COMPARISON OF TWO AEROSOL GENERATOR NOZZLE SYSTEMS: ESTIMATES OF DROPLET SIZE AND CAGED MOSQUITO ASSAYS[1]

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ABSTRACT. A comparative study of Micro-Gen and Leco aerosol generator nozzle systems showed that they dispersed aerosols of mosquito adulticides of similar droplet sizes. Aerosols of malathion applied with these nozzle systems produced corresponding kills of caged adult female *Aedes taeniorhynchus* (Wiedemann) and *Anopheles quadrimaculatus* Say. Original droplet size estimates for propoxur, phenthoate, and fenthion resembled those for malathion.

We believe that there is a need for both physical and biological testing of aerosols dispersed by new aerosol generators offered for use in mosquito control programs. In a previous study (Mount et al. 1975) we obtained droplet size data for a promising prototype truck-mounted aerosol generator. The present study was conducted to obtain additional droplet size and mosquito kill data for this generator nozzle system compared to a standard nozzle system. Also, in the comparative tests original droplet size estimates were obtained for three mosquito adulticides.

The prototype nozzle system tested is an integral component of Micro-Gen Models MS2–15 and LS2–15 aerosol generators (Micro-Gen Equipment Corporation, San Antonio, Texas). Although these models have the same nozzle system, they differ in power capabilities (MS2–15 = 6.5 HP vs. LS2–15 = 10.5 HP). The standard for comparison was the nozzle system on the Leco Model HD (Lowndes Engineering Company, Valdosta, Georgia). Both nozzle systems combine a form of venturi with a coaxial vortex airflow that assists in the initial dispersion of the aerosolized liquid adulticides. Unlike pneumatic nozzles that require low air volumes and high air/liquid pressures, these two nozzles utilize high air volumes at relatively low air/liquid pressures. These low liquid pressures have an inherent advantage in safety over high liquid pressure systems in the event of transfer line rupture.

DROPLET SIZE ESTIMATES. The liquid formulations of adulticide dispersed in the study of droplet size were technical malathion (95% AI), technical fenthion (93% AI), technical phenthoate (90% AI), chlorpyrifos (6 lb AI/gal Dursban® Mosquito Fogging Concentrate), and propoxur (1 lb AI/gal Baygon® Mosquito Oil Spray).

The hand wave method of droplet collection used in the study was reported in detail by Mount and Pierce (1972b). Glass microscope slides coated with either silicone (General Electric SC-87 Dri-Film) or Teflon® (Gulva Associates, Inc., Belle Chasse, Louisiana) were used. After each application of aerosol, samples of 100 droplets were measured at random on each of three glass slides. Volume distribution of the aerosol droplets and volume median diameters were estimated on the basis of corrected droplet diameters. The spread factors used in correcting droplet diameters were determined according to a direct measurement method described by Mount and Pierce (1972b). For the Teflon-coated slides, they were: propoxur 0.55, phenthoate 0.67, fenthion 0.64, and malathion 0.7. For the silicone-coated slides, they were: chlorpyrifos 0.49, and malathion 0.5.

We found that both nozzle systems dis-

[1] This paper reflects the results of research only. Mention of a pesticide or a commercial or proprietary product in this paper does not constitute a recommendation or an endorsement of this product by the U.S. Department of Agriculture.

persed aerosols of chlorpyrifos, phenthoate, and malathion in similar sized droplets (see Table 1). The Micro-Gen nozzles dispersed aerosols of propoxur and fenthion in droplets that were slightly larger than those dispersed by the Leco nozzle, but the volumes of these droplets in the range we consider optimum (5–20 μ) were about the same for the two systems.

The droplet sizes estimated for propoxur, phenthoate, and fenthion were of special interest because they have not been reported previously. The volume median diameters (VMD) for these adulticides (respective flow rates given in Table 1) resembled those reported for malathion dispersed at a rate of 90–130 ml (= 3–4.3 fl oz) per min.

CAGED MOSQUITO ASSAYS. In a second study, the efficacies of aerosols of technical malathion dispersed by the two nozzle systems were determined in simulated field tests with caged adult female mosquitoes. (The Micro-Gen Model MS2–15 was used in these comparisons since the Model LS2–15 was not available.) The 23 paired tests were conducted in a fairly level, open field near Gainesville, Florida, in October 1973 and April and May 1974. The aerosols were applied between 0900 and 1030 hours on 12 mornings. Air temperatures near ground level ranged from 68 to 84° F and averaged ca. 76° F. Wind velocities at 5 ft above ground ranged from 2 to 8 mph and were usually ca. 3 mph.

The MS2–15 engine was operated at maximum throttle (ca. 3400 rpm), which produced blower air pressures of 3.5–4 psi. The Leco HD was operated at the standard air pressure, 4 psi (engine speed of ca. 2500 rpm). Both aerosol generators were operated alternately with the same

Table 1. Droplet size of ultralow volume ground aerosols of 5 mosquito adulticides dispersed by 2 nozzle systems.

Adulticide	Flow rate (ml/min)	No. droplets measured	% of Total volume in droplets in indicated size range (μ)			VMD (μ)
			<5	5–20	>20	
Micro-Gen MS2–15 (3.5–4 psi blower pressure)						
Propoxur	340	300	2	57	41	18[a]
Chlorpyrifos	40	300	9	89	2	11[b]
Phenthoate	90	300	4	68	28	16[a]
Fenthion	60	300	5	67	28	16[a]
Malathion	90	300	7	65	28	15[a]
Micro-Gen LS2–15 (4 psi blower pressure)						
Malathion	130	600	2	55	43	19[b]
Micro-Gen LS2-15 (6 psi blower pressure)						
Malathion	130	600	8	82	10	12[b]
Leco HD (4 psi blower pressure)						
Propoxur	340	300	4	75	21	14[a]
Chlorpyrifos	48	300	15	85	0	9[b]
Phenthoate	90	300	10	64	26	14[a]
Fenthion	60	300	19	71	10	10[a]
Malathion	90	300	11	71	18	16[a]
Malathion	130	600	7	61	32	16[b]
Leco HD (6 psi blower pressure)						
Malathion	130	600	15	74	11	11[b]

[a] Droplets collected on Tefion-coated slides by hand waving.
[b] Droplets collected on silicone-coated slides by hand waving.

instrument panel (needle valve, flowmeter, liquid temperature gauge, blower air pressure gauge, and liquid flow solenoid valve). This panel was mounted in the cab of the dispersal truck so that each application could be monitored.

The dose of malathion was varied by changing either flow rate and/or dispersal speed. Flow rates of malathion were 65 and 130 ml/min (2.15 and 4.3 fl oz/min), and dispersal speeds were 5, 10, and 20 mph.

Aedes taeniorhynchus (Wiedemann) were used in all tests; *Anopheles quadrimaculatus* Say were used only in the 1974 tests. Adult female mosquitos, 2 to 5 days old, were exposed in 16-mesh galvanized screen wire cages (25/cage) suspended 4 ft above the ground on stakes 150, 300, 450, and 600 ft downwind in two rows perpendicular to the line of travel of the generators. Immediately after each aerosol application had drifted through the target area, the mosquitoes were blown from the cages into plastic tubes lined with clean paper. Except during exposure, they were held in insulated chests containing ice in cans and moist cotton. Absorbent cotton pads moistened with 10% (v/v) sugar water solution were placed on each of the holding tubes immediately after they were returned to the laboratory. Mortality counts were made 24 h after the mosquitoes were exposed to the aerosols. Cages of both species of mosquitoes that were not exposed to the aerosols of malathion but were otherwise handled in the same manner, showed an average 3% mortality.

Table 2 shows the results of the tests with caged *A. taeniorhynchus*. Probit analysis of these data indicated no statistically significant differences between the doses of aerosolized malathion estimated to produce 90% mortality (ED_{90}).

The data obtained with *A. quadrimaculatus* (see Table 3) were insufficient for probit analysis; however, the average percentage mortalities for mosquitoes exposed to aerosols applied with the Leco nozzle system were slightly higher than those for mosquitoes exposed to aerosols applied with the Micro-Gen nozzle system.

DISCUSSION. The results presented in the present report and those we obtained previously (Mount et al. 1975) demonstrated that the Micro-Gen and Leco nozzle systems disperse aerosol droplets of similar size. Furthermore, with both nozzle systems, the droplet size was dependent

Table 2. Comparison of two ULV nozzle systems dispersing aerosols of technical malathion against caged female *Aedes taeniorhynchus* in 23 paired tests during 1973 and 1974.

Dose (lb/acre)	Flow rate (ml/min)	Dispersal speed (mph)	Average percentage and range of mortality	
			Micro-Gen MS2–15	Leco HD
		300 ft swath[a]		
0.1	130	5	93(64–100)	96(80–100)
0.05	130	10	92(64–100)	90(52–100)
0.025	65–130	10–20	82(44–100)	84(32–100)
0.0125	65	20	68(20–100)	65(32–100)
ED_{90}[b]			0.05(0.035–0.08)	0.05(0.035–0.08)
		600 ft swath[c]		
0.05	130	5	87(48–100)	89(52–100)
0.025	130	10	78(20–100)	83(32–100)
0.0125	65–130	10–20	62(8–100)	68(26–100)
0.006	65	20	42(4–100)	42(4–100)
ED_{90}[b]			0.058(0.04–0.1)	0.04(0.03–0.06)

[a] Exposures at 150 and 300 ft.
[b] Effective dose estimated to produce 90% mortality and fiducial limits at the 95% probability level.
[c] Exposures at 150, 300, 450, and 600 ft.

Table 3. Comparison of two ULV nozzle systems dispersing aerosols of technical malathion against caged female *Anopheles quadrimaculatus* in 8 paired tests during 1974.

Dose (lb/acre)	Flow rate (ml/min)	Dispersal speed (mph)	Average percentage and range of mortality	
			Micro-Gen MS2–15	Leco HD
		300 ft swath [a]		
0.05	130	10	87(60–100)	96(76–100)
0.025	65–130	10–20	89(68–100)	92(64–100)
		600 ft. swath [b]		
0.025	130	10	75(44–100)	90(60–100)
0.0125	65–130	10–20	69(28–100)	84(40–100)

[a] Exposures at 150 and 300 ft.
[b] Exposures at 150, 300, and 600 ft.

on the liquid flow rate and blower air pressure. However, the flow rate of any given formulation of adulticide is governed by the effective dose and the dispersal velocity; thus blower air pressure is the most important means of controlling droplet size. Since the Micro-Gen LS2–15 and Leco HD feature blower air capacities of at least 6 psi, these generators should provide efficient aerosolization of any adulticides presently used.

The correlation between estimates of droplet size of aerosols and adult mosquito kill was interesting. In our opinion, this test and previous studies (Mount *et al.* 1968, 1970, and Mount and Pierce (1972a) show that the efficiency of mosquito kill with ground aerosols can be predicted from estimates of droplet size. Certainly the correlation demonstrated in these tests is more than adequate justification for continued study of the physical characteristics of aerosols intended for use in mosquito control programs.

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