EVALUATION OF EMD VAPORIZERS AND BIOALLETHRIN VAPORIZING MATS AGAINST MOSQUITO VECTORS

D Dominic Amalraj, M Kalyanasundaram and PK Das

Vector Control Research Centre (ICMR), Medical Complex, Indira Nagar, Pondicherry-605 006, India.

Abstract. Different Electric-Mat-Device (EMD) vaporizers and bioallethrin impregnated mats were evaluated for the knockdown and mortality in the adults of *Culex quinquefasciatus, Anopheles stephensi* and *Aedes aegypti*. Percentage knockdown of 80-100 was recorded throughout the test period of 11 hours. However, the percentage mortality observed was not appreciable in all types of EMD vaporizers. Device "A" was found to be effective only against *Ae. aegypti*. Devices "C" and "D" showed moderate effects against *An. stephensi* and *Ae. aegypti*. Only device "B" was found to give appreciable mortality in all three vector mosquito species compared to other devices which may be attributed to the uniform release rate (2 mg/hour) of bioallethrin.

INTRODUCTION

Man-mosquito contact is one of the major components in the dynamics of disease transmission. The common methods presently used to reduce both man-vector contact and indoor resting density of vector mosquitos are burning mosquito coils and vaporizing mats impregnated with pyrethroids to volatilize small amount of insecticide in human dwellings. Though information on the bioefficacy of mosquito coils impregnated with synthetic pyrethroids against vector mosquitos is abundant (Maclver, 1963, 1964; Smith and Obudho, 1967; Chadwick, 1970, 1975; Smith *et al*, 1972; Rauch *et al*, 1974; Winner and Kuria, 1975; Charlewood and Jolley, 1984; Yap and Foo, 1984; Chen, 1985; Yap 1986; Bailey *et al*, 1987; Yap and Chung, 1987; Coene *et al*, 1989; Mosha *et al*, 1989; Yap *et al*, 1990), the same for the mosquito mats is scarce.

Even though mats containing pyrethroid when heated are known to cause knockdown and mortality in the mosquito vectors (Smith, 1973; Chadwick, 1975; Elliott *et al*, 1978), the exact mortality will depend on the amount of the compound released, which in turn to a greater extent depends on the type of heating devices. Several types of EMD vaporisers producing different ranges of temperature are available in the market but no information is available on the efficacy of these vaporizers on the effective duration of knockdown, repellency, or mortality in relation to release rate of the insecticide. Since the quantity of pyrethroid in the air determines mortality and alters the orientation of mosquitos towards the host (Chadwick, 1975; Chadwick and Lord, 1977; Yap *et al*, 1990), it is necessary to undertake a study on the release pattern with different heating devices. Hence, the present study was aimed to investigate significant differences in the protective period and rate of release of insecticide with different EMD vaporizers.

MATERIALS AND METHODS

Mats impregnated with bioallethrin [(1-R-trans) -2-methyl-4-oxo-3-(2-propenyl)-2-cyclopentene-1-yl-2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropanecarboxylate)] and four different Electric-Mat-Device (EMD) vaporizer units, received from National Organic Chemical Industries Ltd, India were used to study the bioefficacy against laboratory strains of *Culex quinquefasciatus, Anopheles stephensi* and *Aedes aegypti* under laboratory conditions. Analysis of bioallethrin with different heating devices at various time intervals of heating was performed.

Temperatures were measured on the upper surface of the heater pad using a small thermocouple. For estimating bioallethrin in mats at different periods of heating, individual mats were used in different heating devices and after known periods of heating, ie 1, 2, 4, 12 and 24 hours. Each mat was extracted with acetonitrile and the extract was analyzed for the concentration of bioallethrin using high performance liquid chromatography

(HPLC) using a UV detector at 230 nm with a 0.01 AUFS sensitivity. Acetonitrile: water (with 0.1% phosphoric acid) in the ratio of 70 : 30 was used as a mobile phase at the flow rate of 2 ml/minute and a C-8 RP column was used for the analysis.

The knockdown and mortality of adult mosquitos were examined in a Peet-Grady chamber (2 × 2 × 2 m). The mat was heated throughout the test period of 11 hours. Batches of 100 fed female mosquitos were released at hourly intervals and after 1 hour exposure, the number of mosquitos knocked down, alive and dead were collected and kept in a holding cage (0.3 × 0.3 × 0.3 m) with glucose pads for observing the mortality after 24 hours. The experiments were conducted from 1900 to 0500 hours for *Cx. quinquefasciatus* and *An. stephensi* and from 0700 to 1700 hours against *Ae. aegypti.* In order to simulate conditions of a well ventilated room, exhaust fan fitted in the Peet-Grady chamber was operated and two ventilation inlets in the bottom corners of the one wall were opened during the test period.

RESULTS AND DISCUSSION

Four types of EMD vaporizers coded as "A", "B", "C" and "D" showed temperature ranges of 95-115°C, 80-102°C, 68-75°C and 75-88°C respectively between the heater pad and the mat. The temperature fluctuations over a period of 8 hours are depicted in Fig 1.

During the analysis of bioallethrin in mats with different heating devices using HPLC technique, it was observed that the concentration of bioallethrin in different mats was found to vary significantly eventhough each mat was expected to contain an active ingredient of 40 mg. It was also noticed that the concentration of bioallethrin in the same mat was not uniformly distributed.

Results showing the amount of bioallethrin remained in a mat after different periods of heating with different vaporizers are depicted in Fig 2a. Devices "A" and "B" released bioallethrin uniformly and all the bioallethrin in the mat was released during 24 hours of heating. In the case of device "D", the release was high during the initial period of 4 hours and virtually no bioallethrin was released thereafter upto the 12th hour. Then there was a steady increase in the release upto 24th hour with more than 40% of bioallethrin available in the mat. This indicates that initial release for 4 hours is probably due to the depletion of the available insecticide on the outer surface and thereafter some time is required for diffusion of insecticide from the core to the outer surfaces.

There was a pronounced release rate of bioallethrin from the mat in the initial 1 hour period with device "C" and the release remained static at a very low level for the remaining period. In this case, the amount of material remained in the mat after 24 hours of heating was found to be over 80%. This could be probably attributed to the low temperature range which is insufficient to vaporize the insecticide.

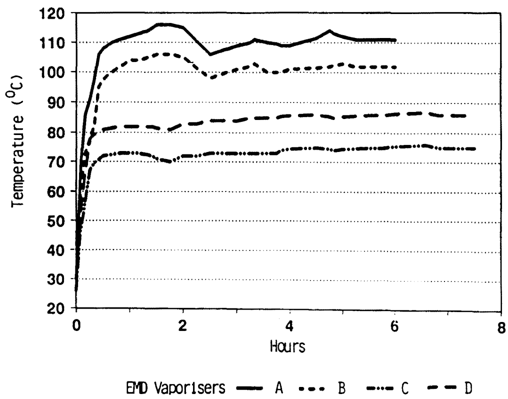

Fig 1—Temperatures recorded after switching on EMD vaporisers.

Results showing the rate of release of bioallethrin from the mat over different heating devices at different periods of hours are shown in Fig 2b. Device "A" elicited rapid initial release of about 4 mg/hour. Thereafter release rate of about 2.5 mg/hour was recorded till 12th hour and dropped to less than 1 mg/hour during the remaining period of heating. Though release rate was about 4.4 mg/hour in the first hour with device "C", release from the mat was found to be poor (0.5 mg/hour) throughout the remaining period.

In the case of device "D", there was a gradual decrease in release rate from 2.8 to 2.3 mg/hour in the first 4 hours and dropped to less than 0.3 mg/hour till the 12th hour. The rest of heating period recorded a release rate of over 1.3 mg/hour. As far as device "B" is concerned, the rate of release of

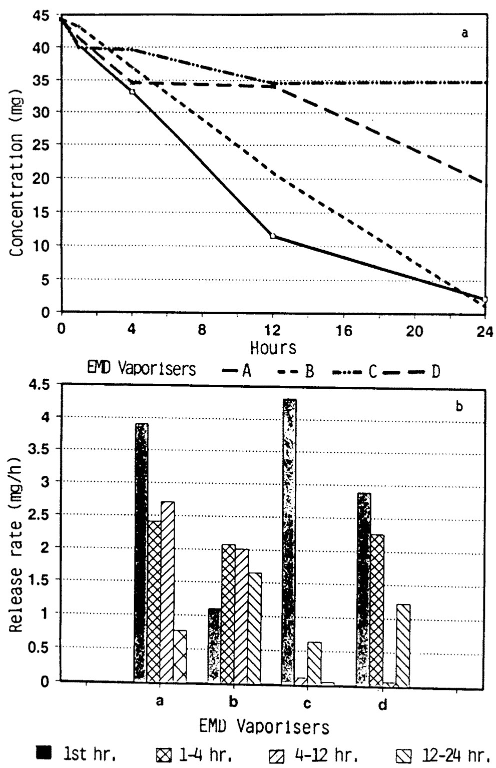

Fig 2—(a) The amount of bioallethrin remained in a mat after different periods of heating of EMD vaporisers.
(b) The release rate of bioallethrin after different hours of heating of EMD vaporisers.

bioallethrin was almost uniform centering around 2 mg/hour. A comparison of temperature produced by different heating devices with insecticide release rate indicates that a temperature range of 80-115°C is needed to get better performance.

Results showing the percentage knockdown and mortality by vapor by heating a mat containing 40 mg bioallethrin with different heating devices during the heating period of 11 hours in *Cx. quinquefasciatus, An. stephensi* and *Ae. aegypti* are shown in Figs 3 and 4. A percentage knockdown of 80-100 was recorded throughout the test period of 11 hours (Fig 3). Earlier studies on mats containing 88 mg allethrin showed a similar knockdown effect against caged *Ae. aegypti* in a 25 m^3 room (Chadwick and Lord, 1977).

Variable results were obtained with different heating devices regarding mortality in the mosquitos. Device "A" exerted mortality of little over 60 to 92% in *Ae. aegypti* during the test period. The data for *An. stephensi* and *Cx. quinquefasciatus* were 17-56% and 0-33% respectively. In the case of device "C", 55-95% mortality occurred in *Ae. aegypti.* As for *An. stephensi,* the mortality ranged from 30-100%. Mortality of only 5% was observed in *Cx. quinquefasciatus* for initial 4 hours and increased gradually to 88% at 9th hour. Device "D" could produce appreciable mortality only in *An. stephensi.* In contrary, over 90-100% mortality was recorded in *An. stephensi* when device "B" was used in heating the mat. The respective figures for *Cx. quinquefasciatus* and *Ae. aegypti* were 15-95% and 53-82%. The uniform release rate in this device could account for the mortality produced in all three mosquito vector species (Fig 4). This is in agreement with the earlier observations made by Maclver (1963) and Chadwick (1970).

The results of the present study imply significant efficacy of bioallethrin based mosquito mats with proper heating devices (80-115°C) in reducing indoor mosquito nuisance and indicate that use of mats could give 11 hours protection as against 8 hours with mosquito coils reported earlier (Yap *et al,* 1990).

ACKNOWLEDGEMENTS

The authors would like to thank Dr Vijai Dhanda, Director, Vector Control Research Centre, Pondicherry, India for having given us all support and facilities to carry out this study. We also thank National Organic Chemical Industries Ltd for having supplied the materials. Technical assistance rendered by Mr N Sivagnaname, Mr K Satyanathan and Mr N Patchayappan is gratefully acknowledged.

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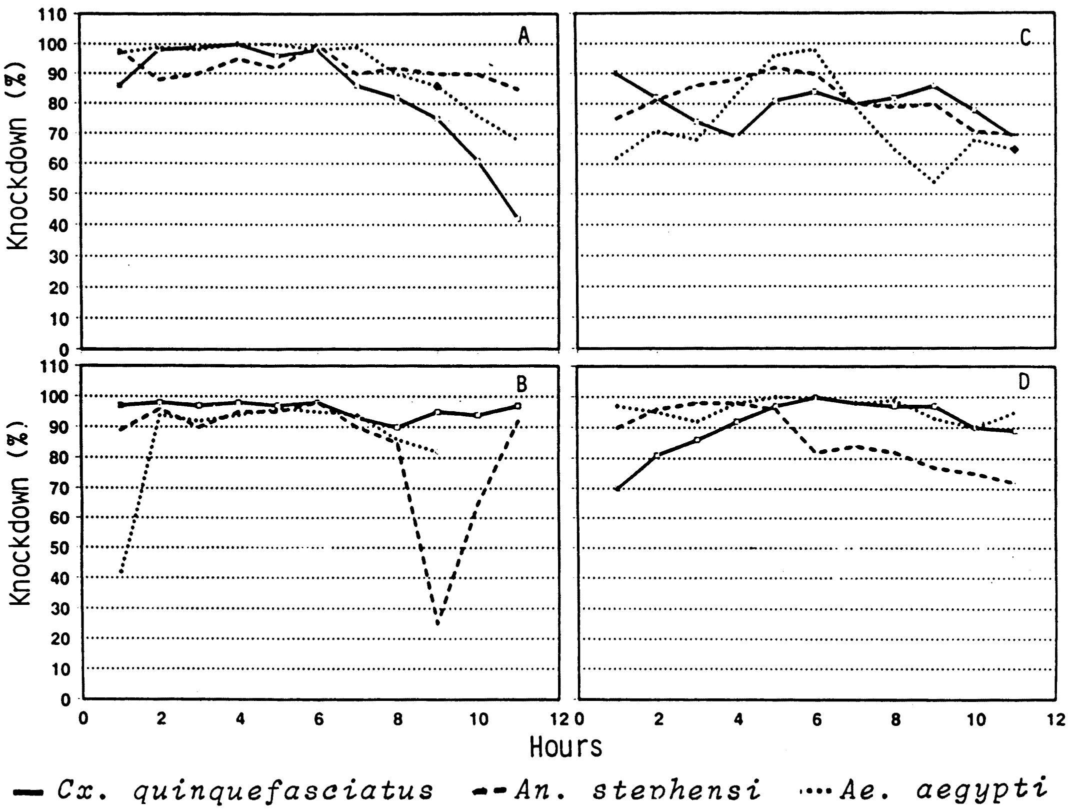

Fig 3—Percentage knockdown of three vector mosquito species using different EMD vaporisers (A, B, C, D).

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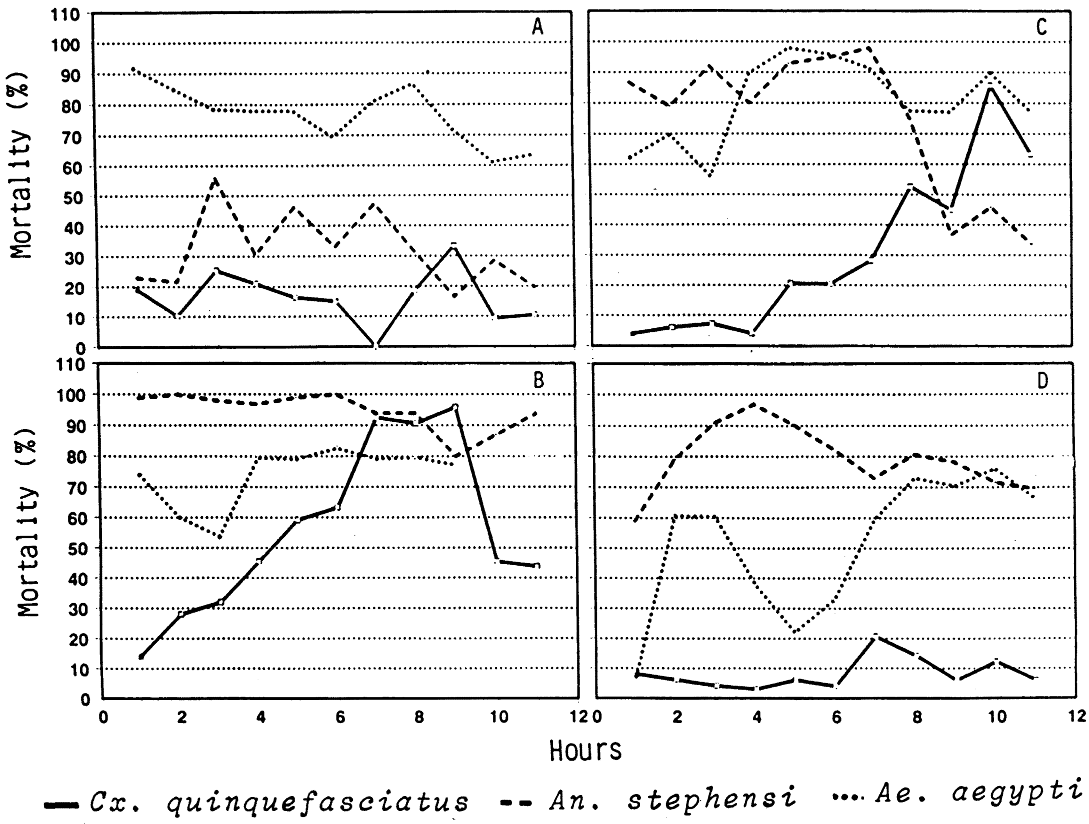

Fig 4—Percentage mortality of three vector mosquito species using different EMD vaporisers (A, B, C, D).

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