EFFECT OF THREE PYRETHROIDS ON BLOOD FEEDING AND FECUNDITY OF *AEDES AEGYPTI*

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ABSTRACT. Caged *Aedes aegypti* were exposed to a range of concentrations of d-phenothrin, d-allethrin and tetramethrin in a wind tunnel. Mortality, blood engorgement and egg production among these mosquitoes and their progeny were recorded. Tetramethrin was the most effective (LC_{50} of 0.0017%), followed by d-phenothrin (LC_{50} 0.0031%) and d-allethrin (LC_{50} 0.01%). Blood engorgement was decreased by treatment with each pyrethroid at the high concentration (0.002%, 0.003% and 0.01% respectively). Treatment with d-phenothrin or d-allethrin decreased egg production, but tetramethrin increased oviposition. These effects had ceased in the F_2.

INTRODUCTION

Insecticide-induced changes in the fecundity of insects have been reported by many authors. Adkisson and Wellso (1962) noted that DDT reduced the number of offspring from house flies and pink bollworm. Knutson (1955, 1959) found that treating house flies and *Drosophila melanogaster* with dieldrin resulted in a change in the fecundity of laboratory and field populations. Organophosphates, such as malathion and diazinon, were found to reduce the number of offspring from house flies (Hunter, et al. 1958). El-Khatib[3] observed that the treatment of larvae of *Culex quinquefasciatus* Say with temephos depressed the fecundity of survivors. Georghiou (1965) reported that isolan, a carbamate, depressed the fecundity, longevity and amount of food consumed, in house flies. Grosch (1975) noted that carbaryl reduced the number of eggs of *Bracon hebetor*. David and Vago (1967) have reported that adult *D. melanogaster* treated with *Bacillus thuringiensis* serotype 1, showed reduced longevity and fecundity.

Liu and Georghiou[4] found that trans permethrin, a pyrethroid, caused a significant decrease in blood engorgement and egg raft production of *Cx. quinquefasciatus* from pyrethroid resistant and susceptible strains. This paper describes the effect of three pyrethroids, d-phenothrin, d-allethrin and tetramethrin, on the blood feeding activity and egg production of a susceptible strain of *Aedes aegypti* (Linnaeus). Since pyrethroids are being used extensively, some as substitutes for organophosphate and carbamate insecticides, the effect of pyrethroids upon insect fecundity should be investigated.

MATERIALS AND METHODS

A susceptible strain of *Ae. aegypti* was utilized. This strain had been reared in the laboratory at Insect Control & Research, Inc. under standard conditions free from insecticides for many years. Three to five day old females were used for testing.

The insecticides used were d-phenothrin (Sumithrin®), 93.5%, d-allethrin (Pynamin Forte®), 91.4% and tetramethrin (Neopynamin®), 90.8% The solvents were acetone and kerosene (1:1).

Groups of 30–50 female mosquitoes were aspirated from a stock cage and placed in circular metal cages, (9.5 cm diam, 5 cm deep, both ends covered with nylon screen). Mosquitoes were treated in the Gerberg wind tunnel (American Biological Supply Co., Baltimore, MD 21228). Several concentrations of each insecticide were tested to determine the most suitable. Treatment was achieved by injecting the insecticide into the tunnel, using a 0.1 ml micropipette. The wind tunnel and its use is described by Morgan and Retzer (1981). The wind speed was 250–400 ft/min and the nozzle pressure was 6 psi. Ten sec after the mosquitoes were exposed to the spray, the cages were removed from the tunnel. The mosquitoes were left in the treated cages to avoid additional handling. Morgan and Retzer (1981) compared mortalities among house flies left in treated cages to those that had been transferred to clean cages. They found no significant differences. We exposed 200 mosquitoes, in 4 replicates of 50 to each concentration. Cotton balls, soaked in 10% sucrose solution, were placed on each cage. Mortality was recorded 4 to 6 hr following treatment with

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[3] El-Khatib, Z. 1983. Compatibility and biotic potential of different genotypes of *Culex quinquefasciatus* Say with reference to strategies for disrupting the development of resistance. Ph.D. Dissertation, University of California, Riverside. 242 p.

[4] Liu, Weide and G. P. Georghiou. Influences of permethrin treatment on blood feeding and fecundity of *Culex quinquefasciatus* Say resistant and susceptible to pyrethroid insecticides. (Unpublished data).

d-phenothrin or d-allethrin. The remaining mosquitoes were then allowed to feed upon a rabbit for 25 min. Treatment with tetramethrin caused rapid knockdown followed by recovery after several hours. Mosquitoes subjected to tetramethrin were therefore provided with blood 24 hr later, at which time mortality was noted.

Feeding was accomplished by placing the circular metal cage on the abdomen of the rabbit and fastening it with a belt. The mosquitoes were able to feed through the nylon screening. After the blood meal, the numbers of engorged mosquitoes were counted and released into a mosquito cage (12 × 12 × 12 in.). A plastic container of water, lined with paper towelling, was placed in the cage for oviposition. The number of eggs were counted each day.

In order to evaluate blood feeding and egg production by the F_1 and F_2 generations, 20 females were aspirated from the stock cage and placed in a circular metal cage and fed on a rabbit. Blood engorgement and oviposition were then recorded as above. Engorgement ratios were calculated by comparing the percentage of treated females engorged with the percentage of controls engorged. The LC_{50} values were obtained graphically.

RESULTS AND DISCUSSION

We found that the droplet distribution obtained in the tunnel at 400 ft/min was more uniform than at 250 ft/min and that mortality was slightly higher. Thus at 250 ft/min the LC_{50} for d-phenothrin was 0.0031%, while at 400 ft/min, a 0.003% concentration gave 56.5% mortality. The results of these trials are given in Table 1. Tetramethrin proved the most effective of three pyrethroids, followed by d-phenothrin and d-allethrin.

Blood engorgement was inhibited among the surviving *Ae. aegypti,* as shown in Table 2. Significant depression of engorgement was found at the highest dose level of all 3 pyrethroids, as revealed by the *t* test. The engorgement ratios were; tetramethrin 0.57, d-phenothrin 0.50, d-allethrin 0.40. Depression of blood feeding was less at dose levels of ca. or below the LC_{30}. This finding agrees with that of Liu and Georghiou (unpublished data) using permethrin against *Cx. quinquefasciatus.* The mechanism of this depressive effect upon engorgement is unknown. We noticed that many mosquitoes lost one or more of their legs after treatment; this may be related to the depression since this was not noticed among the controls. Similar observations were made by Khoo and Sutherland (1981) with bioresmethrin. These authors speculate that leg fracture was caused by excitation by this pyrethroid. Engorgement among the F1 of treated mosquitoes was normal, compared to that of the controls, suggesting that insecticide induced suppression of blood feeding is a transient phenomenon, confined to the generation which is treated.

Table 1. The toxicity of three pyrethroids to *Aedes aegypti* adults.

	Mortality %[1]		
Conc. %	d-phenothrin[2]	d-allethrin[3]	tetramethrin[3]
0.001	—	—	30.2
0.0015	6.5	—	38.5
0.002	8.0	—	49.4
0.0025	—	—	67.1
0.003	46.5	—	—
0.004	76.0	—	91.8
0.005	96.0	—	—
0.006	—	6.0	—
0.008	—	14.0	—
0.01	—	52.0	—
0.015	—	92.0	—
Check	0.5	0.0	2.5
LC_{50}	0.0031	0.01	0.0017
LC_{95}	0.0053	0.017	0.005

[1] Mortality based upon 200 mosquitoes per concentration and corrected by Abbott's formula.
[2] Wind speed 250 ft/min.
[3] Wind speed 400 ft/min.

Table 3 shows the differences in egg production of females treated with the 3 pyrethroids. Egg production was most markedly reduced by d-allethrin; down to 69% and 45% in the low and high doses respectively compared with the control. Tetramethrin showed no effect upon egg production. Egg production of mosquitoes treated with d-phenothrin was increased by 33% at the low dose, but decreased by 30% at the high dose relative to the control. The egg production of the F_1 of the d-phenothrin treated population was considerably less than in the control; 75% and 58% in the low and high doses respectively. There was, however, no significant difference in egg production in the F_2 compared with the control, indicating a reversion to normal production. The phenomenon of insecticide treatment causing insects to produce more eggs has been noted before; for example, Knutson (1955) reported that *D. melanogaster* produced 7.6% more eggs when treated with a sublethal dose of dieldrin. Afifi and Knutson (1956) reported house flies treated with dieldrin produced 62.9% and 9.3% more eggs respectively than the control in the F_1 and F_2 generations. Ouyer and Knutson (1957) found that malathion treatment in-

Table 2. The effect of three pyrethroids on blood engorgement of *Aedes aegypti*.

Sample	Mosquitoes: Number × replicates	Mosquitoes: Total	Blood meal: Surv*	Blood meal: Number	Blood meal: %	Blood engorgement ratio	*t*
d-phenothrin							
0.001%	50 × 4, 30 × 1	230	218	202	92.7	0.97	
0.002%	50 × 2	100	78	65	83.3	0.87	
0.003%	50 × 4, 30 × 2	260	147	71	48.3	0.50	2.4[a]
Check 1	50 × 4, 30 × 2	260	258	247	95.7	1.00	
F_1 of d-phenothrin							
0.001%	20 × 1	20		19	95.0	0.95	
0.003%	20 × 1	20		18	90.0	0.90	
Check 2	20 × 1	20		20	100.0	1.0	
F_2 of d-phenothrin							
0.001%	20 × 1	20		20	100.0	1.0	
0.003%	11 × 1	11		11	100.0	1.0	
Check 3	20 × 1	20		20	100.0	1.0	
d-allethrin							
0.006%	50 × 5	250	209	152	72.7	0.76	
0.01%	50 × 5	250	94	36	38.3	0.40	2.6[b]
Check 4	50 × 3	150	150	143	95.3	1.00	
F_1 of d-allethrin							
0.006%	20 × 1	20		20	100.0	1.11	
0.01%	20 × 1	20		20	100.0	1.11	
Check 5	20 × 1	20		18	90.0	1.00	
tetramethrin							
0.001%	50 × 2, 30 × 2	160	109	87	79.8	0.84	
0.002%	50 × 3, 30 × 2	210	104	56	53.8	0.57	2.4[c]
Check 6	50 × 2, 30 × 2	160	155	147	94.8	1.00	
F_1 of tetramethrin							
0.001%	20 × 1	20		20	100.0	1.00	
0.002%	20 × 1	20		20	100.0	1.00	
Check 7	20 × 1	20		20	100.0	1.00	

* Survivors.

[a] df = 12, $P<0.05$; [b] df = 8, $P<0.05$; [c] df, = 9, $P<0.05$.

creased egg production in house flies. The occurrence of increased egg production following a low dose treatment and decreased production following a high dose treatment, does not appear to have been reported previously. Insecticidal treatment generally reduced egg production rather than increasing it.

CONCLUSIONS

Blood engorgement decreased among *Ae. aegypti* survivors which had been treated with d-phenothrin, d-allethrin and tetramethrin at a high dose (ca. LC_{50}) and at a low dose ($<LC_{30}$). Egg production was decreased among mosquitoes treated with d-phenothrin and d-allethrin but not those treated with tetramethrin.

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Table 3. The effect of three pyrethroids on the egg production of *Aedes aegypti*.

Sample	Mosquitoes			Blood meal	Egg production		Egg production ratio
	Number × replicates	Total	Surv*		Total	% increase	
d-phenothrin							
0.001%	30 × 4	120	113	72	4747	65.9	1.33
0.003%	30 × 4	120	77	40	1393	34.8	0.70
Check 1	30 × 4	120	120	115	5699	49.6	1.00
F_1 of d-phenothrin							
0.001%	20 × 1	20		20	1406	70.3	0.75
0.003%	20 × 1	20		20	1100	55.0	0.58
Check 2	20 × 1	20		20	1881	94.1	1.00
F_2 of d-phenothrin							
0.001%	20 × 1	20		20	1530	76.5	0.94
0.003%	11 × 1	11		11	988	89.8	1.10
Check 3	20 × 1	20		20	1633	81.3	1.00
d-allethrin							
0.006%	50 × 2	100	60	41	1174	28.6	0.69
0.01%	50 × 2	100	40	18	340	18.9	0.45
Check 4	50 × 1	50	49	49	2041	41.7	1.00
F_1 of d-allethrin							
0.006%	20 × 1	20		20	1683	84.2	1.08
0.01%	20 × 1	20		20	1771	88.6	1.14
Check 5	20 × 1	20		20	1554	77.7	1.00
tetramethrin							
0.001%	30 × 2, 50 × 1	110	78	66	1747	26.5	0.89
0.02%	30 × 2, 50 × 1	110	55	28	883	31.5	1.06
Check 6	30 × 2, 50 × 1	110	109	103	3071	29.8	1.00

* Survivors.

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