

EFFICACY OF DIBROM®, TRUMPET®, AND SCOURGE® AGAINST FOUR MOSQUITO SPECIES IN LOUISIANA

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ABSTRACT. Adult mortality of *Anopheles quadrimaculatus*, *Culex quinquefasciatus*, and the *Aedes* spp. complex (*Aedes sollicitans* and *Aedes taeniorhynchus*) was observed after aerial ultra-low volume (ULV) exposure to Dibrom®, Trumpet®, and Scourge®. Dibrom was applied at 112 g active ingredient (AI)/ha, Trumpet at 112 g AI/ha, and Scourge at 1.96 g AI/ha. At all time intervals, Dibrom and Trumpet were significantly more effective against the *Aedes* spp. complex than against *An. quadrimaculatus* and *Cx. quinquefasciatus*. Scourge was significantly more effective against *An. quadrimaculatus* and *Cx. quinquefasciatus* than Dibrom or Trumpet. Trumpet was evaluated at lower labeled rates (28, 56, and 84 g AI/ha) against *Cx. quinquefasciatus* and the *Aedes* spp. complex. Adult mortality with Trumpet increased significantly at 1 and 24 h against *Cx. quinquefasciatus*. With the *Aedes* spp. complex, mortality increased with rate at 1 h, but at 12 and 24 h, the medium and high dosages were not significantly different from each other. *Culex quinquefasciatus* and the *Aedes* spp. complex were also subjected to ULV ground applications of Dibrom, Trumpet, and Scourge. Dibrom was applied at 22.4 g AI/ha, Trumpet at 22.4 g AI/ha, and Scourge as a 1:6 mineral oil mixture at 1.96 g AI/ha. Relative to Dibrom and Trumpet, mortality from Scourge differed greatly with mosquito species. Against *Cx. quinquefasciatus*, Scourge was significantly more effective than Dibrom and Trumpet at all times and distances, but against the *Aedes* spp. complex Scourge was significantly less effective.

KEY WORDS Adulthoodicide, Dibrom®, Trumpet®, Scourge®, *Anopheles quadrimaculatus*, *Culex quinquefasciatus*, *Aedes sollicitans*, *Aedes taeniorhynchus*

INTRODUCTION

Pest mosquito management programs rely on economical and effective means for the control of adult mosquito populations. The use of aerial and ground ultra-low volume (ULV) adulticide applications of organophosphate and synthetic pyrethroid insecticides is an important component of these management programs. Because organophosphates and synthetic pyrethroids have long been used in abatement programs to control adult mosquitoes, studies are continually necessary to evaluate effectiveness of control and to monitor potential development of insecticide resistance in mosquito species (Meek and Meisch 1997). The frequent use of the few available materials that perform adequately as mosquito adulticides demands a search for new alternative control methods (Weathersbee et al. 1991). In an effort to reduce insecticide resistance, alternative insecticides must be placed in a rotational scheme to reduce the selective pressure placed on mosquito populations by the few available compounds (Efird et al. 1991).

A study was conducted in the summer of 1997 to compare 2 formulations of naled (Trumpet® and Dibrom®) and 1 formulation of resmethrin (Scourge®) in aerial and ground trials against *Anopheles quadrimaculatus* Say, *Culex quinquefasciatus* Say, and the *Aedes* spp. complex (i.e., *Aedes sollicitans* (Walker) and *Aedes taeniorhynchus* (Wiedemann)). An aerial trial also was conducted

to evaluate Trumpet at 3 lower labeled rates against *Cx. quinquefasciatus* and the *Aedes* spp. complex.

MATERIALS AND METHODS

Three adulticide tests were conducted on the evenings of July 14, 15, and 16, 1997, at Calcasieu Parish Mosquito Control District in Lake Charles, LA. Adult *Cx. quinquefasciatus* were collected along septic ditches in East Baton Rouge Parish 24 h before treatment for all tests and adult *An. quadrimaculatus* were collected in Vermillion Parish with battery-powered, handheld aspirators described by Meek et al. (1985) and battery-powered, backpack aspirators equipped with screened collection cups as developed by the U.S. Department of Agriculture at the Medical and Veterinary Entomology Research Laboratory in Gainesville, FL. *Aedes* spp. complex (*Ae. sollicitans* and *Ae. taeniorhynchus*) were collected as 4th instars from St. Bernard Parish before the test and allowed to emerge into adults. The *Aedes* spp. adults used in the test were approximately 3 days old for each test. The ratio of *Ae. sollicitans* to *Ae. taeniorhynchus* was approximately 50:50.

Mosquito adults of all species were anesthetized with CO₂ in the laboratory, and approximately 20 mosquitoes per each genus were transferred to separate 10.2 × 25.4-cm cylindrical screened cages (as described by Weathersbee et al. 1991). The cages were held at room temperature until testing time.

Each evening before the aerial or ground adulticide applications, screened cages of each mosquito species (ca. 20 mosquitoes/cage) used as the untreated mosquitoes (controls) were placed on 9 1.5-m-high stakes (i.e., 3 × 3 pattern with stakes separated by 30.5 m) within each of 3 test plots for

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Table 1. Mean percentage mortalities for Dibrom[®], Trumpet[®], and Scourge[®] applied as an aerial application treatment against the *Aedes* spp. complex (salt-marsh mosquitoes)¹, *Anopheles quadrimaculatus*, and *Culex quinquefasciatus* adults in Lake Charles, LA, in 1997.

Time posttreatment (h)	Formulation/rate (g AI/ha)	Percent mortality ^{2,3}		
		<i>Aedes</i> ¹	<i>Anopheles</i>	<i>Culex</i>
1	Dibrom (112)	99.8aA	64.0bB	56.1bB
1	Trumpet (112)	99.5aA	56.2bB	55.4bB
1	Scourge (1.96)	99.4aA	99.6aA	97.7aA
12	Dibrom (112)	99.7aA	69.7bB	65.6bB
12	Trumpet (112)	100aA	66.7bB	68.9bB
12	Scourge (1.96)	100aA	100aA	98.9aA
24	Dibrom (112)	99.7aA	73.4bB	68.0bB
24	Trumpet (112)	100aA	69.2bB	70.9bB
24	Scourge (1.96)	100aA	100aA	98.8aA

¹ *Aedes sollicitans* and *Aedes taeniorhynchus* complex.

² Means for each time period followed by a different letter within rows (lowercase) and columns (uppercase) are significantly different ($P \leq 0.05$) for species and formulation/rate, respectively.

³ Untreated controls did not exceed 3.0%.

10 min, removed, and transported to the laboratory. The untreated mosquitoes were anesthetized again with CO₂ and transferred to clean 237-ml unwaxed paper cups with screened lids (=half-pint ice cream containers). Each screened lid was supplied with a cotton pad of 10% sucrose solution for adult sustenance.

Aerial test 1: Three identical test plots consisting of 3 rows of 3 1.5-m-high stakes (i.e., 3 × 3 pattern) were arranged in a flat grassy field on the evening of July 14. Rows were separated from one another by 30.5 m. Slide rotators (Hock Equipment Co., Gainesville, FL) were used to monitor the spray cloud in each adulticide test. Rotators equipped with Teflon[®]-coated slides were placed on each of the 3 stakes in the center row of each plot to collect droplets. The rotators were started immediately before spraying and were allowed to spin for approximately 10 min after application. Before the adulticide applications, 1 cage of each mosquito species (*Cx. quinquefasciatus*, *An. quadrimaculatus*, and *Aedes* complex) was suspended from each stake. Aerial ULV applications of 1 of 3 chemicals (Dibrom, Trumpet, or Scourge) were applied using a single-engine Cessna Ag Wagon plane equipped with an Obendorfer 24-V motor, a brass-gear pump (Cessna Aircraft Co., Wichita, KS), and 6 80015 tee-jet[®] nozzles (Spraying Systems, St. Louis, MO). Three swaths were made, 1 test with 1 pass directly over the plot and the subsequent passes 15.0 m upwind. Altitude was 33 m, air speed 177 kph, and windspeed > 3.2 kph. Dibrom was applied at a rate of 112 g AI/ha, Trumpet at 112 g AI/ha, and Scourge at 1.96 g AI/ha. Each of the 3 plots was treated individually with each insecticide, that is, replicated 3 times. Droplet sizes (mass median diameters [MMDs]) for compounds tested averaged 30.1, 37.1, and 43.6 μm for Dibrom, Trumpet, and Scourge, respectively, for all replications.

Aerial test 2: Trumpet was administered as de-

scribed above at 28 g AI/ha, 56 g AI/ha, and 84 g AI/ha. Each treatment was replicated 3 times as described above. Three test plots consisting of 3 rows of 3 1.5-m-high stakes (i.e., 3 × 3 pattern) were arranged in a flat grassy field on the evening of July 15. Rows were separated from one another by 30.5 m. Before the adulticide applications, 1 cage of each mosquito species (*Cx. quinquefasciatus* and *Aedes* spp. complex) was suspended from each stake. Aerial ULV applications of 3 dosages of Trumpet were applied as described above. Droplet sizes (MMDs) for Trumpet dosages tested averaged 51.2, 47.3, and 40.5 μm for 28 g AI/ha, 56 g AI/ha, and 84 g AI/ha, respectively, for all replications.

Ground test: Three test plots consisting of 3 rows of 3 1.5-m stakes (i.e., 3 × 3 pattern as described previously) were arranged in a flat grassy field on the evening of July 16. Rows were situated perpendicular to and downwind of the spray route and separated from one another by 30.5 m. Stakes within each row were set at 30.5, 61.0, and 91.4 m, respectively, downwind from the spray route. Before the adulticide applications, 1 cage of each species of mosquitoes (*Cx. quinquefasciatus* and *Aedes* spp. complex) was suspended from each stake approximately 1.5 m from the ground. Ground ULV applications of 3 chemicals (Dibrom, Trumpet, and Scourge) were applied using 3 separate cold foggers. Two of the cold fogger trucks were equipped with identical Leco HD ULV sprayers (Lowndes Engineering, Valdosta, GA), and 1 Londonaire 1820 sprayer (London Fog, Long Lake, MN) was used. Dibrom was administered at 22.4 g AI/ha with the Londonaire sprayer, Trumpet at 22.4 g AI/ha with the Leco sprayer, and Scourge as a 1:6 mineral oil mixture at 177.6 ml/min using a Leco sprayer. Each treatment was replicated 3 times, and ca. 25 min lapsed between applications.

Ten minutes after each insecticide treatment, the cages of mosquitoes were collected from the plot

Table 2. Mean percentage mortalities for 3 dosages of Trumpet® applied as an aerial application treatment against the *Aedes* spp. complex (salt-marsh mosquitoes)¹ and *Culex quinquefasciatus* adults in Lake Charles, LA, in 1997.

Time posttreatment (h)	Rate (g AI/ha)	Percent mortality ^{2,3}	
		<i>Aedes</i>	<i>Culex</i>
1	Low (28)	64.8aC	17.1bC
1	Medium (56)	98.9aA	57.0bA
1	High (84)	89.0aB	43.0bB
12	Low (28)	85.7aB	24.6bC
12	Medium (56)	100aA	69.0bA
12	High (84)	98.5aA	51.4bB
24	Low (28)	89.5aB	27.0bC
24	Medium (56)	100aA	72.6bA
24	High (84)	98.8aA	56.7bB

¹ *Aedes sollicitans* and *Aedes taeniorhynchus* complex.

² Means for each time period followed by a different letter within rows (lowercase) and columns (uppercase) are significantly different ($P \leq 0.05$) for species and dosage, respectively.

³ Untreated controls did not exceed 3.0%.

and transported to the laboratory. The treated mosquitoes were anesthetized with CO₂ and transferred to clean 237-ml paper cups with screened lids. Each screened lid was supplied with a cotton pad of 10% sucrose solution. Posttreatment mortality for untreated and treated adults was observed at 1, 12, and 24 h. Percent mortality data were subjected to a subsequent analysis of variance (GLM) and mean separation was determined using least squared difference (SAS Institute 1985).

RESULTS AND DISCUSSION

Aerial test 1

Against the *Aedes* spp. complex, mortality was higher than 99% at 1, 12, and 24 h, and did not

significantly differ with formulation (Table 1). At all time intervals, Dibrom and Trumpet were significantly more effective against the *Aedes* spp. complex than against *An. quadrimaculatus* and *Cx. quinquefasciatus*. No significant difference was found between Dibrom and Trumpet. Scourge caused greater than 97% mortality against all 3 species, and mortality did not differ significantly with species. Scourge also was significantly more effective against *An. quadrimaculatus* and *Cx. quinquefasciatus* than Dibrom and Trumpet. Mortality between *An. quadrimaculatus* and *Cx. quinquefasciatus* was not significantly different (Table 1).

Aerial test 2

Adult mortality increased significantly at 1 and 24 h with Trumpet at the medium rate against *Cx. quinquefasciatus* (Table 2). With the *Aedes* spp. complex, mortality increased with Trumpet at the medium rate at 1 h, but at 12 and 24 h, the medium and high rates were not significantly different from each other. Mortality of *Aedes* was significantly greater than that of *Cx. quinquefasciatus* at all 3 Trumpet rates and time intervals. The medium dosage of Trumpet was significantly more effective than the high dosage at 1 h posttreatment against the *Aedes* spp. complex and at all time intervals against *Cx. quinquefasciatus* (Table 2).

Ground test

No interspecies comparison is given in Table 3. However, the Dibrom and Trumpet numbers exhibit a greater difference between species than does Scourge. Against *Cx. quinquefasciatus*, Scourge was significantly more effective than Dibrom and Trumpet at all times and distances, but against the

Table 3. Mean percentage mortalities for Dibrom®, Trumpet®, and Scourge® applied as an ultra-low volume ground-application treatment against the *Aedes* spp. complex (salt-marsh mosquitoes)¹ and *Culex quinquefasciatus* adults in Lake Charles, LA, in 1997.

Time posttreatment (h)	Formulation/rate (g AI/ha at 10 mph)	Mean percentage mortality ^{2,3}					
		<i>Aedes</i> (distance downwind, m)			<i>Culex</i> (distance downwind, m)		
		30.5	60.9	91.4	30.5	60.9	91.4
1	Dibrom (22.4)	85.7aA	91.2aA	78.8bA	12.0aB	16.9aB	12.6aB
1	Trumpet (22.4)	100aA	100aA	87.5aA	14.8aB	8.7aB	6.8aB
1	Scourge (1.96)	69.9aB	60.7aB	48.8aB	89.2aA	78.1aA	75.4aA
12	Dibrom (22.4)	98.9aA	96.8aA	92.2aA	16.1aB	22.4aB	17.2aB
12	Trumpet (22.4)	100aA	99.5aA	98.8aA	17.6aB	14.2aB	9.5aB
12	Scourge (1.96)	76.0aB	67.9aB	60.5aB	82.5aA	71.0abA	56.0bA
24	Dibrom (22.4)	98.9aA	96.8aA	92.7aA	17.7aB	26.0aB	18.4aB
24	Trumpet (22.4)	100aA	98.4aA	99.2aA	21.1aB	14.9aB	10.8aB
24	Scourge (1.96)	75.3aB	63.9aB	56.1aB	78.5aA	66.2abA	51.7bA

¹ *Aedes sollicitans* and *Aedes taeniorhynchus* complex.

² Means within each time and species followed by a different letter within rows (lowercase) and columns (uppercase) are significantly different ($P \leq 0.05$) for distance and formulation/rate, respectively.

³ Untreated controls did not exceed 4.0%.

Aedes spp. complex, it was significantly less effective (Table 3). No significant difference was found between Dibrom and Trumpet against either species at any time or distance. Scourge resulted in a high level of mortality against both species at 30 m downwind, with mortality across species and times ranging from 69.9 to 89.2%. Mortality with Dibrom and Trumpet was quite high (>85%) at 30 m downwind against *Aedes* spp. complex, but was low (<22%) against *Cx. quinquefasciatus*. It was noted that some recovery occurred with *Cx. quinquefasciatus* 24 h after treatment with Scourge.

In summary, Trumpet and Dibrom gave comparable control of the 3 mosquito species in both the aerial and ground tests. The 3 lower labeled rates of Trumpet were efficacious against the *Aedes* spp. complex after aerial application. Trumpet and Dibrom were more efficacious than Scourge against the *Aedes* spp. complex in the ground test. However, Scourge was more efficacious against *An. quadrimaculatus* in the aerial test and against *Cx.*

quinquefasciatus in both the aerial and ground applications.

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