Plant parasitic nematodes: a major stumbling block for successful crop cultivation under protected conditions in India*

Background

In India on an average, a national loss of Rs 21,068.73 million has been estimated due to plant parasitic nematodes[1]. The overall average annual yield loss in major horticultural crops due to nematodes goes up to 60% under protected cultivation[2]. Rapid spread of nematode infestation through soil, crop residues and indiscriminate use of agro chemicals in horticultural ecosystems is a major concern for crop protection specialists and policy makers.

Demand for high-quality export-oriented horticultural products and need for the availability of horticultural crop produce round the year, especially during off-season, compelled growers to cultivate select crops under protected cultivation in 1980s. As a result, cultivation of horticultural crops under protected conditions began in all Indian states. Soon nematode incidence under protected cultivation became severe and led to complete crop losses because of congenial conditions of higher temperature, humidity and use of high agronomic inputs like fertilizers and plant growth promoters in polyhouses. Symptoms such as chlorosis and stunting appear after sufficient damage is inflicted. The proliferation rates of nematodes in polyhouse cultivation reached up to 10–30-fold more than in the open field cultivation.

Farmers continue to incur losses in crops under protected cultivation without appropriate solutions to problems posed by nematodes. The population build-up is rapid in polyhouses and the nematode population reaches 5–6 times the threshold levels within 18–24 months, making polyhouse cultivation a wasteful exercise. In tomato, dynamics of root-knot nematode showed enhanced population build-up from 1 to 30 juveniles per g soil within a period of 6–12 months, which is comparatively higher in contrast to the open cultivation.

Crops such as capsicum (bell-pepper), tomato, chilli, okra, gherkins, muskmelon, watermelon, carnations, roses, gerbera and anthuriums are being grown under protected cultivation (in polyhouses/greenhouses/shade nets). These crops which are grown throughout India are seriously infested with nematodes such as *Meloidogyne incognita*, *Meloidogyne javanica* (root-knot nematodes) and *Rotylenchulus reniformis* (reniform nematode). Nematode problems on all these crops under protected conditions have assumed alarming proportions leading to huge losses (up to 80%) in select crops. The nematode infestations exacerbate severity of fungal diseases leading to complete crop losses.

M. incognita infection makes the plants highly susceptible to *Fusarium oxysporum* f.sp. *dianthi* attack[3]. *Phytophthora parasitica* + *M. incognita* interact to produce a disease complex in gerbera leading to reduction in the yield around 40–60% (ref. 4). In capsicum a pathogenic bacteria *Ralstonia solanacearum* gets entry into the roots infested by root-knot nematode and together they produce wilting disease that reduces yield to 60–70%.

Management practices adopted by farmers include continual use of chemical nematicides, often at higher than recommended rates resulting in the build-up of resistance. In addition, biomagnification and environment deterioration due to hazardous chemicals[5] have rendered several cultivated ecosystems unstable and non-profitable. In this context, ICAR-Indian Institute of Horticultural Research (IIHR), Bengaluru and All India Coordinated Research Project (AICRP-Nematodes) conducted a brainstorming session to discuss potential eco-friendly methods of nematode management under protected cultivation. Nematologists at IIHR standardized successful management strategies of nematodes and other disease complexes using biopesticides like *Paecilomyces lilacinus*, *Pochonia chlamydosporia*, *Trichoderma harzianum*, *Trichoderma viride* and *Pseudomonas fluorescens*. Farmers who adopted the IIHR technology reduced the use of agrochemicals to 40–45% and obtained 30–35% increased yields in capsicum, gerbera and carnations. IIHR wanted to showcase and disseminate these eco-friendly and sustainable technologies among other researchers, farmers, Krishi Vigyan Kendras, scientists, students, officials from the developmental departments and policy makers.

In his introductory remarks, R. K. Jain (Project Coordinator AICRP-Nematodes) emphasized the need to educate the polyhouse farmers about the prophylactic measures to be taken up before planting and the integrated management measures to overcome the nematode problem in polyhouses. Soil solarization and application of FYM enriched with *Trichoderma viride* have proved effective in protecting crops from soil-borne pathogens and nematodes across India.

Uma Rao (IARI, New Delhi) mentioned that scientists should explore the wild relatives for offering resistance to nematodes and understand the basic behaviour of nematodes and their host preferences. She reiterated the need for trained nematologists in the developing countries of Southeast Asia.

P. Parvata Reddy (IIHR) delivered the keynote address and stressed upon the importance of protected cultivation for increasing the productivity per unit area and the loss due to nematodes and associated disease complexes. He also elaborated on various physical, cultural, chemical and biological measures for integrated management of nematodes. He reiterated the need for the establishment of a Centre for Excellence in Nematology in India at the earliest.

N. G. Ravichandra (GKVK, Bengaluru) observed that Karnataka is the hotspot for root-knot nematodes, *M. incognita* in horticultural crops grown under protected conditions. He also spoke about the integrated management practices for reducing nematode infestation.

*A report on the one-day brainstorming session on 'Nematode problems under protected cultivation', held at the Indian Institute of Horticultural Research, Bengaluru, on 8 September 2014.

Several farmers from towns in the outskirts of Bengaluru, like Chikkaballapura, Doddaballapura, Malur and Hoskote opined that severe infestation by nematodes leaves the crops beyond recovery. Thus it is advisable to monitor the soil nematode population regularly, specially at the time of sowing and planting in polyhouses. Use of certain safe chemicals, bionematicides/biopesticides with organic materials such as vermicompost, FYM, neem/pongamia cakes during the nursery bed preparation was suggested.

H. S. Sidharth (Rijk Zwaan India Seeds Pvt Ltd) and personnel from several commercial nurseries felt that toxic chemicals should not be applied against nematodes under protected conditions, because it would wipe out soil beneficial flora and fauna. Use of safe chemicals and residue-free products is desired.

M. S. Rao (IIHR) presented a practical sustainable management of nematodes on vegetables (tomato, capsicum, gherkins) and flower crops (gerbera, carnation) through two videos prepared on the basis of demonstrations conducted in polyhouses. He emphasized on the treatment of seed (20 g biopesticide per kg seeds) and treatment of substrates with FYM, vermicompost, neem/pongamia cakes enriched with biopesticides (2 kg each of *Paecilomyces lilacinus*, *T. harzianum* and *Pseudomonas fluorescens* per 2000 kg of FYM/500 kg of vermicompost/200 kg of neem/pongamia cakes). These practices are effective in curbing the initial nematode population and ensure emergence of healthy seedlings. Advantage of organic substrates enriched with biopesticides over chemical practices is that the former enhances the colonization of bioagents, restricts the proliferation of nematode and soil pathogens and sustainably increase soil fertility.

Vishwanatha Reddy and Ravikumar (farmers) shared their success stories on management of nematodes in polyhouses by adopting the technologies developed by IIHR, in tomato, capsicum, gerbera and carnation.

In the plenary session senior nematologists, farmers, policy makers and commercial nursery personnel suggested that biointensive integrated approaches utilizing bioagents, endomycorrhizae, physical, cultural methods and resistant cultivars should form the main plan for nematode problems under protected cultivation.

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