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Notes and Comments

Meloidogyne incognita and *Meloidogyne javanica* (Rhabditida: Meloidogynidae): first report parasitizing cassava in Goiás State, Brazil

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Cassava (*Manihot esculenta* Crantz), an important subsistence culture in developing countries (Oliveira et al., 2020), is the third main source of carbohydrates (Ramcharan et al., 2017) for approximately 800 million people worldwide (Rocha et al., 2020). This plant is easily propagated by stem segment (Atwijukire et al., 2019) with good resistance to water stress conditions and high temperatures (Gabriel et al., 2014) and demanding few cultural treatments. In addition, its harvest occurs throughout the year, which increases its importance for small producers in the arid climate regions of Brazil (Aparecido et al., 2020).

Associations of phytoparasitic nematodes and cassava plants are poorly known in Brazil, despite the socioeconomic importance of this plant (Rosa et al., 2014). The nematodes *Meloidogyne incognita*, *Pratylenchus brachyurus*, *Rotylenchulus reniformis* and *Scutellonema bradys* parasitized cassava roots and *Aphelenchoides* sp., *Aphelenchus* sp., *Helicotylenchus* sp., *Mesocriconema* sp. and *Tylenchus* sp. were obtained in the rhizosphere of this plant (Garrido et al., 2008).

Meloidogyne spp. induce gall formation in plant roots, disrupting the cortex and the vascular cylinder and reducing the absorption and transport of water and nutrients. This causes yellowing, wilting and reduced growth (Williamson and Gleason, 2003; Anwar and Javed, 2010; Khan et al., 2020), besides increasing the susceptibility of infected plants to bacteria, fungi and phytopathogenic viruses (Al-Hazmi and Al-Nadary, 2015; Ali et al., 2017).

Meloidogyne incognita and *Meloidogyne javanica*, the most harmful nematode species to Brazilian agriculture (Mazzonetto et al., 2015), are aggressive with high reproduction rate (Hemmati and Saeedizadeh, 2020) and wide dissemination and geographical distribution (Garrido et al., 2008). *Meloidogyne incognita* parasitized cassava plants in the Brazilian Amazon (Rosa et al., 2014), but *M. javanica* was not reported on this plant in this country. The objective of this work is to report the occurrence of the nematodes *M. incognita* and *M. javanica* parasitizing cassava plants in agricultural soils in the state of Goiás in the center-western region of Brazil.

Cassava-producing areas registered by the "Empresa de Assistência Técnica e Extensão Rural do Estado de Goiás (EMATER/GO)" in the municipalities of Morrinhos (17° 45' 21.80"S 49° 00' 35.40" W) and Joviânia (17° 48.6' 43.0" S 49° 36.7' 25.0") were studied. Samples with 500 g of soil and 100 g of roots each composed of fifteen sub-samples collected near the rhizosphere at a depth of 20-25 cm were packed in plastic bags inside Styrofoam boxes identified and stored in a refrigerator for a maximum of eight days (8 °C) before being analyzed.

Cassava roots, without visible symptoms of galls or nematode females, in good condition for biochemical analysis, were placed in polyethylene pots (1L) with a tomato host plant *Solanum lycopersicum*, cv. Santa Cruz grown in a mixture of soil and sand in a proportion of 2:1 (v/v) previously autoclaved (120 °C for 2 h) to multiply the possible *Meloidogyne* species present. After 60 days of cultivation in a greenhouse, the tomato roots were sent for biochemical analysis.

Meloidogyne spp. eggs were extracted from tomato roots with galls, but without females of these pathogens, for biochemical analysis (adult females and milky whitish females), by the domestic blender method (Boneti and Ferraz, 1981). The roots of the tomato were washed in running water, chopped into 1-2 cm pieces and crushed in a blender with 0.5% NaOCl solution for 20 seconds. The obtained egg suspension was immediately poured through a 200 mesh (0.074 mm) sieve coupled to a 500 mesh (0.025 mm) sieve. These eggs were quantified in a Peters counting chamber and the suspension calibrated to 1000 mL^{-1} eggs under a photonic microscope (100X magnification). Tomato plants cv. Santa Cruz Kada were inoculated with 5,000 eggs of the nematode per polyethylene pot of 1L capacity containing a mixture of soil and sand, previously autoclaved in the proportion of 2:1 (v/v). The gall nematodes were multiplied in a greenhouse at a temperature of 25 +/- 2 °C for 60 days and sent for biochemical analysis.

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The root samples with galls, containing some soil to maintain the moisture, were packed in plastic bags and sent for analysis to the Laboratório de Nematologia of the Universidade Federal de Viçosa (UFV). *Meloidogyne* spp. species were identified by biochemical analysis of its females and isoenzyme esterase electrophoresis (EST) by the vertical discontinuous system (mini-Protean 3/ Bio-Rad) (Freitas et al., 2016).

The gall nematodes in the samples collected from cassava roots were identified as *M. incognita* and *M. javanica* by the esterase phenotypes I1 and J3, respectively (Figure 1). Infected plants were underdeveloped with symptoms of nitrogen deficiency, few secondary roots and galls ranging from 0.5 mm to 3 cm in diameter, in addition to cracking and root stripping (Figure 2) and nematodes signals were observed in samples (Figure 3).

The identification of *M. incognita* in the state of Goiás increases the area of occurrence of this nematode in cassava plants after its report in the states of Amapá and Pará, Brazil (Rosa et al., 2014). Infection with *Meloidogyne* spp. reduced the fresh matter mass of the plant crown, plant height, fresh mass and number of roots in susceptible cassava cultivars in Uganda and Nigeria (Coyne and Talwana, 2000; Akinsanya and Afolami, 2019). In addition, it reduced

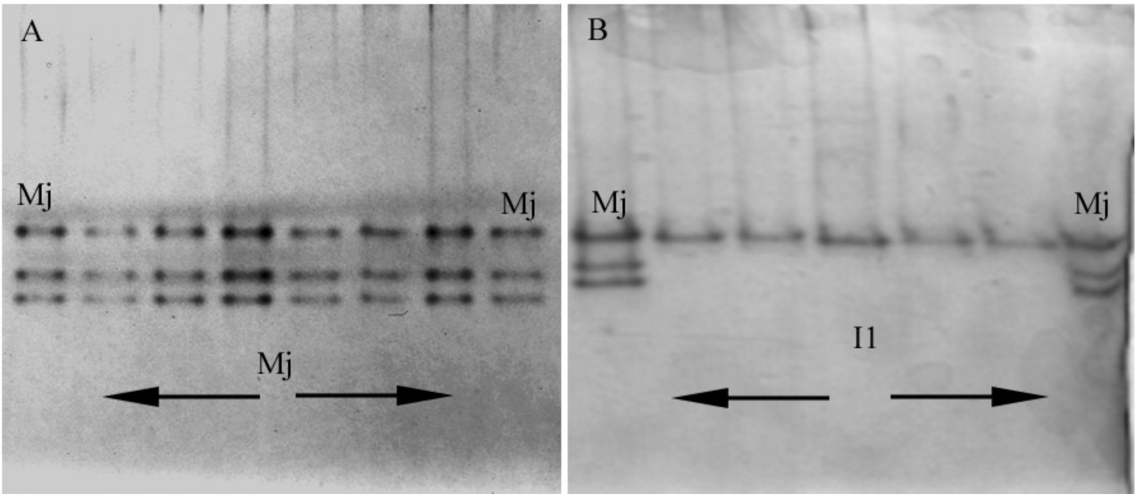

Figure 1. Root-knot nematode extracted from cassava roots (*Manihot esculenta*). Isoenzymatic phenotypes of female esterase: Mj (Rm: 1.0; 1.25 and 1.4) from *Meloidogyne javanica* (A) and I1 (Rm= 1.0) from *Meloidogyne incognita*. Mj phenotype of *M. javanica* used as a standard (B).

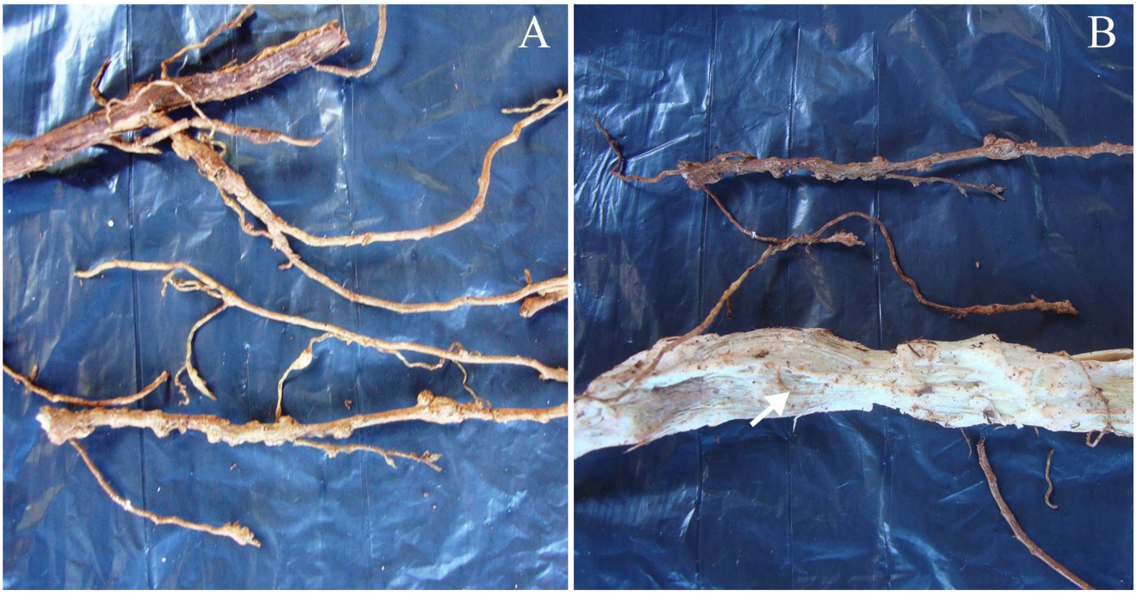

Figure 2. *Meloidogyne incognita* galls in roots of cassava plants (*Manihot esculenta*) (A, B); stripped roots (indicated by arrow) (B).

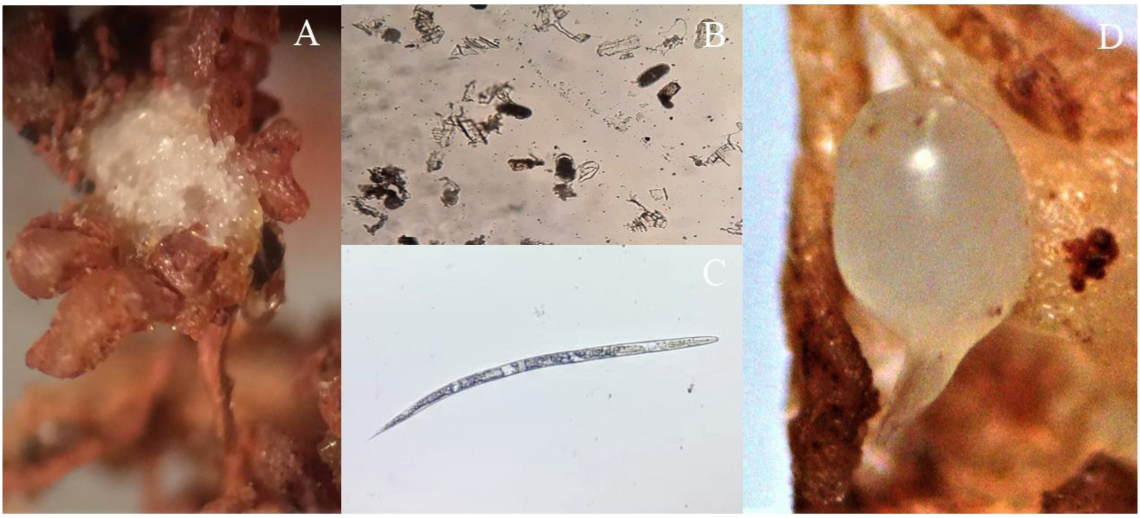

Figure 3. *Meloidogyne incognita* galls in roots of cassava plants (*Manihot esculenta*): Egg mass (A); eggs (B), juveniles 2nd stage (C) and exposed female at the root (D).

the sprouting and the establishment of cassava cuttings (Talwana et al., 1997; Makumbi-Kidza et al., 2000). Damage by *Meloidogyne* spp. reduced the productivity of cassava in the field in Nigeria (Abidemi, 2014) and increased the incidence of rot on roots of this plant stored (Akinsanya and Afolami, 2018; Coyne and Affokpon, 2018). The reduction in cassava productivity by *M. incognita* is due to the decrease in the number of reserve roots of this plant (Makumbi-Kidza et al., 2000). Nematode management is difficult, but preventive tactics, including the use of phytoparasitic nematode-free equipment, healthy propagating material and crop rotation, can reduce the damage by these pathogens (Akinsanya et al., 2020).

The diagnosis of *M. incognita* and *M. javanica* in cassava represents the first report of these species parasitizing this plant in Brazil.

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