Bacillus thuringiensis applied as a spray

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Bacillus thuringiensis (*Bt*) is a species of bacterium found in the soil. It was isolated in 1901 and named in 1911. It was used as a commercial biological insecticide for the first time in the United States in 1958. *Bt* kills caterpillars, some fly larvae and some beetle larvae but does not kill other organisms. A few strains of *Bt* are available in products used in the United States. *Bt* var. *kurstaki* is toxic to lepidopteran (butterfly, skipper and moth) larvae; *Bt* var. *aizawai* is toxic to wax moth larvae; *Bt* var. *israelensis* is toxic to mosquito, midge, fungus gnats and blackfly larvae; *Bt* var. *galleriae* is toxic to larvae of May or June beetles (white grubs); *Bt* var. *tenebrionis* (or var. San Diego) is toxic to Colorado potato beetle, elm leaf beetle and willow leaf beetle larvae. However, it does not kill all leaf beetles.

Because this insecticide kills larvae of butterflies, moths and skippers (lepidopterans), care should be taken so that nontarget plants are not treated and drift on other plants does not occur. If the product drifts to a nontarget plant with larvae of lepidopterans on them and is eaten by the larvae, then it will kill them. Monarch butterflies feed only on milkweed plants, so they will not be harmed if the insecticide does not come in contact with milkweed plants.

Bt strains are specific to the insects they kill; therefore, identifying the injurious insect is extremely important. The correct strain must be applied to susceptible insects. Applications of *Bt* to insects that are not susceptible will not kill them. It does not kill predators, parasites or bees. *Bt* is most effective against young larvae and usually does not kill insects in the adult or other growth stages. Thus, inspections should be made frequently and applications made while larvae are small. Insects must eat *Bt* for it to be effective, and good coverage of the plant is important. Some insects do not eat the outside of the plant part they attack, so applications of *Bt* on the surface of the plant will not kill them. For example, the pecan nut casebearer (a moth) bites the outside of nutlets and spits it out. This insect eats the inside of nutlets and does not eat the *Bt*.

Bt as a biological insecticide applied to plants is not systemic (moving throughout the plant) or translaminar (moving throughout the leaf) and does not kill on contact. It is not toxic to predators, parasites or pollinators and is listed as an organic insecticide. It is placed in a group of microorganisms that disrupt the midgut membranes of specific insects.

Bt is rapidly deactivated by ultraviolet sunlight. Applications made in the evening and on cloudy or on rainy days last longer. However, heavy rains can wash *Bt* off a plant. Applications become inactivated in one to a few days and may need to be reapplied in three to seven days. Applications for leaf beetles may be effective for only one day. Applications of *Bt* do not result in continuous or long-term insect management, and *Bt* is applied similar to chemical insecticides. Once a solution of *Bt* is prepared, it should be used immediately; especially if the water used to make the solution has a pH greater than 7 (basic).

The effectiveness of *Bt* may be reduced after two or three years of storage. Dry formulations last longer than liquid formulations. *Bt* products should be stored out of sunlight and in cool, dry conditions.

A crystalline toxin and spore is usually produced by *Bt* cells. The toxin is called a delta endotoxin. *Bt* products usually, but not always contain the toxin and spores of the bacterium. Spores may become bacterial cells inside the insect. Once the insect eats the *Bt,* the delta endotoxin is activated in the insect's gut by enzymes and alkaline conditions of the gut. The endotoxin disrupts the cell walls of the gut, and bacterial cells enter the insect's body. Infected insects stop feeding in a few hours and die in a few hours to weeks (frequently two to three days). Different strains of *Bt* have different endotoxins and kill different insects. The endotoxin is not activated in the gut of humans.