

Bed bug product efficacy under the spotlight

PART 1



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The February 2005 edition of *Professional Pest Manager* presented an article by Peter May titled, Bed bug resistance to insecticides – real or imagined?

In the article, Peter forewarned that greater research was required in the areas of product efficacy and insecticide resistance if pest managers were to successfully tackle the growing challenge presented by the modern bed bug resurgence.

The reality is that resistance to most of the insecticide groups used today was documented decades earlier.

At the time, however, these reports were coming from under-developed nations.

The ultimate spread of resistant bed bug strains around the world was probably due to the increase in international travel when it became affordable to the average person. This resistance – coupled with a poor understanding of the pest's biology by pest managers, and a reliance on insecticides rather than an IPM approach – meant that control failures became a regular occurrence.

Recent research has shown that modern bed bugs are resistant to both the synthetic pyrethroids and the carbamates (Boase *et al.*, 2006, Romero *et al.*, 2007).

The problem for Australian pest managers is that there are only three insecticide groups available (registered) for bed bug control: synthetic pyrethroids; carbamates; and organophosphates. As noted above, resistance is known with two of these.

The problem is that up until now we have not known which of the presently registered products are the most effective in controlling bed bugs, and the issue of resistance makes this lack of knowledge especially confounding.

In this two part series, we present the findings of a research program that has evaluated a range of insecticides against the common bed bug, *Cimex lectularius*.

Different treatment methods were selected because, in urban pest control, insects are generally exposed to insecticides by two main means: direct spray (i.e. topically); or as a residual, whereby the pest picks up the product while walking on treated surfaces.

The former method aims for a direct kill, whereas the latter provides protection over time.

As there have been anecdotal reports of poor residual action with many of the products, it was decided to undertake both topical and residual efficacy trials.

Table 1: Products selected for evaluation of efficacy against the common bed bug, *Cimex lectularius*.

Product	Active ingredients	Chemical group	Group
Ficam W Insecticide	Bendiocarb	Carbamate	1A
Actellic 900 Solvent Free Insecticide	Pirimiphos methyl	Organophosphate	1B
Diazinon EC	Diazinon	Organophosphate	1B
Preclude Insecticide	Pyrethrins (plus piperonyl butoxide)	Pyrethrins	3
Coopex EC Residual Insecticide	Permethrin	Synthetic pyrethroid	3
Cislin Residual Insecticide	Deltamethrin	Synthetic pyrethroid	3
Crackdown Residual Insecticide	Deltamethrin, Tetramethrin (plus Piperonyl butoxide)	Synthetic pyrethroid	3
Tempo Residual Insecticide	Betacyfluthrin	Synthetic pyrethroid	3

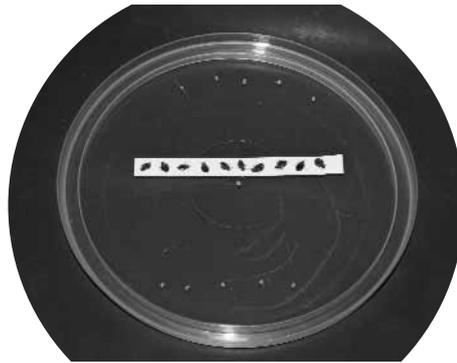


Figure 1: Bed bugs secured to tape and onto a container lid.



Figure 2: 1µl droplet of insecticide was applied to the bed bug ventral surface.

This first report provides the topical results, while the second presents the residual application results and discusses the implications of the findings.

Topical assay methodology

Eight products were selected for the trials (Table 1). These encompass all the classes of currently registered insecticides for use against bed bugs and include many products that are routinely used by pest managers.

Mixed sex and age adult common bed bugs were selected from the colony maintained by the Department of Medical Entomology, Westmead Hospital, NSW.

Bed bugs were secured to a small strip of double-sided adhesive tape (Figure 1) for exposure to a controlled dose of insecticide.

Each product was diluted to the maximum label rate and a 1µl drop was applied to each bed bug (Figure 2).

For each product, four replicates of ten bed bugs were used. Untreated replicates, also of ten bed bugs, were included as controls.

Readings of mortality were taken every hour for the first six hours, and then at 24 hour intervals thereafter.

Replicates for each compound were pooled and a percentage cumulative mortality determined. Control mortality was determined by combining all the control replicates.

Results – Topical application

The graphs present the percentage cumulative mortality for the first 10 days for each product.

The organophosphate products (Actellic and Diazinon EC) far outperformed all other products in total mortality and kill time, both achieving 100% mortality within six hours of application (Figure 3).

Crackdown was the highest performing of the synthetic pyrethroids, achieving 90% mortality after seven days and increasing slowly thereafter. However, 100% mortality was not achieved over the ten days.

Presumably the addition of the synergist piperonyl butoxide resulted in the greater mortality as deltamethrin alone (as in Cislin) achieved poorer results with just over 60% mortality at 10 days (Figure 4).

Ficam W initially performed well (Figure 3), with 25% mortality in the first six hours; however total mortality failed to increase over the following days and eventually after 10 days, mortality was on par with Tempo and Cislin.

Permethrin (Coopex EC) resulted in a 10% kill within 24 hours but thereafter failed to provide any further control (Figure 4).

The natural pyrethrins in Preclude provided no control at all (Figure 4).

Discussion

Overall, the majority of the synthetic pyrethroids, pyrethrins and carbamates performed poorly in these trials.

Given that the doses used here could be expected to rapidly kill other susceptible insects, it is hypothesized that a degree of resistance is present to these group of insecticides in this strain of bed bugs.

With the recent importation of a susceptible strain of bed bugs to be used as a baseline comparison, it is hoped that we can determine the level of resistance present in Australian bed bug populations.

Regardless of resistance, an issue potentially impacting on efficacy of the products tested was penetration of the solution through the bed bug cuticle. Only the Diazinon and Actellic formulations were readily absorbed through the cuticle, presumably due to high concentration of hydrocarbon solvents. All other products formed distinct beads on the insect abdomen and took extended periods of time to penetrate or dry (Figure 2).

In many instances treated bed bugs had to be left for up to 20-25 minutes before the solution had penetrated or evaporated. This phenomenon may well be exacerbating any inherent resistance. Unfortunately, most of the products available must be diluted with water, and solvents that may assist in penetration of the solution through the cuticle are extremely restricted when the environment in which the product is to be sprayed is taken in to account.

In the next issue we will present the results for the residual bioassays along with the implications of the findings.

Furthermore on Thursday, May 7, a full day course on bed bugs and their control will be held at Westmead Hospital and as part of this course the latest research findings will also be presented and discussed in greater detail.

More information on the course next issue, otherwise contact Stephen Doggett on (02) 9845 7265 or Stephen.Doggett@swahs.health.nsw.gov.au ■

REFERENCES

- Boase, C., Small, G., and Naylor, R. (2006). Interim report of insecticides susceptibility status of UK bedbugs. *Professional Pest Controller*. Summer: 12-13.
- Romero, A., Potter, M.F., Potter, D.A., and Haynes, K.F. 2007. Insecticide resistance in the bed bug: a factor in the pest's sudden resurgence? *Journal of Medical Entomology*. 44: 175-178.

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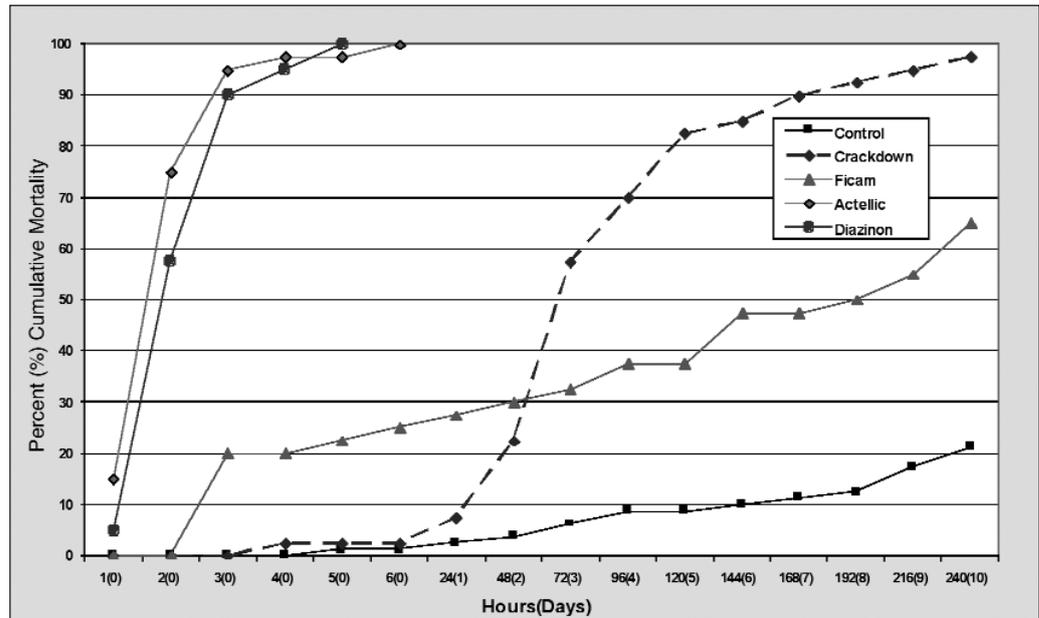


Figure 3: Cumulative mortality when 1µl droplet of insecticide was applied to the ventral bed bug surface for the products Actellic, Crackdown, Diazinon, Ficam and the control.

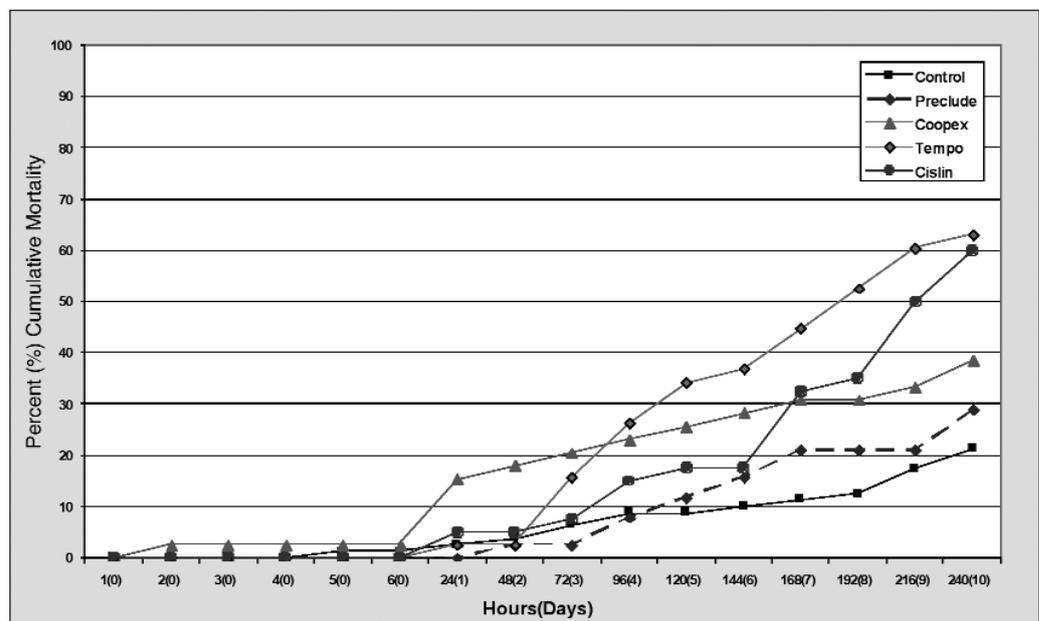


Figure 4: Cumulative mortality when 1µl droplet of insecticide was applied to the ventral bed bug surface for the products Cislin, Coopex EC, Preclude, Tempo and the control.