West Virginia Department of Agriculture
Plant Industries Division

Gypsy Moth Program

PESTICIDE FACT SHEET ON *Bacillus thuringiensis* (Bt)

What is Bacillus thuringiensis?

Bacillus thuringiensis, or Bt, is a naturally occurring spore-forming bacterium that is found throughout the environment. It was first isolated in 1911 by a German entomologist named Berliner from diseased Mediterranean flour moths in Thuringia, Germany, hence the name thuringiensis.

There are currently 22 varieties and 800 strain isolates of Bt, with Bacillus thuringiensis Berliner regarded as the type species. Generally, different varieties affect different insects; but some species, such as gypsy moth, are susceptible to representative strains of more than one variety. The Bt used for agricultural and forest insect control is presently produced from the HD-1 strain of the variety kurstaki. This strain has a fairly broad spectrum of activity against a large number of Lepidoptera pest species and was selected on the basis of its high toxicity to test insects by Dr. H. T. Dulmage of the U. S. Department of Agriculture. Commercial brand name products based on this strain are marketed for agricultural and forest pest control.

How Does Bt Work?

Some bacteria have the capacity to transform themselves into small ovals or spheres, which are highly resistant cells known as spores. Bt is one of these bacteria. Compared with vegetative cells, spores are extremely resistant to adverse physical and chemical agents, enabling them to survive in adverse environments. When Bt forms spores, it also produces a protein body commonly referred to as the crystal. When spore formation is complete, both the spore and crystal are released into the surrounding growth medium. Commercial Bt products are liquid suspensions or wettable powders that contain these spores and crystals as their active ingredients. Bt formulations currently used are aqueous suspensions containing 48 or 76 billion international units (BIU's) per gallon of active ingredient.

Bt is not a contact poison. Caterpillars do not die from being sprayed directly with it or coming into contact with treated surfaces. The spores and crystals must be eaten before they can act. Shortly after ingestion, the highly alkaline (ph>9) digestive system of the caterpillar dissolves the crystal's coating, releasing the toxic protein. This protein causes the gut cells to swell and burst, which in turn paralyzes the gut and stops further feeding. Some gut contents spill into the blood at this point; and in highly susceptible species, the larvae stop feeding within a few minutes and death follows in a few hours. In less susceptible species, the ingested spores invade the blood, germinate and multiply and the caterpillars may not die for 3 to 5 days. Generally, susceptibility to a given dose of Bt is related to the age and size of the insect; young caterpillars are more susceptible than older ones.

How Safe is Bt

All safety data collected within the last 35 years have shown that Bt has no adverse effect on humans and other animals. This lack of toxicity has brought about its exemption from any tolerance requirements on all raw agricultural commodities by the U. S. Environmental Protection Agency. On food crops, it can be used up to the day of harvest and has not entry restrictions on sprayed areas.

What is Bt's Environmental Impact ?

Environmentally, Bt is the least destructive insecticide for gypsy moth control that is commercially available. Its selective toxicity makes it highly suitable for use in integrated pest management programs where it can be combined with parasites, predators, pathogens, and other control techniques. The only nontarget impact that may occur would be on other Lepidoptera present at the time of application; but since all species, and even stages of caterpillar growth within the same species, are not necessarily equally affected by the same dosage rate or the Bt strain being used, the effects should range from no effect through sublethal effects to mortality. Furthermore, those species that are not feeding in the forest canopy for the period that Bt is active are physically removed from any impact. This is particularly true for butterflies, since they occur predominately in open areas and on the edge of forest-field borders. Although spraying of small woodland clearings cannot be avoided, larger open areas are not sprayed, thus minimizing Bt's potential impact on the species in those areas. The sublethal and prolonged mortality effects mentioned above can even be of benefit to gypsy moth caterpillar parasite programs, since they prolong the period of caterpillar vulnerability.

Bt and Gypsy Moth

Bt's high degree of environmental safety and recently improved efficacy has placed it at the top of alternative materials for most gypsy moth suppression projects. In certain situations more than one application may be necessary to achieve suppression or eradication objectives; but generally, one proper application can be expected to provide good foliage protection. Population reduction in the form of residual egg mass density, however, can be highly variable. Generally, you would expect to reduce gypsy moth populations by up to 60% to 70%.

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