Reprinted from AMERICAN JOURNAL OF TROPICAL MEDICINE AND HYGIENE
Vol 13, No. 6, November, 1964
Printed in U S A

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EFFECTIVENESS OF DEPOSITS OF SEVIN, DDT, BAYER 39007, AND BAYER 37344 AGAINST *ANOPHELES ALBIMANUS* IN HAITI*

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Studies at Savannah, Georgia, by Mathis and Schoof[1] indicated that Sevin, Bayer 39007, and Bayer 37344 were sufficiently promising as residual sprays against mosquitoes to warrant small-scale field tests in tropical areas. Such tests were included in a cooperative project established with the Government of Haiti, the Pan American Health Organization, and the Agency for International Development. The experimental area selected was at Source Matelas, approximately 20 miles north of Port-au-Prince. This paper describes the studies made in 1962 and 1963 to determine the residual activity of three carbamate compounds and DDT when applied to the interior surfaces of occupied houses in that area

Experimental Area

The rural section of Source Matelas is bordered on the east by semi-arid and sparsely populated land and on the west by the sea. The climate is subtropical with fairly stable year-round temperatures that seldom drop below 65°F or rise above 95°F. Approximately 40 inches of rain falls during the year, principally during the spring and autumn seasons.

The houses are small (8–10 ft wide x 12–18 ft long) and of similar structure, with mud walls, thatched roofs, and wooden doors and shutters (Fig. 1). The walls are made by plastering native clay over a frame of wood, then whitewashing them after they dry. The thatched roof is usually made from sugar cane attached to a wooden frame. Despite the small size, most dwellings have 3 to 6 doors and an equal number of windows.

METHODS AND MATERIALS

In the first study in July 1962, Sevin (1-naphthyl-N-methylcarbamate) and Bayer Compound 39007 (o-isopropoxyphenyl methylcarbamate) were the experimental treatments, with a DDT application used for comparison.§ In the second treatment, February 1963, DDT, Sevin, and Bayer Compound 37344 (4-(Methylthio)-3,5-xylyl methylcarbamate) were the compounds tested. The number of houses sprayed with each compound and the dosages used were as follows:

Toxicant		Number houses treated
% in wettable powder	g/m²	
1962 Treatment		
DDT 75	1.0 & 2.0	33 & 34
Sevin 50	1.0 & 2.0	29 & 25
Bayer 39007 50	1.0 & 2.0	37 & 34
1963 Treatment		
DDT 75	1.0 & 2.0	10 & 10
Bayer 37344 50	1.0 & 2.0	10 & 10
Sevin 50, 80 and 85	2.0	30 (10 each)

All formulations were from wettable powders that contained 75 percent DDT, 50 percent Bayer 39007, 50 percent Bayer 37344, and 50, 80, or 85 percent Sevin. Spray brigades from the Service National d'Eradication de la Malaria (SNEM) made the applications with conventional cylindrical hand-compression sprayers, each equipped with an "8004" nozzle (Spraying Systems Co., Bellwood, Illinois). Each application was made in the same manner followed under normal field operations so that the treatment procedures would be comparable to those of the operational program. Technical supervision was limited to observations to insure that the

* These studies were accomplished as part of a contractual agreement between the Communicable Disease Center and the Agency for International Development.

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§ Use of trade names is for identification purposes only and does not constitute endorsement by the Public Health Service.

houses were sprayed with the proper formulation and dosage.

To evaluate the treatments, the plastic-cone method[2] in which adult female mosquitoes are confined on the treated surfaces for 1 hour was used. Ten females were placed in each cone, and single cones were placed on each of three surfaces (wood, thatch, whitewashed mud) in five to seven houses at weekly or biweekly intervals. In the first study the same five houses were checked routinely plus two other houses selected at random. In the second study the same five houses were inspected for the entire period. One untreated house was used as a control for each compound and dosage. After exposure the mosquitoes were removed to clean cages, a sugar-water pad was placed on the cage, and the specimens were transported to the laboratory in Port-au-Prince where they were held for 24-hour mortality determinations. An average mortality of 70 percent on a surface residue was considered satisfactory.

To obtain a broad coverage of the surfaces in each house and to minimize the effects of possible variations in the amount of toxicant present thereon, each successive test was made on a different site. All sites tested were marked to prevent replication on the same spot. All test specimens were 3- to 4-day-old females obtained from a laboratory colony of *Anopheles albimanus* maintained in Port-au-Prince. This strain, established from one maintained at Savannah, Georgia, and supplemented by eggs from Guatemala, showed a resistance to DDT in 1962 but this regressed in early 1963 to complete susceptibility.

FIGURE 1. Typical rural house in Haiti with mud wall and thatched roof.

TABLE 1

Average percent mortality of female A. albimanus *after 60-minute exposure to deposits of Sevin and Bayer 39007 on whitewashed mud, thatch and wood*

Residue age (weeks)	Sevin 50 W		Bayer 39007†
	1 g/m²	2 g/m²	2 g/m²
2–3*	100	100	99
4–5	78	99	72
6–7	—	100	58
8	—	94	59
9	66	94	—
10	71	97	55
11	47	95	59
12	72	83	38
13	63	96	69
14	50	95	37
15	89	94	72

* Test at 1 and 2 g/m² made in alternate weeks (odd- and even-numbered weeks, respectively).

† At 1 g/m² Bayer 39007 gave 90, 55 and 45 percent kills at weeks 2, 4, and 6, respectively.

RESULTS

Table 1 gives average mortalities obtained on the whitewashed mud, thatch, and wood surfaces treated with Sevin and Bayer Compound 39007. Sevin at 1 g/m² gave 100 percent mortality at week 3, but at week 5 the average mortality had dropped to 78 percent. At weeks 9 and 10 the average mortalities were 66 and 71 percent, respectively; and thereafter, the kills varied in the range of 47 to 89 percent. The kills on whitewashed mud were poor after week 3. Residues on thatch and on wood gave similar kills, most of which were above 70 percent. However, residues on neither surface provided consistent mortalities above 90 percent. The 2 g/m² dosage of Sevin was highly satisfactory as average mortalities, with the exception of week 12, remained at or above 94 percent. The average mortality of 83 percent at week 12 reflects a 51 percent kill on whitewashed mud. The kills for the remaining weeks on whitewashed mud ranged between 78 and 96 percent after week 6, but on thatch 100 percent mortalities were obtained for the entire 15 weeks tested. Accidental spraying of the experimental houses terminated the test at 15 weeks.

Bayer Compound 39007 at 1 g/m² gave satisfactory average kills for 3 weeks and at 2 g/m²

TABLE 2

Average percent mortality of female A. albimanus *after 60-minute exposure to deposits of Sevin, Bayer 37344 and DDT on whitewashed mud, thatch and wood*

Residue age (weeks)	Sevin, 2 g/m²			Bayer 37344		DDT	
	50 W	80 W	85 W	1 g/m²	2 g/m²	1 g/m²	2 g/m²
5	100	100	—	67	92 (wk 6)	95	100
7	100	100	96	97	99	—	100
9	100	100	95	96 (wk 10)	100 (wk 10)	99* (wk 10)	96 (wk 10)
11	100	99*	100*	—	—	100*	—
13	98	100	95	99	99*	95	100
14	99	98	99	100	100*	91	99
15	95	100	—	65	98	—	—
16	97	99	100	91	91	98	97
17	—	97	90	84	40	22	99
18	90	97	95	91	95	71	95
19	96	99	96	91	78	70	100
20	100	100	100	87	82	95	100
21	99	100	97*	80	63	78	92
22	93	79	80	52	60	48	77
23	80	76	95	71	49	33	73
24	74	55	69	63	75	40	28
25	53	87	73	18	69	38	45
26	87	51	50	48	39	—	40

* Control mortality greater than 20 percent.

for 4 weeks. Kills above 70 percent were obtained on wood for 13 weeks with Bayer 39007 at 2 g/m². Mortalities were poorest on whitewashed mud where they ranged from 5 to 53 percent after week 2. As the *A. albimanus* used were slightly resistant to DDT, the results obtained against these deposits were considered invalid for comparison with those of the experimental compounds.

Table 2 gives data on the 1963 treatments with Sevin, Bayer Compound 37344, and DDT. The three formulations of Sevin at 2 g/m² gave average mortalities of 90 to 100 percent for 21 weeks. Mortalities were usually slightly lower on whitewashed mud than on wood or thatch but were 79 percent or above through week 21 with the three formulations. No kills below 84 percent occurred on wood or thatch until week 24.

Bayer Compound 37344 at 1 g/m² gave an average mortality of 67 percent at the initial test at week 5. However, after this time the average mortalities ranged from 80 to 100 percent through week 21 with the exception of week 15. Residues on whitewashed mud were erratic in performance, the kills dropping to unsatisfactory levels at weeks 5, 15, 17 and 20. The treatment at 2 g/m² gave similar average results to those obtained with the 1 g/m² application. On whitewashed mud the residues gave unsatisfactory kills after week 18. Both dosages gave kills above 70 percent on thatch for 24 weeks and on wood for 21 weeks except for week 17 with the 2 g/m² dosage.

DDT at 1 g/m² gave average mortalities of 91 to 100 percent for 16 weeks, but on week 17 the average kill was only 22 percent (Table 2). From weeks 18 through 21 the average mortalities ranged from 70 to 95 percent. The mortalities on whitewashed mud usually were slightly poorer than those on wood and thatch but were satisfactory through week 16. At 2 g/m² DDT gave average mortalities of 77 to 100 percent for 22 weeks. The results on whitewashed mud were equal to those on thatch and wood through week 21.

DISCUSSION

These results indicate that Bayer 37344 and Sevin have greater potential as a surface treatment against *A. albimanus* than does Bayer 39007. The latter gave disappointing results when considered in regard to data previously reported by Mathis and Schoof[1] which indicated that this

TABLE 3

Percentage mortality of female A. albimanus *on deposits of Sevin and Bayer Compound 39007 on whitewashed mud (WM), thatch (T), and wood (W), Haiti*

Age of deposits	Sevin 50 W						Bayer 39007					
	1 g/m²			2 g/m²			1 g/m²			2 g/m²		
	WM	T	W	WM	T	W	WM	T	W	WM	T	W
Weeks 2–7	59	98	100	99	100	100	43	62	85	61	79	89
Weeks 8–15	41	81	76	82	100	98	—	—	—	28	63	74

TABLE 4

Percentage mortality of female A. albimanus *on deposits of DDT, Bayer Compound 37344, and Sevin on whitewashed mud (WM), thatch (T), and wood (W), Haiti, 1963*

Age of deposits	DDT						Bayer 37344					
	1 g/m²			2 g/m²			1 g/m²			2 g/m²		
	WM	T	W	WM	T	W	WM	T	W	WM	T	W
Weeks 5–13	94	98	99	98	100	100	76	99	92	93	100	100
Weeks 14–26	55	64	77	75	80	81	55	83	81	52	84	80

Age of deposits	Sevin 2 g/m²								
	50 W			80 W			85 W		
	WM	T	W	WM	T	W	WM	T	W
Weeks 5–13	99	100	99	100	99	100	96	96	98
Weeks 14–26	82	95	91	80	92	92	75	94	92

compound was equal to or better than Sevin against *Anopheles quadrimaculatus* on 9 different surfaces. Other workers[3] also have indicated Bayer 39007 to be an insecticide of promise as a residual treatment against that species

Bayer 37344 at 1 or 2 g/m² gave good average kills through week 21, but its performance on whitewashed mud was erratic. In contrast, Sevin in all three formulations produced kills of 79 to 100 percent through week 22. The residues from the 50 and 80 percent water-wettable formulations gave only 2 and 0 weeks of kills below 90 percent on whitewashed mud from week 5 to week 21.

When the data for the treatments are summarized on the basis of surface treated, it is apparent that the results on whitewashed mud were generally less favorable than those on thatch or on wood (Tables 3 and 4). However, with Sevin at 2 g/m² the average kills on all surfaces remained at or above 75 percent.

Through week 16 Sevin and Bayer 37344 at 2 g/m² gave consistently excellent results, but in subsequent weeks Sevin proved superior (Table 2). The availability of high concentrate wettable powders of Sevin and its mammalian toxicity* are factors enhancing its potential as a residual agent against mosquitoes.

The extended period of effectiveness (beyond 16 weeks) for the Sevin treatments was not anticipated. In view of laboratory tests at Savannah, Georgia, which indicate temperature as having a marked effect upon the activity of Sevin, the higher daily temperatures in June

* Sevin—acute oral LD_{50} for male rats is 850 mg/kg, dermal LD_{50}, > 4,000 mg/kg; Bayer Compound 37344—acute oral LD_{50} in female rats is 135 mg/kg, dermal LD_{50}, 1,000 mg/kg

and July may have prolonged the activity of the toxicant beyond that which might be expected if the treatment, in its later phases, was subject to declining daily temperatures.

SUMMARY

Residual applications of suspensions of Sevin, Bayer Compound 39007, DDT, and Bayer Compound 37344 were evaluated at Source Matelas, Haiti, in occupied houses by exposing female *Anopheles albimanus* for 1 hour to the deposits. Based on average female mortality from exposure on three surfaces (whitewashed mud, thatch, wood), Sevin and DDT at 2 g/m² were effective for a greater period of time than were Bayer 39007 and Bayer 37344. At 1 g/m² DDT was effective for longer periods than either of the experimental compounds. In general the deposits on wood and thatch gave higher kills over longer periods than did those on whitewashed mud. However, Sevin and DDT at 2 g/m² were highly effective on mud for 21 weeks. Sevin and DDT at 2 g/m² gave similar results and satisfactory kills (70 percent or greater), for 23 to 25 weeks after application. Deposits of Sevin from water-wettable powders containing 50, 80, and 85 percent toxicant gave similar results.

ACKNOWLEDGMENT

The authors wish to express their appreciation to the personnel of Service National d'Eradication de la Malaria (SNEM) for making the applications of the experimental insecticides for these studies and for their general assistance

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