

Chitin Synthesis Inhibitors against the Western Drywood Termite, *Incisitermes minor*

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Introduction

Termites are eusocial insects of economic and ecological importance found on every continent except Antarctica (Rust and Su 2012). The western drywood termite, *Incisitermes minor* (Hagen), is a wood-destroying pest that causes significant economic damage estimated to be up to \$250 million dollars annually in California and Arizona alone (Cabrera and Scheffrahn 2017). *Incisitermes minor*'s cryptic ecology alongside increased urbanization and globalization involving the movement of wood and cellulose-containing products both establishes and maintains *I. minor*'s pest status (Lewis *et al.* 2014).

Structural fumigation is the most effective whole treatment method for drywood termite control. However, it is expensive, disruptive (as the treated structure must be uninhabited for three days or more), and does not provide residual protection meaning the treated structure is not protected from future infestations. Although structural fumigation is the most effective method for drywood termite control, these characteristics as well as the public's increased wariness towards pesticide and toxic chemical use creates a need for effective alternative methods for drywood termite control.

Baits containing chitin synthesis inhibitors (CSIs) are an insect growth regulator that are commonly used for subterranean termite control, and they are generally considered to be able to provide the complete elimination of large colonies. Baiting is relatively environmentally friendly when compared to the traditional liquid termiticide application in the soil method. CSIs have several characteristics that contribute to their high efficacy. They are dose independent, slow-acting, and nonrepellent. CSIs kill insects by disrupting the molting process preventing advancement to the next instar. CSIs are incorporated into a bait matrix which the termites feed on and spread throughout the colony through trophallaxis, eventually resulting in colony elimination. I aim to investigate if the application of a similar method, a baiting system using CSIs as the active ingredient, is feasible for drywood termite control. This study is the first step towards evaluating the efficacy of the use of CSIs for *Incisitermes minor* control. The effect of continuous exposure of the CSI noviflumuron against the western drywood termite over three weeks as well as future directions are discussed.

Methods

A piece of 4 cm x 2.7 cm balsa wood (~0.64 grams) was treated with 200 μ L of 0.5% or 0.1% noviflumuron (Dow AgroSciences LLC, Indianapolis, IN) solution in acetone. An acetone only control was used. Wood was stored in the fumehood for three hours after treatment application to allow for solvent evaporation. The wood was placed in a petri dish (55 mm) and 19 nymphs (wing buds present) and one soldier were introduced. The petri dish was covered and placed in a humidity chamber kept at greater than 75% relative humidity. The 0.1% and 0.5% treatments (n=10 each) were kept in one humidity chamber while the control (n=10) was kept in another. The experiment ran at 27° C in complete darkness except for time of observation. Observations were made daily for three weeks. After week 3, observations were made every three days.



Fig. 1. Dead individual unable to complete molt.

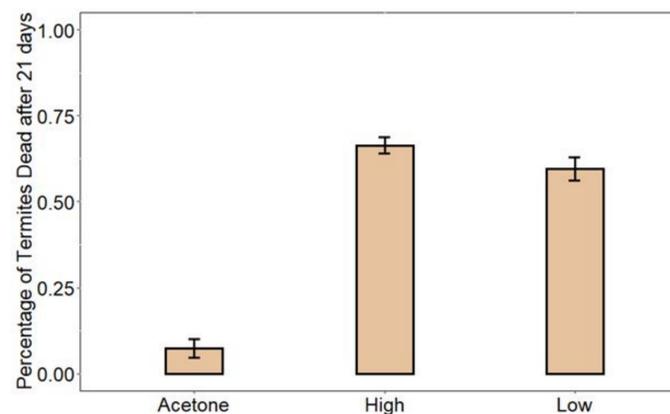


Fig. 2. Mean percentage (\pm S.E.) dead at three weeks. High = 0.5% noviflumuron, Low = 0.1% noviflumuron, Acetone = clean acetone only.

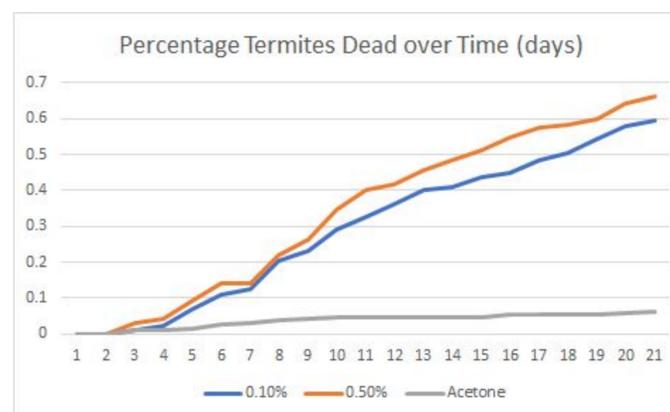


Fig. 3. Percentage termites dead over three weeks.

Results

Mortality began starting day three of the experiment. Many individuals showed direct signs of a failed molting, dying mid molt (Fig. 1). The data for the complete trial (100% mortality in treatments) is not available yet, so the data from the first three weeks is summarized. The control group had a mean 0.074 % individuals dead after three weeks. The "High" concentration (0.5% noviflumuron) had 0.663 % dead and "Low" (0.1%) had 0.595 % dead after three weeks (Fig. 2). Only one soldier out of 30 died after the 1st three weeks. Both treatments were significantly different from the control ($P < .0001$) but not significantly different from each other (Tukey's HSD test). By the end of week 3, the mortality appeared to be plateaued.

Discussion / Future Direction

Exposure to chitin synthesis inhibitors resulted in mortality of the western drywood termite, *Incisitermes minor*. This was expected given the known effects of CSIs on other termite groups such as subterranean termites. However, since there is no literature available on the effects of CSIs on *I. minor*, this study is a step towards developing a localized insecticide treatment with a CSI as the active ingredient.

There is pressure to shift towards more sustainable environmentally friendly pest management methods, and CSIs are appropriate given their low mammalian toxicity. Interestingly, if the trends of the data continue until 100% mortality, the efficacy of a CSI treatment on *I. minor* might not differ between "High" and "Low" concentrations. Thus, the lower concentration would be sufficient for pest management applications. This contributes to the commitment of more environmentally friendly options as less chemicals are introduced into the environment. It remains to be seen if *Incisitermes minor* treated with CSIs reaches 100% mortality in an appropriate time frame that is suitable for professional pest management use.

The same protocol will be used for an experiment using another chitin synthesis inhibitor, bistrifluron. It will be interesting to see any differences of the effect between noviflumuron and bistrifluron against *Incisitermes minor*. A limited exposure experiment using both CSIs will also be performed in the future. Drywood termite baiting incorporated with CSIs may be a possible method for drywood termite control. However, the efficacy of such a treatment remains to be seen. Future lab experiments will indicate if this study should be continued in field experiments.

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