TOXICITY OF THE PYRETHROID ROUSSEL-UCLAF 22974 TO MOSQUITO LARVAE IN LABORATORY AND SEMIFIELD TESTS[1]

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ABSTRACT. A concentration of 0.5 ppb of the light-stable pyrethroid, Roussel-Uclaf 22974; NRDC-161; or Decis® (*S*-[cyano(3-phenoxyphenyl)methyl] *cis* - (+) - 3 - (2,2 - dibromoethenyl - 2 - 2 - dimethylcyclopropanecarboxylate) gave complete kill of 4th-instar larvae of *Culex quinquefasciatus* Say in laboratory tests at ca. 24.4°C (76°F). The LC_{50} was 0.14 ppb. In semifield tests in 1 liter of water [plastic containers and daytime temperatures of ca. 37.8°C (100°F)] all 4th-instar *Cx. quinquefasciatus* larvae were killed by a concentration of 1 ppb; the LC_{50} was 0.45 ppb. In semifield tests in 1-m^2 sod-lined ponds (daytime temperatures of ca. 37.8°C) all larvae of *Cx. tarsalis* Coquillett, *Cx. peus* Speiser, and *Cx. quinquefasciatus* were killed at a rate of 8.41 g/ha (0.0075 lb/acre). A minimum residual effectiveness of 15 days in the ponds was obtained at a rate of 11.21 g/ha (0.01 lb/acre).

INTRODUCTION

In 1976 we conducted laboratory and semifield tests against mosquito larvae with a new, light-stable pyrethroid, Roussel-Uclaf 22974; NRDC-161 (Elliott et al. 1974); or Decis® (*S*-[cyano(3-phenoxyphenyl)methyl] *cis* - (+) - 3 - (2,2 - dibromoethenyl) - 2 - 2 - dimethylcyclopropanecarboxylate).

According to a Procida/Roussel Uclaf brochure, Decis was first synthesized and tested as a 2-isomer compound called NRDC-156 or RU-22950 [cyano(3 - phenoxyphenyl)methyl *cis* - (+) - (2,2 - dibromoethenyl) 2 - 2 - dimethylcyclopropanecarboxylate]. The more active of the 2 isomers was subsequently synthesized separately, and the production of RU-22950 was dropped. However, test data for the material (compiled primarily with RU-22950 by Procida/Roussel Uclaf and cooperators and made available to prospective investigators) indicated strongly that Decis should be effective against mosquitoes. The results of our tests with the compound are the subject of this paper.

MATERIALS AND METHODS

In the laboratory, tests were performed with laboratory-reared, 4th-instar larvae of *Cx. quinquefasciatus* Say in 250 ml of distilled water in ca. 473.1 ml (1 pint) glass jars at ca. 24.4°C (76°F). Twenty-five larvae were placed in each jar; there were 2 replicates per concentration. The material used was technical Decis in ethyl alcohol. From 0.15 ml to 0.5 ml of stock solution was added to each test jar. Larvae were not offered food during the test. Mortality was determined at the end of 24 hr.

The semifield trial was carried out in 2

[1] This paper reflects the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended.

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segments. The first part was performed in a screened house (screen on top, sides, and ends) in full sunlight with 2 replicates per concentration. Temperatures in the house reached about 37.8°C (100°F) during the day. The test unit was a 1.5 liter plastic container ca. 11.5 cm in diameter, in which we placed larval food, 1 liter of tap water, and 25 laboratory-reared, 4th-instar larvae of *Cx. quinquefasciatus*. The water was held in the environment for a minimum of one day before each test. The test material was technical Decis in ethyl alcohol. From 0.2 ml to 0.6 ml of stock solution was added to each test container then mixed thoroughly with a glass rod. Larval mortality was determined at the end of 24 hr.

The tests in the screened house are referred to as semifield because *Cx. quinquefasciatus* will readily oviposit on a similar volume of rearing water in one of the containers, and larval development, pupation, and emergence will occur in a minimum of time for the species.

The other part of the semifield tests was performed outdoors in small, square, man-made ponds. The banks sloped at a 35° angle, and when the surface area of the water was 1 m^2 the mid-pond depth was ca. 22.9 cm (9 in.). Each pond was lined with clear, 6 mil polethylene plastic film over which we snugly abutted strips of commercially-grown Bermudagrass sod. About 200 laboratory-reared 4th-instar larvae of *Cx. quinquefasciatus* were placed in each pond before the larvicide was applied. In addition, a natural infestation of about 200 mosquito larvae per dip and considerable numbers of unhatched egg masses were present in each pond. The natural infestation consisted of *Cx. tarsalis* Coquillett (ca. 45%), *Cx. peus* Speiser (ca. 22%), and *Cx. quinquefasciatus* (ca. 33%). Maximum temperatures were similar to those reported for the screened house. Decis was provided as a 25 g/liter (0.21 lb/gal) company-formulated emulsion concentrate. An appropriate quantity of a company-recommended dilution was applied to the surface of the water in each pond and then stirred with a wooden paddle. Mortality was determined at the end of 24 hr. Residual effectiveness was judged to have ceased when reinfesting larvae survived to the 2nd instar.

LC_{50}'s for all tests were estimated from lines fitted by eye on logarithmic probability paper.

RESULTS AND DISCUSSION

In the laboratory, a concentration of 0.5 ppb gave complete mortality; the LC_{50} was estimated to be about 0.145 ppb.

In the screened house, a concentration of 1 ppb—twice the amount required in the laboratory—gave complete mortality; the LC_{50} was estimated to be about 0.45 ppb. The differences in concentrations required to get comparable responses in the 2 environments probably resulted primarily from the negative temperature coefficient (Blum and Kearns 1956, Plapp 1976) of the pyrethroids.

Results of most of the tests in the ponds are presented in Table 1. In those tests, all rates except the lowest (0.001 lb/acre) gave complete kill of larvae of *Cx. quinquefasciatus*. From our calculations, in ppb the 0.001 lb/acre rate was somewhat lower and

Table 1. Effect of treatments of Decis with larvae of *Culex* spp.[a] in grass-lined ponds ca. 22.9 cm (9 in.) deep and 1 m^2 in area.

Rates of AI in g/ha	Rates of AI in (lb/acre)	No. of ponds	Percent kill in 24 hr
1.12	(0.001)	1	50
2.80	(.0025)	1	75
5.60	(.005)	1	90
8.41	(.0075)	6	100
11.21	(.01)	16[b]	100
0 (Control)	—	8	0

[a] Each pond contained a natural infestation of about 200 larvae per dip, a population composed of *Culex tarsalis* (ca. 45%), *C. peus* (ca. 22%), and *C. quinquefasciatus* ca. 33%). In addition, before each treatment, about 200 laboratory-reared, 4th-instar larvae of *C. quinquefasciatus* were placed in each pond.

[b] A minimum residual effectiveness of 15 days was determined for 9 of these 16 ponds. Circumstances prevented the completion of other residual determinations.

the 0.0025 lb/acre rate was higher than the concentration that gave complete kill of *Cx. quinquefasciatus* larvae in the screened house. Screened house tests, then, may prove to be a useful method of obtaining reliable preliminary evaluations of rates for field tests.

Treatments of 0.0075 lb/acre and higher killed all larvae of *Cx. tarsalis* and *Cx. peus;* amounts below 0.0075 lb/acre, however, gave less than complete kill of those species. Thus *Cx. tarsalis* and *Cx. peus* exhibited greater tolerance to Decis than was exhibited by *Cx. quinquefasciatus,* an unexpected result that may be of little practical significance. In fact, complete initial kill of all larvae at a rate of 0.0075 lb/acre indicated unusual susceptibility rather than budding resistance. The 0.01 lb/acre treatments were effective for at least 15 days, an indication of both the persistance of the compound and also unusual susceptibility.

Since we had considerable replication and were dealing with natural populations in sod-lined ponds in open sunlight over a period of several weeks, we believe our results will prove to be very similar to the results that will be obtained from regular field tests. In any case, our data indicate that Decis (NRDC-161) warrants further testing with other species and under a wider variety of conditions.

References Cited

Blum, M. S. and C. W. Kearns. 1956. Temperature and the action of pyrethrum in the American cockroach. J. Econ. Entomol. 49:862–865.

Elliott, M., A. W. Farnham, N. F. Janes, P. H. Needham and D. A. Pulman. 1974. Synthetic insecticide with a new order of activity. Nature 248:710–711.

Plapp, F. W. 1976. Biochemical genetics of insecticide resistance. Annu. Rev. Entomol. 21:179–197.