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Entomopathogenic Fungi: A Novel Approach in Insect Pest Control

Priyanka P. Patil
Ph. D., Department of Agricultural Entomology,MPKV, Rahuri (M.S.)

SUMMARY

A group of fungi that kill an insect by attacking and infecting its insect host is called entomopathogenic fungi. Entomopathogenic fungi are identified as a promising biocontrol agent in the regulation of insect pest population without harming the non-target insects. Over 800 species of entomopathogenic fungi and 1000 species of protozoa pathogenic have been described and identified. EPF are a major component of integrated pest management techniques as biological control agents against insect pests and other arthropods and are an integral part of myco-insecticides in horticulture, forestry and agriculture.

INTRODUCTION

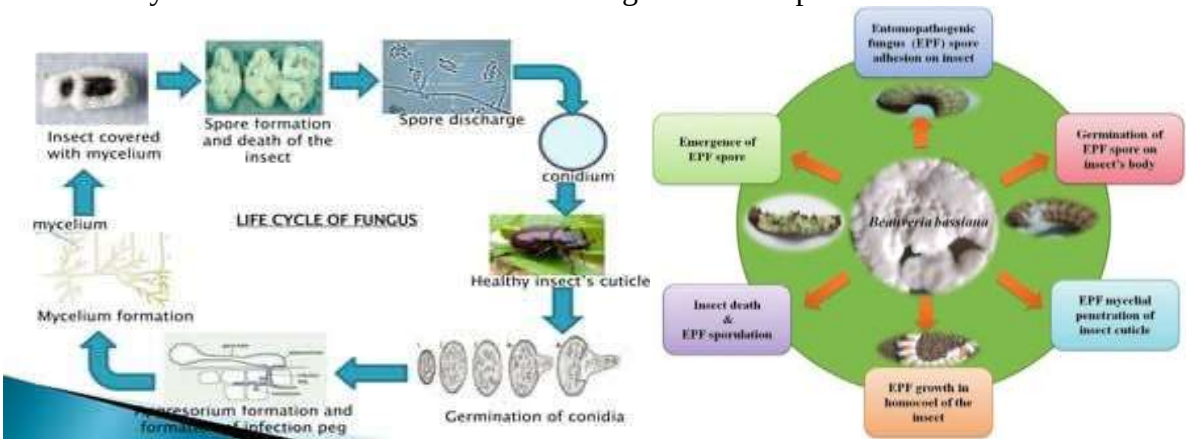
An entomo-pathogenic fungus is a fungus that can act as a parasite of insects and kills or seriously disables them. They are effective against eggs, larvae, intermediate stages and adults of a variety of insects including locusts, grasshoppers, mosquitoes, and others. It is a form of microbial control. Here virulence is caused by contact and action is through penetration. Main aim of insect control is to keep the population of insect below economic threshold level (ETL).

Important Entomopathogenic Fungi :

- *Beauveria*
- *Metarhizium*
- *Lecanicillium*
- *Paecilomyces*
- *Hirsutella*
- *Nomurae*

Mode of Action of Fungus :

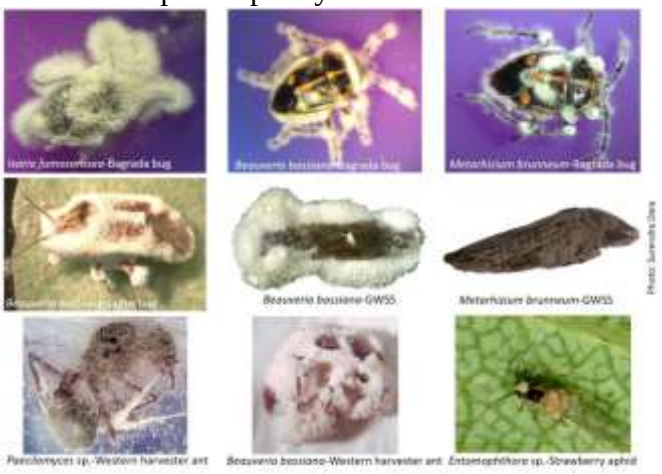
- Entry of fungi is through the integuments.
- Infective unit spore (conidium).
- Germination of conidia and formation of appresoria.
- Penetration of cuticle by enzymatic as well as mechanical action.
- Complete invasion.
- Production of conidiophores by erumpent of cuticle.
- Death of the host by obliteration of tissues as well through the toxins produced.



Symptoms shown by insects on infestation by fungus :

- Discolored patches on integuments.
- Body hardens and the insect is in upright on its leg at the time of death.

- Specifically we uses the term "Mycoses" for such changes in insects and can be seen in Lepidoptera, Hemiptera, Hymenoptera, Coleoptera and Diptera.
- Loss of appetite.
- Attempt to climb higher up and General/partial paralysis.



Toxin Produced :

- They are the only mycotoxins detected in the insect body at advance stages of infection in sufficient quantities to cause death.
- Toxins produced are the byproducts of metabolism and are not primarily used by the producer for killing the insect.
- Entomogenous fungi are known to produce "Destruxins" and "Aflatoxins".

Important Entomopathogenic Fungi :

1. ***Beauveria bassiana* (Wraight *et al.*, 2000) :**

- **Targeted insect :** Termites, Aphids, Thrips, Whiteflies, Caterpillars and Beetles etc.
- Pest of agricultural and forest including the Colorado potato beetle, the codling moth, and several genera of termites, Bollworm.
- Can be isolated from insect cadavers or from soil in forested areas by using media as well as by baiting soil with insects.
- Discovered in 1835 as cause of the Muscardine Disease of domesticated Silkworms.
- Got high host specificity.
- White muscardine fungus.
- These enter the host insects body through food or in contact with the host cuticle and reproduce inside the insect body.
- It produces toxins namely beauvericin, bassianocide etc. inside the host body causes paralysis of the host insects and ultimately kills the insects within four or five days.
- They are used particularly to control sucking pests and caterpillars infesting crop plants.
- These fungi are used to control the caterpillars of yellow stem borer and leaf folder of rice, white grub of groundnut, sugarcane pyrilla, coconut rhinoceros beetle, caterpillars of pulses, tomato and cotton, diamond back moth, leaf eating caterpillars of tobacco and sunflower etc.

2. ***Metarhizium anisopliae* :**

- **Targeted insects** : Bollworm, Grasshopper, Sugarcane Pyrilla, Rice BPH and Grubs of Coconut rhinoceros.
- Causes green muscardine disease.
- Pathogenic to a large number of agricultural and forest insect species.
- Earlier it was first isolated from infected larvae of the wheat cockchafer *Anisopliae austriaca* in 1879 and named as *Entomphthora anisopliae*.
- Renamed as *M. anisopliae* by Sorokin in 1883.
- This pathogenic fungus is used to control mainly coconut rhinoceros beetle, groundnut cut worm, rice brown plant hopper, diamond back moth and early shoot borer, top shoot borer and internode borer of sugarcane.

3. ***Lecanicillium muscarium* :**

- **Targeted Insects:** Coffee green scale and other Hemipterans
- The fungus appears to have been first observed in Ceylon (Sri Lanka) about 1861, on diseased *Lecanium coffeae*.
- Previously known as *Verticillium*
- Widely distributed fungus
- Controls whitefly and several aphids' species, including the green peach aphids (*Myzus persicae*) for use in the greenhouse chrysanthemums.
- Fungus attacks nymphs and adults of white fly and stuck to the leaf underside by means of a filamentous mycelium.
- This beneficial fungus is mainly used to control whiteflies, aphids, thrips, brown plant hopper, scale insects, mealy bugs and other sucking insect pests of crop plants.

4. ***Nomura erileyi* :**

- **Targeted insect:** Tobacco cutworm
- The host specificity of *N. rileyi* and its ecofriendly nature encourage its use in insect pest management.
- Although, its mode of infection and development have been reported for several insect hosts such as *Trichoplusiani, Heliothis zea, Bombyx mori, Pseudoplusia* includans.
- *Nomura earileyi* can be cause to epizootic death in insects.
- Lepidopteran including cutworm and some belonging to Coleoptera are susceptible to it.

5. ***Paecilomyces fumosoreus* (Wraight *et al.*, 2000) :**

- **Targated insects:** *Trichoplusia, Heliothis zea, Bagrada cruciferarum, Bombyx mori, Anticarsia gemmatalis.*
- Grows extensively over the leaf surface under humid conditions that helps it to spread rapidly through whitefly populations.
- Best for controlling the nymphs of whitefly.
- *Paecilomyces fumosoroseus* also called "Yellow Muscardine".
- Effective over whitefly and *Trialeurodes spp.* in both greenhouse and open field environments.
- These fungi cover the body of whitefly with mycelia threads and stick them to the underside of the leaves.
- The nymphs show a "feathery appearance".
- This fungus is used to control yellow and red mite, whiteflies etc.

6. ***Hirsutella thomsoni* :**

- **Targeted insects :** It is specific to the eriophyid mites. 1. Coconut mite 2. Citrus rust mite
- Originally isolated from an eriophyid mite in TN.
- Effective on Eriophyid mites, particularly the coconut mite.
- Major crop use is in coconut plantations, but can be used in palmyrah palm and in arecanut.
- Widespread in nature.
- Beneficial to non-target species.
- Beneficial effects on the environment.
- These fungi are used to control different hoppers and bug pests, whiteflies, red mites etc.

Entomopathogenic Fungi Product in Available in Market :

Fungi	Product Name/Trade Name
Beauveria bassiana	Bio-guard rich, Bio-power, Racer, Baba, Beavera
Metarhizium anisoplia	Bio-magic Pacer, Kalichakra, Cropmet, Mctaz
Lecanicillium muscarium	Bio-catch, Mealikil, Vertimust, Biograde-v and Vertifire- L
Paecillomyces spp	Mysis, Nematox, Paci hit rich

Use of different type of microbial pesticides against various pest and diseases in crops

Sr. No.	Microbial pesticides	Target pests and crops
1	*Beauveria bassiana*	Aphids in chilli and brinjal (*Aphis gossypii*), cabbage (*Brevicoryne brassicae*), cowpea (*Aphis craccivora*) and rice leaf folder (*Cnaphalocrocis medinalis*)
2	*Bacillus thuringiensis* var. kurstaki	Fall armyworm (*Spodoptera frugiperda*) in maize, Legume pod borer (*Helicoverpa armigera*, *Maruca* sp.), Diamondback moth (*Plutella xylostella*), Spotted stem borer (*Chilo partellus*), Rice leaf folder (*Cnaphalocrocis medinalis*), Brinjal shoot borer (*Leucinodes orbonalis*), Red hairy caterpillar (*Amsacta albistriga*) and *Spodoptera litura* in soybean
3	*Lecanicillium lecanii*	Aphids in chilli and cowpea
4	*Metarhizium anisopliae*	White grubs (*Holotrichia* spp.) in sugarcane, Fall armyworm (*Spodoptera frugiperda*) in maize and Rice leaf folder (*Cnaphalocrocis medinalis*)
5	*Pseudomonas fluorescens*	Thrips spp. in capsicum and Fusarium wilt of red gram

Potential benefits of using Biopesticides in Agriculture :

- Specificity of the host.
- When used in little amounts, it can be quite effective.
- Decomposes naturally and fast.
- Cross resistance isn't an issue.
- Most other plant protection strategies used in an IPM programme can be easily integrated with this one.
- There is no worry of contamination, making it environmentally beneficial.

Constraints in popularization of biopesticides :

- From the screening stage to the selection of prospective strains for sale, packaging, storage, and distribution, biopesticide production requires a large initial financial commitment.
- The selling of substandard or fake biopesticides, as well as biopesticides tainted with chemical pesticides not permitted by the Central Insecticide Board and Registration Committee, is the main impediment to its development and expansion (CIBRC).

Role of Microbial Pesticides in IPM :

- The use of microbial pesticides and bioagents has assumed significance as an important component of IPM due to their economic viability and ecofriendly nature instead of chemical synthetic pesticides.
- Microbial pesticide application as a component of IPM programmes can play important role in overcoming disadvantage of chemical insecticides that have some important characteristics such as biodegradable, self-perpetuating and less harmful on beneficial pests, mostly host specific and less shelf life.

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