WIND TUNNEL TESTS WITH SEVEN INSECTICIDES AGAINST ADULT *CULICOIDES MISSISSIPPIENSIS* HOFFMAN[1, 2, 3]

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ABSTRACT. The effectiveness of 7 insecticides, which included 4 synthetic pyrethroids (NRDC-161[4], permethrin, resmethrin and *d*-phenothrin) and 3 organophosphorous (OP) compounds (fenthion, malathion and naled), was tested against field-collected adult female *Culicoides mississippiensis* in a laboratory wind tunnel. Knockdown (1 hr posttreatment mortality) and 24-hr mortalities were determined for each compound to indicate relative effectiveness. The pyrethroids were more effective than the OP compounds tested. NRDC-161 was the most effective pyrethroid, followed by permethrin, resmethrin and *d*-phenothrin. Of the OP compounds, naled was slightly more effective than malathion, and fenthion was the least effective.

Some *Culicoides* spp. (biting midges) are extremely annoying pests in coastal areas. However, very little research effort has been directed toward control of these insects with adulticide applications. This is partially due to difficulties of conducting definitive research with an insect of such small size.

We feel that compounds already proven effective for ULV applications against mosquitoes will also give effective temporary local reductions of biting midges. This was indicated by Giglioli et al. (1980) in aerial application tests with fenitrothion against adult biting midges in Grand Cayman, West Indies. Presently, there is a need for data on the relative effect of various candidate chemicals against adult *Culicoides*. This paper reports the methods developed for conducting wind tunnel tests with *Culicoides mississippiensis* Hoffman and the results of tests with 7 insecticides, including 4 synthetic pyrethroids (NRDC-161, permethrin, resmethrin and *d*-phenothrin) and 3 organophosphorous (OP) compounds (fenthion, malathion and naled).

METHODS AND MATERIALS

The wind tunnel system of testing used in this study was basically that described by Mount et al. (1976). The major change involved use of a fine mesh screen in the exposure cages to contain the small adult *Culicoides*; 15.7-mesh per cm (40-mesh per in.) screen was used instead of the 6.3-mesh per cm (16-mesh per in.) screen used for mosquitoes. Thus, the screened area in the tunnel cross-section that surrounds the cage support bracket was also changed to 15.7-mesh per cm to insure uniform airflow through the tunnel and cage. The fabricated atomizing nozzle was also replaced with a commercially-available air atomizing nozzle (#12891 1/8 JJ, Spraying Systems Co., Chicago, Illinois).

The wind tunnel consisted of a cylindrical tube 15.5 cm in diameter and 88 cm in length. A variac controlled blower was used to force air through a plenum chamber into the tunnel, where air ve-

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[1] Diptera: Ceratopogonidae.

[2] This paper reports the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended. Also, mention of a commercial or proprietary product does not constitute an endorsement by the USDA.

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[4] (*S*)-[cyano(3-phenoxyphenyl)methyl] (1*R*)-*cis*-3-(2,2-dibromoethenyl)-2,2-dimethylcyclopropanecarboxylate.

locity was maintained at 1.78 m/sec. The treatment sample of biting midges was confined in cardboard exposure cages, 8.6 cm in diameter and 5.0 cm high with 15.7-mesh per cm brass screen ends, which were placed in the center of the tube for exposure. One-fourth ml of the desired concentration of the technical insecticide in acetone (wt A.I./volume diluent, expressed as % concentration) was atomized at the tunnel entrance with an air pressure of 10.3 kpa (105.5 g/cm^2), and the insects were exposed momentarily as the aerosol passed through the cage. We used an automatic pipette to introduce the insecticide solution into the nozzle for convenience and efficiency.

Immediately following exposure, the insects were lightly anesthetized with CO_2 and transferred to new 8.6 × 5.0 cm cardboard holding cages covered with fine mesh cloth screen tops. A cotton pad, soaked in a 10% sucrose solution was placed on each holding cage to provide food for the caged insects. The cages were then placed into large styrofoam chests, containing a moistened layer of cotton to maintain a high humidity environment. Mortality was checked 1 hr after treatment to determine knockdown capability and 24 hr mortality was recorded as overall effectiveness. Checks were exposed to contact sprays containing acetone only and handled in the same manner.

In our testing procedure to establish an effective range of concentrations for LD-50 determination the candidate insecticides were first tested at concentrations of 0.25% (wt/v), then the concentration was successively reduced by one-half until the 24-hr mortality fell below 50%. After an effective range was established, tests with serial dilutions of a given insecticide were made sequentially from low to high concentrations without cleaning the wind tunnel. However, the tunnel was cleaned at the beginning and end of each test series and before each new insecticide was tested.

Because we do not have a laboratory colony of biting midges, field collections of adult females of *C. mississippiensis* were made with CO_2-baited suction traps. The biting midges were transported to the laboratory, knocked down in a cold room at ca. 2°C and transferred to exposure cages with ca. 25/cage. Duplicate cages were used at each concentration tested, and at least 4 concentrations of each insecticide were used in each test. At least 3 replicates were made of each test. All tests were conducted within 6 hrs from time of collection.

A probit analysis using log-transformed dosage data was applied to the results to determine the LC-50 and LC-90 of each compound. The 95% fiducial limits for LC-50 and LC-90 values are used to indicate variability of the test procedures. Check mortality ranged from 5–8%, and therefore no correction for check mortality was made.

This testing procedure is not intended to yield results that can be compared closely; however, it does eliminate those insecticides that are not toxic enough to warrant further testing, and it identifies the range of concentrations that are highly effective.

RESULTS AND DISCUSSION

The 24-hr mortality data (LC-50's and LC-90's and their respective 95% fiducial limits) are presented in Table 1 along with the LC-50 for knockdown (1 hr) mortality. The compounds are ranked in order of decreasing toxicity (based on LC-90 of 24-hr mortality) to *C. mississippiensis*. The synthetic pyrethroids were more effective than the OP compounds with NRDC-161 the most toxic followed by permethrin, resmethrin and *d*-phenothrin. Of the OP compounds tested, naled was slightly more effective than malathion, and fenthion was least effective.

Quick knockdown is a desirable characteristic for biting midge adulticides, since immediate relief from biting is helpful and reinvasion from untreated areas is

Table 1. Effectiveness of 7 insecticides (% concentration) in laboratory wind tunnel tests against field-collected adult female *Culicoides mississippiensis.*

		24-hr mortality					
			95% Fiducial limits			95% Fiducial limits	
Insecticide	1 hr knockdown (LC-50)	LC-50	lower	upper	LC-90	lower	upper
NRDC-161	.00001	.00005	.00004	.00006	.00087	.00063	.00136
Permethrin	.00017	.00034	.00020	.00049	.00487	.00310	.00983
Resmethrin	.00115	.00115	.00071	.00159	.01134	.00832	.01781
d-Phenothrin	.00062	.00224	.00016	.00125	.03027	.01156	.03688
Naled	.03523	.01143	.00820	.01488	.07379	.05123	.12876
Malathion	.03339	.02395	.01469	.03336	.21206	.13198	.49897
Fenthion	2.15851	.02903	.02435	.03461	.35899	.25343	.56174

very probable. The knockdown LC-50 for all the pyrethroids was equal to or less than the 24 hr mortality and was much better than the OP compounds. Some recovery from knockdown was indicated for NRDC-161, permethrin, and *d*-phenothrin, since the knockdown LC-50 was less than the 24-hr LC-50. Of the OP compounds, naled and malathion had approximately equal knockdown capability. Fenthion demonstrated practically no knockdown capability and gave the lowest 24-hr mortality.

The data derived from these wind tunnel tests will be useful in the design of field application experiments. Plans are currently being formulated to test several of these candidate insecticides in ground and aerial application experiments.

References Cited

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