OPERATIONAL AND SCIENTIFIC NOTES

FIELD TESTS OF TWO GRANULAR *BACILLUS THURINGIENSIS* (H-14) FORMULATIONS AGAINST SNOWPOOL *AEDES* SPP.

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Bacillus thuringiensis Serotype H-14 [*B.t.* (H-14)] is an entomopathogen with rapid larvicidal activity against mosquitoes and black flies (WHO 1982). Since its discovery by Goldberg and Margalit (1977) this bacterium has undergone rapid commercial development. By the end of 1981, three manufacturers had registered four formulations with the U.S. Environmental Protection Agency for larval mosquito control.

These wettable powder (WP) and flowable concentrate (FC) formulations are very effective larvicides; however, they have some shortcomings in several field situations: (1) aerial application can be difficult because of spray droplet evaporation and drift; (2) heavy canopy or emergent vegetation can intercept spray droplets applied from either air or ground; and (3) *B.t.* (H-14) WP and FC have short residual activities, usually less than 48 hours (Dame et al. 1981, Sebastien and Brust 1981, McLaughlin and Billodeaux 1983).

Granular formulations reduce or eliminate the problems of evaporation, drift, and interception. They are also easy to apply and require no mixing. The Saginaw-Bay Mosquito Control Commission (SBMCC) annually treats ca. 5,000 ha (12,000 acres) of snowpools for spring *Aedes* spp. control. In this paper we report field test results for two granular *B.t.* (H-14) formulations used in this habitat during 1982 and 1983.

The first formulation we tested was a 1.56% *B.t.* (H-14) sand granule. These granules were produced on site in Saginaw, MI, using the SBMCC's formulating equipment and the following procedure: (1) place 45.4 kg (100 lb) of sand in a rotary mixer; (2) with the mixer running, gradually add 0.5 liter (17 fluid oz) of Bio-Treat Binder (Summit Manufacturing, Baltimore, MD) and mix for 5–10 min; (3) with the mixer still running, gradually add 1.5 kg (3 lb 4 oz) of Bactimos 50% WP (Biochem Products, Montchanin, DE) and mix for 10 more min. This formulation contains 109 *Aedes aegypti* (AA) International Toxic Units (ITU) per mg of granules, or 49,531,989 AA ITU per pound.

The *B.t.* (H-14) sand granules were applied to eight snowpools in April, 1982, using Cyclone Seeders. The application rate was 9 kg/ha (8 lb/acre), which is equivalent to 0.3 kg/ha (0.25 lb/acre) of Bactimos 50% WP. Six untreated snowpools in the same area were monitored as check plots. The size of the 14 pools ranged from 6.5–44.5 square meters (70–480 sq ft). We did not monitor water temperature during this test. Species present in these snowpools were: *Aedes c. canadensis* (Theobald) 60%; *Ae. stimulans* (Walker) 33%; *Ae. excrucians* (Walker) 3%; *Ae. s. spencerii* (Theobald) 3%; and *Ae. vexans* (Meigen) 1%. At the time of application most larvae were third or early fourth instars.

The second material we tested was Bactimos Granules (Biochem Products, Montchanin, DE), a corncob formulation containing 5% Bactimos 50% WP by weight. In terms of International Units, these granules contain 175 AA ITU per mg, or 79,379,479 AA ITU per pound. This product was applied at 5.6 kg/ha (5 lb/acre) using both aerial and ground equipment. This rate is equivalent to 0.3 kg/ha (0.25 lb/acre) of the WP.

Bactimos Granules were applied from a Bell 47 G2A helicopter on April 26, 1983. The material was loaded into aluminum saddle tank hoppers (total capacity 275 kg [600 lb]) which fed into electric driven blower fans and dispensed the material through spreaders attached to the rear of the aircraft. The treatment site was a 12 ha (30 acre) woodlot in Thomas Township, Saginaw County, MI, containing numerous snowpools. To check for proper coverage, we placed three plastic tarpaulins (each 11.4 square meters) randomly in the woodlot to collect granules. Larval populations were monitored in 10 of these treated pools.

Bactimos Granules were also applied from the ground to 12 small snowpools in St. Charles Township, Saginaw County, on April 27, 1983. We measured the surface area of each snowpool before treatment, and determined the quantity of granules needed for each based on the 5.6 kg/ha (5 lb/acre) rate. Total surface area of the 12 pools was < 0.4 ha (< 1 acre).

Nine untreated snowpools were used as check plots for the 1983 tests. Four were located at the ground application site, and the other five were near the aerial site. No significant differences in larval counts existed between the two groups of check plots, so we used all nine as checks for both treatments. Water temperatures during the 1983 tests ranged from 3–16°C.

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Mosquito species collected from the 1983 plots (checks and treated combined) were: *Ae. c. canadensis* 66.3%; *Ae. stimulans* 26.7%; *Ae. excrucians* 5.6%; *Ae. vexans* 0.8%; *Ae. triseriatus* (Say) 0.3%; and *Ae. grossbecki* Dyar and Knab 0.3%. Larvae were third and early fourth instars at the time of application.

Sampling locations within the snowpools for all tests were biased, based on expected aggregated clumped larval habitats. All pre- and posttreatment samples were collected with a standard 0.5 liter (1 pint) dipper. On each date samples from a given replicate (n = 10/replicate) were combined and concentrated in the field using a device developed by Fanara (1973). Larvae were then preserved in alcohol and returned to the SBMCC laboratory for counting and species identification. The total number of larvae from each replicate was divided by the sample size to obtain the number of larvae/dip.

Percent reduction in larval counts following treatments, corrected for changes in check plots, was calculated using the formula given by Mulla et al. (1971):

$$\% \text{ Reduction} = 100 - [(C_1/T_1) \times (T_2/C_2) \times 100]$$

where C1 and C2 are counts from check plots before and after treatment, respectively; and T_1 and T_2 are before and after counts from treated plots. Changes in larval counts (number/dip) before and after granule applications were tested for statistical significance using the Wilcoxon signed rank test (Zar 1974). This is the nonparametric analogue of the paired *t*-test. It was used to compare pretreatment larval counts (number/dip) with those obtained each day after treatment.

The *B.t.* H-14 sand granules tested in 1982 gave very good control in woodland snowpools (Fig. 1). Larval counts in the treated pools 48 and 72 hr after application were significantly lower than pretreatment values ($P < 0.005$). Percent reduction was 91.6% after 48 hr and 96.2% after 72 hr. During this same time span no significant changes ($P > 0.3$) occurred in larval counts from the six check snowpools (Fig. 1). No pupae were collected in any of the posttreatment samples from the treated snowpools.

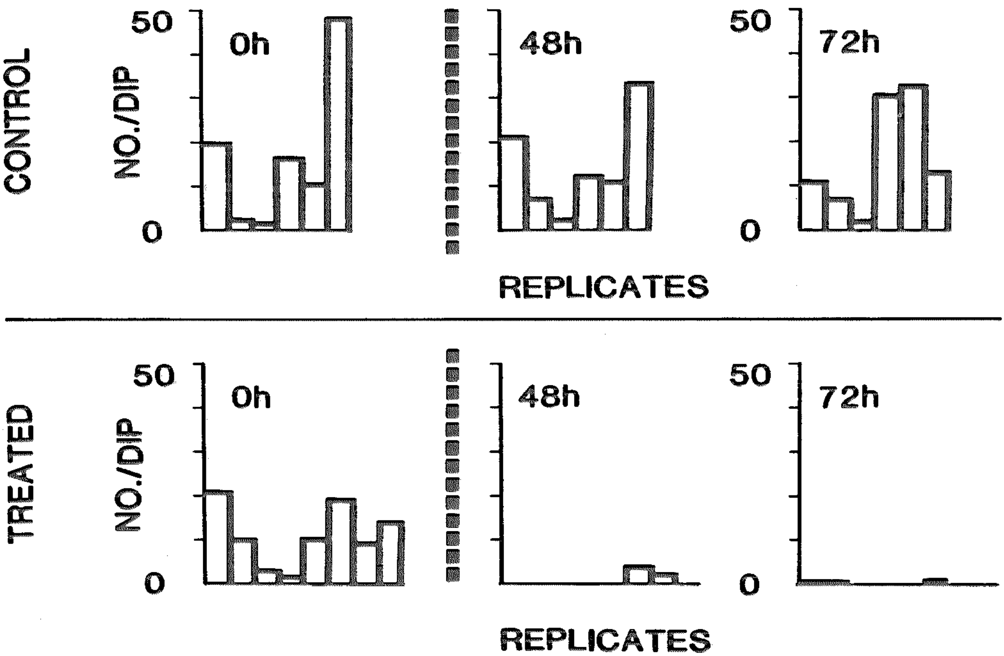

Fig. 1. Larval mosquito counts in six control and eight treated snowpools before (0 hr) and after ground application of Bactimos 1.5% sand granules at 9 kg/ha (8 lb/acre), April 27–30, 1982.

Counts taken 24 hr posttreatment are not presented. Both living and dead larvae were collected and preserved in the field on this date. This made it impossible for the laboratory staff to determine the number of living larvae/dip. No dead larvae were collected on the following days.

The Bactimos Granules also gave good control of snowpool *Aedes* species. In the helicopter test larval counts 1, 2 and 6 days posttreatment were all significantly lower than pretreatment values ($P < 0.005$; Fig. 2). By the sixth day posttreatment, percent reduction (corrected for changes in check plots) averaged 91% (Fig. 2).

Larval counts in the ground plots also decreased significantly following treatment ($P < 0.0025$; Fig. 2). Percent reduction 5 days posttreatment (corrected for changes in check plots) averaged 96%.

Results in Fig. 2 suggested that granules applied from the ground worked more rapidly and effectively than those applied by helicopter. One possible reason for this was an equipment problem we encountered. After the granules had been applied, we discovered some material obstructing flow through one of the helicopter spreaders. Data from the three tarpaulins placed in the woodlot illustrated the results of this problem. At the 5.6 kg/ha (5 lb/acre) rate, 6.4 g of granules should have been collected on each tarp. However, the tarpaulins had 13.6, 4.0 and 1.9 g, or 0.3 to 2.1 × the correct quantity. Considering this uneven application, we feel the results were quite satisfactory.

In summary, both the sand and corncob *B.t.* (H-14) granules we tested possessed good larvicidal activity, and they caused high larval mortality in test populations.

We thank the field and laboratory staff of the Saginaw-Bay Mosquito Control Commission for their help in the collection and identification of larval mosquitoes and the application of test

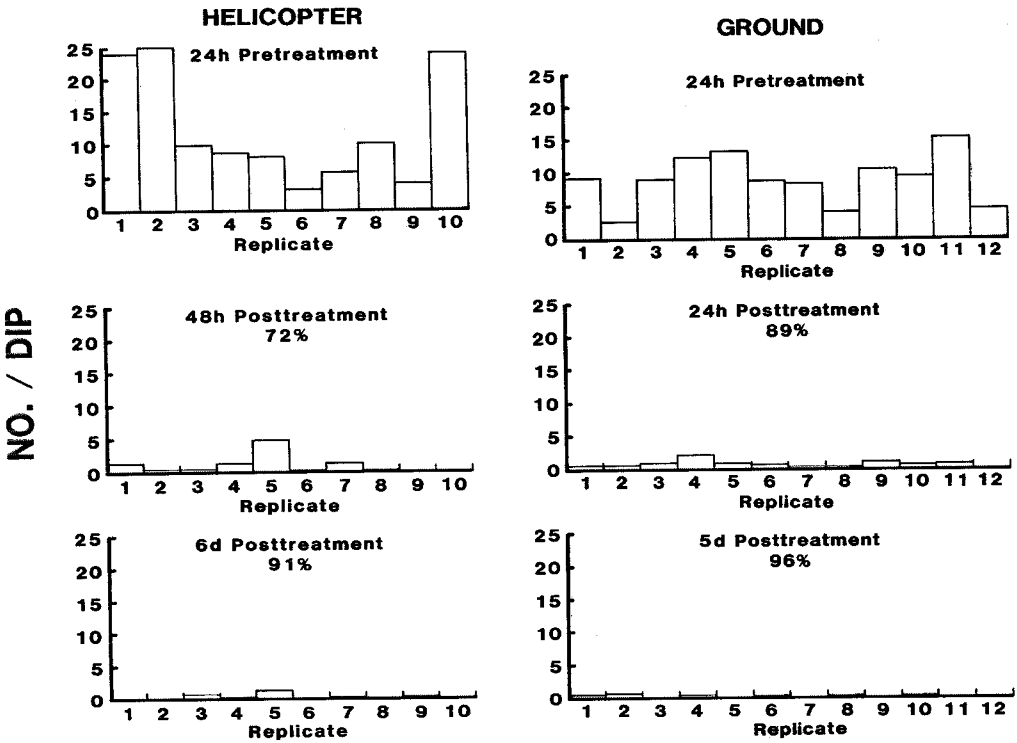

Fig. 2. Larval mosquito counts in snowpools treated by helicopter and ground application with Bactimos granules at 5.6 kg/ha (5 lb/acre), April 25–May 2, 1983. Percentage reduction corrected for changes in check plots is shown for posttreatment samples.

materials. We also thank Dr. L. A. Lacey and two anonymous reviewers for their comments on an earlier version of this manuscript.

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A LIGHTWEIGHT, HAND-PORTABLE VEHICLE-MOUNTED INSECT TRAP[1]

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Vehicle-mounted traps are one of several methods of non-attractant sampling of flying insects (Bidlingmayer 1961). A history of this method was provided by Bidlingmayer (1966) and reviewed by Barnard (1979). We required a vehicle-mounted trap that could be mounted at the front of the vehicle to avoid the turbulence caused by air passing over the hood and windshield (Bidlingmayer 1969), that could be adapted to a variety of motor vehicles, and that could be taken apart and fitted into a case for hand transport. Our trap consists of 3 main parts: (1) a trap bag of lightweight canvas and nylon insect netting; (2) a lightweight but sturdy inner framework to support the bag; and (3) an outer framework to hold the bag in place. The longest individual part is 112 cm, and the weight of all trap parts and the carrying case is 19 kg.

This trap is being used to monitor adult populations of *Culicoides variipennis* (Coquillett) as part of field studies on the control of bluetongue disease in ruminant livestock through vector suppression.

OUTER FRAMEWORK. The outer framework of the trap has 6 elements: 2 interchangeable front bumper supports (Figs 1.1 and 3A); an inverted U-shaped front mount that fits into the front bumper supports and to which the leading edge of the trap bag is fastened (Figs. 1.2 and 3B); a rear mount above the passenger compartment

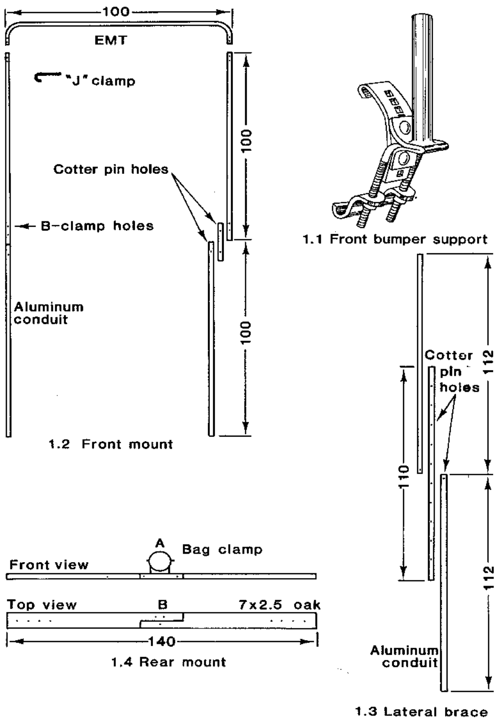

Fig. 1. Outer framework elements, dimensions in cm.

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