

## **Efficacy of detection and spot treatment for the drywood termite *Incisitermes snyderi* (Kalotermitidae) in naturally infested lumber using three RTU products**

by

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### **Abstract**

Cypress lumber infested with drywood termites was examined for activity using a Termatrac® motion detector, galleries were identified using a Resistograph drill, and treated with one of three RTU products. Results indicated that the Termatrac was excellent at locating termite activity but provided 25% false negatives in our limited sample size (N=8). The resistograph located termite galleries with an average, within treatment, of one to 4 extra holes drilled to find at least one gallery. Treatments included a foam-based, a dry and an experimental RTU product and all treatments provided evidence for reduced termite populations per board compared to the control.

**Key words:** drywood termite, *Incisitermes snyderi*. Termatrac®, resistograph

### **Introduction**

Termites from the family Kalotermitidae, the drywood termites, have a worldwide distribution and can be serious structural pests in tropical and non-tropical coastal regions (Gay 1969, Weesner 1970, Eggleton 2000). The biology of termites in this family is little studied but several species have been examined and the group is considered to be biologically homogenous (Eggleton 2000). Drywood termites nest in and feed on wood and are considered single-site nesters with a dynamic caste developmental system including neoteny (Abe 1987, Korb and Lenz 2004). Nest architecture is considered complex with numerous wide galleries connected by narrow passageways (Grace et al. 2009).

Control of drywood termites in structures is complicated by their biology and nest architecture in addition to issues surrounding detection and non-destructive evaluation of treatments (Scheffrahn et al. 1993, Lewis and Haverty 1996, Scheffrahn et al. 1997, Thoms 2000, Lewis et al. 2004, Woodrow et al. 2006). A study was conducted using cypress lumber naturally infested by *Incisitermes snyderi* (Light) to evaluate two questions relative to drywood termite management. The first was efficacy of three ready-to-use (RTU) formulations including an imidacloprid foam, a dry fipronil formulation applied with a compression bulb applicator and a BASF experimental formulation in a pressurized can. Second was to appraise the usefulness of microwave motion detection (Termatrac®) in identifying live drywood termite activity. Results are discussed in regard to increasing the reliability of and level of confidence in drywood termite spot treatments.

## **Materials and methods**

Termites. A stack of naturally infested cypress boards was noted in the summer of 2009 near a house at the University of Georgia Marine Institute on Sapelo Island, Georgia, USA. Approximately 30 infested boards, identified by location of kick-out holes and pellets, were relocated near an isolated area and rearranged in two stacks placed on cinder blocks at least 20-cm above soil level. Those boards were used in the study beginning one year later in August 2010. The cypress boards were custom cut and measured 2.6 X 15.8-cm X 3.3-m (D:W:L).

Detection of termite activity. Boards were numbered and divided into 12, 15-cm sections that were also divided down the middle of the board to provide 24 sections for recording the termite activity data. Boards were placed, one at a time, on a platform supporting the two ends and termite activity within each board measured using a Termatrac® (Termatrac 14 / 65 Christensen Road Stapylton, 4207 Queensland, Australia) microwave motion detector. The Termatrac® unit was placed in each of the 24 sections for at least 15 seconds to determine if motion was detected. Indications of motion, as per Termatrac® instructions, which we assumed to be drywood termite activity, were recorded by board number and board section. Activity was recorded one day before treatment (Day 0), the day of treatment (Day 1), and 65 days after treatment (Day 65). Activity data were compared for each board by number of active sites per board and location of sites within boards.

Experimental Design. The activity data, by board, was used to place individual boards into one of 5 categories based on number of active sections – Category I; 1-2, Category II; 4-5, Category III; 7-9, Category IV; 10-11, and Category V; >13. Boards were then randomly assigned to treatments based on Category classification to equilibrate pre-treatment measures of activity across treatments assuming activity correlated with number of termites/level of infestation.

Boards selected for treatment were restacked in the same outdoor location and separated to prevent movement of termites between boards by using 2, 3 X 3 X 10-cm wood blocks covered in aluminum foil placed 40-cm from the two ends of each board.

Treatments. Prior to treatment a resistograph drill (IML-Instrumenta Mechanic Labor GmbH, 1275 Shiloh Road, Ste. 2780 - 30144 Kennesaw, GA) was used to locate at least one gallery within the 61-cm and 122-cm sections regardless of the location of activity in that board. The resistograph drill hole that indicated at least one gallery within that respective section was used as the point of application of the appropriate treatment.

The 0.05% imidacloprid foam, designated as ‘foam’ in discussion of results, was applied until an excessive amount of foam leaked from other holes in the wood or from weak surface veneers caused by termite excavation. This generally took 1-3 seconds before excessive leakage occurred resulting in approximately 6.5 ml – 19.5 ml respectively being applied. (label states 26 ml/4 sec.)

The 0.5% fipronil dry formulation, designated as ‘dry’ in discussion of results, was applied using three compressions of a compression bulb applicator per hole applying approximately 0.1 grams of formulation.

The BASF experimental formulation, designated as ‘exp’ in discussion of results, was applied from a pressurized can at a rate of one second per hole.

Evaluation of Treatment Efficacy. Boards were cut into 12, 15-cm sections using a hand-held circular saw. Sections were destructively sampled using hammer and chisel to remove all live termites. The

number of live termites was recorded by caste (soldier, reproductive, and workers) and board number. The presence of dead termites (dried or fungus-covered cadavers, headcapsules) was noted but numbers not recorded.

### **Results and discussion**

The data on drywood termite activity as indicated by the Termatrac® showed a consistency that increased our confidence in the ability of the device to accurately indicate the presence of termites in 2.5-cm thick cypress boards. The activity data from the control boards was consistent or increased in 4 of 5 boards while live termites were found in each control board at the end of the 65-day experiment. The control board data showed that the Termatrac® was useful in detecting even small numbers of termites as indicated by control board #10 that consistently provided activity data at one location and only 8 termites were recovered at the end of the study (Table 1). The ability of the Termatrac® to

Table 1. Number of active sections by board out of 26 possible sections as indicated by Termatrac readings on three separate days before and after treatment and the number of termites found per board 65 days after treatment.

Board #	treatment	# activity zones/ board	# activity zones/ board	# activity zones/ board	# termites
		8-24-10	8-24-10	10-28-10	10-28-10
12	control	10	7	3	762
10		1	1	1	8
18		7	7	11	1,144
9		11	11	10	1,170
22		14	16	15	1,082
14	foam	1	2	1	25
20		13	12	4	638
26		5	6	5	171
15		10	10	8	1,363
7		7	6	3	444
25	dust	4	8	2	162
16		10	8	3	345
6		1	2	0	38
1		13	9	0	0
19		2	3	0	0
11		7	3	0	0
13	exp	8	9	0	0
17		9	8	3	54
3		4	2	0	0
21		11	10	1	231
2		16	8	0	6

indicate activity was verified in every one of the 14 boards where we recorded activity because on Day 65 each of those boards also provided termites using the destructive sampling technique we employed. These data support the work of Mankin (2004) who showed rates of detection of stored product pests. The difficulty in locating every single insect or area of activity was, however, highlighted by the 8 boards where we obtained no Termatrac® reading but found termites by destructive sampling. The rate of false negative readings - by board, we obtained 25% (2 out of 8 boards) – was higher than that reported by Evans (2002) using subterranean termite aggregation stations. However, this should not be taken as an indictment of the device but as a word of caution toward interpretation of inspection data. It is our opinion, based on the experience gained during this experiment, that indications of termite activity are dependent on movement by the termites – which we did not attempt to simulate – and proximity of the detection device to the area of activity. In this experiment we placed the detection device sensor (an area approximately 4X4-cm) within a ‘section’ of the board that measured 16X8-cm to standardize and facilitate timely inspection within and between treatments. It seems likely that use of a technique to agitate (move) the termites and/or using a smaller area (placing the detection device in several locations per section) would have reduced the number of false negatives we obtained. These are questions that were beyond our experimental design but deserve further study because it is important to understand, with any detection device, the probability of false negative readings.

Directed application of insecticide into infested structural components (spot treatment) for drywood termite management is not only hampered by efficient verification of activity (discussed above) but by accurate location of galleries. This study employed a resistograph drill to ensure that voids (galleries), identified by a drop in resistance while drilling into the lumber, were in the path of each injection hole. Our previous work with drywood spot treatments always involved a bit of guesswork on gallery location prior to treatment that was usually ‘verified’ by the amount of formulation accepted at the time of treatment (unpublished data). The resistograph obviated that guesswork and every drill hole that was treated intersected a gallery as verified by the destructive sampling. The mean number of galleries treated by location (61 & 122-cm) ranged from 1.3 to 2.8 while the mean number of holes drilled to find those galleries ranged from 3.2 to 6.8 by location per board (Table 4). It took at least 2 attempts before a gallery was intersected in most boards (Table 4).

The treatments we conducted all provided evidence of impact on drywood termite populations using the metrics of mean Termatrac® readings per board or mean number of termites per board (Tables 2 & 3). Interestingly we found, when conducting the destructive sampling, dead termites in all treatments including the controls. None of the treatments eliminated all live termites from all boards by 65 days (Tables 2 & 3). The dry and exp treatments did, however, provide several boards where no live termites were found after destructive sampling (Table 3). This study was conducted as a rigorous test of the products because applications were made at only two locations, 16-cm from either end of a 3-m board. This type of ‘hole’ spacing for delivery of a spot treatment for drywood termites should be considered extreme given the application of treatment locations used in past studies (Lewis and Haverty 1996). The time frame we used to evaluate our naturally-infested lumber treatments could also be considered short compared to studies on spot treatment efficacy that typically employ intervals from 90 days to one year (Lewis and Haverty 1996, Sheffrahn et al. 1997, Woodrow et al. 2006).

Table 2. Mean number ( $\pm$  SD ) of active sections per board as determined by Termatrac® motion detector by treatment .

Treatment	Mean number of active sections per board		
	One day prior	Day of treatment	65 days post treatment
Control	8.6 $\pm$ 4.4	8.4 $\pm$ 5.5	8 $\pm$ 5.2
Foam	7.2 $\pm$ 4.1	7.2 $\pm$ 3.5	4.2 $\pm$ 2.3
Dust	6.2 $\pm$ 4.3	5.5 $\pm$ 2.9	0.8 $\pm$ 1.2
EXP	9.6 $\pm$ 3.9	7.4 $\pm$ 2.8	0.8 $\pm$ 1.2

Table 3. Mean number of termites per board by caste and the number of boards where no termites were found after destructive sampling by treatment.

Treatment and number of boards per treatment	Mean number of termites per board			Number of boards with no termites
	workers	soldiers	reproductives	
Control N=5	803 $\pm$ 427	27 $\pm$ 16	3 $\pm$ 2	0
Foam N=5	511 $\pm$ 454	14 $\pm$ 14	3 $\pm$ 2	0
Dust N=6	88 $\pm$ 124	1 $\pm$ 2	1 $\pm$ 1	3
EXP N=5	57 $\pm$ 88	0.6 $\pm$ 0.8	0.4 $\pm$ 0.8	2

Table 4. Mean number of galleries per treatment location in boards by treatment type as determined by resistograph readings and number of resistograph drill attempts per board required to find at least one gallery for treatment.

Treatment	Mean number of galleries per board		
	@ 61-cm	@ 122-cm	Resistograph holes/ board
Control	2.4 $\pm$ .5	2.2 $\pm$ .4	3.2 $\pm$ 2.4
Foam	1.8 $\pm$ .8	2.8 $\pm$ .8	4.0 $\pm$ 1.4
Dust	1.5 $\pm$ .5	1.3 $\pm$ 1.3	6.8 $\pm$ 2.9
EXP	2.2 $\pm$ 1	2.2 $\pm$ 1.2	3.8 $\pm$ 1.7

Therefore we would hypothesize that given more time all of these treatments would have shown further reductions in numbers of live termites... if not outright elimination.

One outcome we gained from this study is the opinion that spot treatment for drywood termites is hampered by an inability to obtain ‘complete’ coverage because of the architecture of the gallery system. The gallery system of the *I. snyderi* examined for this study was characterized by enlarged gallery-sections connected by small diameter (2-mm) tunnels. This arrangement created bottlenecks that thwarted the uniform distribution of the formulations we tested because those small galleries could have easily been blocked by fecal pellets or live termites. The fact that we only treated two locations along a 3-m board highlights a high degree of efficacy considering we were able to eradicate termites in 5 of 16 treated boards (30%). We believe these data are evidence that certain formulation/active ingredient combinations provide a high level of confidence in drywood termite drill and treat spot treatments. These efficacy data appear to question our earlier stated opinion on complete coverage and we hypothesize those treatments were successful because termites contacted the treatments after application rather than obtaining a lethal dose during application. We believe a better understanding of drywood

termite behavior, improved detection/treatment techniques and patience (i.e. allowing time for optimum results) may demonstrate that drill and treat spot treatments can provide a useful alternative to fumigation for (relatively) low-level infestations with a greater degree of certainty than we currently have for this methodology. Future studies will examine these same formulations with markers to examine the distribution within a gallery system following application and will use an extended time frame in addition to destructive sampling over time to examine the role of residual activity and insect contact after application.

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