EFFICACY OF A ULV INSECTICIDE MIXTURE (HAN—MALATHION—RESMETHRIN) AGAINST CAGED *CULEX* MOSQUITOES

RANDALL G. KNEPPER

Saginaw County Mosquito Abatement Commission, Saginaw, MI 48602

Ground applied ultralow volume spraying is part of the integrated pest management program undertaken by the Saginaw County Mosquito Abatement Commission, and as such, is subject to scrutiny of its effectiveness in the program. For several years, the Commission relied almost exclusively on ultralow volume (ULV) malathion in the adulticiding program but always had problems effectively controlling mosquitoes during cold temperatures. American Cyanamid (1986) states that their malathion product produces optimal control when the ambient temperature is at least 18°C (65°F). Henderson et al. (1984) reported that as the temperature increased from 21°C (69°F) to 25°C (77°F), the percent reduction resulting from ULV malathion increased. Data plotted from Jantz[1] by temperature resulted in a temperature dependent correlation. The mean nightly lows in Saginaw for the month of May and June are 8°C (47°F) and 11°C (51°F), respectively, although early evening temperatures are somewhat higher. On the basis of the above information, it was decided to seek an alternative insecticide for use during periods of low temperature. Harris and Kinoshita (1977) had described a 3.2 fold increase in toxicity of resmethrin as the temperature declined from 32°C (90°F) to 15°C (59° F). After evaluations, it was decided to use resmethrin for ULV application during cool nights.

Saginaw County is located in a northern latitude where night temperatures vary greatly during the summer. The use of the two ULV insecticides solved our problem but created a new one: providing the proper insecticide for our fleet of trucks which worked best in relation to temperature. The resulting operational problem forced us to seek an insecticide which had no correlation with temperature. Walter and Meisch (1982) reported good results with mixtures of resmethrin and malathion, while L. W. Trager (personal communication, 1985) reported excellent results with mixtures of resmethrin, malathion and H.A.N.®. These reports were sufficient evidence for us to conduct tests on these mixtures by ground ULV against caged *Culex* mosquitoes.

Tests were undertaken during the summers of 1985–87 on caged *Culex pipiens* Linnaeus and *Cx. restuans* Theobald mosquitoes to determine the operational effectiveness of the mixture; 7 parts HAN, 3 parts malathion and 1 part resmethrin (7:3:1). The purpose of these tests were twofold: (1) to determine the effectiveness of the 7:3:1 mixture and (2) to decide if there is a correlation between temperature and efficacy of the mixture. This paper summarizes the data obtained during the evaluation.

All tests were conducted at sunset or within one hour thereafter. Wind speed varied from 0 to 11 kph (0–7 mph). ULV insecticide manufacturers recommend that wind velocity should not exceed 16 kph (10 mph) during spray application. Wind direction was determined prior to testing with cages being placed at 15 meters (50 ft.) downwind in an open field perpendicular to the truck spray route.

The cages were 30 cm^3 (12 $in.^3$) constructed of wooden frames covered with aluminum window screen (16–18 mesh) with a cloth sleeve on one side. Cages were set 40 cm (16 in.) in height by placing each on a wooden base. This was the best height as determined by results of the Commissions's 1983 CO_2-baited CDC trap collections of spring *Aedes* mosquitoes. Control cages were transported and set up the same way at an untreated location. Field collected larvae and

Table 1. Efficacy of various insecticides applied by ULV cold aerosol against *Culex pipiens* and *Culex restuans* contained in cages, at the Saginaw County Mosquito Abatement Commission, Saginaw, Michigan, 1985–87. There were 4 replicates for treated and control groups, with the exception of 21 and 28°C groups which had 3 controls each.

Temperature °C (°F)	Mean mortality (%)		Mean percent reduction
	Control	Treatment	
12 (54)	6	99	99
21 (70)	3	93	93
26 (79)	10	100	100
28 (83)	9	83	81
32 (90)	9	83	82

[1] Jantz, O. K. 1972. Dursban® insecticide as a cold fog treatment compared to Dowco 214 and the commercial standard, malathion for adult mosquitoes. Mimeo. Ag-Organics Dept. Dow Chemical, U.S.A.

Table 2. Cost comparisons per acre and gallon of ULV insecticides 7:3:1, malathion and resmethrin/oil.

	Malathion (3.5 fl. oz./min)	Resmethrin/oil (9.0 fl. oz./min)	7:3:1 mixture (5.0 fl. oz./min)
$/acre	0.08	0.30	0.10
$/gallon	17.55	25.60	15.36

pupae which consisted of 92% *Culex pipiens* and 8% *Cx. restuans*, were reared to adults in an insectary where the air temperature was maintained at 27°C (80°F) with an average relative humidity of 70%. Adults consisted of 47% males and 53% females. Adults were not bloodfed but were provided with a 10% sucrose solution, and were used in the test when they were 1–7 days old.

The ULV equipment was a LECO® (model 26-3210) cold aerosol generator mounted on a one-half ton pickup truck. The aerosol was delivered by a positive displacement pump (Micron-gen® digital flow control) at 4 to 5 psi, with the spray head 1.8 meters (6 feet) above ground. Droplet size of the ULV aerosol was determined by passing a silicone (SurfaSil®) treated glass slide through the aerosol. Mass median diameters were computed according to manufacturers' methods (American Cynamid Corp. 1986).

Both control and treated cages were left in the field one hour following treatment and then returned to the insectary. Mosquitoes remained in their cages (Walker and Meish 1982, Leiser et al. 1982) and were supplied with the sucrose solution and covered with damp towels. Mortality counts were made 12 hours after treatment. Percent reduction was corrected by Abbott's formula (Abbott 1925).

Mosquito mortalities obtained during testing can be seen in Table 1. Percent reduction for cages ranged from 56 to 100% with the mean reduction being 91%. Checks on the accuracy of droplet mass median diameter (MMD) showed that regardless of temperature, the ULV machines were operating properly and the average MMD was 13.6 microns with a range of 3–28 microns. Control mortalities for all tests varied from 3 to 10% with a mean of 7.4% mortality.

Ambient air temperature varied greatly during testing with a range of 12–32°C (54–90°F). A regression analysis comparing percent reduction and temperature was calculated with no correlation found. The fact that this product appears to have no temperature correlation is very advantageous for an abatement district this far north. Additionally, the cost of product as seen in Table 2 is very competitive with other ULV products making it a valuable insecticide for programs experiencing cold temperatures during adulticiding activities.

I am especially grateful to L. W. Trager for his assistance and encouragement in the use of the 7:3:1 adulticide.

REFERENCES CITED

Abbott, W. S. 1925. A method of computing the effectiveness of an insecticide. J. Econ. Entomol. 18:265–267.

American Cyanamid Corp. 1986. Modern mosquito control. Sixth edition. American Cyanamid Corp., Agriculture Div., Wayne NJ, 35 pp.

Harris, C. R. and G. B. Kinoshita. 1977. Influence of post-treatment temperatures on the toxicity of pyrethroid insecticides. J. Econ. Entomol. 70:215–218.

Henderson, J. M., R. G. Knepper and D. M. Fanara. 1984. Field studies of temperature effects on ULV malathion, chlorpyrifos and resmethrin on *Culex pipiens*. Proc. 19th Annu. Meet. Ohio Mosq. Control Assoc. 17:40.

Leiser, L. B., J. C. Beier and G. B. Craig. 1982. The efficacy of malathion ULV spraying for urban *Culex* control in South Bend, Indiana. Mosq. News 42:617–618.

Walker, T. and M. V. Meisch. 1982. Evaluation of pyrethrins and two synthetic pyrethroids alone and in mixtures with malathion as ULV ground aerosols against riceland mosquitoes. Mosq. News 42:167–171.