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Strategies for Managing Root-Knot Nematodes in Commercial Tomato Production

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Tomato (*Lycopersicon esculentum* Mill.) is an important vegetable crop grown throughout the world. It is a self-pollinated crop belonging to the family Solanaceae. Tomato is originated from South America, specifically Peru, Ecuador, and Bolivia. China, Egypt, India, Italy, The United States and Turkey are the world's top tomato growing countries. After China, India is the world's second largest producer of vegetables.

The crop can be grown in both temperate and tropical climates around the world. It is therefore, extremely useful to growers and provides an additional source of income even during the off-season. Tomato is an important vegetable that may be found in any vegetable dishes with their attractive colour, excellent flavour, refreshing juiciness and mild acidity. It is processed in ketchup, sauce, juice or powder form and also eaten as raw salads and sandwiches. Tomato contributes to good nutrition by supplying vital amino acids and a variety of minerals. It includes 98.0 per cent edible part, 23.00 kcal energy, 4.5 g carbohydrate, 1.9 g protein and 0.1 g fat per 100 g, as well as vitamin A, B, C (John *et al.*, 2010), calcium, and carotene. It includes lycopene, a powerful antioxidant with anti-carcinogenic qualities (Agarwal and Rao, 2000) which helps to lower the risk of prostate cancer. Tomato has therapeutic characteristics and is known to be a fantastic blood purifier in addition to having a delicious flavour. Because of these characteristics, the tomato is known as "Protective Food" and is eaten both ripe and green condition.

Plant-parasitic nematodes (PPNs) causing significant yield losses in tomato, including poor seed quality, unfavourable environmental conditions and the presence of illnesses. PPNs constitute one of the biotic factors negatively influencing increased tomato production. Nematodes are a significant pest of horticultural crops, particularly tomato. Overall, PPNs cause 21.3 per cent yield losses of Rs. 102,039.79 million (1.58 billion USD) annually. *Meloidogyne incognita* was economically most important root-knot nematode (RKN) causing 23% yield losses of Rs. 6035.2 million in tomato (Kumar *et al.*, 2020). The top most economically important obligate plant parasitic genus is *Meloidogyne* spp. distributed worldwide (Jones *et al.*, 2013). *Meloidogyne* spp. are polyphagous in nature infecting more than 3000 host species including vegetables, fruits, oil, fiber, grains and leguminous crops (Jones *et al.*, 2013). The most frequently occurring species of root-knot nematodes include *Meloidogyne incognita*, *M. javanica*, *M. arenaria* and *M. hapla*. Among these, *M. incognita* and *M. javanica* are the most common and economically important species which are responsible for high economic yield losses in various crops. RKN was first noticed on tea roots in Kerala's Devala area (Barber, 1901).

Pathogen

Root-knot nematodes belong to the genus *Meloidogyne.* Several species of root-knot nematode infect tomato, including *Meloidogyne incognita* (Southern root-knot nematode), *M. arenaria* (peanut root-knot nematode), *M. javanica* (Javanese root-knot nematode), *M. hapla* (Northern root-knot nematode), and the recently emerging *M. enterolobii* (guava root-knot nematode).

The life cycle of root-knot nematodes takes about 25 days to complete, but this length of time may be affected by soil temperature, moisture, or the presence of host plants. Second stage juveniles, which initiate infection in a host, hatch from eggs and travel to plant roots via films of water. Once a host plant root has been located, a J2 enters the plant root and migrates to the vascular system where it begins to feed. The J2s rapidly molt, during which feeding is paused. In most cases, the juveniles will develop into adult females, which produce egg masses that can contain numerous eggs ranging from around 300 to 600 eggs per female, depending on the species. However, when conditions such as poor plant nutrition, nematode over-crowding, or competition occur, J2s may develop into males that exit the plant root. Among the concerns of the root-knot nematode life cycle is their quick generation turn-over rate and ability to overwinter for several years, making management difficult.

Host Range of Pathogen

Root-knot nematodes have a broad host range, meaning they can infect many other crops in addition to tomato. However, not all root-knot nematode species are able to infect the same crops, although the host ranges of several root-knot species overlap. Among the many host plants are tomato, pepper, sweetpotato, corn, soybean, tobacco, cotton, and numerous species of weeds. Identification of root-knot species may help dictate a suitable crop rotation plan; however, the large number of host plants may limit options for planting in certain situations.

Resistance to specific species of root-knot nematode is available in some hosts, including tomato. Certain tomato cultivars possess the *Mi*-1 gene, which renders the plant resistant to *M. arenaria, M. incognita,* and *M. javanica.* However, the newly emerging root-knot nematode, *M. enterolobii*, is capable of infecting tomatoes cultivars with the *Mi-1* resistance gene.

Signs and Symptoms

Signs and symptoms of root-knot nematode infection occur below ground in the roots. Roots will display characteristic galls or swellings, where female nematodes and their egg masses may be found. Using a magnifying glass can help you look for galls on the roots produced by root-knot nematodes.

Different species of root-knot nematodes produce similar symptoms; therefore, it is not possible to differentiate species based on symptoms alone. However, galls may be larger in more aggressive species such as *M. enterolobii* and smaller for species such as *M. hapla*. Further, it is possible for multiple species to inhabit the same field.

Nematodes are rarely evenly distributed in the field and instead are often found in clusters. Therefore, symptoms within a field are usually found in 'hot spots' or patches, where nematodes are more concentrated. Above-ground symptoms, when present, are often associated with high nematode populations, and may include stunting, chlorosis (yellowing), and wilting of plant. In cases of moderate to severe infestation, plants are more susceptible to drought, and their ability to uptake water and nutrients decreases. A decline in yield is often observed with root-knot nematode infection in more susceptible tomato varieties, especially under high nematode population levels. Above-ground or foliar symptoms may not always be present when nematode populations are low.

In addition, root-knot nematode root infection can increase susceptibility of the host plant to other pathogens, such as Fusarium crown and root rot, when these pathogens are also present in the field.

Management

Effective nematode management begins with field selection, sampling for nematode populations, and starting with nematode-free planting material. It is difficult to completely eradicate nematodes from a site once they are established; therefore, it is crucial to follow recommended guidelines and sanitation practices to ensure the site remains free of root-knot nematodes and highly productive. If nematode populations establish within the site, the following disease management tools can be used to bring root-knot nematode populations to below damaging levels. Producers are highly encouraged to implement more than one tool for durable and robust management.

Exclusion and Sanitation: Due to their microscopic size, root-knot nematodes naturally have limited movement in the soil; therefore, it is important to limit the spread of nematodes to new areas by exclusion and sanitation. Nematodes can easily be moved in contaminated soil on equipment, shoes, garden tools, or vehicles. To reduce the risk of moving nematodes through contaminated soil, equipment and tools should be sanitized by washing with a solution of 10% household bleach, rinsing with clean water, and air drying before moving to unaffected fields or areas. The use of nematode free transplants and planting media is important to exclude nematodes from the greenhouse, garden, and field.

Crop Rotation: Crop rotation to a non-host crop can be a useful tool to help manage root-knot nematodes. By alternating to a crop that the nematodes can neither feed on nor complete their life cycle on, this tool can promote a decline in root-knot nematode populations in the soil. However, effective use of non-host rotational crops for management of root-knot nematodes is dependent upon the species (and sometimes race) of root-knot nematode present in the field, or if the crop possesses any resistance genes. For example, *M. hapla* can reproduce on tomato cultivars without the *Mi-1* gene, but cannot reproduce on corn and only poorly on cotton. Yet *M. incognita* race 3 reproduces very well on tomato, corn, and cotton. When considering crop rotation, it is useful to also consider whether any cover crops that are used may be a host to root-knot nematodes.

Soil Solarization: Covering soil with clear plastic sheets during the hottest months can increase soil temperatures, effectively killing nematodes and other soil-borne pathogens.

Organic Amendments: Incorporating organic matter, such as compost or manure, can improve soil health and encourage beneficial organisms that naturally suppress nematodes.

Resistant Varieties: Planting nematode-resistant tomato varieties can help reduce damage, as these varieties are bred to withstand nematode infestation.

Chemical Control: Chemical control options including fumigants and non-fumigant nematicides are available for use in tomato production to suppress root-knot nematodes and minimize yield losses (Table 1). Prior to selection and application of a chemical option, be sure to review all product registrations and labeling.

Table 1. Chemical control options and relative efficacy to suppress root-knot nematodes in tomato.

Product Name	Active Ingredient	Product Type	Relative Efficacy
Movento	spirotetramat	Non-fumigant	Fair
Nimitz	fluenslfone	Non-fumigant	Fair
Velum Prime	fluopyram	Non-fumigant	Good
Vydate L	oxamyl	Non-fumigant	Good
K-Pam	metam potassium	Fumigant	Fair

Vapam	metam sodium	Fumigant	Fair
Telone II	1,3-dichloropropene	Fumigant	Excellent
Telone C17	1,3-dichloropropene + chloropicrin	Fumigant	Excellent
Pic-Clor 60	1,3-dichloropropene + chloropicrin	Fumigant	Excellent
Tri-Pic 100	Chloropicrin	Fumigant	Poor
Dominus	Allyl isothiocyanate	Bio-fumigant	Fair
DiTera DF	*Myrothecium verrucaria* strain	Biocontrol	Fair
MeloCon WG	*Paecilomyces lilacinus* strain 251	Biocontrol	Fair

Biocontrol: Several biocontrol agents and products are available to help suppress root-knot nematodes in tomato. Biocontrol products are non-chemical alternatives that have shown to reduce root galling, egg masses, and overall nematode populations. However, their use can be limited due to their sensitivity to environmental conditions. Further, the suppressive effects of biocontrol agents may take longer to manifest when compared to those seen with traditional chemical control options.

References

1. Agarwal, S. and Rao, A.V. 2000. Tomato lycopene and its role in human health and chronic diseases. *Canadian Medical Association Journal*, **163**(6): 739-744.
2. Barber, C. A. 1901. A tea ell worm disease in South India. Dept. L and Record, Madras Agricultural Branch 2. Bull No. 45.
3. Kumar, V., Khan, R. M. and Walia, R. K. 2020. Crop loss estimations due to plant parasitic nematode in major crops in India. *National Academy Science Letters*.
4. John, D., Suthin, R. T., Usha, R. S. and Udhayakumar, R. 2010. Role of defense enzyme activity in tomato as induced by *Trichoderma virens* against Fusarium wilt caused by *Fusarium oxysporum f.sp lycopersici*. *Journal of Biopesticide*, **3**: 158-162.
5. Jones, J. T., Haegeman, A., Danchin, E. G. J., Gaur, H. S., Helder, J. and Jones, M. G. K. 2013. Review- top 10 plant-parasitic nematodes in molecular plant pathology. *Molecular Plant Pathology*, **1**:16.