

RESIDUAL EFFECT OF 10% BIFENTHRIN WP ON MOSQUITOES, AND COMMUNITY ACCEPTANCE, IN EASTERN THAILAND

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Abstract. This study was conducted from May to October 2008 in two villages in Chanthaburi Province: village No.2 Tup Sai Canton (control) and village No.12 Pong Nam Ron (treatment area). Indoor residual spraying, using 10% bifenthrin WP (Bitecthrin WP[®]) was conducted at a concentration of 25 mg/m² with 87.3% spray coverage of the houses in the treated area. Monthly entomological studies showed that in the control area, *Anopheles minimus* density was significantly higher than the treatment area. A WHO cone bioassay test showed the residual effect against laboratory-bred, *An. dirus* persisted for up to 6 months. Community acceptability was good and most preferred insecticide spraying. 10% bifenthrin WP applied six-monthly can be used as an indoor residual spray for malaria control.

INTRODUCTION

Malaria has been recognized as a public health problem in Thailand since 1918, with an estimated 40,000 to 50,000 deaths annually. It was the leading cause of death (271.7-194.9 per 100,000) until 1950 (Division of Malaria Control, 1997). The establishment of the National Malaria Control Program with a variety of activities including expansion of community co-operation and malaria clinic significantly reduced the mortality rate from 351 per 100,000 population in 1947 to 1.26 per 100,000 population in 1998 (Vijaykadga, 1999). At present, malaria trans-

mission is largely confined to forested rural areas, mainly along the borders with Cambodia and Myanmar (Chareonviriyaphap *et al*, 2000). Beginning in 1950, the Malaria Control Program had used DDT indoor residual spraying to control malaria (Division of Malaria Control, 1999), but this was replaced with pyrethroids in 1995. Nevertheless, malaria transmission persists, especially along the borders with neighboring countries.

Chanthaburi Province, on the eastern border with Cambodia, has been among the top-ten provinces for malaria transmission in Thailand, with 1,224 cases in 2006 and 1,102 in 2007. The major vector, *Anopheles minimus*, is found occasionally. This province has used pyrethroid insecticides for indoor residual spraying to control malaria. This study reports the residual effects of an alternative pyrethroid insecticide, 10% bifenthrin WP (Bitecthrin WP[®]) on mosquito abun-

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dance, and the insecticide's acceptability to the community.

MATERIALS AND METHODS

Study area

Chantaburi Province is located 250 km from Bangkok in eastern Thailand, on the Cambodian border. Pong Nam Ron District has the highest malaria-transmission rate in Chantaburi Province. Two villages in this district were selected for this study: village No.2 Tup Sai Canton (272 persons in 155 houses) and village No.12 Pong Nam Ron Canton (345 persons in 110 houses). Most of the houses in the study areas were cement-wall houses; some were made from wood or bamboo.

Indoor residual spraying (IRS)

Village No.12, Pong Nam Ron Canton was the treatment area using 10% bifenthrin WP (Bitecthrin WP®), and No.2, Tup Sai Canton was the control area. Spraying using a hand-operated compression sprayer followed WHO IRS procedures (WHO, 2007). The insecticide was sprayed at a concentration of 25 mg/m².

Entomological study

Anopheles mosquitoes were collected monthly using a standard landing catch technique in both treatment and control areas in May-October 2008. Collections were performed on 3 consecutive nights at 06:00-12:00 PM. with 2 mosquito collectors, one indoors and another outdoors at each site. The mosquitoes collected were identified to species and the numbers of mosquitoes per human per night were recorded.

Bio-assay test

Three cement-walled houses were selected to evaluate the persistence efficacy of indoor residual spraying using the WHO cone bioassay method (WHO, 1996). The test was carried out every 4 weeks for 6 months

using *Anopheles dirus* mosquitoes from the insectarium of the Department of Medical Entomology, Faculty of Tropical Medicine, Mahidol University. Ten cones were randomly set on the treated surfaces inside the house. Fifteen 3-5 day old, non-blood-fed female mosquitoes were released into each cone. After 30 minutes exposure, the mosquitoes were carefully removed and put in clean cups and covered with netting. The mosquitoes were provided with 10% sugar solution soaked in cotton wool and placed on the net. The number of dead mosquitoes was counted after 24 hours and the percentage mortality was calculated.

Community acceptance

A questionnaire survey was conducted in the area treated with 10% bifenthrin WP (Bitecthrin WP®); it covered willingness of the respondent to spray the house, itching effect, killing effect on mosquitoes, and acceptability for further application with this insecticide. Interviews were conducted two months after spraying.

RESULTS

Spraying operation

Residual spraying was started in early May 2008. Ninety-six of 110 houses (87.3% coverage) were sprayed with 10% bifenthrin WP (Bitecthrin WP®) following WHO standard spraying methods (WHO, 2007).

Mosquito collection

Six *Anopheles* mosquito species were captured in the 2 study sites; *An. vagus* was found in the highest density at 62.6%, followed by *An. minimus* (24.5%), *An. barbirostris* gr (12.5%), *An. varuna* (0.2%), *An. tessellatus* (0.1%) and *An. hycanus* gr (0.1%). The densities of *An. minimus*, the major malaria vector, in the treatment and control areas were significantly different ($t = 4.21$, $df = 5$). Indoor landing catches showed the

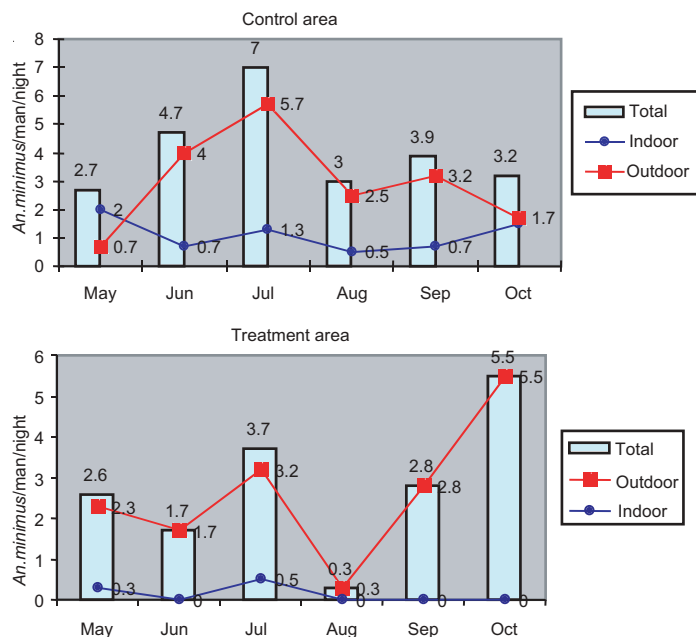


Fig 1—Comparison of mosquito densities with in door and out door collections in treatment and control areas.

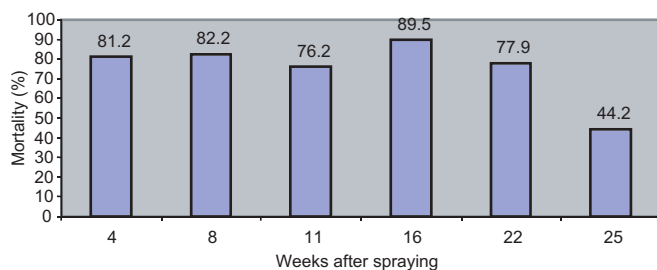


Fig 2—Residual effects of bifenthrin 10% WP (Bitecthrin WP®) against *Anopheles dirus*, sprayed onto a cement wall.

An. minimus density in the control area was significantly higher than the treatment area ($t = 2.05$, $df = 5$) (Fig 1).

Bio-assay test

Persistence bioassay testing revealed 80-90% mortality among laboratory raised *An. dirus*, for up to 16 weeks post-treatment, 77.9% at Week 22 and 44.2% at Week 25 (Fig 2).

Community acceptability

A structured questionnaire survey in 60 of 96 treated houses (62.5%) showed high levels of acceptance by the residents to insecticide spraying in their houses. There were no complaints of itching (100%), the willingness to spray was 100%, mosquitoes were reported to decrease in 88.3% and 95% reported no bad smell, 100% reported willingness to accept further applications of 10% bifenthrin WP.

Malaria cases

The malaria cases report from active case detection (ACD) and passive case detection (PCD) were collected monthly from the Vector Borne Control Unit, Pong Nam Ron District, Chanthaburi Province. In 2007, there were 6 indigenous malaria cases in the treatment area and 3 in the control area. During the same period in 2008 the indigenous cases were increased in both areas to 12 in treatment area, 28 in the control area. The numbers of cases in the two areas were significantly different from each other ($\chi^2 = 4.235$). In this study, the impact of the residual spray on malaria cases was not clear. However, the incidence rate in the treatment area was smaller than the non-treatment area. This indicates indoor residual spraying with 10% bifenthrin WP appears to reduce the risk of contracting malaria.

DISCUSSION

Indoor residual spraying of human dwellings is an important activity for community malaria control, as are early case

detection and prompt treatment for infected individuals. Therefore, it is essential that residual insecticide spraying should be planned and implemented with the appropriate insecticide and sound technical skills under expert guidance. Bifenthrin, a non-alpha-cyano pyrethroid insecticide and acaricide, is one of the insecticides recommended by the WHO for indoor residual spraying. Bifenthrin has low toxicity by dermal route ($LD_{50} > 2,000$ mg/kg body weight in a rabbit), and no irritation has been noted after application to the abraded or intact skin of tested animals. It has a relatively low irritant and knockdown effect on mosquitoes, compared with permethrin and deltamethrin. Therefore, it provides a high killing rate by allowing mosquitoes to rest on treated surfaces for a longer period, thus permitting exposure to a lethal dose. These properties could have an impact on mosquito population densities if complete spray coverage is achieved in a community.

The residual persistence of sprayed insecticide depends on several factors, including the insecticide formulation, application dosage and type of surface sprayed. In the current study, a minimum mortality rate of 70% was used as the cut-off for defining satisfactory residual activity. With indoor residual spraying, using 10% bifenthrin WP at the concentration of 25 mg/m², the residual effect lasted up to 6 months and did have an impact on the indoor density of mosquito vectors. Similar results were observed in a study by Prajakwong *et al* (2001) in northern Thailand on the residual effects of 10% bifenthrin WP against *An minimus*. The results showed the mortality rate gradually reduced, but persistence remained for 6 months and a mortality rate of >70% was observed. In a study in Mexico (Arredondo-Jimenez *et al*, 2001) a concentration of 37.5 mg/m² was used, which yielded a residual mortality of $\geq 75\%$ at Week 22 on cement,

wood and bamboo walls. In India, Yadav *et al* (2001) studied the effects of 10% bifenthrin WP on different surfaces, and found that a concentration of 25 mg/m² yield 100% mortality at Week 16 on galvanized metal sheets, 8 weeks on mud and 4 weeks on brick and wood surfaces. When the dosage was double to 50 mg/m² on mud walls, >80% mortality was achieved at Week 24.

For indoor residual spraying to be effective, at least 80% of houses in a given area should be sprayed (WHO, 2006). Therefore, acceptance by the residents of spraying insecticide inside their houses is important for the success of malaria-control program. Many residents resist the spraying of DDT due to a variety of factors, including its unpleasant odor and the stains it leaves on walls. Pyrethroid insecticides are reportedly more acceptable, since they do not leave visible residues on walls. In this study, there was a high level of acceptance of spraying with 10% bifenthrin WP. 10% bifenthrin WP (Bitecthrin WP[®]) is another alternative pyrethroid insecticide for use as an indoor residual spray for malaria control. However, it is recommended that spraying be conducted twice yearly, to cover peak transmission periods, and so reduce the incidence of disease.

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