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Citrus Nematode *Tylenchulus Semipenetrans*: Understanding the Problem to the Solution

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Introduction

Citrus is a worldwide grown fruit crop. It is the third important fruit crop after mango and banana. The trend of share in world citrus production is as follows: oranges (55%) with the highest share followed by mandarins (25%), lemon (13%) and grapefruits (7%) (Global Citrus outlook, 2019).The important commercial cultivars of citrus grown in India are the mandarin (*Citrus reticulata* Blanco), sweet orange (*Citrus sinensis* Osbeck) and acid lime (*Citrus aurantifolia* Swingle).Cultivation area of Kinnow mandarin is distributed to Punjab, Haryana, Himachal, western parts of Rajasthan and Uttar Pradesh; Khasi mandarin to the states of north-eastern regions such as Assam, Mizoram, Meghalaya, Manipur, Nagaland, Arunachal Pradesh, Tripura, Sikkim; Coorg mandarin in Coorg area; Darjeeling mandarin in Darjeeling; Nagpur mandarin in Vidarbha region of Maharastra and adjoining areas of Madhya Pradesh; Acid lime in Kheda district of Gujrat, Peryakulam district of Tamilnadu and Akola district of Maharastra, Mosambi in Sathgudi in Andhra Pradesh and Marathwada region of Maharashtra (Singh et al., 2012).

Plant-parasitic nematodes are the major problem in the cultivation of citrus crops. Major nematode pests infecting citrus crops are *Tylenchulus semipenetrans, Xiphinema index, Meloidogyne spp. Radopholus similis and ratylenchus coffee.* Among these *Tylenchulus semipenetrans* is dominating. Localized damage is observed in several geographical regions by various other species viz., *Belonolaimus longicaudatus, Rotylenchulus reniformis, Rotylenchus orientalis, Hemicycliophora arenaria and H. nudata, Paratrichodorus lobatus and P. minor, Pratylenchus brachyurus, Hoplolaimus indicus, P. vulnus and P. jaehni, Helicotylenchus dihystera, Tylenchorhynchus sp., Criconemoides citri and C. parvatum, Longidorus brevicandatus and Xiphinema spp*. (Kumar and Das, 2019). Availability of root for feeding to the nematodes help in building up their population and persisting throughout

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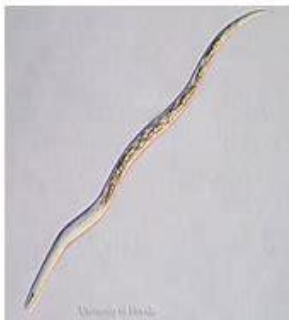
the year. The annual crop losses due to infection of plant-parasitic nematode cost about Rs. 242.1 billion (Jain et al., 2007).

***Tylenchulus semipenetrans*-** Major nematode infecting citrus crop

Tylenchulus semipenetrans is the major nematode pest and it has been reported to cause injury to 50 species or hybrids of Citrus belonging to the Rutaceae family. *T. semipenetrans*mediated crop loss estimate about 15 to 30% annually (Ducan 2005).Apart from citrus species this nematode also infects grape, olive and a few additional plant species of minor importance. This nematode was first identified for infecting citrus in California (Thomas 1913). Later on, this nematode is described as a causal agent of slow decline in citrus (Nathan Cobb, 1913). Egg of nematode can persist in the soil even up to 9 years in the absence of host (Van Gundy et al. 1967). Stunting, yellowing, slow growth, reduced foliage, fruit size and yield are the major symptoms of nematode infection. Three biotypes of citrus nematode are mainly recognized such as Citreus, Mediterranean and Poncirus types. The Poncirus biotype reproduces on grapes and is mainly confined to California (the USA). The Mediterranean biotype reproduces on persimone, grapes and most citrus varieties and is found in the Mediterranean region, southern Africa and India (Duncan 2005). The citrus biotype has a common host range but additionally reproduce on olive. The infection results in loss of yield and poor growth. It does not directly kill the plants but make them susceptible to secondary infection. This pathogen is semiendoparasitic in nature. Reproduction occurs via parthenogenesis in which both male and female second-stage juveniles (J2s) are produced from unfertilized females. J2S hatch from eggs. 2nd 3rd and 4thstage juveniles feed upon root cells of the hypodermis.



Tylenchulussemipenetrans

Citrus decline caused by *Tylenchulussemipenetrans*

1. **Soil conditioning**
2. **Nematicide treatment**
3. **Cultural practices**
4. **Use of resistant rootstock**
5. **Microbial agents**

Management

Figure: Citrus nematode *Tylenchulussemipenetrans,* symptoms and management

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During infection vermiform young adult females penetrate deeply into parenchyma keeping one-half of the body outside the root. The feeding site consists of 8-10 nurse cells which have thick walls, a large nucleus and nucleolus. The area may become invaded by other micro-organisms. Males do not penetrate roots and they are about the same size as the J2s. The male passes through 3 moults without feeding, and the stylet becomes progressively less distinct; males reach maturity in one week. The J2 female is a persistent stage and has been recovered from stored soil after 2.5 years and from field soil 4 years after pulling lemon trees.

Management

Nematode management requires a thorough knowledge of three factors as understanding the growth of the host plant; the biology, ecology, and epidemiology of the nematode; and the influence of the environment on the nematode-plant interaction in a given region. When selecting management techniques one should be clear about the adverse effect of combining more than two techniques. Research in the area to find the ways to interrupt the nematodes life cycle, identification of key compounds involved in interference host finding mechanism of nematodes, enhance microbial growth near rhizosphere to enhance host tolerance to nematode and increase the yield. The cultural, microbial, chemical or any other management practices that are developed should be both economical to the grower and safe to the environment. The use of resistant rootstocks can be one of the ways to manage nematode infection. *Poncirus trifoliata* is resistant to most populations of *T. semipenetrans.* Resistant hybrids of P. *trifoliata* also provide acceptable rootstocks, Swingle citrumelo (*C. paradisi* x *P. trifoliata*) is a commercially acceptable rootstock with resistance against *T. semipenetrans.* Micronema a bacterial consortium containing *Serratia* spp. *Pseudomonas* spp., *Azotobacte*r spp., *B. circulans* and *B. thuringiensis* give229% high fruit yield comparison to control (Hammam et al., 2016). *P. fluorescen*s application in talc formulation @ 20 g/tree is effective in 71.49 % reduction in *T. semipenetrans* population and increase the fruit yield threefold compared to control (Deepa et al., 2011).

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