RESIDUAL CONCENTRATION AND EFFICACY OF THREE TEMEPHOS FORMULATIONS FOR CONTROL OF LARVAL *AEDES AEGYPTI*

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ABSTRACT. The residual concentration and efficacy of Abate® 5CG (impregnated in celatom granules) and plaster pellets impregnated with either Abate® 4E or technical temephos were compared against late 3rd-instar *Aedes aegypti* larvae. Both plaster pellet formulations resulted in 100% larval mortality during the 6-wk test, compared with 2 wk for a similar level of mortality for the celatom formulation. The maximum temephos concentration in water treated with the celatom formulation occurred 30 min after treatment at 0.071 ppm. Temephos concentration of water treated with the 4E plaster formulation peaked at 12 h at 0.148 ppm while the concentration of the technical plaster formulation peaked at 48 h at 0.30 ppm.

Mosquito larvicide formulations that exhibit slow or sustained release properties have been recognized as cost effective agents in mosquito control programs. Several insecticides have been impregnated in various materials for this purpose (Nelson et al. 1974) and one such insecticide has been temephos. Quick et al. (1981) evaluated a plastic matrix impregnated with 7.2% temephos (Ecopro 1707 ®) against first and second instar *Culex quinquefasciatus* Say and *Aedes aegypti* (Linn.). They found that the LT_{100} of this product ranged from 1 to 6 days in water at concentrations of 1.5–3.6 ppm during a 1,108-day test. Anderson et al. (1983) evaluated silicate pellets containing 1.2% temephos by weight, against laboratory-reared 3rd-instar *Ae. aegypti* and obtained ≥ 80% mortality for up to 80 days at an application rate of 0.19 ppm and 150 days of similar mortality at 0.76 ppm. Further studies of this formulation in rice field plots against 3rd-instar *Psorophora columbiae* (Dyar and Knab) resulted in ≥ 80% control up to 7 days at 0.38 ppm and up to 71 days at 3.83 ppm (Anderson et al. 1983). Each of the studies cited above used formulations incorporated in non-biodegradable matrices. With the purpose of minimizing the introduction of such substances into the environment, we report in this paper on the residual concentration and efficacy of 3 temephos biodegradable slow release formulations in laboratory studies against *Ae. aegypti* larvae.

Metal tanks (1.1 × 0.6 × 0.5 m deep) containing 266 liters of tap water were used. Celatom granules (Abate® 5CG, 5% AI) and experimental pelletized plaster formulations containing 5% (AI) temephos formulated with either technical temephos (93.3% AI) or Abate® 4E (44.56% AI) were received from Clark Outdoor Spraying Co., Roselle, IL. These formulations were compared at an application rate of 13.2 mg/liter (0.7 mg AI/liter) of water. Each treatment was replicated 3 times. Three untreated tanks served as controls. No organic matter was added to any of the tanks. This study was conducted from September 22 to October 27, 1987.

One-liter water samples were collected from each tank at 30 min; 3, 6, 9, 12, 18, 24, 30 and 48 h after treatment and thereafter at weekly intervals for 6 wk for subsequent bioassay with *Ae. aegypti* larvae. Water was added to each tank to compensate for evaporation. Five minutes prior to sampling, the water in each tank was stirred slowly to attain equal mixing of the dissolved temephos. Water temperature at the time of sampling ranged from 17 to 23°C, while pH averaged 8.17 ± 0.10.

Larvae used in bioassays were reared from eggs of an insecticide susceptible laboratory colony received from the Medical and Veterinary Entomology Research Laboratory, U.S. Department of Agriculture, Gainesville, FL. Twenty-five 3rd-instar larvae were collected with an eyedropper, placed onto filter paper strips and immediately transferred to separate 250-ml glass beakers containing 200 ml of water from each respective tank. Efficacy of each temephos formulation was based on larval mortality, which was determined by tapping the side of each beaker with a glass stirring rod 24 h after larval exposure. Larvae that did not respond by a wiggling motion were recorded as dead. There was no mortality in control beakers.

Temephos concentration of each formulation in the water tanks was determined as follows: A dose-mortality curve using 3rd-instar *Ae. aegypti* was obtained by serial dilutions of a 1% weight/volume solution of technical temephos (93.3% AI, American Cyanamid, Princeton, NJ) in a range of 0.0001–0.01 ppm. Water samples from each tank for each time interval were diluted in a range from 1:2.5 to 1:100 (water sample:dechlorinated water) because undiluted water samples had produced 100% larval mortality. A dilution that resulted in <100% larval mortality was related to its corresponding temephos concentration from the dose-mortality line. This concentration was then multiplied by the dilution ratio to calculate the final temephos concentration of the undiluted water sample. The same procedures and evaluation criteria of larval mortality were used as mentioned earlier for the efficacy tests.

Data were analyzed with a repeated measures analysis of variance with time as the repeating factor (Steel and Torrie 1980). If formulation, time and their interaction were significantly different, a one-way analysis of variance was performed on the data at each time interval. Mean comparisons at each time interval used Tukey's multiple range test. Differences in all data analyses were considered significant at $P < 0.05$.

Undiluted water samples of the Abate 4E and technical temephos plaster formulations resulted in 100% larval mortality for each sample interval throughout the 6-wk test. The celatom granule (Abate 5CG) formulation resulted in 100% mortality only through week 2. Significantly greater concentrations of temephos were found at 30 min and 3 h in the water treated with the celatom formulation when compared with water treated with the 4E and technical plaster formulations (Table 1, Fig. 1). However, from 18 h to 6 wk, the temephos concentration in the water was greatest for the technical based plaster formulation followed by the 4E plaster and celatom formulations, respectively (Table 1, Fig. 2). The temephos concentration of the water in the tanks treated with the 4E plaster formulation was greatest at 12 h at 0.148 ppm while the concentration of the technical plaster formulation was greatest at 48 h at 0.30 ppm. At 6 wk no significant concentration difference was found between the 2 plaster formulations, but both were still significantly greater than the celatom formulation. Over the 6-wk period the 4E plaster formulation had degraded to less than half the original concentration recorded at 30 min (0.012 ppm), while the concentration of the technical plaster formulation at 6 wk was similar to that recorded at 30 min (0.016 ppm). At the end of the study the temephos concentration of the celatom formulation had degraded to 70-fold less than the concentration recorded at 30 min (0.001 ppm).

Under the conditions of this study, the plaster formulations resulted in a longer period of larval mortality than the celatom formulation.

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Table 1. Water concentration (ppm ± SE) of 3 temephos formulations at various time intervals, based on *Aedes aegypti* larval dose mortality line for technical temephos.[a]

Formulation	Temephos concentration (ppm)—time after treatment							
	30 min	3 h	6 h	9 h	12 h	18 h	24 h	30 h
Celatom	0.071 ± 0.010a	0.057 ± 0.007a	0.057 ± 0.013ab	0.035 ± 0.013a	0.044 ± 0.017a	0.037 ± 0.002a	0.041 ± 0.017a	0.031 ± 0.005a
Plaster (4E)	0.032 ± 0.001b	0.025 ± 0.001b	0.053 ± 0.002b	0.058 ± 0.008b	0.148 ± 0.008b	0.074 ± 0.007b	0.086 ± 0.006b	0.047 ± 0.003b
Plaster (Technical)	0.017 ± 0.005b	0.024 ± 0.001b	0.065 ± 0.006a	0.160 ± 0.0003c	0.080 ± 0.005c	0.120 ± 0.007c	0.267 ± 0.021c	0.224 ± 0.020c

Formulation	Temephos concentration (ppm)—time after treatment						
	48 h	1 wk	2 wk	3 wk	4 wk	5 wk	6 wk
Celatom	0.025 ± 0.002a	0.019 ± 0.002a	0.009 ± 0.001a	0.007 ± 0.001a	0.003 ± 0.001a	0.002 ± 0.001a	0.001 ± 0.001a
Plaster (4E)	0.148 ± 0.007b	0.040 ± 0.002a	0.030 ± 0.005a	0.027 ± 0.005b	0.022 ± 0.001b	0.019 ± 0.001b	0.012 ± 0.0003b
Plaster (Technical)	0.300 ± 0.024c	0.219 ± 0.018b	0.190 ± 0.012b	0.065 ± 0.008c	0.039 ± 0.005c	0.034 ± 0.001c	0.016 ± 0.0002b

[a] Means in each column followed by the same letter are not significantly different ($P > 0.05$); Tukey's multiple range test.

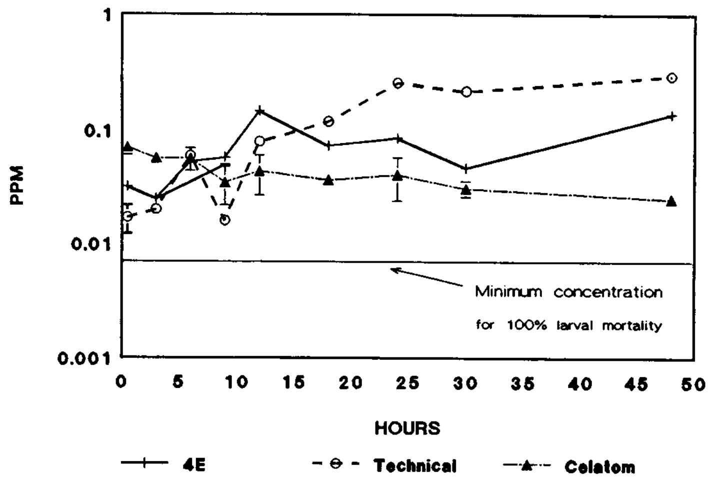

Fig. 1. Mean (± SE) concentration (ppm) of 3 temephos formulations 30 min to 48 h after placement in water. Concentrations based on *Aedes aegypti* larval dose mortality line for technical temephos.

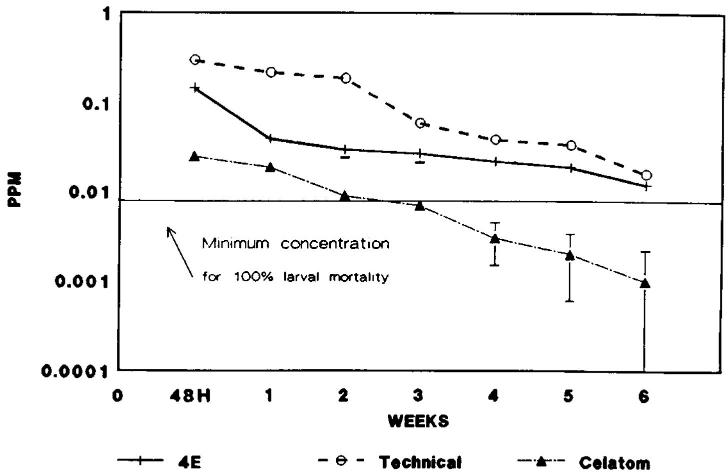

Fig. 2. Mean (± SE) concentration (ppm) of 3 temephos formulations 48 h to 6 wk after placement in water. Concentrations based on *Aedes aegypti* larval dose mortality line for technical temephos.

nection with a project of the Kentucky Agricultural Experiment Station and is published with approval of the Director.

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