

Bed bugs on the label... but what does this really mean?

Many insecticides have bed bug control on their labels. Yet practical experience suggests that controlling modern bed bug strains with many of these can be problematic. How can that be? Internationally renowned bed bug expert, Stephen Doggett, and his PhD student, David Lilly, believe they have the answer. In this article they share their views.

There are many insecticides on the market that claim to be effective at killing bed bugs. Yet the simple fact is that most have little impact on modern bed bug strains.

The reason is due to insecticide resistance. In reality you should expect that every infestation you treat will be composed of resistant bed bugs.

As with other insect pests, resistance in bed bugs is extremely complex and modern strains may possess multiple resistance mechanisms that could confer reduced susceptibility to one or more insecticide groups. They have been described with target-site insensitivity knockdown (kdr) resistance, increased detoxification, reduced cuticular penetration resistance and may even exhibit behavioural resistance. Different strains may also vary in what combination of resistance mechanisms they possess. So, whilst almost all bed bugs can be expected to exhibit a degree of resistance, the magnitude of that resistance may vary from one infestation to the next.

The net effect is that the humble old bed bug has developed a range of defences to nullify the insecticide you, as professional pest controllers, are using. It would be wise to assume that not all bed bugs encountered are the same. (For a full discussion of resistance mechanisms in bed bugs, see the paper by Dang, Doggett and Lilly in *Pest* issue 28: July & August 2014).

The reality is that due to the existence and variety of resistance mechanisms, there is not one synthetic insecticide on the market that will provide any great level of residual control against bed bugs. Thus it makes you wonder, just how did bed bugs make it onto the label of that product you are using, if it is so ineffective at controlling bed bugs?

Only tested on susceptible strains

The vast majority of products that are sold for bed bug control today were evaluated against old laboratory strains that are susceptible to all insecticides. Given that today the world is full of insecticide resistant bed bug strains, such data is totally irrelevant. Even worse,



David Lilly, left, with Stephen Doggett have concerns about how bed bug insecticide efficacy trials are conducted.

there are companies out there that still insist their product is tested on old bed bug strains, despite being aware of the issues of resistance! Their aim is to get the product on the market and make a quick buck. Invariably, their adverts present a positive efficacy image with data that is just too good to be true. Unfortunately, efficacy authorities around the world have yet to clamp down on this problem.

Tested on inadequately defined 'resistant' bed bugs

Many researchers and insecticide suppliers claim that their efficacy data was derived via testing on resistant bugs. However, as stated above, bed bugs possess many different resistant mechanisms, and a particular strain may not have them all. The result is that there can be tremendous variation in the magnitude of resistance observed between different strains.

In testing over 20 different bed bug strains within our laboratory, many with known kdr resistance, the level of efficacy when exposed to high doses of deltamethrin varied between 100% killed to 0% killed. Thus which 'resistant' strains are testing laboratories using? Those that are highly resistant, or those with a lower degree of resistance? Any claim of residual efficacy via the pyrethroids against so-called 'resistant' bed bugs has, without a doubt, been tested on bugs with little resistance.

Furthermore, resistance is lost in colony strains over time. For

example, within our Sydney strain, 30% no longer have any kdr resistance. Very few laboratories routinely undertake resistance profiling of their laboratory strains to ensure that resistance has not been lost. Also, there are no standards as to what constitutes a resistant strain. Nor are there any universally accepted standards on how to test for resistance in bed bugs.

Inappropriate test pressure

Efficacy testing of products must take into account the normal biology of the pest. For example, if bed bugs were exposed to an insecticide 'bomb' without any harbourage, then they may succumb to the product. However, bed bugs do not live in the open; they naturally hide in a variety of cracks and crevices that would protect them from such products. This is why insecticide bombs are useless against bed bugs.

Minimal testing

Many household aerosols have bed bugs on the label and indeed these products will kill insecticide resistant bed bugs when sprayed directly at the insect. However, they have zero residual effect. Thus, presumably the insecticide companies do not provide residual data to registration authorities, as the product would never end up on the market. Curiously, the labels omit the fact that they have no residual effect!

Efficacy testing not required

In some parts of the world, products can be registered for insect control if they are considered to have low toxicity. In the USA for example, products can belong to a category called 25B which covers food grade chemicals and efficacy data does not have to be provided to the registration authority – in this case, the US Environmental Protection Agency (EPA). The EPA believes that it is more important to ensure products are safe to humans, rather than being effective against the pest. They allow market forces to decide whether a product is effective and will stay on the market. Such a view is a recipe for disaster; it encourages exploitation of the people through the provision of bad products and can result in greater insecticide resistance. Not good when we have so few products available for use.

Do unscrupulous labs fake the results?

It is abhorrent to think that testing organisations, or chemical companies, would fake efficacy data to get their product onto the marketplace, but Recently we were provided with a product to evaluate against bed bugs, which had been tested by a commercial testing facility. The results from the group included data from the testing of a very slow acting insecticide that normally takes a week, or more, to kill bed bugs. Yet, this

facility claimed control in a few hours, which is simply not possible with the mode of action of that particular insecticide.

So why would anyone fake results? Money!!! In the trial mentioned above, my testing proposal for the product was for around AU\$10K (£5K) worth of research. Our research proposal was planned over several stages, and progression onto the next stage was dependent on the success of the previous. In our case, the pilot study failed to demonstrate any efficacy, thus the trial was ended and our final bill was only around AU\$1K (£500). It is thus easy to see why less scrupulous laboratories might be averse to being overly critical in their testing regimes; it ensures ongoing money!

In a nutshell, always beware of claims when it comes to bed bugs, especially with the pyrethroids - whoever is making them. Some researchers are paid enormous amounts to promote dubious products. Some conference organisers are also paid huge dollars to have these researchers present at bed bug conferences.

The consequences of bad efficacy data

The most obvious consequence of an inadequately tested product is that it probably will not kill the bed bugs that you have been contracted to control. The result is a treatment failure.

These failures cost you time, money and can even affect your reputation. More insidiously with bed bugs, treatment failures often results in the dispersal of the infestation. This can lead to the adjoining premises also becoming infested. Product failures also exacerbate insecticide resistance. Treatment failures reflect badly on the pest control industry as a whole, something that we should all be concerned with.

Until quality efficacy guidelines for bed bug products are produced and until standards on resistance testing are developed, my best advice is to be sceptical. Always be wary of company claims by ensuring that you always conduct thorough follow-up inspections following any bed bug control programme. The best sources for quality information are the various industry standards on bed bug management.

About the authors

Stephen Doggett is from the Department of Medical Entomology, Pathology West, Westmead Hospital, Westmead NSW, Australia. Since the beginning of the modern bed bug resurgence, Stephen has been at the forefront of documenting the rise and impact of bed bugs.

David Lilly is a PhD Candidate at the University of Sydney and the recipient of an Australian Postgraduate Award partly comprising an industry grant from Bayer Environmental Science (Australia). Such grants are administered by the University of Sydney to ensure independence and the 'rights to publish' are maintained for the duration of the student's candidature.

Below: Products may be effective if sprayed directly onto the bugs, but bed bugs do not live in the open, so how is this to be achieved in practice?



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