FIELD EVALUATION OF BIODEGRADABLE CONTROLLED RELEASE FORMULATION OF FENTHION AGAINST *MANSONIA* MOSQUITOS

MP Prasad, G Rajendran, S Sabesan and M Kalyanasundaram

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

Abstract. Controlled release monolithic formulation of fenthion, an organophosphorus mosquito larvicide, prepared by the physical entrapment of the active agent into biodegradable polymer matrices was evaluated against *Mansonia* mosquito larvae breeding in hydrophytes infested coconut husk retting ponds. Field evaluation was carried out at two application rates *viz*, 2.5 and 1.0 ppm. Absolute control of larval breeding was observed for 25 and 17 weeks and over 50% reduction in breeding density was observed for another 3 and 2 weeks for the respective application rates of 2.5 and 1.0 ppm. The bioassay carried out with the water samples collected from the ponds treated at 2.5 ppm against the fourth instar larvae of *Mansonia annulifera* showed larval mortality of more than 95% for 14 weeks and 80-95% from 15 to 25th week. The concentration of fenthion in the treated ponds was found to vary between 0.006 and 0.095 ppm during the evaluation period.

INTRODUCTION

An insecticide formulation which would allow controlled release of toxicant into an aquatic environment at levels sufficient to eliminate or effectively reduce larval mosquitos without causing any undue environmental effect would be a major contribution to mosquito abatement programs. The World Health Organization Expert Committee on Insecticides (1975) recommended that such formulations are likely to extend the effectiveness of less persistent insecticides and reduce environmental pollution.

The concept of controlled release polymeric formulations of larvicides has generated considerable interest. The literature pertaining to the use of controlled release formulations of mosquito larvicides has been extensively reviewed by Whitlaw and Evans (1968), Wilkinson *et al* (1971), Nelson *et al* (1974) and Cardarelli (1985).

The controlled release formulations of larvicides based on plastics and rubbers as entrapping matrices would result in the residual loss of the active agent within the matrix and such matrices may pose environmental magnification (Kydonieus, 1980). A few reports of controlled release formulations of larvicides using natural carrier materials are available in the literature (Schandle *et al*, 1976; Novak *et al*, 1985; Nisha *et al*, 1987 and Yoshiko *et al*, 1987).

Controlled release systems of larval control agents based on the physical entrapment in chemically modified natural polymers are promising as they are biodegradable and economic. This communication reports the results of the field evaluation of one of the formulations of fenthion, an organophosphorous larvicide based on its entrapment in crosslinked matrices of carboxymethylcellulose. The field evaluation was carried out against *Mansonia* mosquitos in coconut husk retting ponds infested with water plants.

MATERIALS AND METHODS

Formulations

Fenthion (O, O-dimethyl-O-4-methylthio-m-tolylphosphorothioate), an organophosphorus larvicide was obtained as 82.5% emulsifiable concentrate from Bayer India Ltd, Bombay (India). Commercial grade sodium carboxymethylcellulose of Gujchem Distillers India, Ltd, Gujarat was used. Initially, formulations were prepared in a neutral aqueous slurry of the polymer and the required amount of fenthion and dried sheets were made by solution casting and slabs of 4 × 4 cm size were cut followed by crosslinking of the slabs in the gelling agent (Prasad and Kalyanasundaram, 1991). Thus the formulated slabs, each containing approximately 1.0 g of fenthion were prepared for the field evaluation.

Study area

The field trial was conducted in a village at Shertallai Taluk, Kerala State, India, which is highly endemic for Brugian Filariasis transmitted by *Mansonia* mosquitos viz, *Ma. annulifera*, *Ma. uniformis* and *Ma. indiana* (Rajagopalan *et al* (1989). Coconut husk-retting ponds infested with water plants viz, *Pistia stratiotes, Salvinia molesta* and *Eichhornia crassipes,* the potential breeding habitat of Mansonioides were selected for the study. The depth of the ponds was 3-4 m in the center with an average depth of 1 meter and the surface area of 75 to 100 m^2.

Application of the formulation

The ponds were treated with fenthion slabs at two application rates, viz, 1 and 2.5 slabs per m^2 corresponding to 1 and 2.5 ppm of fenthion. Two ponds were selected for each application rate. The slabs were released uniformly to cover the entire area of the ponds. The application at 2.5 slabs per m^2 was carried out between July 1990 and February 1991 and the application at 1.0 slab per m^2 was carried out during December 1991 - June 1992. During each treatment, two ponds in the same area were selected as control.

Evaluation

The breeding densities of *Mansonia* larvae in the selected ponds were monitored two weeks prior to the application of the formulations. The larval densities in treated and control ponds were monitored after 24 hours of treatment followed by weekly intervals by standard procedures using specially designed cloth dipper by collecting the aquatic weeds (Rajendran *et al*, 1991; Krishnamoorthy *et al*, 1992). The percentage reduction in breeding density in the treated ponds was calculated by using the standard formula (Mulla *et al*, 1971),

Reduction in breeding density (%)

$$= 100 - [(C1/T1 \times T2/C2) \times 100]$$

where C1 and T1 are the pretreatment and C2 and T2 are the posttreatment larval densities in control and treated ponds respectively. Water samples (1 liter) were collected at weekly intervals for carrying out the bioassay against the field collected fourth instar larvae of *Mansonia annulifera* by standard procedure (WHO, 1981) and for the estimation of fenthion concentration. The evaluation was continued till the larval population in the treated ponds reached above 50% of the larval density in the control ponds.

Analysis of fenthion

The analysis was carried out using Shimadzu HPLC of model LC 3A (Japan) equipped with Zorbax-C8 column (4.6 mm id × 25 cm), column oven, UV detector and a C-R3A data processor. The mobile phase used for the analysis was acetonitrile-water (70 : 30) at a flow rate of 2 ml/minute. The column temperature was maintained at 60°C and the samples were detected at 249 nm. The water sample (10 ml) was extracted with dichloromethane (2 × 10 ml). The extract was dried over anhydrous magnesium sulphate and the solvent was removed using a Kuderna-Danish evaporator at 50°C. The residue obtained was dissolved in 2.0 ml of acetonitrile, filtered through a 0.5 μ PTFE membrane filter and 5 μl of the solution was injected to HPLC under the above column conditions. The retention time of fenthion was around 3.11 minutes under these column conditions. A two point calibration method with the help of the data processor was used for estimating fenthion concentration.

RESULTS AND DISCUSSION

The results of the field trial carried out at the application rate of 2.5 ppm in the coconut husk retting ponds harboring *Mansonia* mosquitos are presented in Fig 1. The average pretreatment larval densities in the ponds selected as control and the application of fenthion slabs were 813 and 703 larvae/dip respectively. The breeding density in the treated ponds was decreased to 20 larvae/dip after 24 hours of application with 97% reduction in breeding density. The breeding density was reduced to zero in the following week and continued for subsequent 25 weeks after treatment. From the 26th week onwards, the treated ponds were found to be positive for breeding and the larval density fluctuated between 5.5 and 177 larvae/dip upto 31st week. The larval density in the control ponds was found to fluctuate between 109 and 752 larvae/dip during the entire evaluation period of 31 weeks. Thus the application of fenthion slabs at 2.5 ppm showed absolute control of *Mansonia* breeding for

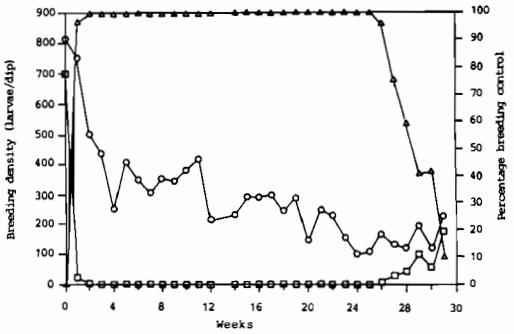

Fig 1–Average breeding densitities in the control ponds (o), treated ponds (□) and percentage breeding control (Δ) at the application rate of 2.5 ppm of fenthion.

25 weeks and more than 50% reduction in larval density compared to control for 28 weeks (Fig 1).

The results of the treatment of fenthion slabs at 2.5 slabs per m^2 corresponding to 2.5 ppm which showed effectiveness for more than 25 weeks prompted to undertake another trial at reduced application rate, *ie* 1.0 slab per m^2 corresponding to 1.0 ppm.

At the application rate of 1.0 ppm, the respective average pretreatment larval densities in the ponds selected as control and for treatment were 97.4 and 107.8 larvae/dip. The breeding densities in the control ponds fluctuated between 32.3 and 176 larvae/dip whereas the treated ponds were negative for *Mansonia* breeding for a period of 17 weeks after treatment followed by more than 50% reduction in breeding density for two more weeks (Fig 2).

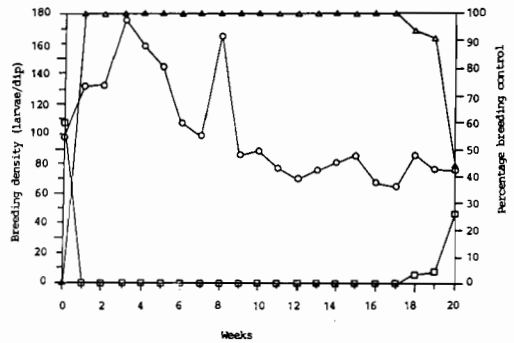

Fig 2–Average breeding densities in the control ponds (o), treated bonds (□) and percentage breeding control (Δ) at the application rate of 1.0 ppm of fenthion.

These results are comparable to the earlier observation made by Wilkinson *et al* (1971) with polyvinylchloride based fenthion formulations at 2.5 ppm against *Culex pipiens quinquefasciatus*. Krishnamoorthy *et al* (1992) reported the results of the field trial carried out with granular formulations of fenthion (Baytex 2G) in similar habitats for the control of Mansonioides. They noted control of larval breeding for 14 to 18 days at the application rate of 0.1 ppm.

The bioassay conducted with the water samples collected from the ponds treated at the application rate of 2.5 ppm of fenthion, against the fourth instar larvae of the field collected *Mansonia annulifera* showed more than 95% mortality for 14 weeks and the mortality fluctuated between 80 and 95% from 14 to 25 weeks. The analysis of fenthion concentration in the water samples was found to fluctuate between 0.006 and 0.095 ppm during the evaluation period.

Thus the biodegradable controlled release formulation of fenthion has been found to be effective for the absolute control of larval breeding for 25 weeks and 17 weeks at the respective application rates of 2.5 and 1.0 ppm. The concentration of fenthion in the treated ponds was less than 0.1 ppm during the entire period of evaluation. Since the application is restricted to twice a year, this formulation may play a useful role in large scale larval control programs because the cost of the control operations can be reduced by minimizing both the quantity of insecticide and manpower requirement and spray-equipments are not required for their application. Moreover, the possiblility of resistance development is minimal as the duration of larval exposure to sublethal concentrations of the larvicide is minimum. The polymer used for entrapment of the larvicide is biodegradable thereby eliminating the biomagnification of the insecticide and polymer as envisaged in the other nonbiodegradable formulations.

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