EFFECTIVENESS OF VARIOUS INSECTICIDES AGAINST *AEDES AEGYPTI* INFESTATIONS IN WATER STORAGE DRUMS IN U. S. VIRGIN ISLANDS[1]

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Throughout tropical areas of the Western Hemisphere, the collection and storage of rainwater for household use is commonly practiced. The numbers of individual storage containers in these areas are phenomenal and represent equivalent numbers of individual breeding sites for *Aedes aegypti*. Implementation of the Aedes aegypti Eradication Program has emphasized the need for safe biological toxicants to be employed against this source. The primary objective of the present studies was to field-test certain compounds and formulations which had displayed potential for safe use in potable water supplies in previous laboratory and simulated field evaluations.

MATERIALS AND METHODS. Since a preponderance of this type water container existed in the Virgin Islands, the island of St. Thomas was chosen as the test area. Later, requirements necessitated the substitution of additional sites on the island of St. Croix. The selection of specific test sites was based on the prevalence of infested 55-gallon water storage drums. Each of the premises in the test areas contained from 1 to 10 such drums (Fig. 1).

In preliminary tests in May of 1964, two drums were treated with DDT 75 percent wettable powder at the rate of 20 p.p.m. and nine were treated with dimethrin-piperonyl butoxide,[2,3] 5–5 percent granules at 10 and 20 p.p.m. (Tables 1 and 2).

General field trials were initiated in July and November of 1964 for the testing of two emulsifiable concentrates, one additional wettable powder, and nine granular formulations of five other candidate compounds (Tables 1 and 2). The 44 applications of emulsifiable concentrates were made directly into the drum water. SD-8447[4] was used in 2 drums only at the rate of 5.0 p.p.m., while AC-52,160[5] was placed in 20 containers, 10 at 0.1 p.p.m. and 10 at 0.25 p.p.m. The remaining 22 drums were treated with AC-52,160 at 0.1 p.p.m. of toxicant per container in a solution of 10 ml. of refined kerosene (Deobase).

Applications of wettable powder at 1.0 p.p.m. and 2.5 p.p.m. were made with SD-8211[4] in 10 drums at each treatment level. The required amount of wettable powder was mixed into a slurry, then added to the drum.

In addition, eight granular formulations were applied in 522 drums. For each treatment the required amount of granules was preweighed and packaged in the laboratory. The granules were dispersed so as to insure an even distribution of the toxicant over the bottom of each drum. Granular formulations, number of tests, and dosages tested are listed in Table 2. Two hundred sixty-eight containers, interspersed through the test areas, were left as untreated checks.

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[1] From the Biology/Chemistry Section, Technology Branch, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

[2] Use of trade names is for identification purposes only and does not constitute endorsement by the Public Health Service or by the U. S. Department of Health, Education, and Welfare.

[3] Furnished through the courtesy of McLaughlin, Gormley, King Company, Minneapolis, Minn. (Dimethrin: 2,4-dimethyl benzylchrysanthamate).

[4] Furnished through the courtesy of Shell Development Company, Modesto, Calif. (SD-8447, phosphoric acid, 2-chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl ester); (SD-8211, 2-chloro-1-(2,5-dichlorophenyl) vinyl dimethylphosphate); (SD-7438, toluene-α,α-dithiol bis(o,o-dimethyl phosphorodithioate).

[5] Furnished through the courtesy of American Cyanamid Company, Princeton, N. J. (AC-52,160: o,o,o′,o′α-tetramethyl o,o′-thiodi-ρ-phenylene phosphorothioate). This compound is now known as "Abate."

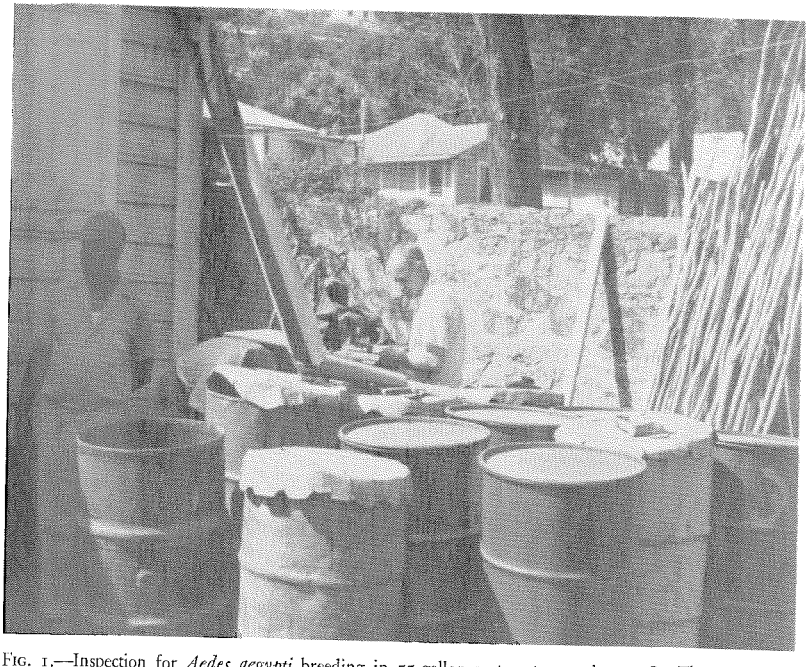

FIG. 1.—Inspection for *Aedes aegypti* breeding in 55-gallon water storage drums, St. Thomas, U. S. Virgin Islands.

Weekly inspections were made of all drums for indications of reinfestations. The week in which more than 10 percent of the drums treated with a single compound appeared positive for larvae was used as the point at which the toxicant was no longer considered operationally effective.

Since observations during the initial tests indicated a drum turnover for cleaning, etc., of 40 to 60 percent within 4 to 5 weeks, a 3-week period was considered the criterion for satisfactory performance of a candidate material.

RESULTS. DDT wettable powder failed to give satisfactory mortalities of *Ae.*

TABLE 1.—Wettable powder and emulsifiable concentrate treatments.

Compound	Formulation	Treatment (p.p.m.)	Number of tests	% initial mortality	Ave. wks.* effect.
AC-52,160	25% EC	0.1	10	100	>5
		0.25	10	100	>5
AC-52,160 in refined kerosene (Deobase)	25% EC	0.1	22	100	5
SD-8447	1#/gal. EC	5.0	2	100	>5
DDT	75% WP	20.0	2	62	..
SD-8211	75% WP	1.0	10**	100	4
		2.5	10	100	3

* Based on number of weeks of 10 percent or less reinfestation rate.

** Sixty percent of test lost to cleaning of drums; average weeks effectiveness is based on 4 drums only.

TABLE 2.—Granular treatments.

Chemical	Formulation	p.p.m.	Number test drums	Wks. effective control** May	July	November
Dimethrin-piperonyl butoxide	5–5 volclay	5	1	1*	..	..
		10	3	1*	..	..
		20	5	1*	..	..
		10	61	..	3	..
		20	61	..	3	..
AC-52,160	1% on sand	0.1	15	..	2	..
		0.25	10	..	3	..
	1% on 30/60 mesh bentonite	0.1	15	..	2	..
		0.25	14	..	2	..
		1.0	24	..	..	>5
		2.5	25	..	..	>5
SD-8447	2% on 24/48 mesh attaclay	5.0	15	..	2	..
		10.0	15	..	2	..
SD-7438	1% sand core granule	1.0	14	..	5	..
		2.5	17	..	5	..
	2.5% sand core granule	1.0	12	..	2	..
		2.5	13	..	>5	..
		1.0	48	..	..	2
		2.5	30	..	..	>5
SD-8211	2.5% sand core granule	1.0	48	..	..	2
		2.5	47	..	..	3
Bromophos	3% on attaclay	1.0	18	..	..	2
		2.5	20	..	..	4

* Observations discontinued after one week.
** Based on 10 percent or less reinfestation rate.

aegypti larvae at 20 p.p.m. Earlier work by Flynn *et al.*, 1964, indicated a high level of resistance to DDT in the St. Thomas strains of *Ae. aegypti*. The wettable-powder formulation of SD-8211 produced 100 percent initial kills at concentrations of 1.0 and 2.5 p.p.m. and remained effective from 4 to 3 weeks, respectively.

The emulsifiable concentrate formulations of AC-52,160 applied at 0.1 and 0.25 p.p.m. and SD-8447 applied at 5.0 p.p.m. yielded control for more than 5 weeks. AC-52,160 in 10 ml. of Deobase applied at 0.1 p.p.m. was effective for 5 weeks only.

Granular formulations of dimethrin + piperonyl butoxide gave 3 weeks of effective control at both the 10 and 20 p.p.m. applications in July (Table 2). AC-52,160 on a sand or bentonite carrier gave control for 2 to 3 weeks when applied at 0.1 and 0.25 p.p.m. At the dosage levels of 1.0 and 2.5 p.p.m., control exceeded 5 weeks with bentonite granules of this compound. Application of 1.0 and 2.5 p.p.m. of SD-8211 (2.5%), bromophos (3%),[6] SD-7438 (2.5%),[4] and SD-7438 (1%) granules produced control for 2 to 5 weeks. Applications of SD-8447 granules, at rates of 5.0 and 10.0 p.p.m. were effective for only 2 weeks.

DISCUSSION. The difference in results obtained with SD-8211 wettable powder

[6] Furnished through the courtesy of CELA, GMBH, Ingelheim/Rhein, West Germany (bromophos, 0,0-dimethyl-0-2,5 dichlorobromophenyl thionophosphate).

at the two dosage levels apparently is a result of bias introduced by the loss of 60 percent of the drums at 1.0 p.p.m. application shortly after treatment. Less effective residual action was attained with SD-7438 in St. Thomas than obtained in concurrent simulated field studies in Georgia (Brooks and Schoof, in press).

Reinfestations that were noted in some of the drums treated with insoluble granular toxicants on one inspection were observed to be controlled the following week. Mortalities occurring in this way were attributed to prolonged exposure and to oral ingestion of the toxicant by older larvae as they fed deeper in the drum.

One of the basic problems affecting these field trials was the public reaction to any foreign matter placed in the water drums. This factor and the objectionable clouding of the water by emulsifiable concentrate and wettable powder formulations accounted for total losses of test drums on at least three premises. The degree of responses by the householder precluded further testing of the promising emulsifiable concentrate formulations of SD-8447 and AC-52,160 as well as the wettable powder formulation of SD-8211.

Observations and inquiries were made during the test period with respect to other influencing factors such as taste, odor, and appearance. With none of the granular formulations and only one of the emulsifiable concentrates was there any objection or complaint in regard to taste or odor. Complaints were lodged on the appearance of water treated with emulsifiable concentrates and wettable powders.

CONCLUSIONS

1. With the exception of DDT, all compounds tested displayed potential for use as larvicides in potable and nonpotable water.

2. Wettable powder SD-8211 and the emulsifiable concentrate formulations, although highly effective, were unsuitable for field use because of public reaction to clouding of the water.

3. Granular formulations appear as the formulation of choice due to the ease of handling and their innocuous appearance after treatment. The biological activity of the compounds tested as granules in order of effectiveness were: AC-52,160, SD-7438, bromophos, SD-8211, dimethrin-piperonyl butoxide, and SD-8447.

4. With the exception of SD-8211, 75 percent wettable powder, dimethrin and AC-52,160 (1%) on 30/60 mesh granule at 0.1 and 0.25 p.p.m., all formulations indicated an increase in residual action corresponding to an increase in dosage.

5. Acute oral LD-50's levels against rats for the materials used in this study were >1,000 mg./kg. with the exception of SD-7438 which is reported to be 280 mg./kg. Although presumably safe for use in potable water as indicated by these values, toxicological clearance must be obtained prior to operational usage of any of these compounds.

SUMMARY. Field evaluation was made of six experimental insecticides for use in controlling *Ae. aegypti* larvae in 55-gallon water storage containers on the islands of St. Thomas and St. Croix, U. S. Virgin Islands, during 1964.

AC-52,160 gave the most effective results; at 1.0 p.p.m. a granular treatment gave >5 weeks of effective control versus 2 weeks for granules of bromophos, SD-7438, or SD-8211. At 2.5 p.p.m., SD-7438 produced >5 weeks of control; bromophos, 4 weeks; and SD-8211, 3 weeks. Dimethrin-piperonyl butoxide (5–5%) on volclay at 10 and 20 p.p.m., and AC-52,160 (1%) on sand at 0.25 p.p.m. also produced 3 weeks' effectiveness. SD-8447 gave 2 weeks at 5 or 10 p.p.m.

Undesirable tastes, odors, and appearances at treatment occurred with emulsifiable concentrate and wettable powder formulations of several compounds. However, data indicated that satisfactory performance of >4 weeks was obtained with SD-8211 (75% WP) at 1.0 p.p.m., AC-52,160 (25% EC) at 0.1 p.p.m., and SD-

8447 (1 lb./gal. EC) at 5.0 p.p.m. DDT (75% WP) was ineffective when applied at 20 p.p.m. against the St. Thomas *Ae. aegypti*.

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References

BROOKS, G. D., and SCHOOF, H. F. 1965. Simulated field tests of new insecticide formulations against *Aedes aegypti* larvae in 55-gallon water storage containers. Proc. N. J. Mosq. Extermin. Assoc. (In press.)

FLYNN, A. D., SCHOOF, H. F., MORLAN, H. B., and PORTER, J. E. 1964. Susceptibility of seventeen strains of *Aedes aegypti* (L.) from Puerto Rico and the Virgin Islands to DDT, dieldrin, and malathion. Mosquito News 24(2):118–123.

EVALUATION OF LARGE-SCALE TREATMENT WITH DICHLORVOS FOR THE CONTROL OF *CULEX PIPIENS QUINQUEFASCIATUS* SAY

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The establishment of *Culex pipiens quinquefasciatus* as an important vector in the transmission of St. Louis encephalitis virus (Chamberlain *et al.*, 1959) re-emphasized the need for control measures against this mosquito. The application of the residual-fumigant technique with dichlorvos vapor was a new control approach which originated at Savannah, Georgia, in 1962 (Maddock *et al.*, 1963). The success of these first trials indicated a need for further studies of new formulations and proof of the practicability of operational usage. This work describes such an evaluation of a large-scale treatment with 20 percent dichlorvos formulation in plastic resin.

MATERIALS AND METHODS. The test area selected met two established criteria: (1) the area was a metropolitan portion of the City of Savannah which normally sustained heavy *Culex* production; and (2) it contained a minimum of the hazards normally encountered in a control operation of this type (i.e., danger to personnel working under congested traffic conditions). The area chosen contained 1,284 basins (approximately one-fifth of the catch basins of the city) and extended over 212 city blocks.

Based on previous studies with the sustained-vapor technique in catch basins (Brooks *et al.*, 1963), a 20-gram dichlorvos dosage, characteristic of a 10-inch length of 20 percent dichlorvos-resin formulation, was used throughout the treatment.

Dispenser installations were made in all basins between May 16 and 18, 1963. Within each basin the dispenser was suspended by a 24-inch length of coated copper wire from the front support rod of the basin top. In basins where this rod was missing, dispensers were attached to a perforated metal tape hanger nailed to the upper basin wall.

Evaluation of the overall treatment was based on weekly inspections for *Culex*

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