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Inhibition of termite damage by N'N-napthaloylhydroxyamine (NHA): *Reticulotermes flavipes* (Kollar) vs. *Coptotermes formosanus* Shiraki

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Inhibition of termite damage by N/N-napthaloylhydroxyamine (NHA): Reticulotermes flavipes (Kollar) vs. Coptotermes formosanus Shirdaki

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Abstract

The calcium precipitating agent NHA has been shown to protect southern yellow pine (SYP) from wood decay and termite damage comparable to CCA in field tests (Gulfport, MS) for two years (Crawford and Green, 1999). In a collaborative study, SYP wood blocks were vacuum treated with three concentrations of aqueous NHA and exposed in a no-choice test to Eastern subterranean termites (FPL, USA) and Formosan subterranean termites (WRI, Japan) to determine protection against termite damage. Individual blocks (leached and unleached) were exposed to *R. flavipes* (AWPA) or *C. formosanus* (JWPA) for 3-4 weeks. Mean weight loss of wood blocks after termite exposure ranged from 0.0 to 18.0% for *R. flavipes* and 6.0 to 20% for *C. formosanus*. Wood blocks exposed to *R. flavipes* were completely protected by 0.5 and 1.0% NHA, but weight loss in similar blocks challenged by *C. formosanus* were 6.0% and 6.2% respectively at the same concentrations. NHA acted as an effective termiticide for *R. flavipes* with 100% mortality after 3 weeks, but only soldiers were preferentially killed in *C. formosanus.* Formosan subterranean termite workers showed enhanced resistance to NHA treatment when compared to Eastern subterranean termites.

Key words: Termite damage, wood preservation, calcium precipitation

Introduction

A specter is haunting the forest products industry – the specter of the Formosan Subterranean Termite (FST). Hitching a ride on boats returning from the orient after World War II, the insect has spread across the south, especially since 1988 when potent organo-chlorine poisons were banned. The infestation centers on New Orleans where the annual damage to trees and wooden structures is estimated at $300 million dollars. In addition, FST damage one billion dollars US wide and two billion US dollars worldwide. In 1999, the Louisiana legislature declared the FST a public nuisance and authorized its agriculture commissioner to adopt regulations for its control. A likely outcome will be the banning of untreated wood from structural members in construction, initially within the five parish New Orleans area, later statewide. Of more than passing interest to the wood products industry is the possibility that such a move could spur similar steps in other states (Spelter, 2000).

"This is a super bug. This Formosan termite is a soldier in a well-organized army of billions. When they join together, Formosans form a perfect eating machine, wrecking buildings and felling trees. In 10 years, they have destroyed more of metro New Orleans than hurricanes, tornadoes and floods combined. Many years ago, vigilance might have stopped them. Now, they are dug in. They are strong and they are hungry." (McQuaid, 1998).

In terms of biodeterioration, the most hazardous region in the temperate zone is Hawaii, USA (The Professional Treater, July 1998). Hawaii's proscription set a precedent for the Louisiana measure. Over the last three decades, codes there have banned the use of untreated wood in new construction and since 1970 chromated copper arsenate (CCA) has been the chemical of choice. However, Hawaii is a Douglas fir consuming market and that species is hard to treat. A local area standard was created, but wood received setbacks from failure of improperly treated lumber on some projects. That, combined with the higher cost of treating, has led some builders, primarily large volume developers, to switch to metal. The exact shift in market has not been determined but estimates of around 30 percent have been reported based on tonnage of steel shipped to residential projects (Spelter, 2000). In Japan, *C. formosanus* is an equally economically important pest for wood structures (Yoshimura, 1995).

In response to this growing threat, new wood treating options need to be explored not only to save wood and structures, but to protect the wood industry. The leachability of disodium octaborate tetrahydrate (DOT) treatments in ground applications and disposal problems with chromated copper arsenic (CCA) will be further exacerbated with pressure treatment of all home framing members, as proposed in Louisiana, so it is prudent to explore some new approaches to termite control. Because of environmental concerns and the risk for pest control operators and residents, safer and more environmentally acceptable measures making better use of ecological and physiological characteristics of target termite species should be aimed as future directions (Yoshimura, 1995)

N'N-napthaloyhydroxyamine (NHA) is a water soluble calcium precipitating agent which has been shown to protect SYP from fungal decay and termite damage at a concentration of 1% in soil-block tests. Field tests have also shown that pressure treatment with 1% NHA can protect SYP to the same degree as CCA in a high degradation environment like Gulfport, MS, for over 30 months (Green et al., 1997; Crawford and Green, 1999). The primary objective of this study was to compare and contrast the ability of NHA to inhibit weight loss of SYP from *R. flavipes* and *C. formosanus* in a no-choice lab test using vacuum treated test blocks.

Materials and Methods

Treating Procedure. Test blocks were cut from southern pine sapwood. Small feeder blocks (10 x 10 x 20mm; JWPA) and medium feeder blocks (25 x 25 x 6mm; AWPA), vacuum treated with aqueous NHA (0.1%, 0.5% and 1.0%) were compared to those treated with chromated copper arsenate (CCA) at 6.4 kg/m^3. The Standard method of determining leachability, AWPA Standard E11-87, was followed (AWPA, 1987).

No-choice test with *C. formosanus*. Test samples measuring 10 x 10 x 20mm (~1.2gm) were placed on the center of plaster bottom of an acrylic cylinder test container (90mm in diameter and 60mm in height) with 150 workers and 15 soldiers of *C. formosanus*. The containers were placed on damp cotton pads to supply sufficient water for termites and were maintained in the dark at 28^o C and over 85% relative humidity (RH) for 3 weeks. At the end of the test, the samples were oven dried and reweighed to determine percentage weight losses. Mortality of the termites was also recorded. Five replications of each sample were used.

No choice test with *R. flavipes.* Test samples measuring 25 x 25 x 6mm (~2.2gm) were placed in plastic containers containing 9cm filter paper with one gram of *R. flavipes*. Dishes were maintained at 25°C and 80% RH for 4 weeks following the methods of AWPA E1-72. At the end of the test, samples were oven dried and reweighed to determine weight loss. Mortality was recorded (N=5).

Results and Discussion

During the 4 week test, *R. flavipes* survived well and consumed 19% of the SYP control blocks (Table 1). At 1.0% NHA (not leached) more than 20% of individuals survived at the end of the test, but at 0.5% NHA (not-leached) we observed 100% mortality (Table 2). This might be due to repellency at the higher level of NHA. Treated blocks showed less than 2% weight loss, but leached feeder blocks showed increased weight losses approximately 20-fold at 0.1% NHA. Combined mortality of *R. flavipes* on NHA exceeded that of CCA (22%).

Coptotermes formosanus had higher mortality on SYP controls (N=5) but similar weight loss on smaller blocks with one half as many termites (500 mg) in only 3 weeks. Weight loss of blocks plateau at 6-7% for all groups of NHA treated blocks (Fig. 1). Worker mortality plateaus at about 25% but soldier mortality increased to nearly 100% in unleached blocks (0.5 and 1.0% NHA), (Table 2). Soldier mortality might result from reduced feeding by workers. Test block weight loss (%) and termite survival for *C. formosanus* vs. NHA was not as effective as that reported for 0.3-1.0% BAE disodium octa-borate tetrahydrate (DOT) (Grace and Yamamato, 1994b; Mauldin & Kard, 1996).

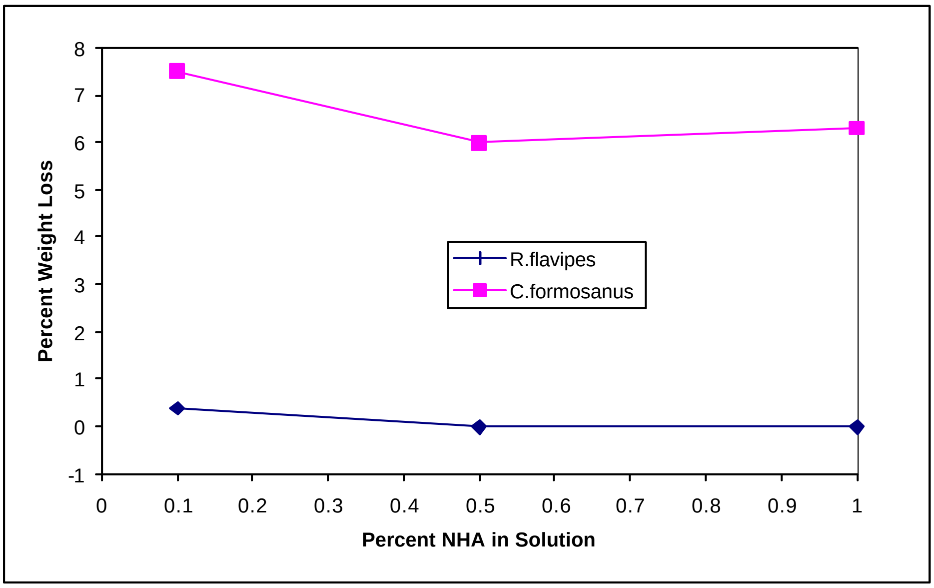

Figure 1. Weight-loss of wood blocks vs percent NHA (non-leached) in solution.

In spite of encouraging results for *R. flavipes*, further supported by 30 month NHA field stake tests in Gulfport, MS, (Crawford and Green, 1999) the results for *C. formosanus* did not meet the quality requirement of JWPA standard that needs less than 3% weight loss at the highest concentration of NHA. There was no special repellency of NHA-treated blocks against *C. formosanus*. As such, the feasibility of developing NHA, or some other calcium precipitating agent, for use against *C. formosanus* is not warrented at the tested concentrations, although higher retentions above 1% should be tested and the mechanism of inhibtion determined.

Numerous authors have tested wood treatments against Formosan subterranean termites but little comparative data is available for other termite species (Grace et al., 1993; Tamashiro et al., 1998). Recently, a task force at AWPA 1999 (Lax) looked for comparative data in order to estimate thresholds concentrations of preservatives for Formosan subterranean termites (FST) based upon efficacy data for other termites i.e. *R. flavipes*. Many preservative systems had no FST data. El-97 laboratory tests on efficacy against termites showed that CBA-A controls attack by both Formosan termites and *R. flavipes* at 0.204 pcf (3.3 kg/m^3) which is the recommended AWPA above-ground retention. Additional comparative studies should be designed and match tested in the future.

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Table 1. Wood weight loss (%) of no-choice laboratory termite tests on pine sapwood vacuum treated with NHA or CCA (N=5)

Treatment Group	*Reticulotermes flavipes* (US)	*Coptotermes formosanus* (Japan)
Untreated	19.0 ± 13.7	20.1 ± 3.3
0.1% NHA	0.4 ± 0.9	7.5 ± 0.5
0.1% NHA (leached)	7.7 ± 7.1	20.6 ± 4.7
0.5% NHA	0.0 ± 0.0	6.0 ± 1.2
0.5% NHA (leached)	4.3 ± 4.0	10.9 ± 2.6
1.0% NHA	0.0 ± 0.0	6.3 ± 1.1
1.0% NHA (leached)	1.4 ± 0.4	7.2 ± 1.5
CCA	1.3 ± 0.0	not done

Table 2. Percent mortality of termites in no-choice test of NHA & SYP

	Mortality		
	R. flavipes[a]	*C. formosanus*[b]	
	Combined	Workers	Soldiers
Untreated	0.0±0.0	12.2±4.5	20.0± 8.2
0.1% NHA	39.1±3.6	20.0± 9.2	64.0±23.7
0.1% NHA (leached)	N.D.	12.0± 6.8	14.7± 5.6
0.5% NHA	100%	26.7± 9.5	93.3± 8.2
0.5% NHA (leached)	N.D.	26.0± 9.8	36.0± 9.0
1.0% NHA	78.6±17.8	27.3±10.0	98.7± 2.7
1.0% NHA (leached)	N.D	23.1± 8.7	73.3±18.9
CCA	21.8±6.3	(N.D. = Not Done)	

[a] 4 weeks [b] 3 weeks