Journal of Environmental Biology **April 2006,** 27(2) 251-255 (2006)
©Triveni Enterprises, Lucknow (India) For personal use only
Free paper downloaded from: www.jeb.co.in Commercial distribution of this copy is illegal

Laboratory evaluation for comparative insecticidal activity of some synthetic pyrethroids against vector mosquitoes in arid region

S. K. Bansal and Karam V. Singh
Desert Medicine Research Centre (ICMR), New Pali Road, Jodhpur - 342 005, India

(Received: 1 March, 2005 ; Accepted: 29 October, 2005)

Abstract: *Comparative efficacy of three synthetic pyrethroids viz., cypermethrin, lambdacyhalothrin and cyfluthrin was evaluated against Anopheles stephensi, Aedes aegypti and Culex quinquefasciatus, the three important mosquito vectors prevalent in arid region. Studies were carried out on late 3rd or early 4th instar larvae of these species using standard WHO technique. Based on concentration mortality data LC_{50} and LC_{90} values along with their fiducial limits, regression equation, chi-square (χ^2)/ heterogeneity of the response have been determined by log probit analysis. LC_{50} values as observed were 0.0064, 0.00060 and 0.00012 mg /l for cypermethrin, 0.0090, 0.0019 and 0.0010 mg /l for lambdacyhalothrin and 0.0087, 0.0005 and 0.0004 mg /l for cyfluthrin for the above three vectors respectively. The results showed that larvae of Cx. quinquefasciatus were most susceptible followed by Ae. aegypti and An. stephensi to all the pyrethroids tested. The chi-square values calculated during the analysis did not show any heterogeneity of the response. Experiments conducted with adults of An. stephensi, Ae. aegypti and Cx. quinquefasciatus with three synthetic pyrethroids viz. lambdacyhalothrin (0.05%), cyfluthrin (0.15%) and deltamethrin (0.05%) showed that all the three compounds are very effective and a 98- 100% kill was observed when subjected from 15-60 min. time exposure. This study would be useful while planning use of these insecticides for the control of adult mosquito vectors in this area.*

Key words: *Synthetic pyrethroids, Vector mosquitoes, Arid region.*

Introduction

Mosquitoes, the best known group among dipteran insects, are of great importance to man as pests and vectors of many dreaded human diseases such as malaria, filaria, dengue/dengue hemorrhagic fever (DHF) etc. Among the anophelines, *Anopheles stephensi* is an important vector of malaria while among the culicines, *Culex quinquefasciatus* and *Aedes aegypti* are the vectors of filaria and dengue/DHF respectively. Development of resistance to various types of insecticides such as organochlorines, organophosphates and carbamates (Bansal, 1998; Bansal and Singh, 1995a, 1996 2002; Singh and Bansal, 1996a, 1996b, 2001) poses a serious threat to the conventional control measures for vectors, especially the mosquitoes. At the same time many of these insecticides are regarded as environmental pollutants and create health hazards. As such search for safer insecticides for adult vector control under the National Anti Malaria Programme (NAMP) becomes inevitable. Currently synthetic pyrethroids (SP) are being used to control insect vectors because of their biodegradable nature, low mammalian toxicity without any harmful residual effect and higher efficacy against the target species and resistant vector population (Babu, 1985; Rahman, 1989). Although these compounds are very toxic even at very low concentrations but no studies have been conducted to evaluate the range of their toxicity to both adults and larvae in arid situation. Therefore, studies were carried out on three SP compounds viz., cypermethrin (Technical grade-98%), lambdacyhalothrin (5% EC) and cyfluthrin (95.5% Technical grade) against the larvae of above three important mosquito vectors in this arid region.

Materials and Methods

Fully fed female mosquitoes of all the three species were collected early in the morning from different areas of Jodhpur city. Collection was made from inside the human dwellings and cattle sheds with the help of an aspirator supplied by WHO and kept in Barraud cages provided with cotton pads soaked in 10% glucose solution and inside with an enamel water tray for laying eggs. Different larval stages from 1st to 4th instar were reared in the laboratory and used for the tests. During this period the larvae were fed with finely powdered dog biscuits and yeast powder in the ratio of 2:1. Various test concentrations were prepared by adding standard insecticide solution of all the three pyrethroids to 249 ml. of tap water in a 500-ml. beaker. Control tests were also conducted by adding the same amount of solvent to 249 ml. of water. To each of the beakers containing different test concentrations, 25 healthy late 3rd or early 4th instar larvae were released. Percent mortalities were calculated 24 hrs later by counting both dead and moribund larvae as per instructions given by WHO (1981a, 1981b). Larvae were considered moribund if they failed to flex head to siphon when provoked with a glass rod. Susceptibility tests were also carried out with adults of these mosquito species using viz. *Anopheles stephensi*, *Aedes aegypti* and *Culex quinquefasciatus* with impregnated papers of three synthetic pyrethroid compounds viz., Lambdacyhalothrin (0.05%), cyfluthrin (0.15%) and deltamethrin (0.05%). 20-25 fully fed females were exposed for 15-60 minutes to diagnostic doses of above SP impregnated WHO papers obtained from NAMP and mortality noted 24 hr later. All tests were carried out at a temperature of 28±2°C and RH at 75±5%. All the tests

Table – 1: Toxicological status of cypermethrin, lambdacyhalothrin and cyfluthrin to the larvae of three major mosquito vectors.

Mosquito species/ concentrations (mg/l)	Percent experimental mortality with			Percent corrected mortality with		
	CP	**LC**	**CF**	**CP**	**LC**	**CF**
An. stephensi						
Control	6.6	5.1	4.1	-	-	-
0.0005	16.3	-	-	10.4	-	-
0.0010	24.2	19.6	17.7	18.8	15.3	17.7
0.0050	39.7	37.1	34.7	35.4	33.7	34.7
0.0100	64.0	53.2	53.1	61.5	50.7	53.1
0.0250	96.0	-	-	95.7	-	-
0.0500	-	84.0	82.6	-	83.1	82.6
0.1000	-	94.8	92.6	-	94.5	92.6
Ae. aegypti						
Control	3.0	3.1	2.8	-	-	-
0.00005	-	-	10.3	-	-	10.3
0.00010	9.0	-	22.6	9.0	-	22.6
0.00025	19.6	-	-	19.6	-	-
0.00050	36.5	18.6	41.9	36.5	18.6	41.9
0.00100	74.7	31.7	83.5	74.7	31.7	83.5
0.00250	95.9	51.5	-	95.9	51.5	-
0.00500		79.2	98.1	-	79.2	98.1
0.01000		96.9	-	-	96.9	-
Cx. quinquefasciatus						
Control	5.6	5.7	5.1	-	-	-
0.000025	16.3	-	-	11.3	-	-
0.000050	36.8	-	9.1	33.1	-	4.2
0.000100	60.5	-	22.7	58.2	-	18.5
0.000250	-	15.3	-	-	10.2	-
0.000500	76.0	27.2	51.5	74.6	22.8	48.9
0.001000	92.7	57.4	77.7	92.3	54.8	76.5
0.002500	-	74.5	-	-	73.0	-
0.005000	-	96.1	98.1	-	95.9	98.0

CP – Cypermethrin; LC – Lambdacyhalothrin; CF - Cyfluthrin

were repeated four to five times to investigate variations and average was taken. Data were corrected by using Abbott's formula (1925) if mortality was between 5-20% in control experiments. The LC_{50} and LC_{90} values were computed using log probit regression analysis (Finney, 1971).

Results and Discussion

The results of the comparative insecticidal efficacy of three synthetic pyrethroids against larvae and adults of all the three vector mosquitoes are given in Tables 1-3. From Table 1 it is very clear that all the pyrethroids used in the present study are very effective at very low concentrations for each mosquito species. A perusal of the Table 2 showed that larvae of *Cx. quinquefasciatus* were most susceptible followed by *Ae. aegypti* and *An. stephensi* towards all the pyrethroids tested in the present investigation. *Cx. quinquefasciatus* was found more susceptible (LC_{50}-0.00012) for cypermethrin as compared to *Ae. aegypti* (LC_{50}-0.0006) and *An. stephensi* (LC_{50} - 0.0064 mg /l) which showed that larvae of *Culex* are 53.3 and of *Aedes* 10.7 times more susceptible than *Anopheles* to cypermethrin. Among the pyrethroids tested cypermethrin was found more toxic to the larvae of *An. stephensi* (LC_{50} - 0.0064) followed by cyfluthrin (LC_{50}- 0.0087 mg/l) and lambdacyhalothrin (LC_{50}- 0.0090 mg/l). Verma *et al*. (1983) also evaluated the efficacy of cypermethrin to the larvae of above three mosquito species and found *Culex quinquefasciatus* to be more susceptible (LC_{50}- 0.00032) instead of Ae. *aegypti* (LC_{50}- 0.00037 and *An. stephensi* (LC_{50}-0.0054 mg/l). Verma and Rahman (1984) also evaluated the efficacy of synthetic pyrethroids over natural pyrethrins and DDT and found the formers to be much more effective for the above three mosquito species. Experiments carried out with lambdacyhalothrin in the present study found the LC_{50} values for *An. stephensi*, *Ae. aegypti* and *Cx. quinquefasciatus* as 0.0090, 0.0019 and 0.0010 mg/l respectively which showed that larvae of *Culex* were 9 and of *Aedes* 4.7 times more susceptible than *An. stephensi*.

Table – 2: Log probit analysis of the mortality data of larvae of three mosquito vectors to cypermethrin, lambdacyhalothrin and cyfluthrin.

Insecticide/ mosquito vector sp.	Regression equation	Chi-square (DF)	LC_{50} (Fiducial limits)	LC_{90} (Fiducial limits)
Cypermethrin				
An. stephensi	Y=2.83+1.20x	5.26(3)	0.0064 (0.0041-0.0099)	0.0750 (0.0265-0.2114)
Ae. aegypti	Y=1.39+2.03x	2.83(3)	0.00060 (0.00044-0.00082)	0.00256 (0.00120-0.00546)
Cx. quinquefasciatus	Y=3.39+1.49x	4.63(3)	0.00012 (0.00008-0.00017)	0.00087 (0.00039-0.00193)
Lambdacyhalothrin				
An. stephensi	Y=3.85+1.20x	0.91(3)	0.0090 0.0055-0.0148)	0.1045 (0.0310-0.3531)
Ae. aegypti	Y=2.87+1.67x	1.66(3)	0.0019 (0.0014-0.0026)	0.0110 (0.0048-0.0251)
Cx. quinquefasciatus	Y=0.80+2.08x	1.37(3)	0.0010 (0.0008-0.0014)	0.0043 (0.0023-0.0080)
Cyfluthrin				
An. stephensi	Y=3.98+1.09x	0.92(3)	0.0087 (0.0050-0.0150)	0.1285 (0.0310-0.5390)
Ae. aegypti	Y=2.81+1.32x	5.24(3)	0.0005 (0.0003-0.0007)	0.0043 (0.0015-0.0124)
Cx. quinquefasciatus	Y=2.22+1.70x	1.68(3)	0.0004 (0.0003-0.0006)	0.0024 (0.0012-0.0051)

All values of LC_{50} and LC_{90} along with their fiducial limits are in mg /l.

Experiments have also been done on the same three mosquito species with cyfluthrin. LC_{50} values as determined for *An. stephens*i, *Ae. aegypti* and *Cx. quinquefasciatus* were 0.0087, 0.0005 and 0.0004 mg /l respectively which showed that larvae of *Cx. quinquefasciatus* were much susceptible than rest of the two species. Experiments carried out in triple insecticide resistant areas of Gujarat and Maharashtra (Yadava *et al*., 1996) on cyfluthrin showed it to be an effective and safe insecticide for control of *An. stephensi* and *Cx. quinquefasciatus* with consequent decrease in the vector density and cases of malaria. Mohapatra *et al.* (1999) also evaluated the efficacy of cyfluthrin on these mosquito species and showed it to be ovicidal on *An. stephens*i and *Ae. aegypti* while checked the complete hatchability of eggs in *Cx. quinquefasciatus*. In the present investigation larvae of *Cx. quinquefasciatus* and *An. stephensi* were found more susceptible to cypermethrin and that of *Ae. aegypti* to cyfluthrin.

Experiments have also been carried out with adults of all the three mosquito vectors with the diagnostic doses and found that all were fully susceptible to the pyrethroids tested (Table-3). Complete susceptibility of many mosquito species towards several synthetic pyrethroids have also been observed by many authors (Kulkarni *et al*., 1992, Vijayan and Revanna, 1993, Vasuki *et al*., 1995, Bansal and Singh, 1995b, 1996). However, resistance to these pyrethroids is also inevitable when mosquito generations were continuously exposed to the selection pressure of these insecticides (Thomas *et al*., 1991, Rajasree and Shetty, 1998).

Results of the present study clearly reiterate the unmatched efficacy of these synthetic pyrethroids against different vector mosquitoes. It also suggests that these pyrethroids can be effectively employed in adult mosquito control during period of outbreaks and emergencies in the integrated vector management programme. Further studies are

Table – 3: Relative potency of different synthetic pyrethroid compounds to the adults of *An. stephensi, Ae. aegypti and Cx. quinquefasciatus.*

Synthetic pyrethroid	Exposure time	No. exposed	Percent test mortality	Percent control mortality	Percent corrected mortality
An. stephensi					
Lambdacyhalothrin (0.05%)	15	100	99.0	2.0	99.0
	30	100	100.0	1.1	100.0
	60	100	100.0	0.0	100.0
Cyfluthrin (0.15%)	15	80	98.8	1.2	98.8
	30	80	100.0	2.5	100.0
	60	80	100.0	1.2	100.0
Deltamethrin (0.05%)	15	95	100.0	1.1	100.0
	30	95	100.0	0.0	100.0
	60	95	100.0	2.1	100.0
Ae. aegypti					
Lambdacyhalothrin (0.05%)	15	75	100.0	0.0	100.0
	30	75	100.0	0.0	100.0
	60	75	100.0	1.3	100.0
Cyfluthrin (0.15%)	15	80	98.8	1.3	98.8
	30	80	100.0	0.0	100.0
	60	80	100.0	2.5	100.0
Deltamethrin (0.05%)	15	100	98.0	1.0	98.0
	30	100	100.0	1.0	100.0
	60	100	100.0	0.0	100.0
Cx. quinquefasciatus					
Lambdacyhalothrin (0.05%)	15	80	98.8	1.3	98.8
	30	80	100.0	2.7	100.0
	60	80	100.0	0.0	100.0
Cyfluthrin (0.15%)	15	75	98.7	0.0	98.7
	30	75	100.0	1.3	100.0
	60	75	100.0	2.7	100.0
Deltamethrin (0.05%)	15	75	97.3	0.0	97.3
	30	75	100.0	1.3	100.0
	60	75	100.0	0.0	100.0

needed to unravel the mechanism of differential insecticidal tolerance exhibited by these mosquito species.

Acknowledgments

Authors are thankful to NAMP (Delhi) for providing the WHO standard samples of insecticides and different manufacturing firms in India for supplying the technical and EC grade samples.

References

Abbott, W.S.: A method of computing the effectiveness of an insecticide. *J. Econ. Entomol.,* **18**, 265-267 (1925).

Bansal, S. K. : Prevalence of some major disease vectors and their control in semi-arid areas of the Thar desert. *Proc. Acad. Environ. Biol.*, **7**, 17-25 (1998).

Bansal, S.K. and Karam V. Singh : Comparative susceptibility of two culicine vectors of DF/DHF and Lymphatic filariasis to insecticides in district Bikaner. *Proc. Intnl. Symp. Vectors and Vector- borne Dis.,* pp. 86-90 (1995a).

Bansal, S.K. and Karam V. Singh : Susceptibility status of two species of Japanese encephalitis vectors to insecticides in the Thar desert, district Bikaner (Rajasthan). *Indian J. Med. Res.,* **101**, 190-192 (1995b).

Bansal, S. K. and Karam V. Singh : Insecticide susceptibility status of anophelines in district Bikaner, Rajasthan. *Indian J. Malariol.*, **33**, 1-6 (1996).

Bansal, S. K. and Karam V Singh : Toxicological evaluation of some organophosphorous compounds against larvae of *Culex quinquefasciatus* in district Bikaner, Rajasthan. *Annals of Arid Zones,* **41**, 169-173 (2002).

Babu, C.J.: Synthetic pyrethroids and its safety limits. *J. Commun. Dis.,* **17**, 140-145 (1985).

Finney, D. J. : Probit analysis – A statistical treatment of the sigmoid response curve. 3rd Edn. (Cambridge university press, Cambridge) London. (1971).

Kulkarani, S.M., G. Geevarghese, and P.J. George: Susceptibility status of five species of Japanese encephalitis vectors to insecticides from Kolar district, Karnataka. *Indian J. Med. Res.,* **95**, 297-300 (1992).

Mohapatra, R., M.R. Ranjit and M. P. Dash: Evaluation of cyfluthrin and fenfluthrin for their insecticidal activity against three vector mosquitoes. *J. Commun. Dis.,* **31**, 91-99 (1999).

Rahman, S.J.: Role of synthetic pyrethroids in vector control. *J. Commun. Dis.,* **21,** 333-338 (1989).

Rajasree, B.H. and N. J. Shetty : Genetic study of deltamethrin resistance in the malaria mosquito, *Anopheles stephensi*, Liston. *J. Parasitic Dis.,* **22**, 140-143 (1998).

Singh, Karam. V. and S.K. Bansal: Current status of *Anopheles stephensi* response to various insecticides in some areas of the Thar desert. *Indian J. Med. Res.,* **103**, 299-303 (1996a).

Singh, Karam. V. and S.K. Bansal: Present susceptibility of *Culex tritaeniorhynchus*, to conventional and some other insecticides in Kota (Rajasthan). *J. Commun. Dis.,* **28**, 64-66 (1996b).

Singh, Karam. V. and S.K. Bansal: Susceptibility of *Culex quinquefasciatus*, the vector of lymphatic filariasis, to few conventional and newer insecticides in different parts of Rajasthan. *Annals of Arid Zones,* **40**, 79-84 (2001).

Thomas, Anita., Kumar, Sarita and M.K.K. Pillai : Piperonyl butoxide as a countermeasure for deltamethrin resistance in *Culex quinquefasciatus* Say. *Entomol.,* **16**, 1-10 (1991).

Verma, K.V.S., B. L. wattal and A.C. Rajvanshi : Larvicidal efficacy of two synthetic pyrethroids against mosquitoes. *J. Commun. Dis.,***15**, 219-221 (1983).

Verma, K.V.S. and S. J. Rahman : Comparative efficacy of synthetic pyrethroids, natural pyrethrins and DDT against mosquito larvae. *J. Commun. Dis.,***16**, 144-147 (1984).

Vasuki, V., A.R. Rajavel, D. Dominic Amalraj and P. K. Das: Insecticidal activity of some new synthetic compounds against different mosquito species. *J. Commun. Dis.,***27**, 146-150 (1995).

Vijayan, V.A. and M. A. Revanna: Insecticide susceptibility of *Culex gelidus* Theobald, a Japanese encephalitis vector, in Mysore. *Annals Entomol.,* **11**, 67-70 (1993).

W.H.O.: Instructions for determining the susceptibility or resistance of mosquito larvae to insecticides. *WHO/VBC 81*.807. (1981a)

W.H.O.:Instructions for determining the susceptibility or resistance of adult mosquito to organochlorines, organophosphates and carbamates insecticides, diagnostic test. *WHO/VBC/81*.806, 1-7, (1981b).

Yadava, R.L., C. Krishna Rao and H. Biswas: Field trial of cyfluthrin as an effective and safe insecticide for control of malaria vectors in triple insecticide resistant areas. *J. Commun. Dis.,* **28**, 287-298 (1996).

Correspondence to :
Dr. S.K. Bansal
Desert Medicine Research Centre (ICMR)
New Pali Road, Jodhpur- 342005
Rajasthan, India
E-mail: bansalshivk@hotmail.com
Tel.: +91-291-2726223
Fax: +91-291-2720618