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Guava root knot nematode (*Meloidogyne enterolobii*): Challenging threat to future guava production

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Abstract
Root knot nematode is currently wreaking havoc on guava cultivation and is considered a severe danger. The current problem was taken into consideration and an investigation was planned and conducted during the survey that was taken up at Karadkal, Mudgal, Gudihal villages of Lingasuguru taluk. Representative samples of soil and root were collected from the affected plot of respective villages. Plant development was significantly reduced in the nematode-infested plant, as well as the absence of fine roots, a poorly developed root system, and a drop in quality and quantity of fruit. Tiny leaves, browning leaves, leaf loss, and growth retardation are indicators of a seriously diseased plant, while roots are twisted by little and large numerous galls, causing tree death. Root-knot nematodes may have caused the heavily galled roots in the affected seedlings. The nematode *Meloidogyne enterolobii* has been connected to a decrease in guava growth in Lingasugur surrounding villages for the first time. Root samples were taken from infected guava plants, and mature females were isolated and analysed separately.

Keywords: Root knot nematode, *Meloidogyne*, Lingasugur

Introduction
Guava, *Psidium guajava*, is an edible fruit from an evergreen shrub or small tree in the Myrtaceae family. The trunk of the guava tree is slender, with smooth green to red-brown bark.

The base of the trunk may be branched, and the branches may drop down to the ground. The plant's leaves are oval or elliptical in shape, with a smooth upper surface and a hairy under surface. Guava has a berrylike fruit and single white blooms. The fruit is round in form and var ies in colour from green to yellow. The interior flesh might be white, yellow, pink, or red in hue, with many yellowish seeds (Plate 1).

a. Flower formation

b. Formation of fruit

Guava trees may reach a height of 10 metres (33 feet) and survive for 40 years. It is also known as the poor man's apple since its low-cost and high in nutrients. It can also be cultivated in high density planting (HDP). India grows the fruit on around 268 thousand hectares, with a total yield of 3668 thousand metric tonnes. The crop may be produced in virtually all types of soil and in almost all Indian states, with the biggest acreage in Uttar Pradesh (45.0 thousand ha). Many pests and diseases attack guava, but root knot nematode (*Meloidogyne enterolobii*.) is a now a challenging threat in guava orchards in North eastern parts of Karnataka. Fungi, bacteria, algae, and nematodes are among the plant pathogens that have been found to cause a number of diseases. The root knot nematode, *Meloidogyne enterolobii* was found from all the samples collected from Guava orchard of four different places of the Lingasugur taluk, which may pose a serious threat to the guava cultivation of the state. *Meloidogyne enterolobii*, a new species of root-knot nematode, is a developing concern in guava that has been reported from Tamil Nadu in recent years and is now spreading across the country (Poornima *et al*., 2016, Satya kumar and Shilpa Rawat, 2018) [6, 8].

Identification of the disease

The current problem was taken into consideration and an investigation was planned and conducted during the survey that was taken up at Karadkal, Mudgal, Gudihal villages of Lingasuguru taluk. Representative samples of soil and root were collected from the affected plot of respective villages.

Symptomatology

Above-ground symptoms of nematode-infested guava trees include a drastic reduction in plant growth, before tree death, bronzing of leaves (Plate 2), stunting of plant, and reduced fruit number and size, whereas below-ground symptoms include relatively large galls, absence of fine roots, a poorly developed root system (Plate 3), and declining yield quality and quantity. Small and huge numerous galls twist severely contaminated roots, and after cutting the infected roots, brown coloured deterioration is obvious. Root-knot nematodes could be responsible for these symptoms in mature plants.

Plate 2: Symptoms on guava leaves

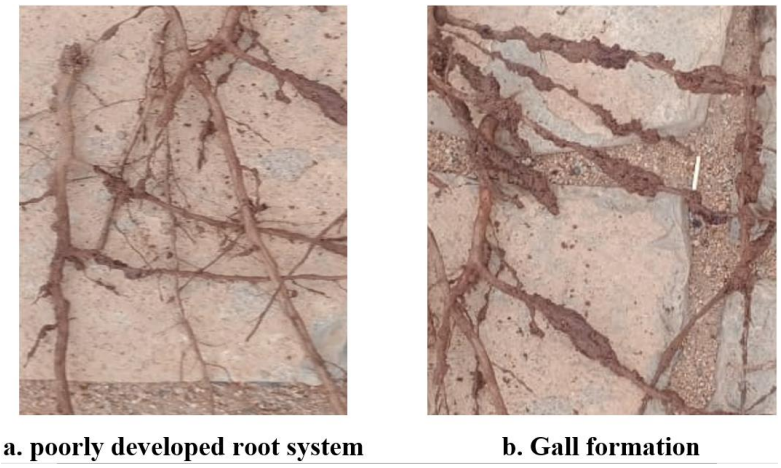

Plate 3: Typical symptoms on roots

Methodology

The nematodes were extracted from the soil through different sized sieves. For methods based on nematode weight and rate of sedimentation, the 'critical' moment is when sufficient dirt has settled, but most nematodes are still afloat. Methods that apply an undercurrent (Oostenbrink, Seinhorst and Kort funnels) are easier to control than methods without an undercurrent (decanting, Baunacke, Fenwick), although the former require more expensive equipment and larger volumes of water. So the simple sieve and Baermann funnel has been used here to extract nematodes from soil and plant. Once after the nematodes are settled down then they were observed under microscope for its morphological differentiation.

Results and Discussions

The egg masses inside the galled tissues were seen, The presence of egg masses, as well as multiple long necked females, was seen on stained diseased roots (Plate 4). Small, pigmented, pear-shaped females of root knot nematodes were seen in clusters when examined under a 40x microscope. Also male root knot nematodes were found (Plate 5). The second-stage juveniles (J_2) and adult females were used for identification which was taken from the infected root galls. The process of fixation, dehydration and the mounting of J^2 were performed according to (Seinhorst, 1959) [9].

The species was verified as *M. enterolobii* in laboratories based on morphological and microscopic examinations. The nematode *M. enterolobii* was discovered in all of the infected plants' roots samples.

The tail of second stage juvenile was relatively thin, long and rounded ending portion and with hyaline region, and sometimes with a lobed terminus. The male head shape for *M. enterolobii* is described as "not set off", while a slightly set off head region was observed as described for *M. Enterolobii* (Satya Kumar and Shilpa Rawat, 2018) [8].

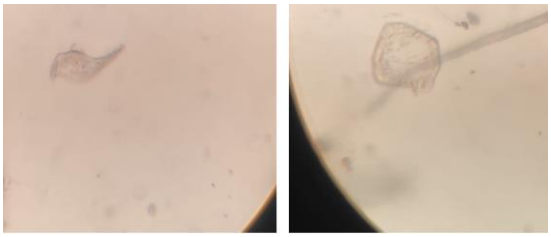

Plate 4: Presence of female nematode, microscopic examination (40x)

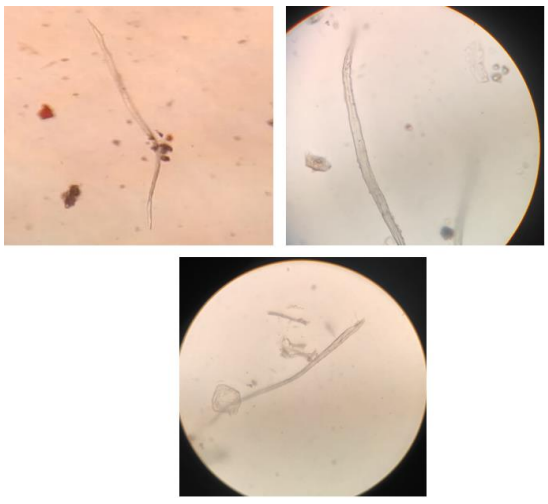

Plate 5: Presence of male nematode, microscopic examination (40x)

Conclusion

The present population thus was identified as *M. enterolobii* as it is the major root rot causing nematode and its spread is vastly present in villages around the Lingasgugur taluk where guava is grown. The variation may be due to environmental condition or stress. *Meloidogyne enterolobii* is considered as very damaging due to its wide host range, high reproduction rate and induction of large galls (Castagnone-Sereno, 2012) [1]. Severe damage caused by *M. enterolobii* has been reported for *Psidium guajava* (guava; da Silva and Krasuski, 2012 and Martins *et al.*, 2013) [3, 5], *Lycopersicon esculentum* (tomato) and *Citrullis lanatus* (water melon; Cetintas *et al.*, 2007, Kiewnick *et al.*, 2009 and Ramirez-Suarez *et al.*, 2014) [2, 4, 7] and *Enterolobium contortisiliquum* (pacaraear pod tree, Yang and Eisenback, 1983). *M. enterolobii* was identified as the current population, and the variance could be attributable to environmental conditions or stress. Due to its wide host range, strong reproductive rate, and induction of enormous galls, it is considered to be extremely harmful (Castagnone-Sereno, 2012) [1]. *Psidium guajava* (guava; da Silva and Krasuski, 2012 and Martins *et al*., 2013) [3, 5], *Lycopersicon esculentum* (tomato) and *Citrullis lanatus* (water melon; Cetintas *et al*., 2007, Kiewnick *et al*., 2009 and Ramirez Suarez *et al*., 2014) [2, 4, 7], and *Enterolobium contortisiliquum* (Pac *M. enterolobii* is highly aggressive when compared to other root-knot nematode species since it demonstrates virulence against various sources of root-knot nematode-resistance genes.

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