

OPERATIONAL AND SCIENTIFIC NOTES

EFFICACY OF VARIOUS GROUND-APPLIED PYRETHROIDS AGAINST ADULT *ANOPHELES QUADRIMACULATUS* IN THE RICE GROWING REGION OF ARKANSAS¹P. K. EFIRD,² A. D. INMAN,³ A. A. WEATHERSBEE III² AND M. V. MEISCH²

ABSTRACT. Ground-applied ULV, cold aerosol, insecticide sprays were evaluated against caged adult female *Anopheles quadrimaculatus*. Treatments included 2 rates each of resmethrin, permethrin and a water-based permethrin formulation. Mortality at 24 h posttreatment was not significantly ($P \geq 0.05$) different between the resmethrin and water-based permethrin treatments. Both rates of permethrin were significantly ($P < 0.05$) less effective than the other treatments.

The eastern Delta region of Arkansas is plagued annually by hordes of mosquitoes. This region of the state is largely agricultural with towns in the area surrounded by rice and soybeans (Meisch and Coombes 1976). Organized mosquito abatement districts in this area utilize truck-mounted, cold aerosol ULV sprays for the control of adult mosquitoes (Weathersbee et al. 1989).

Although some natural breeding occurs, the predominant cause of the mosquito problems in this region arise from the methods of rice culture (Coombes and Meisch 1976). The species of major interest are *Psorophora columbiae* (Dyar and Knab), a floodwater species, and *Anopheles quadrimaculatus* Say. *Psorophora columbiae* reaches peak numbers earlier than *An. quadrimaculatus* and is generally more susceptible to insecticides. The high mobility of mosquitoes often requires nightly insecticide application to control mosquitoes migrating into the city from untreated areas (Walker and Meisch 1982, Weathersbee et al. 1986). Presently, the insecticides used against mosquitoes in this area are resmethrin, malathion and permethrin. Resmethrin continues to offer excellent control of both species, while malathion no longer provides adequate control of *An. quadrimaculatus* at the maximum allowable rate (Efird et al. 1991).

The following study evaluated a new water-based permethrin formulation against 2 currently labeled standards, resmethrin and per-

methrin, for the control of adult *An. quadrimaculatus*.

Adult *An. quadrimaculatus*, primarily blooded females, were collected with handheld (Meek et al. 1985) and backpack aspirators (U.S. Department of Agriculture, Medical and Veterinary Research Laboratory, Gainesville, FL 32604) from a livestock barn near Stuttgart, AR. The mosquitoes were placed in cooled polystyrene containers and transported to a holding facility near the test site. Mosquitoes were anesthetized with carbon dioxide and transferred to cylindrical screened test cages as described by Sandoski et al. (1983). Approximately 25 mosquitoes were placed in each test cage. The caged mosquitoes were stored in polystyrene containers and transported to the test site. Mosquitoes were tested within 3 h following capture.

The test plots consisted of 3 rows of stakes placed at 15, 30, 60 and 90 m downwind and perpendicular to the spray path. Cages of mosquitoes were suspended approximately 100 cm above the ground from these stakes.

The insecticides applied were Permanone^{®4} (10% permethrin, unsynergized), Aquapermanone^{®4} (20% permethrin, 20% piperonyl butoxide) and Scourge^{®5} (18% resmethrin, 54% piperonyl butoxide). Aquapermanone was evaluated as a new alternative adulticide while Permanone and Scourge were applied as currently labeled standards. All adulticides were delivered at a high rate (H) of 3.9 g AI/ha and a low rate (L) 1.96 g AI/ha. Tests were conducted between 1900 and 2100 h on August 1-2 on nonagricultural land near the University of Arkansas Rice

¹ This study was completed as part of USDA, CSRS Southern Regional Project S-230 on Riceland Mosquitoes and is approved for publication by the Director of the Arkansas Agricultural Experiment Station.

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Research and Extension Center approximately 11.5 km east of Stuttgart, AR.

The insecticides were applied with a truck-mounted, Leco Model 1600 HD cold aerosol generator driven at 24 km/h. Calibrations of droplet size by the volume median diameter (VMD) method were conducted before each test.

Scourge and Permanone were mixed with Orchem 796[®]. Scourge was delivered at 360 ml/min with a nozzle pressure of 492 g/cm² and a droplet size of 25.9 μm VMD. Permanone was also applied at 360 ml/min with a nozzle pressure of 422 g/cm² and a droplet size was 20.6 μm VMD. Aquapermanone was delivered at a flow rate of 360 ml/min with a nozzle pressure of 404 g/cm². Droplet size of Aquapermanone could not be measured because of a lack of proper equipment for measuring water-based compounds.

Wind speed, monitored with a handheld, ball-movement anemometer, was between 2 and 8 km/h for all tests. Temperature for all tests was 28°C.

The treatment cages were positioned just prior to each test and removed 5 min after exposure. They were then immediately transported to the holding facility. Control cages were handled similarly but in a separate area near the holding facility. The mosquitoes were anesthetized with carbon dioxide within 1 h posttreatment and transferred to clean, 237 ml paper cups with screened lids. An aqueous 10% sugar solution was provided on cotton placed on top of the screened lids. Mosquitoes were observed at 1 and 24 h posttreatment to determine initial knockdown and 24 h mortality.

Data were corrected for control reduction by Abbott's formula (Abbott 1925), transformed (arcsine) and subjected to the general linear model procedure (SAS Institute 1985) to test the hypothesis that treatment means and distance means were equal. Means were separated by Duncan's multiple range test (SAS Institute 1985).

Knockdown from both rates of Permanone at 1 h posttreatment (Table 1) were significantly ($P < 0.05$) less than all other treatments. Permanone H provided slightly more knockdown than did Permanone L. The low rates of Aquapermanone and Scourge exhibited slightly better knockdown than did the respective higher rates. Scourge L had the highest knockdown of all the insecticides tested but was only significantly ($P \geq 0.05$) greater than that of Permanone H and L. Both rates of Aquapermanone exhibited good knockdown activity out to 60 m. The drop in activity at 90 m may have been due to evaporation or other physical components of the water carrier used for this formulation. Duncan's multiple range tests for means of distances indicated knockdown at 15, 30 and 60 m was significantly greater ($P \geq 0.05$) than that produced at 90 m for all treatments.

There was some recovery of treated mosquitoes from initial knockdown at 24 h posttreatment (Table 1). Mortality produced by both rates of Permanone remained significantly ($P \geq 0.05$) less than that produced by the other treatments. The low rates of Aquapermanone and Scourge had slightly higher mortality than their own higher rates. The lack of difference between

Table 1. One hour knockdown and 24 h mortality for various ULV cold aerosol adulticides applied against adult *Anopheles quadrimaculatus* at Stuttgart, AR, during the summer of 1990.

Treatment	Rate (gAI/ha)	Distance (m)				Treatment means**
		15	30	60	90	
<i>1 h knockdown</i>						
Scourge L	1.9	97.3	83.7	96.2	77.5	88.7 a
Scourge H	3.9	95.5	89.1	82.1	84.3	87.8 a
Aquapermanone L	1.9	96.9	94.3	91.7	47.3	82.6 a
Aquapermanone H	3.9	92.2	94.1	86.0	62.8	83.8 a
Permanone L	1.9	77.1	23.7	21.4	6.1	32.1 c
Permanone H	3.9	63.1	54.4	58.6	52.7	57.2 b
Distance means*		87.0 a	73.2 a	72.7 a	55.1 b	
<i>24 h mortality</i>						
Scourge L	1.9	100.0	79.9	88.8	76.1	86.2 a
Scourge H	3.9	97.8	85.9	82.8	70.5	84.3 a
Aquapermanone L	1.9	100.0	100.0	86.6	62.4	87.3 a
Aquapermanone H	3.9	97.1	94.1	95.4	58.7	86.3 a
Permanone L	1.9	73.4	41.1	34.5	13.9	40.7 c
Permanone H	3.9	75.2	52.4	58.1	42.9	57.2 b
Distance means*		90.6 a	75.6 b	74.4 b	54.1 c	

* Distances means followed by the same letter are not significantly different ($P \geq 0.05$) by Duncan's multiple range tests.

** Treatments means followed by the same letter are not significantly different ($P \geq 0.05$) by Duncan's multiple range tests.

knockdown data and mortality data seems to indicate that there was not sufficient difference between the applied rates to show separation. Both rates of Aquapermanone performed slightly better than either rate of Scourge. Recovery of mosquitoes from the Aquapermanone treatment was not as high as that seen in the Scourge treatment. Duncan's multiple range tests for means of distances indicated mortality at 15 m was significantly greater than that of all other distances, and mortality at 30 and 60 m significantly greater than that at 90 m. Aquapermanone shows promise as a new adulticide against mosquitoes. Performance in this test indicated it was comparable to Scourge when applied against *An. quadrimaculatus*.

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