SUSCEPTIBILITY DIFFERENCE IN TWO POPULATIONS OF *CULEX QUINQUEFASCIATUS* SAY (DIPTERA : CULICIDAE) TO THREE SYNTHETIC PYRETHROIDS

VA Vijayan and N Ningegowda

Department of Zoology, University of Mysore, Manasagangothri, Mysore-570 006, India

Abstract. Three synthetic pyrethroids were tested for their efficacy against two populations of the filariasis vector *Culex quinquefasciatus* under laboratory conditions following the WHO procedure, Emulsifiable concentration and technical grade formulations of deltamethrin (2.5% wp), cypermethrin (1.0% EC) and permethrin (25% EC) were employed on the larvae of the said species collected from Mysore and Mandya. All the three pyrethroids were found to be effective. But among the three, deltamethrin was found to be the most effective and cypermethrin was more efficient than permethrin. Mysore species were found to be more susceptible than the Mandya population to all the chemicals tested though they are separated by hardly 50 km.

INTRODUCTION

Cx. quinquefasciatus Say is the vector of Bancroftian filariasis in many tropical countries including India. It has developed resistance to many insecticides in different parts of the world (Curtis and Pasteur, 1980). So there is a need for more effective and alternate insecticides with no harms on non-target organisms. In recent years, the synthetic pyrethroids have emerged as being highly effective against pests and vectors in the field of agriculture and public health respectively due to their environmental stability, low mammalian toxicity and high insecticidal action (Elliot *et al,* 1978; Rajavanshi *et al,* 1982). Their larvicidal potential has been extensively evaluated against different species of mosquitos in the laboratory as well as in the field (Mulla *et al,* 1975; Miura and Takahashi, 1976; Barlow *et al,* 1977; Mount *et al,* 1978; Thompson and Meisch, 1978; Priester, 1980; Verma and Rahman, 1984; Rahman, 1989; Vijayan *et al,* 1993). *Cx. quinquefasciatus* has been found in high density in Mysore City (Gowda and Vijayan, 1990; 1992; 1993). Recently Japanese encephalitis virus has been isolated from this species in Karnataka, India (Mourya *et al,* 1989; Dhanda *et al,* 1989) which further magnifies its vectorial capacity. As no susceptibility studies were undertaken on this predominant urban species at Mysore and nearby places, the present investigation was initiated to determine the larvicidal efficacy of three pyrethroids against this species.

MATERIALS AND METHODS

For the purpose of comparison, two urban populations of the vector species from Mysore (12°, 18'N and 76° 18'E latitudes and longitudes) and Mandya (12° 14'N and 70° 20'E latitudes and longitudes) of Karnataka, India were employed. These two townships are separated by hardly 50 kms. Susceptibility tests were conducted as per the standard WHO method (WHO, 1981) at the ambient temperpature 26 ± 2°C and relative humidity 70 ± 5%.

Stock solutions (1%) were prepared in acetone from the technical grade formulation of deltamethrin (2.5% wp) [cyano(3-phenoxyphenyl) methyl 1-3-(2,2-dicromoethenyl)-2, 2-dimethyl cyclopropane carboxylate], emulsifiable concentrate of cypermethrin (1.0% EC) [cyano (3-phenoxyphenyl) methyl 3-(2, 2-dichloroethenyl)-2,2-dimethyl cyclopropane carboxylate] and permethrin (25% EC) [3-phenoxybenzyl (±) cis, trans-2,2-dimethyl-3-(2,2-dichlorovinyl)-cyclopropane-I-carboxylate]. Serial dilutions were prepared in acetone as needed. The required volume (1.0 to 0.2 ml) of the stock solution was added to 250 ml of the tap water in a 500 ml beaker. Twenty-five early fourth instar larvae were released into each of the concentration. Four to six replicates were maintained per concentration. Along with each test, four acetone controls were also kept. After 24 hours exposure, mortality counts were made both in the treated

and control series. The results of all the tests were subjected to a log probit regression analysis to obtain LC_{50} and LC_{90} values in ppb.

RESULTS

Susceptibility of *Cx. quinquefasciatus* larvae from both Mysore and Mandya against pyrethroids such as deltamethrin, cypermethrin and permethrin are presented in Table 1 and their LC_{50} and LC_{90} values are given in Table 2. Deltamethrin in concentrations of 0.032 ppb, 0.064 ppb, 0.096 ppb and 0.128 ppb produced an experimental mortality of 28.0%, 48.0%, 64.0% and 96.0% respectively, in the Mysore population with zero percent control mortality. In Mandya larvae, the same concentrations produced 13.3%, 45.0%, 72.9% and 89.8% mortality respectively, against 2.0%, 0.0%, 4.0% and 2.0% of control mortality. Concentrations of 0.2 ppb, 0.4 ppb, 0.6 ppb and 0.8 ppb of cypermethrin caused a mortality of 42.0%, 47.0%, 82.0% and 93.0% respectively, in Mysore larvae in contrast to 10.0%, 30.0%, 60.0% and 85.0% mortality respectively, in case of the Mandya population. Permethrin in 2.0 ppb, 4.0 ppb, 6.0 ppb and 8.0 ppb recorded a mortality of 5.0%, 36.0%, 77.0% and 86.0%, respectively, in Mysore larvae with 0% control mortality. In Mandya population same concentrations produced 6.0%, 30.0%, 70.0% and 85.0% mortality respectively. The differences in experimental mortalities between Mysore and Mandya populations were statistically significant ($p < 0.01$) in case of cypermethrin, while it was not so ($p > 0.05$) with most of the concentrations of deltamethrin and permethrin (Table 1). The LC_{50} and LC_{90} values showed (Table 2) that among the three pyrethroids tested, deltamethrin was the most effective and permethrin the least. The Mysore population was found to be less susceptible to all the three pyrethroids tested than the Mandya population (Table 1, 2).

DISCUSSION

Synthetic pyrethroids have been reported to be highly lethal to insects, exhibiting low mammalian toxicity and under normal conditions they may not be hazardous to man. They are photostable with a potentially valuable residual activity

Table 1

Effect of three pyrethroids on the larvae of *Cx. quinquefasciatus* of Mysore and Mandya.

Insecticides	Concentration (ppb)	Exposure time (hrs)	Mysore			Mandya			Difference in mortality (%)
			Test mortality (%)	Control mortality (%)	Experimental mortality (%)	Test mortality (%)	Control mortality (%)	Experimental mortality (%)	
Deltamethrin (2.5% wp)	0.032	24	28.00	0	28.00	15.00	2.0	13.3	14.7*
	0.064	24	48.00	0	48.00	45.00	0.0	45.0	3.0
	0.096	24	64.00	0	64.00	74.00	4.0	72.9	8.4
	0.128	24	96.00	0	96.00	90.00	2.0	89.8	6.2
Cypermethrin (1.0% EC)	0.2	24	42.00	0	42.00	10.00	0	10.0	22.0**
	0.4	24	47.00	0	47.00	30.00	0	30.0	17.0*
	0.6	24	82.00	0	82.00	60.00	0	60.0	22.0**
	0.8	24	93.00	0	93.00	85.00	0	85.0	8.0
Permethrin (25.0% EC)	2.0	24	5.00	0	5.00	6.00	0	6.0	1.0
	4.0	24	36.00	0	36.00	30.00	0	30.0	6.0
	6.0	24	77.00	0	77.00	70.00	0	70.0	7.0
	8.0	24	86.00	0	86.00	85.00	0	85.0	1.0

* $p < 0.01$; ** $p < 0.001$

Table 2

Larval LC_{50} and LC_{90} levels (in ppb) with fiducial limits* of *Cx. quinquefasciatus* exposed to pyrethroids.

Pyrethroid	Formulation (%)	Mysore population		Mandya population	
		LC_{50}	LC_{90}	LC_{50}	LC_{90}
Deltamethrin	2.5 WP	0.0189	0.0375 (0.0303 - 0.0420)	0.0660	0.1420 (0.4400 - 0.5200)
Cypermethrin	1.0 EC	0.3890	0.5740 (0.5340 - 0.6170)	0.4800	1.000 (0.4400 - 0.5200)
Permethrin	25.0 EC	4.5400	7.4800 (7.4800 - 9.400)	4.8000	9.200 (4.5000 - 5.2000)

* Figures in parenthesis indicate fiducial limits

(Mulla *et al,* 1980; Rajvanshi *et al,* 1982). Several reports are available on field and laboratory trials, indicating the efficacy of synthetic pyrethroids (Barlow *et al,* 1977; Thompson and Meisch, 1978; Mulla and Darwazeh, 1985; Rahman, 1989; Revanna and Vijayan, 1993; Vijayan *et al,* 1993) against vectors of public health importance. Verma and Rahman (1984) investigated the three pyrethroids cypermethrin, permethrin and decamethrin, comparing their efficacy with that of the natural pyrethrins and DDT, against the larvae of NICD (National Institute of Communicable Diseases) strain of *Cx. quinquefasciatus* in New Delhi. Anita and Pillai (1986) reported that K-othrine (deltamethrin) was highly toxic (LC_{50} = 0.166 ppb) to larvae of *Cx. quinquefasciatus* in Delhi. However, in the present study deltamethrin was found to be more effective on *Cx. quinquefasciatus* of both Mysore and Mandya (LC_{50} = 0.0189 and 0.0660 ppb respectively). Among the three pyrethroids tested deltamethrin was the most effective and permethrin was least effective. The data also indicate that these chemicals were highly effective even in lower doses than those recommended by WHO. So, such synthetic pyrethroids could become an alternative choice over the conventional organochloride and organophosphate compounds to control mosquito vectors under the existing situation.

The present investigation reveals that, the two populations tested are distinct with regard to their chemical susceptibility. This is true for other chemicals investigated (Gowda, 1993) in the same populations. As the Mandya population has been exposed to a spectrum of insecticides since many years by virtue of its vast stretch of irrigated lands, may be the reason behind the increased tolerance of the mosquito. Perusal of the literature shows that the Delhi population is more tolerant than the two Karnataka populations to deltamethrin. Thus, it is important to investigate such differential tolerance of various strains in order to unravel their susceptibility status. Such studies will be helpful in discovering the development of resistance by the vector species.

ACKNOWLEDGEMENTS

The authors are grateful to the Director, Vector Control Research Centre (ICMR), Pondicherry for providing the insecticides. Thanks are also due to the CSIR, Delhi, for the financial assistance and to the Chairman, Department of Studies in Zoology, University of Mysore, Mysore for the facilities provided.

REFERENCES

Anita T, Pillai MKK. Toxicity and irritability of K-othrine against four species of mosquitoes. *Entomol* 1986; 11 : 29-33.

Barlow F, Hadaway AB, Flower LS, Grose JEH, Turner CR. Some laboratory investigations relevant to the possible use of pyrethroids in mosquito and tse fly control. *Pesticide Sci* 1977; 8 : 291-300.

Curtis CF, Pasteur N. Organophosphate resistance in

vector population of *Culex pipiens* complex. *Bull Entomol Res* 1980; 71 : 153-61.

Dhanda V, Mourya DT, Mishra AC, *et al.* Japanese encephalitis virus infection in mosquitoes reared from field collected immatures and in wild-caught males. *Am J Trop Med Hyg* 1989; 41 : 732 - 6.

Elliot M, James NF, Poter C. The future of pyrethroids in insect control. *Ann Rev Entomol* 1978; 23 : 443-69.

Gowda NN. Ecology, insecticide susceptibility and some aspects of genetics of *Culex quinquefasciatus* Say (Diptera: Culicidae) in Mysore City. University of Mysore, India 1993; 166 pp.

Gowda NN. Ecology, insecticide susceptibility and Mysore City (Karnataka) - influence of certain physicochemical factors. Trends in Ecotoxicology, Proceedings of 10th Annual Session of AEB and Symposium on Environmental Pollution of Biosystems, Madras, 1990; 1 : 153 - 62.

Gowda NN, Vijayan VA. Indoor resting density, survival rate and host preference of *Cx. quinquefasciatus* Say (Diptera culicidae) in Mysore City, India. *J. Commun Dis* 1992; 24 : 20 - 8.

Gowda NN, Vijayan VA. Biting density, behaviour and age distribution of *Cx. quinquefasciatus* Say in Mysore City, India. *Southeast Asian J Trop Med Public Health* 1993; 24 : 152 - 6.

Miura T, Takahashi RM. Effect of a synthetic pyrethroid SD 43775, on non-target organisms, when utilised as a mosquito larvicide. *Mosq News* 1976; 30 : 322-6.

Mount GA, Haile DG, Pierce NW, Baldwin KP, Mulla MS, Trai SC. Aerosols of permethrin and propoxur for control of adult mosquitoes. *Mosq News* 1978; 38 : 39-42.

Mourya DT, Ilkal MA, Mishra AC, *et al.* Isolation of Japanese encephalitis virus from mosquitoes collected in Karnataka State, India from 1985-1987. *Trans R Soc Trop Med Hyg* 1989; 83 : 550-2.

Mulla MS, Darwazeh HA. Larvicidal activity of two new pyrethroids against mosquito larvae. *Bull Soc Vector Ecol* 1985; 10 : 1-6.

Mulla MS, Darwazeh HA, Majori G. Field efficacy of some promising mosquito larvicides and their effect on non-target organism. *Mosq News* 1975; 35 : 179-85.

Mulla MS, Darwazeh HA, Dhillon MS. New pyrethroids as mosquito larvicides and their effect on non-target organisms. *Mosq News* 1980; 40 : 6-12.

Priester C. Penetration of permethrin in larvae of *Cx. quinquefasciatus* and its relationship to knockdown and resitance. *J Econ Entomol* 1980; 73 : 165 - 7.

Rahman SJ. Role of synthetic pyrethroids in vector control. *J Commun Dis* 1989; 21 : 333-8.

Rajvanshi AC, Watal BL, Das M, Joshi GC. Laboratory evaluation of two new synthetic pyrethroids against larvae of five vector mosquitoes. *J Commun Dis* 1982; 14 : 52-6.

Revanna MA, Vijayan VA. Insecticide susceptibility of *Culex gelidus* Theobald, a Japanese encephalitis vector in Mysore. *Ann Entomol* 1993; (In Press).

Thompson GD, Meisch MV. Efficacy of permethrin as a larvicide and adulticide against rice field mosquitoes. *J Econ Entomol* 1978; 70 : 771-4.

Verma, KVS, Rahman SJ. Comparative efficacy of synthetic pyrethroids, natural pyrethrins and DDT against mosquito larvae. *J Commun Dis* 1984; 16 : 144-7.

Vijayan VA, Revanna MA, Vasudeva KS, Pushpalatha N, Poornima. Comparative susceptibility of two Japanese encephalitis vectors from Mysore to six insecticides. *Indian J Med Res* 1993; 97 : 215 - 8.

World Health Organisation. Instructions for determining the susceptibility or resistance of mosquito larvae to insecticides. *WHO/VBC/81.807,* 1981.