EFFECTIVENESS OF ULV GROUND AEROSOLS OF PHENOTHRIN AGAINST MOSQUITOES, HOUSE FLIES, AND STABLE FLIES[1]

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ABSTRACT. Ground application of ULV aerosols of phenothrin (3-phenoxyphenol)methyl *cis,trans*-(±)-2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropanecarboxylate alone and combined in a 1:1 ratio with piperonyl butoxide, α-[2(2butoxyethoxy)-ethoxy]4,5(methylenedioxy)-2-propyltoluene were tested against caged *Aedes taeniorhynchus* (Wiedemann), *Anopheles quadrimaculatus* Say, *Musca domestica* L., and *Stomoxys calcitrans* (L.). Based on calculated effective dosages for 90% control, there were definite differences in species susceptibility to phenothrin. *S. calcitrans* was the most susceptible followed in decreasing susceptibility by *An. quadrimaculatus, M. domestica,* and *Ae. taeniorhynchus*. Piperonyl butoxide had a varied effect in reducing the amount of phenothrin needed for 90% control. It was most effective against *M. domestica*, followed by *An. quadrimaculatus* and *S. calcitrans*. However, combination with piperonyl butoxide increased the amount of phenothrin needed for 90% control of *Ae. taeniorhynchus*.

Since the advent of the synthetic pyrethroids, we have tested most of them in the laboratory against mosquitoes and house flies. Recently, the pyrethroid phenothrin, (3-phenoxyphenol) methyl *cis, trans*-(±)-2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropanecarboxylate, was found to be ca. 18× more effective than the malathion, diethyl mercaptosuccinate *S*-ester with *0,0*-dimethyl phosphorodithioate, test standard. In addition, laboratory tests with phenothrin in various combinations with piperonyl butoxide, α-[2-(2-butoxyethoxy)ethoxy]-4,5-(methlyenedioxy)-2-propyltoluene, indicated that a 1:1 ratio could be effective in reducing the amount of phenothrin needed for control. This paper presents the results of field studies of phenothrin applied as a ULV ground aerosol with and without a synergist against caged insects.

[1] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the U.S. Department of Agriculture nor does it imply registration under FIFRA as amended. Also, mention of a commercial or proprietary product does not constitute an endorsement of this product by the USDA.

MATERIALS AND METHODS

The tests were conducted in a fairly level open field near Gainesville, FL, during May and June 1978 and May 1979. Temperatures at ground elevations of 1.8 m and 9.1 m and wind speed were measured during these tests. Tests were conducted in the evening between 7 and 10 pm during favorable weather.

A Leco Model® HD aerosol generator with a blower pressure of 0.28 kg/cm^2 was used to disperse the adulticide, which was delivered to the nozzle by a positive displacement pump (Micro-Gen® digital flow control) at 30 ml/min. The phenothrin concentrate (40% AI; 0.902 kg/liter) was formulated in klearol at the concentrations necessary for treatment at the desired rate of active ingredient per ha, based on a 91-m swath and truck speeds of 4, 8, 16, and 32 km/hr.

Malathion ULV concentrate applied at a rate of 30 ml/min at a vehicle speed of 8 km/hr (27.2 gm/ha) was used as the standard for comparison.

Insecticide-susceptible strains of *Aedes taeniorhynchus, Anopheles quadrimaculatus, Musca domestica*, and *Stomoxys calcitrans* were reared in the laboratory for the tests. (The test insects were immobilized on a cold table (Berry et al. 1978) for handling and counting.) The technique used by Mount et al. (1974) for testing mosquitoes and house flies together was used. Adult female mosquitoes (4–6 days old) and female flies (2–5 days old) were exposed in groups of 25 in 16-mesh screen wire cages (4.5 cm diam. × 15 cm long). Four cages of each species were suspended 1.2 m above ground on stakes 7.6 m and 15.2 m downwind for house flies and stable flies and 45.7 and 91.4 m downwind for mosquitoes in 2 rows 30.5 m apart and perpendicular to the line of travel of the ULV generator. Immediately after each aerosol had drifted through the test plot (5–15 min), the insects were transferred to plastic holding tubes lined with clean paper.

Before and after exposure, test insects were held in insulated chests containing ice and moist cotton. During the 12 hr holding period prior to mortality counts, the test insects were held at room temperature and supplied with sugar water. Cages of test insects not exposed to the insecticide but handled in the same manner were used as controls. Control mortalities averaged 3.7, 3.2, 1.8, and 4.8% for *Ae. taeniorhynchus, An. quadrimaculatus, M. domestica,* and *S. calcitrans*, respectively.

Estimated effective dosages (ED's) for 90 and 95% control were calculated with a probit analysis program written for a Hewlett-Packard Model 9810A programmable calculator according to the procedures given by Finney (1971).

RESULTS AND DISCUSSION

The results of the aerosol tests with phenothrin alone and in combination with piperonyl butoxide are presented in Table 1. The estimated effective dose (ED) for each species is presented in Table 2.

There were definite differences between the species in susceptibility to phenothrin. Based on the ED-90, *S. calcitrans* was the most susceptible to phenothrin, followed, in order of decreasing susceptibility, by *An. quad-*

Table 1. Efficacy of ULV aerosols of phenothrin and phenothrin + piperonyl butoxide (1:1) against caged insects of indicated species.

Treatment rate gm AI/ha	Average 12-hr percentage mortality[a]			
	Aedes taeniorhynchus	*Anopheles quadrimaculatus*	*Musca domestica*	*Stomoxys calcitrans*
	Phenothrin			
11.2	79(4)[b]		73(4)	
5.6	73(5)		25(5)	
2.8	36(5)		16(5)	
1.4	38(5)	88(5)	2(2)	96(4)
0.7		74(5)		89(4)
.35		56(5)		61(4)
.18		33(5)		37(4)
	Phenothrin + piperonyl butoxide (1:1)			
11.2	82(6)		82(5)	
5.6	72(5)		64(5)	
2.8	65(6)		30(4)	
1.4	54(7)	90(5)	7(1)	99(4)
0.7		83(4)		89(4)
.35		56(4)		75(4)
.18		35(4)		46(4)

[a] Mosquitoes exposed at 45.7m and 91.4m downwind. House flies and stable flies exposed at 7.6m and 15.2m downwind.

[b] Numbers in parentheses show number of tests at each rate.

Table 2. Calculated effective dose (ED) in grams/ha for 90 and 95% control of caged adult females of indicated species with ULV aerosols.

Species	Phenothrin		Phenothrn + piperonyl butoxide (1:1)	
	ED_{90} (gm AI/ha)	ED_{95} (gm AI/ha)	ED_{90} (gm AI/ha)	ED_{95} (gm AI/ha)
Aedes taeniorhynchus	23.5 (16.8–41.5)[a]	43.7 (26.9–88.5)	29.1 (16.8–75.1)	74.0 (35.9–279.1)
Anopheles qadrimaculatus	1.6 (1.2–2.1)	2.5 (1.9–3.7)	1.2 (1.0–1.6)	1.9 (1.4–2.7)
Musca domestica	22.4 (17.9–31.4)	30.3 (22.4–44.8)	14.6 (12.3–19.0)	20.2 (15.7–28.0)
Stomoxys calcitrans	0.8 (0.7–1.0)	1.1 (1.0–1.6)	0.6 (0.5–0.8)	.09 (0.8–1.2)

[a] 95% Fiducial range in parentheses.

rimaculatus, *M. domestica*, and *Ae. taeniorhynchus*.

The use of piperonyl butoxide had a variable effect on the amount of phenothrin needed for control. This synergist reduced the amount of phenothrin needed at the ED-90-ED-95 levels ca. 33–35% for control of *M. domestica* but less for control of *An. quadrimaculatus* (ca. 24–25%) and *S. calcitrans* (ca. 18–19%).

The synergist had the opposite effect in the tests with *Ae. taeniorhynchus*. The amount of phenothrin needed was increased ca. 24% at the ED-90 level and ca. 69% at the ED-95 level. Similar variable effects were noted in a series of wind tunnel tests in Arkansas with field populations of *Psorophora columbiae* and *An. quadrimaculatus* (Roberts et al. 1980). In those tests, the amount of phenothrin needed was reduced ca. 78% against *Ps. columbiae* but only ca. 40% against *An. quadrimaculatus*, a field strain that was ca. 16 × more resistant to malathion than our laboratory strain.

Under the conditions of our tests the average mortalities for the control treatment (malathion) for *Ae. taeniorhynchus*, *An. quadrimaculatus*, *S. calcitrans*, and *M. domestica* were 93, 98, 69, and 2%, respectively.

Compared to the malathion treatments of 27.2 gm/ha, phenothrin at an ED-90 of 23.5 gm/ha, was slightly better against *Ae. taeniorhynchus*. However, phenothrin at an ED-90 of 1.6 gm/ha was very effective against *An. quadrimaculatus*. Phenothrin was also highly effective against *S. calcitrans* (ED-90 of 0.8 gm/ha) while the malathion was only partially effective. In a previous study with 6 pyrethroids (Mount et al. 1974) synergized RU-11678 ((5-benzyl-3-furyl) methyl *trans*-(+)-3-(cyclopentylidenemethyl)-2,2-dimethylcyclopropanecarboxylate) was the best pyrethroid against *M. domestica* with an ED-90 of 34.7 gm/ha. Phenothrin with an unsynergized ED-90 of 22.4 gm/ha and a synergized ED-90 of 14.6 gm/ha is a more effective adulticide against *M. domestica*. Based on these investigations, further studies with phenothrin, both with other mosquito species in laboratory tests and with field populations, are warranted.

References Cited

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