# Biopesticides: An ecofriendly approach for pest control

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**ABSTRACT**

An ecofriendly alternative to chemical pesticides is biopesticides, which encompasses a broad array of microbial pesticides, biochemicals derived from micro-organisms and other natural sources, and processes involving the genetic incorporation of DNA into agricultural commodities that confer protection against pest damage. Biopesticides fall into three major classes. The potential benefits to agriculture and public health programmes through the use of biopesticides are considerable. The interest in biopesticides is based on the disadvantages associated with chemical pesticides are discussed. The total world production of biopesticides is over 3,000 tons/yr, which is increasing at a rapid rate. India has a vast potential for biopesticides. However, its adoption by farmers in India needs education for maximizing gains. The market share of biopesticides is only 2.5% of the total pesticide market. The stress on organic farming and on residue free commodities would certainly warrant increased adoption of biopesticides by the farmers. Biopesticides being target pest specific are presumed to be relatively safe to non-target organism including humans. However, in India, the registration committee requires the data on chemistry, bioefficacy, toxicity and packaging and labeling, for registration. Pesticide Registration Committee has so far not approved any guidelines for the registration of GM biopesticides. In India, some of the biopesticides like Bt, NPV, neem based pesticides, etc. have already been registered and are being practiced.

**Key words:** Biopesticides, IPM, PIPs, Bt, NPV.

## INTRODUCTION

Agriculture has had to face the destructive activities of numerous pests like fungi, weeds and insects from time immemorial, leading to radical decrease in yields. With the advent of chemical pesticides, this crisis was resolved to a great extent. But the over dependence on chemical pesticides and eventual uninhibited use of them has necessitated for alternatives mainly for environmental concerns. Degraded soils and groundwater pollution has resulted in nutritionally imbalanced and unproductive lands. Violative pesticide residues also sometimes raise food safety concerns among domestic consumers and pose trade impediments for export crops. Therefore, an eco-friendly alternative is the need of the hour. Biopesticides or biological pesticides based on pathogenic microorganisms specific to a target pest offer an ecologically sound and effective solution to pest problems. They pose less threat to the environment and to human health. The most commonly used biopesticides are living organisms, which are pathogenic for the pest of interest. These include biofungicides (*Trichoderma*), bioherbicides (*Phytopthora*) and bioinsecticides (*Bacillus thuringiensis*). The potential benefits to agriculture and public health programmes through the use of biopesticides are considerable. The interest in biopesticides is based on the advantages associated with such products which are: (i) inherently less harmful and less environmental load, (ii)designed to affect only one specific pest or, in some cases, a few target organisms, (iii)often effective in very small quantities and often decompose quickly, thereby resulting in lower exposures and largely avoiding the pollution problems and (iv)when used as a component of Integrated Pest Management (IPM) programs, biopesticides can contribute greatly.

Besides, biopesticides have the following 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<br>Easy:Liquid formulation |
| Pest resurgence | Less |
| Resistence | 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 |

**Biopesticides fall into three major categories:**

**(1) Microbial pesticides** contain a microorganism (bacterium, fungus, virus, protozoan or alga) as the active

ingredient. Microbial pesticides can control many different kinds of pests, although each separate active ingredient is relatively specific for its target pest[s]. For example, 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 produces a protein that is harmful to specific insect pests. Certain other microbial pesticides act by out-competing pest organisms. Microbial pesticides need to be continuously monitored to ensure they do not become capable of harming non-target organisms, including humans.

**(2) Plant-pesticides** are pesticidal substances that plants produce from genetic material that has been added to the plant. For example, scientists can take the gene for the Bt pesticidal protein, and introduce the gene into the plants own genetic material. Then the plant, instead of the Bt bacterium manufactures the substance that destroys the pest. Both the protein and its genetic material are regulated by EPA; the plant itself is not regulated.

**(3) Biochemical pesticides** are naturally occurring substances that control pests by non-toxic mechanisms. Conventional pesticides, by contrast, 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. Because it is sometimes difficult to determine whether a natural pesticide controls the pest by a non-toxic mode of action, EPA has established a committee to determine whether a pesticide meets the criteria for a biochemical pesticide. The growth of total world production of biopesticides is rising and therefore demand and use is also increasing. In India, biopesticide consumption has shown its increased use over the time (Figure 1). In 2005-06, consumption of biopesticides in India stands at 1920 MT (http:// dacnet.nic.in/ppin ipmpest_ main.html).

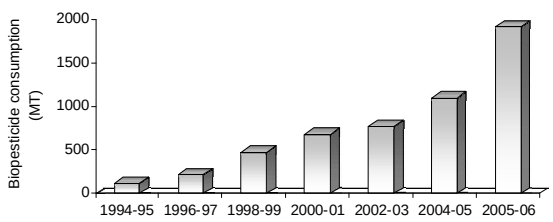


**Figure 1**. Consumption of biopesticides (MT)

India has a vast potential for biopesticides. However, its adoption by farmers in India needs education for maximizing gains. Biopesticides represent only 2.89% (as on 2005) of the overall pesticide market in India and is expected to exhibit an annual growth rate of about 2.3% in the coming years (Thakore, 2006). In India, so far only 12 types of biopesti cides have been registered under the Insecticide Act, 1968 (Table 1)(www.ncipm.org.in/biopesticides/registered.htm).

**Table 1.** Biopesticides Registered under Insecticides Act, 1968

| S. No. | Name of the Biopesticide |
|---|---|
| 1. | *Bacillus thuringiensis var. israelensis* |
| 2. | *Bacillus thuringiensis var. kurstaki* |
| 3. | *Bacillus thuringiensis var. galleriae* |
| 4. | *Bacillus sphaericus* |
| 5. | *Trichoderma viride* |
| 6. | *Trichoderma harzianum* |
| 7. | *Pseudomonas fluoresens* |
| 8. | *Beauveria bassiana* |
| 9. | NPV of *Helicoverpa armigera* |
| 10. | NPV of *Spodoptera litura* |
| 11. | *Neem based pesticides* |
| 12. | Cymbopogan |

Major biopesticides produced and used in India are briefly described below (http://coe.mse.ac.in/taxproj.asp).

***Neem***

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. Recent research carried out in India and abroad has led to the development of effective formulations of neem, which are being commercially produced. As neem is non-toxic to birds and mammals and is non-carcinogenic, its demand is likely to increase. However, the present demand is very small. Although more than 100 firms are registered to produce neem-based pesticides in India, only a handful are actually producing it. Furthermore, very little of the production is sold locally, most being for export markets.

***Bacillus thuringiensis (Bt)***

*Bacillus thuringiensis* is the most commonly used biopesticide globally. It is primarily a pathogen of lepidopterous pests like American bollworm in cotton and stem borers in rice. When ingested by pest larvae, Bt releases toxins which damage the mid gut of the pest, eventually killing it. Main sources for the production of BT preparations are the strains of the subspecies *kurstaki, galeriae and dendrolimus*.

***Baculoviruses***

These are target specific viruses which can infect and destroy a number of important plant pests. They are particularly effective against the lepidopterous pests of

cotton, rice and vegetables. Their large-scale production poses certain difficulties, so their use has been limited to small areas. They are not available commercially in India, but are being produced on a small scale by various IPM centres and state agricultural departments.

***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. Preparation of *Trichoderma* biopesticide is cheap and requires only basic knowledge of microbiology.

***Trichogramma***

Trichogramma are minute wasps which are exclusively egg-parasites. They lay eggs in the eggs of various lepidopteran pests. After hatching, the Trichogramma larvae feed on and destroy the host egg. Trichogramma 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. Trichogramma is the most popular bio-control 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. Trichogramma eggs have to be used within a short period (before the eggs hatch). This limits their production and marketing on a large scale, and is also the reason why Trichogramma is not sold through dealers and shopkeepers.

Some success stories about successful utilization of biopesticides and bio-control agents in Indian agriculture include (Kalra and Khanuja, 2007): 1. Control of diamondback moths by *Bacillus thuringiensis,* 2. Control of mango hoppers and mealy bugs and coffee pod borer by *Beauveria,* 3. Control of *Helicoverpa* on cotton, pigeon-pea, and tomato by *Bacillus thuringiensis,* 4. Control of white fly on cotton by neem products, 5. Control of *Helicoverpa* on gram by N.P.V., 6. Control of sugarcane borers by Trichogramma and 7. Control of rots and wilts in various crops by Trichoderma-based products.

**Opportunities**

The area under organic cultivation (crops) in India is estimated to be around 1,00,000 hectare. Besides, there are lakhs of hectare of forest area being certified as organic. Further, some states like Uttaranchal and Sikkim have declared their states as organic. Moreover, the area under organic crop cultivation may rise because of the growing demand of organic food, a result of increasing health consciousness among the people. This indicates that there is huge scope for growth of the biopesticide sector in India. At the same time increasing population can be fed by organic farming dependence is a big question and unless organic farming yield can be brought equal to that of conventional farming involving the use of agrochemicals etc, the organic farming may not be feasible at the moment. Analysts believe that there would be a greater development in the biopesticides sector (Desai, 1997) . Due to its rich biodiversity India offers plenty of scope in terms of sources for natural biological control organisms as well as natural plant based pesticides. The rich traditional knowledge base available with the highly diverse indigenous communities in India may provide valuable clues for developing newer and effective biopesticide. The stress on organic farming and on residue free commodities would certainly warrant increased adoption of biopesticides by the farmers. Increased adoption further depends on-

1.Concrete evidences of efficacy of biopesticides in controlling crop damage and the resultant increase in crop yield, 2. Availability of high quality products at affordable prices, 3. Strengthning of supply chain management in order to increase the usage of biopesticides. In this regard, an efficient delivery system from the place of production (factory) to place of utilization (farm) of biopesticides is quite essential.

The National Farmer Policy 2007 has strongly recommended the promotion of biopesticides for increasing agricultural production, sustaining the health of farmers and environment. It also includes the clause that biopesticides would be treated at par with chemical pesticides in terms of support and promotion. Further research and development of biological pest control methods must be given priority and people in general and agriculturists in particular must be educated about the handling and use of such control measures. All this will lead to a general understanding about the benefits of biopesticides as green alternative. However, the need in the present day context is on IPM, INM, ICM and GAP and by practicing these the quality of life and health will be assured.

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