RECENT FIELD RESEARCH USING MICROBIAL INSECTICIDES AGAINST GYPSY MOTH

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Field research since 1978 using different formulations, dosages, and spray volumes of Bacillus thuringiensis Berliner (Bt) against the gypsy moth are reviewed. Problems associated with inconsistent results are discussed, with an emphasis on timing of application. Recommendations for proper use of Bt are presented along with suggestions for further studies on the use of Gypchek and development of better spray technology for both Bt and Gypchek.

Introduction

Two microorganisms are frequently used against gypsy moth, Lymantria dispar L; Bacillus thuringiensis Berliner (Bt) and a nucleopolyhedrosis virus (NPV). Field trials and research experiences with Bt in the 1960's and 1970's were summarized and reviewed by Harper (1974), Dubois (1981) and Cibulsky (1982) and will not be covered in this paper. NPV research is still centered on formulation and increased potency. Although NPV (GYPCHEK®) became commercially available in 1983 through Reuter Laboratories, Inc., it has not been used in the field except in research or plot studies. Lewis et al. (1979) and Lewis (1981) reviewed research on NPV and more recent summaries can be found in the 1981 and 1982 National Gypsy Moth Review Proceedings and in Laboratory Reports from the USDA-APHIS Otis Methods Development Center. This paper will concentrate on the recent studies and field experiences with Bt used against the gypsy moth.

Review of Field Trials 1978-1983

1978 and 1979

In 1978 and 1979 Bt was used operationally in suppression programs in only a few northeastern states. The two major Bt formulations applied aerially against the gypsy moth were Thuricide 16B® and Dipel-WP®. Most states relied on chemical insecticides, such as SEVIN® and Dylox®, to combat the gypsy moth because Bt was still trying to overcome its reputation as an environmentally desirable insecticide that produced inconsistent results. Field studies were conducted in New Jersey (McLane and Finney 1979) and New York (Abrahamson et al. 1981) with Thuricide 16B or 24B and results compared favorably with chemical insecticides in some cases and poorly in other cases. In New York State, where Bt was used operationally in several counties, it was applied at 8 BIU's/acre in a spray volume of 128 oz. Half of the treatment blocks were treated with a second application. Control was marginal when compared to results using chemical insecticides. Improper timing of application, poor weather conditions, lack of knowledge by spray applicators in the use of biological insecticides, inadequate mixing equipment and inconsistent spray deposition and droplet size were all factors that contributed to Bt's poor performance (Abrahamson et al. 1981).

1980

The gypsy moth defoliated over 5.1 million acres in the northeast during 1980. Spray acreage increased dramatically in all affected states, and the need for environmentally safe and effective insecticides intensified. Improved formulations of Bt were developed and tested. Wettable powders were no longer desirable and formulations of Dipel 4L, Thuricide 32B and/or Thuricide 16B were field tested in Massachusetts and Rhode Island (McLane and Finney 1980), New York (Abrahamson et al. 1981) and Pennsylvania (Fusco 1982a). Rates were still 8 or 8 + 8 BIU's/acre in a spray volume of 128 oz except for one test at 32 oz/acre. Foliage protection and reduction in larval and egg mass densities were satisfactory in many cases, however results were not always consistent and in some cases exceptionally poor. Again, the reasons for poor results could be attributed to a number of factors, the most common being improper timing of the application. Once the gypsy moth larval population reached late 3rd and early 4th instars the effectiveness of Bt diminished dramatically. It also became more apparent in 1980 that spray equipment, such as aircraft/nozzle configurations and mixing apparatus, and weather conditions played an important role in spray coverage and program results. Uniform spray deposition (20-25 drops/cm^2) and droplet sizes in the 100-200 micron range are necessary in order for Bt to control gypsy moth populations and/or protect foliage.

1981

Gypsy moth defoliation exceeded 13 million acres in 1981 and chemical insecticides were heavily used throughout the northeast. However, Thuricide 16B or Dipel 4L was used operationally in New Jersey, New York, Pennsylvania, Massachusetts and Maine. Bt use increased, but again results against dense populations were inconsistent when compared to chemical insecticides. Research on population reduction and foliage protection were conducted in Massachusetts with Thuricide 16B and 32BX (Burnham 1981 and McLane and Finney 1981) and in Connecticut with Dipel 4L (Andreadis et al. 1982). In Pennsylvania a Bt-parasite interaction study with Dipel 4L was also conducted (Fusco 1982b and 1982c). The above studies used the 8 or 8 + 8 BIU/acre rate in 128 oz spray volume applied aerially except

in Massachusetts where one and two applications of 4 and 12 BIU's/acre were also evaluated. One ground application study also occurred in Connecticut with Dipel 4L at the 8 BIU rate in a spray volume of 100 gallons/acre (Moore and Anderson 1982).

1982

Based on the results from 1980 and 1981, new concentrated formulations of Bt were developed for field testing in 1982 using higher BIU rates (12 and 16 BIU's/acre), and lower spray volumes (48 and 64 oz instead of 128 oz/acre). Tests were conducted in Connecticut with Dipel 4L at 8 + 8, 12 and 16 BIU's/acre in a spray volume of 128 oz (Andreadis et al. 1983); in Pennsylvania with Dipel 4L, Dipel 6L, Thuricide 32LV and Bactospeine at rates of 12, 12 + 12 or 16 BIU's/acre in spray volumes of 128 oz (64 oz for each of the 12 + 12 BIU/acre applications) (Fusco 1983a); in Pennsylvania by the USDA-APHIS with Dipel 4L, Dipel 6L, Thuricide 32LV and Thuricide 48B at rates of 8, 12 or 16 BIU's/acre in spray volumes of 48, 64 or 128 oz (McLane and Finney 1982); in New Jersey with Dipel 4L and Thuricide 32LV at the 12 BIU's/acre in a spray volume of 128 oz (Metterhouse and Balaam 1983a); in New York with Dipel 4L at 8 + 8 and 16 BIU's/acre in spray volumes of 128 oz (Glenister 1982) and a ground application study with Thuricide 32LV at the 12 BIU/acre rate in a spray volume of 100 gallons/acre (Eggen and Abrahamson 1983).

Overall results indicated that one application of these Bt formulations at 12 BIU's/acre in 128 oz spray volume provided foliage protection and reduced egg mass density in the spray blocks. The results from these studies set the stage in 1983 for a large scale suppression program in Pennsylvania with Bt.

1983

During 1983 a number of field studies were conducted throughout the northeast with different formulations of Bt at the 12, 16 or 20 BIU's/acre rate and a number of different spray volumes (24, 32, 48, 64 or 128 oz). These studies were conducted in New Jersey (Metterhouse and Balaam 1983b), Pennsylvania (McLane 1983, Fusco 1983b), and New York (Glenister 1983). Three Dipel formulations (4L, 6L and 8L), four Thuricide formulations (32LV, 48LV, 64LV and 64BX), Bactospeine and Futura were all field tested.

Operational programs using Bt in 1983 were conducted in Pennsylvania, New Jersey, Maryland and West Virginia. Thuricide 32LV, Dipel 4L or Dipel 6L at the 12 or 16 BIU's/acre rate in spray volumes of 64, 96 or 128 oz were evaluated.

The results from the field trials and operational programs indicated that when properly applied, 12 BIU/acre (or higher) in 96 or 128 oz spray volume gave results that were comparable to those obtained with chemical insecticides. Rates lower than the 12 BIU rate or 96 oz spray volume/acre gave variable degrees of foliage protection and egg mass reduction depending on local gypsy moth conditions and other operational factors.

The overriding factor that affected results in these field trials and operational programs was timing of the application so that it coincided with the 2nd and 3rd instars of the gypsy moth. As soon as a majority of the larval population reached the late 3rd and the early 4th instars efficacy dropped dramatically. Application rates of 16 or 20 BIU's/acre provided somewhat better results against 4th instars, but against 2nd and 3rd instars the results were not different than those observed with the 12 BIU's/acre rate.

Conclusions and Recommendations

1. The number one factor to be considered and closely monitored in any spray program using Bt is the developmental stage of the gypsy moth. Bt must be applied after egg mass hatch is completed and larvae are in the 1st-3rd instars. Leaf expansion should be at a minimum of 20 percent. As soon as the gypsy moth reaches the late 3rd to early 4th instar, higher rates of Bt and/or a second application should be considered. If not, application of a chemical insecticide may be necessary.

2. A single application of Bt at 12 BIU's/acre is recommended for operational use in areas with a declining population, or in areas that have building populations with less than 1000 large egg masses per acre. Multiple applications of 12-20 BIU's/acre or switching to a chemical insecticide should be considered in areas with high building populations (> 1000 large egg masses per acre).

3. More studies should be done to evaluate Bt on a range of gypsy moth population densities using low spray volumes with improved aircraft/nozzle spray application systems, such as Micronaire rotary atomizers, which give consistently uniform spray droplet sizes.

4. The newer Bt formulations are definitely better than the older formulations used in the 1960's and 1970's, and with improved application technology (stickers, nozzle types, spray equipment, etc.), results should be more consistent.

5. Research is continuing on newer and more potent Bt strains. The HD-1 strain now currently being used could be replaced by a more potent strain in the future.

6. NPV must be field tested more extensively in various formulations to determine its effectiveness against different population densities and to understand how this microbial can

best be incorporated into state IPM programs. All areas of spray technology must be studied with regard to NPV before it can be used on an operational level.

7. Additional research should be conducted on Bt-parasite interactions.

8. In large scale suppression programs, the effectiveness of a microbial insecticide depends on the amount of time, planning, manpower and monitoring that goes into the effort. The use of biological insecticides on an operational level requires proper application methods, otherwise the program is doomed to failure.

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