Original Article

Residual Effects of Deltamethrin WG 25% as a New Formulation on Different Surfaces against *Anopheles stephensi*, in Southeastern Iran

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(Received 9 Oct 2009; accepted 19 May 2010)

Abstract

Background: Indoor residual spraying (IRS) is functioned as national interventions against malaria in southeastern foci of Iran and deltamethrin WP one of the insecticides have been used since past decade. In this study, the residual activity of the wettable granule (WG) was studied on different surfaces in hut scale trial against *Anopheles stephensi* in Iranshahr District, southeastern Iran.

Methods: Three dosages of 25, 40 and 50 mg a.i./m^2 of deltamethrin WG 25% formulation were applied on plaster, cement, mud, and wooden surfaces using Hudson® X-pert compression sprayer having 10 litters capacity.

Results: The residual effects of deltamethrin WG 25% on different surfaces was assessed based on reduction of mortality *An. stepehnsi* from 100% to about 70%. At 25, 40 and 50 mg a.i./m2 the WG formulation of deltamethrin had a bioefficacy for about 2, 3 and 4 months respectively.

Conclusion: There was an expectable fluctuation in mortality of *An. stephensi* at different sprayed surfaces as well as dosages. The proposed 50 mg/m2 WG is the longest activity for up to 4 months which needs to be applied for two spraying cycles per year at the climatically condition of southwestern Iran.

Keywords: Deltamethrin, Wettable granule (WG), *Anopheles stephensi*, Malaria, Iran

Introduction

Sistan and Baluchistan Province, in the Southeast of Iran is considered as the most prevalent area for malaria, which contains about 42–60% of the total malaria cases in Iran (Sadrizadeh 2001). Various factors cause refractory malaria in Sistan and Baluchistan Province. Presence of five malaria vector including *Anopheles culicifacies*, *An. stephensi*, *An. fluviatilis*, *An. superpictus*, *An. dthali*, and *An. pulcherrimus* (as a suspected vector) has a major role in this scenario (Manouchehri et al. 1976). Knowing the best and effective way is very important in malaria elimination as a new strategy in Iran.

Indoor Residual spraying (IRS) has been considered as the main attempts for control of malaria in Iran since 1950. Resistance to DDT, dieldrin and malathion have been developed on five out of seven malaria vectors in Iran (Mofidi et al. 1958, WHO 1970, Manouchehri et al. 1976). After ap-

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pearance of the resistance in *An. stephensi*, main malaria vector in southern Iran, the house spraying was continued with different adultricides e.g. propoxur from 1978 to 1993 for 13 successive years, Actellic® and propoxur from 1991 to 1992 and from 1993 to 2000 both lambdacyhalothrin (Icon 10% WP) and propoxur have been used for malaria control in the south of Iran (Ladonni et al. 1995).

At present, the IRS operation in Iran has been continued with deltamethrin WP 5% since 2003 but the residual activity of deltamethrin 25% WG has not been studied at field condition of Sistan and Baluchistan Province, which is the endemic area for malaria as well as main area for application of the IRS in the country.

The main objective of this study was to study the residual activity of deltamethrin WG 25% as a new formulation, on different surfaces in human dwellings at malarious area, southeast of Iran.

Materials and Methods

The field operation was carried out in Malek- Abad Village, at suburbs of Iranshahr City from July to December 2006.

The lab-bred *Anopheles stephensi* (IRS strain), sugar fed 2-3 days old females were used for bioassays. The adult were provided from insectary of Iranshahr Research Station, 25 km away from trial area. Temperature and relative humidity of the insectary were 28±2° C and 65±5% respectively.

Deltamethrin WG (Wettable Granule) with empirical formula $C_{22}H_{19}Br_2NO_3$ available under trade name K-Othrine® WG25, supplied by Bayer Environmental Sciences, Co. This insecticide were sprayed at 25, 40 and 50 mg/m^2 on different surfaces including plaster, wood, mud and cement using a Hudson X-pert® sprayer (10 liters capacity) with HSS-8002 nozzle which equipped with a regulator adjusted pressure at range 25–45 psi .

The contact bioassay tests were carried out according the method recommended by World Health Organization, using conical chamber at biweekly interval (WHO 1975). A lot of 10–12 adult females were gently released in any cone at 9 replicates (upper, middle and lower parts of walls) using aspirator with 30 min exposure on treated surfaces as well as 3 replicates of untreated surfaces as negative controls simultaneously. At the end of exposure time, the adults were transferred into clean cup and maintained at optimal condition and the mortality was recorded after 24 h. If mortality rate of control tests was between 5–20%, the mortality rates were corrected using Abbott's formula.

The data (mortality rates) was transferred using arcsine formula. In order to compare the residual activities in each sprayed surfaces, one-way ANOVA, Levene's test, HSD test, or Games-Howell test were used.

The criteria for residual effect of tested insecticide were based on mortality rate and if this rate was decreased to 70%, the bioassays stopped and the data analyzed.

Results

Comparisons of three applied dosages (25, 40 and 50 mg/m^2) showed an efficacy around 3, 3.5 and 5 months on plaster surfaces respectively (Fig. 1).

On mud surfaces, the residual activity of at 25, 40 and 50 mg/m^2 were estimated around 2.5, 3.5 and 4.5 months respectively (Fig. 2).

Residual efficacy of experimental dosages of deltamethrin WG 25% at 25, 40 and 50 mg/m^2 on cement surfaces was around 1, 2 and 2 months respectively (Fig. 3). It is cleared that the average mortality rates of all three dosages did not exceed to 100% anytime.

A wide enhancing ranges of efficacy of deltamethrin WG 25% at applied dosages (25, 40 and 50 mg/m^2) was considered on wood surfaces around 2, 3.5 and 4.5 months respectively (Fig. 4).

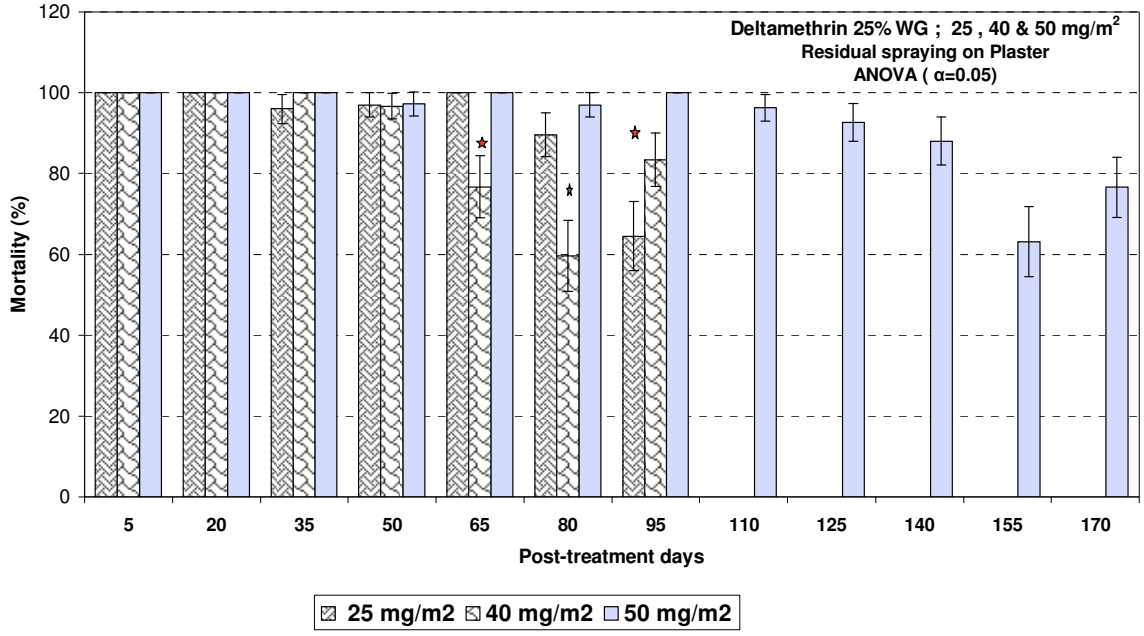

Fig. 1. Efficacy of various doses (25, 40 and 50 mg/m^2) of deltamethrin WG 25% on plaster surfaces, Malek-Abad Village, Iranshahr, southeastern Iran, 2006

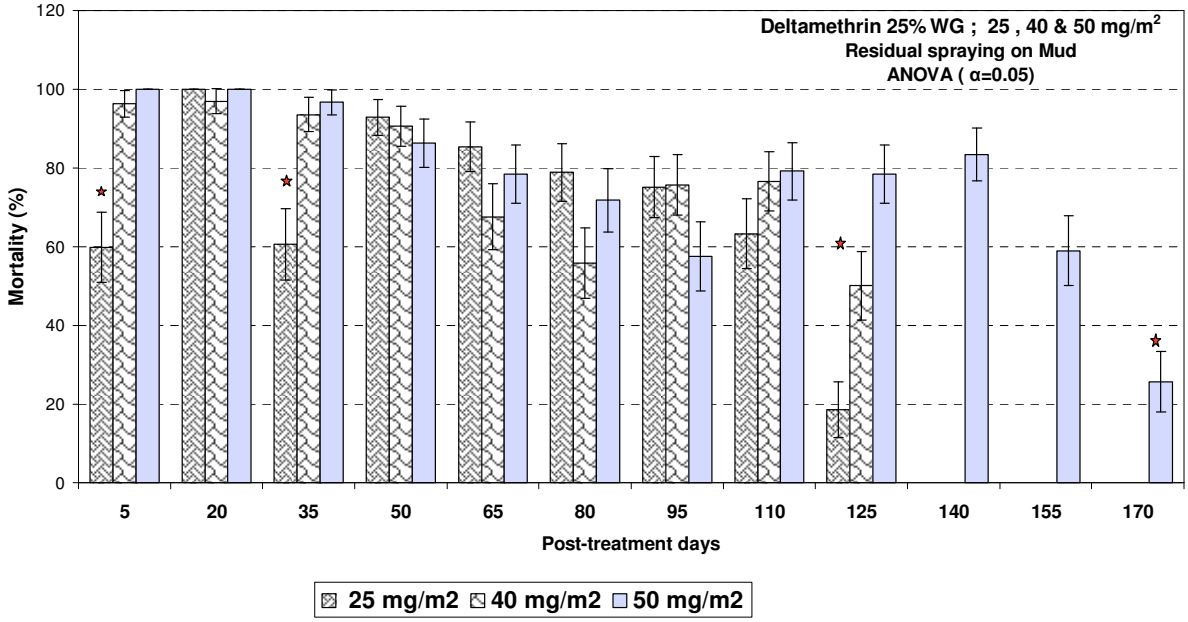

Fig. 2. Efficacy of experimental dosages (25, 40 and 50 mg/m^2) of deltamethrin WG 25% on mud surfaces, Malek-Abad Village, Iranshahr, southeastern Iran, 2006

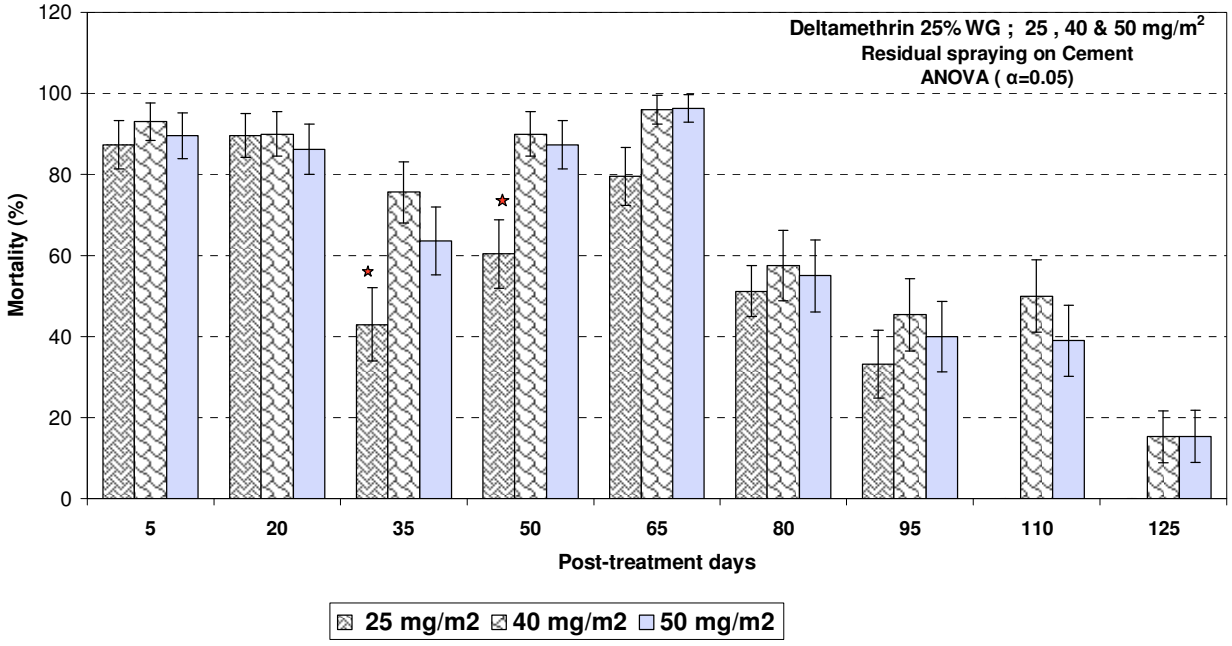

Fig. 3. Efficacy of experimental doses (25, 40 and 50 mg/m^2) of deltamethrin WG 25% on cement surfaces, Malek-Abad Village, Iranshahr, southeastern Iran, 2006

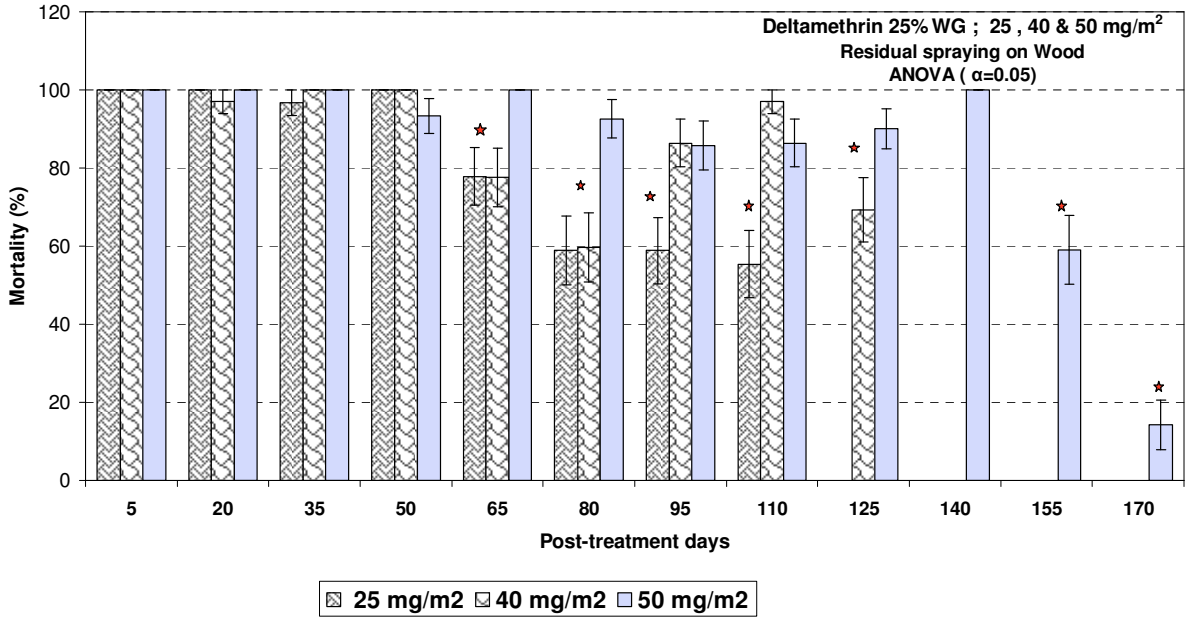

Fig. 4. Efficacy of experimental dosages (25, 40 and 50 mg/m2) of deltamethrin WG 25% on wood surfaces, Malek-Abad Village, Iranshahr, southeastern Iran, 2006

Discussion

Determination of residual activity of insecticides is the essential information for the use of indoor spraying operation. The residual duration of pyrethroids recommended by WHO including alphacypermethrin, bifenthrin, cyfluthrin, deltamethrin, etofenprox, and lambdacyhalothrin WP, have estimated between two and six months (Najera et al. 2001).

Study on residual efficacy of deltamethrin 2.25% WG at 25 mg/m^2 against *An. culicifacies* in India showed 100% mortality up to 12, 10, 9 and 12 weeks on mud, cement, brick and thatch surfaces respectively (Ansari et al. 1997). A village scale trial of deltamethrin 2.25% WG at 25 mg/m^2 against both anophelinae and culicinae mosquitoes also indicated a residual life about 12 weeks both on mud and cement plaster surfaces in India (Singh et al. 1989). In Brazil, residual activity of SC formulation of deltamethrin at 25 mg/m^2 reported 3, 2 and 3 months on wood, plastered brick and brick surfaces respectively (Santos et al. 2007). The extended field trial of deltamethrin 2.5% WP at 25 mg/m^2 confirmed the long residual effectiveness from 15 to 16 weeks on both mud and cement plastered surfaces in India (Gill et al. 1997). The residual activity of WG formulation of deltamethrin at 25 mg/m^2 was effective for 6 weeks after treatment on *Aedes* vectors in Kuala Lumpur, based on biweekly bioassay (Rozilawati et al. 2005).

Based on the present study, 50 days old deposits of insecticide on plaster surfaces caused similar mortality with three dosages (25, 40 and 50 mg/m^2) of deltamethrin WG 25% (P<0.05). Significantly enhance mortality with increasing in dosages has seen on mud surfaces after 50 days.

Surprisingly on mud surfaces there was no significant difference between three applied dosages until day 110. Despite of early depredating of the insecticide on very absorbent cement surfaces, there was no significantly difference between three applied dosages on cement surface. On wood surfaces, the residual effects of all three dosages did not show a significant difference with each other until day 50 as the same for 25 and 40 mg/m^2 until day 80. At greater age after 80 (days 90- 110) the variation between dosages 40 and 50 mg/m^2 was not significant but with dose 25 mg/m^2 the difference was significant (P<0.05).

The persistency of insecticides, as revealed by mortality, depended on the type of surface, the dosage, and the age of spray deposits (Giga et al. 1991). In comparison with the results presented by other authors, our study revealed a clearly lower estimation of residual effect of deltamethrin WG 25% on various surfaces. It seems that the irritancy effect of deltamethrin on tested mosquito, *An. stephensi* IRS strain may responsible for this difference. In mosquitoes, it is commonly observed that casual contact with a surface treated with deltamethrin (or other pyrethroids) can produce an irritant effect, causing the insect to fly away-an effect known as excito-repellency (Dartigues 1987). Study of efficiency of pyrethroids at laboratory condition also showed similar effect related to type of pyrethroids (Alipour et al. 2006). Also other field bioassays of deltamethrin WP %5 which conducted by authors revealed a clearly excito-repellency effect. In the present study, the excito-repellency phenomenon were not equally occurred in applied dosages. The excito-repellency effect of deltamethrin WP can be defeated by using the WG formulation in Sistans and Baluchestan Province.

In conclusion, field hot scale evaluation of deltamethrin WG can be recommended for finding the effects of the insecticide on population dynamic of vectors, effects of other materials and human behaviors on residual effect of the insecticide.

Acknowledgements

The authors would like to thank the Malaria Control Office, Ministry of Health and Medical Education for financial support. The authors also like to thank Health Center of Sistan and Baluchestan Province for providing the facilities to carry out the field trials. The authors would like to acknowledge with gratitude the assistance of staff of Iranshahr Medical Research Station for their kind cooperation with this research. The authors declare that they have no conflicts of interest.

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