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Pest Control through Bio- Pesticides

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Introduction

Biopesticides are certain type of pesticides which are derived from natural materials such as plants, animals, bacteria, and certain minerals e.g., canola oil and baking soda have pesticidal applications and are considered as bio-pesticides which includes bio fungicides (Trichoderma), bioherbicides (Phytophthora), *and* bioinsecticides *(Bacillus thuringiensis).* Biopesticides have emerged as a green tool in the era of sustainable agriculture. These act as alternatives to the harmful synthetic pesticides and are solutions to problems like pest resistance, public health issues and detrimental effect on the surrounding environment. In India, a major technological breakthrough in the field of biocontrol happened when chemical insecticides failed to control *Helicoverpa armigera*, *Spodoptera litura*, and other pests of cotton (Kranthi *et al*. 2002). It was realized that biocontrol is the only means that can be utilized as a safe, cost-effective, and eco-friendly method to control the widespread resistance of chemical insecticides towards pest insects. Later, bio-pesticides became a part of IPM which was previously completely based on the use of chemical pesticides. In India, the concept of biocontrol of plant diseases has been in practice for a very long time. The neem tree (*Azadirachta indica*) and its derivatives, i.e. leaf extract, oil, and seed cake have been used as fertilizers and also for minimizing the risk of post-harvest loss in stored cereals (Isman 1997; Brahmachari 2004).

Types of Biopesticide:

Based on their composition and functions, bio-pesticides are mainly divided into 4 categories.

- Microbial Pesticide
- Plant Pesticide
- Biochemical Pesticide
- Semiochemicals

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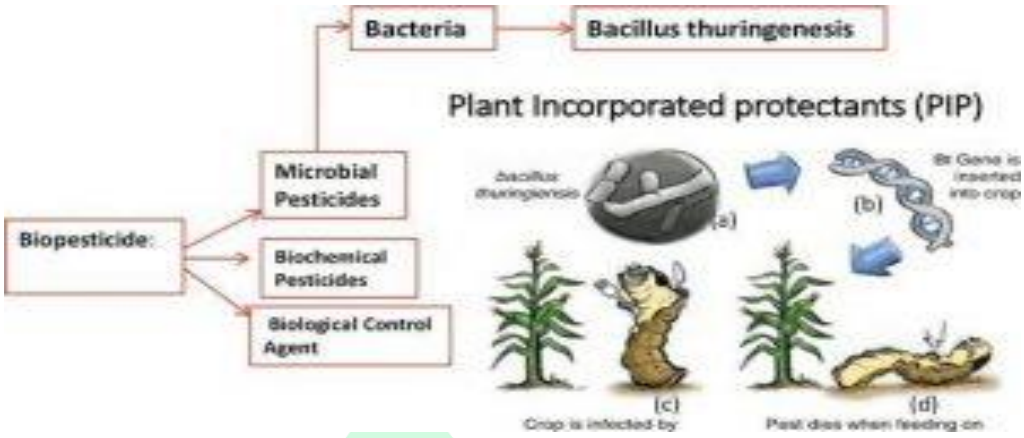

. Microbial Pesticide:

These pesticides contain microorganisms like bacteria, fungus, viruses, protozoans, or even algae as the active ingredient. Many pests can be controlled by these microbial pesticides, although each separate active ingredient is relatively specific for its target pest e.g., there are fungi that control certain weeds, and other fungi that kill specific insects. The most widely known microbial pesticides are varieties of the bacterium *Bacillus thuringiensis*, or *Bt*, which can control certain insects in cabbage, potatoes, and other crops. *Bt* bacteria produces a crystalline toxic protein that kill specific lepidopteran insect pests. These pesticides need to be continuously monitored to ensure they do not harm non-target organisms, including humans.

Beauveria bassiana and *Metarhizium anisopliae* are entomopathogenic fungi which are used as bio-pesticide to control several insect pests' population.

Plant Incorporated Protectants (PIP):

Plant incorporated protectants (PIP) or plant pesticides are based on genetic engineering. Plant genes are altered with pesticide properties or pesticide substances are introduced to resist pest attacks e.g. the gene of *Bacillus thuringensis* pesticidal protein introduces itself into genetic material of plants. Then this plant can manufacture its *Bt* bacterium by binding on gut receptors and kill the pest.

3. Biochemical pesticides:

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These are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides are synthetic materials that usually kill or inactivate the pest. Biochemical pesticides include substances that interfere with growth or mating, such as plant growth regulators, or substances that repel or attract pests, such as pheromones. These pesticides are made from naturally occurring substances like baking soda, neem oil, tree oil.

4. Semiochemicals:

A semiochemical is a chemical signal produced by one organism, usually insects which caused a behavioural change in an individual of the same or different species. For crop protection, the most widely used semiochemicals are the insect pheromones which serve as a signal to communicate with others in their species and synthesized for pest control by mating disruption, mass trapping and lure and kill systems.

Different Formulations of Biopesticides

Biopesticides are formulated in various ways. Depending on the physical states of the biopesticide formulation as dry or liquid forms, the active ingredients are produced by addition of stabilizers, synergist, spreads, stickers, surfactants, colouring agents, anti-freezing compounds, additional nutrients, dispersants and melting agents. In general, biopesticides are usually formulated as dry formulation (for direct applications) and liquid formulations.

Dry formulations of biopesticides:

Dustable Powders (DP): Active ingredient concentration for dust formulations is usually 10% and is formulated by sorption of active ingredient on finely ground, solid mineral powder (talc, clay etc.) with particle size ranging from 50-100 mm. The inert ingredients for dust formulations are UV protectants, adhesive materials (i.e. stickers) to enhance adsorption and anticaking agent.

Wettable Powders (WP): These are also dry formulation ground finely and applied after suspension in water. Wettable Powders are obtained by blending active ingredients with melting and dispersing agents, synergist, surfactants, and inert fillers. WPs have long stability during storage, good miscibility with water and can be applied with conventional spraying equipment's.

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Granules (GR): Active ingredient concentration for granules ranges from 2-20% and the active ingredients either coat the outside of the granule or are absorbed into the granules. Granules are mostly applied to control insects living in soils, weeds and nematodes for uptake by roots. Coarse size granule particles range from 100-600 microns made from such materials such as kaoline, silica, starch, polymers, groundnut plant residue, dry fertilizers etc.

Water Dispersible Granules (WDG): It is designed to be suspended in water and to overcome problems associated with WPs, dust free and with good storage stability

Seed Dressing (SD): A kind of biopesticide formulation obtained by mixing active ingredient carrier in form of powder and accompanying inert to facilitate end product adherence to seed coats.

Liquid formulations of biopesticides:

Oil Dispersion (OD): The product of the formulation is produced in the same ways as suspension concentrate. Instability problems could be avoided by proper selection of inert ingredients.

Emulsion: Emulsion formulations are designed to be mixed with water and it could be normal emulsion which is oil in water (O/W) or an inert emulsion which is water in oil (W/O).

Suspension Concentrate (SC): Formulated by mixing finely ground, solid active ingredient dispersed in liquid phase, usually water. The particle size distribution is 1-10 µm and these small particles size offers easier access of the active ingredients to plant tissue and improved bioefficacy. It is a popular type of formulation because of safety to operator and environment.

Capsule Suspension (CS): Active ingredients are formulated in micro-encapsulated stable suspension intended for dilution with water before use. Capsules made from gelation, starch, cellulose and other polymers are used to encapsulate the bioagents and in this way the bioagents are protected from the harsh environmental conditions. Interfacial polymerization principle is the most frequent applied method of encapsulation which is used to give smaller size and highly efficient formulations typically fungal biopesticides.

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Ultra-Low Volume Liquids (ULV): Formulations not intended to be diluted in water before use and have concentration of active ingredients. It is easy to transport and can be formulated using a suspended biocontrol agent as an active ingredient.

Different Methods of Biopesticides Application

1. Seed Treatment: most effective method or technique. Powder formulations are applied on seeds by tumbling seed with the product that is designed to adhere to the seed.

2. Seedling Dipping: This involves dipping roots of the seedlings in biopesticides suspension for some minutes or hours prior to transplanting. e.g. *Trichoderma spp*. are applied in this way.

3. Foliar Application: Simply means biopesticides application on leaves surface as sprays. For example, application of *B. subtillis* to bean leaves reduced the incidence of bean rust caused by *Uromyces phaseoli.*

Mechanisms of action of biopesticides for pest control:

Antibiosis: This occurs as a result of an interaction with other microbes (microorganisms) mediated by specific metabolite of microbial origin, by volatile compounds, lytic enzymes or other toxic substances. The microorganisms produce antibiotics, bacteriocin, volatile compound and metabolite production.

Competition: shows their ability to compete aggressively, that they grow rapidly and colonize substrate to exclude pathogens. e.g., *T. spp.* are aggressive competitors of *Fusarium spp.*

Hyperparasitism: Hyperparasitism is the lysis of the death by other microorganisms or direct parasitism. e.g *T. lignorum* is found to be parasitizing the hyphae of *R. solani* and therefore soil inoculation with *Trichoderma* spores help to control damping off disease in citrus seedlings (Rikita and Utpal, 2014).

Synergism: The ability of some bioagent to combine actions of hydrolytic enzymes and antibiotic secondary metabolites. e.g., the effectiveness *T. spp.* as a biocontrol agent and its

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fitness in the environment is as a result of synergistic effects of antimicrobial compounds. Example includes pyrones, coumarins etc.

Advantages of Using Biopesticides:

1. Biopesticides are mostly made of organic compounds which are easily degradable thus plant don't face the adverse effects of toxicity.

2. All bio-pesticides are eco-friendly and easily biodegradable by soil. Bio-pesticides chemicals are non-toxic to soil organisms thus keeping soil microorganisms alive.

3. Bio-pesticides are mostly pest-specific they only kill one or two species of pest at a time. This reduces the adverse effect of pesticides on other organisms of the ecosystem.

4. Bio-pesticides are concentrated and easily applicable. These pesticides need a little amount of application on large fields. It is effective in minute quantity.

5. Bio-pesticide is a better option as all the components are natural and plant digestible. Even these plants get benefit from the nutrients of pesticides.

6. Bio-pesticides are alternatives to chemical pesticides as they are non-toxic and biodegradable.

Disadvantages of bio-pesticides

1. Speficity is high which may require an exact identification of the target pest/ pathogen.

2. Their speed of action is slow, so they are often unsuitable if a pest outbreak is an immediate and becomes a threat to crops.

3. Bio-pesticides are not suited for a stand-alone treatment rather they have to be with a compatible method for high efficacy.

4. Living organisms evolve and increase their resistance to biological, chemical, physical and any other form of control.

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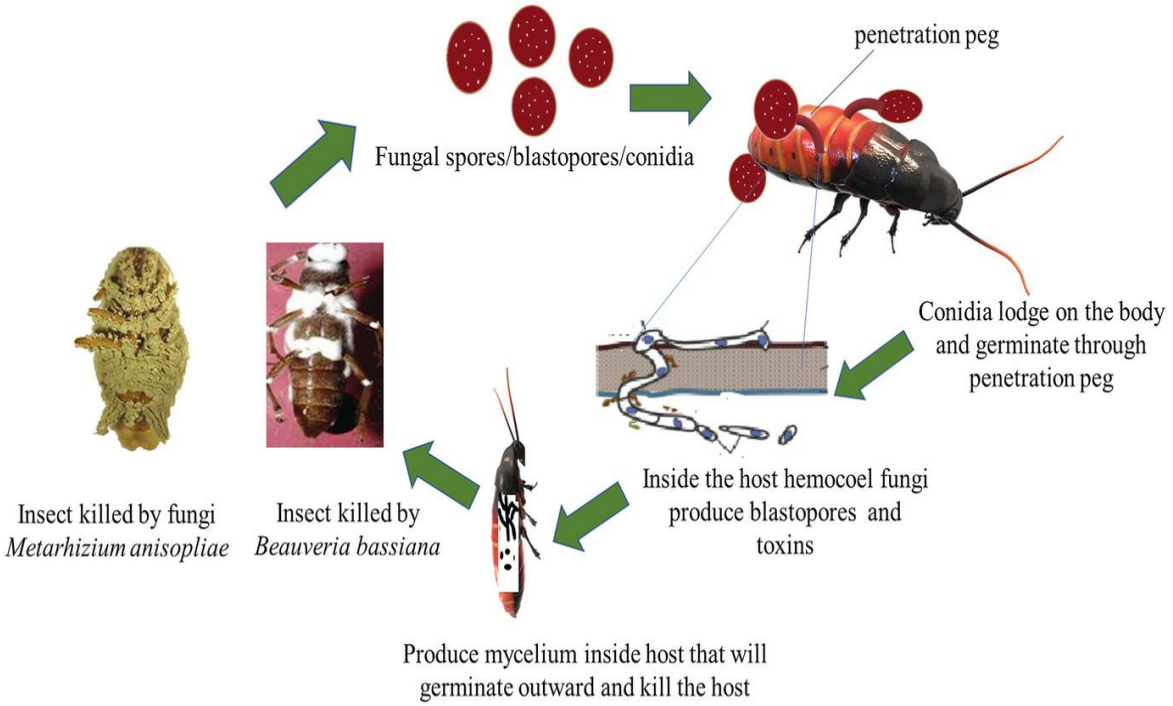

Mode of action of Fungi

Major Examples of Bio-pesticides used to control various pests:

1. Neem: Natural tree extract from the neem tree is used as the pest control agent. Derived from the neem tree *(Azadirachta indica), this* contains several chemicals, including 'azadirachtin', which affects the reproductive and digestive process of a number of important pests.

2. *Bacillus thuringiensis*: *Bacillus thuringiensis is the most commonly used* biopesticide globally. It is primarily a pathogen of lepidopterous pests like American bollworms in cotton and stem borers in rice. When ingested by pest larvae, *Bt* releases toxins that damage the midgut of the pest, eventually killing it. The main sources for the production of *Bt* preparations are the strains of the subspecies kurstaki, galeriae, *and dendrolimus.*

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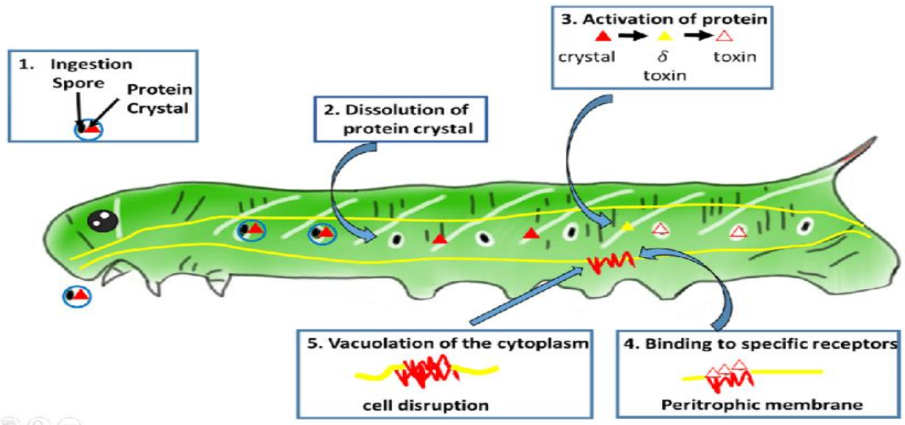

3. *Baculoviruses*: These are target-specific viruses that can infect and destroy a number of important plant pests. They are particularly effective against the lepidopterous pests of cotton, rice, and vegetables.

4. *Trichoderma*: Trichoderma is a fungicide effective against soil-born diseases such as root rot. It is particularly relevant for dryland crops such as groundnut, black gram, green gram, and chickpea, which are susceptible to these diseases.

5. *Trichogramma*: Trichogramma is a minute wasp that is an exclusive egg parasite. They lay eggs in the eggs of various lepidopteran pests. After hatching, the Trichogramma larvae feed on and destroy the host egg. It is particularly effective against lepidopteran pests like the sugarcane internode borer, pink bollworm, and sooted bollworms in cotton and stem borers in rice. They are also used against vegetable and fruit pests. It is the most popular biocontrol agent in India, mainly because it kills the pest in the egg stage, ensuring that the parasite is destroyed before any damage is done to the crop.

Conclusion: The increasing concern of problems associated with synthetic chemicals for pest control, and on food safety has led growers to find new eco-friendly alternatives to replace the injudicious use of chemicals and chemical-based practices. The use of bio-pesticides has emerged as promising alternative to chemical pesticides and their demand is rising steadily in all parts of the world. Therefore, the potential and importance of "bio-pesticides for pest control" could serve as a very effective alternative method for pest control as well as good component of integrated pest management.

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