

Impact of Multiple Exposure of Sub-lethal Deltamethrin Treatments on Resistant Bed Bug Fecundity (*Cimex lectularius*) (Hemiptera: Cimicidae)

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INTRODUCTION

After the resurgence of bed bugs, *Cimex lectularius* L., (Heteroptera; Cimicidae) two decades ago, a variety of insecticides have been evaluated for bed bug control. Pyrethroid insecticides have commonly been used to control bed bug populations; however, some field strains of bed bugs have varying levels of resistance to pyrethroids including deltamethrin. Single exposure of sub-lethal levels of pyrethroid insecticides in previous studies have been shown to affect reproduction, fecundity, development time, and hatch rate of female bed bugs. The purpose of this study was to evaluate sub-lethal dose effect of multiple exposures to deltamethrin on the fecundity of resistant *C. lectularius*.



Figure 1. Treatment of raw wood panels



Figure 2. Post exposure feeding of *C. lectularius*

MATERIALS AND METHODS

The deltamethrin-based product D-fense SC (4.75% deltamethrin, 95.25% other ingredients; Control Solutions Inc.) was applied to 10.16 cm² raw wood panels at the 0.03% label rate using a compressed air sprayer (B&G Pistol Pro sprayer) at 25 psi. Control panels were treated in the same manner using distilled water. All treated wood was allowed to dry 24 hours. One plastic medicine cup (30 ml) with the bottom removed was inverted and secured to each treated panel using heated paraffin wax to prevent bed bug escape. A preliminary 30 minute exposure test using fifteen, fourth-instar Harlan strain pyrethroid susceptible, bed bug nymphs was performed in conjunction with fifteen, fourth instar Jersey City, NJ, deltamethrin resistant (>300X resistant to topical deltamethrin application) bed bug nymphs. There was 100% mortality and moribundity at 24 hours post-exposure for susceptible nymphs, while 94% (1 dead) of the resistant nymphs were alive.

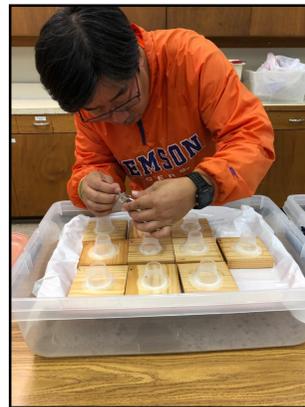


Figure 3. Exposure of nymphs to treated surfaces

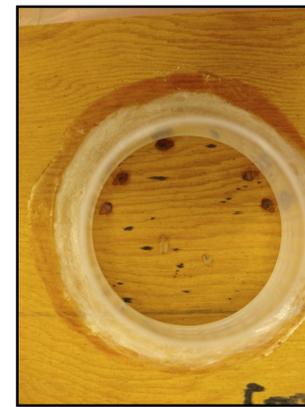


Figure 4. Exposure of 30 minutes to treated surface

After the preliminary exposure test, 140 Jersey City, deltamethrin resistant fourth-instar nymphs were selected. Seventy nymphs were exposed to five deltamethrin treated wood panels and 70 nymphs were exposed to five water treated wood panels for 30 minutes at 24 hours post treatment. All nymphs were then removed to a clean vial to be given a post-exposure blood meal. All bed bugs were exposed to treated panels again for 30 minutes at 10 days post-treatment and then placed back in their corresponding vial. All vials were given a blood meal post exposure. The number of adult male and females were tallied, along with the number of eggs produced by treatment. The proportion of eggs hatched and nymphs alive was recorded.

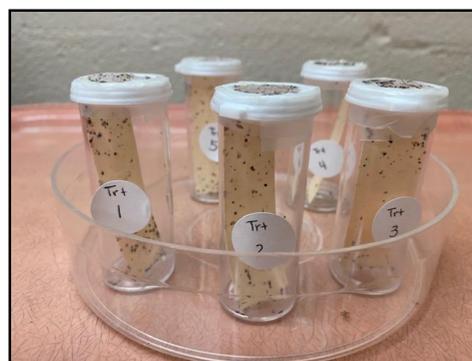


Figure 5. Vials of bed bugs post exposure.



Figure 6. Egg and 1st instar nymphs

RESULTS & DISCUSSION

For this study, there was a significant difference between the mean number of eggs laid by control females and the females deltamethrin exposed, 3.08 and 5.72 respectively ($p=0.035$). There was no significant difference between the mean proportion of nymphs hatched from control eggs and the eggs of deltamethrin exposed bed bugs, 0.899 and 0.773 respectively ($p=0.095$).

Treatment	Mean # of Eggs Per Female	Prop. Eggs Hatched *
Control	3.08 ± 0.930	0.899 ± 0.095
Deltamethrin	5.72 ± 0.930	0.773 ± 0.095

Figure 7. Comparing fecundity of bed bugs after 30 min exposure to treated surface before 5th instar and adult molt. *Study is ongoing. Proportion hatched data is expected to change.

SUMMARY

Understanding sub-lethal impacts of treatment on all stages of bed bugs is important when assessing control options and strategies. In a previous Clemson lab study where only adult virgin males were exposed to deltamethrin, no significant differences were observed in mean number of eggs or proportion of eggs hatched in control versus treated bed bugs. In this study where all bed bugs were exposed as nymphs and again as adults, female deltamethrin resistant bed bugs produced more eggs. However, the proportion of eggs hatched (to date) for deltamethrin exposed bugs was lower than the control hatched rate. Future lab studies looking at longer direct exposure times, more incidents of repeated exposure, and different combinations of male and female bed bugs could be examined to investigate sub-lethal deltamethrin exposure in resistant bed bugs.



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