EFFICACY OF LAMBDA-CYHALOTHRIN (PYRETHROID INSECTICIDE) AGAINST MOSQUITO VECTORS (SPACE SPRAY APPLICATION)

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ABSTRACT

Study was conducted to evaluate the efficacy of Lambda-cyhalothrin (pyrethroid insecticide) against mosquito vectors of dengue haemorrhagic fever /DHF Aedes aegypti and urban lymphatic filariasis Culex quinquefasciatus. Four concentrations of active ingredient 3.75, 3.13, 2.50 and 1.88 g/ha (diluted in water) were evaluated for space spray, namely: thermal fog and Ultra Low Volume (ULV) applications. The study revealed that Lambda-cyhalothrin (concentrations of 3.75 and 3.13 g/ha) applied by using space spray methods, were effective in controlling dengue mosquito vector of Ae. aegypti (mortality 90.40-100.00%). Whereas, the concentration of 3.75 g/ha was effective against lymphatic filariasis mosquito vector of Cx.quinquefasciatus (mortality 90.00-100.00%), for both indoors and outdoors. It means that effective concentrations of lambdacyhalothrin insecticide for both space spray thermal fog and ULV methods application were more than three times of WHO recommendation 1.0 g/ha.

Key words: Efficacy, Lambda-cyhalothrin, space spray, mosquito.
INTRODUCTION

Vector borne diseases continue to be a major public health problem in Indonesia. Approximately 180 million people (80% of the population) are reported at risk of dengue/dengue haemorrhagic fever, mainly in the city and 150 million people at risk of lymphatic filariasis. The use of pesticides is an important component in the integrated approach to control vectors and pest of public health importance. Malathion, permethrin and cypermethrin insecticides, have been used for Dengue control program in Java and Bali mainly space spraying, whereas temefos used for larviciding (Laihat, F in WHO, 2006). Alternative insecticides are needed to be used in controlling either vector or nuisance insect house, which have been resistance by insecticide used before.

Pyrethroids (commonly known as synthetic pyrethroids) are insecticides, which were used in public health widely, because of their relative safety for humans and environment, high insecticidal potency at low dosage and rapid knock-down effects. Lambda-cyhalothrin (pyrethroid insecticide), have been recommended by WHO to be used in vector control programs as well as house hold insecticide products (WHO, 2005).

Space sprays are applied mainly as thermal fogs or cold fogs (Ultra Low Volume/ULV). Thermal fogs, technically a fog (sometimes referred as an aerosol), is a liquid insecticide dispersed into the air to be a millions of tiny droplets less than 50µm in diameter. It is only effective when the droplets remain airborne. Basically, the insecticide which used in thermal fogs is diluted by oil or water as a carrier. The volume of spray mixture applied in vector control is usually 5-10 liters per hectare. Hot gas is used to heat the pesticide spray, decreasing the viscosity of the oil carrier, and vaporizing it. Most of the droplets are smaller than 20µm. The droplet size is effected by the interaction between the formulation, flow rate and temperature at the nozzle (usually >500°C). Fog is produced when aerosol droplets, having a diameter less than 15µm, fill a volume of air such an extent that visibility is reduced. The obscuring power of a fog is greater when droplets are 1 µm in diameter. Insecticides are applied as fog, is particularly useful for control of flying insects, not only through contact with droplets, but also by the fumigant effect of a volatile pesticide.

Ultra Low Volume (ULV), application of insecticide is as efficacious against adult mosquitoes as high volume (HV) or low volume (LV) aerosols. The degree of mosquito kill obtained with any insecticide application is related to the dose of active ingredient and many other application and environmental factors but not to application volume. Inert ingredients such as water or oil diluents do not kill mosquitoes. Technology of ULV offers an increased insecticide payload for more rapid application and increased safety by elimination of dense fogs created by thermal fogging. The efficacy of ULV aerosol against adult
mosquitoes is related to droplet size/diameter because it governs air transport optimum for mosquitoes is 8-15 µm (WHOPES, 2003).

A study was conducted to determine the efficacy of Lambda-cyhalothrin insecticide applied by using space spraying methods against mosquito vectors of *Aedes aegypti* and *Culex quinquefasciatus*.

**MATERIAL AND METHOD**

Location and time of the study.
Field space spraying applications were conducted in Mangunsari Village, Sub district Sidomukti, Salatiga. Laboratory observation was carried out in the Institute for Vector-Reservoir Control Research and Development (IVRCRD), Salatiga Municipality. The study was done on: October-December 2009.

**Tested Insects and insecticide:**
- Mosquitoes *Aedes aegypti* and *Culex quinquefasciatus*, laboratory culture (3-4 days old, stuffed with sugar liquid).
- Insecticide pyrethroid (active ingredient: Lambda-cyhalothrin), formulation (EC).

**Equipment and materials:**
Mosquito boxes, testing cages (12x 12x12cm), thermometer, hygrometer, plastic cups, forceps, timer, aspirator, cotton wool, rubber band, towels, beaker glass and measurement glass, thermal fog machine of IGEBA Type TF35 (Nozzle size 0.8 mm); Ultra Low Volume (ULV) machine.; FONTAN (Nozzle size 2L).

**Method :**
1. Experiment design:
   Randomized Completely Block Design (RCBD), 10 (ten) replication;  25 individuals’ mosquitoes of *Ae. aegypti* or *Cx. quinquefasciatus* for each replicate (mosquito’ cage).

2. Testing: 10 houses as replicates.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Application thermal fog &amp; ULV3 (a.i: g/ha)</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.75</td>
<td>Each concentration was added with water up to 5 liters2</td>
</tr>
<tr>
<td></td>
<td>3.13</td>
<td></td>
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<tr>
<td></td>
<td>2.50</td>
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<td></td>
<td>1.88</td>
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</table>

1/. a.i: active ingredient/technical grade of the insecticide
2/. Volume of solution which is applicable for thermal fog & ULV machines
3/. ULV: Ultra Low Volume

**Assessment of efficacy**
Ten houses situated on the same lane were chosen for assessing each dilution rate formulation. Efficacy for each concentration is assessed at two check points for each house (indoor and outdoor), with adult mosquitoes in cages. Insecticide efficacy was determine by keeping twenty five mosquitoes of each species (2-4 days old, glucose-fed), in cube cages (constructed of fine mesh material with wire frame support of 12x12x12 cm).
Four (4) cages of each mosquito species were placed indoors and outdoors, in different location (without application) as untreated control.

The mosquito cages were hung (approximately 1.6 meters above ground) at each checkpoint. After mosquito’ cages were placed indoors and outdoors (which were selected for bioassay test), space spraying application, was carried out in the test area by using thermal fog machine of IGEBA type TF35 (with Nozzle size 0.8 mm) or ULV machine of FONTAN (Nozzle size 2L).

Outdoors space spraying was conducted at operator’s walking speed of 2 km/hour and not directly aimed at target mosquitoes (at a distance of 2-3 meters).

Observation:
The knockdown of tested mosquitoes was read at 5, 10, 15, 30, 45 and 60 minutes post-spraying. After field exposure, the mosquitoes were transferred into clean plastic cups, provided of 10% sugar pad and brought back to the laboratory for holding. Mosquitos’ mortality was recorded at 24 hours post treatment.

Criteria efficacy was determined as knock down time of 50% and 90% (KT50 and KT90) of the number of tested mosquitoes (calculated based on the data corrected by knock down and mortality of the untreated control by using Abbot’s formula (Yap et al. 1997). .

Data analysis:
Probit analysis of knocked-down and mortality of tested mosquitoes was made by using computer program of SPSS Version 11.0 to determine KT50/KT90 and LC50/LC90. The comparison of the toxicities among concentration was made descriptively based on the percentage mortality of each treatment. The result of the insecticide evaluation is considered good (effective), if the mortality rate is within the range of 90.00–100.00%.

RESULT

Table 1, presents the efficacy of Lambda-cyhalothrin, thermal fog application (KT50 & KT90) and average mortality of tested mosquito of *Ae. aegypti* and *Cx. quinquefasciatus*. Regression of the insecticide’ concentration and mosquito mortality is displayed visually in Figure 1.

Table 2, presents the efficacy of Lambda-cyhalothrin, ULV application (KT50 & KT90) and average mortality of tested mosquito of *Ae. aegypti* and *Cx. quinquefasciatus*. Regression of the insecticide’ concentration and mosquito mortality is displayed visually in Figure 2.

Based on the probit analysis (KT50), of the evaluated concentrations of lambda-cyhalothrin (3.75; 3.13; 2.50 and 1.88 g/ha), applied by using thermal fog method against *Ae. aegypti* indoors were respectively in 11.9; 24.7; 47.0 and 172.0 minutes. The average mortality of this species for each concentration was respectively 100.00; 100.00, 89.20 and 77.60%. Whereas, outdoors (KT50) were revealed slower, in 17.8; 38.4; 66.7 and 194.3 minutes with mortality rates were recorded as 100.00; 90.40; 80.00 and
55.20%, respectively (Table 1). Knock down time (KT50), of lambda-cyhalothrin (concentrations of 3.75; 3.13; 2.50 and 1.88 g/ha), applied by using thermal fog against *Cx. quinquefasciatus* indoors were respectively in 32.3; 51.1; 104.7 and 121.9 minutes. The average mortality of this species was respectively 100.00; 81.20; 64.00 and 63.60%. Whereas, outdoors (KT50) were 66.0; 98.2; 146.1 and 291.5 minutes, with mortality were recorded as 93.20; 60.40; 53.60 and 51.60%, respectively (Table 1).

Knock down time (KT50), evaluated concentrations of lambda-cyhalothrin (3.75; 3.13; 2.50 and 1.88 g/ha), applied by using ULV method, against *Ae. aegypti* indoors were respectively in 12.3; 26.0; 44.5 and 57.3 minutes. The average mortalities of this species were respectively 100.00; 100.00; 76.40 and 73.20%. Whereas, outdoors KT50 were 17.7; 31.3; 57.3 and 61.5 minutes, with mortality rates was recorded as 100.00; 100.00; 74.40 and 64.40%, respectively (Table 2).

Table 1. Knocked-down time (KT50 & KT90)¹ and mortality rate of tested mosquitoes of *Ae. aegypti* and *Cx. quinquefasciatus*, after thermal fogging application of Lambda-cyhalothrin insecticide.

| Tested Mosquito | Concentration (a.i: g/ha) | Indoors Observation (Minutes) | | Outdoors Observation | |
|-----------------|---------------------------|-------------------------------|------------------------|---------------------------------|
|                 |                           | KT<sub>50</sub> | KT<sub>90</sub> | Mortality (%) | KT<sub>50</sub> | KT<sub>90</sub> | Mortality (%) |
| *Aedes*<sup>1</sup> | 3.75                      | 11.9           | 37.9           | 100.00        | 17.8          | 56.6           | 100.00        |
|                 | 3.13                      | 24.7           | 57.2           | 100.00        | 38.4          | 138.5          | 90.40         |
|                 | 2.50                      | 47.0           | 165.1          | 89.20         | 66.7          | 270.3          | 80.00         |
|                 | 1.88                      | 172.0          | 1577.2         | 77.60         | 194.3         | 1695.3         | 55.20         |
| *Culex*<sup>2</sup> | 3.75                      | 32.3           | 114.2          | 100.00        | 66.0          | 297.4          | 93.20         |
|                 | 3.13                      | 51.1           | 163.7          | 81.20         | 98.2          | 424.6          | 60.40         |
|                 | 2.50                      | 104.7          | 455.4          | 64.00         | 146.1         | 513.7          | 53.60         |
|                 | 1.88                      | 121.9          | 327.9          | 63.60         | 291.5         | 1226.1         | 51.60         |

¹/Probit analysis of knock down tested mosquitoes (60 minutes observation)

2/ *Aedes aegypti*

3/ *Culex quinquefasciatus*
Table 2. Knocked-down time (KT50 & KT90)¹ and mortality rate of tested mosquitoes of *Ae. aegypti* and *Cx. quinquefasciatus*, after ULV application of Lambda-cyhalothrin insecticide.

<table>
<thead>
<tr>
<th>Tested Mosquito</th>
<th>Concentration (a.i: g/ha)</th>
<th>Indoors Observation (Minutes)</th>
<th>Outdoors Observation</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>KT50</td>
<td>KT90</td>
</tr>
<tr>
<td><em>Ades</em>¹</td>
<td>3.75</td>
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<tr>
<td></td>
<td>1.88</td>
<td>57.3</td>
<td>163.9</td>
</tr>
<tr>
<td><em>Culex</em>²</td>
<td>3.75</td>
<td>138.0</td>
<td>979.5</td>
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<tr>
<td></td>
<td>3.13</td>
<td>218.0</td>
<td>1242.0</td>
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<td></td>
<td>2.50</td>
<td>304.4</td>
<td>3126.9</td>
</tr>
<tr>
<td></td>
<td>1.88</td>
<td>322.1</td>
<td>1910.6</td>
</tr>
</tbody>
</table>

¹/Probit analysis of knock down tested mosquitoes (60 minutes observation)  
²/ *Aedes aegypti*  
³/ *Culex quinquefasciatus*

Knock down time (KT50) of tested mosquitoes for evaluated concentrations of lambda-cyhalothrin (3.75; 3.13; 2.50 and 1.88 g/ha) applied by using ULV method against *Cx. quinquefasciatus* indoors were 138.0; 218.0; 304.4 and 322.1 minutes respectively.

The average mortality of this species was respectively 90.00; 60.00, 52.80 and 46.80%. Whereas, outdoors knock down time (KT50) were 165.7; 190.3; 202.4 and 236.2 minutes with mortality rates were recorded as 90.00; 51.20; 47.20 and 34.80%, respectively (Table 2).
DISCUSSION

Knock down time (KT50) tested mosquito’ *Ae. aegypti* post exposure of Lambda-cyhalothrin (concentrations of 3.75 and 3.13 g/ha), diluted with water, applied by using thermal fogging were 11.9 and 24.7 minutes for indoors, 17.8 and 38.4 minutes for outdoors. Both concentrations were effective to kill mosquito *Ae. aegypti* indoors and outdoors, with average mortality was 90.4-100% (Table 1). It means that both concentrations 3.75 and 3.13 g/ha of Lambda-cyhalothrin are effective to be used in controlling mosquito vector of *Ae. aegypti*.

The results of probit analysis knock down time (KT50) of tested mosquito’s, shows that only concentration of 3.75 g/ha of Lambda-cyhalothrin (water diluted), applied by using thermal fogging was effective against *Cx. quinquefasciatus* indoors and outdoors. The average mosquito’ mortality was recorded 100.00% indoors and 93.20% outdoors, whereas KT50 were 32.4 and 66.0 minutes, respectively (Table 2). This result shows that only single concentration of 3.75 g/ha was effective to be used in controlling mosquito vector of urban lymphatic filariasis *Cx. quinquefasciatus*.

Knock down time (KT50) of tested mosquito’ *Ae. aegypti* post exposure of Lambda-cyhalothrin (concentrations of 3.75 and 3.13 g/ha), water diluted, applied by using ULV method were 12.3 and 26.0 minutes for indoors, 17.7 and 31.3 minutes for outdoors. Both concentrations were effective to kill tested mosquito of *Ae. aegypti* both indoors and outdoors, with 100.00% mortality (Table 2). It’s mean that both concentrations were effective to be used in controlling mosquito vector of *Ae. aegypti*. The evaluation was revealed that only concentration of 3.75 g/ha of Lambda-cyhalothrin (water diluted), applied by using ULV effective against *Cx. quinquefasciatus* indoors and outdoors, whereas the mortality was recorded 90.00% (Table 2).

Probit analysis of tested mosquito’ mortality shows that the lowest lethal concentration (LC90) of Lambda-cyhalothrin applied by using thermal fog against *Ae. aegypti* and *Cx. quinquefasciatus* were respectively 2.45-2.93 g/ha and 4.05-6.25 g/ha. Even though, for ULV application the LC90 higher, 3.03-3.18 g/ha and 5.46-5.39g/ha, were respectively for *Ae. aegypti* and *Cx. quinquefasciatus*, (Figures 1&2).

Lambda-cyhalothrin concentration recommended by WHO to be used in space spray (thermal fog and ULV) is 1.0 g/ha (WHO recommendation in Chavasse and Yap, 1997). It’s mean that effective concentration to be applied by space spray against both mosquito vectors *Ae. aegypti* and *Cx. quinquefasciatus* is 3-5 times higher of WHO recommendation.

CONCLUSION

The study revealed that Lambda-cyhalothrin (concentrations of a.i. 3.75 and 3.13 g/ha) applied by using space spray methods, were effective in controlling dengue vector of *Ae. aegypti* (mortality 90.40-100.00%). And for concentration of 3.75 g/ha was effective against lymphatic filariasis vector of *Cx.quinquefasciatus* (mortality 90.00-100.00%).
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