EVALUATION OF FENOXYCARB AGAINST SPRING *AEDES* MOSQUITOES IN MASSACHUSETTS

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ABSTRACT. The insect growth regulator, fenoxycarb, when applied at 0.06 kg AI/ha (0.05 lb AI/acre) as 1% sand granules was highly effective (97.5% corrected mortality) against *Aedes communis*, *Ae. stimulans* and *Ae. canadensis* in snowmelt pools in Massachusetts, and 100% effective against *Ae. abserratus* in an insectary study. No larval mortality owing to fenoxycarb treatment was observed, and most mortality occurred in the pupal stage as opposed to aborted adult emergence.

Fenoxycarb [Ethyl-(*p*-phenoxy-phenoxy)-ethylcarbamate], an insect growth regulator, demonstrates juvenile hormone activity against diverse groups of insects (Dorn et al. 1981, Kramer et al. 1981, Peley 1982). Laboratory and field evaluations of different formulations and application rates of fenoxycarb against several species of mosquitoes in California have shown a high degree of efficacy (Mulla et al. 1985, 1986; Schaefer et al. 1987). Tests of fenoxycarb against northern temperate mosquitoes living in cold waters such as spring, snowmelt pools have not been reported. In this study, we evaluated fenoxycarb against immatures of spring *Aedes* mosquitoes in snowmelt pools in Massachusetts, and against field-collected *Ae. abserratus* Felt and Young in an outdoor insectary.

We tested a 1% (by weight) formulation of fenoxycarb (RO13-5223, Maag Agrochemicals, Vero Beach, FL) coated on sand granules. Field tests were conducted in snowmelt pools in Hampshire County, MA, in April–May 1983. The pools ranged in size from 8.5 to 410 m^2, and in depth from 20 to >51 cm. Pools differed in dominant mosquito fauna (based upon larval identifications), including *Ae. canadensis* (Theobald), *Ae. communis* DeGeer and *Ae. stimulans* (Walker). Five pools were treated with 57 g AI/ha (0.05 lb AI/acre) on either April 15 or April 18, while 4 pools were left untreated as controls. Sand was hand-delivered from a salt shaker. Pupae were collected from the pools on May 2 or May 9, and held until death or adult emergence in outdoor cages. Mosquitoes were scored as dead pupae, aborted adults, or live adults, and percentage mortality was calculated as the number of dead pupae plus aborted adults divided by the total number of pupae collected. Ambient temperatures (data from Amherst College weather station, Amherst, MA) ranged from −2 to 29°C, with a range of daily mean temperatures of 8–20°C during the study. Cumulative precipitation from April 15 to May 2 was 16.5 cm.

For the outdoor insectary test, third and fourth instar *Ae. abserratus* larvae were collected from a pool in Lawrence Swamp, Amherst, MA, on April 28, 1983, sorted into lots of 60 larvae each and placed in enameled pans with 1 liter of water. Four pans were treated with 0.05 mg 1% fenoxycarb-coated sand granules, and 4 pans were left untreated as controls. Pans were placed in the insectary, and larvae were fed a 1:1 mixture of brewer's yeast and lactalbumin *ad lib.* Pans were inspected daily and dead larvae were counted and removed. Pupae were collected, held in the insectary until adult emergence, and mortality was recorded as before except that larval mortality was included. In both field and laboratory studies, mortality in treated pools or pans owing to fenoxycarb treatment was calculated using Abbott's formula (Abbott 1925).

In the field experiment, there was a mean of 98.5% (range, 95.7–100.0%) mortality among mosquitoes collected in pools treated with fenoxycarb and a mean of 40.8% (range, 23.7–67.4%) mortality among those collected from untreated pools (Table 1). Most of the mortality in treated pools was manifested as dead pupae as opposed to aborted adult emergences (Table 1). A *t*-test on arcsine, square-root transformed data showed a highly significant ($t = 8.20$, $P < 0.001$) difference between treated and untreated pools. After correction for mortality in control pools, effectiveness of fenoxycarb for all species combined was 97.5%. The cause of the rather high mortality (67.4%) in an untreated pool with *Ae. stimulans* as the predominant mosquito was unknown. Another untreated pool with predominantly *Ae. stimulans* had only 37.0% mortality.

Larval mortality for *Ae. abserratus* in treated (mean of 16.6%; range, 11.5–3.3%) and untreated (mean of 17.4%; range, 10.7–24.6%) pans held in the insectary was comparable, as was the percentage of aborted adults in treated (mean of 3.7%; range, 0.0–6.7%) and untreated (mean of 5.9%; range, 1.7–12.5%) pans. Pupal mortality averaged 79.7% (range, 75.4–86.7%) in treated pans and 23.5% (range, 16.7–35.0%) in untreated pans. No mosquitoes survived to the

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Table 1. Predominant *Aedes* species composition, number of pupae collected for evaluation, percent mortality of pupae and emerged adults, and overall percent mortality in tests of fenoxycarb in spring pools in Massachusetts, April–May 1983.

Site and treatment	Predominant species	No. pupae collected	Percent dead pupae	Percent aborted adults	Percent mortality
S. Amherst Treatment A	*Ae. stimulans*	506	97.4	0.4	97.8
S. Amherst Treatment B	*Ae. canadensis*	475	88.0	11.4	99.4
Hadley Treatment A	*Ae. stimulans*	91	100.0	0.0	100.0
Hadley Treatment B	*Ae. stimulans*	192	100.0	0.0	100.0
Holyoke Treatment A	*Ae. communis*	497	73.4	22.3	95.7
S. Amherst Control A	*Ae. stimulans*	581	62.8	4.6	67.4
S. Amherst Control B	*Ae. canadensis*	393	17.6	6.1	23.7
Hadley Control A	*Ae. stimulans*	288	23.4	13.6	37.0
Holyoke Control A	*Ae. communis*	502	32.5	2.4	34.9

adult stage in any of the treated pans, whereas an average of 53.2% (range, 45.9–60.0%) successfully emerged as adults in untreated pans. A t-test on arcsine, square-root transformed data of percent mortality indicated a highly significant ($t = 25.01$, $P < 0.001$) difference between treated and untreated pans. After correction for mortality in control pans, effectiveness of fenoxycarb against *Ae. abserratus* in the insectary test was 100%.

The field and insectary data indicate that most fenoxycarb-induced mortality occurred prior to adult emergence and few aborted adult emergences. *Aedes communis* showed a higher percentage of aborted adult emergences than did the other species in treated pools. Similar larval mortality for *Ae. abserratus* in treated and untreated pans indicated that fenoxycarb had no measurable acute toxicity against larvae. Previously, Mulla et al. (1985, 1986) showed that larval mortality of several genera of mosquitoes (*Culex*, *Psorophora* and *Aedes*) in treated and untreated field ponds, irrigated pastures and laboratory dishes was similar, and that fenoxycarb-related mortality was evident in the pupal stage.

Fenoxycarb applied at 0.06 kg AI/ha (0.05 lb AI/acre) was highly effective against spring *Aedes* mosquitoes in cold water habitats. Lower rates of application (e.g., 0.02 kg AI/ha: Schaefer et al. 1987; 0.005 lb AI/acre: Mulla et al. 1985) may also be effective, and future tests of lower application rates as well as studies of nontarget effects of fenoxycarb in spring pools are warranted.

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