

TOXICITY OF SELECTED ADULTICIDES TO SIX SPECIES OF MOSQUITOES¹

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ABSTRACT. Six adulticides were evaluated as contact aerosols in a wind tunnel against adult females of *Aedes taeniorhynchus* (Wiedemann), *Aedes aegypti* L., *Culex pipiens quinquefasciatus* Say, *Culex nigripalpus* Theobald, *Anopheles quadrimaculatus* Say, and *Anopheles albimanus* Wiedemann. In general, resmethrin, pyrethrins, and tetramethrin, when synergized with piperonyl butoxide, were considerably more toxic to the mosquitoes than fenthion, naled, and malathion.

At our laboratory, we routinely evaluate candidate mosquito adulticides against *Aedes taeniorhynchus* (Wiedemann) as contact aerosols in laboratory wind-tunnel tests. However, variations in the susceptibility of species to chemicals and the increasing interest in mosquito adulticides in many areas of the world encouraged us to obtain comparable data on the toxicity of six adulticides to five additional species of mosquitoes. We then compared the susceptibilities of these species to those of our standard test strain of *A. taeniorhynchus*.

METHODS AND MATERIALS. The species of mosquitoes tested in addition to the standard species were *Aedes aegypti* L., *Culex pipiens quinquefasciatus* Say, *Culex nigripalpus* Theobald, *Anopheles quadrimaculatus* Say, and *Anopheles albimanus* Wiedemann. All except *C. nigripalpus* were from our laboratory colonies. *Culex nigripalpus* was obtained as eggs from a colony maintained by W. W. Smith, Entomology Department, University of Florida, Gainesville, Florida.

The adulticides evaluated were three pyrethroids, resmethrin, pyrethrins, and tetramethrin, and three organophosphates, fenthion, naled, and malathion. The

The pyrethroid compounds, particularly resmethrin, were outstanding against the two species of *Anopheles*. The finding that unsynergized pyrethroids were about 6 times less toxic to *A. taeniorhynchus* than synergized pyrethroids was of particular interest. Fenthion and naled were consistently more effective than malathion, which was markedly less toxic to the species of *Culex* than to the species of *Aedes* and *Anopheles*.

pyrethroid compounds were tested both unsynergized and synergized with piperonyl butoxide at a ratio of one part adulticide to five parts synergist.

All compounds were tested as contact aerosols in a wind tunnel, a cylindrical tube 4 inches in diameter through which a column of air is drawn at a rate of 4 miles per hour by a suction fan. In each exposure, 25 mosquitoes were confined in a tubular galvanized metal cage with screened ends that was placed in the center of the tube. Then 0.25 milliliter of a solution of the adulticide in deodorized kerosene was atomized at a pressure of one pound per square inch into the mouth of the tunnel, and the mosquitoes were exposed momentarily to the aerosol droplets as they were drawn through the cage. Duplicate cages were used in each test, and one to four tests were made with each concentration of each insecticide. After treatment, the mosquitoes were anesthetized with carbon dioxide, transferred to cardboard holding cages, and furnished with a 10 percent sugar-water solution. Knockdown and mortality counts were taken 1 and 24 hours after exposure, respectively. Mosquitoes handled in the same manner but not exposed to the chemicals showed less than 10 percent kill except for species of *Anopheles* which had an average check kill of 15 percent. The data were corrected by Abbott's formula.

RESULTS AND DISCUSSION. The 24-hour LC₉₀'s for each adulticide against each

¹ This paper reflects the results of research only. Mention of a pesticide or a commercial or proprietary product in this paper does not constitute a recommendation or an endorsement of this product by the USDA.

TABLE 1.—Effectiveness of contact aerosols of six adulticides to females of six species of mosquitoes.

Adulticide	ENT No.	24 hour LC ₅₀ (%) for indicated species					
		<i>Aedes taeniorhynchus</i>	<i>Aedes aegypti</i>	<i>Culex p. quinquefasciatus</i>	<i>Culex nigripalpus</i>	<i>Anopheles quadrimaculatus</i>	<i>Anopheles albimanus</i>
Resmethrin ^a	27474	0.0046 (6.3)	0.0016 (1.6)	0.008 (1.9)	0.0034 (1.3)	0.0013 (1.9)	0.0005 (2.2)
Pyrethrins ^a	3107	.006 (6.2)	.003 (2)	.009 (3)	.006 (2.7)	.003 (4)	.0017 (1.4)
Tetramethrin ^a	27339	.007 (5.8)	.007 (1.5)	.014 (2.3)	.029 (.9)	.002 (1.3)	.0013 (2.4)
Fenthion	25540	.012	.008	.016	.024	.015	.01
Naled	24988	.024	.012	.02	.01	.02	.015
Malathion	17034	.035	.026	.07	.15	.04	.04

^a Synergized at a ratio of 1 part adulticide to 5 parts piperonyl butoxide (ENT-14250); numbers in parentheses indicate reciprocal ratio of unsynergized adulticide.

species of mosquito are presented in Table 1. In general, the compounds are listed in order of decreasing effectiveness, but there are several notable exceptions which will be discussed with respect to the species of mosquito.

Against *A. taeniorhynchus*, the synergized pyrethroids were about 2 to 7 times more toxic than the organophosphates; however, the toxicity of the unsynergized pyrethroids was only about equal to that of malathion and was less than that of fenthion and naled. Also, in our previous field tests (Mount and Pierce, 1971, and Mount and Pierce, 1972) resmethrin (Penick SBP-1382) and tetramethrin were about as toxic as malathion, but pyrethrins synergized with piperonyl butoxide was 7.5 times more toxic than malathion. Rathburn and Boike (1972) also reported that resmethrin was 3 times less effective than malathion against *A. taeniorhynchus* exposed to thermal aerosols in the laboratory. Our results indicated that for maximum efficiency against *A. taeniorhynchus*, pyrethroid compounds must be synergized.

A. aegypti was more susceptible than *A. taeniorhynchus* to all of the adulticides except synergized tetramethrin (LC₉₀'s equal for the two species). Synergized and unsynergized resmethrin and synergized pyrethrins were the outstanding adulticides against *A. aegypti*.

C. p. quinquefasciatus was about as susceptible as *A. taeniorhynchus* to naled and fenthion but about 1.5 to 2.0 times less susceptible to malathion and the synergized pyrethroids. Although synergized resmethrin and pyrethrins were the most toxic of all the adulticides to *C. p. quinquefasciatus*, this species was the least susceptible of all the species of mosquitoes to these two adulticides.

Synergized and unsynergized resmethrin, synergized pyrethrins, and naled were the most effective adulticides against *C. nigripalpus*. This species was 0.5 as susceptible to fenthion and only 0.25 as susceptible to synergized tetramethrin and malathion as adults of *A. taeniorhynchus*. Our results and those of Rathburn and Boike (1972) showed that unsynergized

resmethrin was 33 times more effective than malathion against *C. nigripalpus*. Also, our laboratory data and that of Rathburn and Boike both indicate that *C. nigripalpus* is 4 to 6 times less susceptible than *A. taeniorhynchus* to malathion.

Both species of *Anopheles* were highly susceptible to all the synergized pyrethroids, but synergized resmethrin was the most toxic and was 31 and 80 times more effective than malathion against *A. quadrimaculatus* and *A. albimanus*, respectively. The organophosphates had about the same degree of toxicity to both *Anopheles* species as to *A. taeniorhynchus*.

Thus, as a group, the synergized pyrethroids were considerably more toxic than the organophosphates to the six species of mosquitoes. Without exception, synergized resmethrin was more effective than synergized pyrethrins, which was the second most effective adulticide. The other pyrethroid, tetramethrin (synergized), was slightly more toxic than synergized pyrethrins to the two species of *Anopheles*. Synergized tetramethrin was consistently more effective than any of the organophosphates except against *C. nigripalpus*.

Among the organophosphates, fenthion was the most effective adulticide and

was 1.25 to 2 times more toxic than naled to all species except *C. nigripalpus*. Naled was the most consistent of the adulticides since there was only a two-fold range between the most and the least susceptible species of mosquito. Malathion was uniform in its performance against the species of *Aedes* and *Anopheles*, but it was 2 to 4 times less effective against the species of *Culex*.

The three pyrethroids and naled produced relatively quick knockdown (within one hour) of all the species of mosquitoes at concentrations that were either considerably lower or about the same as the concentrations required for 24-hour kill. Malathion yielded only moderate knockdown and fenthion produced little, if any, knockdown within one hour.

Literature Cited

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