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

T. G. FLOORE, C. B. RATHBURN, JR., A. H. BOIKE, JR., J. S. COUGHLIN AND M. J. GREER

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 (Elliot 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/14% peronyl butoxide (PB)) and Cythion® (91% malathion) in a laboratory wind tunnel against Ae. taeniorhynchus and Cx. quinquefasciatus adults. Zoecn 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 LC50 and LC90 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 2 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 CO2 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 LC50, LC90, corresponding 95% confidence limits and standard error were determined by an EPA probit analysis program. The toxicity ratio (TR) for LC50 and LC90 was found by using the formula:

Toxicity ratio (TR) = \[
\frac{\text{LC}_{50} \text{ or } \text{LC}_{90} \text{ candidate insecticide}}{\text{LC}_{50} \text{ or } \text{LC}_{90} \text{ standard insecticide}}
\]

If the toxicity ratio was less than 1, the standard insecticide was more effective than the can-
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 Ebsiothrin 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 Ebsiothrin at the LC₉₀ level (Tables 1 and 2). Bioresmethrin was more effective than Ebsiothrin or Scourge against Ae. taeniorhynchus 24-h posttreatment.

Against Cx. quinquefasciatus at the LC₉₀ level, Bioresmethrin and Scourge were similar in effectiveness at 1-h posttreatment and both were better than Ebsiothrin. At the LC₉₀ level, Bioresmethrin was 1.2× more effective than Scourge and 1.5× better than Ebsiothrin 1-h posttreatment (Table 2). Bioresmethrin was more effective 24-h posttreatment than either Ebsiothrin 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 LC₉₀ level against Ae. taeniorhynchus and 678× more effective than Cythion against Cx. quinquefasciatus (Table 2). Against Ae. taeniorhynchus at the LC₉₀ level 24-h posttreatment, Bioresmethrin was 5× more effective than Cythion and against Cx. quinquefasciatus was 6× more effective than Cythion.

Both Ebsiothrin 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 Ebsiothrin 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.

ACKNOWLEDGMENTS

This study was funded by Zoecon Corporation, Dallas, Texas. We thank K. R. Shaffer for assistance during the study and J. Smith, Entomology Services, State Department of Health and Rehabilitative Services, Jacksonville, FL, for his comments and constructive review of the manuscript.

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

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Hours post-treatment</th>
<th>Lethal concentration in mg AI/ml</th>
<th>Aedes taeniorhynchus</th>
<th>Culex quinquefasciatus</th>
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<tr>
<td></td>
<td></td>
<td>LC₉₀ 95% CL</td>
<td>LC₉₀ 95% CL</td>
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</table>
| 2% Ebsiothrin     | 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% Ebsiothrin     | 24                   | 0.0818 (0.0692–0.0964)            | 0.1682 (0.1312–0.2958)
| 2% Bioresmethrin  | 24                   | 0.0318 (0.0210–0.0358)            | 0.0805 (0.0734–0.0986)
| 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)

2% Ebsiothrin     | 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                    | 0.0063 (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% Ebsiothrin     | 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 data for 2% Esbiothrin and 2% Bioresmethrin compared to Scourge and Cythion in wind tunnel tests against *Aedes taeniorhynchus* and *Culex quinquefasciatus*.

<table>
<thead>
<tr>
<th>Insecticide</th>
<th>Hours post-treatment</th>
<th>SE</th>
<th>LC$_{50}$ Scourge</th>
<th>LC$_{50}$ Cythion</th>
<th>Scourge</th>
<th>Cythion</th>
<th>LC$_{50}$ Scourge</th>
<th>LC$_{50}$ Cythion</th>
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<tr>
<td>2% Esbiothrin</td>
<td>1</td>
<td>0.3591</td>
<td>1.38</td>
<td>91.29</td>
<td>2.26</td>
<td>60.82</td>
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<tr>
<td>2% Bioresmethrin</td>
<td>1</td>
<td>0.2112</td>
<td>1.91</td>
<td>126.59</td>
<td>2.38</td>
<td>226.56</td>
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<td>2% Esbiothrin</td>
<td>24</td>
<td>0.5484</td>
<td>0.75</td>
<td>2.10</td>
<td>0.79</td>
<td>2.42</td>
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<tr>
<td>2% Bioresmethrin</td>
<td>24</td>
<td>0.1455</td>
<td>1.94</td>
<td>5.41</td>
<td>1.66</td>
<td>5.05</td>
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<tr>
<td>2% Esbiothrin</td>
<td>1</td>
<td>0.3310</td>
<td>0.69</td>
<td>309.01</td>
<td>0.85</td>
<td>464.84</td>
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<tr>
<td>2% Bioresmethrin</td>
<td>1</td>
<td>0.4401</td>
<td>0.98</td>
<td>440.63</td>
<td>1.24</td>
<td>678.50</td>
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<tr>
<td>2% Esbiothrin</td>
<td>24</td>
<td>0.853E</td>
<td>0.67</td>
<td>2.85</td>
<td>0.90</td>
<td>3.54</td>
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<td>2% Bioresmethrin</td>
<td>24</td>
<td>0.1802</td>
<td>1.44</td>
<td>6.15</td>
<td>1.63</td>
<td>6.38</td>
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Toxicity ratio (TR) = $\frac{\text{LC}_{50} \text{ or } \text{LC}_{90} \text{ candidate insecticide}}{\text{LC}_{50} \text{ or } \text{LC}_{90} \text{ standard insecticide}}$

if TR $<$ 1 than standard insecticide more effective;
if TR $>$ 1 than candidate insecticide more effective.

**REFERENCES CITED**


Floore, T. G. 1985. Laboratory wind tunnel tests of nine insecticides against adult *Culicoides* species (Diptera: Ceratopogonidae). Fla. Entomol. 68:678-682.
