BIOASSAY AND DROPLET SIZE DETERMINATIONS OF SIX ULV AEROSOL GENERATORS[1]

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ABSTRACT. Bioassays, droplet size determinations and tests of the effects of the spray droplets on automotive paint panels were conducted using malathion with the Buffalo Turbine Sonic ULV Sprayer, the Leco HD ULV Aerosol Fog Generator, the London Aire Model XW Aerosol Generator, the Micro-Gen Model LS2–15 Cold Aerosol ULV Generator, the Micro Mist ULV Aerosol Generator, and the Tifa Model 100–E–ULV Cold Aerosol Fog Applicator.

Technicial grade malathion was applied in all bioassays at the rate of 1 gal per hr, vehicle speed of 10 mph. Each generator when operated at manufacturers' recommended pressures gave excellent kill of caged adult mosquitoes, produced a similar droplet spectrum, and none of the generators produced droplets that were visible on automotive paint panels under 3X magnification or by unaided eye after the panels were polished using a commercial cleaner-wax car finish product.

Ultra low volumes (ULV) of concentrated insecticide applied by ground equipment were first shown to be effective for the control of adult mosquitoes in 1968 (Mount et al. 1968). Since that time several ULV aerosol generators have been developed and are commercially available for use in mosquito control programs.

Bioassays, droplet size determinations, and tests of the effect of the spray droplets on automobile paint of six ULV aerosol generators are reported here; however, it is not the object of this research to compare these generators but only to demonstrate their individual effectiveness for use in adult mosquito control.

METHODS. The aerosol generators tested were the Buffalo Turbine Sonic ULV Sprayer, the Leco HD ULV Aerosol Fog Generator, the London Aire Model XW ULV Aerosol Generator, the Micro-Gen Models MS2–15 (droplet size data only) and LS2–15 Cold Aerosol ULV Generators, the Micro Mist ULV Aerosol Generator, and the Tifa Model 100–E–ULV Cold Aerosol Fog Applicator. The generators were mounted on a flat-bed 1½ ton truck and the aerosol was discharged rearward at an upward angle of 45°. All generators except the Micro Mist, which utilizes a special air atomizing nozzle, are presently commercially available. Except for the bioassays with the Buffalo Turbine, all generators were operated at manufacturer's recommended operating pressures. The bioassays with the Buffalo Turbine were conducted at 80 psi air pressure instead of 100 psi because the original operating manual did not recommend a specific air pressure.

The bioassay methods and area were the same as reported by Rathburn and Boike (1975). For these tests all generators discharged malathion 95 at 1 gal per hr (gph) at a vehicle speed of 10 mph. Each generator was calibrated prior to use; spraying time was recorded by a stop watch, and the amount of insecticide was measured before and after each test. Tests in which the actual discharge varied more than 10% were discarded.

The droplet size determinations were calculated according to procedures outlined by Rathburn (1970) for impinged

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slides. Silicone-coated slides were used to collect the droplets from all generators except the Leco, London Aire, and Tifa for which Teflon-coated slides were used. A spread factor of 0.5 was used for the silicone-coated slides and 0.7 for the Teflon-coated slides; therefore, the droplet data obtained by the two methods are comparable. Samples were taken at 25 feet from the stationary generators by waving the slides attached to the end of a 3 foot pole through the aerosol cloud. Duplicate determinations at a discharge rate of 2 gph of malathion were made using each generator. Additional determinations were also made at 1 gph with the Buffalo Turbine at 80 and 100 psi air pressure, the Micro-Gen Model MS2–15 (6½ h.p.) at 3.5 psi air pressure, and the Micro Mist at 45 psi air pressure.

The tests of the effects of the spray droplets on automobile paint were conducted by exposing 1½ by 4 in. sections of two 4 by 12 in. automobile paint panels, supplied by General Motors Corporation, to the drift of three swaths of malathion at a discharge of 2 gph and a vehicle speed of 10 mph. The panels were attached to poles 4 ft above the ground and were placed 50 ft downwind of the first swath and 350 and 650 ft downwind of the second and third swaths, respectively. The distance from the first swath was selected because the machines were mounted on a high-bed of a 1½ ton truck with the nozzles at an upward angle of 45°, and had the panels been closer than 50 ft the droplets would have been propelled completely over them. Two panels were used in each test, one black and one metallic dark green. Both panels were acrylic paint. The deposited droplets were viewed both before and after polishing with a commercial automotive paste-type cleaner/wax by the unaided eye, under a microscope at 10X magnification, and with a hand lens at 3X magnification.

RESULTS. The results of the bioassays are given in Table 1. The percent kill shown is the average obtained for the 12 cages in each test placed at 165 and 330 ft downwind of the first swath and was corrected by Abbott's formula for check mortality which averaged 1.5% for *Aedes taeniorhynchus* and 1.0% for *Culex nigripalpus*. Excellent kill of caged *Ae. taeniorhynchus* was obtained with all generators at 1 gph at a vehicle speed of 10 mph. The kill of *Cx. nigripalpus* by all generators was somewhat less than that of *Ae. taeniorhynchus*. This was expected since *Cx. nigripalpus* has been shown to require a higher dosage of malathion than *Ae. taeniorhynchus* to effect an equal kill (Rathburn and Boike 1972). Although the tests with the Buffalo Turbine were run at an air pressure of 80 psi instead of the recommended 100 psi, the mosquito kill was comparable to that of the other generators; therefore, these tests were not rerun at 100 psi.

The results of the droplet size determinations are shown in Table 2. All generators produced a similar droplet spectrum, the greatest volume of each being in the 10–20 μ size range.

Of the two paint panels used, the droplets were more visible on the black than on the metallic dark green panel because the metal flakes in the green panel made it very difficult if not impossible to see the droplets.

Before polishing, a few of the larger droplets deposited on both the black and the green panels by all generators were visible at 10X magnification. A few droplets produced by all generators except the Micro-Gen were also visible on the black panel at 3X magnification and a few of the droplets produced by the Buffalo Turbine, Micro Mist and Tifa were also visible by the unaided eye. None of the droplets deposited on the green panel was visible at 3X magnification except one or two droplets deposited by the Buffalo Turbine and

Table 1. Results of bioassays of six ULV aerosol generators discharging malathion 95 at 1 gal per hr at a vehicle speed of 10 mph against caged adult *Aedes taeniorhynchus* (Wied.) and *Culex nigripalpus* Theob.

								Average corrected percent kill			
								Aedes		*Culex*	
Generator	Model	Air psi	Liquid psi	Avg. wind mph	Avg. temp °F.	Avg. R.H. %	No. tests[a]	Avg.	Range	Avg.	Range
Buffalo Turbine	Sonic	80	40	5	77	76	5–7	100	99–100	91	82–100
Leco	HD	..	4	6	78	87	6–5	100	97–100	92	85–100
London Aire	XW	90	15	5	80	80	5–5	99	96–100	90	86–96
Micro-Gen	LS2–15	..	4½	6	76	72	5–7	100	all 100	98	96–100
Micro Mist	....	65	30	6	70	53	4–4	100	all 100	99	98–100
Tifa	100-E-ULV	..	4	6	78	73	7–7	100	98–100	96	92–99

[a] First figure, number of tests for *Ae. taeniorhynchus;* second figure, *Cx. nigripalpus.*

Table 2. Results of droplet size determinations sample at 25 ft from six ULV aerosol generators discharging malathion 95.

						Percent of total volume in indicated size range in μm.					
Generator	Model	Air psi	Liquid psi	Discharge gph	VMD	<5	5–10	10–20	20–30	30–40	>40
Buffalo Turbine	Sonic	80	40	1	17.1	1	3	46	31	11	8
	Sonic	100	40	2	14.1	0	7	59	23	5	6
	Sonic	100	40	1	12.9	2	10	57	24	7	0
Leco	HD	..	4	2	13.5	5	18	52	20	5	0
London Aire	XW	90	15	2	11.3	3	26	60	10	1	0
Micro-Gen	MS2–15	..	3.5	1	12.0	1	11	65	19	4	0
	LS2–15	..	4.5	2	11.7	1	5	74	19	1	0
Micro Mist	....	45	20	1	17.3	0	4	47	26	16	7
	....	65	30	2	13.8	1	6	55	30	6	2
Tifa	100-E-ULV	..	4	2	17.4	1	9	46	31	7	6

Tifa, and none of the droplets was visible by the unaided eye. After polishing, a few of the droplets deposited by all generators on both the black and the green panels were still visible at 10X magnification but none were visible at 3X magnification or by the unaided eye.

DISCUSSION. It is evident from the data in Table 2 and data of Mount et al. (1975a) that air pressure is an important factor in the production of aerosols. Also of importance is the discharge rate. As the discharge rate increases at a given air pressure the number of larger droplets and hence the volume mean diameter increases. This is evident in the data of Table 2 with the Buffalo Turbine.

The droplet size data reported by Mount et al. (1975a, 1975b) resulted in volume mean diameters at a discharge of 130 ml per min (approximately 2 gph) of 15–16 μm for the Leco at 4 psi, 17 μm for the Micro-Gen MS2–15 and 19 μm for the Micro-Gen LS2–15 at 4 psi. These volume mean diameters are slightly larger than those reported here. The most likely reason for the difference is that the data reported by Mount were sampled at 3–6 ft from the generator nozzle as compared to the 25 ft distance used in these tests. Thus the samples obtained by Mount would include the larger droplets that deposited on the ground within 25 ft of the generator.

The method of sampling droplets by waving the slide attached to a 3 ft pole through the aerosol cloud undoubtedly increases the number of small droplets collected on the slide as compared to a stationary slide, due to increasing the speed of the collecting surface. However, a slide on the end of a 3 ft pole, considering a man's arm length of 2½ ft and a time of 1 second to swing the slide through a 90° arc would create a slide velocity of only 5.9 mph. According to Yeomans and Rogers (1951) the efficiency of deposit of droplets 5 μm in diameter is only 1.25% when a slide is waved at a velocity of 5 mph but increases 4 fold to 5% at a velocity of 20 mph. Therefore, if the droplets are collected by waving the slide through the aerosol cloud at 3 ft from the generator, the air velocity created by some generators, such as the Leco, is considerably more than that caused by the movement of the slide and therefore a greater percentage of the smaller droplets are deposited. This however is not the case with generators such as the Buffalo Turbine which produce little air velocity at 3 ft from the nozzle. Therefore, the techniques of obtaining droplets on slides and machine operation and discharge rate during sampling should be standardized in order to produce useful information.

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