

Laboratory study on the effect of deltamethrin WG and WP formulations against *Anopheles maculatus* Theobald (Diptera:Culicidae) on rough and smooth surfaces of bamboo wall

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Abstract. Adults of *Anopheles maculatus* were tested for their residual activity to wettable powders (WP) and water dispersible granule (WG) formulations of deltamethrin. The residual effectiveness and lifespan of deltamethrin WG and WP were also assessed against the mosquitoes using rough and smooth surfaces of bamboo. Tests were conducted once a month up to 14 months after spraying using WHO standard method for the bioassay of insecticidal deposits on wall surfaces. Mortality data revealed that both deltamethrin WG and WP were effective against *An. maculatus* up to 14 months post-spraying. Efficacy and residual activity of deltamethrin WG at 25mg/m² had proved to be the longest on both rough and smooth surfaces of bamboo.

INTRODUCTION

Malaria Eradication Programmed (MEP) was first launched in Malaysia in 1968, which involved case detection, drug administration, and indoor insecticide residual spray. For the last 30 year, the programme had generally been successful in eliminating the disease nation-wide. At present, Malaysia in general has achieved significant success in the control and elimination of malaria as a public health problem. Malaria now is essentially a problem confined to the rural areas affecting the aborigines and traditional villages (VBDCP, 2005).

Deltamethrin, a pyrethroid is frequently and widely used for indoor residual spraying of house surfaces to control malaria vectors. In Malaysia, deltamethrin wettable powder (WP) has replaced DDT as the main pyrethroid used

in residual spraying since 1988. This compound generally is applied in two spray rounds per year in malaria-endemic areas (VBDCP, 1988). However, malaria control programmes utilizing indoor residual spraying are only effective if a high coverage of targeted area is achieved and an insecticide that is effective against the specific mosquito vector is correctly applied. Efficacy and residual activity of most insecticides is affected by the chemical nature of the sprayed surfaces. Insecticide effect is also dependent on proper application, which in turn is affected by various factors such as the equipment used and the individual skills of the spray persons. For each insecticide, standard deposits are recommended for sprayed surfaces.

New safe insecticide or formulation with longer residual effect on any possible surfaces could overcome this issue.

Deltamethrin WG is a water dispersible granule formulation of a broad-spectrum, fast-acting, water-dilutable pyrethroid for surface application. It is an alternative to liquid (suspension concentration) and a successor to solid (wettable powder) deltamethrin formulations. It has the advantages of reduced operator exposure, easy to handle, reduced bulk thus reducing storage and transport costs.

The objective of this study is to determine the residual efficacy of deltamethrin WG and deltamethrin WP against *An. maculatus* on rough and smooth surfaces of bamboo.

MATERIALS AND METHODS

The wettable powder (WP) and water dispersible granule (WG) formulations of deltamethrin (25% w/w) were supplied by Bayer Environmental Sciences, Malaysia. Efficacy of the deltamethrin were assessed using thatched bamboo of 1m by 2m. Doses of 20mg/m² WP, 20 mg/m² WG and 25mg/m² WG were sprayed separately on rough or smooth surfaces of bamboo wall using an Oxford Precision Sprayer (Hudson X-pert 3 gallon) with a discharge rate of 10ml/sec. The discharge rate was obtained by calibrating the nozzle with water. The pump was operated to ensure working pressured is reached. Then, the water discharged was measured. The procedure was repeated three times to calculate the discharged rate per minute. For control, water was used to replace deltamethrin. The wall was left to dry for at least 24 hours before the first trial. The size of each of the bamboo wall was 60cm X 90 cm.

The bioassay was conducted following the standard WHO technique of assessing insecticidal deposits on wall surface (WHO, 1981). Exposure chambers consisted of transparent plastic cones with an internal diameter of 8.5 cm and height 5.5 cm were used. The cones were affixed onto the vertically positioned walls using masking tape. Into each cone, 10 to 15 sugar fed, 7-10 days old laboratory-bred

females of *An. maculatus* were released and exposed to the surface for 30 min. The cones were covered with black cloth. The cumulative mortality was recorded every 3 minutes until a period of 30 minutes. After the exposure, the live mosquitoes were transferred to paper cups covered with netting. Cotton pads soaked with 10% sugar solution and Vitamin B complex solution (1%) were placed on the nettings of the cups. Final mortality was further recorded after 24 hours of holding period. Percentage corrected mortality was calculated using Abbot's formula. Log-time probit mortality regression and lethal time (LT50) values for each treatment were calculated using the computer program 'Probit Analysis' (Quant) modified by Finney (1989). KD50 values for adult mosquito represents the time required to knock down 50% of test mosquitoes.

Six replicates were performed for each type of wall surface. Tests were repeated monthly for a period of 15 months post spraying. All tests were conducted under laboratory conditions at 28°C and 80% relative humidity.

RESULTS

The effects of the two formulations of deltamethrin against *An. maculatus* are summarized in Figures 1-4. The efficacy of deltamethrin was variable. Mortality figures revealed that *An. maculatus* was susceptible to deltamethrin WG and WP formulations and exhibited an almost sustained level of effectiveness against *An. maculatus* for 7 to 10 months for both rough and smooth surfaces. Mortality was variable after this.

Figures 1 and 2 give the percentage mortality of *An. maculatus* after 24 hours recovery period in successive months, when exposed to three different concentrations of deltamethrin on both rough and smooth surfaces. Doses of 20mg/m² WP and 20mg/m² WG have induced 100% mortality in *An. maculatus* for 7 and 8 months respectively for both treated surfaces. A significant increased

mortality was observed for 20 mg/m² WP for both treated surfaces 7 months post spraying. Deltamethrin WG at 25mg/m² was most effective on both rough and smooth surfaces of thatched bamboo, where it induced 100% mortality in exposed adult *An. maculatus* up to 10 months. Even after 14 months, when cone bioassay tests were completed, 25mg/m² WG treated surface were still killing around 80%. Figures 1 and 2 suggest a gradual decline of mortality with progressive age of spray deposit. It is, however, noteworthy that the trend does not follow the usual pattern of decline in percentage mortality. Residual insecticidal activity of deltamethrin WG and WP first declined and then increased again.

The results in term of knock down time values (KD values) are presented in Figures 3 and 4. Deltamethrin WG at 25 mg/m² sprayed on both smooth and rough surface of thatched bamboo gave the lowest KD 50 values. This showed that deltamethrin 25 mg/m² WG provided the longest effectiveness against *An. maculatus* when sprayed on bamboo. WP at 20 mg/m² induced lower KD50 value compared to 20 mg/m² WG. However, KD50 values showed no significant difference ($p < 0.05$) between the 20 mg/m² WP and WG formulations.

DISCUSSION

Results obtained in this study revealed differences in effectiveness and residual activity of deltamethrin formulation on both smooth and rough surfaces of bamboo. The study has shown that, there was no evidence that the decay rate on rough surface was any faster than on smooth surface. However, the residual effect of deltamethrin depended on the rate of application. Higher doses of deltamethrin produced longer duration of residual effect. This was evident when the dose was increased from 20 to 25 mg/m², but not much difference was observed between 20 mg/m² WG and 20 mg/m²WP formulations. However, the finding of

Ansari *et al.* (1997) reported that the residual efficacy of even the same dose of deltamethrin varies when sprayed on different types of surfaces such as wood, bricks, mud and cement. The residual effect of deltamethrin, like any other insecticides, depends on the nature of the treated surface and the type of formulation used. Smooth surfaces do not absorb insecticide particles produced longer duration of residual effect, while rough and porous surface (highly alkaline surface) absorbs and thus results in a shorter duration of residual effect. Besides the type of treated surface, the residual effect of deltamethrin depended on the rate of application. Higher doses of deltamethrin produced longer duration of residual effect. Earlier workers have reported the residual effect of deltamethrin up to 20 weeks on thatched surfaces against *Anopheles stephensi* at 50mg/m² dosage (Das & Sundram, 1984). However, the effect on cement surface lasted for 3 weeks only.

One interesting observation made in this study was the uncharacteristic decline and then reversal of insecticidal activity of deltamethrin. A similar observation had also been made during deltamethrin 25 mg/m² WP evaluation in India, whereby *Anopheles culicifacies* mortality declined to 80% on the 10th week and then reverted back to 100% on the 11th week after spraying (Ansari *et al.*, 1997). It is not known yet what causes such a reversal in insecticidal activity for deltamethrin, although it has previously been reported for DDT. According to Bordas *et al.* (1953), such an event may be a factor related to environmental humidity. In their study, inactivated deposits of DDT have been observed to be reactivated by increased atmospheric humidity. Although all the tests were conducted under laboratory room conditions, certain extrinsic factors are beyond control and therefore might have affected mosquito's response to the insecticide during exposure.

Malaria endemic areas are often deep in the forest, which is difficult to access, posing a tremendous logistic difficulty and

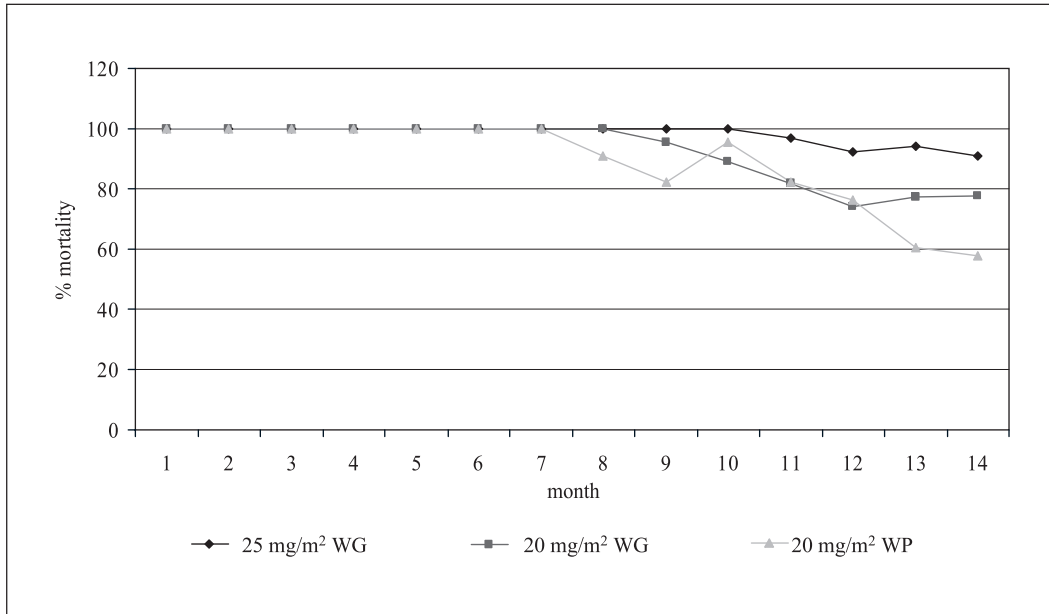


Figure 1. Residual effects of deltamethrin against *Anopheles maculatus* on rough bamboo surface. Percentage mortality was recorded 24 hour post, exposure deltamethrin on a rough bamboo surface.

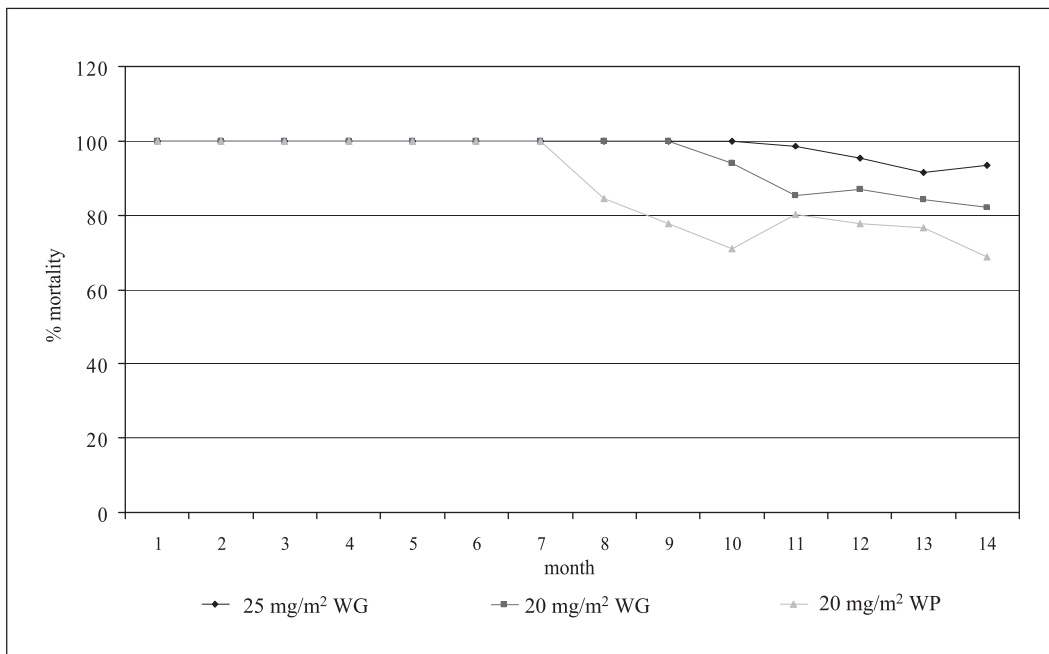


Figure 2. Percentage mortality of *Anopheles maculatus* after 24 hour exposure against deltamethrin on a smooth bamboo surface.

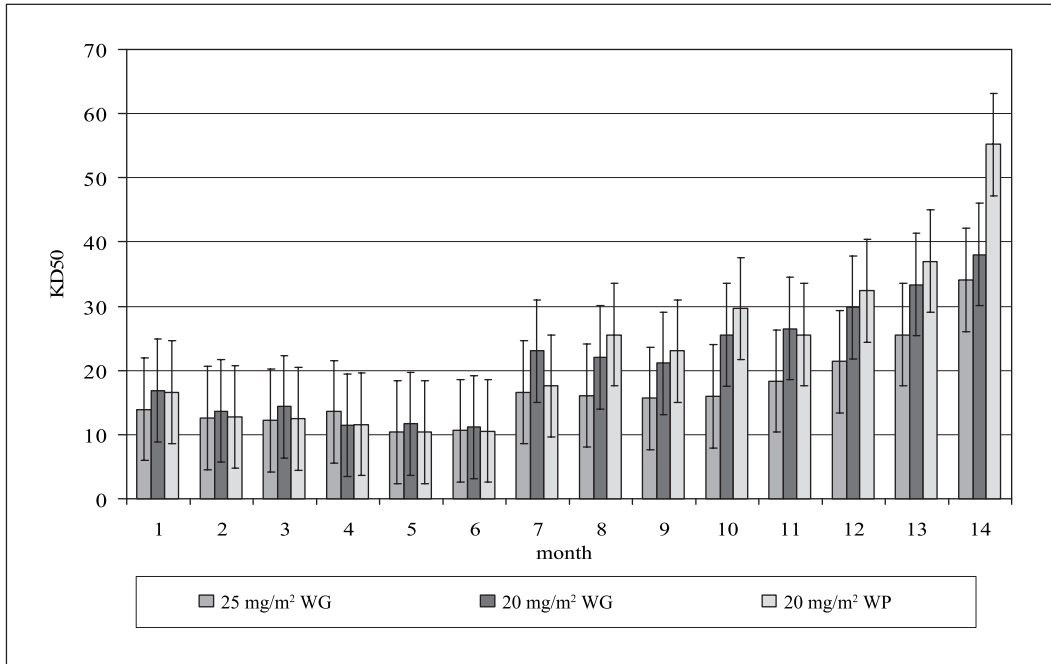


Figure 3. KD50 value (minutes) of deltamethrin against *Anopheles maculatus* on a rough bamboo surface.

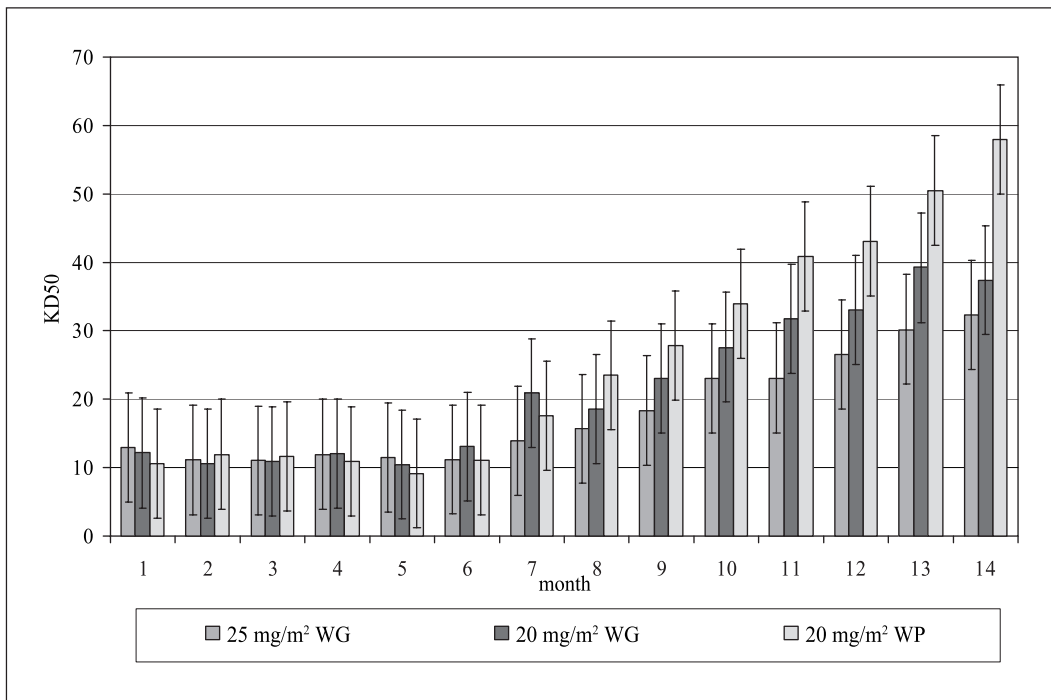


Figure 4. KD50 value (minutes) of deltamethrin against *Anopheles maculatus* on a smooth bamboo surface.

financial burden in implementing sustainable control activities. As the cases occur in more and more remote areas, the current strategy of residual spraying 6-monthly becomes logistically difficult. Based on the results, it can be stated that deltamethrin WG at 25mg/m² possesses great promise as an alternative insecticide for use in the control of malaria vectors. It is highly efficacious to vectors and requires only one treatment per year. Indoor residual spray with a long-lasting insecticide is the most classical methodology for adult control. Further studies, however should be undertaken to determine its actual residual lifespan as well as its performance under field conditions.

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