Field evaluation of lethal ovitraps impregnated with deltamethrin against dengue vectors in Lahore, Pakistan

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ABSTRACT

Vector-borne diseases keep on recurring whenever there is a peak season of vector population in tropical and sub-tropical areas of the world. Pakistan had a series of annual dengue epidemics since 2006. Various synthetic chemical compounds belonging to different classes of insecticides have been used to control the mosquitoes. The extensive usage of insecticides has toxic effects on the environment and non target organisms along with the development of resistance in vector population. Current study deals with the field evaluation of lethal ovitraps impregnated with various concentrations of deltamethrin (1.5% EC) which has been used extensively against the control of mosquito vectors in Lahore for the last two decades. The ovitraps were installed at the residential colony of Fisheries Research Centre, Manawan, Lahore. The results indicated that the ovitraps containing 20 ppm concentration were most effective for the control of Aedes population in selected locality. Furthermore, a significant decrease in the number of eggs was obtained in the treated groups ranging from 2.5-20 ppm of the insecticide.

Key words: Lethal ovitrap, Deltamethrin, Dengue vector.

INTRODUCTION

Dengue and malaria are two important diseases of public health problem in Pakistan. Mosquitoes belonging to the genus Aedes and Anopheles are responsible for these diseases in tropical and sub-tropical parts of the world including Pakistan. Mosquitoes of these two genera along with the Culex are abundant in the city of Lahore, Pakistan (Hameed & Jahan, 2007; Mumtaz & Jahan, 2010). Female mosquitoes transmit pathogens and parasites due to the blood sucking behavior. Different species of mosquitoes have got the potential to transmit various diseases. The two important species, Aedes aegypti (commonly known as yellow fever mosquito) and Ae. albopictus (Asian tiger mosquito) are involved in the spread of dengue fever in Asia (CDC, 2009), Eastern Mediterranean region, North and South America, Africa and Europe (O’Meara, 1997). Most of vector borne diseases have no proper treatment or vaccination. Therefore, vector control is the only option to control these diseases (Chandre, et al., 1999; Nauen, 2007). Traditionally, various synthetic chemical compounds belonging to different classes of insecticides are used to control the mosquitoes. Chemical control in the form of indoor-residual spraying and space spraying cause adverse effects on environment including their long term persistence, impact on non-target organisms, biomagnifications and development of
resistance in vector mosquitoes. It was necessary to find novel method for applying insecticides for controlling an epidemic of dengue. Use of lethal ovitraps (LOs) is a sustainable and environmental friendly method having less adverse effects on surrounding environment and is a novel tool for vector control, especially for container breeders such as *Aedes* mosquitoes. The current study deals with the field evaluation of LOs containing various concentrations of deltamethrin. Deltamethrin is a pyrethroid with a wide range of applications especially for the control of malaria and dengue vectors. It is a stable compound in the presence of atmospheric oxygen (Kidd & James, 1991) and it's mode of action is through direct contact by ingestion (Tomlin, 2006).

In an outbreak of any vector-borne disease or in any emergency situation, the insecticides provide an immediate halt to the expanding problem. In the last few years deltamethrin has been sprayed frequently as space spraying (ultra low volume or by thermal fog generator) in Lahore, Pakistan to control mosquito population.

The objectives of the current study were;

1. To evaluate the LOs impregnated with various concentrations of deltamethrin for the control of dengue vectors.
2. To find out the effective dose of deltamethrin in a specific locality of the Lahore city which can be used in nature for the control of dengue vector population

**MATERIALS AND METHODS**

**Study Site**

LOs impregnated with insecticide deltamethrin (1.5% EC) were evaluated for the control of *Aedes* population in the residential colony of Fisheries Research Complex, Manawan, Lahore (31° 35' 21.53" N; 74° 27' 55.74" E; 219m elevation) from June-September 2010.

**Preliminary Surveillance of Mosquito Vectors**

The indoor and outdoor surveillance of adult mosquitoes in the selected locality was carried out with the help of CDC back pack aspirator (John W. Hock Company, USA). Almost 85-90% of the collected mosquitoes were *Aedes albopictus* and 10-15% was *Culex* whereas, *Anopheles* were present in negligible numbers.

**Preparation of the Lethal Ovitraps and Ovipaddles**

For the preparation of LOs, plastic cups (10.5 cm high, 7.5 and 5.5 cm diameter of upper and lower rim respectively) were purchased from the local market. They were wrapped with black polythene sheet to make them attractive for mosquitoes. Two holes (2-3 mm wide) were drilled equidistant 2 cm below the rim. The ovipaddles which could serve as the oviposition substrate for the mosquitoes were prepared by taking tongue depressors (1.8 x 15 cm) of wood available from the local market and were covered with absorbent towel paper as described by Sarwar & Jahan (2010).

**Insecticide Formulation**

Deltamethrin 1.5% EC was kindly provided by Agriculture Directorate of Pest Management, Lahore. Test doses were selected on the basis of resistance / susceptibility assays against laboratory reared *Aedes albopictus*. The selected
concentrations (2.5, 5 and 20 ppm) were prepared in distilled water and applied through LOs prepared above in the study area.

**Placement of Lethal Ovitraps (Control vs. Treatment Block)**

The selected colony was divided into two blocks: control and treated. The two blocks were separated about 500m from each other. Control block consisted of 20 houses of the officers with a midst greenery, fish farms, hatcheries and experimental ponds while treated block consisted of about 50 houses of the employees. Control block received 18 ovitraps in pairs containing distilled water only whereas, treated block received 18 LOs in pairs treated with 2.5, 5, 20 ppm of deltamethrin.

**Sampling of Eggs from LOs and Plating of eggs**

The ovitraps were examined for the presence of eggs weekly. The ovipaddles containing eggs were wrapped in aluminum foil, kept in zipper plastic bags and brought to the entomological laboratory of Government College University, Lahore. The ovipaddles were allowed to dry at room temperature in the laboratory. The eggs were plated using separate camel hair brushes in the respective doses of deltamethrin and in control with only water. The cups were covered with fine net and tied with a rubber band. A complete record of control and treated cups was maintained up to the formation of adults in each cup.

**Data Analysis**

The data obtained as a result of placement of LOs in the field was analyzed using two parameters. i) The ovitrap positivity index (OPI) which is defined as percent positive ovitraps for the eggs from the total ovitraps examined i.e.

\[
OPI = \frac{\text{Number of positive lethal ovitraps}}{\text{Total number of lethal ovitraps inspected}} \times 100
\]

ii) The efficacy of LO (with each concentration of the used insecticide) in the collection of eggs evaluated as egg density index (EDI) and was calculated as average number of eggs laid per ovitraps both in control and treated ovipaddles.

\[
\text{EDI} = \frac{\text{Total number of eggs on ovipaddles}}{\text{Number of positive ovipaddles}}
\]

The data was statistically analyzed by analysis of variance (ANOVA) and by Tukey’s means of separation procedure test at 95% confidence interval of the difference (SPSS version 16.0; SPSS Inc., Chicago, IL).

**RESULTS**

The results of the field evaluation of LOs impregnated with various concentrations (2.5, 5 and 20 ppm) of deltamethrin (1.5% EC) are presented in terms of the number of LOs installed, total number of collections, ovitrap positivity index (OPI) along with number of eggs and egg density index (EDI) (Table 1). The surveillance result showed that the selected study site at Manawan, contained 85-90% of *Aedes* population (*Aedes albopictus*). Total 3,610 eggs of *Aedes* mosquitoes were harvested from 60 ovitraps in 10 weekly collections from July-September 2010. Treated ovitraps with 2.5, 5, 20 ppm of deltamethrin yielded significantly lowered (p<0.05) number of eggs (189, 87 and 61) as compared to respective (control) ovitraps containing water only (1019, 1305 and
LOs with 20 ppm were found highly significant in reducing the number of eggs (Fig. 1). Furthermore, total number of eggs obtained in August was greater (1483) as compared to July (813) and September (1314). Monthly variation of July, August and September indicated that there were 3, 13 and 24 times increase, respectively, in the number of eggs in control as compared to treated ovitraps (Fig. 2).

**Fig. 1:** Evaluation of lethal ovitraps in comparison of number of eggs of *Aedes*, ovitrap positivity index (OPI) and egg density index (EDI) with different treatment groups of deltamethrin (1.5% EC) compared with respective control in Manawan. Bars representing standard error of mean (SEM); * showing that values are significantly different in each group at p < 0.05.

Ovitrap positivity index (OPI) was recorded as 16.7, 6.7 and 5% against 2.5, 5 and 20 ppm in LOs as compared to 20, 26.7 and 23.3% in respective control groups (Table 1). These results indicated that the OPI was reduced by 3.3, 20 and 18.3% in treated groups against 2.5, 5 and 20 ppm, respectively, compared with corresponding control. It appeared that 20 ppm was highly effective in reducing OPI in Manawan (Fig. 1).

It was observed that number of eggs per ovipaddle (EDI) was reduced by 66, 59.8 and 47.5 in treated groups compared to control. Average 78.1 eggs were harvested per ovipaddle in control and 20.3 eggs from treated ovitraps (Table 1). Moreover, non-significant difference (P > 0.05) was noticed within treated groups (2.5-20 ppm). Any relationship between trends of OPI and EDI was not expressed by all concentrations of deltamethrin (Fig. 1). No pupa or adult emerged from different concentrations (2.5, 5, 20 ppm) of deltamethrin while 90% adults were emerged in control groups.

**DISCUSSION**

The current study evaluated LOs impregnated with different concentrations of deltamethrin in Manawan, Lahore. It was found that the treated ovitraps received significantly lower number of *Aedes* eggs as compared to their
respective control groups (P < 0.05). However, 20 ppm deltamethrin was found most effective to control *Aedes* population in the field where OPI (percent positive ovitraps) was least in number (05) as compared to 5 and 2.5 ppm of deltamethrin.

![Fig., 2: Comparison of number of *Aedes* eggs collected from lethal ovitraps from July –September 2010 in Manwan, Lahore. Bars representing standard error of mean (SEM); * showing that values are significantly different in each group at p <0.05.](image)

The effect of deltamethrin impregnated LOs was also studied in Thailand (Sithiprasasna, *et al*., 2003). The authors observed that the adult population of *Ae. aegypti* in three villages was effectively reduced by using LOs containing 1.0 mg of deltamethrin per oviposition strip. Significant reductions in female populations was observed in one of the selected villages and not found in other two villages (Sithiprasasna, *et al*., 2003). Moreover, the authors also found that LOs were specifically targeting *Ae. aegypti* population in the field. The LOs were also used in Brazil to observe the *Ae. aegypti* population measured by positive container index, mean number of pupae per house and population of adult mosquitoes (Perich *et al*., 2003).

Since mid-1990s, the outbreaks of dengue have taken place recurrently in most of the tropical / sub-tropical areas of the world. Continuous outbreak in Pakistan since 2006 is an alarming situation for the control of dengue vectors. There is a need to control the vector population at all stages of its development. By using LOs there is a minimum wastage of insecticide with no effect on non-target organisms as compared to insecticide spraying over large area by traditional methods to control mosquito population. Results from this study indicated that LOs containing deltamethrin (1.5 % EC) could serve as an effective dengue vectors suppression tool in Lahore, Pakistan.
REFERENCES


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Table 1: Evaluation of lethal ovitraps with various concentrations of deltamethrin (1.5% EC) against *Aedes albopictus* collected from Manawan, Lahore, (July to Sep., 2010).

<table>
<thead>
<tr>
<th>Treatment Groups</th>
<th>No. of LOs</th>
<th>Positive LOs</th>
<th>Total eggs</th>
<th>P – value (T vs C)</th>
<th>P – value (T vs T)</th>
<th>Eggs / LO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Installed</td>
<td>Collected (n)</td>
<td>(n)</td>
<td>OPI</td>
<td>(n)</td>
<td>Total</td>
</tr>
<tr>
<td><strong>C1</strong></td>
<td><strong>6</strong></td>
<td><strong>10</strong></td>
<td><strong>60</strong></td>
<td><strong>12</strong></td>
<td><strong>20.0</strong></td>
<td><strong>1019</strong></td>
</tr>
<tr>
<td><strong>T1 (2.5 ppm)</strong></td>
<td>6</td>
<td>10</td>
<td>60</td>
<td>10</td>
<td>16.7</td>
<td>189</td>
</tr>
<tr>
<td><strong>C2</strong></td>
<td>6</td>
<td>10</td>
<td>60</td>
<td>16</td>
<td>26.7</td>
<td>1305</td>
</tr>
<tr>
<td><strong>T2 (5 ppm)</strong></td>
<td>6</td>
<td>10</td>
<td>60</td>
<td>4</td>
<td>6.7</td>
<td>87</td>
</tr>
<tr>
<td><strong>C3</strong></td>
<td>6</td>
<td>10</td>
<td>60</td>
<td>14</td>
<td>23.3</td>
<td>949</td>
</tr>
</tbody>
</table>
| **T3 (20 ppm)** | 6 | 10 | 60 | 3 | 5.0 | 61 | **C=Control; C1=Control 1; C2=Control 2; C3=Control 3; T=Treatment; T1=Treatment 1; T2=Treatment 2; T3=Treatment 3;**
|                  | **n** | **Total** | ** eggs** | **(n)** | **OPI** | **n** | **Total** | ** P – value (T vs C)** | **P – value (T vs T)** | **EDI ±SEM** | **Average EDI** |
|                  | **C=Control; C=Control 1; C=Control 2; C=Control 3; T=Treatment; T=Treatment 1; T=Treatment 2; T=Treatment 3;**

*P-values indicating significant difference (p < 0.05) between treatment and respective control groups (T vs C) as number of eggs using ANOVA with Tukey's means of separation procedure, at 95% confidence interval of the difference.

†Indicating non-significant difference (p > 0.05) within treatment groups (T vs T) as number of eggs.