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Meloidogyne Incognita: Management of Root-Knot Nematode in Vegetables

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ARTICLE ID: 062

Introduction

Root-knot nematodes (genus: *Meloidogyne*, Greek word means melon, apple or gourd-shaped female) are sedentary endoparasites of diverse crops. Root-knot nematodes are one of the five pathogens affecting world food production. Root-knot causes significant losses in vegetables, especially in crops grown under polyhouse condition, losses up to 30 % recorded in highly susceptible vegetable crops brinjal, tomato and melon by Sikora and Fernandez (2005). The root excludes from root-knot infected plants stimulate the entry of other soil born pathogen and increase the problem further leading to disease complex which includes dumping off in tomato with *M. incognita* and *Rhizoctonia solani* or *Pythium debaryanum* Bacterial wilt *Ralstonia* (Pseudomonas) *Solanacearum*, Fusarium wilt with *M. incognita and Fusarium oxysporum* f. sp. *Lycopersici*, Collar rot in brinjal with *M. incognita and Sclerotium rolfsii and* Wilt in Cauliflower with *M. incognita and Fusarium oxysporum* f. sp. *Conglutinans.*

Damage of root-knot nematodes can be identified by the presence of galls on plant roots, galls are formed as a result of physiological disturbances in the root tissues caused by the trophic interactions of female nematodes. *M. incognita* and *M. javanica* are two major species causing damage in India.

Nematode infestation is more severe in polyhouse as it provides optimal condition (moisture level below 40-60%) of field capacity for survival and locomotion. The use of drip irrigation in protected cultivation provides optimal moisture around the root zone which facilitates rapid movement of nematodes. The optimum temperature for nematode multiplication is 25-35° C which is available inside the protected structure during winters in north India when the outside temperature is relatively less. Nematodes need a suitable host

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and multiply and continue their life cycle, repetitive cultivation of single crop or other host crops increase nematode build in soil.

This article briefs various techniques used for the integrated management of root-knot nematodes.

Prevention of Nematode Introduction in The Field

Nematodes can move a small distance in the field in their life, in a healthy field they are introduced by farmers either with the use of the infected seed, seedling or other plant material or through irrigation water or machinery and tools from infected field. It is recommended to purchase seed and other planting material from authorised dealers after ensuring that planting material is not infected. Machinery should be cleaned after using from one field to other.

If a farmer is constructing a new polyhouse, it is recommended to construct in the land which was under vegetable cultivation as chances that land is already infected are very high, soil testing should be done to check the presence of root-knot nematodes in the soil.

Prevention of Secondary Infection

Once the nematodes are introduced in the field. They move from one part to other parts of the field by different means and it is important to control further spread of nematode from nematode infested field. Nematodes move with water droplets, so optimal irrigation is recommended, contaminated crop plant residue provides support to the nematode life cycle during the off-season, so after harvesting, plant residue needs to be removed and burned. A wide range of weeds also act as an alternative host for nematodes, weeds like *Amaranthus* spp, *Chenopodium album*, *Solanum nigrum*, *Tithonia rotundifoli*are alternative host for nematode, these weeds should be controlled during fellow.

Soil Management

Deep summer ploughing exposes nematode and infected soil tissues to solar heat and dehydration and reduces nematode infestation. Normal (10 cm) and deep ploughing (20 cm) in June followed by a fallow period of 2 months significantly reduces the nematode infestation.

Soil can also be covered with a mulching sheet on moist soil during a period of high ambient temperature, which kills the nematodes.

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Cropping Method

Nematode infestation is low when crop temperature is low, planting crops when the soil temperature is less can reduce nematode infestation. Some crops have chemicals that kills nematodes, crops like marigold have α – terthinyl and bithinyl compounds, allyl isothiocyanate in mustard kills nematodes, planting of these antagonistic crops can reduce infestation. These plants release root exodus which has nematicidal properties, planting of these crops as intercrop can also reduce the infestation. Crop rotation with a non-host crop like sesame, mustard, wheat, maize can reduce the nematode infestation due to the unavailability of the proper host, though it is difficult in polyhouse due to the low value of the non-host crop. In vegetable crops crop rotation with okra-cowpea-cabbage or okra-cucumber-mustard is recommended to reduce infestation. In potato, inter-cropping with onion and maize has been found to reduce galling due to *M. incognita*.

Highly suspectable trap crops can also be planted before the main crop for some time but removed by carefully planning before the nematode complete its life cycle so that the main crop can escape the nematode infestation.

Cover crops like *Crotalaria*, castor bean, velvet bean, jack bean, sorghum-Sudan, castor are non-host crops and supply the organic amendments, improve soil structure, protect the crop of soil erosion, suppress nematodes, weeds, insects, and improve the soil structure. As nematode can only move very short duration, planting cover crops in between the main crops can reduce the infestation

Resistant Varities

Nematode resistant are developed institutes, resistant varieties like SL-120, PNR-7, Hisar Lalit of tomato, Pusa Jwala, NP-46A, Mohini, Pusa Sadabahar, Guchheedar, Surajmukhi, Roshni, Brahmpur of chilli, Black beauty, Banaras Giant, Rajendra Baigan of brinjal, Kashi Jyoti of sponge guard, Kufri Swarna of potato, Arka Suraj on carrot are resistant varieties and can be grown in nematode infestation area to prevent damage of crop.

Biological Control

Different fungal and bacterial parasite feed or parasite the nematodes and release the secondary metabolites with nematicidal activity. The use of these can have a long-term effect on nematode control. *Arthrobotrys* spp. and *Monacrosporium* spp. are nematode-trapping fungi which trap nematodes by constricting rings and adhesive nets respectively; in certain

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soils it is effective. *Paecilomyces lilacinus* is commercially used as fungal bioagents, fungal hype of this fungi penetrates individual hyphae through egg cuticle and then eggs are engulfed with the mycelial network. It can control *M. javanica* and *M. incognita* population in tomato, brinjal and other vegetable crops. Filamentous fungi *Trichoderma* spp. (*Trichoderma viride* and *T. harzianum*) are commercially used for control of root-knot nematodes in vegetable crops. These fungi directly parasitise on the eggs through increasing extracellular chitinase activity and induce systemic resistance in plants.

Antagonistic bacteria can also be used for nematode control. *Pasteuria penetrans* is a gram-positive endospore-forming, obligate parasitic bacteria which attaches its adhesive endospores on second-stage juvenile's cuticle and utilizing resources for its growth by synchronizing its life cycle with nematode development and causing sterility in females by disrupting their reproduction. Plant growth-promoting rhizobacteria (PGPR) like *Pseudomonas fluorescens* and *Bacillus* spp produce an antibiotic DAPG (2, 4-diacetyl phloroglucinol) is responsible for high nematicidal action.

Application of these fungal and bacterial solutions during seed treatment, nursery and main field reduce nematode infestation. These bioagents are available in the market in different brand names like PAECILO®, MYSIS®, BIONICONEMA®, POWER ALL, BioAce®, Nemator® etc.

Organic Amendments

Organic amendments increase soil physical condition and biological activity, improves soil fertility, and recycle nutrients. It simulates the microbiological activities like nematode antagonists, predators, and parasites in the soil during decomposition, release nematicidal components and increase plant immunity. Various plant parts of neem like neem leaves, seed kernel, seed powders, seed extracts, oil and oilcake of neem are used as organic amendments. Castor cake, poultry manure, mustard cake, Goat manures etc can be used as an organic amendment to reduce the nematode infestation in the field

Chemical Control

Judicious or need-based application of nematicides is recommended in the case of highly susceptible crops and high-value cash crops or for early protection of tender stages.

Carbamate group chemicals, Carbofuran 3G and Carbosulfan 25 EC are used for nematode control. Other chemicals like NIMITZ from Adama India which is Fluensulfone 2 % Gr,

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Velum prime from Bayer crop science which is Fluopyrum 34.48% SC and NEMATHORIN® 150EC from Syngenta which is Fosthiazate can also be used for nematode control in their recommended doses.

Conclusion

Root-knot nematodes are a growing cause of concern for vegetables growers in India, especially in the production of crops under protected condition where one crops is grown repeatedly. *M. incognita* is one of the most frequently observed nematodes in vegetables growing areas and it is observed that, the above mentioned approaches are effective for the management of root-knot nematodes in protected condition as well as field condition in vegetables.