Entomopathogenic Fungi as Biological Pest Control Agents

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ABSTRACT

Entomopathogenic fungi are natural biological control agents that target and kill insect pests by infecting them through their cuticle. Fungi such as *Beauveria, Metarhizium* and *Isaria* are used in sustainable pest management practices, offering an eco-friendly alternative to chemical pesticides. These fungi are effective in regulating insect populations, though their use is limited by factors like production costs, environmental conditions, and host specificity. Despite these challenges, they remain a promising tool in Integrated Pest Management (IPM) strategies.

INTRODUCTION

Insect pests cause significant damage to crops, with various species such as beetles, aphids, hoppers, scale insects, whiteflies, thrips, plant bugs, moths, and borers becoming particularly harmful when their populations reach high levels. However, like all living organisms, insects have natural enemies. Microorganisms such as fungi, bacteria, and viruses, play an essential role in regulating insect populations. Among these, fungi are particularly effective, as they parasitize insects and often lead to severe epizootics. During the late 19th and early 20th centuries, many fungi that infect and kill insects (entomopathogenic fungi) were investigated as potential pest control agents. Growing concerns about the harmful effects of chemical pesticides have spurred renewed interest in developing environmentally friendly alternatives. Entomopathogenic fungi are now recognized as valuable components of Integrated Pest Management (IPM) strategies. The diverse range of fungal species found in various ecosystems provides a natural defense against insect pests, helping to maintain a balance that keeps their populations below levels that cause significant economic damage.

Fungi have been suggested as biological control agents of insects for more than a century, yet their application remains extremely limited. Some species, like *Aspergillus* and *Fusarium*, are facultative generalist pathogens and can infect a variety of hosts. However, most species are obligate pathogens, exhibiting high host specificity. Although significant genetic diversity exists within fungal species, they often possess a relatively wide host range. (Driver *et al*.2000). Entomopathogenic fungi are widespread and frequently cause epizootics, making them a key factor in regulating insect populations. Unlike other biological control agents, fungi do not need to be ingested to infect their hosts; they can invade directly through the insect's cuticle. Over 100 fungal genera have been identified as parasitizing living insects (Roberts and Yendol, 1971). As a result, entomopathogenic fungi have emerged as a promising tool in biological control strategies.

How many different kinds of entomopathogenic fungi?

Entomopathogenic fungi are microorganisms that infect and kill insects, serving as natural biocontrol agents in pest control. These fungi belong to several genera, including *Beauveria*, *Metarhizium*, *Isaria*, and *Entomophthora*. They infect insects by penetrating the outer cuticle, growing within the host, and ultimately causing death through nutrient depletion or the production of toxins. These fungi are widely used in agriculture as a sustainable alternative to chemical pesticides. Their ability to specifically target insect pests while remaining harmless to plants and non-target organisms makes them a crucial element of integrated pest management (IPM) strategies. Some of the most promising candidates for microbial pest control are listed here.

1. *Beauveria sp.*
2. *Metarhizium anisopliae*
3. *Verticillium lecanii* (=*Lecanicillium lecanii*)
4. *Nomuraea sp.*
5. *Paecilomyces sp.*
6. *Hirsutella thompsonii*

Isolation of Entomopathogenic fungi: -

Most entomopathogenic fungi belong to the classes Deuteromycetes and Entomophthorales. Fungi like *Metarhizium anisopliae* and *Beauveria bassiana* are well studied for their pathogenicity to various insects and have been widely used as biological control agents for agricultural pests. These fungi can be collected from naturally infected dead insects as well as from the soil.

A. Dead Cadavers: The insects were either attached to the leaf sheath or floating on standing water, covered by a chalky white mass of conidia. The cadavers were collected in sterile glass tubes for isolating the causative organism in the laboratory. The insect cadavers were surface sterilized using 0.5% sodium hypochlorite in 75% alcohol, then rinsed in three changes of sterile water for 1–2 minutes. The washed specimens were cut into pieces and placed on Sabouraud's dextrose agar (SDA) medium with yeast extract. The fungal colonies that developed were observed, and the tip of the mycelial growth was aseptically transferred to SDA slants. The cultures were purified and maintained on SDA slants (Dayakar and Kanaujia 2001).

B. Soil: Sixteen rice moth (*Corcyra cephalonica*) larvae were placed in a plastic container, each layer containing four larvae, with soil collected from four different soil layers. The baited container was kept at room temperature for 3–5 days (Zimmermann 1986). In this method, *Corcyra* was used in place of *Galleria*. After 3 days, the dead larvae were examined under a microscope for fungal infection. The fungus associated with the infected larvae was then isolated as described earlier. Sahayaraj and Borgio (2009) successfully isolated *M. anisopliae* from soil samples collected from various regions in the Tirunelveli district of Southern Tamil Nadu, India.

Mode of action of entomopathogenic fungi:

Entomopathogenic fungi have a unique infection strategy. Unlike bacteria or viruses, they don't need to be ingested by the insect. Instead, they directly penetrate the insect's outer layer (cuticle). According to Clarkson and Chamley (1996), this process involves both physical and enzymatic actions. The infection begins when fungal spores adhere to the insect's cuticle, germinate, and penetrate it by forming an appressorium This appressorium exerts significant pressure on the cuticle while simultaneously releasing enzymes like proteases, lipases, and chitinases that break down the insect's outer layer Once the fungus enters the insect's body cavity (hemocoel), its hyphae grow and may produce blastospores, spreading the infection throughout the host's tissues. The fungus also releases secondary metabolites that paralyze the insect and suppress its immune defenses. This infection process typically lasts about 14 days, with the first symptoms appearing around 7 days after infection. As the fungus absorbs the insect's body fluids and kills it, the cadaver becomes rigid. After consuming all available nutrients, fungal hyphae emerge from the dead insect through natural openings (such as the oral and anal openings or spiracles) and produce resting or infective spores, which can spread the fungus to other insects. Asexual spores can propagate through saprophytic growth on the deceased insects, sustaining both sexual and asexual reproduction cycles (Litwin *et al*., 2020) (fig. 1).

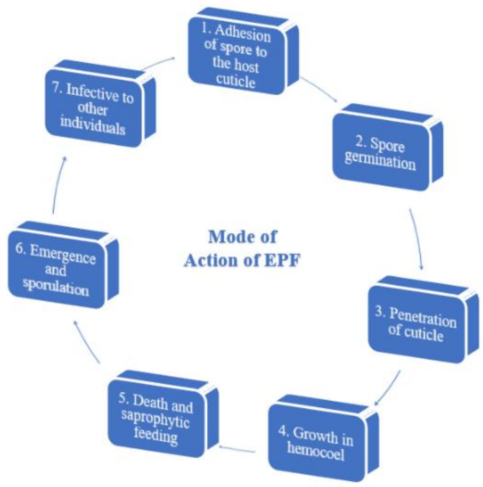

Fig.1: Infection cycle of entomopathogenic fungi (Source: Sinha *et al*. 2016)

S. No.	Positive aspect	Negative aspect
1.	They specifically target pests without harming beneficial predators or harmless parasites.	Their production is costly, and the short shelf life of spores requires refrigeration.
2.	No harm to the environment or mammalian health	The fungal pathogenesis is a bioprocess that requires specific conditions, including temperature, humidity, and light duration.
3.	Their diverse infection methods and prevent resistance	Narrow host range
4.	Some have endophytic capabilities, aiding in immune system activation.	Slow mode of action
5.	Entomopathogenic fungi offer prolonged pest control effects.	They can also pose risks to people with weak immune systems.

CONCLUSION:

Entomopathogenic fungi play a crucial role in pest control, offering a natural, environmentally friendly alternative to chemical pesticides. Their ability to specifically target insect pests, while being safe for non-target organisms makes them an integral part of Integrated Pest Management (IPM) strategies. These fungi, such as *Beauveria*, *Metarhizium*, and *Isaria*, operate through a unique infection mechanism, penetrating the insect's cuticle and spreading infection through the host's body. However, challenges such as high production costs, short shelf life, and specific environmental requirements, along with a slow mode of action and narrow host range, limit their use. Despite these challenges, their continued development and integration into pest control programs provide an important, sustainable solution to the growing concerns about the impact of chemical pesticides. Overall, entomopathogenic fungi are a promising biological control tool with significant potential to help regulate insect pest populations, reduce dependency on chemical pesticides, and promote environmentally responsible agricultural practices.

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