VOLUME AS A FACTOR IN ULV DISPERSAL OF EQUAL DOSAGES OF CHLORPYRIFOS FOR ADULT MOSQUITO CONTROL[1]

S. R. HUSTED, J. A. MULRENNAN, R. M. FREDERICK, D. A. BLAIR AND H. J. U'REN[2]
Navy Disease Vector Ecology and Control Center, Alameda, California 94501

ABSTRACT. Twenty-six ULV field tests were conducted to determine if the effective swath width (>90% mortality for caged mosquitoes) could be increased by diluting the chlorpyrifos technical grade material to 1 pound/gallon and increasing the flow rate to 8 ounces/minute. Test results provided evidence to doubt the single importance of volume as the method to increase the effective swath width during ULV ground dispersal operations. The importance of even small variances in pesticide droplet size when increasing the volume was also demonstrated.

Considerable information has been published concerning the optimum aerosol droplet size for insecticides dispersed by ultra low volume (ULV) equipment to achieve effective adult mosquito control. Relatively little work, however, has been published on comparing different flow rates while maintaining a constant amount of actual toxicant dispersed. It was the purpose of this study to determine if the effective swath width (>90% mortality) could be increased by diluting the chlorpyrifos technical grade to 1 pound/gallon thus increasing the volume dispersed to 8 ounces/minute without changing the amount of actual toxicant.

In varying the volume of material dispersed it was first necessary to establish a desired aerosol droplet size. Akesson (1973) noted that droplet size is probably the most important variable function that must be controlled during ULV operations. Many authors have stated that 10 micrometers (μm) volume median diameter (VMD) is within the range for an optimum droplet size as was noted by Mount (1970) and demonstrated further by Lofgren et al. (1973).

The importance of volume was noted by Lofgren (1973) when he stated that some droplets were found on mosquitoes in the field after repeated exposure of 10 successive applications at a normal rate (malathion 3 ounces/minute). Stains (1969) demonstrated that in a single test an effective swath width (ESW) of 10,500 feet was achieved when technical grade chlorpyrifos was dispersed at 37.2 ounces/minute. Along with this increase in volume, however, was a significant increase in amount of toxicant dispersed (56× the recommended amount on 1974 label).

Fussell (unpublished data) conducted similar tests in the same open terrain in 1969 and 1970 using diluted and undiluted chlorpyrifos formulations. His results indicated an ESW of 5,000 feet with a 1 pound formulation dispersed at 37 ounces/minute (9.3×). When dispersing a 0.1 pound/gallon formulation at 54.1 ounces/minute, a 1,000 ESW was obtained (only 1.2×). Duplicating these results was not possible with commercial ULV units because of the high flow rate, but the ESW of 1,000 feet in open terrain is significant in determining the importance of volume in ULV operations. Referring to the literature by Brett (1974), a 10μm droplet dispersed from nozzles 4 feet from the ground at a wind speed of 5 m.p.h. could theoretically reach a distance beyond 2,000 feet during a temperature inversion. Using this concept, field studies were directed toward relating this potential to increased ESW.

---

[1] This paper reflects the results of research only. Mention of a pesticide, commercial or proprietary product in this paper does not constitute a recommendation or an endorsement of this product by the Navy Department. The opinions or assertions contained herein are those of the writers and are not to be construed as official or reflecting the view of the Navy Department or the naval service at large.

[2] LT MSC USN, CDR MSC USN, Biological Technician, HMC USN, Test Mechanic respectively.

The results presented in this paper and from previous work in open terrain do not imply that similar results of extended swath widths can be obtained in urban areas or areas of high vegetation. These results, however, evaluate to some extent the potential of ULV ground dispersal and thus should stimulate further research in methods to extend the currently accepted 300 feet ESW.

Materials and Methods. Twenty-six field tests were conducted from July to September 1974 at Skaggs Island, a military reservation in Sonoma, California, with flat open terrain consisting of hay fields. Temperature was recorded 6 feet above ground and ranged from 65° F to 80° F. Wind velocities ranged from 0.5 to 8 knots with variances in humidity between 54% to 77%. The tests were conducted between 9:30 a.m. and 12:30 p.m.

Three test lines 250 feet apart were exposed to chlorpyrifos during each test run. The cages for each test line were placed 3 feet off the ground and contained a minimum of 50 susceptible, unsexed *Culex pipiens* Linnaeus. The cages were located 150, 300, 500, 700, 1,000 and 1,500 feet from the path of the ULV aerosol generator for each test line. Exposed mosquitoes were transferred to clean cages within 45 minutes after completion of the test run. Cotton pads soaked with 5% sugar solution were available to all specimens throughout the tests except during exposure on the test line. Mortality percentages of the caged mosquitoes were recorded as an average of the 3 test lines at each distance, at 4, 8 and 24 hours after exposure. Control cages for each test had no mosquito mortality.

Cages utilized in tests were constructed of 16 x 18 mesh screen wire and were 2⅝ inches in diameter by 7 inches long. Cage ends were made from 2 piece fruit jar tops in which the lid portion had been replaced by a screen disc. The cages were discarded after each test.

The insectide used in this study was chlorpyrifos 6 pounds/gallon concentrate. Chlorpyrifos was dispersed at 1⅓ ounces/minute from a ULV aerosol generator and was compared to the concentrate diluted to 1 pound/gallon with Super 94® dispersed at 8 ounces/minute. Vehicle speed for both formulations was 10 m.p.h.

Droplet size determinations were conducted using the gravitational settling technique described by Mount and Pierce (1972). The aerosol generator used in the study was a military cold fogger converted to ULV by Navy Disease Vector Ecology and Control Center, Alameda, personnel. The ULV aerosol generator was run at 3.5 pounds per square inch pressure for all tests.

Results and Discussion. Increasing the ESW in these field tests beyond 300 feet was easily achieved in open terrain. It was not possible, however, to prove that the higher flow rate increased the ESW. Results from 3 of the 26 tests conducted are shown in Table 1. These particular tests were chosen because of identical temperatures and wind velocities which occurred for both formulations. This permitted a better comparison between the 2 formulations.

The low flow rate (6 pounds/gallon at 1⅓ ounces/minute) demonstrated an ESW of at least 500 feet in all 3 tests in Table 1 while the high flow rate (1 pound/gallon at 8 ounces/minute) achieved an ESW of 500 feet only in tests b and c.

Extending the ESW beyond 500 feet was accomplished in only 1 test (low flow rate in test c). It was interesting to note that accidentally dispersing the high flow rate at 9 ounces/minute increased significantly the percent mortality at 700 feet as compared to tests a and b but still was not comparable to the ESW of 1,500 feet achieved by the low flow rate.

The ESW at 1,500 feet was achieved possibly because the wind turbulence was absent along the test line for this particular test and allowed for maximum efficiency in the transportation of the pesticide droplets. This test, even though extraordinary, should indicate the potential of the low flow rate.

Table 1. Average percent mortality of caged *Culex pipiens* in open terrain 24 hours after exposure to two chlorpyrifos formulations.

	Test a[1]		Test b[2]		Test c[3]	
Distance (feet)	1 lb/gal at 8 oz/min	6 lbs gal at 1⅓ oz/min	1 lb/gal at 7.8 oz/min	6 lbs/gal at 1.7 oz/min	1 lb/gal at 9 oz/min	6 lbs/gal at 1.3 oz/min
150	99	100	100	100	100	100
300	74	97	100	100	100	94
500	77	100	100	96	93	95
700	60	64	77	71	83	99
1,000	41	52	39	42	14	97
1,500	51	66	18	5	6	99

[1] Temperature 85° F, wind 3½ knots.
[2] Temperature 65° F, wind 5 knots.
[3] Temperature 73° F, wind 5½ knots.

One possible reason for not extending the swath width by increasing the flow rate in these tests could have been that an increase in volume was not the critical or determining factor. Another reason could have been the requirement for a very narrow spectrum in droplet size. The low flow rate had a droplet size of 8.9 μm VMD as compared to the 12.9 μm VMD for the high flow rate. The increased droplet size of 4 μm could have been enough to sufficiently reduce any effect of the increased volume from 1⅓ to 8 ounces/minute. This conclusion is consistent with observations by Lofgren (1973) who noted that only droplets 8 μm VMD and smaller were located on mosquitoes after being exposed to soybean oil aerosols.

In summary, these tests provided evidence to doubt the single importance of volume as the method to increase the ESW during ULV ground dispersal operations. It further demonstrated that close attention must be given to even small variances in pesticide droplet size when determining causes for successful or unsuccessful ULV mosquito control operations.

References Cited

Akesson, N. B. 1973. Aerosol machine developments. Calif. Mosquito Cont. Assoc. Proc. 41: 58.

Brett, R. L. 1974. Micron-Generation®. Droplet sizes, their measurement and effectiveness. Pyrethrum Post. 12(3):103–109.

Lofgren, C. S., D. W. Anthony and G. A. Mount. 1973. Size of aerosol droplets impinging on mosquitoes as determined with a scanning electron microscope. Jour. of Econ. Entom. 66(5): 1085–1088.

Mount, G. A. 1970. Optimum droplet size for adult mosquito control with space sprays or aerosols of insecticides. Mosq. News 30(1): 70–75.

Mount, G. A. and N. W. Pierce. 1972. Droplet size of ultra low volume ground aerosols as determined by three collection methods. Mosq. News 32(4):586–589.

Stains, G. S., E. M. Fussell, J. P. Keathley, J. A. Murray and L. M. Vaughn. 1969. Caged insect kills of up to two miles utilizing a new low volume aerosol generator. Mosq. News 29(4):535–544.