DROPLET SIZE OF AEROSOLS DISPERSED BY PORTABLE AND TRUCK-MOUNTED GENERATORS[1]

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ABSTRACT. Droplet size determinations of aerosols dispersed by 5 portable and 3 truck-mounted generators were made. The volume median diameters (VMD's) for the Fogmaster® 7401 Micro-Jet, Micro-Gen® S1W-5, Leco® Mini I and Mini II portable generators were about equal (16 to 20μ and 18 to 23μ at flow rates of white mineral oil (Klearol®) of 30 and 60 ml per minute, respectively using white mineral oil). A Fogmaster® Challanger 5100 produced aerosol droplets that were about 50 percent larger than those of the other portable generators. In tests with truck-mounted aerosol generators, the Buffalo Turbine® Sonic gave inefficient aerosolization (VMD's of 24 to 34μ) of technical malathion whereas the Micro-Gen MS2-15 dispersed droplets of both white mineral oil and malathion that were similar in size to those produced by the Leco HD standard. The Leco HD gave near optimum aerosolization (VMD's of 12 and 13μ) of malathion at air pressures of 5 and 6 psi (0.35 and 0.42 kg/cm^2).

The droplet size of an aerosolized insecticide influences its efficiency in killing adult mosquitoes (Diptera: Culicidae). Reports by Mount et al. (1968), Mount (1970), Mount and Pierce (1972a), and Lofgren et al. (1973) indicate that for maximum efficiency, insecticidal aerosols for ground dispersal should have droplets of about 10 μ in volume median diameter (VMD = MMD), with most of the volume in droplets of 5 to 20 μ diam. This relationship between droplet size and mosquito kill exists because the transport of droplets in the environment and impingement on mosquitoes are functions of size. Aside from reduced insecticidal efficiency, improper droplet size of aerosols could cause unnecessary contamination of the environment (an example of this would be oversize droplets spotting automobile paints). Moreover, manufacturers of insecticides have included droplet size requirements on their ground aerosol labels. Thus, it is apparent that droplet size determinations for prototype aerosol generators should be obtained prior to biological testing and certainly before these generators are adopted for general use in mosquito control programs. The present paper gives a summary of droplet size determinations for aerosols dispersed from five portable and three truck-mounted generators.

METHODS AND MATERIALS. Specifications for the aerosol generators tested can be obtained from the manufacturers; therefore, they are not given in this paper. The portable generators tested were the Fogmaster® 7401 Micro-Jet and Fogmaster® Challanger Model 5100 (AFA Corporation of Florida, Miami Lakes, FL), Micro-Gen® Model S1W-5 (both gasoline and electric units were tested; Micro-Gen Equipment Corporation, San Antonio, TX), and Leco® Mini Models I and II (Lowndes Engineering Company, Valdosta, GA). The truck-mounted generators were the Buffalo Turbine® Sonic (Buffalo Turbine Agricultural Equipment Company, Inc., Gowanda, NY), Micro-Gen Model MS2-15, and Leco Model HD.

Klearol® (a white mineral oil, Witco Chemical Corp., Chicago, IL) was dispersed in all tests with the portable generators and in a portion of the tests with two of the truck-mounted generators. Klearol was used to simulate a liquid insecticide since it is essentially nontoxic and, thus, could be dispersed into our droplet settlement chamber without the risk of killing colonies of mosquitoes that are maintained in a building nearby. Technical malathion (95%) was dispersed from all three of the truck-mounted generators.

[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.

This insecticide was used since our past research has shown it to be more difficult to atomize than chlorpyrifos or naled (Mount and Pierce 1972a and 1972b). With one exception, collections of droplets of malathion were made with the hand wave method at a location several miles away from the laboratory.

The hand wave and settlement methods of droplet collection used in this study were described in detail by Mount and Pierce (1972b). We utilized a larger settlement chamber (16 x 16 x 8 ft high) than in the previous experiments. Glass microscope slides coated with Teflon® (Gulva Associates, Inc., Belle Chasse, LA) were utilized in addition to silicone (Dri-Film SC 87) coated slides.

Spread factors for the droplets of malathion and Klearol impinging on the coated glass slides were determined by a direct measurement method previously described in detail by Mount and Pierce (1972b). Spread factors used were as follows: Klearol and malathion on silicone coated slides, 0.4 and 0.5, respectively; Klearol and malathion on Teflon-coated slides, 0.6 and 0.7, respectively.

RESULTS AND DISCUSSION. Droplet size determinations for portable generators are given in Table 1 and those for truck-mounted generators are given in Tables 2 and 3. Comparisons are made without regard to collection methods since we demonstrated previously no difference between hand wave and settlement methods (Mount and Pierce 1972b). Also, we compared results obtained with silicone and Teflon-coated glass slides since aerosols collected on both coatings showed similar droplet sizes.

The VMD's for the Fogmaster Micro-Jet, Micro-Gen S1W–5, Leco Mini I and Mini II generators were about equal (Table 1). Droplet sizes for the Fogmaster Challanger 5100 were about 50 percent larger than for the other portable generators. Although any of these portable generators could be used in small-scale mosquito control programs, our data imply

Table 1. Volume distribution and volume median diameter of aerosolized white mineral oil (Klearol) dispersed from portable generators (Micro-Gen and Leco models operated at 3.5 and 1.5 psi, respectively (=0.25 and 0.11 kg/cm²); air pressure undetermined for Fogmasters).

Flow rate (ml/min)	No. droplets measured	Percentage of total volume in indicated size range (μ)			VMD (μ)
		<5	5–20	>20	
		Fogmaster Challanger 5100[c]			
30	1000	4	21	75	27[a]
100	500	3	25	72	34[a]
		Fogmaster 7401 Micro-Jet			
30	1000	4	58	38	17[a]
60	1000	4	54	42	18[a]
		Micro-Gen S1W–5			
30	3200	5	43	52	20[a, b]
60	1400	4	40	56	21[a, b]
		Leco Mini I[c]			
30	400	9	44	47	16[b]
60	800	5	32	63	22[b]
		Leco Mini II			
30	1500	3	49	48	19[b]
60	1000	3	30	67	23[a]

[a] Droplets collected on Teflon-coated glass slides in a settlement chamber.
[b] Droplets collected on silicone-coated glass slides in a settlement chamber.
[c] Production of these models has been terminated.

Table 2. Volume distribution and volume median diameter of aerosolized white mineral oil (Klearol) dispersed from truck-mounted generators.[a]

Flow rate (ml/min)	Air pressure (psi)[b]	No. droplets measured	Percentage of total volume in indicated size range (μ) <5	5–20	>20	VMD (μ)
			Micro-Gen MS2–15			
45	3	1500	9	59	32	15
90	3.5	1500	10	62	28	13
130	3.5	3000	12	71	17	14
450	3.5	500	3	34	63	22
			Leco HD (standard)			
45	3	1000	9	84	7	14
90	4	900	16	84	0	11
130	4	1000	10	74	16	14
130	5	2000	11	86	3	13

[a] Droplets were collected on Teflon-coated glass slides in a settlement chamber.
[b] Air pressures of 3, 3.5, 4 and 5 psi = 0.21, 0.25, 0.28, and 0.35 kg/cm², respectively.

that none of them would provide highly efficient aerosolization of either technical or concentrated insecticides. These generators were designed primarily for dispersing insecticides in and around premises for control of flies, cockroaches, and other insect pests. According to Yeomans (1960), VMD's for industrial use (indoors) should range from 5 to 15 μ. He states that the smaller droplets will give better dispersion and penetration into small crevices if the aerosol is to be applied

Table 3. Volume distribution and VMD of aerosolized technical malathion dispersed from truck-mounted generators.

Flow rate (ml/min)	Air pressure (psi)[a]	No. droplets measured	Percentage of total volume in indicated size range (μ) <5	5–20	>20	VMD (μ)
			Buffalo Turbine Sonic			
90	80	500	1	23	76	34[b]
90	100	1400	3	39	58	24[b]
90	110	1400	3	32	65	25[b]
			Micro-Gen MS2–15			
90	3	600	4	40	56	22[c, d]
90	3.5	600	5	58	37	17[c, d]
90	4	600	4	70	26	16[c]
130	3.5	600	10	47	43	18[c, d]
130	4	600	5	59	36	17[c]
			Leco HD (standard)			
90	3.5	600	12	59	29	15[c, d]
90	4	2100	7	63	30	15[b, c, d]
130	4	600	10	70	20	15[c]
130	5	1200	8	74	18	13[c, d]
130	6	600	10	81	9	12[c]

[a] Air pressures of 3, 3.5, 4, 5, 6, 80, 100, and 110 = 0.21, 0.25, 0.28, 0.35, 0.42, 5.6, 7, and 7.7 kg/cm², respectively.
[b] Droplets collected on silicone-coated glass slides in a settlement chamber.
[c] Droplets collected on silicone-coated slides by hand waving.
[d] Droplets collected on Teflon-coated glass slides by hand waving.

to a structure or room that can be closed for several hours.

Table 2 shows the droplet sizes of aerosolized Klearol dispersed by two truck-mounted generators. At the time these tests were conducted, the maximum air pressure for the prototype Micro-Gen MS2–15 was 3.5 psi. The blower for this generator was later modified by the manufacturer so that a pressure of 4 psi was obtainable. The atomization characteristics of the Micro-Gen and Leco nozzle systems were similar since droplet sizes were about the same for flow rates up to 130 ml per minute (VMD's of 13–15 μ for Micro-Gen and 11–14 μ for Leco). The MS2–15 gave poor atomization of 450 ml per minute of Klearol since the VMD was 22 μ and only 34 percent of the total volume was in droplets of 5 to 20 μ.

The droplet sizes of aerosolized malathion dispersed from three truck-mounted generators are shown in Table 3. VMD's for the Buffalo Turbine Sonic generator dispersing 90 ml per minute were substantially higher than the 17 μ maximum VMD required by the malathion label for ULV ground aerosol application. These data do not necessarily imply that this generator will not meet the label requirements for dispersal of malathion. For malathion label requirements, droplets are collected 7.6 m (= 25 ft) from the nozzle which allows larger droplets to settle, thus lower VMD's would be obtained. We believe our data are representative of total aerosol volume since the droplets were collected either in a settlement chamber or by hand waving at a distance of only 0.9 to 1.8 m (= 3 to 6 ft). Therefore, we concluded that dispersal of malathion with the Buffalo Turbine Sonic generator would be less efficient than with the Micro-Gen MS2–15 or the Leco HD. The MS2–15 gave adequate aerosolization of malathion at either 3.5 or 4 psi for the 90 ml per minute flow rate and at 4 psi for the 130 ml per minute rate. Combinations of 90 ml per minute and 3 psi and 130 ml per minute and 3.5 psi with the MS2–15 gave VMD's that were slightly larger than the maximum of 17 μ specified on the malathion label. Aerosolization of malathion with the Leco HD was similar to that we reported previously (Mount and Pierce 1972a and 1972b). The standard air pressure of 4 psi was adequate for flow rates of 90 and 130 ml per minute. VMD's of 12 and 13 μ for the higher air pressures (5 and 6 psi) represent near optimum aerosolization of malathion.

Literature Cited

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. J. Econ. Entomol. 66(5): 1085–1088.

Mount, G. A., C. S. Lofgren, N. W. Pierce and C. N. Husman. 1968. Ultra-low volume nonthermal aerosols of malathion and naled for adult mosquito control. Mosq. News 28(1): 99–103.

Mount, Gary 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. 1972a. Adult mosquito kill and droplet size of ultralow volume ground aerosols of insecticides. Mosq. News 32(3):354–357.

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

Yeomans, A. H. 1960. Directions for industrial use of aerosols. USDA, ARS–33–58. 4 pp.