

## THE EFFECTIVENESS OF FOUR CARBAMATE INSECTICIDES AS RESIDUAL DEPOSITS AGAINST *ANOPHELES QUADRIMACULATUS*<sup>1</sup>

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**INTRODUCTION.** The development of resistance by anopheline mosquitoes to DDT and dieldrin has stimulated interest in substitute residual compounds outside of the chlorinated hydrocarbon group. In laboratory and field tests, two organophosphorus toxicants, malathion and Bayer 29493,<sup>3</sup> were found to have much promise although the effectiveness of each varied with the surface involved (Mathis and Schoof, 1958) (Schoof *et al.*, 1961). The field tests also showed that the residual action of a treatment on different surfaces could be appraised by determining the mortalities of female mosquitoes confined on the surfaces under a plastic cone for 30 or 60 minutes. Based on this cone method of evaluation, four carbamate compounds were evaluated on various surfaces under simulated field conditions at Savannah, Georgia, in 1961.

**METHOD.** To expose treated panels to the normal fluctuations of temperature and humidity, all tests were conducted out-of-doors, during the July to October period. A shed, 120 feet long (Figure 1) was built and the panels (1' x 4') placed in a vertical position under the center of the peaked roof, 10 panels per section. Each section contained panels of clay, thatch, bamboo (3 types), cement (plaster), plywood, whitewashed plywood, galvanized metal, and brick. The mud was local clay pressed into blocks (12" x 4" x 4") and

the thatch was native broom sedge. The panels of bamboo matting were from Philippines, one from Indonesia. The Philippine bamboo was 'Bala'; the smooth outer surface (P-O) was used in one panel, the rough inner surface in a second (P-I). The width of the 'B' strip was 1.0 cm, that of the Indonesian was 2.5 cm. The unglazed brick was considered as representative of a roof-surface.

All panels were treated in position using a 1-gallon compression sprayer equipped with an 8002 nozzle. A plywood section inserted on both sides of the panels under treatment protected the adjacent panels from contamination during spraying process.

Each of the test insecticides was prepared as a suspension from a 50-percent wettable powder just prior to application. The test insecticides included Hercules 5727 and 7522H,<sup>5</sup> Union Carbide 10854,<sup>4</sup> Bayer 39007,<sup>6</sup> and Sevin.<sup>7</sup> Malathion and Bayer 29493,<sup>8</sup> as 25 percent wettable powder served as comparison standards. Application rates were at levels of 25, 50, or 200 mg./sq. ft., the dosage range depended upon the relative mammalian toxicity of the compound.<sup>9</sup>

Evaluation of the treatments was by exposure of dieldrin-resistant *Anopheles*

<sup>4</sup> *m*-isopropylphenyl N-methylcarbamate.

<sup>5</sup> 2-chloro-3-isopropylphenyl N-methylcarbamate.

<sup>6</sup> *o*-Isopropoxyphenyl methylcarbamate.

<sup>7</sup> 1-naphthyl N-methylcarbamate.

<sup>8</sup> O, O-Dimethyl O-[4-(methylthio)-*m*-terphenyl] phosphorothioate.

<sup>9</sup> Acute oral LD-50's of female rats for Hercules 5727 and 7522H are reportedly in the range 27 to 29 mg./kg., for Union Carbide 10854 20 mg./kg., for Bayer 39007 175-200 mg./kg., for Sevin 500 mg./kg.

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<sup>3</sup> Use of trade names is for identification purposes only and does not constitute endorsement by the U. S. Public Health Service.



FIG. 1.—Outdoor panel shed; each section contains 10 surfaces.

*quadrimaculatus* females to the deposits for 1 hour beneath a plastic cone. Tests were run at biweekly intervals; each represented 30 males, 10 females per each of 3 cones. Different sites were employed at each test interval. After exposure the specimens were held at 80° F. and 70 percent R.H. for 24 hours, at which time the percent mortality was determined.

**RESULTS.** Hercules 7522H at 25 or 50 g./sq. ft. gave poor kills on clay, metal, whitewashed plywood, cement and brick in the initial 2-week evaluation. At 4 weeks the treatment failed on 9 of the 10 surfaces at the two dosages tested.

The results with U.C. 10854, Hercules 5727, Sevin and Bayer 39007 are shown in table 1. These data show that at the dosages tested, deposits of U.C. 10854 and Hercules 5727 were most durable on thatch, plywood (plain or whitewashed), bamboo or brick; mortalities of 90 percent or better were obtained for 4 to 6 weeks. On clay and cement, both toxicants were effective at 2 weeks.

Sevin and Bayer 39007 at 200 mg./sq. ft. gave kills above 90 percent for 12-14

weeks on thatch, whitewashed plywood, plywood and metal. Except on clay and cement, both compounds appeared to be in the same general range of effectiveness. On clay at 200 mg./sq. ft. Bayer 39007 produced 8 weeks of satisfactory kills as compared to 2 with Sevin. The latter was definitely superior on cement. Both compounds produced complete kills for extended periods. Sevin at 200 mg./sq. ft. yielded 100 percent mortalities on thatch, metal, whitewashed plywood, bamboo and brick for 14, 12, 12, 10 and 10 weeks, respectively. Bayer 39007 at the same dosage gave similar kills on thatch, metal, whitewashed plywood, bamboo and brick for 10, 14, 10, 10 and 8 weeks, respectively.

In considering the results of these tests too much emphasis must not be placed on a difference of 2 weeks in the persistence of the residues on different surfaces. The data give a relative measure of the potential of the different compounds. Minor variations in the durability of the deposits in these tests could be more than compensated for by the variables present under field conditions in occupied homes.

TABLE 1.—Number of weeks that various surfaces treated with Union Carbide 10854, Hercules 5727, Sevin, and Bayer 39007 gave 90 percent or greater mortalities of dieldrin-resistant *A. quadrimaculatus*. All dosages expressed in milligrams per square foot.

Surface	US 10854		H 5727		Sevin		B 39007		
	50	100	25	50	100	200	50	100	200
Clay	0	0 <sup>b</sup>	0	0	0	2	2	0 <sup>a</sup>	4
Thatch	6	6	4	6 <sup>a</sup>	10	14	8	14	14
Metal	0	2	0	2	10 <sup>a</sup>	12 <sup>a</sup>	4	8	14
Plywood	6	6	4	4	8 <sup>a</sup>	12	8	10	14
Plywood (W)	4	6	4	4 <sup>a</sup>	10	14	8	10	14
Bamboo P-I	4	4 <sup>a</sup>	4	4	4 <sup>c</sup>	12	6 <sup>a</sup>	8	10
Bamboo P-O	4	4 <sup>a</sup>	0 <sup>a</sup>	4	6 <sup>a</sup>	12	6 <sup>a</sup>	8	10
Bamboo Indo.	0	4	2 <sup>a</sup>	4	2 <sup>a</sup>	10 <sup>a</sup>	6 <sup>a</sup>	6 <sup>a</sup>	10
Cement	0	0	0	0	4	8	0	0	2
Brick	0	6	2 <sup>a</sup>	4	6	10	4	8	8

Based on a 70-percent mortality level, the residues were effective for additional periods of: <sup>a</sup>—2 weeks, <sup>b</sup>—4 weeks, or <sup>c</sup>—6 weeks.

DISCUSSION. The data indicate that U.C. 10854 and Hercules 5727 offer little promise as residual agents.<sup>10</sup> At 50 mg./sq. ft. the two formulations are similar in effectiveness although Hercules 5727 gave superior kills on brick and Indonesian bamboo. These results are disappointing in view of the reports of LaBrecque *et al.*, 1960, that a dosage of 100 mg. of Hercules 5727/sq. ft. was highly effective against *A. quadrimaculatus*; 100-percent kills were obtained for 24 weeks at a 15-minute exposure period. In preliminary tests of Hercules 5727 at 50, 100 and 200 mg./sq. ft., the maximum dosage was effective on wood, thatch, clay and cement for 10, 10, 7 and 1 week, respectively. Although kills with the 200 mg./sq. ft. application persisted longer than those obtained with 50 mg./sq. ft., the differences were only in the range of 2 to 3 weeks.

Sevin and Bayer 39007 show promise as residual applications except for the poor results on clay with both toxicants and on metal with Bayer 39007. In comparison

to malathion or Bayer 29493 at 100 mg./sq. ft., Bayer 39007 was superior on thatch and Sevin on metal (Table 2). Bot

TABLE 2.—Effectiveness of Sevin and Bayer 39007 versus malathion and Bayer 29493 as measured by number of weeks of kills of 90 percent or above obtained at a dosage of 100 mg./sq. ft.

Surface	Malathion	Bayer		Bayer 39007
		29493	Sevin	
Clay	2	2	0	0
Thatch	10	10	10	14
Metal	6	8	10 <sup>a</sup>	8
Plywood	8 <sup>a</sup>	10	8 <sup>a</sup>	10
Plywood (W)	2 <sup>a</sup>	8	10	10
Bamboo (I)	6	10	4 <sup>c</sup>	8
Bamboo (O)	6	10 <sup>b</sup>	6 <sup>a</sup>	8
Bamboo (S)	4	8	2 <sup>a</sup>	6
Cement	0	4	4	0
Brick	0	2 <sup>a</sup>	6	8

Based on a 70-percent mortality level, the residues were effective for additional periods of: <sup>a</sup>—2 weeks, <sup>b</sup>—4 weeks, or <sup>c</sup>—6 weeks.

Bayer 39007 and Sevin gave longer periods of effectiveness than either malathion or Bayer 29493 on brick and whitewashed

<sup>10</sup> From a chemical standpoint these toxicants are identical, but the mammalian toxicological data reported for them have differed.

wood. On bamboo, Bayer 29493 gave effective kills for longer periods than any of the other three toxicants. Previous laboratory data for tests with Sevin on plywood panels showed it to give essentially complete kills for 24 and 32 weeks at dosages of 100 and 200 mg./sq. ft., respectively.

The poor results obtained on clay with insecticides that persisted for 10 to 14 weeks on other surfaces follow the same trend exhibited in previous laboratory panel tests with malathion, DDT, and dieldrin. However, formulations of malathion that showed little residual action after several days in the laboratory were found to be adequate for 2 to 3 months when tested under field conditions (Schoof *et al.*, 1961). Bayer 29493 also produced similar intervals of effectiveness. From the lack of correlation between field and laboratory tests it is apparent that factors that influence the effectiveness of treatments may differ markedly under laboratory versus field evaluation.

Based on the over-all comparison of surface versus toxicant, residues on cement and clay were the least effective, while those on thatch, followed by plywood and whitewashed plywood, were the most effective.

Past experience has shown that the type of surface may exert a profound effect on the persistence of a residual application. The current data likewise show that any one surface may show a negative or positive effect upon a residue depending on the toxicant involved. Because of this factor, the possibility exists that insecticidal treatments may prove satisfactory under circumstances where a single toxicant may be used.

On this premise, insecticidal formulations could be prescribed in accordance with the surfaces found in a project area.

**SUMMARY.** At Savannah, Georgia, suspension residues of Hercules 5727 and 7522H, Union Carbide 10854, Sevin, and Bayer 39007 were evaluated against *Anopheles quadrimaculatus* on surfaces of clay, thatch, bamboo, cement (plaster), plywood, whitewashed plywood, galvanized metal, and brick. All surfaces were maintained under a shed out-of-doors. Based on 1-hour exposure of adult females at biweekly intervals, Hercules 5727 and 7522H at 25 and 50 mg./sq. ft. and Union Carbide 10854 at 50 and 100 mg./sq. ft. offered little promise as residual agents; Hercules 7522H was the least effective; it failed on nine surfaces at 4 weeks. Both Sevin and Bayer 39007 showed promising results in giving 90 percent kills for 12 to 14 weeks on thatch, whitewashed plywood, plywood, and metal when applied at 200 mg./sq. ft. Bayer 39007 was superior to Sevin on clay but inferior to it on cement. Residues of all compounds were least effective on cement followed by clay. Deposits on thatch gave the maximum periods of effectiveness.

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