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Trichoderma spp. as a Biocontrol Agent of Root Knot Nematode

Jisna George[1] and Nangki Tagi[2]
[1]Ph.D. Research Scholar, Department of Nematology College of Agriculture, Assam Agricultural University, Jorhat, Assam
[2]Ph.D Research Scholar, Department of Nematology College of Agriculture, Assam Agricultural University, Jorhat, Assam

SUMMARY

Agriculture is an essential global activity because it guarantees food security and provides a source of income for many families, particularly in developing nations. Farmers have increased crop output land to satisfy the rising demand for food and avoid a food shortfall as the global population continues to expand. Despite this, farmers are still harvesting smaller yields than expected, endangering global food security. Pests and illnesses, as well as obsolete and poor farming practises, have resulted in lower yields. Diseases are a major cause of lower crop yields around the world. Diseases are caused by both biotic and abiotic sources. Root knot nematodes, commonly known as *Meloidogyne* spp., are plant-parasitic nematodes that inflict enormous costs to farmers in terms of yield and quality. *Meloidogyne incognita, Meloidogyne arenaria, Meloidogyne javanica,* and *Meloidogyne hapla* are the most common root-knot nematodes found. Several investigations on the effectiveness of *Trichoderma* spp. fungi as a biocontrol agent for various infections have been undertaken throughout the years. Biological control with microbial antagonists has been emerged as a promising and eco-friendly treatment to control pathogens.

INTRODUCTION

Root knot nematode (RKN) is one of the world's most dangerous plant-parasitic nematodes, endangering the growth and production of over 5500 species, including vegetables and weeds. Chemical and physical methods are currently ineffective in the treatment of RKN illness. Furthermore, nematicides cause major environmental issues. So, safe and effective management measures for root knot nematodes are required. *Trichoderma* spp., a free-living soil fungus, may be a biological control agent for plant-parasitic nematodes. Trichoderma species are parasitic on several soil-borne and foliar plant diseases, according to their hostile behaviour. Recent research has revealed that this fungus not only functions as a biocontrol agent, but also boosts plant resistance, growth, and development, resulting in increased crop yield. Sedentary endoparasitic nematodes are the most successful plant-parasitic nematode species. These nematodes develop a permanent feeding site within the host's roots, where they acquire nutrients while finishing their lifetime. Wheat, finger millet, rice, maize, potato, and sweet potato are among the crops impacted by these worms. *Meloidogyne* spp. is found all over the world. There are over 100 species in this genus. *M. javanica, M. halpa, M. graminicola, M. chitwodii, M. arenaria,* and *M. incognita* are among the species that inflict the most severe crop damage.

Symptoms of a root knot nematode infestation

RKNs cause symptoms in plants both above and below ground. Yellowing of leaves, patchy fields, and stunted growth are aboveground indications of nematode infestation, whereas galled, swollen, or deformed roots, reduced root volume, and stunted root growth are below ground symptoms. Galls (root knots) can be as little as a pinhead or as large as 25 mm in diameter. Root knot nematode infestation causes wilting in leaves, galling, swelling, distortion, or reduced volume in roots, and dwarfing or wilting of the entire plant, depending on the plant parts affected.

Trichoderma spp.

Trichoderma can be isolated from rotting wood, soil, and other organic plant materials. Because there is no known sexual (haploid) stage, the fungus is classified as imperfect fungi by scientists (Howell, 2003). Conidiospores are produced by the fungi and are used for asexual reproduction. The fungi grow quickly in culture and produce a large number of spores with various shades of green at maturity. *Trichoderma* spp. appears uncoloured, yellow, yellow-green, or amber on the back side of a culture plate (Howell, 2003). The biological control and plant promotion properties of several strains in this genus have piqued scientists' curiosity, resulting in a slew of studies since their discovery.

Plant pathogenic microorganisms are considerably suppressed by *Trichoderma* spp., and plant growth is regulated. Recent research has demonstrated that *Trichoderma* spp. can prevent common plant diseases such root rot, damping off, wilt, fruit rot, and other plant diseases. Trichoderma contains a number of methods that are beneficial to plants, including improving plant growth, increasing mineral nutrient solubilisation, inducing secondary metabolite production, producing growth regulating chemicals, stimulating plant defence, and producing siderophores.

***Trichoderma* spp. as a root knot nematode biocontrol agent**

Previous research has shown that *Trichoderma* spp., such as *T. atroviride, T. viride, T. asperellum,* and *T. harzianum,* are effective biocontrol agents for root knot nematode. When growing plants vulnerable to root knot nematodes, usage of *Trichoderma* spp. minimises the production of root galls and enhances plant tolerance and growth. *Trichoderma* spp. generates conidia, which attach to various worm stages, via extremely branching conidiophores. The attachment and parasitic activity of these conidia are determined by the Trichoderma species and strain; nonetheless, successful parasitism of root knot nematodes at any stage necessitates mechanisms that allow hostile Trichoderma to penetrate pathogen eggs and cuticles. Appressoria is formed as a result of fungal coiling. Further research indicates that lytic enzymes produced by *Trichoderma* spp., such as 1, 3-glucanase, chitinase, protease, and lipase, has a role in *Meloidogyne* spp. parasitism (Mukhtar *et. al*, 2018; Sayed *et. al*, 2019). Apart from direct antagonism, *Trichoderma* spp. use a variety of strategies to suppress *Meloidogyne* spp., including induced plant resistance and the fungal metabolites mentioned earlier. *Trichoderma* spp. modulated the host plant's hormone-signaling network for induction of nematode resistance, and researchers discovered that plant roots colonised by the fungi inhibited RKN development locally and systematically (Martinez *et. al*, 2013).The impediment occurred at many stages, including reproductive, gall formation, and gall formation. The fungus achieved this by stimulating salicyclic acid regulated defences, which inhibit J2s from invading the roots (Molinari *et. al*, 2019). They also increased jasmonic acid controlled plant defences, preventing nematodes from disrupting jasmonic acid dependent immune responses, which hampered the establishment of root galls and female fertility (Molinari *et. al*, 2019).

CONCLUSION

Plant parasitic nematodes, particularly root knot nematodes, are causing enormous losses to farmers growing a variety of crops. Because root knot nematodes are polyphagous and can generate dauer stages, which allow them to persist in the soil for lengthy periods of time until they find a susceptible host plant, controlling them is usually challenging. Biocontrol agents such as *Trichoderma* spp. fungus, on the other hand, provide long term and effective remedies to RKNs. Furthermore, the fungus boosts plant development in the plants they colonise, resulting in a beneficial twofold impact. However, understanding the mechanisms of action of the various Trichoderma fungus is critical for effective application. Overall, farmers and researchers should apply *Trichoderma* spp. to the soil before planting to support the appropriate establishment of the fungi on the plant rhizosphere, which is critical for root knot nematode management and control.

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