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VERSATILITY OF BAITS CONTAINING NOVIFLUMURON FOR CONTROL OF STRUCTURAL INFESTATIONS OF FORMOSAN SUBTERRANEAN TERMITES (ISOPTERA: RHINOTERMITIDAE)

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ABSTRACT

Four buildings (two high-rise condominiums, a single-family residential structure, and a trailer) in Broward and Miami-Dade Counties, Florida, infested with Formosan subterranean termites (FST, *Coptotermes fomosanus* Shiraki) were treated with baits containing 0.5% wt/wt noviflumuron. Each building represented a challenging treatment scenario for liquid termiticides due to the location of the infestation within the structure and/or occupant refusal to permit pesticide application in termite-infested living and activity areas. Marking of FST by in-situ baiting with blank bait matrix treated with 0.5% wt/wt Neutral Red dye indicated only one FST foraging population infested each building. Two FST infestations were aerial in high-rise condominiums. Noviflumuron baits were applied to two buildings in aboveground stations, one building with in-ground stations, and the remaining building with both station types. All detected FST infestations were eliminated within 71-92 days after first application of noviflumuron baits. FST foraging populations with confirmed ground contact consumed approximately 4-fold more bait than did aerial infestations; mean ± SD, 242 ± 74 g vs. 62 ± 51 g, respectively. Termite feeding activity was monitored before, during, and after bait application at two buildings with an acoustic emissions detector (AED) and in one building with a microwave detector. Cessation of termite activity measured with these devices corresponded with elimination of live FST previously observed in stations, infested wood, and foraging tubes. No FST were observed in any monitoring station or building during the 12-18 month inspection period following elimination of the detected FST infestation.

Key Words: Sentricon™ System, Recruit™ termite bait, noviflumuron, chitin synthesis inhibitor, *Coptotermes formosanus*

RESUMEN

Cuatro edificios (dos condominios altos, una estructura residencial para una sola familia, y una casa trailer en los Condados de Broward y de Miami-Dade, Florida, infestadas con la termita subterranea de Formosa (FST, *Coptotermes fomosanus* Shiraki) fueron tratadas con cebos que contienen 0.5% peso/peso de noviflumuron. Cada edificio representó un desafio para el tratamiento con los termiticidas liquidos debido al lugar de la infestación dentro la estructura y/o el rechazo del occupante para permitir la aplicación de un pesticida en áreas infestadas de sus hogares donde ellos tienen sus actividades. Al marcar los FST in-situ con una matriz de cebo vacio tratado con 0.5% peso/peso de tinta Roja Neutral indico una sola población de FST forrajera infestando cada edificio. Dos infestaciones áereas de FST fueron presentes en los condominios. Se aplicaron cebos de Noviflumuron en puestos encima de la superficie en dos edificios, en puestos subterraneos en un edificio, y en puestos de las dos clases en los otros edificios. Todas las infestaciones de FST detectadas fueron eliminadas dentro de 71-92 dias después de la primera aplicación de los cebos de Noviflumuron. Las poblaciones forrajeras de FST con contacto confirmado con la tierra consumieron aproximadamente 4 veces mas cebo que las infestaciones áereas; con un promedio ± DS de 242 ± 74 g vs. 62 ± 51 g, respectivemente. Se realizó un monitoreo de la actividad de la alimentación de las termitas antes, durante y después de la aplicación de cebo en dos edificios con un detector de emisiones acústico (AED) y en un edificio con un detector de microhonda. La paralización de la actividad de las termitas medida con estos aparatos correspondia con la eliminación de los FST vivos observados anteriormente en los puestos de estudio, madera infestada, y en los tubos de forrajeo. Ningun FST fue observada en cualquier puesto o edificio durante el periodo de inspección de 12-18 meses después de la eliminación de la infestación detectada de FST.

Hexaflumuron, a chitin synthesis inhibitor, was documented in the late 1980s to cause ecdysis inhibition resulting in delayed mortality in *Reticulitermes flavipes* (Kollar) and *Coptotermes formosanus* Shiraki (Su & Scheffrahn 1993). Since that discovery, many field studies have ver-

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ified that termite baits containing hexaflumuron eliminated colonies or populations of 15 species of subterranean termites in 15 states in the US, and in Australia, Japan, Malaysia, Taiwan, France, England, Italy, Cayman Islands, Puerto Rico, and US Virgin Islands (Lee 2002; Sajap et al. 2002; Su 2002a, b; Su et al. 2002; Su et al. 2003; Su & Hsu 2003).

In 1995, Dow AgroSciences developed the chitin synthesis inhibitor, noviflumuron, and began trials to assess its toxicity against common household and structural pests, including subterranean termites (Smith et al. 2001). In laboratory trials in which *R. flavipes* were fed radiolabeled noviflumuron or hexaflumuron, noviflumuron demonstrated significantly faster speed of action, greater potency, and nearly 4-fold slower clearance from termites compared with that of hexaflumuron (Sheets et al. 2000; Karr et al. 2004). In field trials conducted throughout the US from 1998-2000, 74 colonies of *Reticulitermes* spp. baited with noviflumuron were eliminated in about half the time as the 53 colonies baited with hexaflumuron (mean = 107 days vs. 205 days, respectively, Smith et al. 2001). Sajap et al. (2005) eliminated five structural infestations of *Coptotermes gestroi* (Wasmann) within 35-56 d with aboveground (AG) baits containing 0.5% noviflumuron.

The purpose of the trials described in this study was to determine if bait containing 0.5% noviflumuron could eliminate structural infestations of FST. Although not a selection factor, each building in this study represented a challenging treatment scenario for liquid termiticides due to the location of the infestation within the structure (dispersed in the upper story of high-rise condominiums or in a difficult to access crawlspace) and/or occupant refusal to permit pesticide application in critical areas.

Materials and Methods

Termite Bait/Monitoring Stations

In-ground (IG) or AG stations used in the Sentricon System (Dow AgroSciences, Indianapolis, IN) were used to monitor termite activity and apply noviflumuron baits. IG stations, as described by Su et al. (2002), contained monitoring devices (two 1.4 × 2.8 × 17.5 cm wood slats, Fig. 1) when first installed. To apply the bait, the wood monitoring devices were replaced by a bait tube containing 0.5% wt/wt noviflumuron on a 35-g roll of textured laminated cellulose.

An AG station consisted of a rigid, rectangular plastic housing (14.8 cm long × 9 cm wide × 5 cm deep) containing two 35-g laminated textured cellulose rolls (Fig. 2). One side of the housing was open to expose the matrix to the termite-infested substrate; the other side was closed by a removable lid. Blank bait containing no active ingredient was used to monitor termite activity in both IG and AG stations.

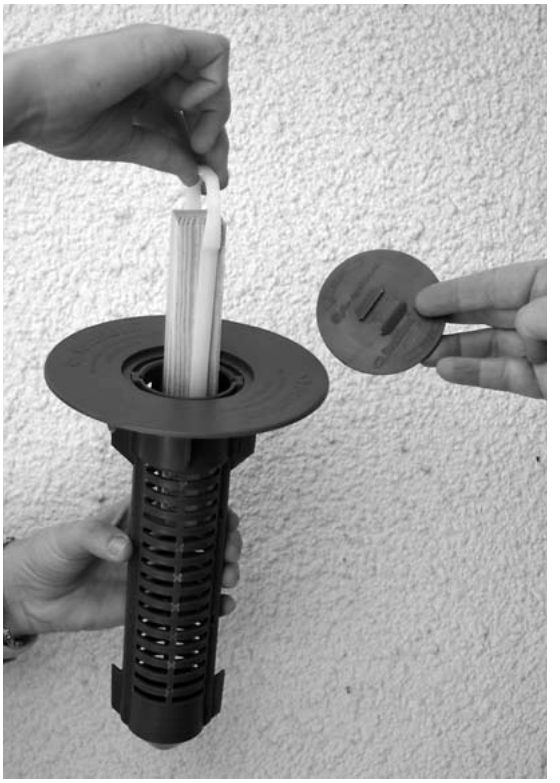


Fig. 1. In-ground (IG) station for applying wood monitoring devices (shown here) or bait tube containing 35-g roll of laminated cellulose matrix; blank or impregnated with 0.5% wt/wt noviflumuron.

Study Sites

Noviflumuron baits were evaluated at three buildings in Broward County and one in Miami-Dade County, FL that had active subterranean termite infestations. Soldiers and/or alates were collected and identified as FST with the key by Scheffrahn (1994).

DAYCARE was a 195.2-m^2, single-story, concrete block, slab-on-grade house in Hollywood Hills, FL, converted to a daycare center for infants and preschool children. In mid-May, 2001, daycare employees reported that massive emergence of FST alates forced them to evacuate the daycare center and relocate the children. Subsequently, on 18 May, 2001, the first author found live FST in a backyard mango tree (Fig. 3) and in the garage in an aerial carton nest located between pieces of plywood propped over the expansion joint abutting the house slab. The nest was removed to expose many FST mud foraging tubes emerging from the expansion joint. FST damage,

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Fig. 2. Slicing bait of aboveground (AG) station containing two 35-g rolls of laminated cellulose matrix; blank or impregnated with 0.5% wt/wt noviflumuron.

including alate release slits, was found on the garage rear entrance doorframe and the nearby exposed header in the breezeway (Fig. 3). DAYCARE had not been treated with liquid termiticides due in part to concerns of the staff about pesticide exposure.

TRAILER was a small, wood frame, 40-m^2 trailer with aluminum siding and a crawlspace. A 33.2-m^2 addition consisting of three rooms (storage, sewing, and entry area) and a porch on a raised concrete slab were attached to the trailer (Fig 4). According to detailed records maintained by the owner, FST alate flights occurred in the front rooms or bedroom between approximately 6:00 pm and 12:30 am on 48 different days from May 27 through August 1, 2002. On June 5, 2002, a pest control company applied Premise™ termiticide, containing 0.05% imidacloprid (Bayer Environmental Science, Montvale, NJ), around the trailer perimeter and in the crawlspace according to the company service report and owner observations. No evidence was found that the hollow block foundation supporting the raised concrete slab was drilled and treated with termiticide. Access to this foundation through the crawlspace was very restricted. During an inspection on June 28, 2002, the first author found dead FST alates in the bedroom and storage room, and FST alate release slits in the wall paneling of the bedroom and living room (Fig. 4). No evidence of live FST was found in the crawlspace.

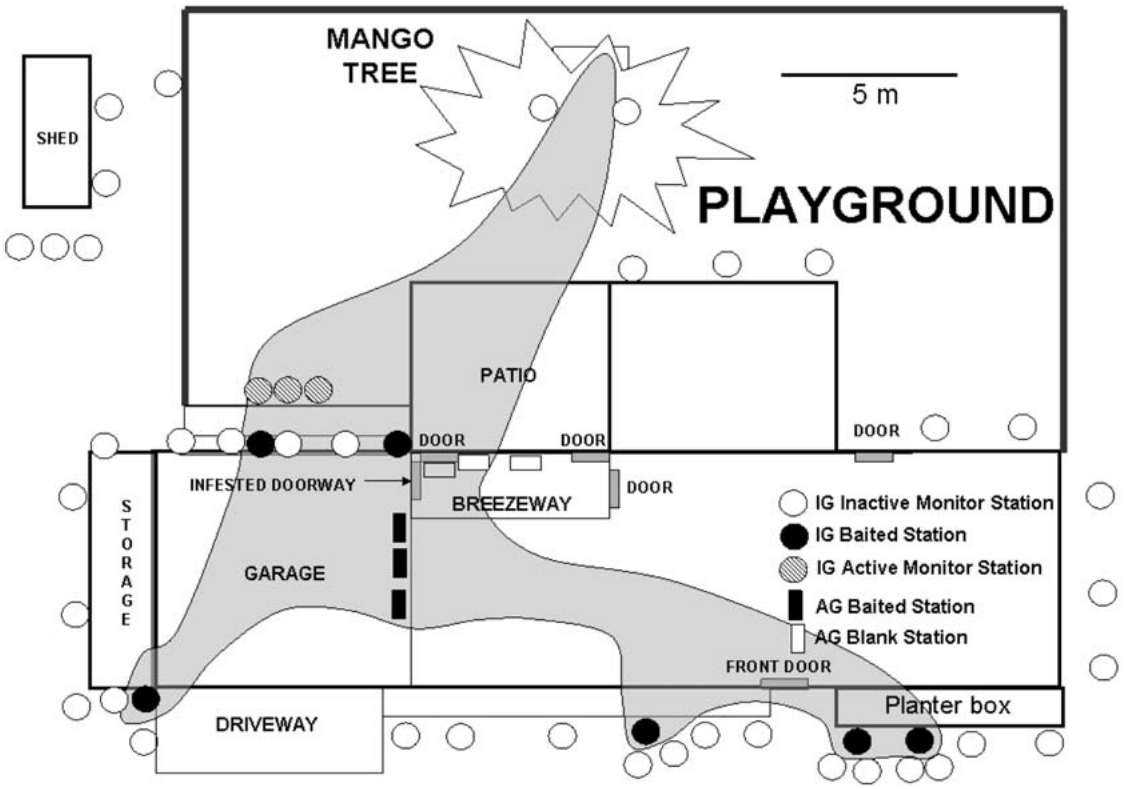


Fig. 3. Ground plan of DAYCARE showing placement of in-ground and aboveground stations and 0.5% noviflumuron bait. Gray shaded area indicates population foraging area based on presence of termites in the mango tree, dyed termites in bait stations, and AED readings.

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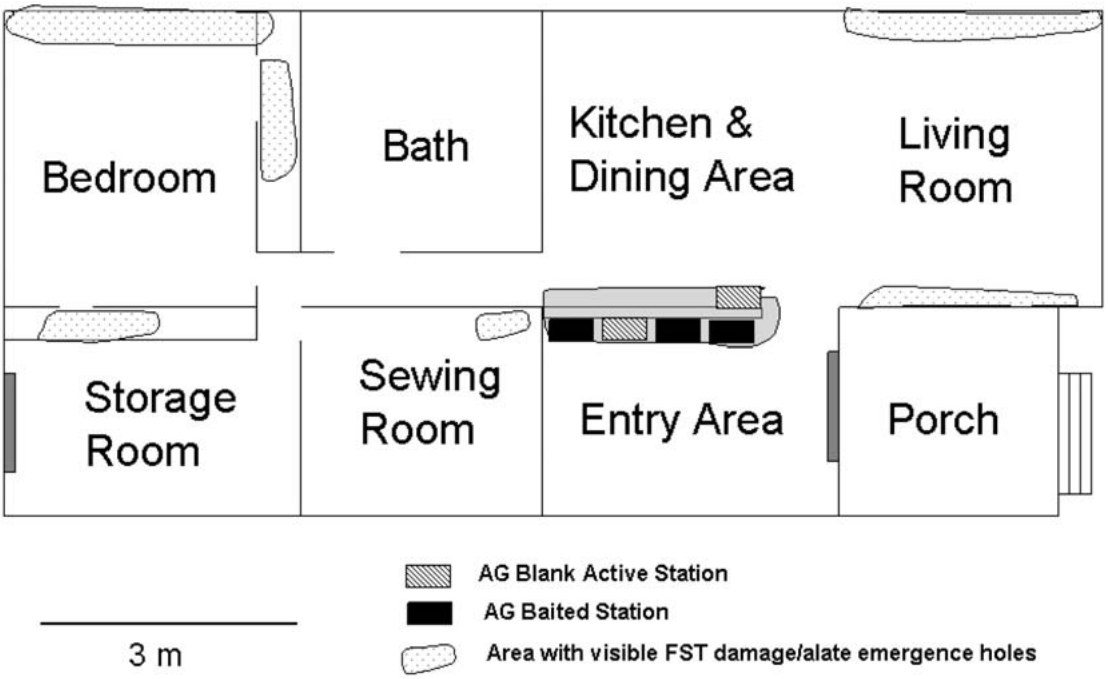


Fig. 4. Floor plan of TRAILER showing placement of aboveground stations after inspection on October 25, 2002, 0.5% noviflumuron bait, and areas damaged by Formosan subterranean termites. Gray shaded area indicates population foraging area based on presence of dyed termites in bait stations.

CONDO was an eight-story, reinforced concrete, multi-unit residential building in Hallandale, FL. On April 19, 2002, the first author found FST infesting extensive foraging tubes extending up the west stairwell onto the 8th floor landing and attic. There was no evidence of termite damage or activity on the ground floor or around the building perimeter. In mid-May, 2002, a husband and wife reported FST infesting their 8th floor condominium adjacent to the west stairwell. Because the wife was 6-mo pregnant and her infirm mother was about to be moved into their condominium, the occupants would not permit any pesticide application inside their condominium. Subsequently, on May 30, 2002, in this condominium the authors found termite damage and carton material in the doorframes of the two bathrooms and the second bedroom and in the master bedroom closet wall next to the west stairwell, where termites remained active (Fig. 5).

PENTHOUSE was a 29-story, reinforced concrete, multi-unit residential building in Aventura, FL. On November 1, 2002, the first author found live FST infesting a palm tree stump and in the soil around the base of another palm stump inside a planter, and in foraging tubes and several joists on the underside of the raised, wood patio deck (Fig. 6). No termite damage was reported by any other occupants or found indoors in the rooms directly below the infested patio. FST have been documented previously to establish aerial infestations on flat rooftops of high-rise buildings similar to CONDO and PENTHOUSE (Su et al. 1989; Weissling & Thoms 1999).

Installation of Monitoring Stations

In-ground (IG) stations were installed following the label directions for Recruit II™ termite bait. Stations were installed around the perimeter of DAYCARE (Fig. 3) and TRAILER (Fig. 4) more than 45 cm from the foundation to avoid placement in soil previously treated with termiticide. Spacing between stations did not exceed 6 m where soil access was not restricted by driveways and concrete patios (Fig. 3). Stations also were installed adjacent to areas with visible termite activity, such as in the rooftop planter box of PENTHOUSE (Fig. 6). After initial IG station installation, one or two "auxiliary" IG stations were installed within 30 cm of each IG station with termite activity if space permitted.

Aboveground (AG) stations containing blank bait rolls were installed where live FST were visible in surface foraging tubes (DAYCARE expansion joint, CONDO stairwell, and PENTHOUSE deck joist) and damaged wood (TRAILER partition wall and PENTHOUSE palm stump, Figs. 3-6). AG stations were installed adjacent to where acoustic emissions detector (AED) counts indi-

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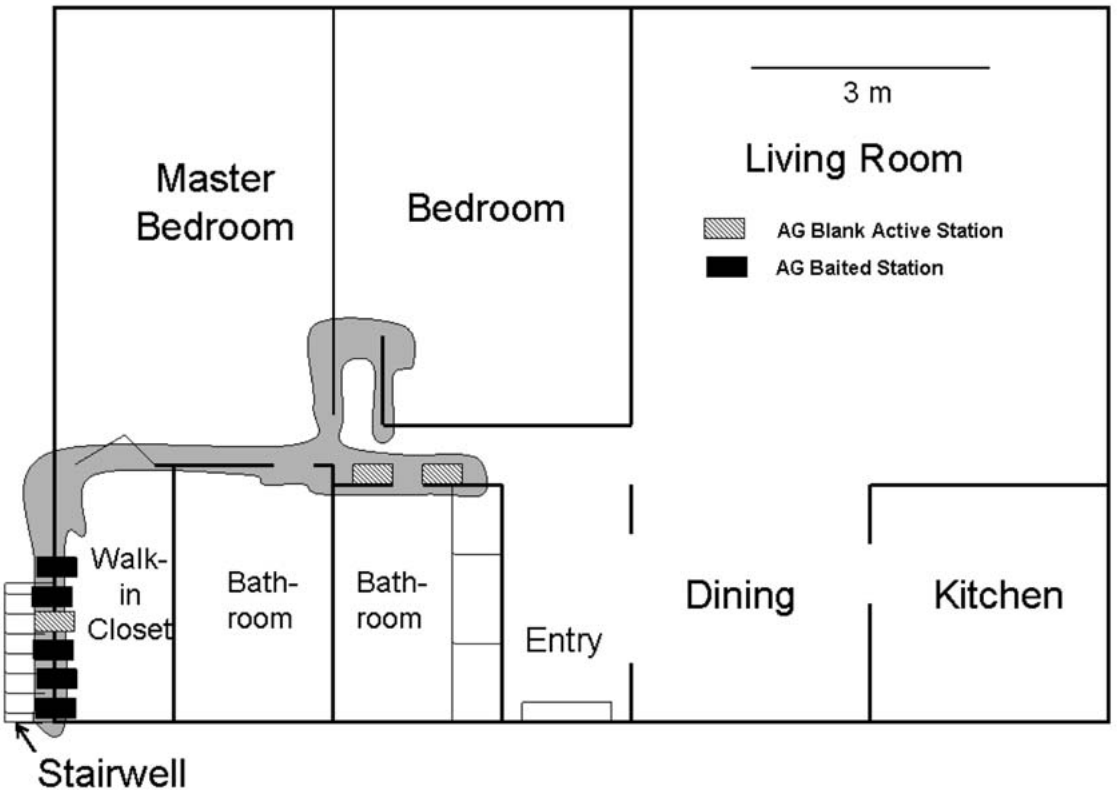


Fig. 5. Floor plan of CONDO showing placement of in-ground and aboveground stations, 0.5% noviflumuron bait, and area monitored with an acoustic emissions detector. Gray shaded area indicates population foraging area based on presence of dyed termites in bait stations and AED readings.

cated termite feeding but FST were not visible (DAYCARE breezeway header and CONDO door frames). In these locations, 2-mm diam holes were drilled into the wood before attaching each AG station to provide the termites access to the bait.

Each AG bait roll was sliced several times longitudinally (Fig. 2) and then moistened with 30-60 ml of water (DAYCARE), 5% sucrose water solution (CONDO, PENTHOUSE, TRAILER), or sports drink (TRAILER; Gatorade™, Gatorade Corp., Chicago, IL). The sliced bait rolls were placed directly in contact with the FST-infested surface. The station housing was attached to the surface with screws for wood surfaces and latex caulk (Polyseamseal™, OSI, Mentor, OH). The removable lid was sealed to the housing with screws and masking tape. All IG and AG stations were numbered and their locations were documented on site maps.

Use of Electronic Termite Detection Devices

At DAYCARE and CONDO, an Acoustic Emission Detector (AED, Locator™ Insect Detection Device, Dow AgroSciences, Indianapolis, IN) was used to monitor FST feeding activity in exposed wood. The AED has been documented to be a simple, non-disruptive method to quantify subterranean termite feeding activity (Scheffrahn et al. 1993) before and after application of termite baits (Su et al. 2000; Su et al. 2002; Su et al. 2003; Weissling & Thoms 1999).

Thirteen locations on one doorframe and the breezeway header at DAYCARE (Fig. 3) and 27 locations on three doorframes at CONDO (Fig. 5) were monitored with an AED. The sensors were attached by putty (Handitak™, SuperGlue Corp., Hollis, NY) to monitored wood members. Each AED location was marked and monitored once for 30 s in the noise reduction setting during each visit before, during, and after bait application. Based on user experience, readings of less than 5 counts usually do not indicate termite activity. Readings were repeated if sensor movement or detachment occurred. The last AED monitoring was conducted at 16.5 mo (DAYCARE) and 1 mo (CONDO) after elimination of all detectable FST activity. Acoustic detection was not continued at CONDO because damaged doorframes were replaced by the condominium owners after elimination of all detectable FST activity.

A microwave detector (TermaTrac™ Archerfield, Queensland, Australia) was used to detect

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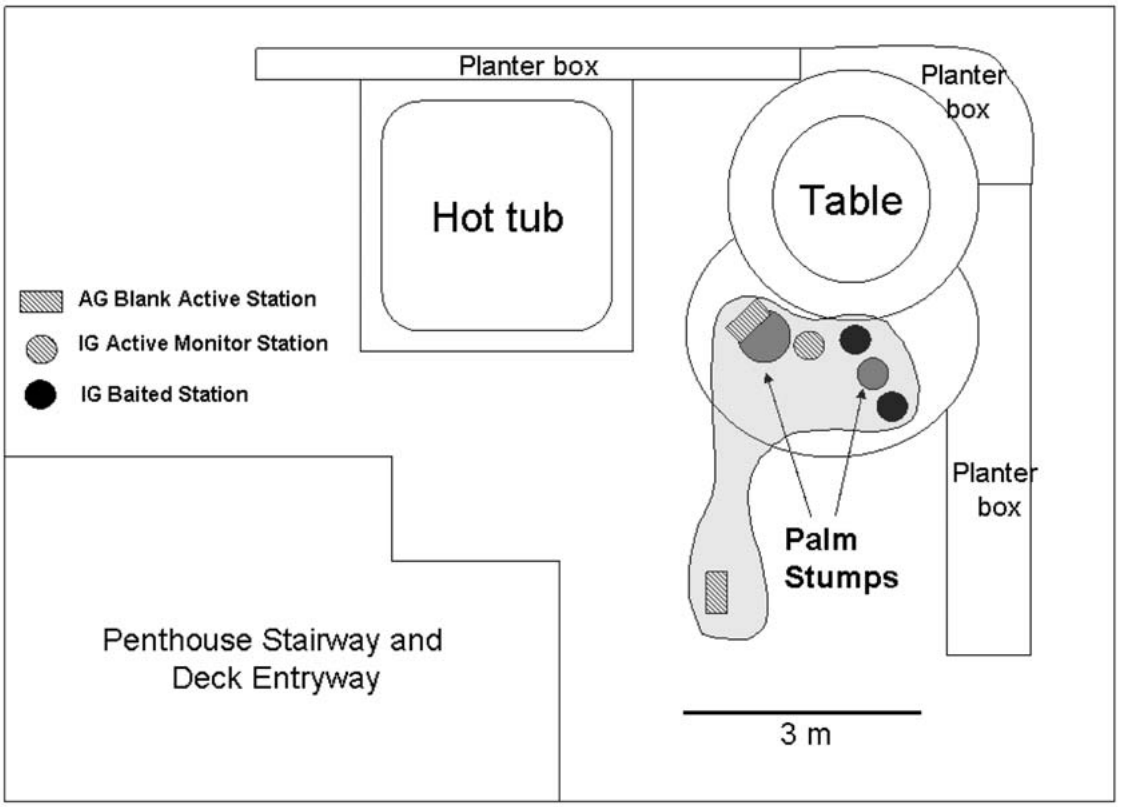


Fig. 6. Floor plan of PENTHOUSE showing placement of in-ground and aboveground stations and 0.5% noviflumuron bait. Gray shaded area indicates population foraging area based on presence of dyed termites in bait stations.

FST activity at TRAILER. Evans (2002) verified that the TermaTrac had a 90% success rate for detecting subterranean termites. The detector was used to locate FST in and near areas of the wall and floor of the trailer with visible termite damage. For wall paneling, the sensor horn was held flush against the surface while taking readings for 30 to 60 s. On the floor, the horn was placed upright directly on the surface for the same amount of time. The detector was used again on the same areas of the floor one year after elimination.

Bait tube Installation in IG Stations

At least 20 ml of water was used to moisten the matrix (blank, dyed or with noviflumuron) in a bait tube before installation. Termites from infested wood monitors or bait tube were gently transferred to the chamber in the top of the bait tube. The new bait tube was placed in the same station from which the termites were extracted.

Replenishment of AG Stations

Dry AG bait was remoistened with 30-60 ml of water on subsequent inspections after installation. If one third to one half of the matrix was consumed, one additional AG station with moistened matrix (blank, dyed or with noviflumuron) could be attached on top of the existing station with screws and masking tape.

Delineating Termite Populations with Dye Markers

When live termites were found in two or more IG and/or AG stations at a test site, the bait dyed with a 0.5% wt/wt Neutral Red in a bait tube or AG station was installed as previously described. On subsequent inspections, stations containing dyed termites were documented, classified as being connected, and the termites were considered to be from the same foraging population. Dyed matrix was introduced into additional stations containing dyed termites if the intensity of the color in dyed termites or the number of dyed termites was very low.

Application of Noviflumuron Baits

Application of noviflumuron bait began when two or more IG and/or AG stations with live termites were found to be connected based upon the

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dye marker. Noviflumuron baits were not applied in at least one connected station with live termites at each site to provide an independent monitor for termite activity. Only blank baits were applied in FST-infested stations located within the children's play yard and breezeway at DAYCARE (Fig. 3) and in the condominium at CONDO (Fig. 5), due to occupants' requests not to have pesticides applied in these areas. By three mo after termite activity had ceased in all stations and in previously detected infested locations within a building, all noviflumuron baits were replaced with wood monitors in IG stations and blank bait in AG stations.

Station Inspections

Stations were inspected approximately every 1-4 weeks before and during application of noviflumuron. Wood monitors or baits that were moldy, degraded, or more than 50% consumed were replaced. The station type (IG or AG), type of device in station (monitor, dye, active ingredient), station device action (new, inspected, or replaced), estimated consumption of device, presence or absence of termites, presence of dyed termites, and estimated number of termites were recorded. The amount of wood and bait consumed was calculated by multiplying the total estimated percentage of the device consumed by the known mean, dry weight of whole devices: 62 g for wood monitor, 35 g for IG bait roll and 70 g for AG bait roll (Tables 1 and 2; DeMark & Thomas 2000; Weissling & Thoms 1999).

Stations were inspected approximately every 3 mo for at least one year following removal of all noviflumuron bait. During the final site inspection, the previously infested building or condominium unit and landscape features, such as the mango tree at DAYCARE, were visually inspected for evidence of any new termite activity.

Results and Discussion

Dye marking indicated only one FST foraging population infested each building. Dyed termites were found in all IG and AG stations with termite activity at each site. The cessation of termite activity detected in foraging tubes, infested wood, and by electronic monitoring following application of noviflumuron in stations where dyed termites were found further indicate only one FST foraging population infested each building. Hussneeder et al. (2003) demonstrated FST in New Orleans collected within a foraging territory delineated by mark-recapture were genetically similar and could be genetically differentiated from termites in adjacent territories.

Stations were rapidly infested by FST, so baiting with noviflumuron began within 2-6 weeks after station installation, except at TRAILER. At this site, 22 IG stations were installed on July 8, 2002, 17 IG stations were installed on July 26, 2002 along the sides of two neighboring trailers, and three AG stations containing blank bait were installed in the bedroom on August 2, 2002. These stations were inspected through September 30, 2002, but no FST activity was detected in any station. On October 2, 2002, the first author conducted a thorough structural inspection, including the crawlspace, with a flashlight, probing tool, and the Termatrac™, but no FST were seen or detected. Subsequently, all stations were removed from TRAILER.

At the request of the property owner, the first author visually re-inspected TRAILER on October 25, 2002. Live FST were found in a low-rise, wood-paneled partition separating the kitchen and entry areas (Fig. 4) along the juncture of the trailer and raised slab addition. The termites were likely entering through the hollow blocks of the stem wall of the raised slab. AG stations containing blank bait moistened with sucrose solu-

Table 1. Summary of baiting with inground (IG) and aboveground (AG) stations containing 0.5% noviflumuron to control Formosan subterranean termites (FST) infesting four buildings in Broward and Miami-Dade counties, Florida, 2001-2003.

Site	Date monitor stations installed	Date 1st bait applied	Date detected FST infestation eliminated	Days to eliminate	Total estimated g dry wt bait matrix consumed	Total estimated mg AI consumed	Total # noviflumuron bait devices installed[2]	Days post-elimination final inspection[1]
DAYCARE	6/29/01	7/13/01	10/05/01	82	294	147	15IG, 6AG	499
TRAILER	7/08/02	2/21/03	5/02/03	71	189	95	6 AG	364
CONDO	5/30/02	6/28/02	9/30/02	92	98	49	6 AG	549
PENTHOUSE	11/27/03	1/13/03	3/26/03	73	26	13	4 IG	373

[1]Inspection of all monitoring stations and building

[2]Numbers of noviflumuron bait devices installed are greater than number of baited IG and AG stations indicated in Fig 3-6 because noviflumuron baits were replaced as required if consumed or degraded in IG and AG stations.

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TABLE 2. TOTAL ESTIMATED NUMBER OF FORMOSAN SUBTERRANEAN TERMITES (FST) AND ESTIMATED G MATRIX CONSUMED BY DEVICE TYPE (BLANK MONITOR OR 0.5% NOVIFLUMURON BAIT), MONTH OF BAIT APPLICATION, AND STUDY SITE IN BROWARD AND MIAMI-DADE COUNTIES, FLORIDA, 2001-2003.[1]

Site (station type[2])	Type of matrix[3]	Initial noviflumuron application		1st Month		2nd Month		3rd Month	
		# FST (*n*)[4]	Total g (*n*)[5]	# FST (*n*)	Total g (*n*)	# FST (*n*)	Total g (*n*)	# FST (*n*)	Total g (*n*)
DAYCARE (IG & AG)	Blank	970 (10)	266 (8)	1570 (8)	85 (6)	100 (1)	231 (5)	0	0
	0.5% AI	—	—	175 (4)	28 (3)	700 (4)	247 (7)	129 (3)	19 (1)
TRAILER (AG)	Blank	183 (4)	172 (4)	1210 (5)	151 (5)	400 (2)	105 (3)	2 (1)	11 (3)
	0.5% AI	—	—	670 (3)	175 (3)	50 (1)	14 (2)	0	0
CONDO (AG)	Blank	1595 (7)	221 (7)	420 (3)	35 (2)	200 (1)	14 (1)	0	0
	0.5% AI	—	—	500 (4)	98 (5)	7 (3)	0	0	0
PENTHOUSE (IG & AG)	Blank	525 (5)	265 (5)	560 (3)	114 (5)	1280 (4)	168 (4)	0	14 (1)
	0.5% AI	—	—	55 (2)	26 (2)	0	0	0	0

[1]No termites or matrix consumption observed at any site after 3rd month.
[2]IG = inground station, AG = aboveground station.
[3]Blank = IG wood monitoring device (62 g), blank IG bait (35 g), or blank AG bait (70 g). 0.5% AI (noviflumuron) = IG bait (35 g) or AG bait (70 g).
[4]*n* = total number of stations with live termites by inspection period.
[5]*n* = total number of stations with matrix consumption by inspection period.

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tion were installed over live FST on this partition wall on November 8, 2002. Termites did not consume any of the bait through January 2003. Blank bait was then moistened with a sports drink on January 24, 2003 and two weeks later, termites were found actively consuming the bait.

The previous termiticide application and excessive wood decay in the trailer may have interfered with FST foraging and feeding on IG and AG stations. The untreated soil under the slab in the attached addition appeared to be the refugia for the remaining FST infestation. FST workers contacting the imidacloprid perimeter treatment may have suffered lethal and sublethal effects, preventing them from foraging in IG stations. The trailer frame was damp and decayed as a consequence of flooding several years before. Certain species of wood-decay fungi have been shown to make some wood species more palatable to *C. formosanus* than non-decayed wood (Cornelius et al. 2003; Cornelius et al. 2004). The combination of high wood moisture and fungal decay may have made the wood more palatable to the termites than the bait matrix until the sports drink was added. Although this observation suggests this product is a feeding stimulant, Cornelius (2005) found no significant feeding preferences by *C. formosanus* workers when offered filter paper disks soaked with water or Gatorade.

Detected FST infestations were eliminated in 71 to 92 days (mean ± SD = 80 ± 10 days) at all buildings after first application of noviflumuron bait (Table 1). The date of elimination was determined by cessation of all termite activity in IG and AG stations, previously infested foraging tubes and wood, and in electronically monitored locations. There were some aberrant AED readings at CONDO when monitored on September 6 and September 30. Four exceptionally high AE counts (69, 171, 240, and 602) recorded from two of the doorways on September 6, 2002 appear to have been anomalies possibly due to a malfunction with the equipment and were excluded from the mean counts for this date (Fig. 8). On that day, 75 dead soldiers were found in one AG station inside CONDO. On a previous inspection on August 29 of AG stations in the stairwell, only 7 live termites, all soldiers, were found. The absence of workers and presence of only soldiers are two indicators of a termite population in decline after workers have fed on noviflumuron bait. A single high reading (18 counts) recorded on September 30 inside the condo appeared to be aberrant based on the absence of termites in stations. September 30, 2002 was determined to be the date for elimination of the detected FST infestation because no consumption of AG bait occurred since the previous inspection and no live termites were observed. The lack of AE counts on October 25 2002, the subsequent absence of termites in damaged wood removed by the tenants, and lack of FST activity in AG stations through the following 18 mo until the final structural inspection further indicate this FST infestation was eliminated.

Ground-based FST foraging populations at DAYCARE and TRAILER ate approximately 4-fold more bait matrix with noviflumuron compared with that eaten by aerial populations at CONDO and PENTHOUSE (mean ± SD; 242 ± 74 vs. 62 ± 51 g, respectively). Weissling & Thoms (1999) also found a ground-based FST colony consumed, on average, 2.5-fold more termite bait than two aerial FST colonies. This may be due to differences in foraging population size. It has been observed that the availability of food and water can be limited for aerial termite colonies (Su et al. 1997, 2001) which could restrict population growth. Although we did not estimate the population size, the furthest distances between detected foraging locations were less for rooftop infestations at PENTHOUSE (6 m) and CONDO (9 m) than for DAYCARE (20 m).

No re-infestation by FST was found in any building or monitoring station during the remaining evaluation period following elimination of FST activity. The final inspection of stations and buildings occurred 12-18 mo after FST elimination (Table 1). During final inspections, no live termites were found in any station, building, or previously infested landscape feature, such as the mango tree at DAYCARE. No consumption of termite monitors in stations or new termite damage or signs of recent termite activity, such as foraging tubes, were found.

Results indicate 0.5% noviflumuron is not a feeding deterrent to FST. At DAYCARE during the third and final month of bait application, live termites and matrix consumption were observed only in noviflumuron baits, not in blank baits or wood monitors (Table 2). In addition, AED monitoring detected no termite feeding activity after August 15, 2001 during the second month of bait application (Fig. 7). Live termites and consumption were observed in monitoring stations containing blank monitors, but not noviflumuron, during the second and third month after initial application of noviflumuron at PENTHOUSE. The reason for this is during the second month of noviflumuron bait application, the owner relandscaped the planter bed removing the palm stumps with AG stations and all but one noviflumuron-baited IG station. The stacked AG stations attached to the wood decking were not disturbed. New IG stations containing wood monitors were subsequently installed, but no further termite activity was observed in any IG station. Despite this disruption in the bait application process, the detected FST infestation was eliminated at PENTHOUSE.

This study demonstrates the versatility of cellulose baits containing 0.5% noviflumuron for eliminating structural infestations of FST. Novi-

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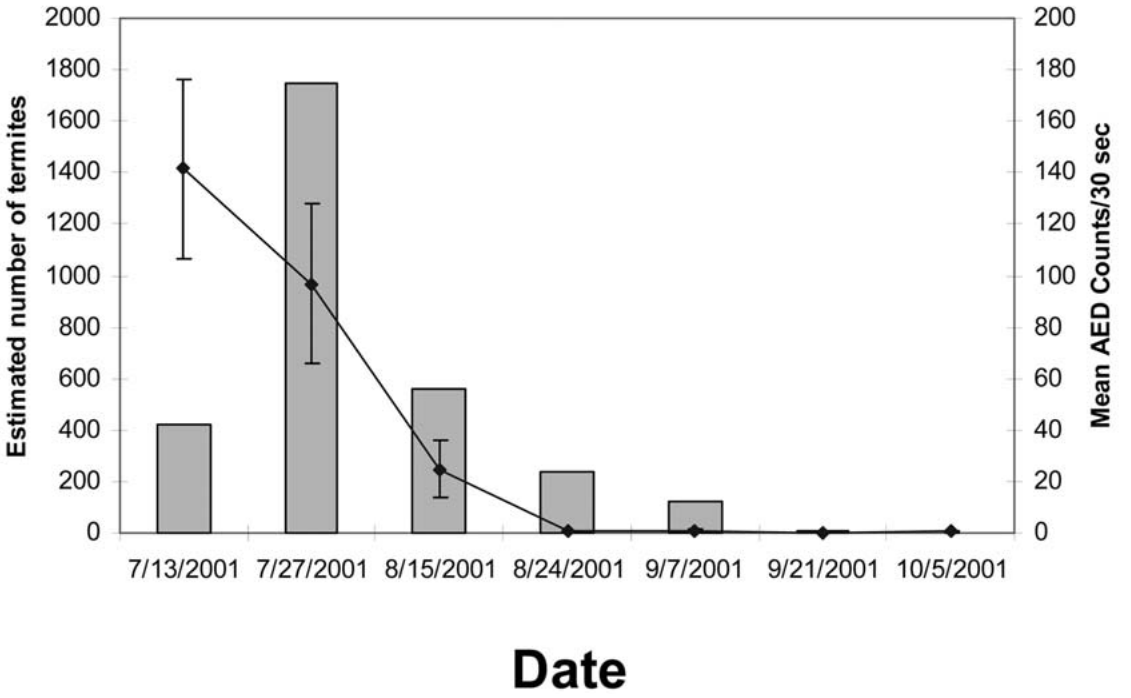


Fig. 7. Total estimated number of termites (bars) and mean (± SE) acoustic emissions counts (line) per monitoring location before, during, and after application of 0.5% noviflumuron bait, DAYCARE, Broward County, Florida, 2001.

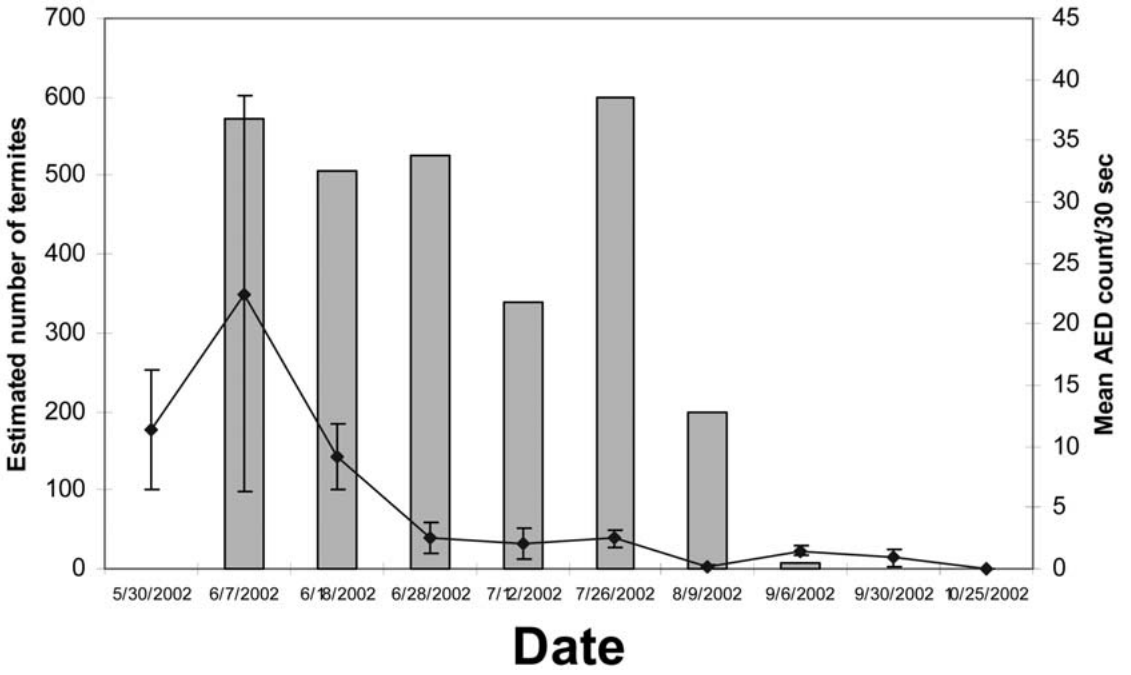


Fig. 8. Total estimated number of termites (bars) and mean (± SE) acoustic emissions counts (line) per monitoring location before, during, and after application of 0.5% noviflumuron bait, CONDO, Broward County, Florida, 2002.

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flumuron baits can be applied IG and/or AG to eliminate FST populations. Unlike liquid termiticide treatments, all areas of soil access to the building for a ground-based FST population and all termite activity within the building for aboveground infestations did not need to be treated with noviflumuron baits to eliminate the structural infestation of FST. We also were able to eliminate FST infestations in two situations (CONDO and DAYCARE) where the occupants would not permit application of pesticide to indoor living or outdoor activity areas.

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