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Nematode Management in Protected Cultivation

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Nematodes are microscopic, worm-like animals but not true micro-organisms as they have all the systems that higher animals possess, except the circulatory and respiratory organs.

What Actually Nematodes Do In Plants?

- It is believed that the most dangerous nematodes are semi-endoparasitic and endoparasitic ones.
- When compared to the main roots, the feeder roots, or fine branches, are typically killed.
- Rather, the lack of nutrients causes the plants to become weak, stunted, and pale in appearance.
- On the other hand, they frequently make plants more susceptible to infection by harmful bacteria and fungus, which can result in extreme damage or death.
- The semi-endoparasitic and endoparasitic nematodes are considered most harmful
- They modify the conducting vessels (xylem and phloem cells) of plant tissues. They direct the flow of water and nutrients for their own feeding.

Nematode Management In Protected Cultivation

It is always better to prevent infection than to cure. To maintain Greenhouse clean, paths should be free of soil, organic matter, weeds, and algae, benches should be disinfected. Water sources should be pathogen-free and hose ends kept off the floor. Unhealthy plants and plant parts from the greenhouse have to be removed.

The first strategy includes the practices to prevent the introduction or entry of a PPN species inside the poly/greenhouse, and can be achieved by testing of soil sample prior building the "protected set-up" and avoiding heavily infested areas; monitoring and customization of the presence and prevalence of any particular nematode species that is dominant in the surrounding; restricted entry of farm implements and machineries that might be used in other nearby nematode infested fields.

Preparation of beds: Soil should be brought to a tilth and the land should be fully ploughed. Add 20 tons of FYM supplemented with biopesticides to the soil prior to preparing the beds in the polyhouse. It is necessary to bring the soil to a level surface before building raised beds. The size of the bed might vary depending on the needs and the type of crop being cultivated. Add fertilizer at the recommended dosages. Also add carbofuran or phorate @ 50g/sq.m + 200g neem/ pongamia/ mahua cake enriched by bio-pesticides per sq. m. Further incorporate bio-pesticide enriched FYM@ 2kg/sq. m or biopesticides enriched vermicompost

@ 500g/sq.m in top 18 cm of soil in the beds. Water the beds for 7-10 days for proper decomposition of these organic materials.

Process of Enrichment of FYM: 1 ton of Farm Yard Manure has to be enriched by mixing with 2 kg each of Pseudomonas luorescens + Trichoderma harzianum + Paecilomyces lilacinus. It has to be covered with mulch and optimum moisture of 25 - 30% has to be maintained for a period of 15 days.

Process of Enrichment of neem/ pongamia/ mahua cake: 1 ton of neem/ pongamia/ mahua cake has to be enriched by mixing with 2 kg of each of Pseudomonas luorescens + Trichoderma harzianum + Paecilomyces lilacinus. It has to be covered with mulch and optimum moisture of 25 - 30% has to be maintained for a period of 15 days. © Once in a week thoroughly mix the neem cake for maximum multiplication and homogenous spread of the microorganisms in the entire lot of neem cake.

Spraying: The organic formulation containing Pseudomonas fuorescens and Trichoderma harzianum has to be sprayed on the plants at regular intervals of 20 days at a dosage of 5g/ lit or 5ml/lit. Alternately, take 20 kg of neem/ pongamia/ mahua cake enriched in the above mentioned manner and mix it in 200 litres of water, leave it for a period of 2-3 days. Filter this suspension and use it for spraying by mixing 250ml of suspension in 1 lit. of water at regular interval of 20 days.

Summer Solarization: Every year, during peak summer (May-June), after the crop is over and removal of leftover roots is complete, the field should be ploughed thoroughly, leveled and watered lightly just to dampen the soil.

- The soil surface should be covered with thin (25 µm) transparent polythene sheet.The edges should be overlapped and sealed properly.
- The whole polyhouse should be sealed by dropping the polythene curtains on all sides.
- This practice can coincide with preparation of nursery in the meantime, besides preparing the multiplication of bio-agents outside.
- Soil solarization singly is so effective that if done meticulously, there may not be any necessity of using chemical pesticides

Organic Amendments Fortified With Bio-Agents

Successful management strategies of nematodes and other disease complex using bio-pesticides like Paecilomyces lilacinus, Pochonia chlamydosporia, Trichoderma harzianum, T. viride and Pseudomonas fluorescens. Shady, cool and covered place for stacking well rotten FYM or Vermicompost or both. One ton of FYM (one big tractor trolley) is sufficient for one- acre poly house. Procure bio-control agents like Trichoderma harzianum or T. viride and Pseudomonas fluorescens from a reliable source. The efficacy of bio-agents is important in terms of no. of propagules (CFU-Colony Forming Units) present per cc/g in the bio-agentculture being used for fortification of FYM. • Trichoderma harzianum or T. viride should have a minimum of 2x108 CFUs per cc, while P. fluorescens should contain 2x1012 CFU per cc.

organic matter: Soil enriched with organic matter include green manure, poultry and cattle manure, oilseed cake, defatted seed meal etc. elicit a suppressive effect on PPNs by

(i) improving the soil nutrient status that increase plant vigor and tolerance to PPN,
(ii) stimulating the nematode antagonistic microbial activity, and
(iii) releasing the toxic compounds during decomposition

Sanitation: PPN infestation has often been found to be closer to the entrance of protected structure and walk-in spaces along the crop rows. This usually results in PPN introduction to another protected site via contaminated farming tool, planting material, irrigation water, people etc. After harvesting of previous crop and prior to planting of next crop, tilling the soil using clean implements, shoes and tractor wheel is recommended.

Crop rotation: Considering that most of the major crops including cucumber, tomato and capsicum are susceptible to root-knot nematode infection, rotation among host crops is not a feasible approach in protected agriculture. Nevertheless, rotating crops with non-hosts or trap crops or antagonistic crops that fetch profit to grower can be an alternative. Marigold (*Tagetes* spp.) is an excellent choice as rotation crop because of its high antagonistic effect on different PPN genera and highly remunerative as a commercial flower crop. Marigold can also be used as an intercrop or cover crop. Short cycle susceptible crops, such as carrot, lettuce and radish can be used as trap crop for sedentary endoparasites, provided that they are uprooted prior the nematodes start reproducing, i.e., by 2–3 weeks of planting. A number of biofumigant crops such as Brassicas (e.g. cole crops, mustard, radish, rapeseed, turnip, salad rocket etc.), *Crotalaria*, sorghum and Sudan grass can also be used as cover crop or their chopped residue can be incorporated as green manure which resulted in the biocidal effect (alike of methyl bromide fumigant) on different PPN species.

Why Nematode Problems Flare-up in Polyhouses Nematodes

Basically Require Three Essential Conditions for Survival and Multiplication.

1. **Moisture**: Drip irrigation in polyhouses ensures availability of optimum moisture around the root zones continuously and this factor ensures their rapid movement favouring infection, as compared to open field conditions where irrigations are given after 15-20 days and moisture levels in rhizosphere vary from saturation to almost dry.
2. **Temperature**: Nematodes multiply optimally from 25-35° C, though they can reproduce from 15-40° C. Below 15 °C is not lethal for nematodes, but multiplication is temporarily arrested, and they can survive through cold spells. But temperatures higher than 45° C are lethal for nematodes. Compared to open field conditions, particularly in north India, the night temperature during winter remains high inside the polyhouses, so the nematode multiplication continues, while it is arrested in open field conditions. Nematodes are able to complete their life cycles within the shortest possible time (25- 30 days) inside the polyhouses compared to openfield conditions.
3. **Continuous Cultivation of Susceptible Hosts:** Intense and continuous cultivation with most susceptible hosts in the polyhouses ensures uninterrupted availability of food for nematodes. There is little choice for crop rotation with non-host crops in protected cultivation systems considering the market compulsions. Besides this, major polyhouse vegetable crops like tomato have longer duration as compared to open field which leads to more number of nematode generations.