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EVALUATION OF ULTRA LOW VOLUME GROUND EQUIPMENT IN BRAZORIA COUNTY, TEXAS[1]

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Introduction. Mount *et al.* (1966) demonstrated that nonthermal aerosols and thermal aerosols were equally effective when malathion, fenthion, and naled were used as toxicants. Mount *et al.* (1968) concluded that U.L.V. nonthermal aerosols of malathion were at least as effective as high volume thermal aerosols against caged mosquitoes. These authors also indicated that U.L.V. aerosols of malathion and naled were more effective than high volume aerosols against caged and free-flying mosquitoes. In both of the above tests, the nonthermal aerosols were produced by a modified Curtis aerosol generator (Model 55,000).

Recently, Lowndes Engineering Company manufactured a conversion unit for the Leco 120 thermal aerosol generator. This conversion unit replaces the combustion chamber and operates at a pressure of 3 p.s.i. on the insecticide container and has a flow rate ranging from ½ to 1 gallon per hour. At the higher flow rate, the mass median diameter of the droplets is expected to be in the range of 10 microns.

The many advantages of ground application of U.L.V. aerosols have been reported by Mount *et al.* (1968): (1) Reduce to a minimum the need for carriers, solvents, and additives; (2) reduce drastically the amount of spray solution that has to be carried; (3) lessen greatly the amount of insecticide placed in the biosphere; (4) reduce size of equipment; (5) no dense fog to obscure traffic or roads.

Methods and Materials. The tests were conducted during the summer and fall of 1969 to obtain performance data on malathion and Dursban[3] using an ultra low volume ground application. All treatments were applied with a U.L.V.

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[3] Registered trademark of The Dow Chemical Company, Midland, Michigan.

conversion unit for the Leco 120 calibrated to deliver ½ to 1 gallon of insecticidal solution per hour. The unit was mounted on a pick-up truck, which was driven at 10 m.p.h. moving perpendicular to the wind direction. The dosage in lb./A. was calculated on the basis of the above speed and a swath width of 300 feet (364 acres per hour). It is apparent that this method of recording dosages leaves much to be desired, since it is not a true measure of insecticidal deposit per acre; however, it does enable various investigators to relate one test with another.

The experimental plots were located at the Brazoria County fair grounds, which were open and level. Approximately 20 adult female *Culex quinquefasciatus* (Say) were placed in cages made from 18-mesh screen, measuring 73 mm. in diameter and 169 mm. in height. The mosquitoes were laboratory reared and were 4–8 days old.

In all tests, temperature and wind velocity were recorded.

The cages were suspended 3 feet above ground level on wooden stakes placed every 50 feet for a distance of 500 feet. The first stake was adjacent to the lane that the fogging truck traveled. Every attempt was made to place the stakes directly downwind.

In those tests where larvicidal action of the insecticide was to be evaluated, a small plastic petri dish with approximately 10 fourth-instar *Culex quinquefasciatus* larvae was placed at the base of each stake. Approximately 10 minutes after the aerosol dispersal, the dishes and cages were collected and returned to the insect holding room for observation. Mortality counts were made at 1, 2, 4, 6, 8, and 24 hours posttreatment for adults, and at 24 hours posttreatment for larvicidal action.

RESULTS AND DISCUSSION. Twenty-one tests were conducted with malathion at a dosage range of 0.0133 to 0.0265 lb./A. (Table 1), and 16 tests were conducted with Dursban at dosages of 0.0005 lb./A. to 0.016 lb./A. (Table 2). The above dosages were calculated on the basis of a 300-ft. swath width and vehicle moving at 10 m.p.h. (364 acres per hour). Acceptable control of adult mosquitoes was obtained with dosages as low as 0.0198 lb./A. malathion and Dursban at 0.005 lb./A. There was no indication of larval kill with malathion even at the highest

TABLE 1.—Mortality of adult female mosquitoes 8 hours after exposure to nonthermal aerosols of malathion.

Date	Dosage Lb./A.	Gal./Hr.	Temperature ° F.	Wind Ft./Min.	% Kill
7–29	.0133	1/2	76	100	95.4
7–29	.0133	1/2	76	50	93.6
8–5	.0133	1/2	92	220	46.1
8–5	.0133	1/2	93	600	100.0
7–29	.0159	3/5	76	0	59.5
7–29	.0159	3/5	75	0	91.3
8–5	.0159	3/5	94	400	54.0
8–5	.0159	3/5	92	500	90.0
7–29	.0198	3/4	76	0	93.3
7–29	.0198	3/4	76	0	100.0
8–5	.0198	3/4	93	600	100.0
8–5	.0198	3/4	93	650	86.0
8–20	.0198	3/4	92	500	100.0
8–20	.0198	3/4	94	300	97.0
6–27	.0265	1	79	200	100.0
6–27	.0265	1	79	100	100.0
7–2	.0265	1	78	250	100.0
7–11	.0265	1	82	150	96.6
7–15	.0265	1	78	100	82.5
7–17	.0265	1	77	150	90.8
7–19	.0265	1	78	0	86.2

TABLE 2.—Mortality of adult mosquitoes 8 hours after exposure to nonthermal aerosols of Dursban

Date	Dosage Lb./A.	Temperature ° F.	Wind Ft./Min.	% Kill
8–20	.0005	95	300	56.0
8–20	.005	95	700	33.0
8–20	.002	92	500	71.0
8–20	.002	94	600	78.0
9–26	.005	72	200	96.0
9–26	.005	74	200	98.7
9–3	.008	90	200	100.0
9–3	.008	91	300	94.9
9–26	.008	76	250	90.9
9–26	.008	77	350	98.2
9–3	.011	92	250	90.4
9–3	.011	90	400	94.5
9–26	.011	80	250	99.0
9–26	.016	84	350	100.0
9–3	.016	91	400	100.0
9–3	.016	91	500	100.0

level (0.0265 lb./A.). Dosages of 0.008 lb./A. and higher of Dursban gave excellent to complete control of mosquito larvae (Table 3).

Wind velocity varied from zero (unmeasurable) to 650 ft./min., and did not greatly reduce the effectiveness of malathion and Dursban (see Tables 1 and 2).

Although temperature varied from 75° F. to 94° F., there was no apparent effect on the mortality of the mosquitoes.

SUMMARY. Nonthermal U.L.V. aerosol applications (Leco 120 U.L.V. conversion unit) of malathion and Dursban were evaluated on adult *Culex quinquefasciatus.* The effective dosages appear to be 0.0198 lb./A. for malathion and 0.005 lb./A. for Dursban insecticide.

No effect was noted on mosquito larvae when treated with malathion at a dosage of 0.0265 lb./A., while Dursban was found to be effective at 0.008 lb./A.

The effects of wind and temperature on mosquito kill may be less critical for the U.L.V. ground application than for conventional thermal fog application.

The U.L.V. ground application of nonthermal aerosols appears to have many

TABLE 3.—Mortality of mosquito larvae after exposure to nonthermal aerosols of malathion and Dursban

Date	Dosage Lb./A.	Temperature ° F.	Wind Ft./Min.	% Kill 24 Hrs.
6–27	.0265 Malathion	79	200	0
6–27	.0265 "	79	100	0
8–20	.002 DOWCO 179	92	500	0
9–26	.005 "	72	200	91.3
9–26	.005 "	74	200	81.8
9–3	.008 "	90	200	100.0
9–3	.008 "	91	300	93.7
9–26	.008 "	76	250	85.4
9–26	.008 "	77	350	97.1
9–3	.011 "	92	250	93.6
9–3	.011 "	90	400	100.0
9–26	.011 "	80	250	100.0
9–26	.011 "	84	350	99.1
9–3	.016 "	91	400	100.0 (8 hrs.)
9–3	.016 "	91	500	100.0 (6 hrs.)

advantages over conventional thermal fogs and should become an important tool in mosquito control activities.

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PHOTOPERIOD ENTRAINMENT OF TWO *ANOPHELES* MOSQUITOES [1]

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The well-recognized cyclic nature of certain aspects of insect behavior is frequently an expression of endogenous circadian rhythms entrained (set in phase) by the photoperiod (Harker, 1961; Beck, 1968). Among mosquitoes, such diverse rhythmic activities as oviposition, pupation, nectar feeding, biting, and flight are recognized as circadian, the times at which these activities occur being established by the daily cycle of light and dark. Evidence for such control of flight activity in anophelines has been found for several species (Bates, 1941; Eyles and Bishop, 1943; Jones *et al.,* 1966; Taylor, 1969). Anophelines frequently show a pattern of daytime seclusion and quiescence with periods of intense activity associated with sunset and sunrise. These habits can have inconvenient consequences for laboratory studies of anopheline responses to environmental factors. Assessments of behavior made during conventional working hours may be seriously biased because of the mosquitoes' low level of responsiveness during the day. Laboratory evaluations of light trap designs are particularly subject to this limitation. Ordinarily, such tests must be done at night because the alternative of daytime tests in a dark chamber does not include the mosquitoes' normal periods of maximum activity.

Artificially entrained mosquitoes appear to provide a way of meeting this objection. The procedure described in this paper was devised to determine whether photoperiod manipulation could be used to produce adults of *Anopheles albimanus* Wied. and *A. stephensi* Liston with high levels of flight activity at predetermined times during the day.

Methods and Materials. The mosquitoes used in these tests were obtained from insectary colonies long established at Technical Development Laboratories. The *A. albimanus* strain came from El Salvador. The *A. stephensi* colony was started with material originally from India which came to this laboratory via colonies in London, England, and Atlanta, Georgia.

All specimens were received as pupae. Those to be used as controls emerged in netting-covered gallon cartons placed near a window to expose them to the natural

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