

Nematodes associated with eggplant crop in Cañada Honda, Mexico

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Abstract

Eggplant is a crop of great development and opportunity for economic growth worldwide, it can be compromised by pests and phytopathogenic diseases that affect the yield in the production of the crop. The objective of the research was the identification of nematodes associated with the eggplant crop, the sampling was carried out in the state of Aguascalientes in the community of Cañada Honda (latitude 22 002254, north latitude 22° 0'8 11584", west longitude -102 192580, 102° 11' 33 2862") in 2019, the technique used to extract filiform nematodes was that of sieving and centrifugal fluctuation with sucrose solution. The keys to the identification of nematodes were those proposed by Cid del Prado (2009), the keys of Esienbcach (1985); Nickle (1991); Hunt (2009), for the root samples, the dissection of the galls was performed to obtain the possible nematodes existing in the root, in the same way, a visual analysis of each root was carried out and the damage caused by galls was classified. The average of nematodes in each soil sample analyzed was 85 nematodes in 100 g of soil, the root damage index showed a value of 5 to 6 according to Bridge and Page's scale. Four genera were identified: *Nacobbus* spp., *Rhabditis* spp., *Psilechus* spp., and *Dorylaimus* spp.

Keywords: galls, phytopathogenic nematodes, Solanaceae.

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Eggplant is a crop of great development and opportunity for economic growth worldwide, in 2017 alone, its world production was led by China with a volume of 35 590 700 t followed by India with 12 680 00 t and Egypt with 1 180 240 t, Mexico ranks 12 th worldwide with a production of 185 234 t (FAOSTAT, 2019). In 2018, the main producing state was Sinaloa with 178 586 t, followed by Yucatan with 4 426 t and Sonora with 1 433 t (SIAP, 2018).

At the national level, the gains shown by eggplant exports were on average 4 684 658 dollars in 2018 and its highest value occurred during March with a value of 10 097 391 dollars (SE, 2018). This crop can be compromised by pests and phytopathogenic diseases that affect the yield, among which nematodes stand out (Medina *et al.*, 2018), despite their importance there are few studies in eggplant crop.

Nematodes cause damage to the roots, hindering the absorption of water and nutrients, in addition to the obstruction of the translocation of minerals and the poor development of photosynthesis, as a result of these deficiencies, the plant does not develop satisfactorily, decreasing its yield (Anwar and Mckenry, 2010).

Some genera of nematodes are extremely aggressive such as *Pratylenchus* spp., *Ditylenchus* spp. *Psilenchus* spp., and the false root-knot nematode, *Nacobbus* sp., together with *Meloidogyne* spp., the latter consisting of 98 species, among which the species *Chitwood*, *Incognita*, *Hapla*, *Javanica* and *Arenaria* are responsible for causing economic losses between 12 and 20% in the crops where they appear (Hussey and Janssen, 2002; Jones *et al.*, 2013, Karssen, *et al.*, 2013). The objective was to identify the genera of nematodes associated with eggplant crop.

The sampling was carried out in the state of Aguascalientes in the community of Cañada Honda (latitude 22 002254, north latitude 22° 0'8 11584", longitude -102.192580, west longitude 102° 11' 33 2862"), which has a semi-arid climate and average annual temperature of 17-18 °C, the sampling was carried out in April and May, 2019 in an eggplant crop, a total of 25 random soil composite samples were obtained from a profile of 0-30 cm deep, 200 to 400 g of soil were collected, 25 root samples were taken when the plant was in fruiting, the samples were processed individually, the nematode population of each sampling point was calculated with the aim of knowing the variation in the population and in the end the total nematodes extracted from the 25 points were averaged to determine the density of nematodes found in the crop based on 100 g of soil per sample.

The technique used to extract filiform nematodes was that of sieving and centrifugal fluctuation with sucrose solution (Jenkins, 1964). One milliliter was taken from the tubes containing the nematodes and placed on a clock glass for counting, preparations with lactophenol blue were made to identify the structures of the individuals and visualized in a Motic microscope under the 40x and 100x objectives.

The keys to the identification of nematodes were those proposed by Cid del Prado (2009), the keys of Esienbcach (1985); Nickle (1991); Hunt (2009), in the root samples, the dissection of the galls and a visual analysis of each root were performed, and the damage caused by galls in the root was classified in reference to Bride and Page (1980). The above was carried out in the department of parasitology, toxicology laboratory of the Autonomous Agrarian University Antonio Narro.

The average number of nematodes found in each soil sample analyzed was 85 individuals in 100 g of soil, counting as the highest value per sample unit 178 nematodes in 100 g of soil and as a lower value 9 nematodes in 100 g of soil analyzed. The tolerance limit as well as the economic threshold of nematodes are values that one must know to achieve high yields in one's harvest, authors such as Ferris (1981); Shurtleff *et al.* (1997) indicate that the population density of nematodes that compromises the productivity of a crop must be greater than 30 nematodes per 100 g of soil, likewise the tolerance limit is below 20 nematodes per 100 g of soil, however, depending on the genus present in one's crop, the tolerance limit and the economic threshold can be modified by the habits and voracity of the nematodes present.

The nematode genera identified were the following: *Nacobbus* spp: the genus *Nacobbus* spp. was identified in the root samples, observing a notable sexual dimorphism, with a well-defined stylet and median bulb (Figure 2), adult females of fusiform shape and swollen appearance, globose (Figure 1), with a single ovary and vulva located in the part almost at the end of the body with or without masses of eggs (Figure 3), in the case of males, these were found in the soil attached to the root, vermiform, in their juvenile stages, elongated and thin, curved in appearance in their ventral region, rounded tail, stylet and median bulb well developed (Manzanilla-López *et al.*, 2002; Cid del Prado, 2009).

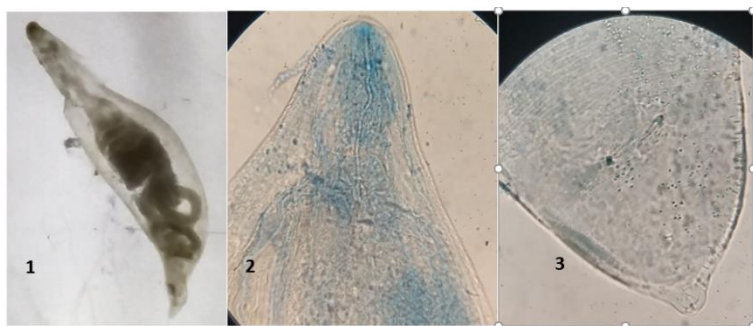


Figure. 1) female *Nacobbus* with a globose swollen shape; 2) defined stylet and define median bulb; and 3) vulva of female *Nacobbus*.

This highly infective nematode during all its juvenile stages, both males and females, and only mature females remain sedentary, this nematode is related to the genus *Meloydogine* spp., since it presents very similar symptoms in the roots, forming galls in a spherical and continuous form (Perry and Moens, 2006). The nematode *Nacobbus aberrans* has been identified in soils cultivated with potato in the community of Aypa Yauruta of the department of La Paz Bolivia, where it was found with 62% incidence, this nematode is considered a pest that significantly affects the yield of the potato crops in the world (Martínez and Cruz, 2018). On the other hand, a study was carried out in which root-knot nematodes were identified affecting vegetables in north-central Mexico, where *Nacobbus aberrans* was found associated with bean crops (Velásquez, 2001).

Rhabditis spp: the genus *Rhabditis* spp., was identified., both females and males are vermiform in shape, this nematode has a tubular buccal cavity (Figure 4 and 6), shows absence of well-defined stylet, its cardia valve is butterfly-shaped, in females the vulva is located at 57% of its length, presents phasmids in the caudal region, its tail has variants between rounded and filiform (Figure 5), this nematode feeds on bacteria in the soil as well as fungal spores, this can

cause a negative effect on the production of vegetables, its feeding habits degrade organic matter, in the case of the property analyzed, having a high population density of the genus already mentioned causes a lack of nutrients in the soil (Cepeda, 2016). *Rhabditis* spp., has been found naturally in soils soil infested with *N. aberrans*, in a greenhouse for tomato production located at the National University of La Plata in Buenos Aires Argentina, where it was found in magnitudes equivalent to *Helicotylenchus* spp., and saprophytic nematodes (*Rhabditis* spp. and *Cephalobus* spp.) (Martínez *et al.*, 2021).

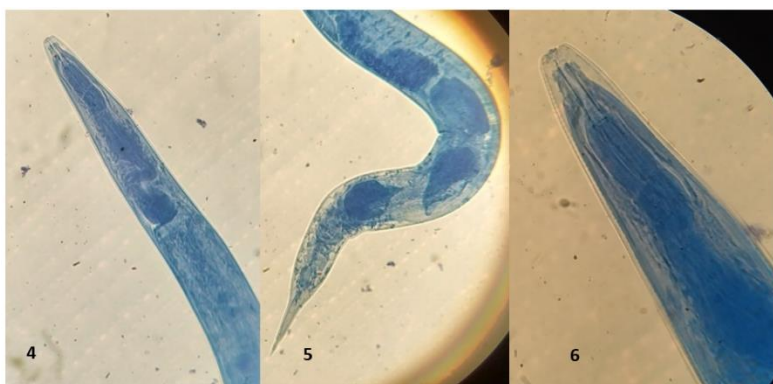


Figure. 4) nematode *Rhabditis* with tubular buccal cavity; 5) tail of the nematode *Rhabditis* spp., in pointed filiform shape; and 6) absence of well-defined stylet in the tube-shaped oral cavity.

Psilenchus spp: the genus *Psilenchus* was identified, which is vermiform in shape, its tail has the characteristic of being filiform with a drop-shaped end (Figure 7 and 9), elongated stylet (Figure 8), it can be present with or without basal nodules, this nematode is ectoparasite, feeds on root hairs generating necrosis and root atrophy, an approximate length of 1 to 1.12 mm (Ferris, 1981; Espinosa *et al.*, 2004; Cepeda, 2016). These phytopathogenic nematodes have been little studied, mainly because their size is small and are known to influence crop production due to their high population density (Hassan, 2020).

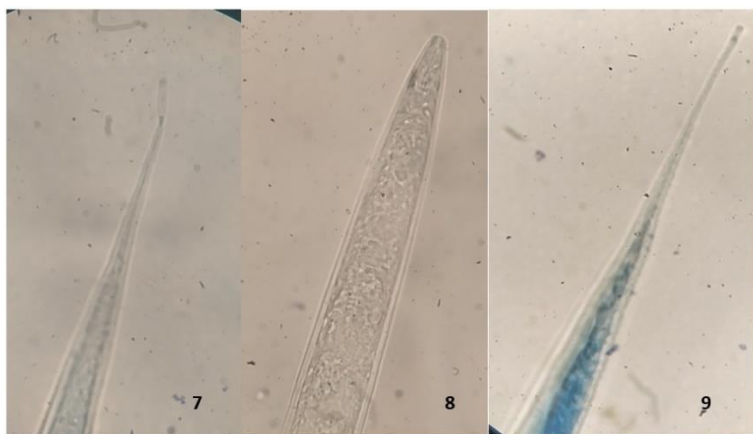


Figure. 7) tail of the nematode *Psilenchus* with filiform tip and a drop-shaped end; 8) cephalic region with stylet absents from basal nodules; and 9) filiform tail with terminal drop-shaped widening.

Dorylaimus spp: the genus *Dorylaimus* spp., was identified, its main feature is its false stylet (Figure 10) and its tail with a small tip (Figure 12), its esophagus shows a bottle-shaped gradual expansion, the vulva in females of this genus is located at 60% of the length, of a considerable size of 3 to 5 mm and with very wide food habits, in root, it causes lesions that leave it in the form of a brush thus atrophying the root system (Shafqat *et al.*, 1991; Cepeda, 2016).

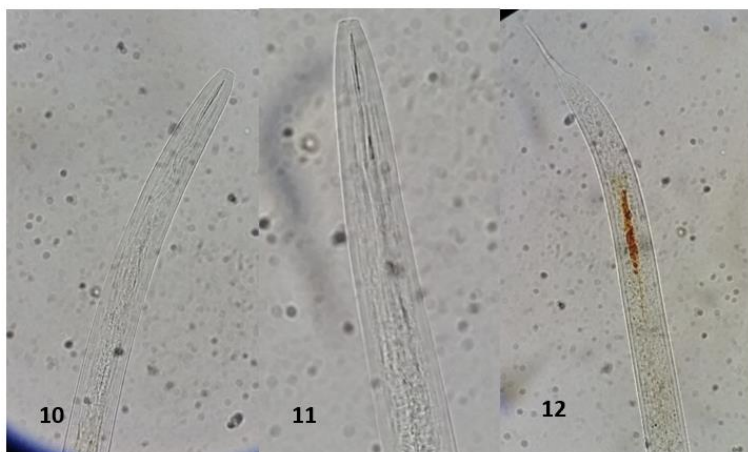


Figure. 10) false stylet of the nematode *Dorylaimus*; 11) gradual expansion of the esophagus; and 12) tail with small tip.

In a study carried out in a greenhouse at the Julio Hirschhorn experimental station, belonging to the Faculty of Agricultural and Forestry Sciences of the National University of La Plata, La Plata Buenos Aires, Argentina, where phytohormones on the yield and damage produced by *N. aberrans* in the roots of a tomato crop, were evaluated. At the beginning of the test, the soil was naturally infested with *N. aberrans*, where a significantly higher number than *Dorylaimus* spp., was found (Martínez *et al.*, 2021).

The incidence of each genus was obtained from the population of nematodes obtained, being *Nacobbus* spp., with 40%, followed by *Rhabditis* with 35%, *Psilenchus* with 20% and *Dorylaimus* with 5%. The root damage index shown by the formation of galls was classified with a value of 5 to 6 according to the scale of Bridge and Page (1980), likewise, females of the genus *Nacobbus* spp., were found within the dissected root, parasitizing the plant in addition to eggs around it.

The reference of the values established by Bridge and Page (1980) indicate that 50% of the root is infested, reducing its root system, value 6 indicates that the root system is infested by more than 50% and it is present in its main roots, these values are preferably to the genus *Meloidogyne* spp.; however, a damage similar to that caused by the genus *Nacobbus* spp., can be interpreted., the gall density can be represented with these values, the genus *Meloidogyne* spp., as well as the genus *Nacobbus* spp., are hosts of Solanaceae, therefore a certain value for the damage evidenced by galls can be represented (Velázquez, 2001).

Conclusions

Nematode genera were identified: *Nacobbus* spp., *Rhabditis* spp., *Psilenchus* spp., and *Dorylaimus*.

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