Agricultural Research Quarterly, 15:175-179.