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STATISTICAL EVALUATION OF GROUND APPLIED ULV MALATHION ON NATURAL POPULATIONS OF *AEDES VEXANS* AND *CULEX* SPECIES

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ABSTRACT. New Jersey light trap data collected daily from 1977 through 1981 were analyzed to evaluate the efficacy of ground applied ultra-low volume (ULV) malathion against natural populations of *Aedes vexans* and *Culex* species mosquitoes. A comprehensive statistical evaluation of the light trap data for the three days before and three days following ULV application demonstrated statistically significant declines averaging 21% in the female population of *Ae. vexans* and 27% in female *Culex* species.

INTRODUCTION

Ground ultra-low volume (ULV) application of insecticides used to reduce adult mosquito populations has undergone numerous evaluations since its introduction over a decade ago (Mount et al. 1968). Some investigators utilizing ovitrap data concluded that local ULV application exerts no significant effect on natural adult populations (Strickman 1979). However, local attempts to duplicate these results have been unsuccessful due to the extremely high variability found with this method (unpublished data). Some researchers using caged mosquitoes under simulated natural conditions have obtained very high mortality rates (Alvarez 1974). However, the rates observed in a caged mosquito population do not necessarily reflect those of a natural, dynamic population. Thus, a need for an alternate method of evaluation of ULV applied malathion against natural populations exists. Our analysis with light trap data was completed in an attempt to satisfy this need.

MATERIALS AND METHODS

The Desplaines Valley Mosquito Abatement District, covering 76.5 mi² in the western Chicago suburbs, has operated ten New Jersey light traps at established locations throughout the district since 1941. These locations consist of five backyards in residential areas, two backyards bordering wooded floodplains, one backyard bordering a cemetery, one wooded site and one golf course. Since 1977, the traps have had the added capacity to sample mosquito populations over weekends without human intervention, (a time controlled carriage shifts a separate collection jar into position for each weekend day) consequently providing a daily count. Data collected from these ten traps for the five years 1977–81 provide the basis for this study.

Adulticiding operations covering the entire district were performed about 32 times over the 5-yr period. All ULV applications were made with truck-mounted LECO-HD (Lowndes Engineering Co. Inc., Valdosta, GA) aerosol generators dispensing 91% malathion at a rate of 3.5 fl. oz./min. at a vehicle speed of 8 mph. Applications were made during evening, pre-midnight hours when adult mosquitoes were most active (unpublished data) and only when weather conditions were acceptable for the parameters of ULV application.

Retrospective analysis of the District's adulticiding records for this period demonstrated the dates on which various sections containing light traps received ULV treatment. The ten light trap locations were treated an average of about 32 times each, resulting in 318 treatments. Light trap data from 22 of the 318 treatments had to be rejected due to trap failure (i.e. power outages). This left data from 296 ULV treatments to be used in this study. Data for the actual night of treatment were not used due to uncertainty whether mosquitoes were trapped before or after actual treatment. The daily counts of female *Aedes vexans* (Meigen) and *Culex* species from before and after ULV application were compared. The numbers of *Ae. vexans* and *Culex* species for each of 3 days following treatment and for the average of those 3 days were compared with the average number of females for the 3 days prior to treatment. The *t*-test for paired samples was used to analyze this data.

RESULTS AND DISCUSSION

Mosquito populations experienced statistically significant reductions ($p < .001$) averaging 21% for *Ae. vexans* and 27% for *Culex* species over the 3 days following ULV application. (Table 1). Specifically, *Ae. vexans* levels declined from the pretreatment levels by 20.5% 1 day after treatment. The reduction from pretreatment levels after 2 days was 20.3%. Three days after treatment the population was down 21.8% from pretreatment levels (Table 2). *Culex* species counts were reduced by 39.1% the first day after treatment. Two days after treatment showed a 24.5% decline from pretreatment levels. Finally, the reduction in the *Culex* population after 3 days was only 18.0% compared to pretreatment levels (Table 2). All of the observed reductions were statistically significant ($p < .05$). Thus, while the effect of ULV application on *Ae. vexans* levels appeared to be constant, the effect on *Culex* populations seemed to diminish over the 3 posttreatment days.

By studying the effect of ULV treatment in 296 separate applications under normal adulticiding procedures, several advantages are realized. The large sample size yields sufficient degrees of freedom to achieve statistical significance and to overcome large variances encountered in mosquito populations. This large sample size also checks the undue influence of any of the many non-spray factors, such as temperature, wind, rain, and even natural fluctuations in the mosquito population, which could exert profound, significant effects on light trap data in a smaller study. Of course, these factors still influenced the data used in this analysis. However, these effects tend to be randomly distributed among the pre- and post-spray dates. Consequently, these influences should exert a negligible effect on our final results. In addition, any biases inherent to the trapping method are irrelevant since the method, and therefore any biases, remain constant. One bias that would not necessarily be controlled through randomness in a study of this magnitude would be due to the dates chosen for ULV application. *Aedes vexans* activity tends to take the form of a normal curve centered around a predictable peak occurring 5 days after eclosion (Clarke and Wray 1967). A greater frequency of peaks occurring before ULV application would tend to overestimate the amount of control, for the reduction observed in light trap *Ae. vexans* counts would be caused by a combination of the effects of ULV treatment and the natural falloff in activity which follows the peak.

A comparison of the dates of ULV treatment and the dates of the predicted peaks demonstrated that there were more peaks occurring after treatment, suggesting that our observed values for *Ae. vexans* control are underestimates of the actual effectiveness of treatment.

The effect of ULV application on *Culex* species has been examined previously with caged mosquitoes (George and Berry 1968, Berry et

Table 1. Effectiveness of ULV malathion for control of adult female mosquitoes for average of the 3 days following treatment.

	Aedes vexans		*Culex* spp.	
	Pretreatment 3 day total	Posttreatment minus pretreatment 3 day total	Pretreatment 3 day total	Posttreatment minus pretreatment 3 day total
Totals	34,635	−7,231	6,222	−1,695
No. of samples	296	296	296	296
Mean no. mosquitoes	117.01	−24.43	21.02	−5.73
t′		3.49*		5.26*
Percent change		−20.9%		−27.3%

* Significant at $p = .001$.

Table 2. Effectiveness of ULV malathion for control of adult female mosquitoes after 1, 2 and 3 days following treatment.

Aedes vexans	Pretreatment 3 day average	1 night after treatment minus pretreatment average	2 nights after treatment minus pretreatment average	3 nights after treatment minus pretreatment average
Totals	11,544.93	−2,369.93	−2,341.93	−2,518.93
No. of samples	296	296	296	296
Mean no. of mosquitoes	39.00	−8.01	−7.91	−8.51
t′		3.19*	2.24*	2.75*
Percent change		−20.5%	−20.3%	−21.8%
***Culex* spp.**	**Pretreatment 3 day average**	**1 night after treatment minus pretreatment average**	**2 nights after treatment minus pretreatment average**	**3 nights after treatment minus pretreatment average**
Totals	2,074.05	−812.05	−509.05	−374.05
No. of samples	296	296	296	296
Mean no. of mosquitoes	7.01	−2.74	−1.72	−1.26
t′		7.41*	4.41*	2.68*
Percent change		−39.1%	−24.5%	−18.0%

* Significant at p = .05.

al. 1969, Taylor and Schoof 1971. Moseley et al. 1977, Alvarez 1974) and with oviposition traps (Strickman 1979). While Berry demonstrated that ULV malathion is highly effective in open field studies, the results with caged mosquitoes under simulated natural conditions have ranged from fair to excellent. Both Taylor and Moseley recorded mortalities of less than 25% when cages were placed in sheltered areas. It should be noted that Alvarez obtained from 65–100% mortality in caged *Cx. pipiens* Linn. while working in the same mosquito abatement district as this study. Strickman's is the only other recorded study besides this one to use the natural population and not caged samples. In addition, Strickman's is the only study with results from the day after ULV treatment that approach those obtained in this evaluation. The reduction he recorded for the first day after application (47%) approximates that seen here (39%).

While this study observes the change in mosquito populations over several days following a ULV treatment, it does not determine an initial mortality rate. However, it does provide post-treatment information not found in caged tests by including the mosquitoes in the population that are not exposed to the malathion or that are resistant to the insecticide.

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