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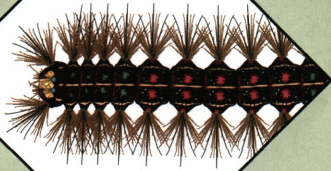
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Bt: One Option for Gypsy Moth Management

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Are you familiar with gypsy moth caterpillars? If not, chances are these big, hairy caterpillars will get your attention soon!

Gypsy moth was introduced into Massachusetts from Europe in 1869. Despite many efforts to eradicate this exotic pest, populations are now found throughout much of the eastern United States and Canada. Isolated populations were present in Michigan as early as the 1950s and have since spread throughout lower Michigan and much of the Upper Peninsula. The first gypsy moth outbreaks in Michigan occurred in the mid-1980s. Since then, much of lower Michigan has experienced at least one gypsy moth outbreak. This pest continues to spread into Wisconsin, Indiana and other North Central states.

Gypsy moth caterpillars hatch from eggs in late April or May. The caterpillars feed for six to eight weeks on the leaves of trees in forest, rural and urban areas. Oak trees are their favorite hosts, but the caterpillars also feed on aspen, willow, crab apple and at least 300 other trees and shrubs. Defoliation can be severe and may weaken or sometimes kill trees. Trees weakened by defoliation can become more susceptible to other pests.

A gypsy moth outbreak can be unpleasant for residents in an affected area. Large caterpillars are abundant, and may wander in search of cool, shady areas, often resting on the sides of houses and trees during the day. In addition, caterpillar droppings, known as frass, rain down on driveways and picnic tables. Some people experience skin or eye rashes or respiratory allergies when they are exposed to the hairs on the caterpillars.

Most gypsy moth outbreaks typically last two to four years in urban areas, then collapse, usually



Gypsy moth caterpillars can feed on 300 different trees and shrubs.

because the caterpillars die from viral and fungal diseases. Parasites, predators, starvation and unfavorable weather may also help reduce gypsy moth numbers. Populations remain low for a few years until some unknown factors trigger the next outbreak.

Though the gypsy moth will never go away, you have a variety of options to help manage this pest during outbreaks. One option involves the use of Bt to protect tree foliage and reduce the annoyance caused by gypsy moth caterpillars during an outbreak. Bt or Btk refers to a microorganism called *Bacillus thuringiensis* var. *kurstaki*. Bt has been widely adopted for gypsy moth control because of its efficacy, its low toxicity to other animals and its ease of use. This bulletin is designed to answer some frequently asked questions about Bt.



What is Bt?

Bt is the abbreviation for *Bacillus thuringiensis*, a native bacterium that is commonly found in soil and on plants. Thousands of Bt strains exist in nature, each with its own unique characteristics. Most Bt strains are insect pathogens that cause disease in specific groups of insects. Several strains of Bt are registered with the U.S. Environmental Protection Agency (EPA) as insecticides. Though Bt products can be highly effective in controlling specific groups of insects, they have little impact on populations of other animals. Therefore, sprays made with Bt are much less harsh on the environment and on non-target organisms than conventional insecticides.

The Bt products used to control gypsy moth during outbreaks are made from a single strain of Bt known as *Bacillus thuringiensis* var. *kurstaki* HD-1. This type of Bt specifically affects caterpillars. It has not been genetically modified. Bt var. *kurstaki* is applied to control many species of caterpillars, including pests of agricultural crops and forests in the United States, Canada, Europe, Asia, Australia and other areas. Many organic farmers and conventional farmers use Bt to control leaf-feeding caterpillars on vegetables, fruits and other crops. Bt has been used to control gypsy moth in the northeastern United States since 1961 and in Michigan since 1985.

How does Bt control the gypsy moth?

When Bt grows, it produces spores and non-living protein crystals. When caterpillars eat Bt, the protein crystals dissolve in their digestive system and become toxic. This can occur only in caterpillars because of the many unique conditions present in their digestive system. For example, caterpillars have an alkaline digestive system, while humans and many other animals have acidic digestive systems. Soon after caterpillars eat leaves that were sprayed with Bt, they stop feeding. If the caterpillars consume enough Bt, they die after a few days from a combination of starvation, damage to their digestive system and bacterial growth within their bodies.

There are a few unusual but important things to remember about the way Bt works:

- Bt must be eaten by caterpillars to be effective. Therefore, the leaves of trees or shrubs must be well coated with Bt.
- Young gypsy moth caterpillars are more sensitive to Bt than older, larger caterpillars. This is why Bt must be applied soon after gypsy moth caterpillar eggs hatch. Older, larger caterpillars may become ill but can often survive a Bt application.
- Caterpillars stop feeding soon after consuming leaves treated with Bt but often do not die until two or three days later.

What ingredients are present in a Bt product?

Commercially available Bt products are composed of two major components: the active ingredients and the inert ingredients.

The **active ingredients** in products used to control gypsy moth are Bt *kurstaki* HD-1 spores and protein crystals. Bt *kurstaki* HD-1 is a naturally occurring bacterium and is not genetically engineered.

Inert (non-active) formulation ingredients are added to the Bt spores and crystals. These ingredients make it easier to mix, spray and store the product. These ingredients are typically food-grade additives that appear on the U.S. Food and Drug Administration's "Generally Recognized As Safe" list (described in the Federal Food, Drug, and Cosmetic Act and Title 21, Code of Federal Regulations).

How does Bt differ from conventional chemical insecticides?

Unlike Bt, conventional insecticides are man-made chemicals that usually affect the nervous systems of insects and other animals. These products will kill most insects that consume treated leaves. Furthermore, conventional insecticides will also kill most insects that come into contact with the material, even if they don't feed on treated leaves. This means that conventional insecticides can kill a variety of non-target insects such as other kinds of caterpillars, pollinators, and beneficial predators and parasitoids.

How long does Bt last?

Most of the Bt sprayed on tree foliage is destroyed by sunlight and microbial activity within a few days. Some Bt spores and crystals can reach the soil, carried by rain, wind or Bt-killed caterpillars that drop to the ground. Some become buried in the soil and may remain there for weeks or even months because they are protected from the damaging effects of the sun. Bt will not be present in the soil at adequate levels to control gypsy moth caterpillars, however. This is why Bt must be reapplied to tree foliage each year during a gypsy moth outbreak.

Does Bt harm other insects?

Bt is much more selective than conventional chemical insecticides, but it can affect many other kinds of foliage-feeding caterpillars if they consume treated leaves. This is a good reason to use Bt only when gypsy moth populations are at high levels. Some caterpillar species are more sensitive to Bt than gypsy moth; others are less sensitive. Scientists have studied non-target species of cater-



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pillars after Bt was sprayed for gypsy moth suppression. They found that populations of native species recover or recolonize an area relatively quickly. Bt *kurstaki* has little or no effect on the large majority of insects, including honeybees, lacewings, ladybird beetles and other beneficial species. This is a significant benefit of using Bt rather than conventional chemical insecticide products, which are toxic to many kinds of insects.

How safe is Bt for humans?

After 40 years of testing and widespread use, Bt has demonstrated minimal hazards to mammals, birds, fish, beneficial insects and other non-target organisms. To ensure the continued safety of Bt for the public, the EPA administers an extensive system of regulatory safeguards. These include requirements for mammalian and environmental toxicology testing of the Bt active ingredients and formulated Bt products. Quality control procedures are also in place to ensure the safety of each batch of the Bt product.

As part of its regulatory function, the EPA recently conducted a reassessment of Bt safety. This reassessment confirmed earlier findings: "...the lack of any reports of significant human health hazards of the various *Bacillus thuringiensis* strains..." (EPA document #EPA738-R-98-004, March 1998).

Major studies were recently conducted in New Zealand when populated areas were repeatedly sprayed with Bt to control another introduced pest, the white-spotted tussock moth¹. A key citation in a report on the New Zealand study stated: "...The data support the belief that they [*Bt kurstaki* products] can be safely used in environments in which human exposure is likely to occur." However, if you are concerned about your exposure to Bt, remaining indoors during the spray application is a good, common-sense strategy.

Will Bt get rid of ALL my gypsy moth caterpillars?

It's important to realize that a Bt spray will probably not kill every gypsy moth caterpillar on your property. When Bt is applied properly, however, it can help protect

your trees from serious defoliation and reduce the annoyance caused by gypsy moth caterpillars during an outbreak.

Is it possible to buy Bt to spray caterpillars in my own garden?

Yes, several commercially available Bt products can be used to control caterpillars on shade trees, fruit trees or plants in the garden. Both liquid formulations and wettable powders are available from local garden stores. Be sure to follow the directions on the label.

Where can I get more information on Bt?

More information on Bt can be found by visiting the web sites of the EPA at

<http://www.epa.gov/epahome/search.html>

the U.S. Food and Drug Administration at:

<http://vm.cfsan.fda.gov/~dms/>

or the Extension Toxicology Network² at:

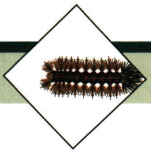
<http://ace.orst.edu/cgi-bin/mfs/01/pips/bacillus.htm>



Oak trees (left) can be severely defoliated by gypsy moth caterpillars. Red maple trees (right) are rarely defoliated by gypsy moth.

¹1998 Report to the Ministry of Forestry prepared by Jenner Consultants Ltd., Parnell Auckland, New Zealand, to address issues raised in 1995 by Diane Wharton, Society Targeting Overuse of Pesticides, North Vancouver.

²EXTOXNET is a cooperative effort of the University of California-Davis, Oregon State University, Michigan State University, Cornell University and the University of Idaho. Primary files are maintained and archived at Oregon State University.



Are there other options for controlling gypsy moth caterpillars?

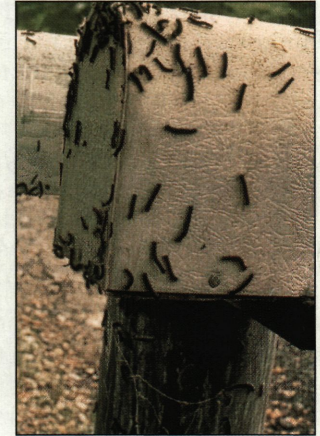
Yes, there are several other approaches to gypsy moth control that are summarized here. Many of these management strategies are explained in more detail in the MSU Extension publications listed below. Contact your county MSU Extension office for free copies of these and other bulletins on gypsy moth biology, natural enemies and management options.

■ A gypsy moth egg mass typically contains 250 to more than 1,000 eggs. These egg masses can be destroyed by scraping them into a can or bucket of soapy water. Hiding bands or sticky bands can be used on shade trees in your yard to help reduce the number of caterpillars feeding on the foliage of the trees. These methods are most effective when gypsy moth populations are at low or moderate levels and when only a few trees require protection. See bulletins E-2634, E-2300 and E-2301 for more information on physical and cultural controls for gypsy moth.

■ Learn to recognize the natural enemies of gypsy moth that occur throughout Michigan. A virus disease and a fungal disease are especially important in con-

trolling populations. Several predatory and parasitic insects also attack gypsy moth eggs, caterpillars or pupae. See MSU bulletins E-2700, E-2604 and E-2622 for information on how to identify and conserve these natural enemies.

■ Conventional chemical insecticides can effectively control gypsy moth in some situations. However, precautionary measures must be followed to avoid toxicity to humans, animals and other non-target organisms. Remember that these products usually affect a broad spectrum of insects, including beneficial predators, parasitoids and pollinators. Always follow all label instructions when using these or any other pest control product.



Large gypsy moth caterpillars can be annoying during outbreaks.

Contact your county MSU Extension office for copies of these gypsy moth bulletins:

- E-2634 Gypsy Moth and Your Shade Trees.
- E-2633 Common Oak Defoliators in Michigan (It's Not Always Gypsy Moth!).
- E-2700 Natural Enemies of Gypsy Moth: The Good Guys!
- E-2299 Comparison of the Gypsy Moth, Eastern Tent and Forest Tent Caterpillars.

- E-2300 Cloth Banding Trees to Suppress the Gypsy Moth.
- E-2301 Barrier Bands to Suppress the Gypsy Moth.
- E-2585 Pheromone Traps and the Gypsy Moth.
- E-2604 *Entomophaga maimaiga*: a Natural Enemy of Gypsy Moth.
- E-2622 *Calosoma sycophanta*: A Natural Enemy of Gypsy Moth Larvae and Pupae

This bulletin was reviewed by Dr. Wendy Gelernter, PACE Consulting, San Diego, California; Dr. Kenneth Raffa, University of Wisconsin; Dr. Richard Reardon, USDA Forest Service, Forest Health Management Center; and Dr. John Witter, University of Michigan.