Evaluation of several novel and conventional termiticide formulations against the Asian subterranean termite, *Coptotermes gestroi* (Wasmann) (Isoptera: Rhinotermitidae)

by
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Abstract

Five novel and conventional termiticide formulations, i.e. DPX-E2Y45 18.5% SC, indoxacarb 14.5% SC, WellTech 0980 24% SC, Termidor® (fipronil) 2.5% EC and Biflex® (bifenthrin) 24% SC were tested against the Asian subterranean termites, *Coptotermes gestroi* in the laboratory to determine their efficacies and their repellent properties. Two methods were used in this study: modified glass tube method, and petri-dish method. Four concentrations (1, 10, 50 and 100 ppm w/w) were evaluated for all termiticides in the glass tube method, while only recommended concentration was tested in the petri-dish method. Results indicated that with exception to bifenthrin, all termiticides demonstrated non-repellent properties. At extremely low concentration (1 ppm), bifenthrin did not show repellency effect against termites. The efficacies of each termiticide based on tunneling and wood consumption activities of the termites are discussed.

Keyword: subterranean termites, termiticides, non-repellent, tunneling, wood consumption.

Introduction

The Asian subterranean termite, *Coptotermes gestroi* (Wasmann) is an economically important subterranean termite species in South East Asia (Kirton and Brown 2003). Management of this species has been relying heavily on the use of chemical methods such as soil termiticide, baiting and dusting (Lee et al. 2003). Soil termiticide treatment, via creating a chemical barrier for exclusion of subterranean termites from buildings and structures, has been a popular mode of termite control for the last 50 years (Ibrahim et al. 2003; Su et al. 1997; Miller 2002; Jones 2003). In the past, repellent termiticides have been the principle approach to exclude termites from structures. Insecticides especially those from the pyrethroid group are key candidates of repellent termiticides. However, over the last several years, there has been increasing popularity in using termiticides with non-repellent properties. This characteristic is crucial because termites will not be able to detect the presence of the treated termiticide in soil, and thus will continue to forage through until the demise or suppression of the whole colony (Spence 1998; Shelton & Grace 2003). These compounds also have a delayed mode of action that continues to allow termites to forage freely in and out of the treated zone, thus promising a greater impact to the whole colony (Shelton & Grace 2003). In this study, we examined the laboratory performance of several novel and conventional termiticide formulations against the Asian subterranean termite, *Coptotermes gestroi* using two evaluation methods.

Materials and methods

The Asian subterranean, *C. gestroi* was used in this study. They were freshly collected from the underground monitoring stations which were established earlier in the Universiti Sains Malaysia Minden campus. They were brought back to the laboratory and separated from debris using the method described by Tamashiro *et al.* (1973). Five termiticide formulations, i.e. DPX-E2Y45 18.5% SC [DuPont Professional Products], indoxacarb 14.5% SC [DuPont Professional Products], WellTech 0980 24% SC [WellTech Healthcare Co. Ltd, Thailand], Termidor® (fipronil) 2.5% EC [Bayer Environmental Science] and Biflex® (bifenthrin) 24% SC [FMC] used in the evaluation.

Two evaluation methods had been adopted: Glass-tube method and Petri-dish method. The glass tube method, modified after Su and Scheffrahn (1990) (Figure 1) is a 30-cm glass tube (1.4 cm diam.) that contained a 21-cm long moistened sand and 2-cm termiticide-treated sand sandwiched between 2-cm sawdust and 2-cm 10% agar. Two pieces of moistened filter paper were placed into the 3-cm void adjacent to the agar layer. Two hundred termite workers and 10 soldiers were introduced into the void and allowed to tunnel freely. The cumulative tunneling distance was measured daily up to 7 days post-treatment. The number of termite survivors was recorded at the end of the experiment. Four different concentrations [1, 10, 50 and 100 ppm (w/w)] were tested and each concentration was replicated 3 times.

For the petri-dish method, a polyethylene container measuring 16 cm diam. x 6 cm height) was separated into 2 sections with a piece of glass. One section was filled with 140 g of untreated sand, while the other was filled with equal amount of sand that was treated with the termiticide. Two pieces of rubber wood (*Hevea brasiliensis*) measuring 2 x 1 x 1 cm were placed in each section. Four hundred workers and 20 soldiers were then introduced into the untreated section and allowed to acclimatize for 48 hours. After that period, the glass pieces was removed and termites were allowed to forage freely. Termite survivorship and total wood consumption were calculated after one week post-treatment. Tunneling activities in both treated and untreated section were qualitiatively ranked. Each experiment was replicated 5 times.

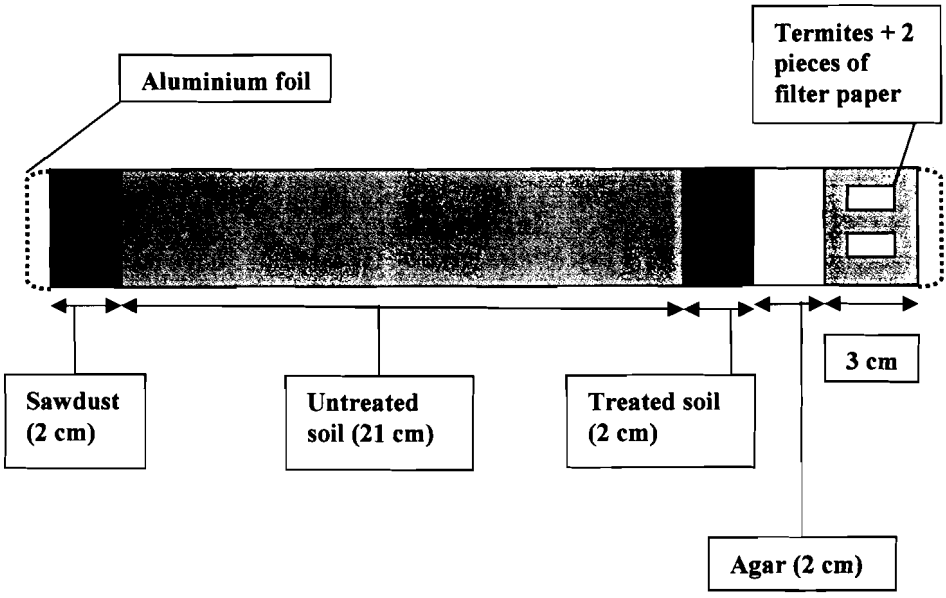

Figure 1: Experimental setup of the tube method for evaluation of termiticide performance.

Results and Discussion

Results indicated that all termiticide formulations (with exception to bifenthrin) evaluated show non-repellent characteristics (Table 1). Under glass-tube method, both DPX-E2Y45 and indoxacarb showed excellent performance even at 10 ppm w/w. Termites continued to tunnel forward without detecting the presence of the compounds, thus resulting complete mortality of the test insects after 7-day post-treatment. As for fipronil and WellTech 0980, similar efficacies were recorded at 1 ppm w/w. At higher concentrations, most formulations showed a faster killing action, as evident from the shorter tunneling distance of the termites. In this experiment, there was minimal mortality of termites in the control replicates and the maximum tunneling distance was achieved within 48 hours post-treatment.

Table 1: Summary of the performance of the termiticides evaluated using the modified glass tube method.

Termiticide	Conc. (ppm)	Evaluated parameters		Characteristic
		Tunneling distance[1]	Mortality of termites[2]	
Control (water)	-	Long	Low	-
DPX-E2Y45	1	Long	Low	Non-repellent
	10	Long	High	
	50	Short	High	
	100	Short	High	
Indoxacarb	1	Long	Low	Non-repellent
	10	Long	High	
	50	Long	High	
	100	Short	High	
WellTech 0980	1	Long	High	Non-repellent
	10	Long	High	
	50	Long	High	
	100	Short	High	
Fipronil	1	Long	High	Non-repellent
	10	Short	High	
	50	Short	High	
	100	Long	High	
Bifenthrin	1	Long	Low	Repellent
	10	Short	Low	
	50	Short	High	
	100	Short	High	

[1]Tunneling distance: 0 – 30% total distance = short; 31 – 60% total distance = moderate; 61 – 100% total distance = Long.
[2]Termite mortality: 0 – 25% = Low; 25 – 70% = moderate; >75% = High.

Evaluation using the petri-dish method confirmed the characteristics of the compounds evaluated in the earlier experiment. WellTech 0980 was found to be an excellent non-repellent termiticide candidate. Termites was found to forage freely between the two sections (treated and untreated) and complete mortality of termites was recorded after several days (Table 2). Despite the foraging activity of termites in the treated zone, the amount of wood consumption was still relatively low. Both DPX-E2Y45 and indoxacarb also demonstrated good non-repellent insecticide properties with moderate tunneling activities in treated zone and minimal wood damages. Fipronil, however, showed a quicker killing action when compared to the former three candidates. On the other hand, bifenthrin was clearly a repellent insecticide with high termite tunneling activity in untreated section and no activity in the treated zone.

To achieve greater colony suppression or even elimination, it is crucial that the termiticide used is slow-acting and non-repellent. This is because termites demonstrate necrophobic behavior where quick mortality of the poisoned termites may result in abandon or sealing of tunnels that leads to the treated zone by healthy colony members (Su et al. 1982). Once the decomposed corpses accummulated near and in treated zones, the healthy termites will no longer come in contact with the treated zone and thus survived the treatment (Su 2005).

Table 2: Summary of the performance of the termiticides evaluated using the petri-dish method.

Termiticide	Conc. (ppm w/w)	Tunneling activity (wood consumption)		Termite mortality
		Untreated section	Treated section	
Control (water)	-	High (high)	High (high)	Low
DPX-E2Y45	100	High (moderate)	Moderate (low)	High
Indoxacarb	100	High (moderate)	Moderate (low)	High
WellTech 0980	30	High (moderate)	High (low)	High
Fipronil	11	Moderate (low)	Low (low)	High
Bifenthrin	30	High (high)	No (no)	Low

In this study, two methods were used to evaluate the termiticides. The glass tube provides a reliable quantitative method that permit measurement of tunneling distance of test insects under the presence of a treated barrier (layer). On the other hand, the petri-dish method provides a simple qualitative approach to study the response of termites between the treated and untreated zones. This method also enables accurate determination of the wood damage in both treated and untreated zones. It is believed that when all parameters obtained from the two methods were taken in account, it can provide a relatively reliable interpretation on the actual performance of termiticide formulation.

Acknowledgments

The authors thank Clay Scherer (DuPont Professional Products USA) and Wichai Chivakanit (WellTech Health Co Ltd, Thailand) for providing the termiticide formulations used in this study.

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