

RESIDUAL EFFECTIVENESS OF SOME NEW INSECTICIDES AGAINST ADULTS OF *ANOPHELES* *QUADRIMACULATUS* SAY

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The application of insecticide residues in buildings has been the principal method of reducing vector populations in malaria eradication programs. Residual treatments have also been widely used by the Armed Forces, as well as by individuals, for protection against mosquito attacks. The chlorinated hydrocarbon insecticides, especially DDT and dieldrin, and BHC to a lesser extent, have been the insecticides of choice, but resistance to these materials is continually spreading and alternate groups of insecticides are needed as substitutes. To fill this need, the residual effectiveness of various organophosphorus compounds

and insecticides in other chemical groups is being investigated at various laboratories. Since 1943, when tests were initiated at Orlando, Fla., in cooperation with the Armed Forces to evaluate the residual effectiveness of DDT against anophelines, numerous insecticides have been examined at this laboratory, with emphasis on organophosphorus compounds in recent years.

Within the last year the 19 organophosphorus and carbamate insecticides listed below were tested against *Anopheles quadrimaculatus* Say, in comparison with DDT and malathion standards:

Hercules AC-5727	<i>m</i> -isopropylphenyl methylcarbamate
Bayer 29493	<i>O, O</i> -dimethyl <i>O</i> -(4-methylthio- <i>m</i> -tolyl)phosphorothioate
Monsanto CP 11223	2, 2-dichloro-1-(dimethylphosphinyl)vinylidene dimethyl phosphate
American Cyanamid 12008	<i>O, O</i> -diethyl <i>S</i> -(isopropylthiomethyl) phosphorodithioate
Bayer 24869	1-chloromethyl ethyl 2, 2-dichlorovinyl ethyl phosphate
Sevin	1-naphthyl methylcarbamate
Methyl Trithion	<i>S</i> -(<i>p</i> -chlorophenylthio) methyl <i>O, O</i> -dimethyl phosphorodithioate
Dimethoate	<i>O, O</i> -dimethyl <i>S</i> -(<i>N</i> -methylcarbamoylmethyl) phosphorodithioate
Dibrom Trithion	1, 2-dibromo-2, 2-dichloroethyl dimethyl phosphate
Phorate	<i>S</i> -(<i>p</i> -chlorophenylthio)methyl <i>O, O</i> -diethyl phosphorodithioate
Delnav	<i>O, O</i> -diethyl <i>S</i> -(ethylthio) methyl phosphorodithioate
Dimetilan	2, 3- <i>p</i> -dioxanedithiol <i>S, S</i> -bis(<i>O, O</i> -diethyl phosphorodithioate) and related compounds
Potasan	3-methyl-5-pyrazolyl dimethylcarbamate
Co-Ral	<i>O, O</i> -diethyl <i>O</i> -(4-methylumbelliferone) phosphorothioate
Bayer 22408	<i>O</i> -(3-chloro-4-methylumbelliferone) <i>O, O</i> -diethyl phosphorothioate
American Cyanamid 12503	<i>O, O</i> -diethyl <i>O</i> -naphthalimido phosphorothioate
Dow ET-15	<i>O, O</i> -diethyl <i>O</i> [2-phenyl-6-(3(2 <i>H</i>)-pyridazinonyl)] phosphorothioate
ethyl DDVP	<i>O</i> -methyl <i>O</i> -(2, 4, 5-trichlorophenyl)phosphoramidothioate
	2, 2-dichlorovinyl diethyl phosphate

The mosquitoes were from a colony which has developed a high level of resistance to dieldrin in the course of many years of laboratory maintenance. At the time these tests were made the larvae showed about 100-fold resistance, and adult mortality did not exceed 16 percent following a 1-hour exposure on papers treated with 0.8 percent dieldrin, using the World Health Organization standard test kit. The strain is not resistant to DDT.

Nine series of duplicate tests were made, each series consisting of three or four experimental insecticides and a standard. Malathion was used as the standard in series 2 and 4, and DDT in the others. Acetone solutions were sprayed on pine

plywood panels at the rate of 100 mg. of active ingredient per square foot. The panels were tested after aging for periods ranging from 1 day to 24 weeks. Enough panels were sprayed with each insecticide to avoid the necessity of using the same panel for two tests. In each test 20 to 40 1- or 2-day-old mosquitoes were exposed under half sections of Petri dishes on the treated panels for periods ranging from 1 to 120 minutes. The insects were then transferred to cylindrical screen cages and provided with a 10 percent honey solution in absorbent cotton pads, and mortality counts were made after 24 hours. The results with the 13 most effective compounds are given in Table 1.

TABLE 1.—Mortality of *Anopheles quadrimaculatus* after exposure to residues of insecticides for various periods. (Average of duplicate tests.)

Insecticide	Series	Minutes of exposure	Percent mortality on residues aged for—								
			1 day	1 week	2 weeks	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks
Hercules AC-5727	6	1	100	100	100	100	100	67	20	0	0
		5	100	100	100	100	100	97	71	60	
		15	—	—	—	—	—	100	100	100	100
Bayer 29493	9	5	100	100	100	100	100	50	50	4	—
		15	100	100	100	100	100	97	84	8	—
		30	—	—	—	100	—	100	100	65	—
		60	—	—	—	—	—	—	—	96	—
Monsanto CP 11223	5	5	100	33	15	—	2	—	19	4	—
		15	—	100	100	56	92	28	30	19	7
		30	—	—	—	72	100	60	95	56	32
		60	—	—	—	100	100	100	100	86	100
American Cyanamid 12008	4	5	100	100	12	46	—	—	1	0	9
		15	—	—	15	100	0	11	30	5	11
		30	—	—	100	100	3	66	98	58	37
		60	—	—	—	—	100	100	100	100	100
Bayer 24869	6	5	100	93	26	—	—	5	—	—	—
		15	100	100	56	—	—	50	7	0	10
		30	—	100	12	—	64	100	89	75	47
		60	—	—	13	40	100	100	100	100	93
Sevin	4	15	7	—	—	—	—	33	36	45	10
		30	20	36	7	44	15	82	100	90	47
		60	95	100	31	92	100	100	100	100	100
		120	100	100	100	100	100	—	—	—	—
Methyl Trithion	5	15	—	—	—	—	—	26	7	30	18
		30	17	—	—	10	30	59	67	86	100
		60	92	50	30	66	78	100	100	100	100
		120	100	100	100	97	100	100	—	—	—

TABLE 1.—(Continued)

Insecticide	Series	Minutes of exposure	Percent mortality on residues aged for—									
			1 day	1 week	2 weeks	4 weeks	8 weeks	12 weeks	16 weeks	20 weeks	24 weeks	
Dimethoate	2	15	17	31	15	—	—	—	—	21	—	
		30	37	97	23	27	4	10	—	100	54	
		60	87	97	35	75	35	8	50	100	81	
		120	100	100	100	100	96	96	100	—	100	
Dibrom	2	5	100	18	—	—	—	—	—	—	—	
		15	—	78	24	7	—	—	—	—	—	
		30	—	100	92	25	15	—	—	—	—	
		60	—	—	100	100	5	—	—	—	—	
		120	—	—	—	—	14	—	—	—		
Trithion	5	30	10	6	—	—	—	—	—	—	—	
		60	15	47	20	13	—	—	—	—	—	
		120	100	100	100	100	64	—	—	—	—	
Phorate	5	5	100	100	95	—	—	—	—	—	—	
		15	—	—	100	4	—	—	—	—	—	
		30	—	—	—	8	—	—	—	—	—	
		60	—	—	—	28	—	—	—	—	—	
		120	—	—	—	93	68	—	—	—		
Delnav	5	30	11	—	—	—	—	—	—	—	—	
		60	55	10	15	10	—	—	—	—	—	
		120	100	86	96	88	61	—	—	—	—	
Dimctilan	2	5	20	—	—	—	—	—	—	—	—	
		15	13	—	—	—	—	—	—	—	—	
		30	50	10	—	—	—	—	—	—	—	
		60	47	31	0	—	—	—	—	—	—	
		120	100	97	43	22	—	—	—	—	—	
DDT	5	5	11	—	—	—	78	93	63	40	53	
		15	36	27	33	39	89	100	83	69	47	
		30	94	86	43	78	100	100	100	97	63	
		60	100	100	100	100	100	—	—	—	100	
	6	5	17	46	19	—	—	79	33	71	10	
		15	45	64	41	—	70	98	85	92	41	
		30	100	100	42	40	96	100	100	100	65	
		60	100	100	97	100	100	100	100	—	—	
	9	5	21	9	73	29	50	29	50	3	—	
		15	59	60	100	57	96	78	89	36	—	
		30	100	100	100	100	100	100	100	85	—	
		60	—	—	—	—	—	—	—	100	—	
Malathion	2	5	60	33	49	0	64	6	23	0	12	
		15	96	97	93	100	87	90	36	100	45	
		30	100	100	100	100	100	93	100	100	100	
		60	—	—	—	—	—	100	100	—	—	
	4	5	34	27	13	24	—	—	0	2	7	
		15	88	100	93	63	0	41	92	27	35	
		30	100	100	100	100	100	93	100	97	93	
		60	—	—	—	—	100	100	—	100	100	
Untreated checks	2	120	7	3	4	2	4	0	6	6	3	
		4	120	1	0	0	6	0	2	0	1	8
		5	120	0	0	4	2	7	2	3	3	0
		6	120	4	6	2	0	1	11	4	0	3
		9	120	0	0	0	1	5	4	0	3	—

During the first 24 weeks of aging the malathion standard was slightly superior to the DDT, usually giving 100 percent mortality after an exposure of 30 minutes whereas 60-minute exposures were more frequently required with DDT. Hercules AC-5727 was the most effective compound, giving 97 percent to 100 percent mortality for more than 8 weeks after a 1-minute exposure and for 24 weeks after the 15-minute exposure. Bayer 29493 was superior to both standards for 12 weeks, and Monsanto CP 11223, American Cyanamid 12008, and Bayer 24869 for 1 week, and CP 11223 was equal to DDT for 8 weeks. Sevin gave 100 percent mortality and Methyl Trithion and dimethoate 96 percent to 100 percent, following a 60- or 120-minute exposure for 24 weeks. The remaining insecticides were less effective.

There were wide variations in mortality at the shorter exposure periods, but they

became less pronounced at the longer exposures, which may be attributable to greater activity of the mosquitoes on certain days or to fluctuations in the susceptibility or vigor of the mosquitoes from generation to generation.

SUMMARY. In laboratory tests with 19 insecticides as residues on plywood panels at 100 mg. per square foot, Hercules AC-5727 was the most effective, giving 97 percent to 100 percent 24-hour mortality after a 15-minute exposure on panels aged for 24 weeks. Malathion usually gave 100 percent kills after 30-minute exposures, and DDT after 60-minute exposures. Bayer 29493 was superior to malathion and DDT for 16 weeks, and Monsanto CP 11223, American Cyanamid 12008, and Bayer 24869 were superior during the first week. Sevin gave 100 percent kills, and Methyl Trithion and dimethoate 96 percent to 100 percent after 60- or 120-minute exposures. The other compounds were less effective.