

BIOCONTROL POTENTIAL OF PAECILOMYCES LILACINUS

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Paecilomyceslilacinus is a species of filamentous fungus that belongs to the Bionectriaceae family within the order Hypocreales. It has gained attention for its biocontrol potential, particularly in the management of plant diseases caused by soilborne pathogens. Though primarily recognized for its biocontrol potential, its role in disease causation and its ecological behavior are significant in understanding both its beneficial and, in some cases, harmful aspects.

1. Taxonomy and Classification

- Kingdom: Fungi
- Phylum: Ascomycota
- Class: Sordariomycetes
- Order: Hypocreales
- Family: Bionectriaceae
- Genus: Paecilomyces
- Species: Paecilomyceslilacinus

The genus Paecilomyces contains several species of fungi, many of which have been studied for their biocontrol potential, and *P. lilacinus* is one of the most prominent due to its pathogenic and antagonistic properties.

2. Etiology and Pathogenicity

Although Paecilomyceslilacinus is primarily known for its role as a biocontrol agent, it has been described as a pathogen in certain contexts. The etiology of *P. lilacinus* refers to its interaction with plants, other fungi, nematodes, and soil environments. In both beneficial and harmful roles, *P. lilacinus* interacts with its host in specific ways:

- Pathogenicity on Soilborne Fungi: While it is often used as a biocontrol agent to combat soilborne pathogens, in some cases, *P. lilacinus* can act as a pathogen itself, primarily when its growth conditions are ideal, and it outcompetes other soil microorganisms.
- Root-Knot Nematodes: *P. lilacinus* has a parasitic relationship with Meloidogyne species (root-knot nematodes). It attacks and feeds on nematode eggs, larvae, and juveniles. The fungus is capable of parasitizing nematodes by penetrating their eggs, feeding on their contents, and ultimately killing them. This parasitic relationship is considered beneficial in agricultural settings for managing nematode populations.
- Fungal Pathogens: *P. lilacinus* also acts as a mycoparasite, meaning it can parasitize and kill other fungi that cause plant diseases. It produces enzymes such as chitinases, cellulases, and proteases, which degrade the cell walls of competing fungi. This helps it invade and kill pathogens like Fusarium, Pythium, and Rhizoctonia.
- Environmental conditions for pathogenicity: The pathogenicity of *P. lilacinus* can be influenced by environmental factors like soil temperature, humidity, pH, and nutrient availability. These factors play a critical role in its growth and ability to become pathogenic to its host.

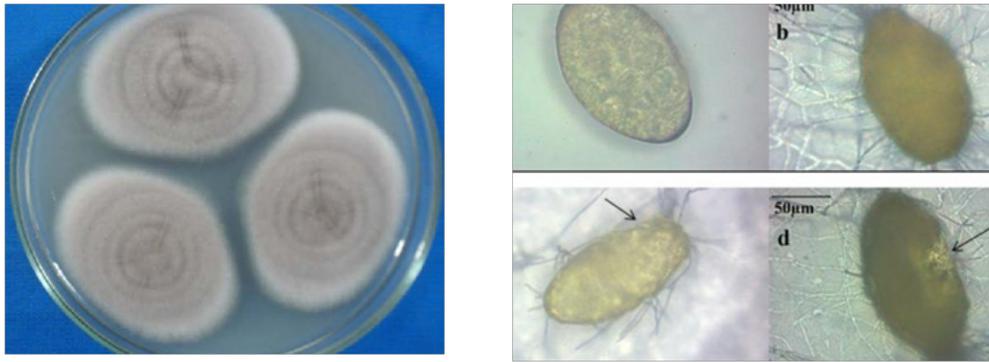


Fig: Destructive process observed under the optical microscope

3. Mechanisms of biocontrol by *Paecilomyces lilacinus*

Antagonism: *P. lilacinus* can directly compete with pathogenic fungi for space and nutrients in the soil. It can inhibit the growth of plant pathogens, especially root-infecting fungi such as *Fusarium*, *Pythium*, *Rhizoctonia*, and *Meloidogyne* (root-knot nematodes).

Mycoparasitism: *P. lilacinus* is known for its ability to parasitize other fungal species. It produces specialized structures like conidia and hyphae that can invade and kill pathogenic fungi, which is particularly important in the management of soilborne pathogens.

Production of Hydrolytic Enzymes: *P. lilacinus* produces a range of hydrolytic enzymes, such as chitinases, proteases, and cellulases, which can degrade the cell walls of pathogenic fungi and nematodes. This helps it break down the protective barriers of these pathogens, making them vulnerable to attack.

Toxin Production: Some strains of *P. lilacinus* produce secondary metabolites or toxins that can inhibit the growth of competing fungi, providing another layer of defense against pathogens.

Induced Systemic Resistance (ISR): *P. lilacinus* may also promote plant resistance by stimulating the plant's own defense mechanisms. This is particularly beneficial in enhancing the plant's tolerance to various stresses and pathogens.

4. Effectiveness against specific pathogens

- **Root-Knot Nematodes (*Meloidogyne* spp.):** *P. lilacinus* is especially effective in controlling root-knot nematodes, which are major agricultural pests. It has been widely used in the biological control of these nematodes by parasitizing their eggs and larvae, disrupting their life cycle.
- **Fungal Pathogens:** *P. lilacinus* has shown activity against several important fungal pathogens that affect crops like tomatoes, potatoes, and bananas. It is effective against *Fusarium oxysporum*, *Rhizoctonia solani*, and *Pythium* spp., which cause root rot and wilt diseases.

5. Applications in Agriculture

- **Soil Amendment:** *P. lilacinus* can be applied as a soil inoculant to enhance its population in agricultural fields, thereby reducing the pathogen load and improving crop health. This is particularly valuable in organic farming, where synthetic chemicals are avoided.
- **Biocontrol Agent in Crop Protection:** Commercial formulations of *P. lilacinus* are available and are used as biofungicides or bio-nematicides for the protection of crops, especially in the greenhouse and field settings.
- **Sustainability and Integrated Pest Management (IPM):** The use of *P. lilacinus* is an integral part of IPM

strategies, which aim to reduce the reliance on chemical pesticides, minimize environmental pollution, and promote sustainable agricultural practices.

Advantages of Using Paecilomyceslilacinus for Biocontrol

- **Non-toxic to Humans and Animals:** Unlike chemical pesticides, *P. lilacinus* is safe for humans, animals, and beneficial organisms, making it a safer alternative for crop protection.
- **Environmental Compatibility:** Being a naturally occurring soil fungus, it has minimal environmental impact and supports biodiversity.
- **Sustainability:** *P. lilacinus* can establish itself in the soil, offering long-term protection against soilborne pathogens, unlike chemical agents that may require repeated applications.

6. Application methods:

1. Soil Inoculation

Soil inoculation is one of the most common and effective methods for applying *Paecilomyceslilacinus* in field conditions.

A. Direct Soil Incorporation

Method: The fungus can be mixed directly into the soil at planting time. This is done by applying a formulated product containing *P. lilacinus* conidia or spores and then thoroughly mixing it into the soil, especially around the root zone.

Soil application: Mix 10 kg of *Paecilomyceslilacinus* with 100 kg of well-decomposed organic manure and apply around the rhizosphere.

Timing: Application is best made just before planting or transplanting, as this allows the fungus to establish in the soil and begin acting on the nematode eggs and larvae. Pre-planting inoculation is crucial for effective nematode suppression during the early stages of plant growth.

B. Soil Drenching

Method: For more targeted application, *P. lilacinus* can be applied as a liquid drench. This involves diluting a spore suspension of the fungus in water and applying it to the soil around the root zone.

Application Rate: The specific rate will depend on the concentration of the suspension, but it typically involves applying several litres of the solution per square meter of soil.

Timing: Soil drenching is often performed during the growing season, particularly during the early stages of plant growth when nematode infestation is most problematic. It can be repeated as needed, typically at intervals of 2-4 weeks, especially during periods of high nematode activity.

2. Seed Treatment

Seed treatment with *P. lilacinus* is another approach for protecting plants from nematode infestation early in their development.

Method: Seeds are coated with a suspension of *P. lilacinus* spores before planting. This can be done by soaking seeds in the suspension or applying a powdery formulation of the fungus directly to the seed surface.

Application Rate: Typically, 10^6 to 10^7 conidia per seed is recommended.

Timing: The treatment should be done shortly before planting to provide early protection as the seeds germinate

and begin to grow. This approach ensures that the fungus is already in place to protect the young root system from nematode attack.

3. Root Dip or Transplant Treatment

For transplanted crops, *P. lilacinus* can be used as a root dip to control nematodes that may already be present in the soil.

Method: Seedlings or young plants are dipped into a suspension of *P. lilacinus* conidia or spores just before transplanting. The fungus then attaches to the roots and provides ongoing protection against nematodes as the plant grows.

Application Rate: The concentration of the spore suspension can vary, but typically 10^6 to 10^8 conidia per litre of water is used for dipping. Use 4 ml of *Paecilomyces lilacinus* per liter of water.

Timing: This method is used right before transplanting, which helps to establish the biocontrol fungus on the plant roots.

4. Foliar Application (for Limited Control)

Though less common, *P. lilacinus* can be applied as a foliar spray in certain situations, especially if nematode populations are present in high numbers on the plant's root system and an extra layer of protection is needed.

Method: A spore suspension is sprayed directly onto the leaves of the plant. This is more commonly used as a secondary treatment to complement soil-based applications and is not typically a primary method for nematode control.

Application Rate: This method involves spraying the fungus at an application rate of approximately 10^7 conidia per liter of water, with a sufficient volume to cover the entire foliage.

Timing: Foliar applications are typically done during the early growth phase, especially when the plant is still young, and the nematode infestation is starting to have a detrimental effect on root growth.

5. Mulching

Mulching with formulations of *P. lilacinus* can enhance soil coverage and help the fungus establish itself in the soil.

Method: Mulch containing *P. lilacinus* spores or a fungal-based soil amendment is applied to the soil surface. The fungus then colonizes the mulch layer, releasing spores into the soil over time.

Timing: Mulching can be done before planting or as an ongoing practice throughout the growing season.

6. Drip Irrigation (for Large-Scale Fields)

For large-scale agricultural operations, using drip irrigation systems to apply *P. lilacinus* in a liquid formulation is an efficient method.

Application Rate: As with other methods, application rates depend on the concentration of the spore suspension. Typically, 10^6 to 10^8 conidia per liter of water are used.

Drip irrigation: Mix 10 kg of *Paecilomyces lilacinus* with 1,000 liters of water, filter, and incorporate into the soil through drip irrigation systems.

Timing: Drip irrigation applications can be done at regular intervals during the growing season, particularly in areas where nematodes are a persistent problem.

7. Combination of Methods

In some cases, a combination of the above methods may be employed for more effective control. For example: Combining soil drenching and root dips for transplants can provide comprehensive protection during both the early and later stages of plant growth.

Soil inoculation followed by drip irrigation can be used for ongoing protection, especially in larger fields.

Limitations and Challenges

- **Environmental conditions:** The effectiveness of *P. lilacinus* can be influenced by environmental conditions such as soil temperature, moisture, and pH, which may affect its survival and activity.
- **Competition with other soil microorganisms:** The success of biocontrol depends on the ability of *P. lilacinus* to outcompete other microorganisms in the soil, which can sometimes limit its efficacy.
- **Consistency and strain variability:** The effectiveness of different strains of *P. lilacinus* can vary, so selecting the right strain is important for optimal results.

Conclusion

Overall, *Paecilomyces lilacinus* shows significant potential as a biocontrol agent against soilborne pathogens, including fungi and nematodes. It is a promising tool for integrated pest management, especially in sustainable agriculture. However, its application requires careful consideration of environmental factors and strain selection to maximize its effectiveness.