EVALUATION OF CHLORFLUAZURON IN CONTROLLING THE SUBTERRANEAN TERMITE *COPTOTERMES CURVIGNATHUS* (ISOPTERA: RHINOTERMITIDAE) IN INDONESIA

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Received September 2007

SUKARTANA P, SUMARNI G & BROADBENT S. 2009. Evaluation of chlorfluazuron in controlling the subterranean termite *Coptotermes curvignathus* (Isoptera: Rhinotermitidae) in Indonesia. We evaluated the effectiveness of a bait formula containing the active ingredient chlorfluazuron in controlling the subterranean termite *Coptotermes curvignathus* which infests houses in Jakarta. Two types of aggregation devices ('stations'), namely, in-ground stations (IGS) and above-ground stations (AGS) were applied. IGS complete with timber interceptors lining the inner station wall and a wood block in the centre was installed around the perimeter of the houses to monitor the termite activity. The number of stations installed was adjusted to the space available. Stations infested by termites were then filled with the bait matrix after the wood block was removed. The AGS (with bait matrix) were installed directly on the points of termite attack found in the houses. Stations were inspected every two weeks to determine the vigour of the termite colony based on the termite population infesting stations, ratios of soldiers:workers and the amount of bait consumption. Results showed that most bait matrix was totally consumed and the ratio of soldiers:workers initially increased and finally the termite infestation ceased. Colony elimination took about six to eight weeks after baiting. Use of the AGS was considered more practical for properties with active termites. However, a combination of treatments using the two station types is recommended.

Keywords: IGS and AGS, bait matrix, foraging area, termite elimination

SUKARTANA P, SUMARNI G & BROADBENT S. 2009. Penilaian klorfluazuron dalam mengawal anai-anai bawah tanah *Coptotermes curvignathus* (Isoptera: Rhinotermitidae) di Indonesia. Kami menilai keberkesanan formula umpan yang mengandungi bahan aktif klorfluazuron untuk mengawal anai-anai bawah tanah *Coptotermes curvignathus* yang menyerang rumah di Jakarta. Dua jenis peranti pengagregatan ('stesen') digunakan iaitu stesen dalam tanah (IGS) dan stesen atas tanah (AGS). IGS yang dilengkapi pelapik pemintas kayu pada dinding dalam stesen dan satu blok kayu di tengah-tengah dipasang di sekeliling rumah untuk memantau aktiviti anai-anai. Jumlah stesen yang dipasang disesuaikan dengan ruang yang ada. Stesen yang diserang anai-anai kemudiannya diisi dengan matriks umpan setelah blok kayu dikeluarkan. AGS (yang mempunyai matriks umpan) dipasang terus di kawasan rumah yang diserang anai-anai. Uji kaji ini dicerap setiap dua minggu untuk menentukan tahap kecergasan koloni berdasarkan populasi anai-anai yang menyerang stesen, nisbah askar:pekerja dan jumlah umpan yang dimakan. Keputusan menunjukkan bahawa kebanyakan matriks umpan telah dimakan keseluruhannya dan nisbah askar:pekerja pada mulanya meningkat dan akhirnya serangan anai-anai terhenti. Penghapusan koloni mengambil masa lebih kurang enam hingga lapan minggu selepas diberi umpan. AGS dianggap lebih praktikal bagi rumah yang mempunyai anai-anai aktif. Namun kombinasi rawatan menggunakan kedua-dua jenis stesen ini adalah disyorkan.

INTRODUCTION

Among various subterranean termites, the genus *Coptotermes* (Isoptera: Rhinotermitidae) is one of the most important structural pests globally. Indonesia is perhaps the richest country in terms of *Coptotermes* species in the world (Tarumingkeng 1971, Kalshoven 1981, Gathorne-Hardy *et al.* 2000, 2001). Damage by these termites to buildings, housing and living trees is easily found in Bogor and its surroundings (Sukartana 2002). In fact some areas of the Indonesian Presidential Palace, Istana Merdeka, Jakarta are also seriously infested.

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Current control measures for termites mostly rely on applying termiticides either for wood preservation or soil treatment. These poisonous chemicals, however, should be used sensibly to avoid possible environmental contamination. Furthermore, wood preservation can only protect wood construction against termite damage. It offers no protection for susceptible goods stored in a house or building. Soil treatments are recommended to deter concealed entry by termites into a building. Some long lasting insecticides for soil treatment, because of environmental consideration, are now banned and have been replaced by chemicals that degrade more readily. However, particularly in tropical countries such as Indonesia, these newer chemicals are still potentially dangerous due to water runoff which may contaminate water resources and spread poisonous materials to the environment. It also creates another serious problem—such chemicals will not give longer protection to building than the persistent termiticides.

Using less toxic chemicals that are still effective for termite control should be pursued to reduce environmental hazards. Some baiting systems employing chitin synthesis inhibitors (CSIs) have been evaluated. A laboratory experiment showed that CSIs containing hexaflumuron or diflubenzuron are effective in controlling both Formosan and Eastern subterranean termites, *C. formosanus* and *Reticulitermes flavipes* (Su & Scheffrahn 1993). Furthermore, hexaflumuron has been demonstrated to be effective to suppress the population of these termite species in the field (Su 1994). This CSI formula is also effective against *C. curvignathus*, one of the most important rhinotermitids in Malaysia (Sajap *et al.* 2000) and Indonesia (Sukartana *et al.* 2001).

Chlorfluazuron is another effective CSI ingredient used to eliminate *C. acinaciformis* in Australia (Peters & Fitzgerald 2003). In this study, the effectiveness of this formula was evaluated for colony elimination of *C. curvignathus* in Indonesia.

MATERIALS AND METHODS

Experimental site

The experiment was conducted in Kelapa Gading Real Estate, one of the most elite areas in North Jakarta. Heavily infested houses or buildings were selected and permission was obtained from the property owners to conduct the experiment. Six infested houses were chosen initially, but finally only four (house I–IV) were regularly inspected.

Aggregation devices and applying baits

The Exterra™ Termite Interception and Baiting System with Requiem™ bait matrix (Ensystex Australasia Pty. Ltd. NSW, Australia) were used in this study. Requiem is cellulose acetate powder containing 0.1% weight/weight (w/w) chlorfluazuron.

Two types of aggregation devices ('station'), i.e. in-ground stations (IGSs) and above-ground stations (AGSs) were used to hold the bait matrix. An IGS basically consisted of a 1.3 l cylindrical plastic container with perforated sides and bottom to allow termite ingress and egress. Six termite interceptor timbers (*Eucalyptus delegatensis*) that were installed in the inner wall of the IGS allowed simple termite detection and the addition of bait matrix without disturbing the termites. A larger wood block of the Indonesian pine *(Pinus merkusii)* was also placed in the centre of the IGS to make the station more attractive to termite. The IGSs were installed using a soil auger around the house perimeter or in the yard around the house at intervals of 2–3 m to aggregate foraging termites. The stations were then covered and left for two weeks (Figure 1). The number of IGSs installed at each house varied depending on the space availability.

The IGSs were inspected every two weeks. When termite activity was discovered, the wood block was removed and replaced with doughy bait matrix, a texture which was achieved by mixing Requiem (240 g) with 1.5–1.7 l of clean water. Inspections were continued to determine the amount of bait consumed by termites. At each visit the bait was replenished to replace bait consumed by termites. Bait replenishment was continued until bait consumption ceased. The IGSs were then left undisturbed and monitored in case further feeding occurred. If no further feeding was detected, the IGSs were cleaned, fresh wood interceptors and wood block were installed and monitoring was continued over the next two months.

The AGS was a plastic box construction with perforations on the bottom allowing the ingress and egress of forager termites. The station was

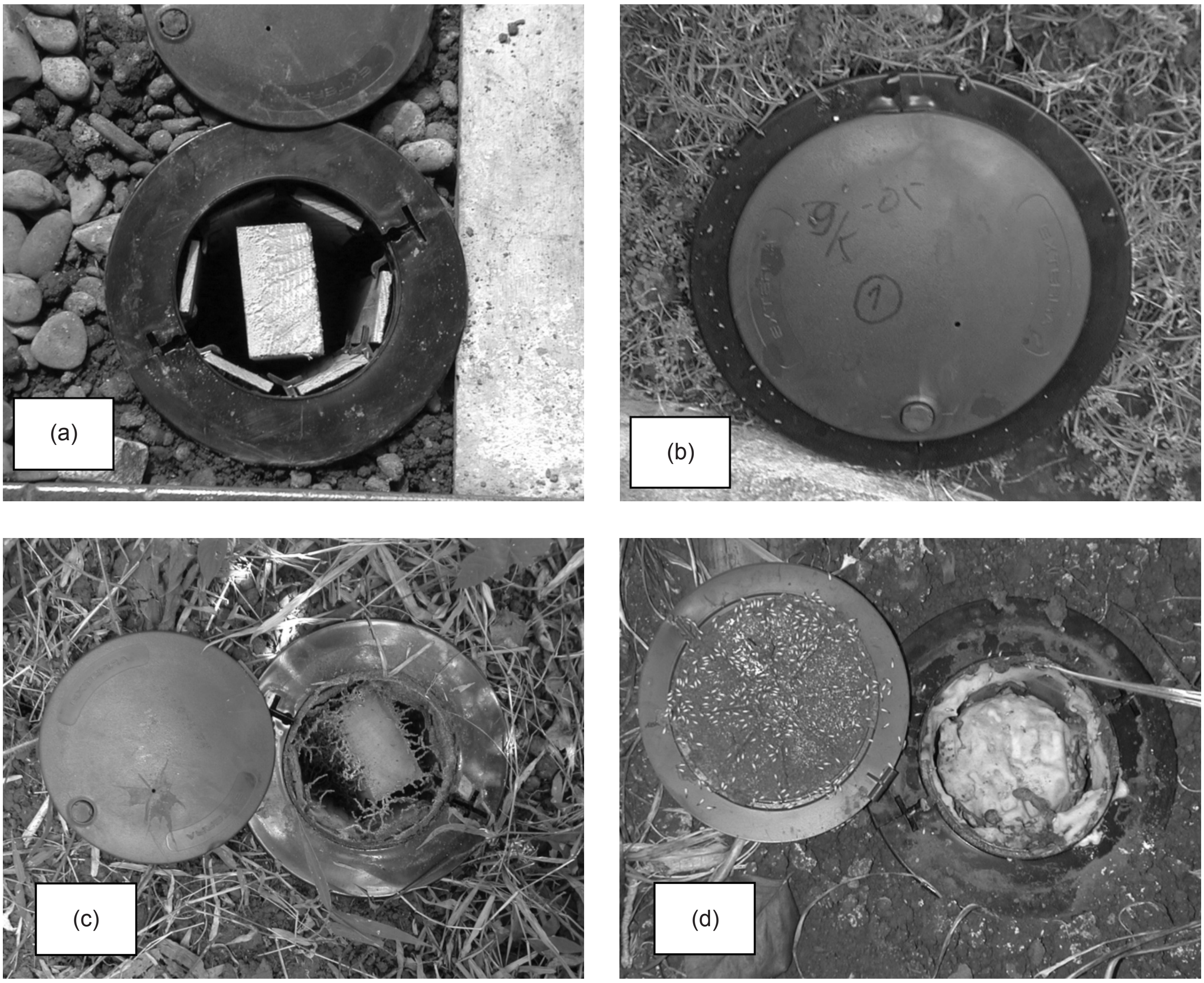

Figure 1 In-ground station (IGS) installation: (a) wood strips (interceptor) and wood block inside; (b) IGS covered; (c) and (d) termite infestation respectively on wood strips and wood block, and bait matrix

mounted using a plastic adhesive tape or nails to areas of a building, e.g. window or door frames, beams, floor and wall, where termite activity was located, and then it was filled with 140 g of bait matrix that had been mixed thoroughly with 0.55–0.88 l of clean water (Figure 2). The number of AGSs installed at each house also varied depending on the number of points of termite activity present.

Inspections were done every two weeks to determine the amount of bait consumed by termites and also to replenish the bait. Bait replenishment was terminated after no bait was further consumed by termites. Monitoring was continued for a further four weeks and the stations were finally removed if the bait was still intact. Termite numbers (Table 1), including the ratio between soldiers and worker termites, were also recorded to monitor colony vigour (Garcia *et al.* 2007).

RESULTS AND DISCUSSION

Most AGSs, but only one IGS, were successful in aggregating foraging termites two weeks after installation (Table 2). Unlike the AGSs, minimum infestation of IGSs seemed to be caused by the random installation of the devices, namely, without observing foraging point of termites. Even at two weeks, large numbers (> 50) of termites, mostly workers, were present in the AGSs and IGS and the bait was totally consumed. The Requiem bait matrix was non-repellent to *C. curvignathus* and termite colonies were still healthy at this stage, as indicated by the low soldiers:workers ratio.

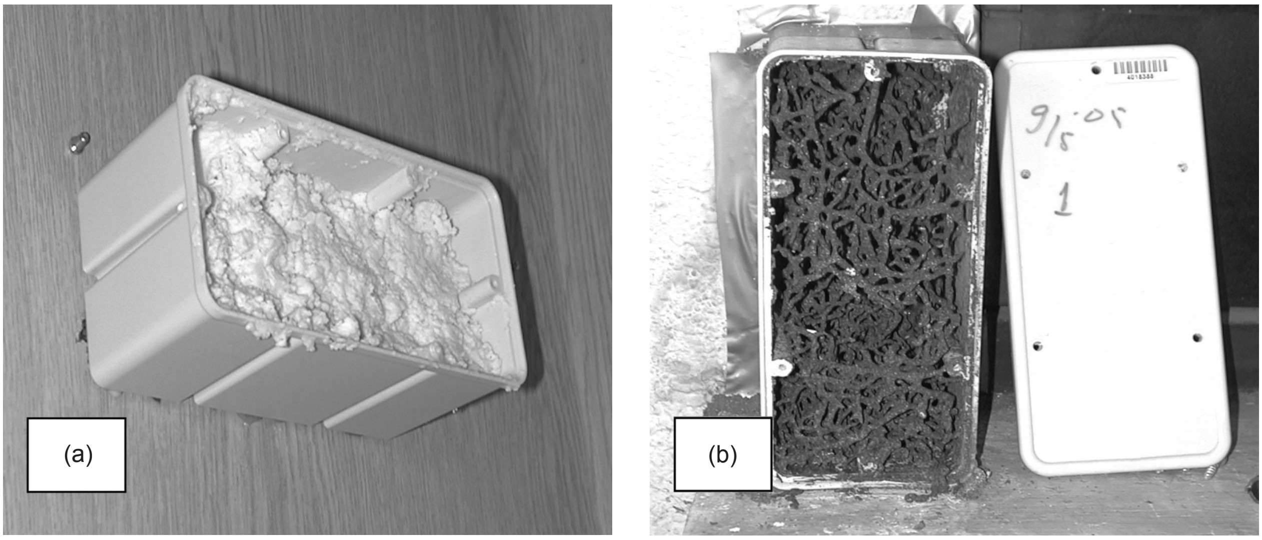

Figure 2 Above-ground station (AGS) installation: (a) an AGS with matrix mounted on the wall and (b) after exposure to *Coptotermes curvignathus*

Table 1 Classification of *Coptotermes curvignathus* numbers in aggregation devices

Population	Classification
0	None
1 to 20	Few
21 to 50	Moderately abundant
Over 50	Abundant

Table 2 Bait matrix (g) consumed by *C. curvignathus* based on the amount of bait replenishment

House and station number[a]	Initial bait (g)	Bait consumed at each inspection period			Total
		2 weeks	4 weeks	6, 8, 10 weeks	
I.I.1	-	-	-	-	-
I.I.2	-	-	-	-	-
I.I.3	240	240	240	-	720
	Total				720
I.A.1	140	140	140	-	420
I.A.2	140	140	70	-	350
I.A.3	140	140	70	-	350
I.A.4	140	140	70	-	350
I.A.5	140	140	70	-	350
	Total				2540
II.A.1	140	140	140	-	420
II.A.2	-	-	-	-	
	Total				420
III.A.1	140	140	50	-	330
III.A.2	140	140	50	-	330
III.A.3	140	140	140	-	420
	Total				1080
IV.A.1	140	140	140	-	420
	Total				420

[a] I–IV = House number, I = in-ground station (IGS), A = above-ground station (AGS), 1–5 = number of stations

At week four, however, all termite colonies were declining and a high soldiers:workers ratio was found (Table 3), and some nymphs were present. A similar observation has also previously been reported by Peters and Broadbent (2005). Interestingly such abnormal caste composition was also found in unbaited areas of house number 1. This means these areas were also affected by the treatment and, therefore, it can be concluded that the termites foraging in these areas were from the baited colony as well.

No termites were found six weeks after initial baiting although monitoring continued until week 10 (Table 3). Similarly, termite activity ceased in the unbaited areas of house number I where termite infestations were previously active. These evidences indicated that termite colonies, or at least their foraging populations had been eliminated or reduced after consuming bait matrix of 420 to 2540 g. This does not indicate the optimum amount of bait matrix required to eliminate a termite colony because it was not determined whether the stations installed covered termites foraging from only one colony or more. The colony size was also not previously verified. For example, treatment at house number 1 used a total of 2540 g in an IGS and five AGSs to eliminate the termites. Conversely, treatments in houses number 2 and 4 were also effective even though only about 420 g of bait matrix per house was applied.

The amount of bait consumed in this experiment is similar to those of previous studies using the same formula for eliminating *C. acinaciformis* in Australia (Peters & Fitzgerald 2003) and a CSI matrix containing hexaflumuron for colony suppression of subterranean termites *C. formosanus* and *R. flavipes* in the US (Su 1994).

Using AGS is more practical because the station is directly installed on the active termites that have been identified. Combination of both station types, however, is recommended. If termite activity has not been found yet, using IGS is still required to monitor and eliminate termite colony before infestation on structures occurs.

ACKNOWLEDGEMENTS

We thank D Murray (Ensystex Australasia, NSW, Australia) for assisting with the installation. Our local team, T Widjanarko and his staff (CV Tata Kawasan Hijau, Jakarta), NE Lelana and D Sudika are also thanked for their generous help during installation and inspection.

Table 3 Estimation of termite population (P) and the ratio of soldiers to workers (S/W) found at each station during each inspection period

House and station number[a]	Inspection period (weeks)					
	2		4		6, 8, 10	
	P	S/W	P	S/W	P	S/W
I.I.1	-	-	-	-	-	-
I.I.2	-	-	-	-	-	-
I.I.3	> 50	S < W	> 50	S > W	-	-
I.A.1	> 50	S < W	> 50	S > W	-	-
I.A.2	> 50	S < W	> 50	S > W	-	-
I.A.3	> 50	S < W	> 50	S > W	-	-
I.A.4	> 50	S < W	> 50	S > W	-	-
I.A.5	> 50	S < W	> 50	S > W	-	-
II.A.1	> 50	S < W	> 50	S > W	-	-
II.A.2	-	-	-	-	-	-
III.A.1	> 50	S < W	> 50	S > W	-	-
III.A.2	> 50	S < W	> 50	S > W	-	-
III.A.3	> 50	S < W	> 50	S > W	-	-
IV.A.1	> 50	S < W	> 50	S > W	-	-

[a] I–IV = House number, I = in-ground station (IGS), A = above-ground station (AGS), 1–5 = number of stations

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