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EVALUATION OF THERMAL AND NONTHERMAL FOGS AGAINST FOUR SPECIES OF MOSQUITOES [1]

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Introduction. Space spray evaluation of malathion, Dursban, naled and Baygon as thermal aerosols was conducted in Savannah, Georgia, in 1966. In addition, the studies included comparison of the relative effectiveness of thermal and nonthermal fogs and of oil and emulsion formulations.

Methods and Materials. The test area used was described by Jakob (1966) and Schoof *et al.* (1962). Except for an increase in the density of the vegetation, none of the physical aspects of the area had changed.

The equipment [2] consisted of a Leco 120 thermal fog generator mounted on a ¾-ton truck and a Curtis "Cold Fogger" mounted on a trailer. In all evaluations malathion was formulated at a rate of 6 oz./gal. of finished spray, and naled, Dursban® (*O,O*-diethyl *O*-[3,5,6-trichloro-2-pyridyl phosphorothioate]) and Baygon® (*O*-isopropoxyphenyl methylcarbamate) at 2 oz./gal. The solvent was No. 2 fuel oil except when emulsions were under test. An auxiliary solvent, Ortho additive, was incorporated in the naled sprays at 0.4 percent by volume.

Oil formulations of malathion, naled, and Baygon were prepared from 95 percent technical malathion, 14 lb./gal. naled concentrate, and 1.5 lb./gal. Baygon concentrate, respectively. Emulsions of malathion and Dursban were formulated from concentrates containing 8 and 4 lb./gal. of the toxicants, respectively.

Tests were conducted at night between 7:00 and 11:00 p.m., using *Aedes aegypti*,[3] *Anopheles albimanus*,[4] and *Culex quinquefasciatus* [4] as the primary test insects, with *Aedes taeniorhynchus* [4] included on a limited basis. Approximately 100 females of each species after knock down by CO_2 were transferred into 3¼-inch diameter by 6-inch screen-wire cages. Caged specimens were prepared for exposure at sites at 150 and 300 feet on each of three streets and for each of four possible test runs per night; thus each test distance and species were replicated three times per run. The cages were hung 6 feet above the ground at the exposure stations, which were located along three streets 270 feet apart (Fig. 1). Malathion and naled also were tested at 75 feet. The length of the application run was 1,300 feet; the travel time at about 5 m.p.h. was 3 minutes. At a discharge rate of 40 gal./hr., 2 gallons of the formulation were discharged during each run. Runs were conducted only when wind velocities permitted a drift of the fog over the test area.

Each night's testing began with the malathion nonthermal fog and was followed by the test material. Malathion was then run as a thermal fog followed by the same test material. Approximately 15 minutes after each test run the cages were removed to the laboratory and the insects transferred to holding cages, given food, and held for 24-hour female mortality counts. Check insects were transported to the test site prior to each test and then returned to the laboratory grounds where they were suspended outdoors in the same manner as the treated specimens. Subsequent handling was the same as that for the treated mosquitoes.

Results. Thermal and nonthermal fog tests with malathion at 6 oz./gal. and

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[2] The use of trade names is for identification purposes only and does not constitute product endorsement by the Public Health Service.

[3] DDT-dieldrin resistant strain.

[4] Susceptible strain.

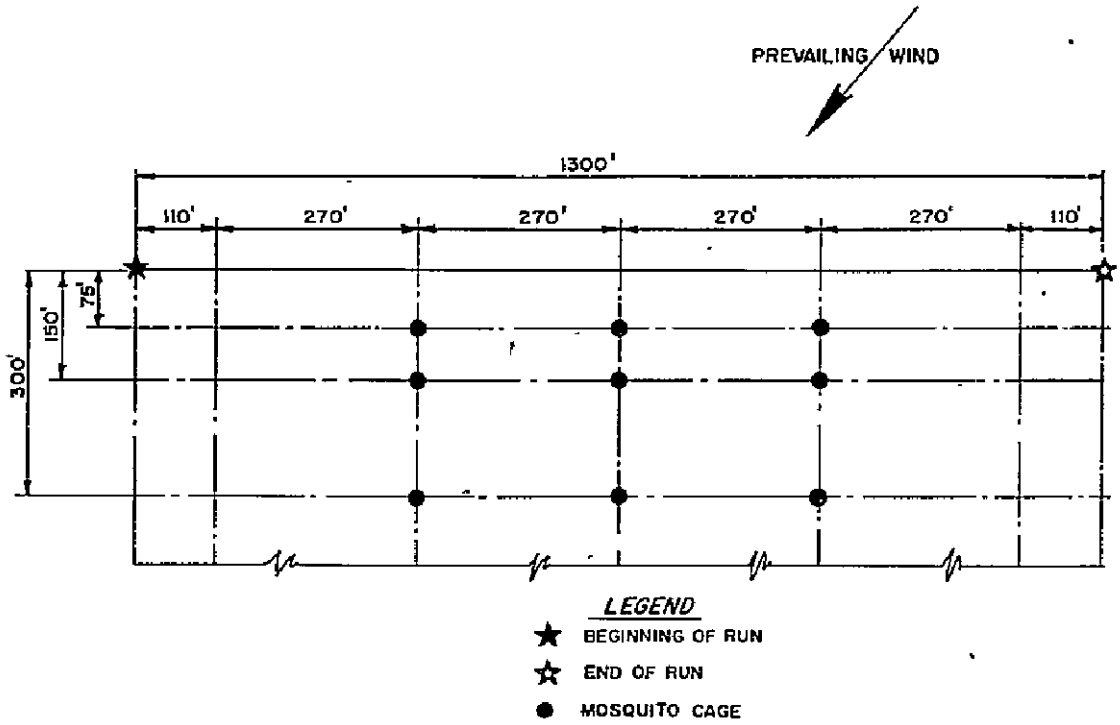

FIG. 1.—Location of caged mosquitoes in space spray studies, Savannah, Georgia, 1966.

Dursban, naled and Baygon at 2 oz./gal. showed malathion to be superior against *Ae. aegypti, C. quinquefasciatus, A. albimanus* and *Ae. taeniorhynchus* at distances up to 300 feet from the point of discharge of the fogs (Tables 1, 2 and 3). Of the compounds tested at the 2 oz./gal. dosage, Dursban was the most effective, Baygon the least effective. Naled gave unsatisfactory results with kills of about 70 to 75 percent of *Ae. aegypti* and *C. quinquefasciatus* at 150 feet. Against *A. albimanus* it was more effective with kills of 84–92 percent at 150 feet.

TABLE 1.—Percent kill of adult female mosquitoes 150 and 300 feet from the point of discharge of thermal fogs.

Insecticide	Test Runs	*Ae. aegypti* 150'	*Ae. aegypti* 300'	*An. albimanus* 150'	*An. albimanus* 300'	*Cu. quinque.* 150'	*Cu. quinque.* 300'
Malathion	12	94	83	94	84	94	82
Dursban	5	91	72	93	73	95	70
Naled	10	69	24	84	49	71	28
Baygon	3	20	14	91	42	43	22

TABLE 2.—Percent kill of adult female mosquitoes 150 and 300 feet from the point of discharge of nonthermal fogs.

Insecticide	Test Runs	*Ae. aegypti* 150'	*Ae. aegypti* 300'	*An. albimanus* 150'	*An. albimanus* 300'	*Cu. quinque.* 150'	*Cu. quinque.* 300'
Malathion	12	97	89	98	95	86	79
Dursban [1]	6	90	75	90	75	91	80
Naled	12	74	24	92	51	75	31
Baygon	3	39	10	85	83	61	22

[1] Dursban was formulated as an emulsion; malathion, naled and Baygon as oil solutions.

TABLE 3.—Percent kill of adult female *Aedes taeniorhynchus* with malathion and naled fogs.

Insecticide (type fog)	Test runs	150′	300′
Malathion (thermal)	4	97	87
Malathion (nonthermal)	5	100	98
Naled (thermal)	2	59	27
Naled (nonthermal)	2	62	8

Thermal fogs of malathion appeared to be equally effective against all of the test species. Nonthermal fogs, however, were somewhat less effective against *C. quinquefasciatus*. The most susceptible mosquito appeared to be *A. albimanus* as indicated in tests with naled and Baygon.

Tests with specimens exposed at 75 feet showed that malathion and naled produced similar high levels of effectiveness against *Ae. aegypti* and *A. albimanus* but against *C. quinquefasciatus* malathion produced higher kills. At 150 feet the kills with naled were considerably less than those with malathion (Table 4).

Comparison of thermal fogs and nonthermal fogs formulated as oil solutions and emulsions showed little difference in effectivity against the test species (Table 5).

Temperatures ranged from 72° to 82° F. during the 7:00 and 11:00 p.m. test period; the average relative humidity was from 85 to 100 percent. Wind conditions varied from 0 to 500 feet per minute (0–6 m.p.h.); however, over 90 percent of the time the wind velocity was less than 1 m.p.h.

DISCUSSION. Against the four species involved, malathion gave the best results at the standard strength of 6 oz./gal., but Dursban at one-third the strength was almost as effective as a thermal fog. All of the compounds were effective against *A. albimanus* at 150 feet.

TABLE 4.—Percent kill of adult female mosquitoes by malathion and naled 75 and 150 feet from the point of discharge of thermal fogs.[1]

	Malathion		Naled	
Species	75′	150′	75′	150′
Aedes aegypti	99	94	98	69
An. albimanus	98	94	97	84
Cu. quinque.	98	94	82	71

[1] Four test runs each at 75 feet, 12 test runs of malathion and 10 test runs of naled at 150 feet.

The fact that naled performed well at 75 feet confirms laboratory data that it is highly toxic to these mosquitoes but its dispersal beyond that distance appears to be much more affected by local conditions than is true of the other materials. Tests in previous years by Jakob (1966) produced much the same results.

There was no demonstrable difference between the biological effectiveness of thermal and nonthermal fogs of malathion, as was also found in tests by Mount *et al.* (1966). Neither was there any difference in effectiveness between oil and emulsion formulations as cold fogs. Emulsions were cleaner materials to work with in formulation and in equipment maintenance than were the fuel oil preparations.

SUMMARY. Baygon, Dursban and naled were tested in the field at Savannah, Georgia, against caged *A. albimanus, C. quinquefasciatus, Ae. aegypti* and *Ae.*

TABLE 5.—Percent kill of adult female mosquitoes with various fog formulations of malathion.

	Thermal Fogs		Nonthermal Fogs			
	(oil solutions)[1]		(oil solutions)[1]		(emulsions)[2]	
Species	150′	300′	150′	300′	150′	300′
Ae. aegypti	94	83	97	89	99	98
An. albimanus	94	84	98	99	99	90
Cu. quinque.	94	82	96	86	96	86

[1] Twelve test runs.
[2] Three test runs.

taeniorhynchus. Baygon and naled were inferior to Dursban at 2 oz./gal. and only the latter approached malathion (6 oz./gal.) in efficacy. *C. quinquefasciatus* and *Ae. aegypti* were far more difficult to kill than *A. albimanus* with either Baygon or naled. Tests with malathion and naled at 75 feet produced similar results; at 150 and 300 feet, however, malathion was superior. No differences in effectiveness were detected between thermal and nonthermal fogs or between oil solutions and water emulsions.

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