LARVAL CONTROL OF *PSOROPHORA CONFINNIS* (LYNCH-ARRIBÁLZAGA) WITH A CONTROLLED-RELEASE FORMULATION OF CHLORPYRIFOS [1]

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ABSTRACT. The effectiveness of a 10.6% chlorpyrifos controlled-release formulation against *Psorophora confinnis* (Lynch-Arribálzaga) larvae was determined by in-pool bioassays conducted in a rice culture habitat. Average mortalities over an 11-week test period were 22, 58, 79, and 99 percent in plots treated at 0.25, 0.50, 1.0, and 2.0 ppm, respectively, based on a theoretical total initial release of all active ingredient. Chlorpyrifos residues recovered from test plot water averaged 0.0004, 0.0006, 0.0009, and 0.0014 ppm in plots treated at 0.25, 0.50, 1.0, and 2.0 ppm, respectively. Based solely upon effectiveness (larval mortality exceeded 95% for 11 weeks at the 2.0 ppm treatment level), and residues recovered from the test plot water (not exceeding 0.0022 ppm at the highest dosage), the controlled-release formulation of chlorpyrifos was considered superior to those larvicide formulations presently available.

INTRODUCTION. In 1966 the US Army began to explore the possibilities of a controlled-release larvicide concept to be applied in military vector control programs. In 1973, following 7 years of intensive laboratory testing and field evaluations under simulated conditions, actual field tests were begun in order to develop guidelines for a controlled-release formulation of chlorpyrifos in anticipation of the impending use of this technology by the military.

Two geographic locations were selected for test purposes to determine differences in system efficiency related to variations in climatic conditions and habitat and to ascertain susceptibility to the formulation by more than one important mosquito species. The study sites included a woodland pool habitat in Middlesex County, NJ, and a rice culture habitat in Arkansas County, AR. The efficacy of the formulation for larval control of *Aedes triseriatus* (Say) and *A. vexans* (Meigen) in woodland pool bioassays was reported by Evans, et al. (1975), and the present report concerns the effectiveness of the formulation for control of *Psorophora confinnis* (Lynch-Arribálzaga) larvae as determined in the rice culture habitat tests.

MATERIALS AND METHODS. Tests were conducted at the University of Arkansas Rice Branch Experiment Station located 11.3 km east of Stuttgart, AR. Fifteen test plots were prepared using standard cultural practices for rice cultivation. All plots were identical in shape, size, and depth, each being 8.5 m wide and 26.3 m long. The growing area (6.1 m x 6.7 m) was covered with water 7.0 cm deep while the peripheral canal contained water 17.6 cm in depth. Water levels were maintained at these depths by adding or draining off as necessary. Other than the rice crop no rooted aquatic vegetation was present within the test plots.

Treatments, based upon calculated water volume, were made in June with a chlorinated polyethylene (CPE) pelletized formulation of 10.6% chlorpyrifos obtained from Dow Chemical Co., Midland, MI. The cylindrical pellets (1.55 mm x 1.37 mm) had specific gravities greater than 1.0. To obtain the desired insecticide levels in parts per million (ppm) in test plot

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water, each treatment was based on a theoretical total initial release of all active ingredient. Randomly selected treatments of 0.25, 0.50, 1.0, and 2.0 ppm, were replicated 3 times and 3 untreated plots served as controls. A hand-held Horn Seed Sower® was used to uniformly distribute the formulation.

In-pool bioassays, using 20 third-instar field-collected *P. confinnis* larvae per test, were conducted on a 24, 48, 72 hr basis for the first 3 days following treatment; then a weekly regimen was maintained for the remaining 11 weeks of the test. Bioassay containers were 470 ml unwaxed cardboard cups from which the bottoms had been removed and replaced with a single thickness of unbleached muslin. Three circular pieces of styrofoam (4.4 cm diameter) were evenly spaced around each cup and secured with a rubber band thus allowing the cups to float upright submerged in 2–5 cm of water. Each cup was attached by string to a wooden stake for stability maintenance. Following the 24-hr mortality check each week the used containers were discarded and replaced with new ones.

Water samples (946 ml) were taken from the surface of each test plot near the location of the bioassay container at the same time the weekly mortality checks were made. After appropriate extraction and clean-up the samples were subjected to gas-liquid chromatographic (GLC) analysis for quantification of chlorpyrifos residues.

RESULTS AND DISCUSSION. In-pool bioassay mortality appeared within 24 hr posttreatment and continued through the 72 hr evaluation in all treated plots (Table 1). Average mortality for the 3 consecutive day period ranged from a low of 2.0% in the control plots, to 97% in plots treated at 2.0 ppm. Average mortalities over the entire 11 week test period were 22, 58, 79, and 99% in plots treated at 0.25, 0.50, 1.0, and 2.0 ppm, respectively. Overall average mortality in the control plots was 4.0%. The highest mortality obtained within the 0.25 ppm plots was 77% observed in posttreatment week 2. Similarly, mortalities reached 100% in the other treated plots during posttreatment week 2. One hundred percent mortality was recorded for 10 of 11 weeks in those plots treated at 2.0 ppm, for 6 of 11 weeks in the 1.0 ppm plots and for 2 of 11 weeks in the 0.50 ppm plots.

A two-way analysis of variance indicated significance (.01 level) between dosages and between weeks. In addition, a significant dosages times weeks interaction was present at the .01 level of probability. A Student-t statistic calculated for group means (all 3 plots comprising a treatment) revealed significant differences (.01 level) between each treatment. No significant differences (.05 level) were indicated between the individual plots within a given treatment.

Chlorpyrifos residues recovered from the test plot water averaged 0.0004, 0.0006, 0.0009, and 0.0014 ppm in the plots treated at 0.25, 0.50, 1.0, and 2.0 ppm, respectively (Fig. 1). Chlorpyrifos was detected in 2 of the control plots in posttreatment week 9 and in all 3 of the controls in posttreatment weeks 10 and 11. This was undoubtedly a result of contamination from the other treated plots and probably accounted for the mortality observed in the controls during those weeks.

Dosage-response values for the field-collected *P. confinnis* utilized for the in-pool bioassays in this study were not determined. Craven and Steelman (1968) reported that LC_{50} and LC_{90} values to chlorpyrifos for *P. confinnis* collected in southern Louisiana were 0.0027 and 0.0234 ppm, respectively. Compared with these data, residue levels in the rice culture habitat do not appear to be consistent with percent mortality observed in the in-pool bioassays, particularly in the higher dosed plots. Although residues recovered from water in plots treated at 2.0 ppm were far below the reported LC_{90}, the mortality there averaged 99%. Either higher residues were present in the water than what was determined by GLC analysis or *P. confinnis* larvae utilized in the present

Table 1. Mortality of *P. confinnis* third-instar larvae exposed to various levels of a 10.6% chlorpyrifos controlled-release formulation.

Posttreatment Time		HOURS				WEEKS											
Treatment Received (ppm)	Pool Number	24	48	72	X*	1	2	3	4	5	6	7	8	9	10	11	X†
		Mortality (Percent)‡															
0.25	IA	5	100	5	37	0	57	0	0	22	5	0	33	12	5	13	13
	IIA	5	80	25	37	0	80	33	0	19	17	0	100	11	0	22	26
	IIIA	67	100	15	61	0	95	88	0	20	0	5	57	21	2	8	27
	$\bar{X}$	26	93	15	45	0	77	40	0	20	7	2	63	15	2	14	22
0.50	ID	10	95	100	68	15	100	100	35	71	100	39	100	0	0	7	57
	IID	20	100	100	73	15	100	100	60	94	55	95	100	10	6	0	58
	IIID	30	100	100	77	15	100	100	20	100	72	0	78	5	80	17	59
	$\bar{X}$	20	98	100	73	15	100	100	38	88	76	45	93	5	29	8	58
1.0	IE	50	100	100	83	100	100	100	85	100	100	19	100	82	100	7	81
	IIE	100	100	100	100	100	100	100	80	100	5	5	100	0	100	90	71
	IIIE	88	100	100	96	100	100	100	75	100	100	100	100	33	100	27	85
	$\bar{X}$	79	100	100	93	100	100	100	80	100	68	41	100	38	100	41	79
2.0	IC	90	100	100	97	100	100	100	100	100	100	100	100	100	100	100	100
	IIC	80	100	100	93	100	100	100	100	100	100	100	100	95	100	100	99
	IIIC	100	100	100	100	100	100	100	100	100	100	100	100	95	100	100	99
	$\bar{X}$	90	100	100	97	100	100	100	100	100	100	100	100	97	100	100	99
Control	IB	10	0	0	3	0	0	0	6	0	0	0	0	0	7	14	2
	IIB	5	0	0	2	0	0	10	8	0	6	5	0	10	7	0	4
	IIIB	0	0	0	0	0	0	0	5	40	12	0	0	12	7	0	7
	$\bar{X}$	5	0	0	2	0	0	3	6	13	6	2	0	7	7	5	4

*Mean mortality over 72 hr period

†Mean mortality weeks 1-11 only

‡Figures rounded to next whole number

study were more susceptible to chlorpyrifos than those collected from southern Louisiana. Similarly, there is a possibility that differences in susceptibility by larval instars was a contributing factor to the variations in LC values.

The application rates of the CPE formulation used in this study were calculated from previously developed information on release rates and dosage response ratios to mosquitoes (Lawson, et al. 1973). The rates are expressed in ppm of active ingredient (AI) which hypothetically would result if all of the AI were released into the water volume at the time of application. The controlled-release formulation releases the insecticide slowly and even though application rates, based on the above were as high as 2.0 ppm, the highest residue detected in the water was 0.0022 ppm (Fig. 1). The application rates for formulations of chlorpyrifos currently registered for use in larval mosquito control are expressed in pounds of AI per acre. When these rates are converted to ppm of AI in water, the application rate for an average water depth of 1 inch (2.54 cm) is equal to 0.442 ppm and 12 inches (30.48 cm) is 0.0041 ppm, both of which exceed the 0.0022 ppm high detected in this study.

Based solely upon the criteria of effectiveness (larval mortality in excess of 95% for 11 weeks at 2.0 ppm treatment level)

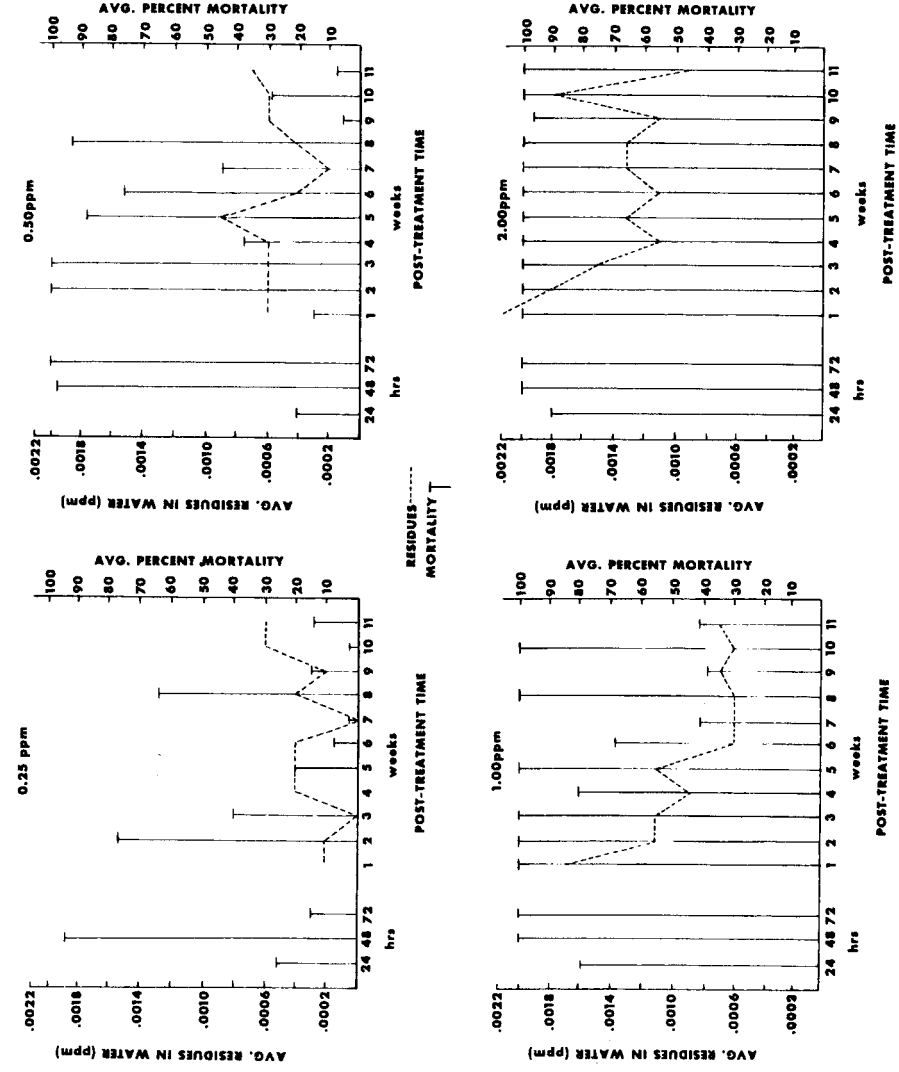

Fig. 1. In-pool bioassay mortality and average chlorpyrifos residues in test plot water.

and actual residues recovered from test plot water (not exceeding 0.0022 ppm at the highest dosage), the controlled-release formulation of chlorpyrifos is considered superior to those larvicide formulations presently available.

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