BETA-CYFLUTHRIN, A SYNTHETIC PYRETHROID FOR MOSQUITO CONTROL

V Vasuki and AR Rajavel

Vector Control Research Centre, Indian Council of Medical Research, Pondicherry - 605 006, India.

Abstract. Beta-cyfluthrin (OMS 3051), a new synthetic pyrethroid and one of the stereoisomers of cyfluthrin, was studied for insecticidal activity against eight mosquito species. Its larvicidal activity with LC_{50} values of 5.62×10^{-5} and 1.19×10^{-4} mg/l respectively for *Culex quinquefasciatus* and *Aedes aegypti* was comparable with that of deltamethrin. This pyrethroid was more effective against the larvae of *Armigeres subalbatus* (LC_{50} - 7.76×10^{-7}) and the adults of *Anopheles culicifacies* (LT_{50} - 27.76 min at 2.0 μ/cm^2) than the other species tested. Residual efficacy at 50 mg(ai)/m^2 was more persistent (for 14-25 weeks) on thatch and asbestos among the four treated surfaces. This compound also elicited oviposition deterrent activity at 0.001 mg/l against *Cx.quinquefasciatus*. β-cyfluthrin is a good insecticide for mosquito control. However, care should be exercised while using it as a larvicide in breeding habitats considering its toxicity to fish.

INTRODUCTION

Chemical insecticides are indispensable and effective means for controlling insects of medical importance particularly, in situations like epidemics and natural calamities (Ware, 1978). With an ideal of controlling insects with absolute selectivity, search for the development of newer insecticides with the best combination of properties continues. The photostable synthetic pyrethroids have the biologic potency to be considered as promising alternative insecticides (Elliott *et al*, 1974). It is of great importance to screen the effect of new pyrethroids against vector mosquitos, since their biological activity has been successfully demonstrated in houseflies (Lim and Visvalingam, 1990), tsetse flies (Spielberger *et al*, 1979), black flies (Shemanchuk, 1981) and cockroaches (Carter and Chadwick, 1978). Therefore, in the present study the biological potency of a new synthetic pyrethroid, β-cyfluthrin, was evaluated against important mosquito species.

MATERIALS AND METHODS

β-cyfluthrin (OMS 3051), cyano(4-fluoro-3-phenoxy-phenyl)-methyl-3-(2,2-dichloro-ethenyl)-2,2-dimethylcyclopropanecarboxylate, a stereoisomer of cyfluthrin was received gratis from Bayer through WHO in two different formulations as 2.5% EC and 5% WP. Immatures and adults of eight mosquito species, viz *Culex quinquefasciatus, Cx.sitiens, Cx.tritaeniorhynchus, Anopheles stephensi, An. culicifacies, Aedes aegypti, Armigeres subalbatus* and *Toxorhynchites splendens,* were obtained from the insectaries maintained at the Vector Control Research Centre, Pondicherry. Susceptibility of malathion resistant and malathion-fenthion resistant strains of *Cx.quinquefasciatus* was also determined. Standard procedures were followed to determine the susceptibility of larvae and adults (WHO, 1982).

A one percent stock solution of β-cyfluthrin was made from which other lower concentrations were prepared in ethanol. The desired concentration of test solution was achieved by adding 1 ml from an appropriate lower concentration solution to 249 ml tap water placed in a beaker (500 ml). Each test was replicated four times with not less than five concentrations. Twenty-five numbers of early fourth instar larvae of the test species were exposed and the mortality counts were recorded after 24 hours.

To assess the adulticidal efficacy of the compound, engorged female mosquitos were exposed to varying time intervals at a dose of 2μg/cm^2

(4μg/cm^2 in the case of *Tx.splendens*), and mortalities were recorded after 24 hours. From the percentage mortalities obtained in larvae and adults, LC_{50} and LT_{50} values were calculated by probit analysis (Busvine, 1971).

Residual efficacy of the compound was determined by considering >50% mortality, following the procedure described elsewhere (Rajavel *et al*, 1987) on four different surfaces (cement, mud, thatch and asbestos) treated at the rate of 50 mg(ai)/m^2. Oviposition deterrent activity of this pyrethroid was studied against *Cx. quinquefasciatus*, at concentrations 0.001, 0.01, 0.1 and 1.0 mg/l following the method reported earlier (Vasuki, 1990).

Toxicity of this pyrethroid against some non-target predatory fish species, viz *Poecilia reticulata, Gambusia affinis, Aplocheilus blochii* and *Sarotherodon mossambica* was also assessed by following the method of Mulla *et al* (1978).

RESULTS

Larvicidal potency of β-cyfluthrin against the larvae of mosquito species tested is given in Table 1. Among the eight species tested the larvae of *Ar.subalbatus* were found to be highly vulnerable whereas *An.stephensi* was least affected when exposed to the pyrethroid. This pyrethroid was found to be effective against the malathion-fenthion

Table 1

Larvicidal and adulticidal efficacy of β-cyfluthrin against mosquito species.

Species	LC_{50}(mg/l)	LC_{90}(mg/l)	Regression	X^2
	Larvae			
Cx.quinquefasciatus	5.62×10^{-5}	9.19×10^{-5}	30.46+2.60lnX	2.55
Cx.quinquefasciatus (Mal resistant)	2.04×10^{-4}	7.07×10^{-4}	13.76+1.03lnX	5.91
Cx.quinquefasciatus (Mal and Fen resistant)	8.13×10^{-5}	4.48×10^{-4}	12.06+0.75lnX	1.55
Cx.tritaeniorhynchus	1.93×10^{-4}	3.63×10^{-4}	22.27+1.93lnX	2.38
Cx.sitiens	1.49×10^{-4}	1.68×10^{-3}	9.66+0.53lnX	2.79
Ae.aegypti	1.19×10^{-4}	2.12×10^{-4}	25.16+2.23lnX	16.58
An.stephensi	0.11603	0.31596	7.63+1.171lnX	6.95
An.culicifacies	5.51×10^{-3}	0.47491	6.49+0.29lnX	3.38
Ar.subalbatus	7.76×10^{-7}	1.66×10^{-7}	6.49+0.29lnX	8.61
Tx.splendens	1.98×10^{-4}	5.21×10^{-4}	16.78+1.32lnX	18.22
	Adults*			
	LT_{50}(min)	LT_{90}(min)	Regression	X^2
Cx.quinquefasciatus	33.05	50.93	-5.35+2.95lnX	5.29
Cx.tritaeniorhynchus	31.29	53.40	-3.24+2.39lnX	21.02
Cx.sitiens	37.48	55.40	-6.87+3.28lnX	12.79
Ae.aegypti	39.92	60.27	6.46+3.11lnX	0.57
An.culicifacies	27.76	45.72	-3.52+2.56lnX	13.99
An.stephensi	34.51	78.90	-0.48+1.55lnX	16.18
Ar.subalbatus	34.52	49.94	-7.27+3.47lnX	6.61
*Tx.splendens***	32.57	65.47	-1.32+1.81lnX	2.41

Adulticidal efficacy determined at
*-2μg/cm^2
**-4μg/cm^2

resistant strain with a LC_{50} value almost equal to the normal strain of *Cx.quinquefasciatus.*

The adulticidal efficacy of this pyrethroid against the species tested is also presented in Table 1. *An.culicifacies* showed maximum susceptibility with an LT_{50} value of 27.76 minutes, while *Ae.aegypti* needed longer exposure time (39.92 minutes) for 50% mortality.

On analysing the residual activity of this pyrethroid it was found that the effect lasted for a longer period on asbestos and thatch surface than on the other two surfaces (Table 2). β-cyfluthrin was found to be more effective on the adults of *An.culicifacies* giving more than 90% kill for a maximum period of 11-14 weeks in all the treated surfaces. However, this compound did not show any residual effect on *Tx.splendens* at the rate of 50 mg/m^2.

When the gravid females of *Cx.quinquefasciatus* were allowed to oviposit on treated waters, no eggs were oviposited in any of the concentrations viz 0.001, 0.01, and 1.0 mg/l tested. But most of the gravid females were found dead on the treated water surface.

Four predatory fish species, non-target macro fauna, were found to be susceptible to this pyrethroid which produced 100% kill even at a dosage as low as 0.01 mg/l.

DISCUSSION

The larvicidal efficacy of several pyrethroids against mosquitos has been established (Das and Kalyanasundaram, 1984; Mariappan *et al,* 1985; Rajavel *et al,* 1987; Amalraj *et al,* 1987). Deltamethrin has been reported to be the insecticide of choice with promising activity for controlling insects of medical importance (Tessier, 1982). The results of the present study show that the larvicidal potency of β-cyfluthrin is comparable with that of deltamethrin (Fig 1).

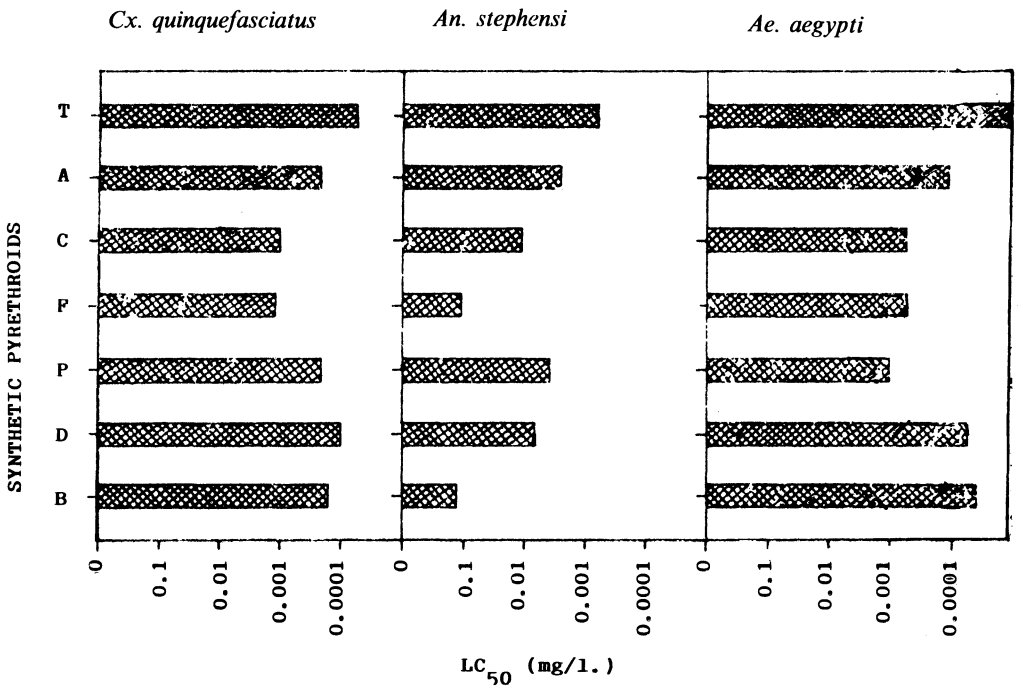

Fig 1—Comparative larvicidal efficacy of β-cyfluthrin with other synthetic pyrethroids (T - Tralomethrin; A - Alphamethrin; C - cyfluthrin; F - Fenfluthrin; P - Permethrin; D - Deltamethrin; B - β-cyfluthrin) against three vector mosquitos.

Table 2

Residual efficacy (in weeks) of β-cyfluthrin against eight mosquito species.

Species	Surfaces treated at the rate of 50 mg (ai)/m^2			
	Thatch	Mud	Cement	Asbestos
Cx.quinquefasciatus	21	9	11	18
Cx.tritaeniorhynchus	25	9	13	25
Cx.sitiens	25	18	18	24
Ae.aegypti	24	17	14	23
Ar.subalbatus	25	9	13	24
An.stephensi	16	9	10	17
*An.culicifacies**	14	11	11	14
Tx.splendens	0	0	0	0

*Residual efficacy based on > 90% mortality.

Table 3

Comparative residual toxicity of β-cyfluthrin with other synthetic pyrethroids.

Compound	Surfaces treated at the rate of 50 mg (ai)/m^2							
	Thatch		Mud		Cement		Asbestos	
	A	B	A	B	A	B	A	B
Tralomethrin	15	15	0	0	0	0	0	0
Cyfluthrin	12	12	5	7	1	2	0	0
β-cyfluthrin	25	16	9	9	11	10	18	17

A - *Cx.quinquefasciatus*
B - An.stephensi

The results also indicate that this compound has high potency in suppressing the adult population of vector mosquitos and similar activity has also been shown by other synthetic pyrethroids earlier (Rishikesh *et al,* 1978; Weidhass *et al,* 1982).

β-cyfluthrin showed longer residual effect (Table 3) when compared to other synthetic pyrethroids. Recently pyrethroids of allethrin series were also shown to possess rapid knock down effect and adequate heat stability (Smith, 1973).

Oviposition by an insect is brought about in three stages (i) orientation which may result in the insect's arrival on a surface because of its attraction or avoidance of a surface from repulsion. (ii) arrest of the insect at the surface after arrival, (iii) deposition of eggs. This pyrethroid influenced the second stage and exhibited deterrent effect on oviposition of *Cx.quinquefasciatus.* Verma (1986) has also observed strong deterrent effect in some synthetic pyrethroids like cypermethrin, fenvalerate, decamethrin and permethrin against *Cx.quinquefasciatus, Ae.aegypti* and *An.stephensi.* A high degree of mortality observed in gravid females which attempted to oviposit on surface treated with β-cyfluthrin, indicated contact toxicity for β-cyfluthrin similar to that shown by Saxena and Sharma (1972) for certain terpenoids against *Ae.aegypti.*

After the introduction of permethrin, the first potent photostable pyrethroid by Elliott and coworkers (1973), numerous photostable and thermostable pyrethroids have been widely recognized as one of the major groups of effective synthetic insecticides. β-cyfluthrin, with above mentioned properties, can be effectively employed in mosquito control in view of its adulticidal efficacy, residual toxicity and ovipositional deterrent activity. This pyrethroid may selectively be used as larvicide in various mosquito breeding habitats considering its toxicity to fish fauna.

ACKNOWLEDGEMENTS

Authors wish to thank Dr V Dhanda, Director, Vector Control Research Centre, Pondicherry, for the facilities provided, Dr PK Das, Deputy Director, for constant encouragement and guidance. The staff of insecticides section is gratefully acknowledged. Thanks are also due to World Health Organization, Geneva, for gratis supply of the insecticide.

REFERENCES

Amalraj D, Ramaiah KD, Rajavel AR, *et al.* Evaluation of alphamethrin, a synthetic pyrethroid for insecticidal activity against mosquitos. *Indian J Med Res* 1987; 86 : 601.

Busvine RJ. A critical review of the techniques for testing insecticides. London: Commonwealth Agricultural Bureau, 1971; 263-88.

Carter SW, Chadwick PR. Permethrin as a residual insecticide against cockroaches. *Pestic Sci* 1978; 9 : 555.

Das PK, Kalyanasundaram M. Evaluation of K-othrin, a synthetic pyrethroid for insecticidal efficacy against mosquito vectors. *Indian J Med Res* 1984; 80 : 74.

Elliott M, Farnham AW, Janes NF, Needham PH, Pulman DA, Stevenson JH. A photostable pyrethroid. *Nature* 1973; 246 : 710.

Elliott M, Farnham AW, Janes NF, Needham PH, Pulman DA. Synthetic insecticide with a new order of activity. *Nature* 1974; 248 : 710.

Lim JL, Visvalingam M. Relative potency of lamdacyhalothrin and cypermethrin applied as thermal fogs for the control of house flies *(Musca domestica)* and mosquito *(Aedes aegypti). Southeast Asian J Trop Med Public Health* 1990; 21 : 77.

Mariappan T, Kalyanasundaram M, Panicker KN, Balakrishnan N, Tyagi BK, Das PK. Evaluation of fenfluthrin (OMS 2013), a synthetic pyrethroid for insecticidal efficacy against mosquito vectors. *Indian J Med Res* 1985; 82 : 1.

Meeting of WHO collaborating centres on the evaluation and testing of new insecticides. *WHO/VBC/82* 1982 : 846.

Mulla MS, Navvab-Gojrati HA, Darwazeh HA. Biological activity and longevity of New synthetic pysethroids against mosquitoes and some non target insects. *Mosq News* 1978; 38 : 90.

Rajavel AR, Vasuki V, Paily KP, *et al.* Evaluation of a synthetic pyrethroid (Cyfluthrin) for insecticidal activity against different mosquito species. *Indian J Med Res* 1987; 5 : 168-75.

Rishikesh N, Clarke JL, Mathis HL, King JS, Pearson J. Stage IV: evaluation of five insecticides OMS-43 and S-1394, OMS-1825, OMS-1856 and OMS 1998, on anopheline mosquitoes in village huts near Kaduna, Nigeria. *WHO/VBC/78* 1978 : 689.

Saxena KN, Sharma RN. Embryonic inhibition and oviposition induction in *Aedes aetypti* by certain terpenoids. *J Econ Entomol* 1972; 65 : 1588-91.

Shemanchuk JA. Repellent action of permethrin, cypermethrin, and resmethrin against blackflies (Simulium spp) attacking cattle. *Pestic Sci* 1981; 12 : 412.

Smith CN. Pyrethrum for control of insects affecting man and animals. In: Casida JE, ed. Pyrethrum - the natural insecticide. New York: Academic Press 1973 : 225-41.

Spielberger U, Na'isa BK, Koch K, Manno A. Tse-tse and trypanosomiasis Division, Federal Livestock Department, PMB 2005 Kaduna, Nigeria. Field trials with the synthetic pyrethroids permethrin, cypermethrin, and deltamethrin against Glossina in Nigeria. *Bull Ent Res* 1979; 69 : 667.

Tessier J. Synthesis and physical-chemical properties of Deltamethrin. In: Deltamethrin Monograph, Roussel-Uclaf 1982; p 412.

Vasuki V. Ovipositional responses of vector mosquitoes to the IGR treated water. *Entomon* 1992; 16: (In press).

Verma KVS. Deterrent effect of synthetic pyrethroids on the oviposition activity of mosquitos. *Curr Sci* 1986; 55 : 373.

Ware GW. The pesticide book. San Franscisco: WH

Freeman and Company, 1978; p. 365.

Weidhass DE, Roberts RH, Swain LR Jr. Laboratory report: Insects affecting men and animals. Evaluation of decamethrin as ULV aerosols for control of adult mosquitoes. Laboratory Report. Research Laboratory USDA, SEA, FR, Gainesville, Florida USA. In: Deltamethrin Monograph. Roussel-Uclaf 1982; 412.