

EFFICACY OF SEVEN COMMERCIAL PEST CONTROL PRODUCTS AGAINST *CIMEX LECTULARIUS* (HEMIPTERA: CIMICIDAE)

KATE L. TURNER AND ANDREW J. BRIGHAM

Rentokil Initial; European Technical Centre, Unit 7-8 Foundry Court,
Foundry Lane, Horsham, West Sussex, RH13 5PY, UK
e-mail: andy.brigham@rentokil-initial.com

Abstract Seven commercial pest control products were assayed against *Cimex lectularius* (L.) adults and 4th instar nymphs under laboratory conditions for 48 hr. After initial exposure a selection of the porous plates were aged under mixed lighting, at 22°C for 5 weeks, and assayed using 4th instar nymphs to determine the residual action. The quickest acting active ingredient against adults was lambda cyhalothrin which achieved total control within 45 min., followed by bendiocarb, alpha cypermethrin, bifenthrin, deltamethrin and d-phenothrin, and finally chlorfenapyr which after 48 hr exhibited less than 40% control. Against the 4th instar nymphs the quickest acting product was alpha cypermethrin, however this along with lambda cyhalothrin, deltamethrin and bendiocarb had achieved total control in 2 hr. D-phenothrin achieved total control at 24 hr with chlorfenapyr only affecting 13% after 48 hr exposure. After aging the deltamethrin, alpha cypermethrin and lambda cyhalothrin plates for 5 weeks, further assays were undertaken with 4th instar nymphs. Alpha cypermethrin showed the best and quickest efficacy followed closely by the other two active ingredients, and were comparable to the initial trial. These results are discussed in terms of best practice for control of bed bug infestations.

Key Words Residual efficacy, laboratory bioassay; pyrethroids, carbamates

INTRODUCTION

Incidences of bed bug, *Cimex lectularius*, infestations seem to be on the increase, and are certainly providing one of the largest growth areas for Pest Control Operators (PCOs). Their cryptic behaviour; ability to fit into the smallest areas; withstand wide environmental conditions and starvation mean that a sub standard service will be very unlikely to lead to infestation control, Coupled with our total intolerance to this pest this means that it is vital to ensure both the service and the products used are the best available. A sub-standard treatment not only decreases company profit margins by providing free call backs, but also runs the risk of damaging the customer's and the PCO's brand reputation.

To ensure that Rentokil Pest Control is able to provide the best level of service using effective products some basic research was conducted. The objective was to establish the relative effectiveness of several different active ingredients with variable formulation types against one susceptible laboratory strain. A selection of compounds were tested five weeks after application to assess their relative residual efficacy.

MATERIALS AND METHODS

Test Insects

Bed bugs were obtained from a laboratory culture maintained at Sheffield University (Sheffield, South Yorkshire, UK). Mixed age and sex adult and fourth instar nymphs were used in the experiments. The culture had been maintained in Sheffield since 1999, originally believed to have been collected in the United Kingdom, and had been in culture for ~ 40 years.

Experimental Design

Ten adults or 4th instar nymphs were confined onto one tile, within a plastic ring (~9 cm dia). The number of knocked down (KD) and dead bed bugs was assessed at 5, 15, 30, 45, 60 min. and 2, 4, 6, 24 and 48 hr after insect introduction onto the tiles. Three replicates were conducted for each treatment on separate tiles. Knock down was classified as being unable to stay upright or move away from a gentle prod stimulus. Dead was

classified as showing no response when gently prodded. After the initial trial a selection of plates were retained in a laboratory setting being exposed to natural and artificial light at a temperature of 22°C for five weeks. These plates were re-tested (as above) with 4th instar nymphs from the same colony as the initial trial.

Seven different commercial products were assessed. The active ingredients tested, formulation type, and solution concentration applied to wooden tiles 15 cm 2.: d-phenothrin OW, 0.15%; deltamethrin WG, 0.02%; alpha cypermethrin SC, 0.03%; bendiocarb WP, 0.30%; bifenthrin WP, 0.05%; lambda cyhalothrin ME, 0.05%, chlorfenapyr SC, 0.49%. These were diluted in water, to label dilution rates, and applied at one application rate directly onto wooden tiles (15 cm x 15 cm). An untreated control treatment was also included for comparative purposes. Surfaces were allowed to dry overnight prior to insect introduction.

RESULTS

Within 6 hr of exposure only one pyrethroid and the chlorfenapyr product had not resulted in total combined KD and mortality (Figure 1). The quickest acting active ingredient was lambda cyhalothrin (an ME formulation), followed closely by bendiocarb, alpha cypermethrin, bifenthrin and deltamethrin. Within the 48 hr period neither the d-phenothrin or chlorfenapyr product resulted in 100% control. The rate of activity against the 4th instar nymphs was much quicker when compared to the adult data and within 2 hr all but the d-phenothrin and chlorfenapyr plates had resulted in total 'control' (Figure 2). The order of efficacy was slightly different than against the adults with alpha cypermethrin (SC) showing the quickest activity followed by lambda cyhalothrin, deltamethrin, bendiocarb, and bifenthrin. With the exception of chlorfenapyr, all individuals were controlled within 24 hr. After a five week ageing period three of the initial compounds were retested using 4th instar nymphs only (Figure 3). Combined KD and mortality data showed very similar results to the original test and within 4 hr all individuals were controlled.

DISCUSSION

This data indicates that lambda cyhalothrin (ME) provides effective control of bed bugs, and would be used by Rentokil as the initial control product. This data is supported by similar data obtained from an independent laboratory strain in USA (Moore and Miller, 2006). For the 2nd treatment (and possibly 3rd) within the overall pest control program alpha cypermethrin (SC) would be recommended, as this is more efficacious against the nymph stages. When considering the residual test data, all three compounds tested showed no reduction in efficacy against 4th instar nymphs. These results are similar to those obtained from a residual study conducted by Fletcher and Axtell (1993). Their research found that lambda cyhalothrin and permethrin applied to wood at previously ascertained LC₉₀ rates for the test strain, and aged for several weeks, showed limited reduction in efficacy.

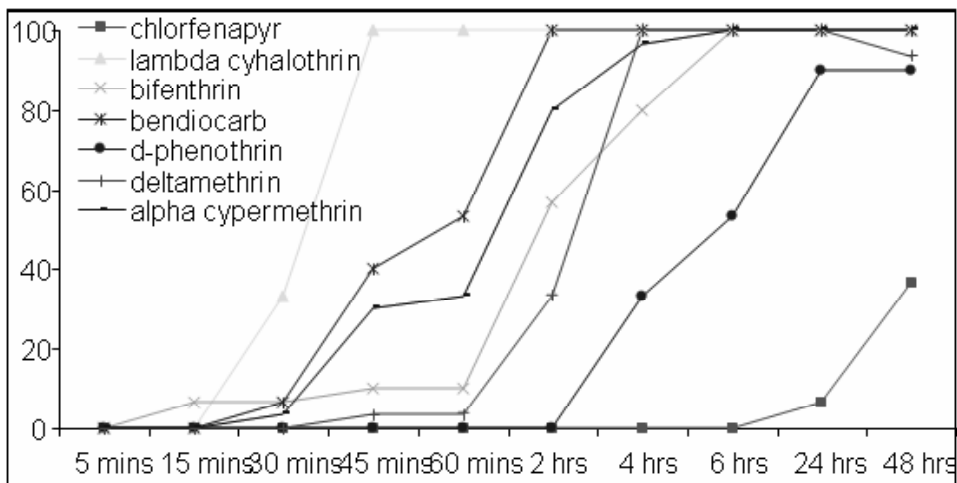


Figure 1. Percentage combined KD and dead adult bed bugs when exposed to seven commercial products of varying active ingredient and formulation type, 48 hr (n = 3).

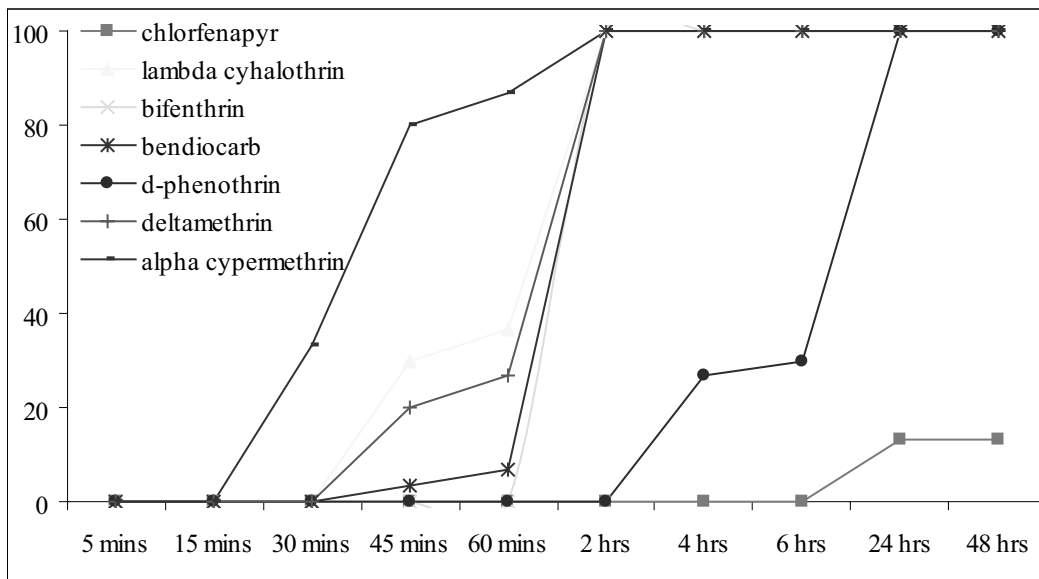


Figure 2. Percentage combined KD and dead 4th instar nymph bed bugs when exposed to seven commercial products of varying active ingredient and formulation type, for 48 h (n = 3).

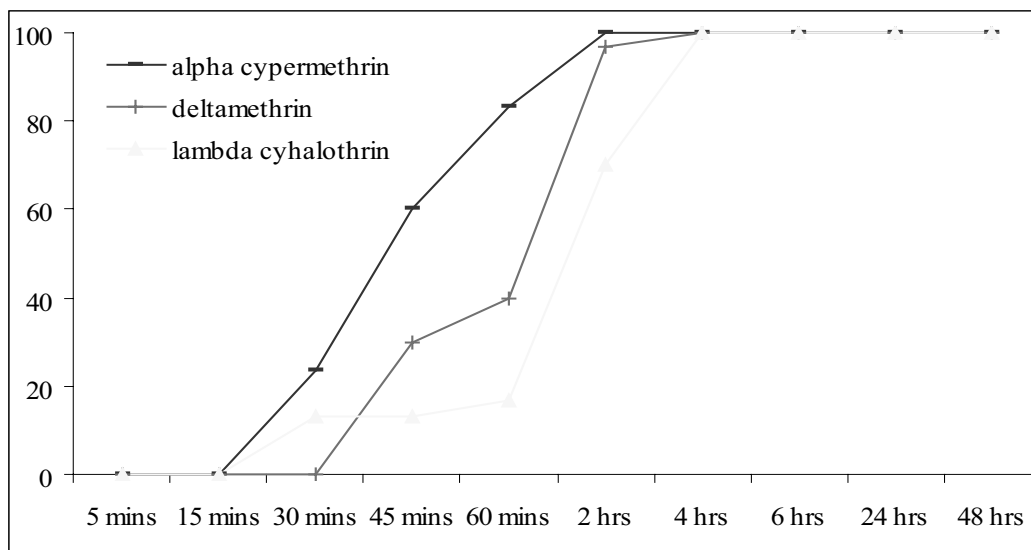


Figure 3. Percentage combined KD and dead 4th instar nymph bed bugs when exposed to three commercial products of varying active ingredient and formulation type, for 48 h, after plates had been aged for 5 weeks (n = 3).

These data would be applicable in a practical pest control scenario if the strain in the field has not been subjected to insecticidal pressure. However, it is likely that different strains will respond in slightly different times than each other, but the order of effect is unlikely to vary dramatically (within laboratory studies this time variation may also be a factor of different experimental design and recording categories). Where research of this nature becomes flawed is when the field population being tested has been previously exposed to pest control compounds, and has developed a magnitude of resistance to specific active ingredients. The global extent of resistance is currently unknown, and many claim that it is widespread. Several studies including Romero, et al. (2007) and unpublished work found significant levels of resistance to pyrethroids and carbamates. However, this is just a small snapshot of the total selection of populations and strains. It could also be argued that field strains selected for resistance studies are not a representative random sample;

because non resistant animals will have been controlled with previous treatments and it is only the resistant survivors that have had time to build up sufficient numbers to be collected for laboratory testing. Without rigorous laboratory testing this situation is unlikely to be clearly defined, as many 'failed' field treatments are being labeled as resistance problems when in fact they are a symptom of a poor treatment. To fully understand the implications of this issue on the control of these pests we must strive to understand the nature of resistance, the degree of cross resistance and the mode of transfer through generations, and this acquisition of knowledge should be jointly attained by all parties involved in the control of this pest.

To further complicate the understanding of how this type of research can provide practical recommendations for pest control, it is essential to understand how the pest control program will ultimately be conducted. For example some PCOs insist that rooms infested with bed bugs are left completely vacant for the whole period of 'treatment'; this may be up to 21 days. In this situation the results presented here are inconsequential. However, many PCOs allow rooms to be reoccupied much sooner — often one or two days after the first and subsequent treatments, due to the commercial pressures on the customer. In these cases, where rooms are left vacant for only the legal minimum time associated with the applied compound, it is essential that the quickest acting product is used, so that when the insects emerge from harborages they pick up a lethal dose and are affected quickly enough so that that are unable to feed upon the 'host' (i.e. the paying guest) within the room.

In a continually developing market, with limited time and resources, no pest control company would be able to conduct research in a manner that would generate significant recommendations to their field staff, which provides the correct product choice for all variations of susceptible and resistant strains in every situation. What studies like the one reported here do provide is a simple comparison between different active ingredients and formulation types, and a general indication of their likely efficacy. It provides critically comparative data that is often lacking in an industry where such technical insights are important to be able to deliver the best service, using the most effective products.

CONCLUSIONS

The data presented indicates that if speed of action was absolutely essential then a series of lambda cyhalothrin and alpha cypermethrin treatments would be the best option. It could however be questioned whether this difference in speed of action would represent a practical difference in overall efficacy in the field, particularly between the pyrethroid compounds tested. Although other products appeared poorer in this study the overall efficacy of these compounds may be highly dependant on the field situation, past insecticide use, possible resistance and the type of pest control program implemented. However, these potential limitations in applying the findings of this study should not detract from their validity, but should be understood and used to benefit further independent studies (however limited to strains, compounds, surfaces or exposure times) to further develop our understanding of the control of this pest.

REFERENCES CITED

- Fletcher, M. G and Axtell, R. C. 1993.** Susceptibility of the bed bug, *Cimex lectularius*, to selected insecticides and various treated surfaces. *Medical and Veterinary Entomology* 7: 69-72.
- Moore, D. J. and D. M. Miller. 2006.** Laboratory evaluations of insecticide product efficacy for control of *Cimex lectularius*. *Journal of Economic Entomology* 99(6): 2080-2086.
- Romero, A, Potter, M. F, Potter, D. A., and Haynes, K. F, 2007.** Insecticide resistance in the bed bug: a factor in the pests sudden resurgence? *Jour. of Medical Entomology* 44(2): 175-178.