CONTROL OF MOSQUITOES WITH DURSBAN® INSECTICIDE APPLIED AS A THERMAL FOG

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INTRODUCTION. Numerous laboratory investigations have demonstrated that extremely small amounts of Dursban® [5] insecticide (0,0-diethyl 0-3,5,6-trichloro-2-pyridyl phosphorothioate) are toxic to mosquito larvae.

Ludwig and McNeill (1966) showed that conventional aerial applications of Dursban insecticide at .025 lb/A gave adult and larval control in tests conducted in Texas during 1965 and in the spring of 1966.

Jakob (1966) reported that thermal fogs of a mix containing Dursban at 1.5 ounces of the active ingredient per gallon of oil gave promising results.

In view of the above reports, it was decided to evaluate the use of Dursban further as a thermal fog.

METHODS AND RESULTS. The following studies were initiated during the summer of 1966 in Brazoria County, Texas, to compare the performance of Dursban, naled and malathion insecticides as thermal fogs against larvae and adults of several species of mosquitoes.

All treatments were made using a Leco 120 thermal fog generator calibrated to deliver 40 gph. When the truck carrying the fog generator was driven at 5 mph and moving crosswind, this unit would treat 180 acres per hour. The dosage per acre was calculated on the basis of a 300-foot swath width. If the effective range should be over 300 feet, the actual dosage would be less than the reported figure.

The intake and bypass hoses to the normal reservoir of the fog generator were disconnected and inserted into 5-gallon gas cans containing the test chemicals in No. 2 fuel oil. Clean fuel oil was used for purging between treatments.

In the following tests, fuel oil was placed in clean gasoline cans and the following chemicals were added, in the amounts indicated, for the various tests:

Chemical	ml/5 Gal.	Lbs. actual/A based on 300-ft swath at 5 mph
malathion	568	.15
naled	331	.031
Dursban 6	378	.026
	331	.023
	284	.02
	189	.013
	142	.01
	71	.005

Wind velocities were determined and recorded for each treatment in each test.

In the first and second tests, the insecticides were evaluated as adulticides. Approximately 40 *Aedes aegypti* adults were placed in quart size screen cages suspended on stakes 3 feet from the ground. Stakes were driven in the ground at 30-foot intervals, beginning 90 feet downwind from the fog source and extending to 300 feet. Adult mosquitoes were exposed to chemical treatments and allowed to remain on stakes for 10 minutes before cages were removed to a holding room.

The total mosquitoes dead and alive were counted and percent control computed. No adjustments were made in percent mortality calculations, as little mortality occurred in the control cages.

Mortality counts were made at 2, 4 and 24 hours post-treatment in the first experiment. The percentage mortality data of the adult *Aedes aegypti* placed at 150 and

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300 feet from the fog generator are presented in Table 1.

TABLE 1.—Percent mortality obtained with thermal fogs of *Aedes aegypti* adults.

Insecticide	lb/A	Wind mph	Percent mortality at indicated distances and hours post-treatment: 150 Feet 2 Hr	150 Feet 4 Hr	150 Feet 24 Hr	300 feet 2 Hr	300 feet 4 Hr	300 feet 24 Hr
Dursban	.013	0	7	30	92	6	10	72
	.026	0	5	27	100	16	49	97
naled	.031	1	78	78	100	0	0	44
malathion	.15	4	92	96	100	60	70	96
control	..	..	..	..	0	..	..	0

The percentage mortality data at 2 and 4 hours post-treatment suggest that Dursban insecticide may not have as rapid knockdown ability as naled and malathion. Dursban at the lower level (.013 lb/A) appeared to be inadequate for control of *Aedes aegypti* adults; however, the higher level (.026 lb/A) was as effective as malathion (.15 lb/A) at the end of 24 hours. Both rates of Dursban were more effective than naled at a distance of 300 feet.

The percent mortality data of caged *Aedes aegypti* adults from the second application of treatments as thermal fogs are presented in Table 2. These results are

TABLE 2.—Average percent mortality of *Aedes aegypti* adults obtained with thermal fogs of several insecticides.

Insecticide	lb/A	Wind Ft/Min.	Hours Post-treatment 2	4	12	24
Dursban	.02	100–220	9	51	88	90
	.026	200	15	68	96	98
naled	.031	300	46	57	73	77
malathion	.15	240	64	75	85	88
control	..	...	0	0	0	0

averages of eight stations located 30 feet apart, beginning 90 feet from the fog generator and extending to 300 feet.

The data at 2 and 4 hours indicate, as previously, that Dursban has slow knockdown when compared to naled and malathion.

Dursban at .02 and .026 lb/A gave adult control of 90 and 98 percent, respectively, at 24 hours. Malathion at .15 lb/A gave 88 percent control of adults, and naled at .031 lb/A gave 77 percent control.

In the latter test, *Aedes aegypti* larvae were also exposed in containers placed at various intervals downwind.

One hundred ml. of water containing 10 third and fourth instar *Aedes aegypti* larvae was placed in 6-inch diameter plastic-coated paper bowls. These containers were placed 100, 150, 200 and 300 feet downwind from the fog source. Each container was exposed to chemical treatment, and after 10 minutes the water containing the larvae was poured into 4-ounce glass bottles and capped. The bottles were returned to the laboratory and held uncapped for observation. Larval mortality counts were taken at 4, 8, 12 and 24 hours post-treatment.

The average percentage control of the larvae is presented in Table 3.

One hundred percent control of *Aedes aegypti* larvae at all six stations, with Dursban applied as a fog, suggested new properties for Dursban not common to other insecticides applied in this manner. Larvicidal activity of Dursban applied as a thermal fog was further evaluated in the following tests.

In these tests, *Culex fatigans* larvae were substituted for the *Aedes aegypti* larvae.

TABLE 3.—Average percent control of *Aedes aegypti* larvae in dishes placed at 50-foot intervals downward from a thermal fogging unit.

Insecticide	Lb/A	Wind Ft/Min.	Hours Post-treatment 4	8	12	24
Dursban	.02	100–220	5	79	96	100
	.026	200	5	90	95	100
naled	.031	300	0	0	0	>2
malathion	.15	240	0	0	0	0
control	..	...	0	0	0	0

The bowls which contained 10 third and fourth instar larvae in 100 ml. of water were placed at 50-foot intervals, starting at 50 feet and continuing to 400 feet. Mortality counts were made two hours after treatment.

Three levels of Dursban (.02, .023, and .026 lb/A) were evaluated in the same manner as reported previously. The results are given in Table 4.

It should be noted that there was a change in species, *Aedes aegypti* to *Culex fatigans*. The *Culex fatigans* larvae appeared to be much more susceptible to Dursban, as indicated by Ludwig and McNeill (1966). This difference could also be observed by the rapid larval kill. With the *Aedes aegypti* larvae, complete kill was not obtained until 24 hours at a dosage of .02 and .026 lb/A (See Table 3).

In the next series of experiments, the technique for handling the larvae was revised. Ten *Culex fatigans* larvae in only 10 ml. of water were placed in 2-inch diameter petri dishes. The dishes were placed at 50-foot intervals, starting at 50 feet and continuing to 500 feet. The tops were removed during treatment and replaced following the 10-minute exposure period. Mortality counts were made intermittently throughout a 24-hour period.

TABLE 4.—Results of a thermal fog test conducted against *Culex fatigans* larvae.

Insecticide	Lb/A	Wind mph	Percent mortality 2 hours post-treatment
Dursban	.020	2	100
	.023	2	100
	.026	2	100
control	..	..	0

In order to determine the lowest effective level, lower dosages of Dursban were evaluated. The percent mortality data are presented in Table 5.

Dursban insecticide at .013, 0.20, and .023 lb/A gave 100 percent control of *Culex fatigans* larvae at all ten stations. Malathion at .15 lb/A did not give effective control, and No. 2 diesel fuel oil was completely ineffective.

In the following test, the 2-inch diameter petri dishes were spaced at 50-foot intervals to 700 feet from the fog source. The handling of containers with larvae was the same as described previously. The results are presented in Table 6.

Dursban insecticide at .005 lb/A gave 100 percent control of *Culex fatigans* larvae beyond 300 feet, but inadequate control closer to the fog source.

Dursban at .013 and .023 lb/A gave 100 percent control throughout the length of the test strips, and diesel oil was again ineffective.

TABLE 5.—Percent mortality of *Culex fatigans* larvae in containers 24 hours after application of insecticides as thermal fogs.

Insecticide	Lb/A	Wind Ft/Min.	Percent mortality indicated distance in feet 100	200	300	400	500
diesel	..	675	0	0	0	0	0
malathion	.15	550	20	0	10	0	0
Dursban	.013	650	100	100	100	100	100
	.020	410	100	100	100	100	100
	.023	500	100	100	100	100	100

TABLE 6.—Results of 12 hours post-treatment for a thermal fog test conducted against *Culex fatigans* larvae.

Insecticide	Active Lb/A	Wind Ft/Min.	Percent mortality at indicated distances in feet						
			100	200	300	400	500	600	700
diesel	..	175	0	10	0	..	..	..	..
Dursban	.005	175	0	44	20	100	100	100	100
	.01	125	87	100	100	90	100	100	100
	.013	125	100	100	100	100	100	100	100
	.023	125	100	100	100	100	100	100	100

To confirm the above results, an additional test was run using the same rates. The distance between stations was again 100 feet and the length of the swath was reduced to 650 feet, as this was the maximum length of the area where the experiment was conducted.

Dursban insecticide at .023 lb/A gave 100 percent control only for the first 350 feet, as can be observed in Table 7.

control of mosquito adults and larvae when applied through a thermal fogging unit. Applications were made using a Leco 120 thermal fog generator operated in a standard manner, using 40 gph of finished oil-insecticide mixture.

As an adulticide, Dursban insecticide at .02, .023, and .026 lb/A gave 90, 100, and 98 percent control, respectively, of caged *Aedes aegypti* adults. These rates com-

TABLE 7.—Results of 24 hours post-treatment of a thermal fog test conducted against *Culex fatigans* larvae in containers.

Insecticide	Lb/A	Wind Ft/Min.	Coverage	Percent mortality at indicated distances in feet						
				50	150	250	350	450	550	650
diesel	..	50	poor	20	0	..	..	..	..	..
Dursban	.005	80	poor	90	70	100	80	0	70	90
	.01	50	poor	77	90	90	90	100	30	50
	.013	100	poor	0	10	20	60	0	60	50
	.023	160	good	100	100	100	100	70	0	60

The application of diesel fuel with no insecticide was again ineffective at all stations.

The wind velocity was very low and, as indicated, the coverage of the treated area was poor. The fog did not move down and over the dishes, but appeared to drift upward.

It is believed that the mortality noted in the above tests is due to a "fall out" of the fog particles, thus carrying a small amount of Dursban into the water.

SUMMARY. During the summer of 1966, field tests were conducted in Brazoria County, Texas, comparing Dursban insecticide with recommended chemicals for pare favorably with naled at .021 lb/A and malathion at .15 lb/A.

As a larvicide, Dursban insecticide was effective at .005 lb/A, the lowest dosage used for the control of *Culex fatigans* larvae. Control of larvae was not obtained with either malathion or naled applied at recommended dosages.

In five out of six experiments, Dursban insecticide at .023 lb/A gave 100 percent control of *Culex fatigans* larvae in containers spaced at 50-foot intervals and located at distances as far as 700 feet downwind from the fog source. Climatic conditions for fogging were generally less than ideal at the time of all applications.

It is felt that a dosage of .005 lb/A would be adequate for control of *Culex* larvae, since fogging units normally cover every block in a given area. For adequate control of both adults and larvae of the more tolerant species such as *Aedes,* it appears that a dosage of .023–.026 pound per acre would be required.

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References

JAKOB, W. L. 1966. Thermal fog tests against *Aedes aegypti* (L.) and *Anopheles albimanus* (Wied.). Mosq. News 26(2):118–121.

LUDWIG, P. D., and MCNEILL, IV, J. C. 1966. Results of laboratory and field tests with Dursban insecticide for mosquito control. Mosq. News 26 (3):344–351.