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Susceptibility and repellency of *Culicoides imicola* and *Culex pipiens* to lambda-cyhalothrin

Y. Braverman[(1)], A. Chizov-Ginzburg[(1)], H. Pener[(2)] & A. Wilamowski[(2)]

(1) Kimron Veterinary Institute, PO Box 12, Beit Dagan 50250, Israel
(2) Laboratory of Entomology, Ministry of Health, PO Box 34410, Jerusalem 94467, Israel

Summary

The basic efficacy of lambda-cyhalothrin was tested in the laboratory against newly colonised adult *Culex pipiens* and field-collected *Culicoides imicola*. *C. imicola* was found to be more susceptible (LD_{50}=0.0098%) than *Cx. pipiens* (LD=0.0233%); the efficacy against both species was definitely higher than that of cyhalothrin. Lambda-cyhalothrin showed slight repellency for *C. imicola* during the first hour post application.

Keywords

Bluetongue – *Culex pipiens* – *Culicoides imicola* – Lambda-cyhalothrin – Toxicity.

Introduction

Culex pipiens is the most common mosquito species in Israel, where it breeds abundantly in all the known water courses throughout the country (16, 19). The species is generally considered as endophilic and anthropophilic, but not exclusively so. Birds and mammals (especially farm animals) are known to be highly attractive to females of *Cx. pipiens* (5, 9). *Cx. pipiens* is also one of the most efficient vectors of mosquito-borne arboviruses; it is implicated in the transmission of 'mosquito-borne mammal-associated viruses' such as Rift Valley fever (20) and bovine ephemeral fever (6), and also in the transmission of 'mosquito-borne bird-associated' viruses, especially flaviviruses such as West Nile (17) and turkey meningo-encephalitis (7, 13). Its vectorial role in pathogen transmission gives *Cx. pipiens* great economic importance in animal health. The biting midge *Culicoides imicola* Kieffer is the most important vector of livestock viral pathogens (bluetongue, Akabane and African horse sickness) in Africa, the Middle East and southern Europe (4, 21). Bovine ephemeral fever virus was also isolated from this species (14). Recently Israel turkey meningo-encephalitis virus was detected from specimens of *C. imicola* (13). The economic loss caused by these diseases is substantial; bluetongue alone causes an estimated worldwide loss of three billion dollars annually (3) and is estimated to be increasing due to the spread of the virus into Europe. In addition, *C. imicola* is the major agent that causes allergic recurrent summer dermatitis in livestock in Israel (8, 26), which reduces the productivity and commercial value of the animals. Efficient control of these two species is necessary in order to prevent further transmission of pathogens and to prevent allergic dermatitis caused by their bites. While control of *Cx. pipiens* is generally targeted against the larval stages and adultciding is practised only as a complementary treatment, the control and deterrence of *Culicoides* is based on adulticiding and repelling methods with compounds that are animal and environmentally safe. The only studies performed on the efficacy of insecticides against adult *C. imicola* were conducted in Israel. In 1994, the pyrethroid cyhalothrin was tested in the laboratory and found to be effective against *C. imicola*. An extensive repellency study on natural and pyrethroid preparations was performed recently (12, 22).

In recent years, an isomer of cyhalothrin, lambda-cyhalothrin has been widely employed in the control of blood-sucking arthropods in medical and in veterinary entomology (2, 23). In addition, because of its long residual effect, lambda-cyhalothrin is used to impregnate bed nets for antimalarial protection (18).

The present study was undertaken to test the efficacy of lambda-cyhalothrin against *Cx. pipiens* and its toxicity and repellency against, *C. imicola*. Its residual

effect could provide an effective tool in the control of both species, especially in and around animal shelters.

Materials and methods

Susceptibility tests were performed in the laboratory on a suction light trapped field population of mainly nulliparous *C. imicola*, which constituted the bulk of the catch (11) and also on 3- to 5-day-old newly colonised females (50%) and males (50%) of *Cx. pipiens*. Both populations were collected at Beit Dagan in Israel. The colony of mosquitoes was started from larvae whereas *C. imicola* adults were collected with three suction light traps (15). In the laboratory, the tested insects were acclimatised for about an hour prior to testing. Test procedures were essentially those described by the World Health Organization (WHO) (25) for routine susceptibility tests of adult biting midges and mosquitoes. The insects were exposed to lambda-cyhalothrin-impregnated papers for 1 h in test kit tubes, held horizontally. Mortality was recorded after a 24 h recovery period, during which 10% sugar solution was provided on cotton wool pads. The test kit tubes were kept in an insectary throughout the experiment and were maintained at 28°C±2°C and 80±2% relative humidity. Test papers were prepared by impregnating Whatman no. 1 filter paper (13.5 cm × 14.5 cm) with 2 ml of a solution containing a known concentration of 125 mg/ml technical grade lambda-cyhalothrin (Syngenta) in reagent grade acetone. Control papers were impregnated with 2 ml of acetone only. The tests were replicated three times for *Cx. pipiens* and seven times for *C. imicola*. In each test, three groups of 30 adults of both sexes of *Cx. pipiens* and females of *C. imicola* were tested for each concentration. The results for each concentration in valid tests (control ≤10%) were pooled and evaluated by probit regression analysis (Spss® 8.0 for Windows). *In vitro* repellency tests with *C. imicola* were conducted in the field from 6 pm until 5 am, using four blacklight suction traps, where each trap was used for a different treatment, as described previously (11). The experiment was performed using 5% lambda-cyhalothrin and preparations containing 4% and 24% of cyhalothrin as well as a control (water).

Results and discussion

The results of the measurement of the susceptibility of both species to lambda-cyhalothrin are summarised in Table I and Figure 1.

Table I
LD_{50} and LD_{90} values (%) following 1-h exposure to lambda-cyhalothrin (in brackets: 95% confidence limits)

Species	LD_{50}	LD_{90}
Culex pipiens	0.0233 (0.0168-0.0313)	0.1341 (0.0952-0.2077)
Culicoides imicola	0.0098 (0.0072-0.0125)	0.0564 (0.0442-0.0767)

While adult *C. imicola* were more susceptible than adult *Cx. pipiens* (LD_{50} for *Cx. pipiens* = 0.0233%, for *C. imicola* = 0.0098%), the efficacy of lambda-cyhalothrin was quite high for both species. Lambda-cyhalothrin was found to be nearly 10 times as effective as cyhalothrin against *Culicoides* (10), and the same has been found for *Cx. pipiens* (internal reports, Entomology Laboratory, Ministry of Health, Israel). Consequently, control of these two vectors could be achieved with a much smaller quantity of insecticide than is currently being used, which would be beneficial both environmentally and economically. It was observed that during the toxicity test, lambda-cyhalothrin was not found to be repellent to either of the species tested as they landed on the filter paper.

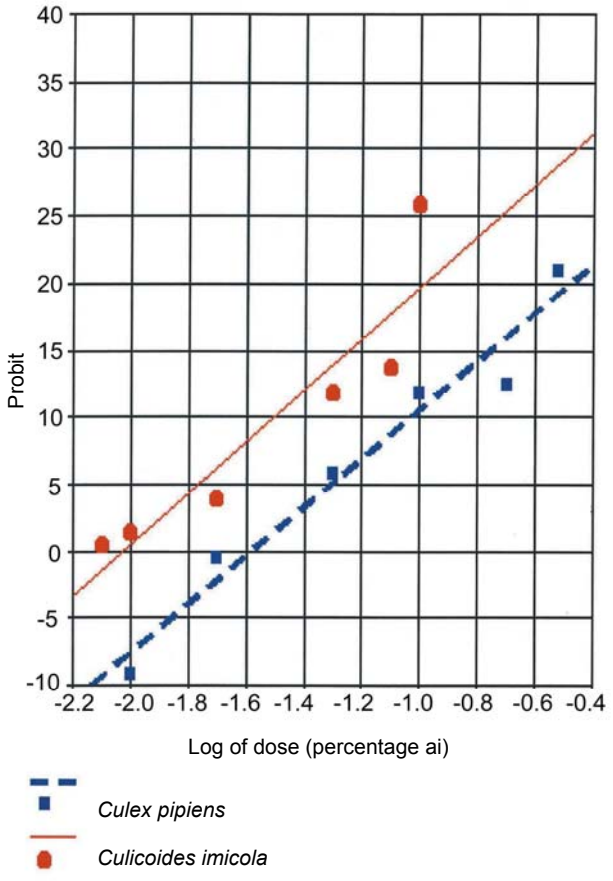

Figure 1
Baseline susceptibility to lambda-cyhalothrin
Dose mortality curve

Lambda-cyhalothrin is an insecticide with contact and stomach action and repellent properties (24). According to Artimev *et al.* (1) lambda-cyhalothrin did not repel *Cx. pipiens*. Therefore, we did not conduct special tests for repellency to this species. No information could be found on its repellency to *Culicoides* spp., therefore we conducted a repellency test for *C. imicola*; the results show that its repellency for *C. imicola* was poor and lasted for up to 1 h and for the two preparations of cyhalothrin, no repellency was detected (Table II). The residual activity of the lambda-cyhalothrin was not tested in the present study. However, since the compound is used against malaria-transmitting mosquitoes, both as a space spray and in the impregnation of bed nets (18), it can be safely assumed that it would also have a long-lasting effect against *C. imicola* and *Cx. pipiens*.

Table II
Repellency of 5% lambda-cyhalothrin and cyhalothrin to *Culicoides imicola*; number of trapped *C. imicola*

Treatments	Hours post-application											
	1	2	3	4	5	6	7	8	9	10	11	12
Control (water)	0	42	80	40	20	20	10	12	10	10	0	10
Lambda-cyhalothrin 5%	0	7	68	72	44	38	28	18	21	0	7	19
Sylotox-4 (4% cyhalothrin)	0	33	99	78	65	49	33	40	11	19	12	8
Sylotox-20 (24% cyhalothrin)	0	24	180	130	115	90	30	10	20	9	9	0

References

1. Artimev M.M., Sorokin N.N., Aliev, A.I., Stepanova A.N., Demyanova E.V., Bakiev R.A., Chabanenko A.A. & Labzin V.V. (1991). – Testing the insecticides Icon and Ficam against mosquitoes in the south of the USSR. *Med. Parazitol.*, **1**, 13-16.
2. Barros A.T., Alison M.W. & Foil L.D. (1999). – Evaluation of a yearly insecticidal ear tag rotation for control of pyrethroid-resistant horn flies (Diptera: Muscidae). *Vet. Parasitol.*, **82**, 317-325.
3. Bath G.O. (1989). – Bluetongue. *In* Proc. 2nd International Congress for sheep veterinarians, Massey University, Palmerston North, 12-16 February. New Zealand Veterinary Association, Wellington, 349-357.
4. Braverman Y. (1994). – Nematocera (Ceratopogonidae, Psychodidae, Simuliidae, Culicidae) and control methods. *Rev. Sci. Tech. Off. Int. Épiz.*, **13**, 1175-1199.
5. Braverman Y. & Rubina M. (1976). – Light trapping of biting insects in poultry houses in Israel. *Isr. J. Zool.*, **25**, 95-101.
6. Braverman Y. (2001). – The vectors of bovine ephemeral fever, Akabane and bluetongue viruses in Israel. *In* Proc. 13th Symposium of Dairy Cattle Science, Zichron Yaakov, Israel, 26-28 February. Israel Ministry of Agriculture, Beit Dagan, 81-82.
7. Braverman Y., Rubina M. & Frish K. (1981). – Pathogens of veterinary importance isolated from mosquitoes and biting midges in Israel. *Ins. Sci. Applic.*, **2**, 157-161.
8. Braverman Y., Ungar-Waron H., Frish K., Adler H., Danieli Y., Baker K.P. & Quinn P.J. (1983). – Epidemiological and immunological studies of sweet itch in horses in Israel. *Vet. Rec.*, **112**, 521-524.
9. Braverman Y., Kitron U. & Killick-Kendrick R. (1991). – Attractiveness of vertebrate hosts to *Culex pipiens* (Diptera: Culicidae) and other mosquitoes in Israel. *J. Med. Entomol.*, **28**, 133-138.
10. Braverman Y., Wilamowski A. & Chizov-Ginzburg A. (1995). – Susceptibility of *Culicoides imicola* to cyhalothrin. *Med. Vet. Entomol.*, **9**, 443-444.
11. Braverman Y. & Chizov-Ginzburg A. (1997). – Repellency of synthetic and plant derived preparations for *Culicoides imicola*. *Med. Vet. Entomol.*, **11**, 355-360.
12. Braverman Y., Wegis M. & Mullens B.A. (2000). – Response of *Culicoides sonorensis* (Diptera: Ceratopogonidae) to 1-Octen-3-ol and three plant-derived repellent formulations in the field. *J. Am. Mosq. Control Assoc.*, **7**, 165-169.
13. Braverman Y., Rechtman S., Frish A. & Braverman R. (2003). – Dynamics of biting activity of *C. imicola* Kieffer (Diptera: Ceratopogonidae) during the year. *Isr. J. Vet Med.*, **58**, 46-56.
14. Davies J.A. & Walker A.R. (1974). – The isolation of ephemeral fever virus from cattle and *Culicoides* midges in Kenya. *Vet. Rec.*, **20**, 63-64.
15. DuToit R.M. (1944). – The transmission of bluetongue and horse-sickness by *Culicoides*. *Onderstepoort J. Vet. Sci. Anim. Ind.*, **19**, 7-16.
16. Kitron U. & Pener H. (1986). – Distribution of mosquitoes (Diptera: Culicidae) in northern Israel: a historical perspective. II. Culicine mosquitoes. *J. Med. Entomol.*, **23**, 182-187.
17. Lundstrom S.O. (1999). – Mosquito-borne viruses in Western Europe: a review. *J. Vect. Ecol.*, **24**, 1-30.
18. Marbiah N.T., Petersen E., David K., Magbity E., Lines J. & Bradely D.J. (1998). – A controlled trial of lambda-cyhalothrin-impregnated bed nets and/or

dapsone/pyrimethamine for malaria control in Sierra Leone. *Am. J. Trop. Med. Hyg.*, **58**, 1-6.

19. Margalit J. & Tahori A.S. (1974). – An annotated list of mosquitoes in Israel. *Isr. J. Entomol.*, **9**, 77-91.
20. Meegan J.M., Khalil G.M., Hoogstraal H. & Adham F.K. (1980). – Experimental transmission and field isolation studies implicating *Culex pipiens* as vector of Rift Valley fever virus in Egypt. *Am. J. Trop. Med. Hyg.*, **29**, 1405-1410.
21. Mellor P.S. (1993). – *Culicoides* – do vectors respect international boundaries? *Br. Vet. J.*, **49**, 5-8.
22. Mullens, B.A., Velten R.K., Gerry A.G., Braverman Y. & Endris R.G. (2000). – Feeding and survival of *Culicoides sonorensis* on cattle treated with permethrin or primiphos-methyl. *Med. Vet. Entomol.*, **14**, 313-320.
23. Talbert A., Nyange A. & Molteni F. (1998). – Spraying tick-infested houses with lambda-cyhalothrin reduces the incidence of tick-borne relapsing fever in children under five years old. *Trans. R. Soc. Trop. Med. Hyg.*, **92**, 251-253.
24. Tomlin C.D.S. (2000). – The pesticide manual, 12th Ed. British Crop Protection Council, Farnham, Surrey, 226-227.
25. World Health Organization (WHO) (1981). – Instructions for determining the susceptibility or resistance of adult blackflies, sandflies and biting midges to insecticides. WHO, Geneva, Mimeographed document. WHO/VBC/81.910.
26. Yeruham I., Braverman Y. & Orgad U. (1993). – Field observations in Israel on hypersensitivity in cattle, sheep and donkeys caused by *Culicoides*. *Aust. Vet. J.*, **70**, 348-352.