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Use of bacillus thuringiensis for insect control in Colorado

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Quick Facts

Bacillus thuringiensis (Bt) is a naturally occurring bacterial disease of insects. Insecticides have been manufactured that contain this bacteria as the active ingredient.

Bacillus thuringiensis insecticides are most commonly used against certain leaf and needle feeding caterpillars. Recently, strains of the bacteria have been produced that affect certain fly larvae, such as mosquitoes, and larvae of leaf beetles.

Bacillus thuringiensis is considered safe to humans and non-target species, such as wildlife. Some formulations can be used on essentially all food crops.

Several Colorado pests can be controlled with *Bacillus thuringiensis*.

Bacillus thuringiensis is an insecticide with unusual properties that make it useful for pest control in certain situations. Bt is a naturally occurring bacteria, common in soils throughout the world. Several strains of this bacteria can infect and kill insects. Because of this property, Bt has been developed for insect control. At present Bt is the only "microbial insecticide" in widespread use for insect control.

The insecticidal activity of Bt was first discovered in 1911. However, it was not commercially available until the 1950s. In recent years, there has been tremendous renewed interest in Bt and several new products developed, largely because of the safety associated with Bt-based insecticides.

Properties

Unlike typical nerve-poison insecticides, Bt acts by producing proteins (delta-endotoxin, the "toxic crystal") that react with the cells of the gut lining of susceptible insects. After feeding on these Bt-proteins, the digestive system becomes paralyzed and the infected insect stops feeding within hours. Bt-affected insects generally die from starvation, which can take several days. Occasionally the bacteria enter the blood of the insect and reproduce within the insect. However, in most insects it is merely the reaction of the protein crystal that is lethal and even dead bacteria containing the proteins are effective insecticides.

The most commonly used strain of Bt (*kurstaki* strain) will kill only leaf and needle-feeding caterpillars. In the past decade, Bt strains have been developed that control certain types of fly larvae (*israelensis* strain, or Bti) and are widely used against larvae of mosquitoes, black flies and fungus gnats. More recently, strains have been developed with activity against some leaf beetles, such as the Colorado potato beetle and elm leaf beetle (*san diego* strain, *tenebrionis* strain). Among the various Bt strains, insecticidal activity is quite specific (i.e., Bt strains developed for mosquito larvae do not affect caterpillars). Development of Bt products is currently

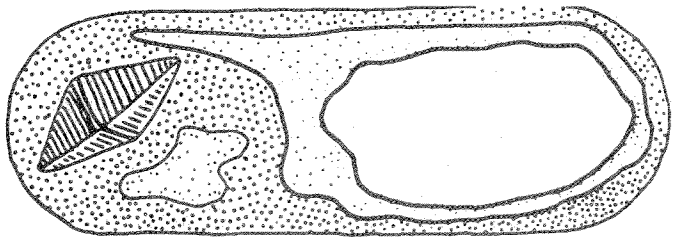

Figure 1: Sporangium of Bacillus thuringiensis, note the protein crystal that has most of the insecticidal activity (greatly magnified).

an active area and many manufacturers produce a variety of products. Effectiveness of the various formulations may differ.

Bt is susceptible to degradation by sunlight and most formulations persist on foliage less than a week following application. Even shorter persistence occurs with some of the newer strains developed for leaf beetle control, which may become ineffective in about 24 hours. Manufacturers are experimenting with several techniques to increase the longevity of Bt after application. One of these involves inserting Bt toxic crystal genes into other species of bacteria

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that can better survive on leaf surfaces (e.g., M-Trak formulation of *san diego* strain).

The highly specific activity of Bt insecticides might limit their use on crops where problems with several pests occur, including non-susceptible insects (e.g. aphids, grasshoppers). As strictly a stomach poison insecticide, Bt must be eaten to be effective and application coverage must be thorough. This further limits its usefulness against pests that are susceptible to Bt but rarely have an opportunity to eat it in field use, such as codling moth or corn earworm that tunnel into plants. The use of additives (stickers, wetting agents) often is useful in a Bt application to improve performance, allowing it to cover and resist washing. Since Bt does not cause a rapid kill, users may incorrectly assume that it is ineffective a day or two after treatment. This, however, is merely a perceptual problem, because Bt-affected insects eat little or nothing before they die.

On the other hand, the specific activity of Bt generally is considered highly beneficial. Since Bt insecticides do not have a broad spectrum of activity (as do most insecticides), beneficial insects are not killed by applications of Bt. This includes the natural enemies of insects (predators and parasites), as well as beneficial pollinators, such as honeybees. Therefore, Bt use can integrate well with other natural controls when trying to control a pest insect. For example, the use of Bt products in Colorado to control corn borers in field corn has been mostly stimulated by its ability to often avoid later spider mite problems; mite outbreaks commonly result following destruction of their natural enemies by less selective treatments.

Perhaps the major advantage is that Bt is essentially non-toxic to humans, pets and wildlife. This high margin of safety recommends its use on food crops or in other sensitive sites where pesticide use can cause adverse effects.

Bt-based products tend to have a shorter shelf life than some other insecticides. Manufacturers generally indicate reduced effectiveness after two to three years of storage, with liquid formulations being more perishable than dry formulations. Shelf-life is greatest when storage conditions are cool, dry, and out of direct sunlight.

Application

The greatest use of Bt involves the *kurstaki* strain used as a spray for control of caterpillars on vegetable crops. In addition, there is now much use of Bt in agriculture as a liquid applied through overhead irrigation systems or in a granular form for control of European corn borer. The treatments funnel down the corn whorl to where the feeding larvae occur. Many formulations (but not all) are exempted from pesticide tolerance restrictions and may be used up to harvest on a wide variety of crops. This aspect of Bt registrations also makes it useful in pesticide applications where pesticide drift onto gardens is likely to occur, such as treating trees and shrubs. The exceptional safety of Bt products also makes them useful where exposure to pesticides during mixing and application is likely.

In the control of mosquito larvae with the formulations containing the *israelensis* strain, the insecticide is placed into the standing water used as a mosquito breeding site. For these applications the Bt usually is formulated as granules or solid, slow-release rings or brickettes to increase persistence; rates of use are determined by the size of the water body. Applications are best made shortly after insect eggs are expected to hatch, such as after flooding due to rain or irrigation. Persistence in water is longer than on sun-exposed leaf surfaces, but it may need to be reapplied when favorable mosquito breeding conditions persist for several weeks. Although the *israelensis* strain also is quite specific in its activity, some types of non-biting midges, which can be used as food for fish and wildlife, also are susceptible and may be affected. (For more information on mosquito control, refer to Service in Action sheet no. 5.526, *Mosquito Control.*)

Use of Bt (*israelensis*) for control of fungus gnat larvae involves drenching the soil. Bt applied for control of elm leaf beetle or Colorado potato beetle (*san diego* strain, *tenebrionis* strain) is sprayed onto leaves in a manner similar to the formulations used for caterpillars. (Bt does **not** control shore flies, another common fly found in greenhouses.)

Insects Controlled by *Bacillus thuringiensis*

Colorado insects that may be controlled with the *kurstaki* strain of Bt (Biobit, Dipel, MVP, Steward, Thuricide, etc.) include the caterpillar stage of the following:

Vegetable insects

Cabbage "worms" (cabbage looper, imported cabbageworm, diamondback moth, etc.)
Tomato and tobacco hornworm

Field and forage crop insects

European corn borer (granular formulations have given good control of first generation corn borers)
Alfalfa caterpillar, alfalfa webworm

Fruit crop insects

Leafrollers	Achemon sphinx

Tree and shrub insects

Tent caterpillars	Fall webworm
Leafrollers	Red-humped caterpillar
Spiny elm caterpillar	Western spruce budworm
Pine budworm	Pine butterfly

Colorado insects that may be controlled with the *israelensis* strains of Bt (Vectobac, Skeetal, Gnatrol, Bactimos, etc.) include larvae of the following:

Mosquito	Blackfly
Fungus gnats (in greenhouses)	

Colorado insects that may be controlled with the *san diego* and *tenebrionis* strains of Bt (Trident, M-One, M-Trak, Foil, Novodor, etc.) include larvae of the following:

Colorado potato beetle	Elm leaf beetle
Cottonwood leaf beetle	

Always read and follow label directions before selecting and using any pesticide!