Occurrence of *Meloidogyne javanica* in a noni (*Morinda citrifolia* L.) crop in Espírito Santo state, Brazil

Rafael Assis de Souza*, Fábio Ramos Alves®, Antônio Fernando de Souza®, Júlia de Assis Pinheiro®, Ângelo Oliveira Gonçalves®, Waldir Cintra de Jesus Júnior® and Willian Bucker Moraes®

*Universidade Federal do Espírito Santo (UFES), Alegre (ES) Brazil
®Instituto Federal do Espírito Santo (IFES), Santa Teresa (ES) Brazil
®Universidade Federal de São Carlos (UFSCar), São Carlos (SP) Brazil
*rafael2012agronomia@yahoo.com.br

**HIGHLIGHTS**

- *Meloidogyne javanica* was found associated with the noni crop in Espírito Santo state.
- This is the first report of this pathosystem in the state.

**ABSTRACT:** Although there are reports in the literature of root-knot nematodes (*Meloidogyne* spp.) occurring in association with noni (*Morinda citrifolia* L.), a plant that helps in the prevention and cure of some human diseases, there are no reports of a nematological survey in the crop in Brazil in commercial areas. The aim of this work was to carry out a survey of phytonematodes associated with noni in commercial plantations in Espírito Santo state, Brazil. The soil and root samples were collected on properties in the counties of Colatina and São Roque do Canaã, the main producers in the upland region of Espírito Santo. The presence of *M. javanica* was identified in all samples using the technique of esterase isoenzyme electrophoresis. This is the first report of this pathosystem in Espírito Santo State.

**Keywords:** field survey, root-knot nematodes, forestry species.

**Cite as**


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**INTRODUCTION**

Noni (*Morinda citrifolia* L.) is a perennial plant from tropical climates, belonging to the Rubiaceae family. The architecture of its crown is similar to the root system, and the adult plant reaches a height of 3 to 10 m. The noni is native to Southwest Asia, and it is cultivated nowadays in Polynesia, India, the Caribbean, North America, Central America and South America[1, 2]. Although its fruit has been widely consumed in Asia for more than 2000 years, the noni is little known in Brazil, having been introduced there very recently[1, 2].

A number of studies have aimed to prove what folk knowledge claims, which is that the use of noni helps in preventing and curing some illnesses in humans. One of the main components of the fruit is proxeraonine, the precursor of the alkaloid xeronine, which activates the catalyzing enzymes of cell metabolism[3]. It is important to highlight the considerable economic interest in *M. citrifolia*, since many commercial products are made from it, including beverages (fruit juice), fruit powders (juice made from dried fruits), toiletries (lotions, soaps, etc.), oil (from seeds), and foliar powders (for encapsulation or pills)[1, 4]. Besides, some authors mention *M. citrifolia* (i.e. cv. Potteri) as a beautiful ornamental plant with small fruits, admired for its bright green foliage.
Some authors state that one of the most serious phytosanitary problems of the noni crop is the occurrence of *Meloidogyne* spp. These pathogens have caused crop damage in various areas of noni cultivation around the world, and in parasitized plants, nutritional deficiencies of nitrogen, potassium and iron can be observed\(^9\). The leaves of attacked plants become pale yellow and suffer from interveinal chlorosis due to the lack of absorption of water and nutrients by the roots. The roots in parasitized plants are characteristically galled, distorted and swollen, so the leaves and branches gradually die as the parasitism becomes more intense, which can lead plants to death\(^6,7\).

In studies worldwide, a reduction of noni productivity of up to 46.6% and 85%, respectively, was recorded in plants parasitized by *M. incongita* (Kofold & White) Chitwood in India\(^6\) and by *M. arenaria* Chitwood in China\(^7\), and this reduction was attributed to the damage that the nematodes caused to the roots.

The first report of root knot nematode in noni in Brazil was in 2015 in Rio Grande do Norte state\(^8\). The plants severely galled by *M. javanica* (Treub) presented reduced vigor. Despite this report, it is important to emphasize that information about phytonematodes associated with noni is still scarce, because this crop has only been exploited in Brazil for the past few years.

Due to the scarcity of nematological searches carried out in areas cultivated with noni in Brazil, the present work aimed to identify the species of root-knot nematode associated with noni in the upland region of Espírito Santo state.

**MATERIAL AND METHODS**

**Surveyed areas**

The nematological survey was carried out in the main noni-producing counties of Espírito Santo state. Samples were collected in the counties of São Roque do Canaã and Colatina. The sampled areas were geo-referenced, and the geographical coordinates are presented in Table 1.

**Collecting and processing samples**

Samples of roots and soil were collected at depths from 0 to 50 cm, following a zigzag route. On average, 30 subsamples were taken per hectare for each area to constitute a soil and root sample from the rhizosphere of the plant. The samples were placed in plastic bags, labeled and taken for extraction and evaluation.

From each sample, 20 g of roots was taken, then washed in running water, cut using scissors and triturated in a liquidizer for 30 s. Later, the processed material was sieved through 20, 60 and 500 mesh, and the supernatant removed in the last sieve was centrifuged in a sucrose solution\(^9\).

**Nematode extraction and counting**

To extract the nematodes from the soil, aliquots of 100 cm\(^3\) of soil were removed and deposited in a bucket of water for later homogenization. The supernatant was sieved through 20 and 400 mesh and centrifuged in a sucrose solution\(^10\).

**Table 1.** Geo-referencing of the areas cultivated with the noni (*Morinda citrifolia* L.) crop in counties in Espírito Santo state, in which nematological surveys were performed.

<table>
<thead>
<tr>
<th>Area</th>
<th>Counties</th>
<th>Altitude (m)</th>
<th>Longitude (w)</th>
<th>Latitude (s)</th>
<th>Age of the crop (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Colatina</td>
<td>83.76</td>
<td>40.650091</td>
<td>19.63823</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>São Roque do Canaã</td>
<td>115.243</td>
<td>40.667434</td>
<td>19.73337</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>São Roque do Canaã</td>
<td>91.691</td>
<td>40.666090</td>
<td>19.72556</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>São Roque do Canaã</td>
<td>119.088</td>
<td>40.667474</td>
<td>19.72519</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>São Roque do Canaã</td>
<td>109.475</td>
<td>40.716977</td>
<td>19.68926</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>São Roque do Canaã</td>
<td>106.351</td>
<td>40.717477</td>
<td>19.58843</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>São Roque do Canaã</td>
<td>117.646</td>
<td>40.717195</td>
<td>19.68671</td>
<td>4</td>
</tr>
</tbody>
</table>
The aqueous suspensions that resulted from the extraction processes were transferred to a Peters chamber, where nematodes were counted in 1 mL under an optical microscope with light magnification of 10x. The procedure was performed three times and the mean of the counts calculated. The data obtained were used to determine the nematode population densities in the area. The total population of nematodes was obtained by the sum of individuals extracted from soil and roots.

**Esterase analysis**

The identification of the species of *Meloidogyne* present in the samples was carried out using the esterase isoenzyme electrophoresis method, following the methodology described by Carneiro & Almeida[11]. The females were extracted directly from the roots to identify the species. From each sample, 10 females were collected for identification, resulting in a total of 70 females analyzed.

**RESULTS AND DISCUSSION**

The electrophoresis analysis confirmed the presence of *M. javanica* associated with the noni crop (Figures 1, 2). This is the first report of the presence of *M. javanica* in noni in Espírito Santo state.

The largest populations of nematodes were observed in the roots from samples 7, 3 and 4. In soil, the largest populations were in samples 7 and 5, respectively. Most of the sampled properties are in the county of São Roque do Canaã, located in the northeastern region of the state (Table 1).

Larger populations of *M. javanica* were observed in more debilitated plants, according to visual observation, in relation to those with lower nematode populations. The roots of severely attacked plants were seen to be deformed and had root galls in clear evidence (Figure 1). Total nematode populations in soil and roots in all the areas evaluated are shown in Table 2.

![Figure 1](image-url) (a) Root galls on noni roots caused by *M. javanica* in São Roque do Canaã county, ES; (b) Debilitated noni plants with a large population of *Meloidogyne javanica* associated with their roots. Source: Antônio Fernando de Souza.

![Figure 2](image-url) Polyacrylamide gel showing the esterase phenotypes of females of *Meloidogyne javanica* extract from seven commercial areas of noni in the State of Espírito Santo, Brazil. Lanes left to right: Samples from: Colatina (1) and São Roque do Canaã (2-7), ES, Brazil. (8) *M. javanica* was used as the standard.
Nematodes from the *Meloidogyne* genus cause considerable damage in many crops, but lack of knowledge among producers may lead them to attribute this damage to other factors, such as abiotic stresses (extreme temperature, nutritional deficiencies, etc.)[12].

As observed in Table 1, most of the sampled areas have been planted for 2 to 4 years. However, area 3 was implanted 10 years ago. Although no systematic study has been carried out to quantify damage in the area, this long coexistence of nematode and plant has led to one of the largest populations of *M. javanica* seen among the sampled areas (32862.5), and this may have caused a reduction in the size of fruit and thus of yield, according to the producer.

When a given crop is cultivated in an area with phytonematodes present, an increase in the population of these pathogens over time can be predicted[13]. This occurs because these pathogens multiply on a logarithmic scale, and thus, according to the aforementioned authors, a female produces, on average, 500 eggs. Taking into account the survival of only 5% of the individuals that are going to complete their cycle, mean populations are reached of 25, 625, 15,625 and 390,625 adults in one to four generations, respectively. This justifies the observations in the present research, in which the older plants (4 and 10 years old), which have coexisted for longer with the nematode, were those that presented the greatest nematode populations (Table 1).

Parasitism of plants by nematodes is characterized by the creation of permanent feeding sites in the root tissues, constituted by giant cells on the cortex, endodermis, pericycle and parenchyma[14]. These feeding sites become drains for photoassimilates and thus jeopardize plant growth and development[15].

Furthermore, the mechanical damage provoked by nematodes that penetrate and move inside plant tissues leads to the blockage of vascular tissues in the feeding sites. This limits the translocation of water and nutrients, reducing plant growth and crop yield[16]. All these physiological and mechanical damages lead to decreased growth of the plants[17], which may explain the decline seen in noni plants parasitized by *M. javanica*.

It is important to emphasize the importance of phytonematode population surveys in commercially cultivated crops[18, 19]. Greater knowledge of phytonematodes associated with the noni crop is also important in the management of these pathogens. Thus, with the knowledge acquired in this study, affirming that the species of nematode associated with areas of noni is *M. javanica*, more effective management measures can be implemented.

In order to manage phytonematodes, the most efficient and economical method is the use of resistant cultivars[20], because these make it possible to maintain nematode populations below the level that causes economic losses[19]. As RKNs present a high level of host specialization, the most desirable management of *Meloidogyne* spp. is the use of genetic resistance[21]. The information generated in the present study is also important because, should the producer wish to remove the noni crop from the area and plant a new one, a crop or cultivar resistant to *M. javanica* could be chosen.

**CONCLUSIONS**

The root-knot nematode species associated with the noni culture crop in evaluated areas in the municipalities of Colatina and São Roque do Canaã, Espírito Santo State, Brazil, is *M. javanica*. This is the first report of this pathosystem in the state.
REFERENCES


