ADULT POPULATION DIFFERENCES IN RESPONSE TO SIX INSECTICIDES IN *CULEX FUSCOCEPHALA* THEOBALD

N Pushpalatha and VA Vijayan

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

Abstract. Adult bioassay was conducted in the laboratory on two populations of *Culex fuscocephala,* a vector of Japanese encephalitis (JE) in India, against two organochloride compounds (DDT and dieldrin), an organophosphate compound (malathion), a carbamate pesticide (propoxur) and two synthetic pyrethroids (deltamethrin and cyfluthrin) using WHO techniques. The adult populations from Mandya an irrigated agricultural area, and Mysore, a non-agricultural place in Karnataka, India, have been employed for the experiments. JE outbreaks were reported from these places at different times. Among the insecticides used malathion in 5% concentration was found to be the most effective while, cyfluthrin (0.05%) and deltamethrin (0.025%) were very effective in much lesser concentration. For both propoxur (0.1%) and DDT (4.0%) the two populations of *Cx. fuscocephala* expressed least susceptibility in terms of the LT_{50}. Against dieldrin (0.4%), cyfluthrin, DDT and malathion Mysore population showed relatively more susceptibility than Mandya population. However for deltamethrin and propoxur the Mandya population registered less tolerance than the Mysore population. Thus adult population responses to different insecticides are variable in the present study.

INTRODUCTION

The first outbreak of Japanese encephalitis (JE) was reported in India during 1955 in the North Arcot district of Tamilnadu (Work and Shah, 1956) and north eastern districts of Uttar Pradesh in 1978 (Mathur *et al,* 1982). Isolation of JE virus, in Kolar and Mandya districts (India) has been made from 10 species of mosquitos including *Culex fuscocephala* (Samuel *et al,* 1987; Dhanda *et al,* 1989; Mourya *et al,* 1989). Of late *Cx. fuscocephala* has been reported to be one of the important vectors of JE in Kolar and Mandya districts of Karnataka (Kulkarni *et al,* 1992). No information is available on the adult susceptibility of this important JE vector from Mandya and Mysore, two JE prone districts of Karnataka. A report from Kolar, another JE affected district of Karnataka showed that this species is susceptible to dieldrin, malathion, fenitrothion, deltamethrin and propoxur on the basis of 100% mortality in 1 hour treatment (Kulkarni *et al,* 1992). An earlier report from Pondicherry, India, shows that adults of *Cx. fatigans, Cx. whitmorei* and *An. subpictus* were highly resistant to DDT and dieldrin but susceptible to organophosphorous compounds and carbamate pesticides tested. Further, *Cx. tritaeniorhynchus,* in the same place was found to be resistant to Dieldrin (Das *et al,* 1980). Our earlier investigations on larval bioassays have revealed that, the mosquito populations of *Cx. quinquefasciatus, Cx. gelidus, Cx. fuscocephala,* and *Cx. tritaeniorhynchus* from Mandya, an irrigated agricultural district were more tolerant to various insecticides, than the Mysore population (Vijayan and Gowda, 1993; Vijayan *et al,* 1993; Revanna and Vijayan, 1993). In the light of available information on the increasing trend in insecticide tolerance under varied ecological situations the present investigation employing six insecticides was carried out during the year 1992-93 on two adult populations of *Cx. fuscocephala.*

MATERIALS AND METHODS

Adult susceptibility to different insecticides was determined as per the standard procedure recommended by the World Health Organization (WHO, 1981a). *Cx. fuscocephala* larvae from the paddy fields of Mandya and from natural habitats, such as ground pools and tanks of Mysore were collected and reared in the laboratory. Just emerged adults were used for the tests. Test kits along with the impregnated papers of certain insecticides from WHO were obtained from the National Malaria Eradication Program (NMEP), Delhi. Impregnated papers were also obtained from Roussel India Limited, New Delhi and Vector Control Research

Centre (ICMR), Pondicherry. For each test, 25 adults (some times 20 to 24) of the two populations were separately exposure to the insecticide impregnated paper for different exposure duration of 5, 10, 15, 30, 45, 60, 90, 120 and 160 minutes along with separate controls. Different time durations were maintained for various insecticides due to differential responses of the populations noted in the pilot experiments. Three to four replicates were maintained for each test. The mortality percentage was recorded 24 hours after the exposure period. Percentage mortalities were corrected against the control mortality (below 20%) using Abbot's formula (WHO, 1981b). LT_{50} and LT_{90} values were calculated by using probit regression analysis (Finney, 1971).

RESULTS

Differential mortality response of the two populations of *Cx. fuscocephala* tested against six insecticides is depicted in Fig 1 considering two time durations for each chemical. It is clear from the figure that cyfluthrin, deltamethrin and dieldrin insecticides are more effective in less duration of exposure in contrast to propoxur and DDT. Data on the differential susceptibility in terms of LT_{50} and LT_{90} along with the fiducial limits are provided in Table 1. Calculations were made on the basis of mortality noted in atleast three time durations for each chemical concentration. The LT_{50} values obtained for deltamethrin, cyfluthrin, dieldrin, DDT and propoxur in the Mysore population are 16.011783, 4.6999507, 25.953468, 69.213107 and 110.62544 minutes respectively in contrast to 12.901293, 11.0980381, 42.977428, 73.771617 and 93.747233 minutes respectively in the Mandya population. The results indicate that, the Mandya population is more tolerant by 1.65, 2.54 and 1.1 times to dieldrin, cyfluthrin and DDT respectively than Mysore population with respect to their LT_{50} values. However against the diagnostic doses of deltamethrin and propoxur the Mysore population was found to be more tolerant by 1.24 and 1.18 times respectively than the Mandya population. Malathion (5.0%) being quite high a concentration, both the populations recorded about 80% mortaliy in five minutes exposure. The results further reiterate the high efficacy of synthetic pyrethroids against mosquitos.

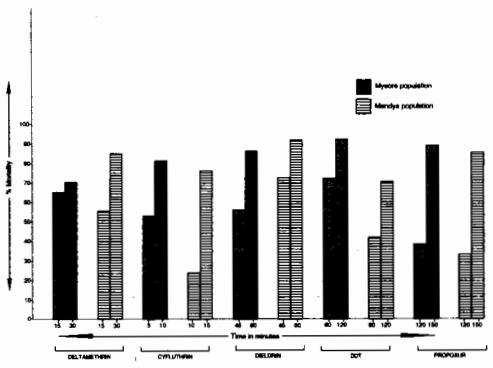

Fig 1–Differential susceptibility of two adult populations of *Cx. fuscocephala* to different chemicals.

DISSCUSSION

Bioassays on adult mosquitos done earlier were usually concentrated on the dose mortality relationships to determine the lethal doses. In the present investigation an attempt has been made to probe the effects of insecticides in terms of exposure time on a JE vector of local importance. Such studies would help to reveal the trend with respect to the increasing tolerance (if any) of different vector populations. Present results have revealed that, the two adult populations of the vector species behaved differently to different insecticides (Table 1). The Mandya population showed 2.54, 1.65 and 1.1 times more tolerance to cyfluthrin, dieldrin and DDT respectively compared to Mysore population. On the other hand the Mysore population registered 1.24 and 1.18 times more tolerance respectively to deltamethrin and propoxur than the Mandya population (Table 1).

Both the populations were equally susceptible to malathion. However our larval bioassay studies employing insecticides such as cypermethrin, deltamethrin, fenthion, fenitrothion, temephos and malathion on *Cx. quinquefasciatus, Cx. fuscocephala, Cx. tritaeniorhynchus* and *Cx. gelidus* (Vijayan and Gowda, 1993; Vijayan *et al,* 1993; Revanna and Vijayan, 1993; Vijayan and Revanna, 1994) have revealed that the Mandya population was more tolerant than the Mysore population.

Mandya being an irrigated agricultural place, the larval populations are exposed continuously to insecticide selection pressure, may be the reason for

Table 1

T_{50}* and LT_{90}* values (in minutes) with fiducial limits for adult females of two populations of Culex fuscocephala exposed to impregnated papers of six insecticides.

Insecticides	Concentration (%)	Mysore population				Mandya population			
		LT_{50}	Fiducial limits	LT_{90}	Fiducial limits	LT_{50}	Fiducial limits	LT_{90}	Fiducial limits
Deltamethrin	0.025	16.011783	14.345528 17.871577	41.943259	31.513833 55.824276	12.901293	10.951043 15.198856	40.192739	25.797465 62.620668
Cyfluthrin	0.05	4.6999507	3.7634886 5.869431	13.532433	9.522671 19.230607	11.980381	10.889632 13.180388	23.363467	20.258608 26.944182
Dieldrin	0.40	25.953468	22.762932 29.591201	65.245176	52.685329 80.799208	42.977428	38.135074 48.434654	159.16188	89.322424 283.60749
DDT	4.00	69.213107	63.247397 75.741507	126.14256	108.67315 146.42025	73.771617	67.213825 80.969225	134.66996	114.37976 158.55948
Propoxur	0.10	110.62544	103.66439 118.05391	166.63215	144.60082 192.02015	93.747233	71.848517 122.32046	143.9333	128.53004 161.1825
Malathion	5.00	**					**		

* By probit regression analysis.

** LT_{50} could not be calculated as 5 minutes exposure produced about 80% mortality.

their consistent tolerance. However, as the adults are not been subjected to such insecticidal pressures the behavior might not be the same in both the populations against the diagnostic doses of all the insecticides. However it is difficult to explain this differential behavior at this juncture. Further studies might explain any specific biochemical mechanism involved. Such differential tolerance of adult populations has also been reported by Chakraborti *et al* (1993) in *Aedes albopictus*.

Both the populations tested in the present study registered maximum sensitivity to synthetic pyrethroids in terms of both dosage and time duration (Table 1). Such an efficacy of these compounds have also been reported earlier (Elliot *et al,* 1978; Mulla *et al,* 1975; Mulla *et al,* 1980; Mulla *et al,* 1982; Mariappan *et al* , 1985; Anita and Pillai, 1986; Rajavel *et al,* 1987; Vijayan *et al,* 1993; Vijayan and Gowda, 1993; Vijayan and Revanna, 1994). Not much information is at hand about the bioassay results on *Cx. fuscocephala* except a report from Kolar, Karnataka (India) showing the susceptibility of this species (100% mortality) to dieldrin, malathion, fenitrothion, propoxur and deltamethrin after one hour exposure (Kulkarni *et al,* 1992). The present data further point-out that, both populations tested showed an increasing trend in tolerance against DDT, propoxur and dieldrin in terms of the LT_{90} values. This may herald the onset of development of resistance. Thus continuous monitoring of the vector population susceptibility has become a necessity, especially in agricultural areas such as Mandya where insecticides of different formulations are being indiscriminately used.

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