Techniques of developing biopesticide formulations

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The living bacteria, fungi, nematodes, protozoa, viruses, etc. and their products used for pest management are called biopesticides. Their application is by inundative or inoculative means. The microbials in use include bacteria (*Bacillus thuringiensis, Pseudomonas fluorescens* etc.), entomopathogenic viruses (nuclear polyhedrosis virus, NPV and granulosis virus, GV), entomopathogenic fungi (*Beauvaria bassiana, Metarhizium anisopilae* etc.) and nematodes particularly *Steinernema thermophillum, S. carpocapsae, Heterorhabditis* sp. etc. against lepidopteran insect pests. Potent isolates have been identified from *Macrophomina phaseolina, Pseudomonas fluorescens, Trichoderma sp., Bacillus subtilis* and others. Fungicide resistant strains of *Trichoderma viride* and *T. virens* have been identified. Several opportunistic fungi namely *Verticillium chlamydosporium, Paecilomyces lilacinus, Exophiala sp.* are stated to hold potential in pest management applications. Opportunistic fungi such as *Gliocladium, Trichoderma* and *Acremonium* affect nematode multiplication and hold potential for use. *Pasteuria penetrans*, an obligate nematode bacterium that infects root knot and cyst nematodes, also holds considerable potential as a biocontrol agent (Parmar, 2010).

Biopesticides formulation in use

A total of 13 products based on bacteria, fungi and virus are registered for use in India (Table 1). Most of the formulations available in India are wettable powder. These are clay based. So it reduces longevity of the active microbes by desiccating and by acting as abrasive agent. These formulations also do not protect the active molecules from external heat and UV light. These are having a very short shelf life.

Table 1. Microbial biopesticides registered for use under Insecticides Act, 1968

Organism	Formulation
Bacteria	
Bacillus thuringiensis var. *israelsensis*	5% WP, 5% AS
Bacillus thuringiensis var. *kurstaki*	5 & 7.5% WP
Pseudomonas fluorescens	0.5 & 1% WP
Fungi	
Ampelomyces quisqualis	2% WP
Beauveria basssiana	1, 1.15, or 2.15% WP, 10% SC
Metarhizium anisopliae	1 & 1.5% WP
Paecilomyces lilacinus	1% WS
Trichoderma harzianum	0.5, 1 & 2 % WP
Trichoderma viride	1% WP
Verticillium chlamydosporium	1% WP
Verticillium lecanii	1.15% WP
Virus	
NPV of *Helicoverpa armigera*	0.43, 0.5, 0.64 &2% AS
NPV of *Spodoptera litura*	0.5 & 2% AS

(WP= Wettable Powder, AS= Aqueous Solution, SC= Suspension Concentrate, WS= Slurry for Seed Treatment
Source: Wahab and Manjunath, 2009)