Nematodes as an enemy and friend in coconut based cropping system

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Introduction

The term 'nematode' is derived from the Greek word 'nema-oides' which means "thread-like" and they are also known as thread worms. Nematodes are numerically the most abundant metazoans on earth and second only to insects, in terms of species diversity and abundance. They are observed to inhabit in all types of niches and majority of them are non parasitic which feeds on microorganisms. However, there are many groups of nematodes which parasitize plants, animals and human beings. Some even cause diseases to human beings.

Most of the plant parasitic nematodes are microscopic with a body length of less than one mm and majority of them are soil inhabiting which attack the root system. Nematodes need a thin film of water and make their way through pore spaces of the soil. Juveniles and adult males are always slender worms, where as adult females of some species like root-knot and cyst nematodes, expand their bodies and become nearly spherical.

In India, plant parasitic nematodes are estimated to cause crop loss worth Rs. 102 billion annually which is about 20.4% of the total loss due to pest and diseases together. Root knot nematodes alone are responsible for 75.8% of this total estimated loss. The losses due to nematode infestation were comparatively higher in horticultural crops (23.0%) than the field crops (18.2%).

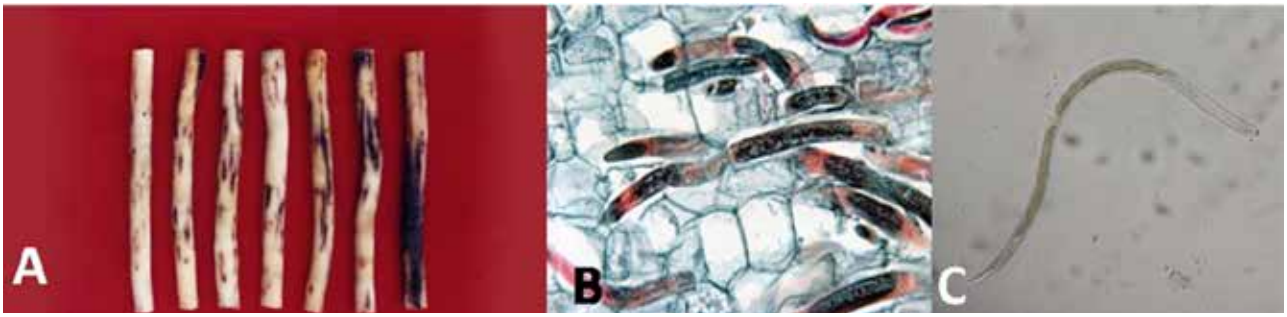

Fig 1: A- Burrowing nematode infestation in coconut root;
B- Burrowing nematode inside coconut root;
C- Adult female of burrowing nematode

Importance of plant parasitic nematodes in coconut ecosystem

The maximization of farm income from coconut based cropping system is possible only through judicious inclusion of various crops like vegetables, fruit crops, spices, tuber crops etc. in the interspaces of coconut garden. The incidence of various biotic stresses like pests and diseases are the major limiting factor in this system. Among them, plant parasitic nematodes are observed to be a major threat to most of the intercrops in the coconut system. This is serious especially in the coastal sandy belts, where the nematodes are abundantly prevalent.

Many are unaware about the relevance of nematodes as they are microscopic, not visible to the naked eye and produce non specific above ground symptoms in the affected plants. Therefore, the crop losses due to plant parasitic nematode infestations are mostly misinterpreted as due to other pests or diseases. It is a silent killer of plant health and affects yield considerably in a concealed manner.

Root infestation of plant parasitic nematodes severely affect the water and nutrient uptake of the plants, which lead to crop loss. As they are obligate parasites and the survival of the host plant is essential for their own existence, plant parasitic nematodes rarely kill their host plant but severely affect the quality and quantity of the economic produce.

Burrowing nematodes (Radopholus similis), Root knot nematodes (Meloidogyne spp.) and lesions nematodes (Pratylenchus spp.) are the most important plant parasitic nematodes which are widely distributed in the coconut based cropping system. Both burrowing and lesion nematodes are migratory endoparasites, which feeds by making burrows in the roots, which lead to the development of lesions and severe rotting of the root system. Root knot nematodes are sedentary endoparasites, which forms galls in the roots or underground root or stem tubers.

Burrowing nematode (*Radopholus similis*)

The burrowing nematode occurs in tropical and subtropical areas of the world and has been reported from coconut palms in Florida, Jamaica, Sri Lanka and India. The burrowing nematode causes non-specific general decline symptoms such as stunting, yellowing, reduction in number and size of leaves and leaflets, delay in flowering, button shedding and reduced yield. They are migratory endoparasites, develop and reproduces inside the roots of coconut seedlings. Their infestation produces small, elongate, orange-colored lesions on tender creamy-white roots. Consequent to nematode parasitization and multiplication, these lesions enlarge and coalesce to cause extensive rotting of the roots. Their impact will be more severe on the seedlings as the infected roots impairs the nutrient uptake potential and leads to production of weaker seedlings in nursery.

Burrowing nematodes also infest intercrops like black pepper, banana, betelvine, ginger, turmeric etc. Burrowing nematode is the causative agent of the slow decline disease of black pepper. The disease is initially manifested as the appearance of few pale yellow drooping leaves. Gradually the number of such leaves increases and within a year or two, the entire foliage becomes yellow which is followed by leaf shedding and appearance of dieback symptoms.

The burrowing nematode infestation in ginger and turmeric result in stunted growth, reduction in vigor, reduced tillering, early drying and maturity. The topmost leaves become chlorotic with scorched tips. Infested turmeric rhizomes tend to lose their

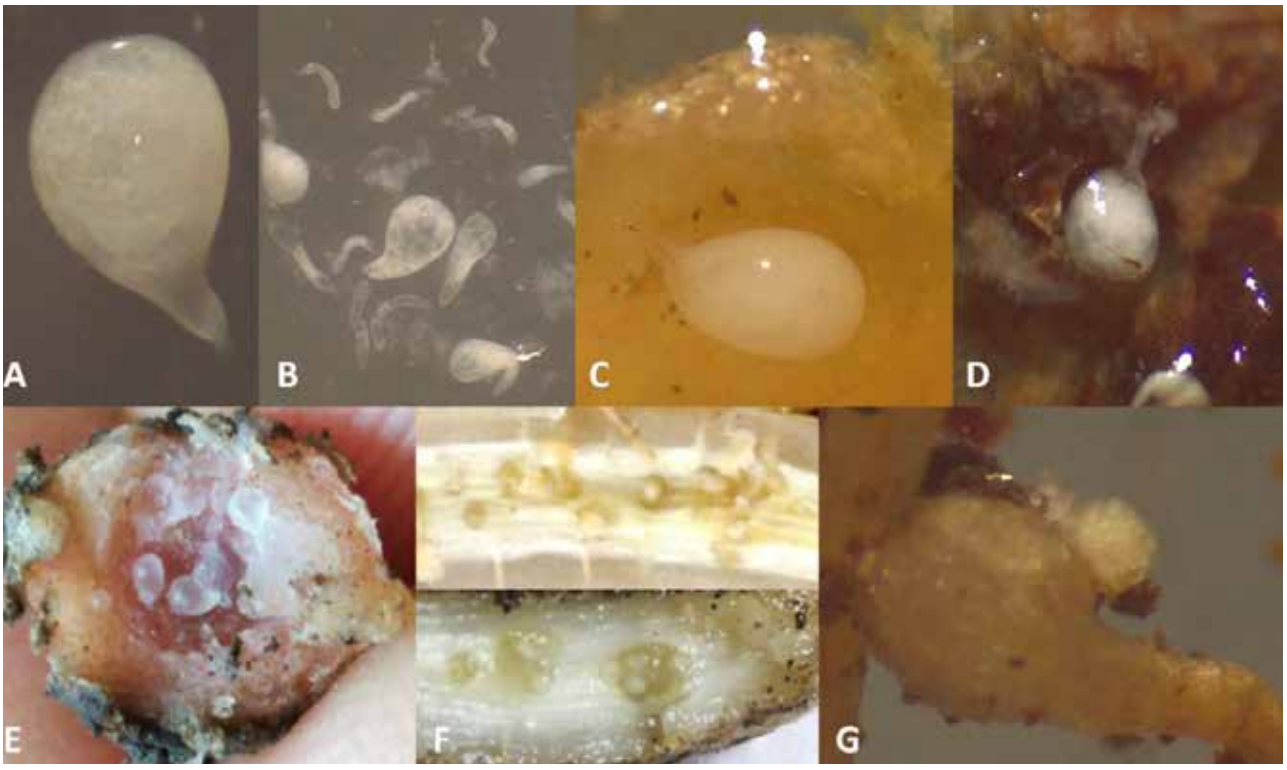

Fig 2: A- Adult female of RKN; B- Develpmental stages of RKN; C- Adult female inside turmeric root; D- Adult female inside guava root; E- Adult females inside amorphophallus; F- Adult females and egg masses inside ginger root; G- Gall with egg mass on the feeder root of papaya.

Fig 3: Symptoms of Root knot nematode infestation. A- Turmeric; B- Ginger; C- Carrot; D- Alternanthera (weed).

characteristic bright yellow colour and show brown rotting.

The burrowing nematode infestation result in the toppling disease in banana. The nematode induces reddish brown cortical lesions on the roots and corms. The root and rhizome necrosis is manifested as stunted growth, yellowing and falling of mature plants.

Root knot nematode (Meloidogyne spp.)

Root knot nematodes (RKN) are the most economically important plant parasitic nematode with a broad host range including weeds. They are obligate endoparasites with sedentary nature causing severe economic damage to a wide range of crops.

Their damage is observed to be very severe in almost all intercrops of coconut especially in the light textured soils. The infested roots become distorted and develop rounded or irregular galls, which are manifested as severe stunting and yellowing of the foliage. During many occassions times these galls coalesce together and cause extensive distortion of the roots or the affected tubers. The RKN infestation also aggravates the effect of many pathogenic bacteria and fungi.

Root knot nematode infested ginger and turmeric show stunting, chlorosis and marginal necrosis of leaves. Roots exhibit galling as well as bulging, which leads to the rotting of the roots and rhizomes. When the infested roots split open, presence of many adult females, egg masses with hundreds of eggs will be seen.

In vegetables and fruit crops RKN induce characteristic galls with varying sizes in the root system. In amorphophallus, RKN attack the corms where they develop rounded galls on the entire

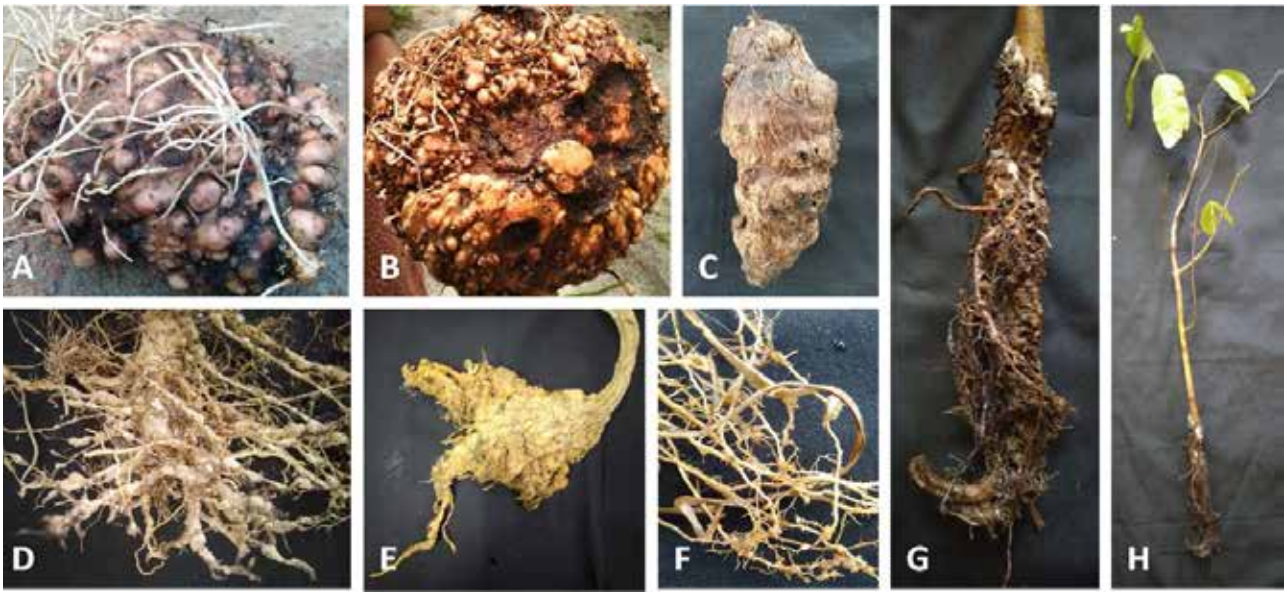

Fig 4: A & B- Root knot nematode infestation in amorphophallus; C- RKN infestation in colocasia; D- RKN infestation in okra; E- RKN infestation in bitter gourd; F- RKN infestation in little millet; G & H- RKN infestation in guava.

surface of the corm. The presence of many adult females along with different developmental stages of the nematode and egg masses in every galls is a characteristic feature.

Spread of Plant parasitic nematodes

Plant parasitic nematodes are able to move to very few distances as their own and the active dispersal is limited to few centimeters. Therefore the long distance spread takes place passively by the wrong cultivation practices like use of infested seeds, seedlings, rhizomes and rooted cuttings of different plants. They are also spread through soil particles adhering to agricultural tools and implements and through the irrigation water.

Diagnosis

The above ground symptoms induced by the infestation of plant parasitic nematodes are confused with the symptoms caused by other soil pathogens or as nutrient deficiencies. Therefore, when a farmer encounters plants that are stunted, chlorotic or yielding poorly, he may take soil and root samples and send to an approved nematology laboratory. The soil samples should be moist and collected from the root zone of the crop, where active roots are present. Collect several samples from the suspected plants and mixed together and take a 200 g representative sample, put in a polythene bag, tie it, label properly, keep away from the direct sun light and send immediately to the approved nematology laboratory. The infestation of nematode at the farmer level can also be confirmed by the characteristic symptoms on the roots or tubers as shown in the figures 1, 3 and 4.

Management

Coconut

1. Care must be taken to ensure the seedlings are free from nematode infestation at the time of transplanting. Remove old roots of coconut seedlings showing the characteristic symptoms of burrowing nematode infestation.

2. Avoid planting of preferable hosts like banana or black pepper near the coconut nursery. Planting of marigold along the borders and interspaces can act as antagonistic crop and reduce the nematode population.

3. Application of neem cake @ 1 kg / sq. m. area of nursery bed at the time of preparation of coconut nursery bed is effective for nematode management.

4. In order to avoid the buildup of the nematode population it is advisable to change the nursery site every year.

Intercrops

1. Use planting materials free from nematode infestation. Care must be taken to remove any roots

Fig 5: A- Cadaver of greater wax moth larva killed by Heterorhabditis sp.; B– Infective juveniles of EPN; C- Cadaver of greater wax moth larva killed by Steinernema sp.; D- Cadaver of red palm weevil grub killed by Steinernema sp.

showing the characteristic symptoms of nematode infestation and soil particles adhering to the planting materials.

2. Infested roots harbor thousands of egg masses of the nematode, which can lead to the huge economic loss to the subsequent crop. Therefore, it is very crucial to remove and destroy all the plant debris including the entire root system after each harvest.

3. Deep summer ploughing once in two weeks followed by fallowing will help in exposure of nematodes hiding in the deep soil layers to scorching sun light and considerable reduction in the population.

4. Soil solarization is the passive heating of moist soil covered with a plastic mulch. Soil solarization during the hottest part of the year by using transparent plastic mulch over the moist soil for a period of three weeks will result in the destruction of nematodes.

5. Growing cowpea and soil incorporation after 30 to 40 days will act as a trap crop for root knot nematode besides improving the fertility status of the soil.

6. Application of green leaf manures and organic amendments to improve organic status of the soil and thereby improving the soil antagonistic activity.

7. Liming, application of recommended dose of fertilizers, adoption of proper drainage and irrigation facilities will induce plants to tolerate nematode infestation to greater extent.

8. Crop rotation by including different types of crops in order to avoid population build up of the nematode. Growing antagonistic crops like marigold in the borders and interspaces will help in reduction of nematode population.

9. Soil application of biocontrol agents like Trichoderma, Pochonia, Paecilomyces etc. enriched in the neem cake and vermicompost or dried farmyard manure is effective for the management of plant parasitic nematodes.

Nematode as a friend: Nematodes for the management of insect pests of coconut

Entomopathogenic nematodes (EPN) belonging to families *Steinernematidae* and *Heterorhabditidae* are soil inhabiting insect pathogens. These nematodes, working with their symbiotic bacteria (*Xenorhabdus* for *steinernematids* and *Photorhabdus* for *heterorhabditids*), kill insects within 24 to 48 hours. They are safe for the plant health, human health, soil and the environment. There is a huge potential for the utilization of these biological control agents for the management of many coconut pests like white grub, rhinoceros beetle, red palm weevil etc.

Use of EPN in coconut pest management is gaining importance due to environmental safety and associated long term pest suppression. Different formulations such as EPN in suspension, cadaver etc. are being attempted for pest suppression.

Conclusion

Nematodes are ubiquitous and present everywhere and majority of them are free living but many are parasitic or pathogenic. Plant parasitic nematodes are widespread in the coconut ecosystem and symptoms are visible only when the population exceeds a particular level. Even at very low population levels, their feeding invites many pathogenic fungi and bacteria and the host plant/crop become susceptible to many diseases. By careful adoption of management practices the population build up of nematodes can be checked and there by protect the crop from the nematodes as well as from other pests and diseases to a greater extent. Entomopathogenic nematodes are promising biocontrol agents which possess great potential to be used against insect pests of coconut and its intercrops. ■