

Review Article

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Biopesticides: Introduction and its Prospects

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ABSTRACT

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Plant and pest coexist on this planet from the ages. Chemical pesticides are generally used to reduce the damage caused by the pest. As chemical pesticides are costly and harmful for ecosystem, biopesticides are gaining importance. Biopesticides are cost effective and ecofriendly. In India, biopesticides covers 3 per cent of total pesticide production. Biopesticides usage in India rose 23 per cent from 2010-11 to 2016-17 while chemical pesticides only 2 per cent. Biopesticides are mainly microbial origin (*Trichoderma* sp, *Bacillus* sp), plant origin (Neem based pesticides) and biochemical compounds (pheromones, repellants, attractants). Many pests like *Helicoverpa armigera*, *Spodoptera litura*, Diamond back moth, *Fusarium* sp are successfully controlled by biopesticides like *Trichogramma*, Bt, NPV and *Trichoderma* sp. respectively. Exploration of new source of biopesticides, formulation and is required. Public private partnership and large investment is required in this sector.

Introduction

Agriculture has been on this planet from time immemorial and so the plant and pests. Pests cause substantial yield loss in agriculture by damaging plant. Recently chemical pesticides are used to protect the crop from this damage. These chemical pesticides found to be highly effective in killing these pests. Now a day farmers are indiscriminately using these chemical pesticides. As a result so many dire consequences are arising. Now a days farmer are facing challenges of resistance development in these pests, resurgence of secondary pest, loss beneficial organism from soil, deteriorating soil health, pollution of soil,

water and environment. Therefore an ecofriendly alternative of these pesticides arises. Use of biopesticides is most appropriate alternative to deal with these challenges.

Environment Protection Agency (EPA) define biopesticide as “Biopesticides include naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants or PIPs).” Most commonly used biopesticides are living organism which kills specific pest.

Biopesticides include biofungicides (*Trichoderma* spp), bioherbicides (*Phytophthora* spp) and bioinsecticides (*Bacillus thuringensis*). Use of biopesticides has many advantage like (i) environmentally safe and easily degradable (ii) target specific (iii) donot cause any kind of pollution etc. Chemical pesticides are highly costly comparison to biopesticides. Under Section 9 (3) of Insecticides Act, 1968 total registered pesticides are 230 till dated 17-06-2011. In India, biopesticides covers around 4.2 per cent of total pesticides market. At global level, pesticides production is 4.5 per cent while in USA it is 6 per cent however, in India it is 3 per cent of total pesticide production. At present, only 12 biopesticides including neem based and microbial formulation based are registered in India under Insecticides Act, 1968. Biopesticides usage in India rose 23 per cent from 2010-11 to 2016-17 while chemical pesticides only 2 per cent. According to data from the Directorate of Plant Protection, Quarantine & Storage, Union Ministry of Agriculture & Farmers Welfare, show that in 2010-11 the all-India consumption of biopesticide was 5,151 tonnes, which has risen to 6,340 tonnes for 2016-17.

Biopesticides and their benefits

Factors	Benefits of biopesticides
Cost effectiveness	Costlier but reduced number of applications
Persistence and residual effect	Low, mostly biodegradable and self perpetuating
Knockdown effect	Delayed
Handling and Bulkiness	Bulky: Carrier based Easy:Liquid formulation
Pest resurgence	Less
Resistance	Less prone
Effect on beneficial flora	Less harmful on beneficial pests
Target specificity	Mostly host specific
Waiting time	Almost nil
Nature of control	Preventive
Shelf life	Less

Characteristics of biopesticides

- Provide protection to the crop throughout their crop growth period.
- Do not cause toxicity to the crop plants
- Provide effective control against disease.
- Ecologically and environmentally safe.
- Easy to apply to the target site.
- Easy to manufacture
- Can be easy mixed with the bio-fertilizer
- Capable to tolerate heat, desiccation,

On the basis of origin, biopesticides are classified under

Microbial origin

It contains bacteria, fungus, virus and protozoan as an active ingredient. Various kind of insects, weed, fungal and bacterial diseases are controlled by these pesticides. For specific pest, specific kind of microbial pesticides are available. These days most commonly used microbial pesticides for insect pest is Bt (*Bacillus thuriengensis*) and *Trichoderma* spp. for fungal diseases. Bt releases a toxin which is harmful for insect pest of tomato, Potato, cotton etc. *Trichoderma* sp act through mycoparasitism, competition and antibiosis and quite effective against soil borne pathogen viz *Fusarium* wilt, *Rhizoctonia solani* etc.

NPV (Nucleo polyhedral virus) is an entomopathogenic virus. It destroys larva of insect belonging to order Lepidoptera. These viruses are highly host specific and environmentally friendly. It is found quite effective against various devastating insect of plant like *Helicoverpa armigera*, *S. litura*, *S. exigua*, *Amsacta moorei*, *Agrotis ipsilon*, *A. segetum*, *Anadividia peponis*, *Thysanoplusia orichalcea*, *Adisura atkinsoni*, *Plutella xylostella*, *Corcyra cephalonica*, *Mythimna separata* and *Phthorimaea operculella*.

Plant origin

Pesticidal substances are produced from a plant which is genetically modified. For example Bt gene from bacteria *Bacillus thuriengenesis* into cotton plant against lepidopteran insects. But these plants and genes are regulated by EPA.

Other example plant origin insecticides are Neem based pesticides and Pyrethrum. Neem based pesticides are effective against various insect like Aphid, white fly, brinjal fruit and shoot borer, pod borer etc.

Neem based pesticides are also effective against soil borne plant pathogens like *Ralstonia solanacearum* (bacterial wilt of solanaceous crop). Pyrethrum based insecticides are effective against Fruit and shoot borer of brinjal, pod borer of pulses etc.

Biochemical pesticides

These are naturally occurring substance that interfere in the growth and mating of insects and check their population. These substance can be growth regulator, repellents, attractants, and pheromones.

Insect origin

It includes egg parasitoid, larval parasitoid and predator. Egg and larval parasitoid are those insect which feed on eggs and larva of insect which damage various crops. Predators are those insect which attack other crop damaging insect. Egg parasitoid includes Trichogramma, larval parasitoid includes *Spinttherus dubius* and Predator includes beetles.

Major biopesticides produced and used in India are briefly described below (Table 1)

Neem: derived from Neem plant (*Azaridachta*

indica). It contains toxic ingredient Azadirachtin which inhibit reproductive and digestive process of number of insect pest.

***Bacillus thuringiensis* (Bt):** Most commonly used pesticides and effective against most of lepidopteran insect like American boll worm and stem borer of rice. Bt releases a toxin which damages gut of an insect and kills them.

HaNPV and NPV-S: These are target specific viruses which are effective in controlling lepidopteran insect. These are insect specific viruses. These biopesticides are not commercially available for the management of *Helicoverpa armigera* and *Spodoptera litura*.

Trichoderma spp.: Trichoderma is a fungal biocontrol agent which is effective against soil borne plant pathogens like wilt, root rot, black scurf etc.

It is useful for dryland crop like Ground nut, chick pea, green gram, black gram which is susceptible to soil borne pathogens.

Trichogramma spp.: minute wasp which parasitize egg. They mainly parasitize on lepidopteran insect's egg like sugarcane shoot borer, pink boll worm and shoot bollworms in cotton and stem borer of rice. They are also used against vegetable and fruit insects and pests.

Some success stories about successful utilization of biopesticides and bio-control agents in Indian agriculture include (Kalra and Khanuja, 2007):

Control of diamondback moths by *Bacillus thuringiensis*

Control of mango hoppers and mealy bugs and coffee pod borer by *Beauveria*

Control of *Helicoverpa* on cotton, pigeon-pea,

and tomato by *Bacillus thuringiensis*
Control of white fly on cotton by neem products,
Control of *Helicoverpa* on gram by N.P.V.,
Control of sugarcane borers by

Trichogramma
Control of rots and wilts in various crops by Trichoderma-based products.

Table.1 Biopesticides registered under Insecticide Act, 1968

Serial No	Name of the biopesticides
1	<i>Bacillus thuringiensis</i> var. <i>israelensis</i>
2	<i>Bacillus thuringiensis</i> var. <i>kurstaki</i>
3	<i>Bacillus thuringiensis</i> var. <i>galleriae</i>
4	<i>Bacillus sphaericus</i>
5	<i>Trichoderma viride</i>
6	<i>Trichoderma harzianum</i>
7	<i>Pseudomonas fluorescens</i>
8	<i>Beauveria bassiana</i>
9	NPV of <i>Helicoverpa armigera</i>
10	NPV of <i>Spodoptera litura</i>
11	Neem based pesticides
12	Cymbopogon

Future prospects of Biopesticides in India

Identification of novel source of biopesticides is required.
Research is required in the use of more than one microbes as biopesticides.
New product formulation should be developed.
Public private approach is required for in biopesticides sector.
Robust supply chain management is required.

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