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Methylobacterium and its bioactive compounds as a biocontrol against guava root knot nematode

Poorniammal, R[1] and S.Prabhu[2]
Dept of Agrl.Microbiology[1], Dept of Plant Nematology[2],
Tamil Nadu Agricultural University
Coimbatore-3

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Root-knot nematodes (RKNs) are responsible for enormous global economic losses in fruits, vegetables and cereals. Biological control of RKNs could provide a long-term substitute for chemical control techniques. Methylobacterium have been shown to fix nitrogen, In addition to producing cytokinins, auxins, and inducible systemic resistance enzymes like pectinase and cellulase. These compounds can support plant growth in a number of ways. Furthermore, because Methylobacterium can break down harmful substances and increase plant resistance to toxins, they can be utilised to lessen environmental pollution. These characteristics have led to a great deal of research on Methylobacterium in agricultural systems. Here, in order to provide theoretical support for the use of Methylobacterium as a biocontrol agent in field production, the biocontrol potential of the bacteria and its active compounds against RKN *Meloidogyne* sp. Methylobacterium may be employed as a biocontrol agent against M. incognita and *M. enterolobii* due to its various defence mechanisms against RKNs.

Keywords: Methylobacterium ; Biocontrol; *M. enterolobii*

Introduction

Meloidogyne enterolobii, also referred to as the guava root-knot nematode, is dangerous because of its wide host range and widespread distribution. Given its ability to emerge and reproduce in plants resistant to other tropical root-knot nematodes (RKNs), this species is acknowledged as the most virulent RKN species. Through the production of numerous root galls, they cause chlorosis, stunting, and reductions in yield in host plants. Farmers find it very difficult to diagnose because the symptoms are similar to malnutrition. It has recently been determined that this pathogen poses a serious global threat to agricultural productivity. Because of the similarities between *M. enterolobii* and other RKN species, diagnosing one can be especially difficult.

Although synthetic chemicals have been employed to manage nematodes, they pose a significant risk to human health and the environment. Due to the fact that several nematicide compounds are carcinogenic, the majority of them—including methyl bromide, dibromochloropropane, and ethylene dibromide (EDB)—have been taken off the market Researchers trying to solve this difficult issue are now focusing mostly on plant resistance, crop rotation, bio-control, and cultural practices. Because bio-control leaves no residue, it is safer and more environmentally friendly than chemicals (Sikandar et al., 2023).

Symptoms

M. enterolobii infections affect plants' ability to withstand a variety of abiotic stresses, as well as their growth and lifespan. Reduced yield quality and quantity are typical effects of *M. enterolobii*. While symptoms below the ground, like root galls, can be significant in size and quantity, above-ground symptoms include leaf yellowing, wilting, and stunted growth. Plants infected with *M. enterolobii* are more susceptible to secondary plant infections, such as *Fusarium solani* parasitizing guava following infestation.

Biocontrol of Guava root knot nematode

For ecological balance and safety, biological control using microbial antagonists (fungi and bacteria) has drawn a lot of attention as a viable and safe alternative to controlling plant-parasitic nematodes (Riascos-Ortiz et al., 2022). Meloidogyne species' eggs, juveniles, and adults have been shown to be susceptible to nematicidal action by *Bacillus firmus*, *B. firmus*, *B. amyloliquefaciens*, *B. subtilis*, *Burkholderia* spp., *Microbacterium* spp., *Paenibacillus* spp., *Pseudomonas* spp., *Serratia* spp., *Sinorhizobium* spp., and *Streptomyces* spp.

The two species that are most effective at biocontrolling *M. enterolobii* are *Purpureocillium lilacinum* and *Pochonia chlamydosporia* . Further research on the effectiveness and broad-spectrum action, enhancing growth conditions, and sustainability of beneficial antagonistic bacteria or fungi for their marketing and use in IDM is needed to control *M. enterolobii*. Arbuscular mycorrhizal fungi (AMF) and plants have a mutualistic, symbiotic partnership. Thus, they modify the structure of roots, thereby enhancing plant tolerance, modifying rhizosphere interactions, restricting the amount of space and food available to plant-parasitic nematodes within the root, and triggering systemic resistance (ISR).

Methylobacterium as a biocontrol against plant pathogens

Methylobacterium is a genus of bacteria that is pink-pigmented and facultative methylotrophic (PPFM). These bacteria can grow on reduced organic compounds that contain one carbon (C1), like methanol and methylamine, and they can also synthesise carotenoids. These bacteria can colonise a variety of environments, including soil, water, and sediment, as well as a variety of host plants as endophytes and epiphytes, because of their high phenotypic plasticity. Plant genotype and interactions with other related microorganisms may affect the frequency and distribution of plant colonisation, which may increase plant fitness.

This genus is made up of rod-shaped, strictly aerobic, gram-negative bacteria that are generally pink in colour due to carotenoid synthesis, and that can grow on monocarbon (C1) compounds like methanol and methylamine. Hence, the term "pink-pigmented facultative methylotrophs" (PPFMs) is used to describe these bacteria. The primary feature of this group is its capacity to use the enzyme methanol dehydrogenase (MDH) to oxidise methanol. The large subunit of this enzyme, which is essential for methylotrophic metabolism and is studied in relation to that class of bacteria, is encoded by the mxaF gene (Dourado et al., 2015).

Methylobacterium species are among the endophytes that can defend host plants through nutrient competition with pathogens, the synthesis of a wide range of antimicrobial molecules or the induction of systemic resistance (also known as induced systemic resistance, or ISR). ISR can be triggered by the volatile organic compounds that certain bacteria release as well as by the genes of bacteria that encode enzymes that break down plant cell walls, like pectinase, glycosidases, cellulases (or endoglucanase) and hemicellulases . It has also been documented that this mechanism (ISR) promotes plant growth and shields plants from infections.

Methylobacterium as a biocontrol against nematodes

Methylrubrum rhodesianum M520 *In vitro* experiments revealed that *M. incognita* second-stage juveniles were 91.9% dead in the presence of strain M520, and that *M. incognita* eggs hatched at a rate that was 21.7% lower than that of eggs treated with sterile water. In comparison to control plant values, the M520 treatment resulted in a 70.8% reduction in root knots and an increase in plant shoot length, stem, and root fresh weights. In split-root tests, the number of root galls in cucumber roots treated with M520 was 25.6% lower than that of control roots (Zhao et al., 2023).

The amount of root penetration by juvenile tomato seeds was significantly reduced when they were treated with culture filtrates of various isolates of *Methylobacterium fujisawaense*. In comparison to *P. fluorescens* and other isolates, the TNAU 14 isolate showed the least amount of juvenile penetration (10.79%) with regard to root penetration . The mechanism underlying the least amount of root penetration by juvenile *M. incognita* may be related to host root exudate modification (Prabhu et al., 2009).

The study by Poorniammal et al., 2023 assessed *Methylobacterium* sp.'s nematicidal potential against *M enterolobii,* a root-knot nematode, in both *in vitro* and *in vivo* settings. *M enterolobii* exhibited significant reduction in hatch of the second-stage juvenile (J_2) and significant mortality under in vitro conditions when exposed to different concentrations (10-30%) of the bacterial culture filtrate (BCF) or crude enzymes that produced *Methylobacterium*. The concentration of BCF and crude enzymes increased, which improved the hatch inhibition and J_2 mortality rate. In a similar vein, the antagonistic effects grew over time as well.

References

1. Dourado, M.N, Neves, A.A.C, Santos. D.S et al. 2015.Biotechnological and agronomic potential of endophytic pink-pigmented methylotrophic *Methylobacterium* spp. Biomedical Research International 2015;2015:909016
2. Sikandar ,A, Jia, L, Wu, H and Yang ,S 2023. *Meloidogyne enterolobii* risk to agriculture, its present status and future prospective for management. Frontiers in Plant Science 13:1093657.
3. Riascos-Ortiz, D., Mosquera-Espinosa, A. T., Varón de Agudelo, F., Oliveira, C. M. G., Muñoz Flórez, J. E. 2022. “Non-conventional management of plant-parasitic nematodes in musaceas crops,” in *Sustainable management of nematodes in agriculture, Vol.1: Organic management. sustainability in plant and crop protection*. Eds. Chaudhary, K. K., Meghvansi, M.

K. (Cham, Switzerland: Springer), 381–422. doi: 10.1007/978-3-031-09943-4_15

4. Prabhu, S, S. Kumar, S. Subramanian and S. P. Sundaram, 2009. Suppressive effect of *Methylobacterium fujisawaense* against root-knot nematode, *Meloidogyne incognita*. Indian Journal of Nematology 39:165-169.
5. Poorniammal, R., S.Prabhuand U.Sivakumar,2023. Bioactive Compounds from Methyobacteriu msp. and their nematicidal activities against root-knot nematode Meloidogyne enterolobii in guava. National Conference Beneficial microbes for Integrated Health Management from 19.09.23 to 21.09.23 at 8th Asian PG PR Indian Chapter GKVK, Bengaluru.