AgriCos e-Newsletter
ISSN: 2582-7049
AgriCos e-Newsletter
Open Access Multidisciplinary Monthly Online Magazine
Volume: 03 Issue: 05 May 2022 Article No: 26

Bioagents for Management of Plant Parasitic Nematodes

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SUMMARY

Plant parasitic nematodes are important pests causing economically high yield losses in plants cultivated worldwide. Plant parasitic nematodes damage the host plant by causing wounds on the plant roots and some microbial diseases, forming brown spots on the root and swelling or rotting of the tubers on the above ground parts of the plant. In agricultural areas, nematicides are often used to prevent the damage of these nematodes. However, alternative methods have been preferred in recent years because the nematicide types used are expensive and lead to adverse effects on the environment or nontarget organisms. The most important of these methods is the use of bio control agents.

INTRODUCTION

Plant parasitic nematodes live in the soil and feed on the root system and damage the root system thoroughly. Besides damaging directly, plant parasitic nematodes also can enhance damage caused by other soil borne fungal and bacterial pathogens. Crops are susceptible to several species of plant parasitic nematodes. Root-knot nematodes (*Meloidogyne* spp.), foliar nematodes (*Aphelenchoides* spp.), root-lesion nematodes (*Pratylenchus* spp.) reniform nematodes (*Rotylenchulus* spp.) and other ectoparasitic nematodes can limit quality and quantity of crops. Plant parasitic nematodes cause serious crop losses worldwide and are among the most important agricultural pests (Koenning *et al.*, 1999). The management of nematodes is more difficult than that of other pests because nematodes mostly inhabit the soil and usually attack the underground parts of the plants (Stirling, 1991). Although chemical nematicides are effective, easy to apply, and show rapid effects, they have begun to be withdrawn from the market in some developed countries owing to concerns about public health and environmental safety (Schneider *et al.*, 2003). The search for novel, environmentally friendly alternatives with which to manage plant-parasitic nematode populations has therefore become increasingly important. Nematodes in soil are subject to infections by bacteria and fungi. This creates the possibility of using soil microorganisms to control plant-parasitic nematodes (Mankau, 1980; Jatala, 1986).

Nature of damage caused by plant parasitic nematodes

Above ground symptoms of nematode infected plant exhibits various degree of stunting, chlorosis (yellowing) and tend to wilt under dry conditions. Nematodes are usually first detected in localized areas within a field. Gradually, the area of infected plants expands in size and the entire planting can eventually affected. Infection can reduce crop yeild and quality.

Below ground symptoms of root-knot nematodes include formation of distinctive swelling called root galls (root knots) on the roots of affected plants. Root-knot galls may vary in size and shape. On heavy infected plants, galls tend to fuse together so that large areas or entire root may be swollen. Root injuries from other nematodes include root necrosis resulting in severe root pruning and subsequent dwarfing of plants. Fibrous or feeder roots are mostly attacked which may reduce the absorption ability of plants and other physiological functions of the plant. Root growth slows and secondary root development is limited.

Fungal bioagents

Fungi naturally exist that have an antagonistic action against the nematodes in general, more precisely *Meloidogyne* spp. The infection process is generally the same: cuticle penetration, immobilization, invasion and digestion of the nematode. The nematodes cuticles and egg walls play an important role in the infestation by fungi. The cuticle is essentially made of proteins (chitin, collagen, fibers) and can play the role of a precursor in the invasion of the nematodes by nematophagous fungi**.** Whatever the mode of action of the fungus, predation or parasitism, the interaction between a fungus and a host organism or prey requires penetration of the outer shell of the body. This penetration occurs before the colonization of the internal structures of the body through digestion, allowing the fungus to meet its nutritional needs.

Paecilomyces lilacinus

- The egg-pathogenic fungus *Paecilomyces lilacinus* is one of the most widely tested soil Hyphomycetes for the biological control of plant parasitic nematodes.

Pachonia chlaydosporium

- Soil borne fungus
- Colonize on plant roots or confined to rhizoplane
- Parasitic on nematodes egg
- Produce toxins that inhibit hatching or kill eggs of nematodes
- Parasite of female root-knot nematodes

Trichoderma viride and Trichoderma harzianum

- Active rhizosphere colonizers
- Compete for nutrients
- Produce antibiotics that affect nematodes

Bacterial bioagents

Antagonistic interactions between bacteria and PPNs can be developed by more than one mode of action. The effect of bacteria on PPNs can be direct and indirect. Direct modes of action are colonization, parasitism and antibiosis (production of lytic enzymes, antibiotics, toxins, VOC (volatile organic compounds)). Indirect mechanisms include ISR, food supply for bacterivorous organisms (protozoa, nematodes), production of siderophores, hormones, phosphate solubilization, nitrogen fixation, transformation of bacterial microbiome etc. following are the examples of bacterial bioagents,

Pseudomonas fluorescens and Bacillus subtilis

- Colonize on roots and exclude nematode niche
- Produce antibiotic compounds
- Induce systemic resistance in plant

Pasteuria penetrans

- Nematode antagonists and endospore-forming bacteria
- Obligate parasites of plant-parasitic nematodes
- Endo-parasite, reduce infectivity and also fecundity of nematodes

Advantage of using bio-control agents

- Cost effective, reusable, farmer & eco-friendly products
- Inherently harmless in comparison with chemical pesticides
- As a component of IPM, can greatly decrease the use of chemical pesticides
- Increase the yield of the crop & lead to sustainable productivity in a long run
- They have specific mode of action on pathogens
- Helps in developing disease suppressive soils

How to enhance biological suppressiveness

- Incorporation of crop residues in the soil
- Addition of organic amendment such as manures and compost
  - Stimulate natural antagonist/ natural enemies of plant parasitic nematodes
  - It improves soil nutrients, soil physical conditions, and crop health

CONCLUSION

Nematode management with nematicides in farmer's field has limitations due to higher cost and difficulties in applying them in fields. Moreover, chemical applications cause hazards to the environment. Therefore, safe alternate methods for managing plant parasitic nematodes in field are critically needed for the

development of sustainable cropping systems. A promising alternative is the use of microbial antagonists against plant parasitic nematodes which are ecofriendly and economically feasible approaches and does not allow the nematodes to develop into new races or biotypes. Considering that microbial communities suppress nematode populations and determine soil suppressiveness application of biocontrol agents, natural inhabitants of an ecosystem, can allow the reduction of the use of synthetic pesticides and stabilize ecological changes.

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