

# ULTRA LOW VOLUME TESTS OF SEVERAL INSECTICIDES APPLIED BY GROUND EQUIPMENT FOR THE CONTROL OF ADULT MOSQUITOES

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**ABSTRACT.** Ultra low volume field tests of several insecticides applied by ground equipment were conducted using caged adult *Aedes taeniorhynchus* and *Culex nigripalpus*. Species susceptibility was an important factor in establishing the effective dosage of each insecticide. Chlorpyrifos,

fenthion, actellic, Dowco 214, malathion and malathion-naled gave better kill of *A. taeniorhynchus* than *C. nigripalpus*, while pyrethrum-piperonyl butoxide and resmethrin gave better kill of *C. nigripalpus* than *A. taeniorhynchus*.

Presently there are 6 insecticides that have label approval for application as ultra low volume (ULV) sprays by ground equipment in Florida. These are malathion, pyrethrins, resmethrin, fenthion, naled and chlorpyrifos (Dursban). The authors have previously reported on the ULV application of malathion (Rathburn and Boike, 1972a) and resmethrin (Rathburn and Boike, 1972b) for the control of *Aedes taeniorhynchus* (Wiedemann) and *Culex nigripalpus* Theobald. This research was conducted to establish effective dosages for the insecticides presently labeled for ULV use and for other insecticides which have shown promise in laboratory spray tests against the above two mosquito species in Florida.

**METHODS.** All tests were conducted in the early evening hours after sunset. Temperatures ranged from 66 to 86° F and averaged 78.8° F. Wind velocities ranged from 1 to 10 mph and averaged 4.6 mph. The test plot was a fairly open beach residential area with a few houses and a few large pine trees but with little ground vegetation.

Four cages of mosquitoes, two of *A. taeniorhynchus* and two of *C. nigripalpus* each containing 25 females, were attached to a metal pole. One cage of each species was hung at 6 ft. and another at 2 ft. above the ground. The poles were placed at 165 and 330 ft. down wind and perpendicular to the line of travel of the first swath of the aerosol generator. A

second and third swath were applied at 1 and 2 blocks (300 and 600 ft.) up wind of the 1st swath. Each test or replicate consisted of the cages of mosquitoes from 3 sets of 2 poles (165 and 330 ft.) placed a block (600 ft.) apart, or a total of 12 cages of each species. The cages were 6 in. in diameter and 1 in. deep with 14 x 18 mesh screen on both circular surfaces, and were hung vertically on the poles with the screened surfaces facing into the wind.

All mosquitoes used in the test were from laboratory colonies and were between 2 and 8 days old. After exposure the mosquitoes were transferred to clean holding cages and held with access to a 5% sugar solution on cotton pads for 12 to 15 hours at which time mortality counts were made.

All tests except those with 1% naled were conducted with a Leco HD ULV cold aerosol generator mounted on a flat bed truck. The aerosol was discharged at an upward angle of 45° and at a vehicle speed of 5 or 10 mph. An insecticide tank pressure of 4 psi was used in all tests except those with malathion and malathion-naled. These tests were conducted with an earlier model Leco HD ULV with which a formulation pressure of 3 psi was recommended. The flow rate was adjusted by means of a needle valve in the flowmeter. Various flowmeter tube and ball float combinations were used to obtain the desired discharge rates over the range of temperatures which would be experienced. The tests with 1% naled were conducted with a Buffalo Turbine Model M cold aerosol generator utilizing 5 Sonicore nozzles at 80 psi air pressure and 40 psi liquid pressure. It was necessary to use this equipment since the desired discharge rate could not be obtained with the Leco HD ULV unit. Spraying time was recorded by a stop watch and the insecticide was measured before and after each test. Actual spray times averaged 16.5 minutes and varied from 11 to 25 minutes, depending on the length of run necessary to cover the test area. Tests in which the actual discharge varied more than 10% were discarded.

RESULTS. The average corrected per-

cent kill of the 2 species of mosquitoes at various discharge rates of the different insecticides is shown in Table 1. All percentage formulations shown except for pyrethrins-piperonyl butoxide are given as volume to volume. The pyrethrins-piperonyl butoxide formulation is given as weight to weight as shown on the label. The pounds active ingredient per gallon are shown in parentheses for each insecticide used as an undiluted ULV spray. Discharges are reported in gallons per hour instead of fl. oz./min. because the amounts discharged in actual control operations can more readily be obtained since spraying time is recorded in hours. The actual kill obtained in each test was corrected for check mortality which averaged 1.3% for *A. taeniorhynchus* and 0.4% for *C. nigripalpus*.

Chlorpyrifos is labeled for use at up to 1 1/3 fl. oz./min. (0.62 gph) at a vehicle speed of 10 mph. Although excellent kill was obtained with *A. taeniorhynchus* at this dosage, it appears that at least 0.75 gph will be required to control *C. nigripalpus*.

Fenthion is labeled for use at up to 1 fl. oz./min. (0.5 gph) at a vehicle speed of 10 mph. At this dosage excellent kill of both *A. taeniorhynchus* and *C. nigripalpus* was obtained.

Naled is labeled for use at 6 to 12 fl. oz./min. of 10% by volume solution of Dibrom 14 in heavy aromatic naphtha (HAN) or soybean oil at 10 mph. However, due to severe respiratory irritation at this concentration, this formulation is not recommended by the Florida Division of Health, Bureau of Entomology. A 1% by volume solution of Dibrom in No. 2 diesel oil with 1% by volume Ortho Additive was shown not to cause respiratory irritation; therefore, this formulation was tested at 20 gph with the Buffalo Turbine Model M. As shown in Table 1, this formulation of naled gave excellent kill of both *A. taeniorhynchus* and *C. nigripalpus*.

A solution of 5% pyrethrins and 25% piperonyl butoxide by weight in Klearol is labeled for use at 2 to 2.25 fl. oz./min. at a vehicle speed of 5 mph or 0.002 to

Table 1. Ultra low volume tests of several insecticides applied by ground equipment for the control of adult mosquitoes.

Insecticide	Formulation percent or (lb.A.I./gal)	Discharge gph	Vehicle speed mph	No. of tests <sup>1</sup>	Average corrected percent kill			
					<i>A. taeniorhynchus</i>		<i>C. nigripalpus</i>	
					Avg.	Range	Avg.	Range
Chlorpyrifos	(6.0)	1.00	10	5	100	99-100	94	89-98
		0.75	10	2	100	all 100	98	97-98
		0.62	10	5(7)	99	97-100	70	44-96
		0.50	10	4	91	83-96	55	38-77
Fenthion	(9.67)	0.50	10	4(5)	100	all 100	98	93-100
Naled	1.0	20.00	10	4	95	89-99	95	89-100
Pyrethrins-Piperonyl Butoxide	5.0-25.0	4.00	10	2	97	96-98	100	all 100
		2.00	10	3	81	69-91	96	93-97
Actellic	(5.0)	1.00	5	2	99	all 99	99	98-100
		0.75	5	1	97	....	62	....
		0.50	5	4	83	56-98	58	32-93
Dowco 214	(6.0)	1.00	5	3	100	99-100	63	38-80
		0.50	5	3	93	79-100	65	all 65
Malathion	25.0	1.00	5	5	95	90-100	57	40-76
Malathion-Naled	25.0-2.5 25.0-5.0	1.00	5	2	95	91-98	72	69-75
		1.00	5	2	96	91-100	64	43-85
Resmethrin	10.0	2.00	5	3(2)	4	2-8	83	72-93

<sup>1</sup> Figures in parentheses are the number of tests for *C. nigripalpus*.

0.0025 lb./acre pyrethrins. For *A. taeniorhynchus* in Florida the label states that rates up to 0.008 lb./acre of pyrethrins may be used. The results show that the 5% pyrethrins-25% piperonyl butoxide formulation by weight in Klearol at 2.0 gph gave excellent kill of *C. nigripalpus*, but 4.0 gph was required to give the same degree of kill of *A. taeniorhynchus*.

Two compounds, Actellic (pirimiphos-methyl) and Dowco 214 (0,0-diethyl 0-(3, 5, 6-trichloro-2-pyridyl) phosphorothioate) which at present do not have label approval for use as ULV sprays, also were tested because they had previously shown promise in laboratory spray tests (Rathburn and Boike, 1972c). As shown in Table 1, excellent control of both mosquito species was obtained with Actellic at 1 gph at a vehicle speed of 5 mph, whereas 0.5 gph was not effective. One test at 0.75 gph resulted in good kill of *A. taeniorhynchus* but poor kill of *C. nigripalpus*. Dowco 214

gave satisfactory kill of *A. taeniorhynchus* at 0.5 gph at a vehicle speed of 5 mph but even at 1.0 gph was not effective against *C. nigripalpus*.

Malathion at 0.5 gph at a vehicle speed of 5 mph has been shown to give excellent kill of *A. taeniorhynchus* (Rathburn and Boike, 1972a) and even lower dosages may be satisfactory in open areas. Because higher discharge rates might result in better coverage and higher kill under varying conditions of terrain and vegetation, a mixture of 25% by volume of malathion 95 in peanut oil was tested at 1 gph. Even at this reduced dosage excellent kill of *A. taeniorhynchus* was obtained. The kill of *C. nigripalpus*, however, was poorer than that obtained with 0.5 gph technical malathion. Since naled is extremely effective against *C. nigripalpus*, small percentages of this toxicant were formulated with the 25% malathion in peanut oil. Although a slight increase in kill of *C. nigri-*

*palpus* was noted, these amounts of naled did not increase the kill to an effective level.

Resmethrin, which is labeled for use at 0.007 lb./a. (equivalent to 0.42 gph @ 5 mph for swath of 330 ft.), also had been tested previously (Rathburn and Boike, 1972b) and was found to be effective against *C. nigripalpus* but not against *A. taeniorhynchus* at 0.5 gph at a vehicle speed of 5 mph. Higher volumes of this insecticide were tested in an effort to increase the degree of coverage and possibly increase the kill. As shown in Table 1, unsatisfactory results were obtained with a 10% by volume dilution of resmethrin (40% technical concentrate) in peanut oil at 2 gph. The results were similar to those previously obtained with the equivalent dosage of 0.2 to 0.25 gph of the undiluted 40 percent concentrate.

DISCUSSION. Mount and Pierce (1971) using field tests of caged *Aedes taeniorhynchus* calculated an LD<sub>90</sub> in fl. oz. per min. at 10 mph of 1.9 for Dowco 214, 2.2 for Dursban (chlorpyrifos) 10.3 for SBP-1382 (resmethrin), 0.7 for fenthion and 2.0 for malathion. Since the actual discharge rates and vehicle speeds were not stated and ranged from 1 to 9.5 fl. oz. per min. and from 5 to 20 mph respectively, precise comparisons with the data shown in Table 1 are questionable, but generally results are similar. Many other similar studies are also reported in the literature, but because different testing procedures, different equipment, different insecticides, and/or different mosquito species were used results cannot be compared to those shown here.

Although labeled dosages of fenthion

appear to be effective against both *A. taeniorhynchus* and *C. nigripalpus*, this is not the case with chlorpyrifos which gives considerably less kill against *C. nigripalpus*. This points out the fact that all insecticides are not equally effective against all mosquito species at the same dosage. Only 2 species of mosquitoes were used in these tests, but they represent 2 different genera, and experience has shown that these species generally show a great difference in susceptibility to many insecticides. For instance, about twice the dosage of malathion is required to kill *C. nigripalpus* as *A. taeniorhynchus*, but with pyrethrins this difference is reversed, *A. taeniorhynchus* requiring about twice the dosage as *C. nigripalpus*; and with resmethrin, a synthetic pyrethrin, the dosage which gave 83% kill of *C. nigripalpus* gave only 4% kill of *A. taeniorhynchus*. Therefore, we cannot state that a particular dosage is effective for all mosquitoes; we must stipulate what species that dosage will control.

#### Literature Cited

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