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8. Integrated Nematode Management

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Abstract:

In agricultural and horticultural settings, worm infestations are managed using a multidimensional strategy called integrated nematode management (INM). Nematodes, tiny roundworms, can seriously harm crops, decreasing yields and having a negative impact on the economy. INM utilizes a number of techniques, including as cultural practices, biological management, chemical treatments, and resistant crop types, to efficiently manage nematode populations with the least amount of negative environmental impact. By limiting the use of chemical pesticides and maintaining the health of the soil, this holistic approach seeks to promote sustainable agriculture. The summary of INM in this article emphasizes its salient features, advantages, difficulties, and potential for future development.

Keywords:

Nematodes, INM, Sustainable agriculture, Crop protection, Cultural practices, biological control, Soil health, Pest management

8.1 Introduction:

Severe losses to vegetable, cereal, pulse, oilseed, and fruit crops are caused by phyto-nematodes, also known as threadworms, eelworms, or roundworms, which are concealed enemies of agri-horticultural crops (Sasser, 1989). They can be discovered all over the world in a variety of habitats. According to estimates, PPNs inflict damage ranging from $US80 billion (Nicol *et al*., 2011) to $US157 billion annually (Abad *et al*., 2008). Nematodes can reduce agricultural output more than other pathogens like fungi, bacteria, and viruses when they operate alone or in combination. *Meloidogyne, Rotylenchulus, Pratylenchus, Heterodera, Ditylenchus, Globodera, Tylenchulus, Xiphinema, Radopholus*, and *Helicotylenchus* are significant genera of plant-parasitic nematodes that harm several agri-horticultural crops. Nematode population density, soil fertility and moisture, crop vulnerability, and degree of damage are all factors that affect how severe the damage is (Sasser and Freckman, 1987).

Achieving good crop yields and crop quality requires integrated nematode management, which is crucial. The population of nematodes should be kept below the economic threshold level; hence producers are urged to apply several management measures. The odds of assault by plant-parasitic nematodes are higher in young, sensitive seedlings of various agri-horticultural crops than in mature plants, which are more tolerant to the parasites. Nematicides are therefore more dangerous to human health than other means of control, while also being the most effective way to control nematodes. Additionally, several of the efficient nematicides have been taken from the global market (Thomson, 1987; Khanna *et al*., 2021). However, fewer pesticides with nematicidal properties are currently accessible to farmers, and many of them are both expensive and unsustainable. As a result, they should be used sparingly to save money and utilize as little chemical as possible (Karuri, 2022). Nematicides can be used in a variety of methods, including seed treatment, seedling dip treatment, bare-root dip treatment, and nursery bed treatment, all of which have been demonstrated to be successful in preventing plant parasitic nematode attacks on early seedlings. Smith and Reynolds (1966) assert that the steps in this method are to 1) determine the presence of pathogenic nematodes in the field, 2) determine whether nematode population densities are high enough to result in economic losses, and 3) choose a successful management approach.

For adopting an integrated nematode management strategy, we have to take following points into consideration:

a. Environmental and health hazards should be minimized
b. Utilization of several compatible measures
c. Maximization of natural biotic and abiotic environmental resistance
d. Understanding and counteracting nematode survival strategies
e. Minimum use of drastic control measures
f. Increased reliance on location specific and resource compatible management strategy
g. Minimizing input costs in harmony with potential gains and
h. viii. Maximizing of profit to the growers.

Physical, Chemical, Cultural, Biological, Regulatory, Resistance, and INM are the various management techniques. We must, however, rigorously adhere to management strategies. Additionally, various nematode control techniques have either proven unsuccessful or unprofitable when used against plant-parasitic nematodes. Therefore, integrating several effective techniques may be a key to managing plant-parasitic nematode issues in various agri-horticultural crops (Prasad, 1977; Singh *et al*., 2019). In the INM project, cultural practices such fallowing, flooding, summer ploughing, timing of planting and sowing, irrigation, manuring and green manuring, cover crops, antagonistic crops, trap crops, and crop rotation are used. Genetic techniques for nematode population control include using several resistant crop cultivars that are now available (Golakiya and Delvadiya 2020). Physical approaches such as solar heat, steam, and hot water treatment are producing positive results in the INM programme, compared to biological ways such as the utilization of nematophagous fungus, parasitic bacteria, and predatory soil fauna (nematodes, mites, collembola, tardigrades, enchytreids). Neem, Mahua, and Karanj utilized as de-oiled seed cakes; leaves; and other botanical methods are regulating nematode populations while also being cost-effective (Yigezu Wendimu, 2021). These are also a source of compounds that are nematicidal to bacteria, anti-metabolites, steroids, etc.

The only long-term strategy for managing the root-knot nematode population, according to Tyler (1933), is the integration of two or more approaches in a comprehensive management programme. INM tactics, however, can be used both sequentially and concurrently. The first strategy integrates tactics from one season or year to the next and is especially pertinent to annual crop cycles (Reddy 2021). The second strategy involves using two or more techniques in tandem (Forghani and Hajihassani 2020). This strategy can be used to increase agricultural yield for both annual and perennial crops. Crop rotation and fallowing were the two techniques utilized by Kuhn (1881) to manage phytonematodes.

Nematologists and breeders have been transferring nematode resistance genes into cultivated species over the past few years using the traditional methods of plant breeding. For small-scale farmers, the most effective and affordable method of worm management is the use of resistant cultivars. It will offer an ever-more-important remedy for numerous phytonematode issues. This strategy will become more important when access to chemical nematicides is limited (Mittal *et al*., 2000; FAO, 2014).

A workable strategy to minimise the nematode population in vegetables is to employ deep summer ploughing during the summer at fortnightly intervals combined with the application of organic matter, followed by planting with nematode-free seedlings (Khan *et al*., 2020). The treatment of *R. reniformis* in brinjal has proven to be successful when *P. lilacinus* and carbofuran are combined at a rate of at least 1 kg a.i/ha. Therefore, using the resources at their disposal, farmers could combine resistant varieties, cultural, biological, and chemical approaches in a way that was appropriate for each crop farming system (Anita *et al*., (2011).

8.2 Conclusion:

The success of integrated nematode management depends on a solid knowledge base, a research foundation, the availability of information on nematodes, crop-related agronomic practises, and their interconnections. When various integrated nematode control strategies are created, they should, however, be implemented in farmer's fields. These activities must be carried out by scientists or trained technicians who can effectively communicate with farmers to control phytonematode populations and increase crop output Prasad *et al.* (1977). NGO and FPO participation in the integrated pest control strategy, however, will unquestionably lead to sustainable agriculture and efficient phytonematode management.

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