AERIAL INSECTICIDE APPLICATIONS FOR CONTROL OF ADULT MOSQUITOES IN THE OHIO RIVER BASIN[1]

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ABSTRACT. A mosquito control evaluation was conducted in the Ohio River basin using a Cessna 336 Skymaster airplane converted for ULV aerial spraying. Insecticides tested included propoxur, fenthion, and synergized pyrethrins on field plots located both in Henderson Co., Ky. and Vanderburgh Co., In. Mosquito populations were evaluated before and after treatments by 2 man landing counts and the use of CDC-light traps. In the Indiana plots mosquitoes were not sufficient in numbers to warrant assessing the effectiveness of treatments utilizing either landing counts or light traps. In Kentucky, however, there was visible mosquito activity. Fenthion at 0.1 kg/ha, propoxur at 0.05 and 0.1 kg/ha and synergized pyrethrins at 0.004 kg/ha all provided high reduction of *Aedes sollicitans* as indicated by landing counts and light trap catches. High reductions also occurred in *Ae. vexans* numbers as indicated by light trap catches.

Ultra-low-volume (ULV) ground units for mosquito control are increasing in use in the Ohio River Valley. However, there are many areas within this region that are inaccessible by ground, making the airplane an essential mosquito control tool. Although there are aerial applicators located in the Ohio River Valley, few, if any, have airplanes fitted for ULV application. This seems rather ironic since the first ULV aerial application for mosquito control was applied in this region (Knapp and Roberts 1965). In 1977 the Clarke Outdoor Spraying Company, Roselle, Ill., saw a need for a small plane fitted for ULV aerial application to be used in this region. Therefore, this company purchased a Cessna 336 Skymaster airplane and equipped it for ULV aerial application.

Field trials with this plane were conducted in the Henderson, Ky. and Evansville, In. area during the week of 18 Sept. 1977. Because the effectiveness of propoxur and fenthion against adult mosquitoes in this area is well documented (Knapp and Pass 1966a, 1966b, Knapp and Gayle 1967, Knapp and Rogers 1968; Knapp 1968, and Knapp et al. 1976), these were 2 of the pesticides chosen for testing. In addition, a pyrethrins compound, not previously evaluated as a ULV aerial spray was included in these tests.

MATERIALS AND METHODS

A Cessna 336 Skymaster airplane converted for ULV aerial spraying was used in these tests. This twin-engine, centerline thrust aircraft, is capable of safe, low-level flight over congested areas at ca 240 kmph (150 mph).

A 265 liter Sorenson streamlined fiberglass tank was belly-mounted to reduce drag and keep insecticide outside the aircraft. A bronze gear pump, with a bypass, driven by a 24 volt D.C. motor, provided flow rates of up to 26.5 liters per min, at 7 kg/cm^2 (100 psi). Filtration was provided by a 50-mesh strainer preceding the pump and a 50-mesh strainer within each tee jet nozzle. Two 0.64-cm nylon lines supplied a 3.7-m spray boom. The spray boom was mounted to the lower portion of the verticle stabilizers between the 2 tail booms and extended 30 cm beyond each vertical stabilizer.

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Sixteen 8003 Spraying Systems Teejet nozzles were spaced along the stainless steel boom. The boom was rotated to provide various nozzle spray angles into the slip stream. The spray was shut off and on by starting and stopping the electrical motor. The shut-off switch, a spray pressure gauge and an adjustable pressure regulator were mounted so that the pilot could easily operate and adjust the system while in flight.

Calibration of the nozzles was made on the ground by covering each nozzle with a deflated plastic bag held in place by rubber bands and then measuring the amount of insecticide sprayed into each bag.

Three mosquito adulticides, propoxur (Baygon 1 Miscible Oil Solution (MOS)—9.27% conc.), fenthion (Baytex Liquid Concentrate (LC)—93% conc.), and MGK 7067 (5% pyrethrins + 25% piperonyl butoxide) were applied over 65 ha (160 A) plots. Twelve plots (6 in Indiana and 6 in Kentucky), adjacent to the Ohio River, were selected for the tests. These plots were easily accessible by air, isolated from populated areas, and active adult mosquitoes were relatively abundant in the immediate vicinity. The plot locations were outlined on topographical maps, numbered and then randomly selected for each treatment. Both propoxur and fenthion were applied at 0.05 and 0.1 kg/ha (0.05 and 0.1 lb/A). The high rate of propoxur was applied undiluted, whereas the lower rate of propoxur and the fenthion rates were diluted with no. 2 fuel oil so that the total volume of all applications was ca 1 liter/ha (12.8 fl oz/A). The MGK 7067 was applied undiluted at 0.004 kg/ha or a volume of 0.01 liter/ha (1.4 fl oz/A) at an air speed of 214 kmph (133 mph) and a 30-m (100 ft) altitude. A 45-m (150 ft) swath for the low rates and for MGK 7067 was used. Sixteen nozzles were used for application of propoxur and fenthion and 4 for applying MGK 7067. All nozzles were positioned backward and downward at a 45° angle for the propoxur and fenthion tests and at a 45° angle forward for the MGK 7067 tests. Applications were made between the hours of 0930 and 1330 during a 2-day period in which the temperature ranged from 21 to 23°C. Other environmental conditions during these time periods for the tests were ideal, i.e. wind speed ranged from 0 to 8 kmph (5 mph) with overcast skies that reduced convection currents to a minimum.

The test plots in Kentucky were in oil fields containing timber, crop fields and swamps. The Indiana plots were predominantly corn fields but contained about 1.5 ha along the river consisting of wooded areas. The river was ca 100 m wide at these sites.

To insure that the pilot was treating the correct plot a person was placed in the center of each plot during each application. To mark the plot a 60-cm diameter balloon filled with helium was raised to 15 m in the air over the center of each plot. This and the use of landmarks on the boundaries of each plot helped the pilot to locate each area to be treated. Test plots were at least 0.8 km apart.

Two criteria were used to evaluate the effectiveness of the treatments. One was by adult mosquito landing counts as described by Knapp and Pass (1966a) and the other was by use of CDC-light traps. In Kentucky landing counts were taken in 10 locations within the center of each test plot at minus 48, 36, 24, 12, and at 0 hr pretreatment and at 1, 3, 8, and 24 hr post-treatment. Additional counts in MGK 7067 plots were made at ¼ and ½ hr post-treatment because of the known quick knockdown properties of pyrethrins. Pre-treatment landing counts were made in the Indiana test plots, but adult mosquitoes were not sufficiently numerous to warrant utilizing this method in assessing the effectiveness of treatments. Mosquitoes were tentatively identified by visual observation during landing counts and verified by collecting a few specimens at each site for laboratory determination.

Two CDC mini-light traps were placed in the center of each test plot 2 successive nights pre-treatment and 2 successive nights post-treatment. Traps were turned

on before dusk, emptied the following morning and captured mosquitoes were identified to species. Post-treatment counts of mosquitoes captured were made and compared with mean pre-treatment counts in evaluating insecticidal treatments on the test plots.

To determine droplet size for each insecticide, 4 glass microslides treated with General Electric SC-87-Dri-Film were placed on wooden stakes 1 m above the ground in each plot. Two slides were placed horizontally and 2 were placed vertically for each test. Calculations of the droplet sizes were similar to those of Mount et al. (1970). The spread factor for each insecticide was determined by a direct measurement as described by Yeomans (1949). The spread factor for propoxur was 0.44 and 0.40 for pyrethrins. No spread factor could be obtained for fenthion because of the rapid spread of the fuel oil carrier.

RESULTS AND DISCUSSION

All mosquitoes identified in the Kentucky landing counts were *Aedes sollicitans*. The Kentucky adult landing counts are shown in Table 1. Pre-treatment landing counts in the untreated plots averaged 25 mosquitoes per 15 sec count per person with a range of 19 to 31, whereas the post-treatment counts averaged 15 with a range of 8 to 24.

The high rate of fenthion applied over the open corn and bean fields was more effective in reducing adult mosquitoes than the low rate which was applied over a dense foliage and swampy area. These results could be attributed, at least partially, to differences in vegetative cover. However, similar results were obtained by Knapp and Pass (1966a) who conducted tests using 0.05 and 0.1 kg of fenthion per ha (diluted or undiluted) in dense foliage areas as encountered in western Kentucky. Propoxur was equally effective at both dosage rates and resulted in a more rapid knockdown of adult mosquitoes than did fenthion. MGK 7067 resulted in a rapid knockdown of mosquitoes a few minutes after treatment, with the peak reduction (96%) appearing at ½ hr post-treatment. Because of the 65 ha plot size, mosquitoes found at 1 and 3 hr post-treatment were considered those recovered from the treatment and not migratory. From previous research the second author has found that *Ae. sollicitans*

Table 1. Effectiveness of ULV aerial application of propoxur, fenthion and MGK 7067 against adult *Ae. sollicitans* mosquitoes in Kentucky (landing counts).

Treatment	Dosage/ha		Average Pretreatment	Percent Reduction[a] Hours After Treatment							
	Kg AI	Vol. (liter)	Counts/15 sec.	¼	½	1	3	8	24	36	48
fenthion	0.05[b]	1	13	—	—	0	0	50	85	58	78
	0.1[c]	1	9	—	—	46	74	99	99	100	98
propoxur	0.05[d]	1	12	—	—	88	90	95	96	99	94
	0.1[e]	1	13	—	—	89	87	99	100	98	99
untreated	0	0	22			0	4	0	18	0	0
MGK 7067	0.004[f]	0.1	23	90	96	86	84	78	78	[g]	[g]
untreated	0	0	18	0	0	6	6	0	0	[g]	[g]

[a] Based on the average of ten 15 sec counts at each site as compared to pretreatment counts.
[b] Wooded area, dense foliage ⅛ to ¼ acre open areas scattered throughout.
[c] Open corn and soybean fields.
[d] Light-to-heavy foliage area adjacent to woods.
[e] Dense timber adjacent to large hay field.
[f] Dense marsh marigolds, shrubs and isolated timber.
[g] No data collected.

will remain in one area unless disturbed by rain or wind. Because there was no change in environmental conditions, there was probably no mosquito migration at the 8- or 24-hr counts either.

MGK 7067 showed little residual effectiveness or lasting knockdown against *Ae. sollicitans* (Table 1). However, an extremely low dosage was required for immediate mosquito reduction. Depending on MGK 7067's availability, the future use of it or other pyrethrins as mosquito adulticides is promising. It is a natural plant product of low mammalian toxicity and is less toxic to non-target organisms than most other chemicals available (Casida 1973).

In light traps, during pre-treatment samplings, the most prevalent species caught in Indiana were *Ae. vexans* (9.3/trap) and *Culex salinarius* (5.3/trap), whereas in Kentucky *Ae. vexans* (23.5/trap), *Ae. sollicitans* (17.9/trap), *Anopheles quadrimaculatus* (6.6/trap), and *Cx. restuans* (7.4/trap) were most abundant.

Because of the small numbers of mosquitoes captured in Indiana light traps during this study (most averaged below 10 mosquitoes per trap) no evaluations were made of insecticidal treatments in Indiana.

For Kentucky test plots, light-trap catches of *Ae. vexans* and *Ae. sollicitans* are given in Table 2. The numbers of individuals of other species were too low to be significant. A high percentage reduction of both species was observed at 1 and 2 days post-treatment with propoxur and fenthion following a similar trend as the landing counts of *Ae. sollicitans* (Table 1). With MGK 7067 a 100% reduction of *Ae. vexans* was observed at 1 day post-treatment with ca ½ less reduction of *Ae. sollicitans*.

Observations made in a shallow 300 m^2 body of water within a hay field in Kentucky 8 hr after the plot was treated with the high rate of propoxur indicated some kill of emerging *Ae. vexans* adults. At 24 hr post-treatment, 3 dead adults/m^2 were found on the water surface. At 36 hr post-treatment numbers had increased to 30 dead adults/m^2 to 75 dead adults/m^2 at 48 hr post-treatment.

Droplet size for both rates of propoxur averaged 68.9 μ and ranged from 28.6 to 118.9 μ. MGK 7067 droplets averaged 51.4 μ and ranged from 18.3 to 104.5 μ.

The Cessna 336 Skymaster airplane used to apply the ULV sprays performed satisfactorily in every respect. The stability of this airplane is such that it requires a

Table 2. Effectiveness of ULV aerial application of propoxur, fenthion and MGK 7067 against adult *Ae. vexans* and *Ae. sollicitans* mosquitoes in Kentucky (light trap counts).

Species	Compound	Rate (kg/ha)	Pre-treatment No. Mosquitoes Per Trap	Percent Reduction Days Post-treatment 1	2
Ae. vexans	propoxur	0.05	31.4	93.6	96.8
		0.1	43.2	93.1	100
	fenthion	0.05	30.1	93.3	100
	MGK 7067	0.004	31.5	100	[a]
	untreated	0	4.9	0	37.8
Ae. sollicitans	propoxur	0.05	4.3	100	0
		0.1	15.8	100	93.7
	fenthion	0.05	13.4	100	46.7
		0.1	6.2	100	83.9
	MGK 7067	0.004	56.8	51.6	[a]
	untreated	0	10.9	0	0

[a] No light trap data collected.

minimum amount of additional training to upgrade a single engine pilot to a twin engine centerline thrust rating. The advantage of this aircraft over other multiple engine airplanes is its twin engine centerline thrust configuration. This aircraft is much safer at the low altitudes required for spraying because, should an engine fail, the thrust remains straight ahead rather than the sudden dangerous yaw to one side common in engine failure on conventional twin engine configuration. In addition, this aircraft meets all requirements of the Federal Aviation Agency for flying over congested areas.

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