

# RESIDUAL EFFICACY OF PERMETHRIN AGAINST ADULT RICEFIELD MOSQUITOES CONTAINED ON TREATED PANELS<sup>1</sup>

G. D. THOMPSON AND M. V. MEISCH<sup>2</sup>

**ABSTRACT.** *Anopheles quadrimaculatus* Say and *Psorophora columbiae* (Dyar and Knab) adults were exposed to various rates of permethrin residues to determine the effective dosage range as well as duration of activity. One ft<sup>2</sup> plywood panels were treated with permethrin at concentrations ranging from 0.0625 to 3.0 grams Ai/m<sup>2</sup>; a standard (malathion 1 g/m<sup>2</sup>) was also included. One set of panels was maintained in indoor (lab) conditions, and one set was exposed to all outdoor elements except rainfall. The effective indoor and outdoor

rates over the 11-week test period were ca 0.125 and 0.50 grams Ai/m<sup>2</sup> respectively for both mosquito species. *An. quadrimaculatus* appeared to be slightly more susceptible than *Ps. columbiae* to residues maintained in outdoor conditions; however, more recovery from the 1-hour knockdown occurred with lower dosages in both situations. Malathion was not as effective as permethrin against either species, especially *An. quadrimaculatus*, under outdoor conditions.

Application of residual insecticides has long been a standard procedure in many mosquito control programs and is still heavily depended upon for malaria control. However, several highly desirable compounds have been lost because of environmental harshness or the development of insecticide resistance, and the choice of compounds now available for residual mosquito control is limited in certain areas. Therefore, a need exists for compounds effective as residual insecticides. A recently developed group of synthetic pyrethroids which are highly toxic to insects and possess residual activity has been under study for possible use as residual mosquito control agents. One of the more promising of those compounds is permethrin ((3-phenoxphenyl) methyl ( $\pm$ ) *cis, trans*-3-(2,2-dichloroethenyl) - 2,2 - dimethylcyclopropane carboxylate), which was described by Elliot et al. (1973). The purpose of this study was to determine the effectiveness of permethrin residues in both indoor and outdoor conditions against adult mosquitoes.

## METHODS AND MATERIALS

Plywood panels were treated with various concentrations of permethrin at the Univ. of Ark. Rice Branch Exp. Stn., Stuttgart. One series of panels was placed outdoors in open storage sheds and exposed to all weather elements except rainfall. A similar series of panels was retained in the laboratory. The effectiveness of the various dosages at the different locations was determined by periodically exposing adult mosquitoes under half-sections of petri dishes and recording mortality.

The panels utilized were 1/4" exterior (AD) unpainted pine plywood and were 930.0 cm<sup>2</sup> (1 ft<sup>2</sup>) in size. The panels were suspended against undisturbed walls in the laboratory, or against the back wall of open storage sheds in the outdoor series. Structures which typically have 3 walls and a roof are common in the Mississippi delta region and are a favorite resting site of adult mosquitoes.

The insecticides were applied with an adjustable aerosol sprayer calibrated to deliver enough solution (9.5 ml) to thoroughly cover the entire surface without run-off. The spray solutions were prepared by adding the desired quantity of permethrin (EC 2/lb Ai/gal) to a known volume of distilled water. A total of 4

<sup>1</sup> Approved for publication, Director, Ark. Agr. Expt. Stations.

<sup>2</sup> G. D. Thompson, graduate assistant, M. V. Meisch, associate professor, Univ. of Arkansas, Fayetteville, AK 72701.

series of panels was treated. Two series, 1 indoor and 1 outdoor, were treated on May 20, 1976, at rates of 0.0625, 0.125, 0.25, 0.50, 1.0, 2.0, and 3.0 grams  $Ai/m^2$  with each dosage replicated 3 times. Two other series identical to the above were treated on July 4, 1976 at 0.0312, 0.0625, 0.125, 0.25, 0.50 and 1.0 grams  $Ai/m^2$ , and a standard (malathion 1.0 grams  $Ai/m^2$ ) was also included for comparison.

The panels were bioassayed weekly with *An. quadrimaculatus* and *Ps. columbiae* throughout the mosquito breeding season. The adults were collected from naturally-occurring populations with a hand-held battery-powered aspirator and placed in styrofoam ice chests lined with clean plastic sheets. A small amount of ice and moist paper toweling was placed in the bottom of each chest to maintain cool temperature and high humidity. The *An. quadrimaculatus* were collected from resting sites such as hollow tree holes and beneath buildings. *Ps. columbiae* were collected in the early morning hours when they were attracted to humans.

After mosquitoes were captured, the holding containers were brought into the laboratory and placed singly into an anesthetizing chamber supplied with 20 ft<sup>3</sup>/hr of  $Co_2$  to anesthetize the mosquitoes (ca 20/container). They were then gently transferred to half-sections of plastic petri dishes and covered with 10 x 15 cm index cards. The covered dishes were then placed on the panels and held in position with rubber bands. Six different positions in the central portion of the panels were utilized. Rubber bands were permanently placed in position and a different position was used for each test. Check containers with mosquitoes were handled in the same manner and exposed to untreated panels. This procedure is similar to that used by Wilson et al. 1973.

After all contained mosquitoes were in position, the index cards were removed in sequence, exposing the mosquitoes to the treated surfaces (Fig. 1). Knockdown (some individual recovery occurred) readings were taken at 0.5 and 1 hr post-exposure, and the index cards were re-

placed after the 1-hour observation. The mosquitoes were then placed in .24 liter holding containers and offered a 10% sucrose solution. Mortality readings were taken at 24 hr and the holding containers were discarded.  $LD_{90}$  values were determined by probit analysis, and the slope of the dosage-mortality curve calculated by linear regression.

## RESULTS AND DISCUSSION

At 3 weeks post-treatment all dosages in the indoor *Ps. columbiae* tests produced over 60% mortality; however, at least 0.125 gram  $Ai/m^2$  was required for 90% kill (Table 1). There was very little change in the effectiveness of the dosages throughout the 11-week test period and 0.125 gram  $Ai/m^2$  still produced 90% mortality after 11 weeks post-treatment, producing 100% mortality. Unfortunately, malathion was not incorporated in the first series of panel treatments and older residue data are lacking.

The effectiveness of permethrin on plywood panels exposed to outdoor conditions against *Ps. columbiae* is presented in Table 2. The 1-week results were similar to the results of the indoor tests, with all dosages producing 80% mortality. At 0.125 gram  $Ai/m^2$  and all higher dosages, 100% mortality occurred. However, the effectiveness of the lower dosages began

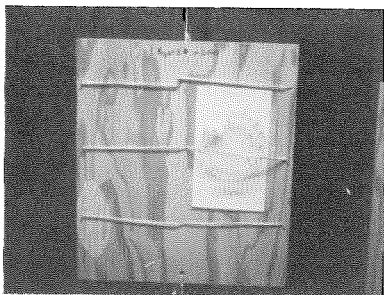


Figure 1.—Technique used to expose adult mosquitoes under petri dish to insecticide residues on plywood panels.

Table 1. Residual efficacy expressed in percent mortality of permethrin against adult *Psorophora columbiae* exposed to treated plywood panels held indoors.

Residue in g/m <sup>2</sup>	Hours post exposure	Number of weeks residue aged					
		2	4	5	7	9	11
<i>Permethrin</i>							
0.03125	1/2	0.0	0.0				
	1	17.9	10.5				
	24	60.3	25.2				
0.6250	1/2	8.8	24.7	9.4	0.0	0.0	16.0
	1	72.1	80.3	56.3	62.6	45.1	50.0
	24	71.7	85.1	26.1	55.1	64.2	86.7
0.125	1/2	67.7	93.9	37.1	23.5	36.7	18.9
	1	100.0	100.0	85.7	89.5	100.0	70.3
	24	96.0	95.5	53.0	93.1	96.2	97.0
0.250	1/2	78.6	49.0	72.2	76.5	87.6	47.1
	1	100.0	100.0	100.0	100.0	100.0	79.4
	24	100.0	95.7	88.6	95.4	93.8	100.0
0.50	1/2	75.0	88.7	83.9	59.3	71.3	37.0
	1	100.0	100.0	96.8	95.7	100.0	97.8
	24	100.0	91.6	100.0	100.0	100.0	95.2
1.0	1/2	92.7	96.4	100.0	100.0	81.4	76.5
	1	100.0	100.0	100.0	100.0	100.0	100.0
	24	100.0	100.0	100.0	100.0	100.0	100.0
2.0	1/2			100.0	100.0	100.0	100.0
	1			100.0	100.0	100.0	100.0
	24			100.0	100.0	100.0	100.0
3.0	1/2			100.0	100.0	100.0	100.0
	1			100.0	100.0	100.0	100.0
	24			100.0	100.0	100.0	100.0
<i>Malathion</i>							
1.0	1/2	35.3	36.8				
	1	93.8	97.6				
	24	100.0	100.0				

to decline as the residue age increased. At 11 weeks posttreatment 0.0625 gram Ai/m<sup>2</sup> produced only 14% mortality, and a dosage between 0.5 and 1.0 grams Ai/m<sup>2</sup> was needed to obtain over 90% mortality. Malathion at 1.0 gram Ai/m<sup>2</sup> produced only 86.8% mortality at the end of 1 month, but permethrin at the same rate maintained 100% kill throughout the 11-week test period.

The results of both *Ps. columbiae* tests are depicted in Figure 2. The compound definitely decomposed more rapidly

when exposed to outdoor conditions. The indoor LD<sub>90</sub> value remained at approximately 0.15 gram Ai/m<sup>2</sup> throughout the 11-week period. However, in the outdoor tests the LD<sub>90</sub> value increased from approximately 0.15 gram Ai/m<sup>2</sup> to 0.50 gram Ai/m<sup>2</sup>. The stability of this compound under indoor conditions was illustrated by the very small slope of 0.004, as compared to the results of the outdoor tests which gave a slope of 0.037.

In both the indoor and outdoor *Ps. columbiae* tests permethrin exhibited ex-

Table 2. Residual efficacy expressed in percent mortality of permethrin against adult *Psorophora columbiae* exposed to treated plywood panels held outdoors.

Residue in g/m <sup>2</sup>	Hours post exposure	Number of weeks residue aged						
		1	3	4	5	7	9	11
<i>Permethrin</i>								
0.03125	1/2	13.5	0.0	0.0				
	1	60.1	8.8	25.0				
	24	84.8	21.8	12.6				
0.6250	1/2	20.2	0.0	1.6	0.0	9.5	0.0	2.4
	1	66.9	6.1	26.2	3.7	70.6	12.2	17.1
	24	88.0	26.2	32.5	43.2	79.9	45.6	14.6
0.125	1/2	10.0	12.5	12.2	2.4	34.4	2.9	0.0
	1	94.8	68.8	68.3	80.5	93.6	66.8	25.0
	24	100.0	79.3	59.9	65.9	80.2	77.7	45.8
0.250	1/2	72.2	40.0	42.6	25.9	9.7	4.0	0.0
	1	100.0	80.0	91.5	51.9	90.1	36.5	25.0
	24	100.0	88.9	86.8	22.9	52.2	97.5	45.0
0.50	1/2	77.6	75.0	87.8	40.6	38.9	9.1	13.0
	1	100.0	100.0	100.0	93.8	100.0	93.0	82.6
	24	100.0	100.0	97.5	90.6	94.1	91.4	87.0
1.0	1/2	90.7	81.0	92.9	87.0	100.0	51.3	73.1
	1	100.0	100.0	100.0	100.0	100.0	100.0	100.0
	24	100.0	100.0	100.0	100.0	100.0	100.0	100.0
2.0	1/2				80.8	100.0	88.0	17.1
	1				100.0	100.0	100.0	100.0
	24				100.0	100.0	100.0	100.0
3.0	1/2				96.4	100.0	84.2	67.4
	1				100.0	100.0	100.0	100.0
	24				100.0	100.0	100.0	100.0
<i>Malathion</i>								
1.0	1/2	84.1	52.8	0.0				
	1	100.0	100.0	19.1				
	24	100.0	100.0	86.8				

## UTAH MOSQUITO ABATEMENT ASSOCIATION

Eighty-five per cent of the people in the state of Utah are now living within the boundaries of organized mosquito abatement districts.

### President

EVAN LUSTY  
Magna M.A.D.  
Box 40  
2611 So. 9085 West  
Magna, UT 84044

### President-Elect

KEITH WAGSTAFF  
So. S. L. Co. M.A.D.  
P.O. Box 367  
Midvale, UT 84047

### Sec.-Treas.

STEVEN ROMNEY  
Uintah Co. M.A.D.  
P.O. Box 983  
1336 E. Highway 40  
Vernal, UT 84078

Proceedings of Annual Meeting & Individual Membership can be obtained from Secretary.

Table 3. Residual efficacy, expressed in percent mortality, of permethrin against adult *Anopheles quadrimaculatus* exposed to treated plywood panels held indoors.

Residue in g/m <sup>2</sup>	Hours post exposure	Number of weeks residue aged				
		1	3	6	8	10
<i>Permethrin</i>						
0.3125	1/2	0.0	6.2			
	1	56.0	26.2			
	24	26.5	32.8			
0.6250	1/2	51.0	29.2	29.0	30.8	66.7
	1	92.2	76.4	87.1	88.5	92.9
	24	84.7	88.1	80.6	74.4	77.8
0.125	1/2	90.2	85.7	73.2	82.7	75.0
	1	100.0	100.0	100.0	100.0	98.1
	24	95.7	100.0	95.1	98.1	88.1
0.250	1/2	87.8	56.1	95.5	89.8	81.1
	1	98.0	100.0	100.0	100.0	97.3
	24	100.0	80.7	97.7	100.0	88.8
0.50	1/2	98.0	100.0	100.0	87.2	100.0
	1	98.0	100.0	96.8	97.9	100.0
	24	100.0	97.0	96.8	97.8	97.9
1.0	1/2	97.2	100.0	97.8	98.0	76.2
	1	100.0	100.0	100.0	100.0	100.0
	24	96.9	100.0	100.0	100.0	97.5
2.0	1/2			100.0	100.0	100.0
	1			100.0	100.0	100.0
	24			100.0	100.0	100.0
3.0	1/2			100.0	100.0	98.0
	1			100.0	100.0	100.0
	24			100.0	100.0	100.0
<i>Malathion</i>						
1.0	1/2	13.3	6.9			
	1	73.3	52.2			
	24	90.1	89.7			

## TEXAS MOSQUITO CONTROL ASSOCIATION

P.O. Box 945  
Orange, Texas 77630

Roy G. Burton—President  
Yashio Fujimoto—President Elect  
J. G. Foyle—Secretary-Treasurer

Annual Meeting Each Fall

Workshop Each Spring

Membership and Proceedings Available from Secretary-Treasurer

Table 4. Residual efficacy expressed in percent mortality of permethrin against adult *Anopheles quadrimaculatus* exposed to treated plywood panels held outdoors.

Residue in g/m <sup>2</sup>	Hours post exposure	Number of weeks residue aged				
		1	3	6	8	10
<i>Permethrin</i>						
0.03125	1/2	65.9	23.4			
	1	93.6	83.0			
	24	74.6	76.8			
0.6250	1/2	37.0	22.5	44.2	45.1	60.7
	1	88.7	72.5	93.0	93.2	79.1
	24	79.8	53.8	73.5	96.1	58.9
0.125	1/2	80.0	46.7	79.6	56.9	64.1
	1	88.4	93.3	98.1	97.7	89.0
	24	97.1	89.1	72.6	90.2	80.0
0.250	1/2	94.7	83.3	78.7	80.4	78.8
	1	100.0	100.0	97.9	100.0	90.0
	24	96.9	84.9	95.1	100.0	86.6
0.50	1/2	100.0	91.7	78.4	82.8	100.0
	1	100.0	100.0	100.0	100.0	100.0
	24	100.0	93.9	79.9	98.3	88.1
1.0	1/2	100.0	95.6	100.0	100.0	100.0
	1	100.0	100.0	100.0	100.0	100.0
	24	100.0	97.6	95.1	100.0	95.4
2.0	1/2			100.0	100.0	100.0
	1			100.0	100.0	100.0
	24			100.0	100.0	100.0
3.0	1/2			100.0	100.0	100.0
	1			100.0	100.0	100.0
	24			100.0	100.0	100.0
<i>Malathion</i>						
1.0	1/2	34.1	2.2			
	1	77.7	34.8			
	24	87.2	67.0			

### THE SOUTH COOK COUNTY MOSQUITO ABATEMENT DISTRICT

155th Street and Dixie Highway  
P.O. Box 30, Harvey, Illinois 60426

#### Board of Trustees

GEORGE J. CULLEN—*President*  
LAWRENCE P. GULOTTA—*Secretary*  
CYNTHIA L. HUMES—*Treasurer*  
CLARENCE BOBBE—*Vice President*  
FRED MASSAT—*Vice President*

The District has served South Cook County Illinois since 1954.

cellent control as a residual adulticide. The effective dosage needed varied with the testing conditions, but the rates of 0.125 gram Ai/m<sup>2</sup> indoor and 0.50 gram outdoor were sufficient for the duration

of the *Ps. columbiae* breeding season in Arkansas.

The results of the *An. quadrimaculatus* indoor tests are illustrated in Table 3. Permethrin was also highly effective against this species; however, there was more recovery from the 1 hr knockdown, especially at the lower dosage, than was shown with *Ps. columbiae*. The treatment rate of 0.125 gram Ai/m<sup>2</sup> provided effective control of this species for the 10-week test period. Malathion was not nearly as effective against *An. quadrimaculatus* as against *Ps. columbiae*. At the rates of 1.0 gram and 0.125 gram Ai/m<sup>2</sup>, malathion provided only 90.1 and 89.7% control respectively during this same period.

The outdoor *An. quadrimaculatus* results are listed in Table 4. The 1-week effective rate was also 0.125 gram Ai/m<sup>2</sup>, but at 10 weeks this had increased to about 0.25 gram Ai/m<sup>2</sup>. As in the indoor tests, there was some recovery from the 1-hr knockdown at all rates except 2.0 and 3.0 grams Ai/m<sup>2</sup>. Particular notice should be taken of the decrease in malathion's (1.0 gram Ai/m<sup>2</sup>) activity to only 67% mortality at 4 weeks post-treatment.

There was almost no decrease in activity of permethrin in the indoor tests against *An. quadrimaculatus* (Figure 2). Only a slight decrease in activity was shown in the outdoor tests. Linear regression calculations projected the slope of the indoor tests at 0.0003 and the outdoor at 0.016.

#### References Cited

- Elliot, M., A. W. Farnham, N. F. James, P. H. Needham, D. A. Pulman and J. H. Stevenson. 1973. A photo stable pyrethroid. *Nature (Lond.)* 246:169-170.
- Wilson, H. G., G. C. LaBreque and D. E. Weidhaas. 1973. Effectiveness of selected compounds as residues against anopheline adults. *Mosquito News* 33 (4):559-560.

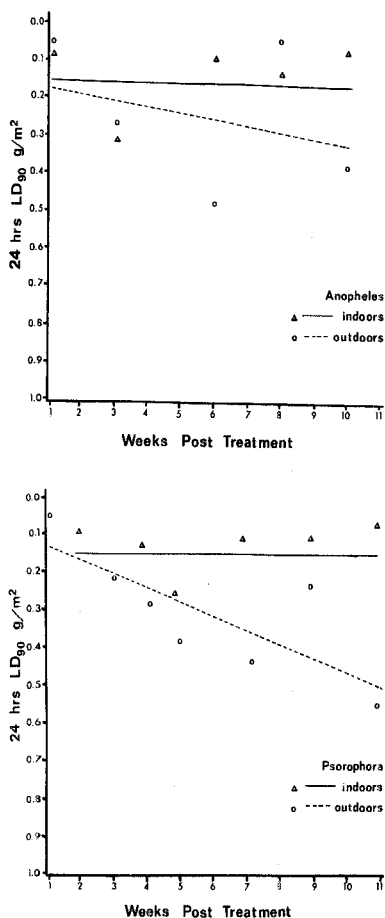


Figure 2.—The residual effectiveness of permethrin against *An. quadrimaculatus* and *Ps. columbiae* in both indoor and outdoor panel tests.