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EFFICIENCY OF ALTOSID® (*S*-METHOPRENE) LIQUID LARVICIDE FORMULATED ON BIODAC® (GRANULAR CARRIER) AGAINST SPRING *AEDES* SPECIES IN FLOODED WOODLOTS

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ABSTRACT. Exposure of spring *Aedes* larvae to Altosid® Liquid Larvicide formulated on the granular carrier Biodac® under field conditions was evaluated. Both aerial and hand-applied treatments were monitored. Mosquitoes collected from aerially treated sites (9 kg/ha) showed an average 80% mortality. In hand-treated sites excellent control was achieved at label rates of 11.3–14.7 kg/ha (10–13 lb/acre); at dosages less than recommended rates, control was unsatisfactory.

Spring *Aedes* mosquitoes developing in temporary woodland pools abound in Bay County, MI. Favorable control of univoltine spring *Aedes* species such as *Aedes canadensis* (Theobald), *Ae. stimulans* (Walker), *Ae. fitchii* (Felt and Young), *Ae. provocans* (Walker), *Ae. implicatus* Vockeroth, and *Ae. intrudens* Dyar is imperative in reducing nuisance mosquito populations. Adults of these species emerge in May in large numbers that persist into the summer months. Nearly 10,000 ha of woodlands are treated annually by aerial spraying in Bay County. Since 1985 Bay County Mosquito Control (BCMC) has utilized both granular and liquid *Bacillus thuringiensis* var. *israelensis* (*B.t.i.*) formulations. Precise timing of *B.t.i.* applications to 2nd and 3rd instars is necessary because these developmental stages are most susceptible to the insecticide formulation. Additionally, the product provides virtually no residual effectiveness, thus timing is critical.

During the spring of 1995 Altosid® Liquid Larvicide (A.L.L.) (Sandoz, Agro., Dallas, TX) (5% AI, *S*-methoprene) formulated on Biodac® (12/20 mesh), an inert granular carrier composed mostly of recycled paper, was evaluated. The cellulose-based carrier is manufactured by Granulation Technology, Green Bay, WI, a company of Edward Lowe Industries, Inc. The product was formulated by Clarke Mosquito Control Products, Roselle, IL, using the following 100-lb batch recipe: 96 lb Biodac, 30 oz. Altosid Liquid Larvicide, and 32 oz. water. McNelly and Lesser (unpublished data) found that both laboratory and field evaluations of methoprene/Biodac at doses of 5, 7.5, and 10 lb/acre produced 100% emergence inhibition of adult *Aedes sollicitans* (Walker) in nearly all replicates from 5 to 12 days posttreatment.

Altosid Liquid Larvicide is an encapsulated formulation designed to provide control for 7 days. The Biodac carrier is intended to extend this effectiveness to 10 days (personal communication, Sandoz, Agro). Sporadic late hatches of spring *Aedes* mosquitoes generated from spring rains could be controlled by using a product such as A.L.L./Biodac that provides residual toxicity. Also, by utilizing a product that affects 4th instars, the treatment window may be expanded. The objective was to assess the efficacy of granular methoprene against spring *Aedes* mosquito larvae under field conditions.

Field evaluations took place from April 21 to May 22, 1995. Two sites were chosen and 24 pools were established at each site, including 4 untreated controls. Four replicates of each of 5 doses were studied (1.1, 3.4, 5.7, 11.3, and 14.7 kg/ha); pools were randomly assigned dosages. After determining the surface area of each woodland pool, the amount of A.L.L./Biodac necessary to treat it was evenly distributed by hand on the surface. Second, 3rd and 4th instars were present during treatment. Third instars were prevalent, comprising nearly 70% of larvae present.

In addition, about 120 ha of flooded woodlots were treated by helicopter (Bell 206 III Jet Ranger, AgRotors, Inc., Gettysburg, PA) equipped with an Isolair® slung-bucket dispersal system with a 272-kg payload capacity. Forty randomly chosen pools were monitored in each of 4 woodlots (3 treated woodlots and one control). Calibration was monitored by weighing A.L.L./Biodac granules dispensed from the bucket and collected from 12 cardboard boxes (1.2 m^2) placed at 3-m centers in a line perpendicular to the flight path of the helicopter. The Biodac granules were somewhat concentrated in the middle of the 80-ft. swath and showed a thinning pattern toward the edges. The helicopter was calibrated at 9.2 lb/acre, but calibration boxes placed randomly in the field during the aerial treatment showed a dosage (under field conditions) of 8 lb/acre.

Less than 5.5 cm of rainfall was recorded during the study, leading to a slow decrease in pool

depth and size throughout the study. Depth ranged from 5.1 to 30.5 cm ($\bar{x}$ = 12.1 cm). Water temperature ranged from 6 to 18°C.

Larval mosquitoes, especially 4th instars, that have been exposed to effective doses (>1 ppb) of methoprene, pupate but fail to undergo eclosion (Gordon and Burford 1984). This mode of action requires that pupae be collected and observed to effectively measure mortality. These single-generation spring species generally pupate synchronously; therefore, all sites were monitored every few days to watch for pupation. Pupal collections were made at day 14 (aerial) and day 17 (hand-treated) posttreatment and continued until pupal activity ceased (approximately 10 days later). Pupae were collected in water from the test or control sites and placed in either mosquito breeders (Bioquip®) or 16-oz. plastic cups that were lined with Ziploc® bags. The number of pupae collected from each pool throughout the study ranged from 12 to 339 ($\bar{x}$ = 90).

Pupae were allowed to complete development in the laboratory. Counts were then made of dead pupae, dead adults (completely emerged), dead adults (tarsi attached to pupal case), dead adults (abdomen/thorax attached to pupal case), and live adults (completely emerged). From this information, mortality was calculated using the formula:

$$\% \text{ mortality} = \frac{\text{dead pupae + dead adults}}{\text{total mosquitoes collected}} \times 100.$$

Mortalities were corrected with Abbott's formula (Abbott 1925).

A one-way analysis of variance (ANOVA) was conducted to compare mortalities between treated and control pools for each application (Hayslett 1968). Compared with mosquitoes in the control pools, both ground and aerial treatments resulted in statistically significant mortality ($F = 9.77$; df 3, 36; $P < 0.01$) and ($F = 36.62$; df 5,17; $P < 0.01$), respectively.

Mortalities observed from the hand-treatment of woodland pools with A.L.L./Biodac are shown in Table 1. Mortality increased from 44% average control at 1.1 kg/ha to 98% average control at 14.7 kg/ha. The formulation was certainly more effective at label rates (11.3–14.7 kg/ha). Aerial treatment (9.1 kg/ha) provided 93.8, 72.7, and 70.1% control in 3 separate woodlots. Control pools averaged 6.7% mortality. Sites that received less than 80% control may have been influenced by windy conditions, which shifted the product deposition during application. Altosid Liquid Larvicide/Biodac is a light-weight formulation that was susceptible to movement in the windy conditions ordinarily affecting our spring treatment operations. At least 7 of the 40 pools that visually received a light dosage of A.L.L./Biodac contributed to a lower average mortality.

Table 1. Mortality of spring *Aedes* mosquitoes after hand-treatment with A.L.L./Biodac.

	Average percent mortality	
Rate (kg/ha)	Site 1	Site 2
1.1	30.8	58.0
3.4	60.1	55.5
5.7	60.8	59.7
11.3	85.5	98.4
14.7	96.9	100.0

Another issue involving the integration of A.L.L./Biodac into our treatment regime is product cost. The A.L.L./Biodac was substantially more expensive than *B.t.i.* based on 1995 prices. The cost/acre for *B.t.i.* based on a dosage rate of 5 lb/acre was $4.45; for A.L.L./Biodac based on a 10-lb/acre dosage, the cost was $14.40. Savings on the A.L.L./Biodac may be realized by formulating the material on-site, but this may not be feasible due to manpower needs and/or product shelf life. The shelf life of A.L.L./Biodac ranges from 1 to 2 wk (personal communication, Sandoz, Agro).

Altosid Liquid Larvicide/Biodac proved successful in controlling spring *Aedes* mosquitoes in woodlots; however, based on the observed mortalities, label rates should be heeded to realize an acceptable control level. Although the formulation provided excellent average control at 11.3–14.7 kg/ha (92 and 98%, respectively), issues of cost and influence of windy conditions must be addressed before implementing the widespread use of this product.

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