CONTROL OF MOSQUITO ADULTS AND LARVAE WITH ULTRA-LOW-VOLUME AERIAL APPLICATIONS OF BAYTEX AND BAYTEX-BAYGON MIXTURE

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Several instances of successful insect control with ultra-low-volume aerial sprays have been reported by various researchers. Grasshopper (Skoog *et al.,* 1965), cereal leaf beetle (Wilson *et al.,* 1965), boll weevil (Burgess, 1965), and horn fly and face fly (Dobson, 1965) have all been controlled with this type of application. This same type of application has effectively reduced populations of adult salt-marsh mosquitoes *Aedes taeniorhynchus* (Wiedemann) and *A. sollicitans* (Walker) as reported by Knapp *et al.* (1965) and Glancey *et al.* (1965).

Previous investigations had not included insecticides useful for the control of mosquito larvae, nor did the researchers attempt to use dosage rates of less than 2 fluid ounces per acre. The product Baytex (*O-O*-diethyl *O*-[4-(methylthio)-m-tolyl] phosphorothioate) has been used effectively in conventional sprays for the control of adult mosquitoes at the rate of 1.6 ounce of active ingredient per acre and for the control of mosquito larvae at the rate of 0.8 ounce of active ingredient per acre. It therefore was of interest to determine whether or not these low rates of Baytex could be applied using the ultra-low-volume technique of aerial application.

To determine the effectivenss of ultra-low-volume aerial sprays of Baytex a series of tests was conducted over the town of Gobles, Michigan and the adjoining Mill Lake area. Mill Lake is a typical Michigan resort area in which there is a lake surrounded by densely wooded tracts. This densely wooded area surrounding Mill Lake made mosquito control very difficult since proper dispersal of spray droplets was hampered by foliage from large trees and low growing shrubs. The town of Gobles is about 400 acres and the Mill Lake area is approximately 125 acres in size. The small amount of acreage in the Mill Lake area made control of mosquitoes difficult because there was a greater chance of reinfestation from the surrounding untreated area.

There was a serious mosquito problem in the spring and early summer of 1965 in many Michigan communities. In the Gobles area the adults and larvae collected at the time of the tests were *Aedes stimulans* (Walker) and closely related species. These were identified by the Toledo Area Sanitary District.

In the first series of tests, Baytex 8 lb./gal. concentrate was used in an undiluted form. At Gobles the rate of 1.5 fluid ounces of formulation (containing 1.5 ounces of active ingredient) per acre was applied. At Mill Lake 0.75 fluid ounce of formulation (0.75 ounce of active ingredient) per acre was applied. The town of Gobles was treated on June 7 at 8:00 p.m. The next morning, June 8, at 6:00 a.m., Mill Lake was treated.

A Piper Pawnee 230 airplane belonging to the Mueller Dusting Service was used to make the applications. The plane flew at tree top height which was from 60 to 75 feet above ground level, at a speed of 100 m.p.h., using a swath width of 100 feet. Pump pressure was maintained at 40 p.s.i. For the high dosage rate two Tee-Jet 8001 nozzles were used. For the low rate of application one Tee-Jet 8001 nozzle was used. When the single nozzle was used it was located on the right side of the plane.

Mosquito landing counts were made just prior to each spray treatment. In each case the person making the count stood for one minute while the mosquitoes landing on him were counted. In both areas five stations were selected for making counts. In the Mill Lake area fewer sta-

tions were used to make landing counts due to lack of time to get to each place. These stations were located around or under trees or shrubs where wind currents were at a minimum and where mosquitoes were considered most abundant.

Three tall quart-size, wax-coated paper cottage cheese cartons, each containing 25 mosquito larvae in water, were placed at each station. One carton was covered with a wax-coated paper lid so that the insecticide would not contaminate the water. This carton was examined after treatment to determine the natural mortality of the larvae. The other two cartons were left uncovered. One was placed in the open and the other was placed under some physical obstruction such as a bush, low tree, or, as in one instance, a porch. The mouth of the carton had an area of approximately 15 square inches. It was calculated that, with maximum exposure of the carton, the 1.5 ounce per acre rate would give a 0.15 ppm concentration.

To check on the concentration reaching a carton having maximum exposure, some cartons containing water but without larvae were placed in an open area during treatment. After the application of 1.5 ounces of Baytex per acre the treated water was further diluted with water 1 to 1, 3 to 1, and 7 to 1; and 25 larvae were added to each dilution to determine the approximate breaking point for control. The information from this test is given in Table 1. These data show that the dosage can be substantially diluted before the concentration falls below the LC_{100}. The theoretical concentration of 0.0188 ppm obtained with the 7 to 1 dilution is in the approximate range of the LC_{100} for most mosquito species.

TABLE 1.—Mortality of 25 larvae in water treated with Baytex at 1.5 ounces active ingredient per acre and diluted with water 1 to 1, 3 to 1, and 7 to 1. Gobles, Michigan, 1965.

Dilution	Theoretical concentration	% Mortality in 24 hours
No dilution	0.15 ppm	100
1 to 1 dilution	0.075 ppm	100
3 to 1 dilution	0.0375 ppm	100
7 to 1 dilution	0.0188 ppm	80

The data obtained from the town of Gobles are presented in Table 2. They show that the dosage rate of 1.5 ounces of active Baytex per acre gave good control of both adults and larvae, but that mortality of adults was slow. At 24 hours the landing counts at two locations remained high. This was probably because these stations were in areas where there were many trees and bushes, where populations were highest, and where coverage with insecticide was most difficult. The larvae in the cartons left out in the open were all killed within 12 hours, but the larvae in the cartons which were placed under physical obstructions were slower to die and in some cases survived. Those larvae which survived were either under low-growing bushes or in one case under a porch. Those which were killed were under tall trees or tall shrubs.

Table 3 shows the data collected from the Mill Lake area where the dosage rate of 0.75 ounce of active Baytex per acre was applied. In this area the mosquito population was higher. Although control was difficult to achieve due to the dense cover afforded by the trees and shrubs, the population was reduced to below the nuisance level. Residents in the area were able to sit outside in the evening, whereas before the treatment they were unable to stand for any length of time in one spot either during the day or in the evening. As was the case in Gobles, larvae in the cartons receiving maximum exposure were all killed in 12 hours, but only part of those under cover were killed.

It was apparent from the data obtained from both Gobles and Mill Lake that Baytex gave slow knockdown of adults. This is unsatisfactory. Under conditions where adult mosquitoes continually move into the treated area after the application, a reduction in the population at the time of treatment might go completely unnoticed by persons residing in the area. Fortunately this was not the case in either the Gobles or Mill Lake areas. Gobles was free from mosquitoes as late as June 21

TABLE 2.—Control of mosquito adults and larvae from ultra-low-volume aerial application of Baytex used at 1.5 ounces active per acre. Gobles, Michigan, 1965.

	Landing counts[a]				Larval counts[b]—Number dead				
					12 hrs.		24 hrs.	48 hrs.	
Station	Pre-count	24 hrs.	36 hrs.	48 hrs.	Exposed	Under cover	Under cover	Under cover	Untreated
I	20	2	0	0	25	0	0	22	0
II	32	15	2	3	25	0	0	3	0
III	22	4	4	0	25	0	0	0	0
IV	28	2	2	0	25	0	25	25	0
V	35	25	0	3	25	0	0	0	0
Average	27.4	9.6	1.6	1.2	25	0	5	10	0
Percent control	....	68.6	94.2	95.6	100	0	20	40	..

[a] The counts represent the number of mosquitoes landing on one person in one minute.
[b] A total of 25 larvae were placed in a 32 ounce carton. Three cartons (one exposed, one under cover, and one to be left untreated) were placed at each station.

and did not have a serious mosquito problem the rest of the summer. At Mill Lake the mosquito population did begin to build up during the later part of June.

By adding the product Baygon (*o*-isopropylphenyl methylcarbamate) to Baytex the authors hoped to retain the excellent larvicidal properties of Baytex and at the same time to obtain quicker adult knockdown. By mid-July the Mill Lake area was again heavily infested with adult mosquitoes. It was decided that the area would be re-treated using a mixture of Baytex-Baygon at the rate of approximately 0.8 ounce of each active ingredient per acre. Baytex 8 lb./gal. concentrate was used in this test as before. It was combined with 2 parts of Baygon 4 lb./gal. ULV concentrate. This mixture was to be applied at 2.4 fluid ounces per acre.

On July 22 at 7:45 p.m. the spray was applied using the same airplane, flying at the same height, using the same pump pressure, and maintaining the same swath width as in the previous test. For this application two Tee-Jet 8002 nozzles were used. The mixture was actually applied at the dosage rate of 2.19 fluid ounces (0.73 ounce of each active ingredient) per acre.

TABLE 3.—Control of mosquito adults and larvae from ultra-low-volume aerial application of Baytex used at 0.75 ounce active ingredient per acre. Mill Lake, Michigan, 1965.

	Landing counts[a]				Larval counts[b]—Number dead				
					12 hrs.		24 hrs.	48 hrs.	
Station	Pre-count	24 hrs.	36 hrs.	48 hrs.	Exposed	Under cover	Under cover	Under cover	Untreated
I	80	2	8	4	25	0	0	0	0
II	25	4	6	2	25	0	8	8	0
III	35	2	15	8	25	0	21	25	0
IV	33	5	+	+	25	0	0	0	0
V	50	+	+	+	25	0	0	0	0
Average	44.6	3.3	10.0	4.7	25	0	5.8	6.4	0
Percent control	....	92.6	75.4	89.5	100	0	23.2	25.6	..

[a] The counts represent the number of mosquitoes landing on one person in one minute.
[b] A total of 25 larvae were placed in a 32 ounce carton. Three cartons (one exposed, one under cover, and one to be left untreated) were placed at each station.

For this test three stations were used to make adult landing counts. The counts were made as previously described except that a single count on three persons was made each time at each station and the results averaged. Because larvae were not abundant in the area, it was difficult to find sufficient larvae to use 25 per carton. For this reason, only 10 larvae were used per carton and this time only an exposed carton and a covered control carton were used. One of each of these was placed at five stations in the area.

To determine the knockdown, the station having the highest pre-treatment population was used to make immediate post-treatment landing counts. Counts were made every 5 minutes after treatment for the first hour. The counts remained essentially the same for the first hour. The station was sprayed at 7:55 p.m. At 8:10 the first dead male mosquito was observed. At 8:30 the first dead female mosquito was observed. Several dead females were observed between 8:30 and 8:55. No landing counts were made after 8:55 p.m. until 9:25 p.m. The results at that time were startling. Over 50 mosquitoes were observed in each landing count up to 8:55 p.m., but at 9:25 p.m. only one mosquito was observed in three separate counts. After the first hour and a half all other stations were checked and no mosquitoes were observed. No reinfestation of the area occurred for the rest of the summer so no further control measures were needed. The results of this test are presented in Table 4. The larvae in all but one carton were killed in 12 hours. The carton which held the surviving larvae was under a tall tree. It was accidentally tipped over before a 24-hour observation could be made.

The results of the second Mill Lake test were highly encouraging and quite dramatic. It was not possible during the balance of the summer to evaluate Baygon alone, but it is possible that where an application for control of the adults only is desired, Baygon without the addition of Baytex might give control.

It is of interest that Mill Lake received a treatment of 0.75 ounce per acre of Baytex and 0.73 ounce per acre each of Baytex and Baygon. There was absolutely no fish kill. After each application fish could be seen swimming actively in the shallow water close to the shore. Species observed were minnows, bluegills, bass, and perch. No dead birds or other wildlife were seen in the area after either treatment, although a large number of various species are known to be present in the area.

These tests indicate that both Baytex and

TABLE 4.—Control of mosquito adults and larvae from ultra-low-volume aerial application of a Baytex-Baygon mixture used at the rate of 0.73 ounce each active ingredient per acre. Mill Lake, Michigan, 1965.

Station	Landing counts[a]				Larval counts[b]—Number dead 12 hrs.	
	Pre-count	1.5 hrs.	12 hrs.	24 hrs.	Exposed	Untreated
I	15.3	0	0	0	10	0
II	12.6	0	0	0	0	0
III	50+	0.3	0	0	10	0
IV	....	...	..	..	10	0
V	....	...	..	..	10	0
Average	26	0.1	0	0	8	0
Percent control	....	99.6	100	100	80	..

[a] Each figure represents the average of three individual counts of mosquitoes landing on one person in one minute.

[b] A total of 10 larvae were placed in each 32 ounce carton. Two cartons (one exposed and one to be left untreated) were placed at each station.

Baytex-Baygon mixtures applied as ultra-low-volume sprays by airplane will give control of adult and larval forms of mosquitoes, and that where rapid knockdown of adults is desired, the Baytex-Baygon mixture is preferred.

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