Seven Biopesticide Active Ingredients You Should Know About

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Biological pesticides are often referred to as soft materials. It is true that their impact is soft to the environment, beneficial insects, wildlife, spray applicators and farm crews.

But there is nothing soft about how biopesticides kill pests.

These seven common biopesticide active ingredients are formulated from naturally occurring bacteria, fungi and viruses. Like the pathogenic diseases and insect pests they control, these beneficial organisms must employ survival strategies to live. These strategies or modes of action allow them to biologically decimate their target pest species.

Yet as destructive as they are to their target pests, beneficial bacteria, fungi and viruses cannot infect or harm non-target species. Their modes of action are specific to certain pests. A virus that infects corn earworm, for example, has no biological activity and therefore no effect on whitefly or honeybees.

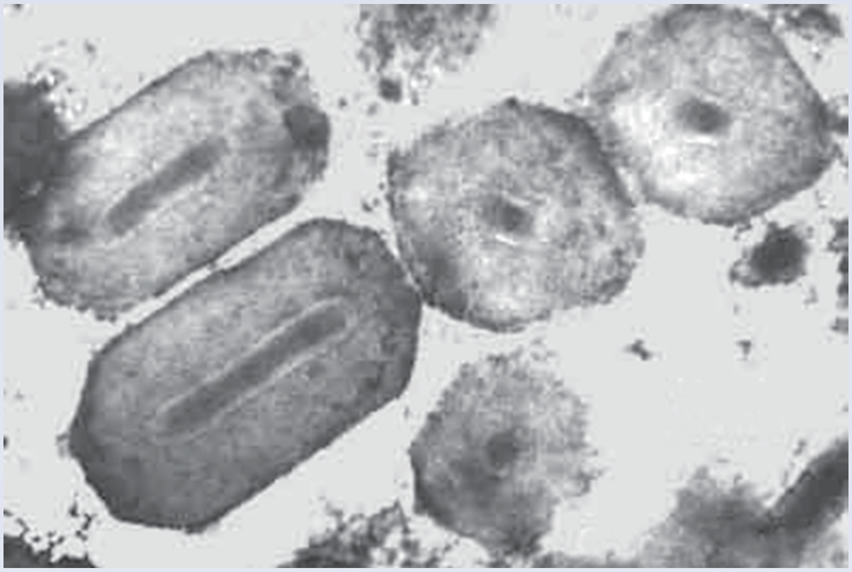
It is important to learn how these biological materials work for you in the field and to appreciate how nature can be both soft and deadly fatal at the same time.

Bacillus mycoides isolate J. Let's start with one of the newest biological active ingredients to be registered for use in the field. Discovered by Montana State University, *Bacillus mycoides* isolate J (BmJ) is a biological plant activator. BmJ triggers a plant's natural immune response in a process known as induced resistance (IR). When the BmJ bacterium is sprayed onto a plant surface, it initiates the immune response by turning on a plant's resistance genes that in turn causes a cascade of metabolic responses. Now fully armed, the plant uses those metabolites to resist infection and disease. It is noteworthy that even though BmJ turns on a plant's immune response to disease, it has no direct effect on pathogens.

Isaria fumosorosea. This fungus is highly pathogenic toward a broad range of pests, including whiteflies, aphids, thrips, soil-dwelling insects and spider mites. Spores applied as a foliar spray or soil drench germinate on contact with the target pest, and the growing fungus then penetrates through the cuticle or natural openings to proliferate inside. The insect or mite stops feeding and dies soon afterward, often with dark spots at infection points as the only visible sign of fungal infection. *I. fumosorosea* can infect all life stages of the pest (eggs, nymphs, pupae and adults).

Bacillus amyloliquefaciens. B. amyloliquefaciens is a broad spectrum preventive fungicide/bacteriacide for foliar and soil application. This bacterium rapidly colonizes root hairs, leaves and other plant

Paecilomyces lilacinus fungus engulfing nematode eggs.
Photo: R. Holland, Macquarie University, Australia



Cydia pomonella granulovirus occlusion bodies (OBs). Photo: BBA, Darmstadt

surfaces and employs multiple modes of action against plant pathogenic bacteria and fungi. *B. amyloliquefaciens* produces antimicrobial metabolites that directly kill plant pathogens by disrupting their cell membranes. It promotes plant growth by improving nutrient uptake and through hormonal interactions. It triggers the plant's immune responses through induced resistance (IR), and it competitively excludes pathogens via colonization to prevent infection.

Paecilomyces lilacinus. A naturally occurring parasite of nematodes, *P. lilacinus* can infect all life stages of the pests, although eggs, egg cysts and infective juveniles are particularly susceptible. When applied to the soil and watered in, the *P. lilacinus* spores move with the water into the rhizosphere (the soil surrounding plant roots) where they come into contact with root knot, cyst and other plant parasitic nematodes. The spores germinate upon contact with host nematodes. The fungus then penetrates and proliferates within the body of the nematode, feeding on its internal organs and eventually killing it.

Cydia pomonella granulosis virus. This insecticidal virus is widely used on apples and pears, and increasingly on tree nuts, to control codling moth. CpGV infects larvae when they ingest it in the form of naturally microencapsulated particles known as occlusion bodies (OBs) contained in CpGv spray products. OBs ingested with treated plant material are broken down in the highly alkaline environment of the larval digestive tract, releasing the virus to infect the cells lining the gut. There, the viral DNA hijacks the nucleus of the cell, causing it to replicate numerous copies of the virus that rapidly spread the infection to other organs. When the larva dies, it "melts" or liquefies releasing billions of new virus OBs that can spread the infection to other codling moth larvae.

Beauveria bassiana. This is another fungus that infects insect pests directly through contact with the insect cuticle. The spores adhere to the host insect, germinate and produce enzymes that attack and dissolve the cuticle, allowing it to penetrate and grow within the insect's body. A common visible indication of insect death is discoloration of the larvae or pupae: as the insect dies, it may change color to pink to brown as its entire body cavity fills with fungal mass. As is the case for *I. fumosorosea* above, the fungus may become visible as it grows out of the host cadaver and sporulates, but this occurs after the target insect has died and is not essential to the efficacy of insect-pathogenic fungal products.

Bacillus thuringiensis. The granddaddy of biopesticides, *Bacillus thuringiensis* or Bt is our most proven, most widely used and most successful of the known biological pesticides. The beneficial bacterium was first isolated in 1901 and has been available commercially since 1938. Formulation technology for many of our biological pesticides has been finely honed over the years by the manufacturers of Bts.

The Bt bacterium produces crystalline proteins (Cry toxins) that are specifically toxic only to certain insects, primarily the larvae of Lepidoptera pests (caterpillars). When ingested by a pest caterpillar, Bt toxin crystals dissolve in the alkaline environment of the larval midgut and are further broken down by Lepidopteran-specific gut enzymes into active toxin proteins. These bind to and destroy the cellular lining of the digestive tract causing the pest to stop eating and die. ■