Continuation Study of the Response of Subterranean Termites (*Coptotermes formosanus*)to Organosilane Treated Wood Wafers (Isoptera: Rhinotermitidae)

By

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ABSTRACT

A standard laboratory termite test was conducted in May of 2012 using termites from a single colony of *Coptotermes formosanus* (Shiraki) gathered in South Central Mississippi. Testing was performed adhering to procedures outlined in the AWPA E1-09 Standard termite test. Wood wafers used in the test were treated with an organosilane compound that has been shown to cause color changes and erratic behavior in native termite species (Johnson & others 2011). Significant results were obtained on the weight loss of treated wafers as well as termite mortality. Observations of worker termites exposed to treated wood wafers during testing did not reveal any abnormal termite activity, and no significant *post mortem* observations were made, as were made with *Reticulitermes sp.* It is hypothesized that the pathogenic response of the gut bacteria *Serratia marcescens* (Bizio) in *Reticulitermes sp.* to the organosilane compound was not observed in *C. formosanus* due to a higher resistance to immuno threats.

INTRODUCTION

Interactions between termites and bacteria and/or fungi have been shown to affect termite feeding (DeBach & McOmie 1939; Cornelius 2002; Amburgey 1977; Johnson & others 2011). According to Su (1982) mortality should nott be the sole basis on which insecticidesare evaluated, rather a behavioral responses should also be considered, due to the nature of termites to effectively seal off or avoid treated areas. When a standard laboratory termite test (American Wood Protection Association E1-09) was conducted in

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September of 2011 utilizing a single colony of *Reticulitermes sp.* exposed to organosilane treated wafers, behavioral changes and color phenomena were observed (Johnson & others 2011) as well significant results in regard to specimen weight losses as well as termite mortality (Johnson 2012). Results of that study indicated termite mortality that was potentially caused by the bacterium *Serratia marcescens* (Bizio), though there was no known introduction of the bacteria to the termite test specimens. Observations made by Johnson & others (2011) closely matched observations made in a study by DeBach and McOmie (1939) in which termites exposed to *S. marcescens* exhibited varying red colorations *post mortem* and characteristic behavior changes. *S. marcescens* is known to have pathogenic effects when introduced to many termite species (DeBach & McOmie 1939; Khan & Others 1977; Connick Jr. & others 2001; Osbrink & others 2001); however, *S. marcescens* is also a facultative anaerobe that is a symbiont of the anaerobic protozoa within the termite gut (Adams & Boopathy 2005). The common presence of *S. marcescens* in the digestive tracts of many insects is found to be non-pathogenic due to the lack of invasive power for the bacterium to penetrate the mid-gut wall (Burges & Hussey 1971). When something disrupts the symbiotic relationships of a gut bacteria however, (*e.g.*, termites treated with immuno-suppressing compounds) the termites' immune defense response is suppressed (Connick & others 2001; Osbrink & others 2001). Johnson & others (2011) hypothesized that a pathogenic response of *S. marcescens*, hosted by the termites, might be triggered by the organosilane compound through the disruption of symbiotic protozoa present in the gut of termites, though termite cadavers of the study were not analyzed for positive identification of the presence of the bacterium. Isolated strains of *S. marcescens* were used in a study on *C. formosanus* (Connick & others 2001), yielding high termite mortality rates, and red features observed *post mortem*. Both members of the family Rhinotermitidae, *Reticulitermes* and *Coptotermes* are classified as "lower termites", which harbor dense populations of gut protists (Ohkuma & others 2001). *S. marcescens* is specifically documented to be present in the gut of *C. formosanus* and is credited to causing septicemia (blood poisoning) in *C. formosanus* (Adams & Boopathy 2001; Osbrink & others 2001. The purpose of this study was to determine if similar phenomena occurred by the introduction of an organosilane treated food source to *C. formosanus*, as occurred with native termite species (Johnson & others 2011).

METHODS

The AWPA E1-09 Standard Method for Laboratory Evaluation to Determine Resistance to Subterranean Termites was observed for this test (AWPA 2011a). Termites (*C. formosanus*) were collected from pine-veneer bucket traps at the Mississippi Agricultural and Forestry Experiment Station in McNeill, MS (AWPA Hazard Zone 5) (Fig. 1). *Coptotermes formosanus* (Shiraki) isthe primary termite species at this site and test organisms were identified based on physical attributes. Southern yellow pine (*Pinus spp.*) sapwood wafers vacuum-treated with formulations of the organosilane 3-(Trimethoxysilyl)-propyldimethyl octadecyl ammonium chloride, (Si-Quat), were used as the food source for worker termites. The Si-Quat used in this study is widely known for its antimicrobial properties (Kemper & others 2005; Isquith & others 1972; Hayes & White 1984; Monticello & others 2009). Non-treated pine sapwood wafers served as controls. The treatments are listed in Tablea 1. Non-sterile test chambers were constructed from French-square bottles containing 150-ml of pool filter sand and 20-ml. of deionized water (deviation from the standard 30-ml.). Test wafers were placed in contact with the sand in each test chamber and 1-g of termites (9% soldiers) was added to each chamber (deviation from the standard 400 termites). The duration of this test was twenty-eight days.

RESULTS AND DISCUSSION

Some mortality was documented with termites exposed to treated wood wafers during an initial inspection fourteen days into the study. Final results at the end of the testing period showed significantly less weight loss of test wafers among all treatment groups in comparison to the untreated control group. The 2.5% Si-Plus treatment group had the least weight lossleast feeding and highest block rating of all treatment groups. As shown in Table 2, block ratings were higher for all treatment groups (indicating resistance to termite attack) than the untreated control group ratings. Termite mortality was significant among all treatment groups with heavy/ complete mortality in the 2.5% ai treatment groups. No unusual observations were made on termite behavior in the present study as were made in past studies with *Reticulitermes sp*. (Johnson & others 2011). One possible explanation is the documented tolerance of *C. formosanus* to chemical treatments in regards to susceptibility. In a study conducted by Su (1990) in which both *C. formosanus* and *Reticulitermes flavipes* (Kollar) were utilized to evaluate eleven soil termiticides, it was concluded that *R. flavipes* was more susceptible to all termiticides used. For many wood preservatives, certain retentions must be attained for suitable use in exposure areas subject to Formosan termite activity (AWPA 2011b) due to higher tolerance of the Formosan.

SUMMARY

The primary goal of the present study was to examine feeding of *C. formosanus* on organosilane-treated wood wafers. Treatment of wood wafers with the organosilane compound showed increased termite resistance over non-treated wafers, and high termite mortality. Though high levels of resistance and mortality were reported, observations of worker termite behavior and *post mortem* appearance did not yield abnormal results as were observed with *Reticulitermes sp.* Perhaps studies conducted utilizing higher concentrations of the organosilane 3-(Trimethoxysilyl)-propyldimethyl octadecyl ammonium chloride should be conducted in an attempt to provoke a pathogenic response of the gut bacteria, *S. marcescens*.

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