

*University of Massachusetts Cooperative Extension System
Integrated Pest Management Program*

USING *B.t.* FOR INSECT CONTROL

WHAT IS *B.t.*?

Bacillus thuringiensis, abbreviated *B.t.*, is a species of bacteria which is common in nature throughout the world. These bacteria live and multiply inside insects and produce spores and protein crystal toxins. The bacteria can kill certain insects and are used as a microbial pesticide. Since the late 1950's, extensive research has isolated many varieties, or subspecies, of *B.t.* and identified which varieties and strains are most effective in controlling certain species of insects. Manufacturers are continually developing methods for culturing the bacteria and formulating pesticides based on *B.t.* spores and toxins. More than 20 different varieties of *B.t.* have been identified. These are some of the varieties and their target pests, currently being used and improved for commercial pest control:

<i>B.t. var aizawai</i>	(Wax Moths and other species)
<i>B.t. var israelensis</i>	"Dipteran active strain" (Mosquitoes, Black Flies and other flies)
<i>B.t. var kurstaki</i>	"Lepidopteran active strain" (Many caterpillars)
<i>B.t. var San Diego</i>	"Coleopteran active strain" (Colorado Potato and Elm Leaf Beetle)
<i>ppB.t. var tenebrionis</i>	" " " " " " " " "

IT IS IMPORTANT TO REMEMBER THAT *B.t.* AFFECTS THE LARVAE, OR IMMATURE FORMS OF THESE INSECTS. *B.t.* HAS LITTLE OR NO EFFECT ON ADULT INSECTS.

HOW *B.t.* WORKS

In order to work, *B.t.* must be eaten by the insect along with plant foliage. After the spores and crystal endo-toxin are ingested, the crystal dissolves and is activated by the high pH of the insect gut. The toxins bind to specific receptor sites on the cells of the gut wall and causes those cells to break apart. Feeding ceases within minutes after ingestion. Death, which is caused primarily by starvation, may take 2-5 days. Spores do penetrate through the spaces in the gut wall and germinate, but the bacteria do not reproduce under field conditions. *B.t.* formulations can be applied to foliage much the same as synthetic insecticides.

WHY USE *B.t.*?

B.t. is considered non-toxic to humans, other mammals, fish and plants. *B.t.* is highly selective; which means it kills only *specific* insects. It does not kill beneficial insects and other organisms, such as ladybeetles, parasitic wasps and other predators. *B.t.* can debilitate pest insects and make them more vulnerable to predators such as birds, spiders and beetles. Parasites may still attack *B.t.* infected larvae, but may not develop as well in them.

B.t. will not contaminate groundwater because it degrades rapidly and becomes a natural component of the organic matter in the soil. Nevertheless, as with any pesticide, *B.t.* products should be handled with care to prevent spills. Since *B.t.* is not toxic to mammals, workers can enter treated fields or landscapes with no waiting period. Vegetables and fruits may be harvested without waiting.

B.t. is compatible with most fungicides and other insecticides. Be sure to check the label, or with the manufacturer, to confirm appropriate tank mixes. *B.t.* is cost effective; it will perform as well as other pesticides at approximately the same cost.

When a susceptible insect eats *B.t.* it will stop feeding within minutes. **Damage** to the plants ceases.

USING *B.t.* EFFECTIVELY DEPENDS ON...

Choosing the correct product. Read the label carefully to choose the **variety**, or subspecies, active against the target pest. Follow the directions for **application rates**. It is important to get **good spray coverage** of all surfaces where insects feed. The ideal droplet size is between 50 and 150 microns. The **pH** of the tank water should be **less than 7.0**. Water at higher pH can activate the *B.t.* prematurely and make it ineffective. Keep packages and containers of *B.t.* shaded and well ventilated during transport and storage. The product stores best in **temperatures** above freezing and below 90 degrees F. Wettable powder formulations have a longer shelf life than liquids. *B.t.* should keep its activity for one to two years if it is stored in a cool, well-ventilated area. Once *B.t.* is mixed in the tank, it should be used within twelve hours.

Timing applications of *B.t.* to coincide with the most vulnerable life stage of the insect will greatly increase its effectiveness. Good timing is best achieved by regular monitoring or scouting. For most insects, the early larval stages are most vulnerable. Plan to treat when there is an abundance of newly hatched larvae and before they begin to develop into the more mature stages. Generally, the best time to apply *B.t.* is in the mid-morning so that there will be at least six hours when temperatures are above 65 degrees F and the target pest is actively feeding. On plants with slick leaves, such as cole crops or oak trees, adding a sticker to the tank mix may improve performance. Other adjuvants are usually unnecessary, but check the product label for details. Rainfall will reduce the effectiveness of *B.t.*. If it should rain within 6-8 hours of application, it may be necessary to make another application.

USE *B.t.* SAFELY

Although *B.t.* is non-toxic to people and other mammals the following precautions should be followed:

- Avoid inhalation of dust or spray mist. The fine organic particles can be irritating.
- Avoid contact with skin, eyes, open wounds or clothing. In one documented instance, *B.t.* spores were retrieved from an infected sore of an applicator.
- Keep *B.t.* products out of lakes, ponds, or streams

The best way to dispose of left-over tank mixes is to apply them broadly to vegetation where the natural processes of degradation will occur.

NEW DEVELOPMENTS WITH *B.t.* PRODUCTS

Researchers and pesticide manufacturers constantly improve *B.t.* products by: **encapsulating** the crystal toxin to make it less susceptible to degradation by sunlight in order to increase the residual action of the product; isolating new, **more toxic strains**; and using genetic engineering techniques to produce strains which are more toxic or toxic to a wider range of species.

Researchers have also learned how to insert genes which make *B.t.* crystals into plants. When the insect eats the plant, called a "**transgenic**" plant, it consumes the crystal. The potential problem with this method of delivering the toxin is that insects may develop resistance to *B.t.* more rapidly because the toxin may be available to the insect throughout its development, for several generations and to an entire local population.

INSECT RESISTANCE TO *B.t.*

Insect resistance to *B.t.* under certain conditions has been documented. The potential for resistance will increase if:

- resistant species are imported on plant material from other areas
- the target pest has no alternative host plants
- all stages of the target pest develop in close association with the host plant.
- *B.t.* is used repeatedly throughout the season and is the only control method used.

By Karen Idoine and Ruth Hazzard.