J Vect Borne Dis 42, June 2005, pp 68–73

Field performance of cyphenothrin: an integrated insecticide strategy against German cockroaches (Dictyoptera: Blatellidae)

Rina Tilak, V.K. Agrawal & J. Dutta

Department of Preventive and Social Medicine, Armed Forces Medical College, Pune, India

Background & objectives: Resistance to organophosphorous and carbamate insecticides amongst German cockroaches is widely reported. Cyphenothrin EC, a new synthetic pyrethroid was evaluated in cookhouses in an urban area, with the aim of exploring alternate control option against the German cockroach *Blatella germanica*.

Methods: Three cookhouses were selected by simple random sampling method, two for treatment and one as control. The impact of treatment on cockroach infestation was monitored weekly by visual assessment sampling technique.

Results: Cyphenothrin brought about 95 to 97.5% reduction in cockroach infestation by the end of six weeks post-treatment.

Interpretation & conclusion: The study reports the efficacy of cyphenothrin in the control of German cockroaches and recommends an "Integrated insecticide strategy" for the control of cockroaches in urban cookhouses.

Key words *Blatella germanica* – chemical control – cyphenothrin – German cockroach – integrated insecticide strategy

Cockroaches are among the most common pests in many houses and other buildings. Cockroach infestations have been indicated as a major contributor to asthma throughout the world. Several studies have shown that large number of asthmatic patients are sensitised to cockroach allergens[1, 2]. Cockroaches can sometime play a role as carriers of intestinal diseases, such as diarrhoea, dysentery, typhoid fever, cholera, etc[3, 4].

Heavy infestations of cockroaches can effectively be managed by chemical control measures (residual spray, aerosol, dust, baits and gels) and environmental management to deprive them of food and shelter[5]. Cockroaches have become resistant to commonly used insecticides. The German cockroach, *Blatella germanica* is resistant to several organochlorines, organophosphates and carbamates and in certain countries resistance to a few synthetic pyrethroid insecticides has also been reported[6,7].

In the Armed Forces, the insecticides propoxur and fipronil are used for the control of German cockroach. However, it has been observed that efficacy of propoxur is suspect and fipronil did not offer instant reduction in the cockroach infestation. The present study was, therefore, conducted with the aim of evaluating a new synthetic pyrethroid insecticide, cyphenothrin EC against German cockroach, *B. germanica* in cookhouses.

Material & Methods

The study was carried out in cookhouses operating in an Armed Forces teaching/training establishment and

cookhouse of a military hospital from October 2004 to January 2005. Three cookhouses were selected, two for cyphenothrin treatment and one as a control.

The trial was planned as a field study to evaluate the efficacy of the candidate insecticide in the control of German cockroaches in cookhouses. The study included the following:

Complaints of residents regarding cockroach infestation: A total of sixteen cookhouses located in the study sites were surveyed for cockroach infestation. The mess staff working in cookhouses in the study sites was briefed about the study to get their full cooperation and participation. They were given a proforma which included their subjective assessment of cockroach problem, importance they attach to control, control measures adopted, etc. The response was either heavy, medium, light infestation or no cockroach seen. The do's and don'ts to be followed post-treatment in the treated as well as the control cookhouse were explained to the concerned staff and it was ensured that the same complied with during the entire trial period.

Pre-spray assessment in field: In every cookhouse included in the present study, the following pre-treatment assessment was done.

Visual counts: The visual counts were done in the night after 2230 hrs. The participant cookhouses were asked to switch off the lights by 2130 hrs. The lights were then switched on after an hour at 2230 hrs and the cockroaches were counted as they ran about, over the tables, sinks, cooking areas, etc. Light from a torch was thrown behind cabinets, storage areas and dish racks for counting the cockroaches. A five minute count of cockroaches was taken[8]. Type of cockroach infestation was assessed in each area. The cookhouses with >250 cockroaches were graded as heavy infestation area, 50–250 range was considered as medium and areas with < 50 cockroaches were graded as light infestation areas. Cookhouses with heavy and medium infestation were considered for inclusion in trial. Two trial sites and a control site were then selected by simple random sampling technique. A total of six trained personnel were used for the trial.

Trap count: Sticky traps were placed around the usual harbourages of cockroaches. Enough number of traps were placed to cover the suspected hiding sites in the study units. Sticky traps were removed next morning to estimate the cockroach density and type of cockroach infestation.

Insecticidal spray: Cyphenothrin @ 50 mg a.i./m^2 was sprayed in selected cookhouses at the infested sites and potential harbourages by compression pneumatic sprayer. No insecticide was sprayed in control cookhouse.

Post-treatment density: Post-treatment density was assessed by visual count method as it was found to be a better indicator of cockroach infestation. The visual assessment data in treatment and control cookhouses were considered for computation of percent reduction of cockroach infestation in the respective cookhouses. The percent reduction was calculated using the following formula of Mulla[9]:

$$\% \text{ reduction} = 100 - (C_1/T_1 \times T_2/C_2) \times 100$$

Where, C_1 is the number of cockroaches in control cookhouse pre-treatment; T_1 is the number of cockroaches in treatment cook house pre-treatment; C_2 is the number of cockroaches in control cookhouse post-treatment; and T_2 is the number of cockroaches in treatment cookhouse post-treatment.

Results

Infestation level and dominant cockroach species: Out of a total of sixteen cookhouses surveyed, five (31%) had heavy infestation, seven (44%) had medium, three (19%) had light and one (6%) cookhouse had no cockroach infestation (Fig. 1). A total of twelve cookhouses with high to medium cockroach

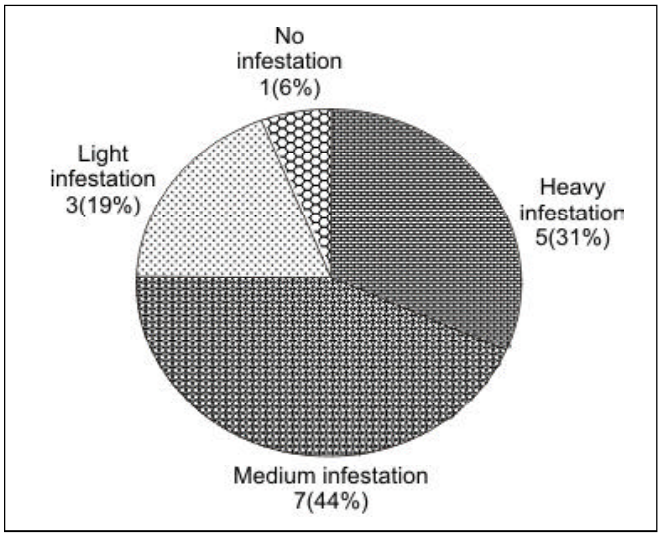

Fig. 1: Type of cockroach infestation and percent cookhouses infested amongst cookhouses surveyed in the study sites

infestation range were considered for random sampling for selection of the trial and control sites. The cookhouses having heavy infestation were found to be located more proximally to the central garbage dump, with declining level of infestation found in cookhouses with increasing distance from the central garbage dump. The common cockroach hiding places in the study areas were the food cupboards followed by refrigerators or freezers and under the sinks and water pipes. The infestation in the cookhouses was primarily of German cockroach *B. germanica.*

Post-treatment sampling and density estimation: The pre-treatment density observation in various cookhouses by the two sampling techniques is presented in Table 1. Visual assessment method was found superior to sticky trap method of density assessment and therefore, this method was chosen as the post-treatment sampling method. The same has also been reported by the authors in their earlier published study[8]. Visual count of cockroaches pre- and post-treatment in treatment and control sites is presented in Table 2. The abundance of cockroaches in the control area was found to increase steadily, whereas after an initial decline, the observations in the treatment sites-1 and 2 also showed a similar trend, however, there was an overall reduction in cockroach infestation post-treatment in both the treated sites.

Table 1. Sampling methods used for assessment of pre-treatment density of German cockroaches

Sites earmarked for treatment/control	Sampling methods	
	Sticky trap (Cockroaches trapped)	Visual assessment (5 min count)
Site-1 (Cyphenothrin spray)	4	154
Site-2 (Cyphenothrin spray)	8	1310
Site 3 (Control)	5	89

Percent reduction in cockroach infestation in treated and control sites in relation to pre-treatment levels: A very high cockroach kill was observed within 24 h of cyphenothrin treatment of the infested cookhouses; the weekly monitoring showed 86.3% reduc-

Table 2. Cockroach density estimation in control and treatment sites by visual assessment method

Area	Visual count of cockroaches with cyphenothrin						
	Pre-treatment	Post-treatment (week)					
		I	II	III	IV	V	VI
Treatment site-1	154	23	8	12	15	15	14
Treatment site-2	1310	46	39	46	63	112	238
Control	89	206	311	313	320	322	324

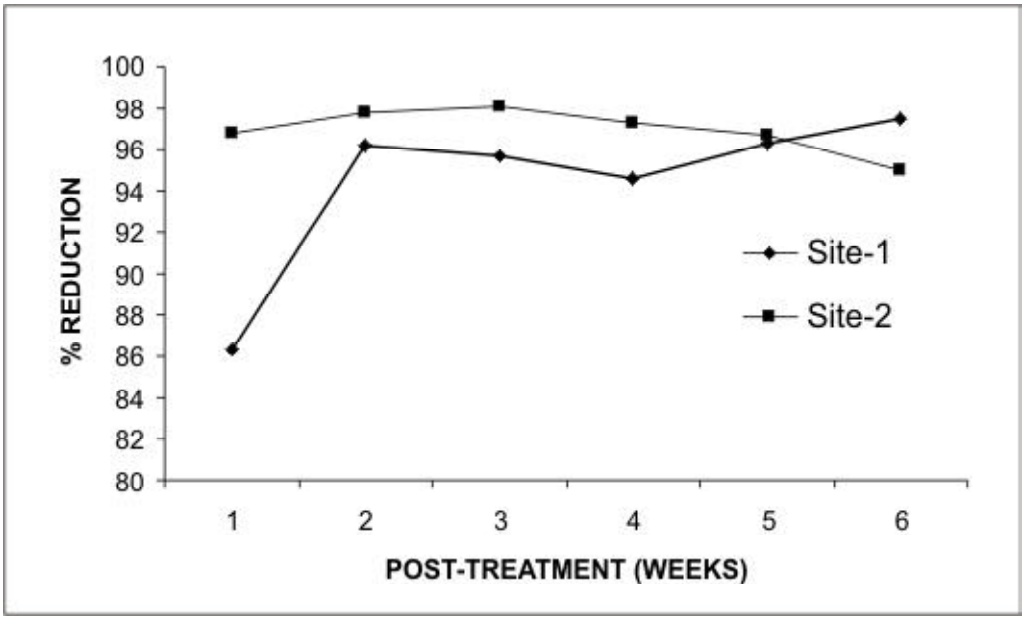

Fig. 2: Field evaluation of residual efficacy of cyphenothrin against German cockroaches

tion in cockroach infestation in the treatment site-1 by first week post-treatment, while it was 96.78% in treatment site-2 (Fig. 2). There was an enhanced reduction (96%) in treatment site-1 by the end of second week and was 97.5% by the sixth week post-treatment. There was a further increase in cockroach mortality with 97% reduction in treatment site-2 which marginally declined by 2% (95%) by the sixth week. The observations were discontinued after six weeks due to an increase in cockroach density by this period in treatment site-2 (238), necessitating re-treatment of the area. The cockroach built up was noticed near the water pipes and under the sinks.

Discussion

The reports on occurrence of resistance in German cockroaches to organophosphates and carbamates have necessitated consideration of newer options for its control[10]. The development of resistance to propoxur and malathion, the routinely used insecticides in cockroach control has been reported by many workers. Propoxur have been reported to cause a greater ootheca detachment with lower hatchability in comparison to few synthetic pyrethroids and organophosphorous insecticide, malathion[11]. Reports on the occurrence of resistance in German cockroaches to various commonly used synthetic pyrethroid insecticides—allethrin, phenothrin, fenvalerate, cyfluthrin, deltamethrin, cypermethrin, etofenprox and permethrin are also available[8,12].

The newer options for cockroach control are the gel/bait formulations of the two insecticides—fipronil of the Phenylpyrazole group and imidacloprid of the Chloronicotinyl group. Both are effective control options for German cockroaches and ideal for use in community cookhouses[13,14]. Fipronil gel (0.05%) was effective up to 90 days with about 98% reduction in the German cockroach infestation when used in cookhouses in an urban area as reported by the authors in their earlier studies in similar settings[8]. The insecticide is also known for its cascade effect which provides a prolonged control of cockroach infestation in the treated areas. Studies from some countries, though not from India, have reported development of resis-

tance in German cockroaches to fipronil as well as imidacloprid, the two very effective insecticides against the German cockroaches[15].

Cyphenothrin, a new synthetic pyrethroid has low mammalian toxicity and has been categorised slightly hazardous[16]. In this study, cyphenothrin sprayed @ 50 mg a.i./m^2 at the infested sites and potential harbourages was found effective in reducing cockroach infestation from 86.3 to 96.78% by the first week and 95 to 97.5% till six weeks post-treatment in comparison to the control site. The areas sprayed with cyphenothrin were not found to be infested by cockroaches again during the entire study duration. The built-up of cockroach infestation was due to the insecticide run-off from the areas under sinks and near the water pipes, where a leakage was noticed. This is the first published report on evaluation of cyphenothrin against cockroaches; the authors have therefore not been able to compare the results with other such studies.

The duration of effective control offered by this insecticide against German cockroaches though is low (6 weeks) as compared to the reported efficacy of up to 90 days with fipronil gel 0.05%, however, the initial control offered by cyphenothrin in the first week post-treatment (86 to 96%) is comparable to fipronil gel (89%) in studies conducted under similar settings[8]. Fipronil gel was found to be effective due to its continued availability even in situations where water was found leaking as it is a crack and crevice treatment. However, fipronil was found to have the limitation of not offering the desired level of control when the cockroaches did not access the treatment present in the cracks and crevices.

Based on the findings of the study and the published reports on cockroach control, the authors recommend an "Integrated insecticide strategy" for German cockroaches with initial spray of cyphenothrin followed by fipronil gel for an effective and long-lasting control of German cockroaches in cookhouses in urban areas. This strategy will ensure a quick initial knockdown with cyphenothrin followed by a prolonged maintenance phase offered by fipronil with its unique cascade effect. The application of fipronil should be undertaken post-cyphenothrin treatment to augment the initial control with cyphenothrin and also to offer better control in areas not very amenable to cyphenothrin treatment. This "Integrated insecticide strategy" may offer a synergistic control of German cockroaches in cookhouses in urban areas, however, there is a need to validate the hypothesis in actual field conditions.

Acknowldgement

The authors gratefully acknowledge the contribution of the mess staff and members of the survey team.

References

1. Katial RK. Cockroach allergy. *Immunol Allergy Clin North Am* 2003; *23*: 483–9.
2. Peyton A. Eggleston, Luisa Karla Arruda. Ecology and elimination of cockroaches and allergens in the home. *J Allergy Clin Immunol* 2001; *107*: 422–9.
3. Voigt TF. Cockroaches: dangerous transmitters of diseases. *Med Monatsschr Pharm* 2005; *28*: 24–9.
4. Czajka E, Pancer K, Kochman M, Gliniewicz A, Sawicka B, Rabczenko D, Stypulkowska-Misiurewicz H. Characteristics of bacteria isolated from body surface of German cockroaches caught in hospitals. *Przegl Epidemiol* 2003; *57*: 655–62.
5. Schal C. Relation among efficacy of insecticides, resistance levels and sanitation in the control of the German cockroach (Dictyoptera: Blatellidae). *J Econ Entomol* 1988; *81*: 536– 44.
6. Wooster MT, Ross MH. Sublethal responses of the German cockroach to vapours of commercial pesticide formulations. *Entomologia Experimentalis et Applicata* 1989; *52*: 49–55.
7. Cochran DG. Monitoring for insecticide resistance in field-collected strains of the German cockroach (Dictyoptera: Blattellidae). *J Econ Entomol* 1989; *82:* 336– 41.
8. Tilak Rina, Tilak VW, Yadav JD, Dutta Gupta KK. Efficacy of fipronil and propoxur in the control of German cockroaches (Dictyoptera: Blatellidae). *J Com Dis* 2002; *34 :* 65–9.
9. Mulla MS. Control of chironomid midges in recreational lake. *J Econ Entomol* 1971; *64:* 300–7.

10. Diaz C, Bisset JA, Gonzalez T, Rodriguez MM. Resistance to organophosphate, carbamate and pyrethroid insecticides in *Blatella germanica* (Dictyoptera: Blatellidae) in two municipalities of the city of Havana. *Rev Cubana Med Trop* 1994; *46:* 130–2.

11. Montada D, Guerrero JA. Effects of 3 insecticide formulations in the removal and hatching of oothecae of *Blatella germanica* (Dictyoptera: Blatellidae). *Rev Cubana Med Trop* 1996; *48:* 83–6.

12. Gliniewicz A, Krzeminska A, Sawicka B. Susceptibility of cockroaches *Blatella germanica* L. collected from hospitals to selected pyrethroid and carbamate insecticide. *Rocz Panstw Zakl Hig* 1996; *47:* 333–41.

13. Durier V, Rivault C. Comparisons of toxic baits for controlling the cockroach, *Blatella germanica*: attractiveness and feeding stimulant. *Med Vet Entomol* 2000; *14:* 410–8.

14. Appel AG, Tanley MJ. Laboratory and field performance of an imidacloprid gel bait against German cockroaches (Dictyoptera : Blatellidae). *J Econ Entomol* 2000; *93:* 112–8.

15. Wang C, Scharf ME, Bennett GW. Behavioural and physiological resistance of German cockroaches to gel baits (Blattodea: Blatellidae). *J Econ Entomol* 2004; *97:* 2067–72.

16. Vector control — methods for use by individuals and communities. Chapter V. Geneva: World Health Organisation 1997; p. 288–301.

Corresponding author: Dr. Rina Tilak, Scientist `E', Department of PSM, Armed Forces Medical College (AFMC), Pune–411 040, India
e-mail: rinatilak@yahoo.com