# COMPARISON OF THE SYNTHETIC PYRETHROIDS ESBIOTHRIN® AND BIORESMETHRIN® WITH SCOURGE® AND CYTHION® AGAINST ADULT MOSQUITOES IN A LABORATORY WIND TUNNEL

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ABSTRACT. Both candidate adulticides, Esbiothrin® and Bioresmethrin®, exhibited quick knockdown 1-h posttreatment. Esbiothrin elicited the fastest knockdown, but Bioresmethrin was more effective at both 1- and 24-h posttreatment than either Esbiothrin or Scourge® against both *Aedes taeniorhynchus* and *Culex quinquefasciatus*. Mosquitoes treated with Scourge required more time and a higher dosage to respond in a physiological manner similar to those treated with either of the candidate adulticides. More than twice the dosage rate of Cythion® was required than either candidate adulticide to cause a similar physiological response in treated mosquitoes.

## INTRODUCTION

Synthetic pyrethroid adulticides exhibit highly selective insecticidal activity, rapid knockdown and low mammalian toxicity, and are promising environmentally acceptable mosquito adulticides. Esbiothrin®, one of the allethrin series of synthetic pyrethroids, exhibited quick knockdown against many flying insects including mosquitoes (Anonymous). Bioresmethrin® combined rapid knockdown and high potency with very low mammalian toxicity (Elliott et al. 1978). Carter (1989) found Bioresmethrin effective as a thermal fog or ULV spray in controlling mosquitoes.

The John A. Mulrennan, Sr. Research Laboratory (JAMSRL) conducts laboratory wind tunnel tests to screen promising new mosquito adulticides for use in the state of Florida. We compared the effectiveness of 2 synthetic pyrethroid candidate mosquito adulticides (2% Esbiothrin and 2% Bioresmethrin) against susceptible, laboratory reared adult *Aedes taeniorhynchus* (Wied.) and *Culex quinquefasciatus* Say.

## MATERIALS AND METHODS

Two candidate adulticides, 2% Esbiothrin (L280-103-1) and 2% Bioresmethrin (L280-103-2) were compared with 2 commercially available adulticides Scourge® (18% resmethrin/54% piperonyl butoxide (PB)) and Cythion® (91% malathion) in a laboratory wind tunnel against *Ae. taeniorhynchus* and *Cx. quinquefasciatus* adults. Zoecon Corporation, Dallas, TX, provided the 2 candidate adulticides.

A laboratory wind tunnel chamber adapted for ULV aerosols was used for testing (Rathburn 1969, Rathburn et al. 1982) a wide range of dilutions (5–8) of each formulation against each mosquito species to determine the $LC_{50}$ and $LC_{90}$ values at 1- and 24-h posttreatment. The stock and serial dilutions were prepared the day of the test with reagent grade acetone (ACS). Treatment consisted of exposing 2 cages of 25 ♀ mosquitoes of each species to 0.5 ml of each dilution for 10 seconds. The treatment regime started with the control cages (treated with acetone only) followed by the lowest dilution and progressed to the highest dilution last. Between each serial dilution, a "blank" of the next higher dilution was sprayed through the chamber prior to actual treatment of the mosquitoes. This procedure prevented dilution of the next treatment by the previous lower concentration.

Twenty minutes after treatment, the caged mosquitoes were anesthetized with $CO_2$ and transferred to clean cylindrical cardboard holding cages (Floore 1985). This procedure was replicated once each week for 4 weeks to compensate for slight variations in the testing conditions. The temperatures ranged from 23 to 26°C (mean = 24°C) during the 4 weeks and the relative humidity was 60–75% (mean = 67.5%).

The term "knockdown" describes the mosquitoes' condition approximately 1 h after exposure to distinguish between reversible paralysis and death. Some recovery of mosquito activity was expected 24-h posttreatment (Beard 1960). Mortality counts were made 24 h after treatment. Abbott's formula (Abbott 1925) was used to correct control mortality, and the $LC_{50}$, $LC_{90}$, corresponding 95% confidence limits and standard error were determined by an EPA probit analysis program. The toxicity ratio (TR) for $LC_{50}$ and $LC_{90}$ was found by using the formula:

Toxicity ratio ($TR_x$)

$$= \frac{LC_{50} \text{ or } LC_{90} \text{ standard insecticide}}{LC_{50} \text{ or } LC_{90} \text{ candidate insecticide}}\text{'}$$

If the toxicity ratio was less than 1, the standard insecticide was more effective than the candidate. If the TR was more than 1, the candidate insecticide was more effective than the standard.

The wire-screened cages used in the tests were decontaminated by washing in 2 acetone baths and baked in a laboratory oven at 146°C for 12–15 h and reused. The cardboard holding containers and organdy screens were discarded.

## RESULTS AND DISCUSSION

At both 1- and 24-h posttreatment, Bioresmethrin was more effective than Esbiothrin against *Ae. taeniorhynchus* (Table 1). At 1-h posttreatment against *Ae. taeniorhynchus*, Bioresmethrin was 1.9× more effective than Scourge and 1.4× more effective than Esbiothrin at the $LC_{50}$ level (Tables 1 and 2). Bioresmethrin was more effective than Esbiothrin or Scourge against *Ae. taeniorhynchus* 24-h posttreatment.

Against *Cx. quinquefasciatus* at the $LC_{50}$ level, Bioresmethrin and Scourge were similar in effectiveness at 1-h posttreatment and both were better than Esbiothrin. At the $LC_{90}$ level, Bioresmethrin was 1.2× more effective than Scourge and 1.5× better than Esbiothrin 1-h posttreatment (Table 2). Bioresmethrin was more effective 24-h posttreatment than either Esbiothrin or Scourge. At 24-h posttreatment both candidate adulticides were more effective against *Ae. taeniorhynchus* than *Cx. quinquefasciatus.*

At 1- and 24-h posttreatment both candidate adulticides were more effective than Cythion against both mosquito species. At 1-h posttreatment, Bioresmethrin was 226× more effective than Cythion at the $LC_{90}$ level against *Ae. taeniorhynchus* and 678× more effective than Cythion against *Cx. quinquefasciatus* (Table 2). Against *Ae. taeniorhynchus* at the $LC_{90}$ level 24-h posttreatment, Bioresmethrin was 5× more effective than Cythion and against *Cx. quinquefasciatus* was 6× more effective than Cythion.

Both Esbiothrin and Bioresmethrin caused rapid paralysis (knockdown), loss of legs and erratic flight in both test mosquitoes. Scourge produced these same physiological properties, but at a slower rate than the candidate adulticides. Bioresmethrin was similar to Scourge in its insecticidal activity, but required less insecticide to cause the same response. These physiological events occurred quicker in mosquitoes treated with higher dosages of Esbiothrin than either Bioresmethrin or Scourge. However, some recovery did occur with all the adulticides, especially with *Cx. quinquefasciatus* at lower dosages. Cythion had little knockdown effect on test mosquitoes even at higher dosages.

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Table 1. Laboratory adulticide tests of 2% Esbiothrin and 2% Bioresmethrin compared with Scourge and Cythion in wind tunnel tests against *Aedes taeniorhynchus* and *Culex quinquefasciatus.*

| Insecticide | Hours post-treatment | Lethal concentration in mg AI/ml $LC_{50}$ | 95% CL | $LC_{90}$ | 95% CL |
|---|---|---|---|---|---|
| | | | *Aedes taeniorhynchus* | | |
| 2% Esbiothrin | 1 | 0.0104 | 0.0074–0.0131 | 0.0276 | 0.0212–0.0447 |
| 2% Bioresmethrin | 1 | 0.0075 | 0.0057–0.0092 | 0.0262 | 0.0196–0.0418 |
| Scourge | 1 | 0.0143 | 0.0105–0.0190 | 0.0624 | 0.0417–0.1261 |
| Cythion | 1 | 0.9494 | 0.6535–1.6949 | 5.9359 | 2.8106–31.1403 |
| 2% Esbiothrin | 24 | 0.0818 | 0.0692–0.0964 | 0.1682 | 0.1312–0.2958 |
| 2% Bioresmethrin | 24 | 0.0318 | 0.0300–0.0338 | 0.0805 | 0.0734–0.0896 |
| Scourge | 24 | 0.0616 | 0.0585–0.0647 | 0.1335 | 0.1239–0.1460 |
| Cythion | 24 | 0.1720 | 0.1631–0.1813 | 0.4068 | 0.3686–0.4586 |
| | | | *Culex quinquefasciatus* | | |
| 2% Esbiothrin | 1 | 0.0077 | 0.0048–0.0101 | 0.0235 | 0.0178–0.0385 |
| 2% Bioresmethrin | 1 | 0.0054 | 0.0027–0.0078 | 0.0161 | 0.0108–0.0397 |
| Scourge | 1 | 0.0053 | 0.0029–0.0075 | 0.0200 | 0.0145–0.0354 |
| Cythion | 1 | 2.3794 | 2.1342–2.6998 | 10.9238 | 8.5148–15.0025 |
| 2% Esbiothrin | 24 | 0.0955 | 0.0657–0.1219 | 0.1828 | 0.1385–0.4360 |
| 2% Bioresmethrin | 24 | 0.0443 | 0.0190–0.0467 | 0.1013 | 0.0937–0.1110 |
| Scourge | 24 | 0.0640 | 0.0604–0.0679 | 0.1648 | 0.1480–0.1878 |
| Cythion | 24 | 0.2725 | 0.2574–0.2882 | 0.6464 | 0.5821–0.7358 |

Table 2. Standard error (SE) and toxicity ratio[1] data for 2% Esbiothrin and 2% Bioresmethrin compared to Scourge and Cythion in wind tunnel tests against *Aedes taeniorhynchus* and *Culex quinquefasciatus*.

| | | | Toxicity ratio | | | |
|---|---|---|---|---|---|---|
| | | | $LC_{50}$ | | $LC_{90}$ | |
| Insecticide | Hours post-treatment | SE | Scourge | Cythion | Scourge | Cythion |
| | | | *Aedes taeniorhynchus* | | | |
| 2% Esbiothrin | 1 | 0.3591 | 1.38 | 91.29 | 2.26 | 60.82 |
| 2% Bioresmethrin | 1 | 0.2112 | 1.91 | 126.59 | 2.38 | 226.56 |
| 2% Esbiothrin | 24 | 0.5484 | 0.75 | 2.10 | 0.79 | 2.42 |
| 2% Bioresmethrin | 24 | 0.1455 | 1.94 | 5.41 | 1.66 | 5.05 |
| | | | *Culex quinquefasciatus* | | | |
| 2% Esbiothrin | 1 | 0.3310 | 0.69 | 309.01 | 0.85 | 464.84 |
| 2% Bioresmethrin | 1 | 0.4401 | 0.98 | 440.63 | 1.24 | 678.50 |
| 2% Esbiothrin | 24 | 0.8535 | 0.67 | 2.85 | 0.90 | 3.54 |
| 2% Bioresmethrin | 24 | 0.1802 | 1.44 | 6.15 | 1.63 | 6.38 |

[1] Toxicity ratio (TR) = $\frac{LC_{50} \text{ or } LC_{90} \text{ standard insecticide}}{LC_{50} \text{ or } LC_{90} \text{ candidate insecticide}}$,
if TR <1 than standard insecticide more effective;
if TR >1 than candidate insecticide more effective.

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