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Biopesticides: A Futuristic Approach

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Introduction

Biopesticides are pesticide derivatives of natural origin like plants, animals, microbes, and certain minerals which are used to control insect pests. It is an emerging sustainable approach to managing proliferating insect pest populations. An ever-increasing population is building huge pressure on farmers to increase production just to serve the growing needs and demand for food. As per UN projections population is going to rise from 7.5 billion to 9.7 billion by 2050 and accordingly, food production will have to increase by 60% to feed an additional 2 billion population. Indeed, the goal of achieving something comes with many challenges and so is agriculture. Long-term shifts in temperature (global warming) and random weather patterns are driving severe pest outbreaks on regular basis. According to FAO estimates, we are losing 20-40 percent of crop production annually due to insect pests. A quick way to address this problem is pesticides which due to their immediate effects are used indiscriminately by farmers. However, their over and indiscriminate use has led to severe environmental issues of great concern as it has contaminated soil and waterbodies causing ecosystem imbalance and also severe health issues of high risk such as cancer, organ deformalilities, and reproductive failures. This is an alarming situation to switch over to new approaches to pest control and biopesticides are one of them.

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Biopesticides

Microbial biopesticides: These incorporate small tiny microbes like bacteria, fungi, baculoviruses, protozoa, and nematodes which use a specific mechanism to kill target insects.

A. Entomopathogenic bacteria: *Bacillus thurengenesis* (Bt) is the most widely exploited species of bacteria which when ingested by an insect gets activated due to the alkaline pH of the insect gut and kills host by producing protein crystal or toxins that bind to a larval gut receptor causing ionic imbalance leading to septicemia or make insect larvae starve or due to sudden drop of oxygen they die. Several species of soilborne bacteria, *Bacillus* and *Paenibacillus* are pathogenic to coleopteran, dipteran, and lepidopteran insects.

- *Bt* subsp. *aizawai* and *Bt subsp. kurstaki* are effective against caterpillars,
- *Bt* subsp. *israelensis* and *Bt subsp. sphaericus* targets mosquito larvae, and
- *Bt* subsp. *tenebrionis* is effective against some coleopterans.

B. Entomopathogenic fungi: Entomofungal pathogens cause infection when they come in contact with the host as fungal spores are able to directly penetrate through integument via enzymatic activities and mechanical pressure and invade host tissue and body cavity, mycelium and spores proliferate and cover the body of the host, produce toxins and cause them to starve and eventually kill them.

- *Beuvaria bassiana* is known to cause white muscardine targeting mainly sucking pests
- *Metarhizium anisopliae* causing green muscardine is effective against soil dwelling insects.

C. Entomopathogenic viruses : Baculoviruses with sub-group Nuclear polyhedrosis(NPV) and Granuloviruses (GVs)are most known group of viruses exploited for lepidopteranian larvaes.Viruses gain entry by ingestion and accordingly are mainly used against insect pest having chewing mouthparts.Viruses after gaining entry into host, integrate their nucleic acid with host genomic machinery and takes charge of cell metabolic system and replicates using cell content starving it to die .

D. Entomopathogenic nematode: EPNs such as *Steinernema* and *Heterorhabditis* are mostly used against soil-dwelling insect pests and tissue borers. Endoparasitic nematodes in

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association with bacterial symbionts invade insect hosts via natural openings such as mouth, spiracles and anus or through intersegmental membranes. Infective juvenile (IJ) once inside the host release symbiont in host, bacteria propagates inside and kills the host through bacterial septicemia.

E. Protozoans :Protozoan either directly kill the insects or reduces the fecundity of adults. They are known to cause debilitating infections as their effect is chronic, also they prolong the larval life in the field, thus exposing them longer to predators and parasitoids. They are exploited against lepidopterans, locusts, grasshoppers, and beetles.

- *Nosema melolonthae* against chafer beetle
- *Farinocystis triboli* against red flour beetle

Entomophagous Insects :

These are important bio-control agents as they consume other insects and they may do so by predation or parasitizing them.

A. Predators: These are free-living insects that devour other insects smaller than themselves and require several prey in their lifetime. Many Coccinelid and ground beetles are known voracious feeders of small sucking insects such as aphids, mealybugs, mites, and scale insects. Some syrphids or hoverflies are also important predators of aphids of several crops. Predatory mites are extensively used for controlling other phytophagous mites in several crop ecosystems.

B. Parasitoids: These are insects whose larvae develop in the host into a free adult and eventually kill it. The majority of parasitoids fall in the hymenopteran order (Wasps) and dipteran order (order). They are categorized as egg parasitoids, larval parasitoids, pupal parasitoids and adult parasitoids on the basis of the stage they attack.

Benefits of biopesticides:

- ✓ Environmentally friendly as have no toxic residual effect
- ✓ Gives long and permanent control of pests,

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- ✓ Host-specific,
- ✓ Effective in very small quantities and is biodegradable,
- ✓ Safe to non-target insect pests and natural enemies

Conclusion:

With the advent of the latest technologies like Artificial Intelligence and genetic mutations, various innovations in the domain of biopesticides are astounding. Pest-specific action of biopesticides is a promising step towards achieving the goal of sustainable agriculture. Various kinds of biopesticides like bacterial, microbial, fungal, protozoan, and predators are all very specific in their pest-killing action, harmless for humans, and are in synch with the natural processes of the food chain and crop production.