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Entomopathogens as Eco-friendly Tools for Insect Pest Management

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For many decades, farmers have relied heavily on chemical pesticides to control insect pests. Although effective, excessive use of chemicals has led to serious problems such as pest resistance, pesticide residues in food crops, environmental pollution, and harmful effects on non-target organisms. These concerns have increased the need for alternative, eco-friendly pest management strategies. Insect pathogens, also known as **entomopathogens**, play an important role in biological control. These include microorganisms such as **bacteria, viruses, fungi, nematodes, protozoa, and rickettsia**, or their by-products, which cause diseases in insects. Based on their mode of entry, insect pathogens are classified as **ingested pathogens** (bacteria, viruses, protozoa, rickettsia) and **penetrating pathogens** (fungi and nematodes).

Entomopathogenic Bacteria

Entomopathogenic bacteria were first discovered in diseased silkworm larvae. The most important and widely used bacterium is **Bacillus thuringiensis (Bt)**. The insecticidal activity of Bt is due to the production of **Cry, Cyt, and Vip proteins**, which damage the insect midgut.

Classification

- **Non-spore formers**: *Serratia entomophila* (grass grub)
- **Spore formers**

✓ Obligate: *Paenibacillus popilliae* (causes milky disease of Japanese beetle)
✓ Facultative:

- Non-crystalliferous: *Bacillus cereus*
- Crystalliferous: *Bacillus thuringiensis*, *Lysinibacillus sphaericus*

Examples

- *Bt var. kurstaki* – soybean looper
- *Bt var. israelensis* – mosquito larvae
- *P. popilliae* – Japanese beetle

Bt formulations are commonly applied at **0.5–1.0 kg/ha** and are highly specific and safe to natural enemies.

Entomopathogenic Viruses

Viruses are **obligate intracellular parasites** that multiply only inside living host cells. The most important insect viruses belong to the family **Baculoviridae** and are characterized by occlusion bodies.

Classification

- **Non-inclusion viruses (NIV)**
- **Inclusion viruses (IV)**

✓ Nuclear Polyhedrosis Virus (NPV)
✓ Granulosis Virus (GV)

✓ Cytoplasmic Polyhedrosis Virus (CPV)

Examples

- *Spodoptera litura* NPV (Spli NPV)
- *Helicoverpa armigera* NPV (Hear NPV)
- *Chilo infuscatellus* GV (sugarcane early shoot borer)

Viral pathogens cause characteristic symptoms such as **tree-top disease** and liquefaction of the insect body.

Entomopathogenic Fungi

Fungi were the first insect pathogens identified due to their visible growth on insect bodies. Unlike bacteria and viruses, fungi can infect insects through **direct penetration of the cuticle**, making them effective against sucking pests.

Important Genera

- *Beauveria bassiana*
- *Metarhizium anisopliae*
- *Lecanicillium lecanii*
- *Hirsutella* spp.

Examples

- *B. bassiana* – white muscardine disease
- *M. anisopliae* – green muscardine disease
- *L. lecanii* – mealybugs and aphids

Fungal formulations are generally applied as **wettable powders (WP)** or dusts.

Entomopathogenic Nematodes (EPNs)

Entomopathogenic nematodes are soil-dwelling endoparasites that kill insects with the help of **symbiotic bacteria**.

Important Genera

- *Steinernema* (with *Xenorhabdus* bacteria)
- *Heterorhabditis* (with *Photorhabdus* bacteria)

Mode of Action

Infective juveniles enter the host through natural openings and release bacteria that kill the insect within 24–48 hours.

Examples

- *Steinernema carpocapsae* – cutworm
- *Heterorhabditis indica* – white grubs

Entomopathogenic Protozoa

Protozoan pathogens mainly belong to **Apicomplexa** and **Microspora**. These organisms cause **chronic and debilitating infections**, rather than quick mortality.

Mode of Action

Spores are ingested by insects and spread throughout the body, reducing growth, longevity, and reproductive capacity.

Example

- *Paranosema locustae* – grasshoppers and locusts

Entomopathogenic Rickettsia

Rickettsia are **obligate intracellular, gram-negative bacteria** that cannot survive outside host cells.

Mode of Action

After ingestion, they multiply inside host cells, causing cell lysis and milky appearance of the insect body.

Example

- *Rickettsiella* spp. infecting scarab beetle larvae