A COMPARISON OF THE MORTALITY OF CAGED ADULT MOSQUITOES TO THE SIZE, NUMBER AND VOLUME OF ULV SPRAY DROPLETS SAMPLED IN AN OPEN AND A VEGETATED AREA

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ABSTRACT. A comparison of the mortality of caged adult mosquitoes to the size, number and volume of ULV spray droplets sampled in an open and vegetated area showed that 2.5-times more droplets with 3.24-times greater volume were sampled in the open area and resulted in 10-times greater mosquito mortality.

INTRODUCTION

Poor adult mosquito control in areas of dense vegetation treated with ground ULV sprays has been observed by many mosquito control workers and has been recently documented by Curtis and Mason (1988). This reduction in mosquito mortality in vegetation is thought to be caused by a reduction in droplet number and volume. Although it is recognized that the degree of control obtained varies with the type of vegetation and is directly proportional to its density, this research was designed to offer some insight into the effects of vegetation on the penetration of insecticide droplets.

METHODS

The general test area was a fairly open beach residential area on Panama City Beach, Florida, having few houses and little vegetation, although containing limited areas of dense vegetation. Four replications were conducted in the early evening hours after sunset in both a completely open and in a densely vegetated area over a period of 3 weeks. Temperatures ranged from 83 to 85°F (28 to 29°C), and wind velocities ranged from 2 to 3 mph (3 to 5 kph). In the open plot, the caged mosquitoes and the rotator with two slides for droplet collection were placed at the edge of a street which had no houses or vegetation other than grass within 100–200 ft (30–60 m) in all directions (see Fig. 1). The vegetated plot consisted of a stand of pine trees 3–30 ft (1–10 m) high with a variety of undergrowth and encompassed an area approximately one-quarter of a city block (150 × 300 ft, or 45 × 90 m).

The adult mosquitoes used in the tests were from organophosphorous susceptible laboratory colonies maintained at the John A. Mulrennan, Sr. Research Laboratory. Two cages of 2–8 day old *Culex nigripalpus* Theobald, each containing 25 females, were attached to the crossarm of each of two PVC poles at 6 ft (2 m) above ground level. The two poles with cages attached were placed approximately 10 ft (3 m) apart in both the open and vegetated area at a distance of 300 ft (90 m) downwind from 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, or 90 and 180 m) upwind of the first swath, or 600 and 900 ft (180 and 270 m) from the cages. Each test consisted of four cages of mosquitoes in each of the two areas. The cages used in the tests were 6 inches (15 cm) in diameter and 1 inch (2.5 m) deep with 14 × 18 mesh screen on both circular surfaces and were hung vertically with the screened surfaces facing into the wind. A like number of cages (4) were used as untreated controls for each test. After exposure, the mosquitoes were anesthetized with carbon dioxide and transferred to clean holding cages which were identical to the treatment cages. All cages of mosquitoes were held with access to a 10% surcrose solution on cotton pads for 12–15 hours at which time mortality counts were made.

Insecticide droplets were collected on two Teflon®-coated microscope slides mounted in a slide rotator (John W. Hock Co., Gainesville, FL) revolving at a speed of 350 rpm (8 mph or 13 kph). The rotators were started when spraying began and were run for 30 min or for approximately 18 min after spraying was completed. The droplets were measured by means of a compound microscope with a calibrated mechanical stage and a 100 division eye piece micrometer at a magnification of 100× (6.67 μm per ocular division). The size of each droplet passing through the micrometer in three traverses on each of two slides was measured. The traverses were exactly 40 mm × 0.67 mm and were 1 mm apart, starting 2 mm in from the leading edge of the slide. A spread factor of 0.69 for malathion on Teflon®-coated slides was used and the volume median diameter (VMD) of the droplets was computed using the standard method for

Fig. 1. The open test area with cages of mosquitoes and rotator with slides for sampling droplets.

impinged droplets which was a plot of the cumulative percent of the diameter times the number of droplets (Rathburn, 1970).

All tests were conducted with malathion (91% concentrate) at a discharge rate of 2.1 fl oz per min (62 ml/min) using a Leco HD ULV cold aerosol generator (Lowndes Engineering Co., Valdosta, GA) mounted on a flat-bed truck driven at 10 mph (16 kph). The generator was calibrated to deliver the discharge rate prior to testing and was operated at an air pressure of 4.0 psi (27.6 kpa). Spraying time varied from 10 to 14 min (mean 12 min), depending on the length of the swaths necessary to completely cover the test area.

RESULTS

In the four tests, 2.5-times ($t = 14.208^{**}$) more droplets were sampled in the open area (mean of 443.25 ± SD of 55.6) than in the vegetated area (177.5 ± 12.6), but approximately 10-times greater mosquito mortality ($t = 6.981^{**}$) was obtained in the open area (91.3 ± 3.4%) as in the vegetated area (8.6 ± 4.3%). Mosquito mortalities were corrected for the mortality in the untreated controls which averaged 1.3% (Sun and Shepard 1947). Although the average VMD of the droplets sampled in the open area (7.5 ± 0.6 μm) was slightly larger than those sampled in the vegetated area (6.8 ± 0.3 μm), there was no statistical difference in the VMD between the two areas ($t = 1.040$).

Table 1 compares the number of different size droplets sampled in the open and in the vegetation. The percent of the total number of droplets sampled which were 9.2 μm or smaller was greater in the vegetation, while the percent of the total number of droplets sampled which were 13.9 μm or larger was greater in the open area. Therefore, a smaller percentage of the larger droplets were sampled in the vegetation than in the open. This reduction in the number of larger droplets in the vegetation is probably due to their impingment on vegetation. The ratio of the total number of droplets sampled in open to those sampled in the vegetation was 2.51, or about 2.5-times more droplets were sampled in the open as in the vegetation. The ratio increased progressively from 2.3 at a droplet size of 4.6 μm to 4.6 at a droplet size of 27.7 μm. This also indicates a reduction in the number of larger droplets in the vegetation.

Table 2 compares the size and volume of the droplets sampled in the open and vegetated areas. The percent of the total volume of droplets sampled which were 9.2 μm or smaller was greater in the vegetated area than in the open area; and, conversely, the percent of the total volume of droplets which were 13.9 μm or larger was greater in the open area than in the vegetated area. The ratio of the total volume of

Table 1. A comparison of the size and number of insecticide droplets in an open and in a vegetated area.

Droplet size (μm)	Average number of droplets		Ratio	Percent of total number of droplets	
	Open	Vegetation	Open/Vegetation	Open	Vegetation
4.6	202.3	89.0	2.3	45.6	50.4
9.2	140.8	58.3	2.4	31.8	33.0
13.9	68.3	20.8	3.3	15.4	11.8
18.5	21.0	5.8	3.6	4.7	3.2
23.1	8.8	2.3	3.8	2.0	1.3
27.7	2.3	0.5	4.6	0.5	0.3
Total	443.3	176.5	2.51	100.0	100.0

Table 2. A comparison of the size and volume of insecticide droplets in an open and in a vegetated area.

Droplet size (μm)	Average volume of droplets		Ratio	Percent of total volume of droplets	
	Open	Vegetation	Open/Vegetation	Open	Vegetation
4.6	12.5	5.5	2.3	3.8	5.3
9.2	61.2	25.4	2.4	18.3	24.7
13.9	100.3	30.5	3.3	30.1	29.6
18.5	73.1	20.3	3.6	21.9	19.6
23.1	59.8	15.6	3.8	17.9	15.2
27.7	26.7	5.8	4.6	8.0	5.6
Total	333.6	103.0	3.24	100.0	100.0

droplets sampled in the open area compared to those sampled in the vegetated area was 3.24. Therefore, there was 3.24-times more droplet volume or 3.24-times greater insecticide dosage in the open area. This difference in insecticide dosage was probably responsible for the 10-fold increase in the caged mosquito mortality in the open area.

CONCLUSIONS

Based on these calculations, it would require 3.24-times the discharge rate of 2.1 fl oz per min (62 ml/min) at a vehicle speed of 10 mph (16 kph) or a discharge of 6.8 fl oz per min (200 ml/min) to obtain a 90% mortality of caged mosquitoes in the vegetated area. This extrapolated effective dosage for the vegetated area is only applicable to the area in which these tests were conducted and may vary greatly between areas with different types and densities of vegetation. Because of their effects on droplet size, it may also vary with different insecticides, discharge rates and spray equipment.

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