

LABORATORY AND FIELD STUDIES ON THE EFFECTS OF *Bacillus thuringiensis* ON NON-TARGET LEPIDOPTERA

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FIELD STUDIES

Bacillus thuringiensis (*B.t.*) is one of the insecticides considered effective for suppression of gypsy moth infestations, and it is considered to one of the most selective in terms of its effects on other insects. Although *B.t.* is touted to be "environmentally safe", there is a paucity of field data to support this claim, particularly as it relates to the effects of *B.t.* on native Lepidoptera. Increasingly, lepidopterists, environmentalists, the general public, and certain forest managers have expressed concerns that *B.t.* may, in fact, have a significant negative impact on non-target Lepidoptera. Although it has been stated that most lepidopterous larvae are present in the field long after *B.t.* applications (and therefore are not affected by early season gypsy moth spraying), and that the larvae of most Lepidoptera would be unaffected by *B.t.* because they are not canopy

feeders, this may not be true for a significant number of species. In fact, we know far too little about the larval stages of most native Lepidoptera to safely make the above generalizations. Furthermore, we have little or no information concerning the indirect negative impacts that *B.t.* application could have on pollination by Lepidoptera, or the impact that *B.t.* applications could have on Lepidoptera that serve as food for other wildlife (birds, bats, etc.).

In an attempt to determine the effects of aerially-applied *B.t.* on non-target Lepidoptera, a field research program was initiated in 1991 in the Goshen Wildlife Management Area, Rockbridge County, Virginia. Cooperating in this research are: the USDA Forest Service (Northeastern Forest Experiment Station and Northeastern Area State & Private Forestry/AIPM); Rockbridge County, VA; Albemarle County, VA; the Virginia Division of Game and Inland Fisheries; the Virginia Department of Agriculture and Consumer Services; Washington and Lee University; and the Shenandoah Valley Agricultural Experiment Station. The *B.t.*/non-target program is a 3-year effort designed to determine if *B.t.*, applied at a rate (36 BIU/Ac) used in gypsy moth suppression programs, has an effect on populations of native, non-target Lepidoptera.

The first year of the Virginia program (1991) was a baseline sampling year, aimed at determining which species of lepidopterous larvae and adults are present in the ten 50-acre plots in the study area. *B.t.* will be applied to half of these plots in 1992, and larval and adult sampling will be repeated as in 1991. Post-treatment sampling will be conducted in 1993 to determine if any effects persist in the year following *B.t.* application.

Populations of non-target Lepidoptera will be monitored using larval and adult sampling during the period March to September for the three years of the study. Larval sampling involves collection of foliage samples (and associated larvae) from three levels in the forest: (1) forest canopy (18-22 m); (2) understory trees (4-6 m); and (3) shrub layer (20-25 cm). The foliage is collected in large plastic bags as it is removed, and is then taken to a laboratory for processing. Leaves and stems in each bag are carefully examined, and all lepidopterous larvae are removed, identified where possible, counted, placed in

plastic rearing cups, and reared to adults (if necessary to confirm identification). Larval sampling will be conducted 2-3 days prior to Bt application, and then 7 and 14 days after application. Using the numbers of larvae collected on these sampling dates, we will ascertain if there are any within-year (1992) and between-year (1993) effects on native Lepidoptera as noted by comparing the number of larvae of selected species found in treated and untreated plots before and after Bt application.

Adult moths will be sampled each of the three years of the study using a single light trap operated in the center of each plot twice per week from March until September. In 1991, the thousands of moths taken in light traps have been used to establish a voucher collection of pinned specimens, and to develop a base of information on species presence and abundance in each of the 10 plots. Light trapping will be repeated in 1992 and 1993 to determine post treatment abundance of moths in treated and untreated plots in the first and second year after Bt application.

LABORATORY STUDIES

Bioassays were conducted in 1990 and 1991 to determine the effects of Bt on larvae of selected native Lepidoptera under laboratory conditions. To date, 16 species (2 Geometridae, 3 Saturniidae, and 11 Noctuidae) have been evaluated in these assays.

Foliage to be subjected to larval feeding is treated with Bt in a spraytower apparatus that simulates the aerial application of Bt in the field. Following foliar treatment, larvae are caged on treated and untreated foliage and their survival and development is monitored. All larvae are evaluated in the instar that they would be at the time of typical Bt application in the field. Larvae that are highly susceptible to Bt infection die in a matter of a few days (similar to second instar gypsy moth larvae). Larvae that are less susceptible to infection die after a long period, or complete a delayed development. Non-susceptible larvae complete development at the same rate as larvae on untreated foliage.

Of the 16 species assayed to date, 5 (2 Saturniidae, 3 Noctuidae) are highly susceptible to Bt infection, 8 (1 Saturniidae, 2 Geometridae, 5 Noctuidae) are moderately susceptible, and 3 (all Noctuidae) are apparently little affected as the result of consuming

Bt-treated foliage. Significant intergeneric differences in response to *B.t.* were recorded for one genus of moths, the *Catocala*. Based on the laboratory assays to date, we conclude that we cannot generalize about the effects of *B.t.* on larvae of native Lepidoptera. The effects appear to vary considerably between species and even between species within certain genera. In some species, early instar larvae succumbed quickly following consumption of *B.t.*-treated foliage, while in other species, early instar larvae seemed to be less affected. On the other hand, in those species where late instar larvae were assayed, most were able to complete development on *B.t.*-treated foliage. In one species, however, last instar larvae succumbed in just two days following consumption of treated foliage.

Laboratory bioassays will be continued in 1992, when an additional 10-12 species will be evaluated.