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Beauveria bassiana : A NATURAL ENTOMOPATHOGENIC SOLUTION FOR ECO-FRIENDLY PEST CONTROL

Vasanthan E
PG Scholar, Pandit Jawaharlal Nehru College of Agriculture and Research Institute, Karaikal, U. T. of Puducherry, 609603
Corresponding Author Mail ID: vasanthanagri@gmail.com

Introduction

The indiscriminate use of chemical pesticides on crops is one of the major environmental issues of our day. Globally, the use of chemical pesticides has been steadily increasing along with crop productivity and population growth, which has negatively impacted the ecosystem and increased risks to human health. The indiscriminate use of chemical pesticides against insect pests in agriculture has resulted in issues like pest resurgence, resistance, and threats to both the environment and human health. The development of alternative methods of managing insect pests has been greatly accelerated by the growing urge to reduce chemical inputs in agriculture and the rise in pesticide resistance. Alternative pest management methods are now prioritized.

Entomopathogenic fungi are those that penetrate, infect, and eventually kill insects. The ability of the enzymatic activity, which includes the presence of lipases, proteases, and chitinases, permits entomopathogenic fungi to demonstrate a wide spectrum of pathogenic activity. These enzymes break down the insect's integument; lipases are the first that entomopathogenic fungi make. Insect pests can be effectively managed by entomopathogenic fungi, which are an essential component of pest management strategies. These fungi have been effectively employed as microbial agents against pests in crop production systems. Entomopathogenic fungi are recognized as a successful biocontrol approach for controlling insect pest populations without endangering nontarget insects.

Their efficacy in controlling a diverse array of insect pests makes them indispensable in the field of pest management. In integrated pest management programs, they can be combined with other biocontrol strategies to offer environmentally friendly substitutes for chemical insecticides. Over 800 species of entomopathogenic fungi and over 1000 species of pathogenic protozoa have been found and characterized.

Entomopathogenic fungi based on *Beauveria bassiana*, *Metarhizium anisopliae*, *Verticillium lecanii* and *Paecilomyces fumosoroseus* are used to treat a variety of insect pests in an environmentally beneficial manner. The entomopathogen *B. bassiana* is one of these that has demonstrated significant promise for controlling insect infestations. *B. bassiana* is a member of the family Clavicipitaceae, order Hypocreales, class Sordariomycetes, kingdom Fungi and phylum Ascomycota. Italian resident Bassi Agostino of Lodi made the discovery in 1835.

As of right now, six species have been identified globally: *B. vermiconia*, *B. amorpha*, *B. caledonica*, *B. brongniartii*, *B. bassiana* and *B. clade*. Among all the species, *B. bassiana* has been the most extensively studied, extensively applied, and commercially accessible biopesticide for the control of insect pests globally.

Beauvericin, bassianin, bassianolide, beauverolides, tenellin, oosporein and oxalic acid are among the toxins that *B. bassiana* produces, and they are essential for the parasitization and death of insect hosts.

The significance of *B. bassiana* is further influenced by its great genetic diversity. According to recent studies, the host and stage of infection can alter the virulence of *B. bassiana* due to particular genes and molecules.

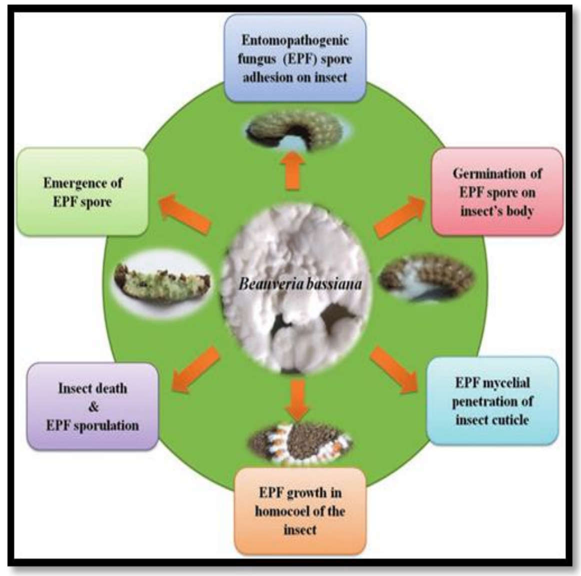
Because of this genetic variability, methods to improve B. bassiana's effectiveness can be developed.

The development of more efficient and long-lasting pest management techniques may result from identifying and focusing on these genes and compounds.

Microbial biopesticide use is significantly increasing globally due to a number of factors, including the demand for chemical-free food residue, a decline in chemical pesticide use, the rise of organic agriculture, and the development and consolidation of integrated pest management (IPM) programs.

It will be easier to use these fungi in pest management tactics if more is known about their ecology.

Mode of action



Numerous mechanisms are involved in *B. bassiana*'s mode of action, which enhances its insecticidal activity. The generation of different poisons is one of the important elements. These metabolites are essential for the parasitisation and eventual death of insect hosts. The poisons have the potential to kill insects by interfering with their physiological functions. Its capacity to pierce insect cuticles is another crucial feature. Enzymes that the fungus makes, like chitinases and proteases, break down the insect's cuticle and make it easier for *B. bassiana* to enter the host's body. Once inside, the fungus spreads throughout the insect and eventually kills it. The fungus *B. bassiana* has multiple mechanisms of action that contribute to its insecticidal activity.

One of the most important mechanisms is the production of different toxins, which are secondary metabolites that are essential to the parasitisation and death of insect hosts. These toxins can cause physiological disruptions that ultimately result in the insects' death. Another important mechanism is the fungus's ability to penetrate insect cuticles, as it produces enzymes like chitinases and proteases that break down the insect's cuticle and make it easier for *B. bassiana* to enter the host's body. Once inside the host's body, the fungus multiplies and colonises the insect, killing it. These enzymes aid in the growth and development of *B. bassiana* within the host by enabling it to use the tissues of the insect as a source of nutrients. Together, these pathways support *B. bassiana*'s insecticidal action and efficacy as a biological control agent.

Symptoms

Depending on the particular host and infection stage, *B. bassiana* infections in insects might present with a variety of symptoms. The following general signs and symptoms are seen in infected insects:

- Infected insects may become lethargic or show decreased movement. Often, this is one of the first indications of an infection.
- Infected insects might exhibit discolouration, such as an alteration in the exoskeleton's hue. This might be as subtle as a minor darkening or as obvious as a discolouration.
- The fungus on the insect's body is growing visibly. The fungus mycelium, which appears as a white or greyish powder on infected insects, can spread.
- *B. bassiana* can make infected insects dehydrated. This may cause the insect's body to shrink and desiccate.
- Infected insects may stop feeding or become less hungry. The feeding habits and nutrient intake of the insect may be affected by the fungal infection.
- In extreme circumstances, the infection may cause the insect to die. The fungus spreads throughout the insect's body, harming internal organs and ultimately resulting in the host's demise.

Host range

B. bassiana is a multipurpose entomopathogenic fungus that may infect and control a wide variety of insect pests. It has a wide host range. The host range encompasses a number of insect orders, such as Diptera, Hemiptera, and Lepidoptera. It is a useful biocontrol tool in agriculture and pest management due to its capacity to infect and parasitise a broad variety of insect species. Coleoptera-*Holotricha* spp., Lepidoptera-*Spodoptera litura*, *Helicoverpa armigera*, Hemiptera-*Aphis craccivora*, *A. gossypii*, *Bemisia tabaci*, Diptera-*Leria serrata* and Orthoptera-*Schistocera gregaria*, *Locusta migratoria* are a few examples of susceptible hosts from diverse orders.

Advantages

When used as a biological control agent for insect pests, *B. bassiana* has a number of benefits.

Broad-spectrum: It can target a variety of agricultural pests due to its broad-spectrum insecticidal activity. This makes it a useful and efficient tool for managing pests in a variety of environments.

Adaptability: It can survive and form populations in semi-natural and agricultural environments. Because of its versatility, it can successfully target pests in a variety of settings, such as greenhouses, natural habitats, and agricultural fields.

Mode of action: It has a unique mode of action compared to chemical insecticides. It infects insects through contact and ingestion, leading to the colonization and eventual death of the pests. This mode of action reduces the risk of resistance development in target pests, as it targets multiple physiological pathways and mechanisms.

Compatibility: It has the potential for integration with other pest management strategies. This integrated approach can provide a more comprehensive and sustainable solution to pest management.

Limitations

Although *B. bassiana* provides many benefits, there are some drawbacks and things to think about:

- **Specificity**: *B. bassiana* works well against insect pests and may be less effective against other pests like nematodes or mites.
- **Environmental requirements**: For best growth and activity, *B. bassiana* needs a certain set of environmental parameters. Temperature, humidity, and UV radiation are a few examples of the factors that can impact its effectiveness and durability in the field.
- **Limited shelf life**: The viability and efficacy of the fungus might wane with time, and formulations usually have a limited shelf life.
- **Slow action**: In comparison to chemical pesticides, this manner of action is slower.

Conclusion

B. bassiana plays a crucial role in sustainable pest management by offering an environmentally friendly alternative to chemical pesticides. Its ability to infect and manage a wide range of insect pests makes it a versatile and valuable tool in integrated pest management programs. Further research and development in understanding the mechanisms of action and improving the virulence of *B. bassiana* will enhance its effectiveness as a biocontrol agent, contributing to the development of sustainable and eco-friendly pest management practices.