TERMITE BAIT SCREENING USING NATURALLY-INFESTED TREES

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Abstract—Bait toxicants were evaluated against Formosan subterranean termites infesting 61 river-bound trees in Lake Charles, Louisiana. This afforded a natural setting from which termite colonies could not escape and bait efficacy could not be misinterpreted by colony movement away from the study site. Of 12 toxicants studied, only hexaflumuron, mirex, and sulfluramid, eliminated tree-infesting termite colonies. Food consumption and colony die-off varied with toxicant studied and time of year evaluated. Most toxicants evaluated proved to be ineffective at colony elimination at the concentrations tested. Site fidelity of forager groups may account for differences in toxic versus untreated bait consumption in the field. No-choice tests on sulfluramid baits in the laboratory showed a reduced feeding when compared with untreated bait consumption, though toxicant consumption increased with increasing bait-toxicant concentrations. Thirteen trees in New Orleans baited with only untreated cardboard rolls for 16 months proved that cardboard consumption significantly varied by month. Bait consumption rate was at its lowest during winter months and at its highest rate just before the swarming period in April.

Termite baits were developed in earnest in the United States in order to reduce pesticide levels in the urban environment (Esenther and Beal, 1979). Baits are intended to reduce a population of termites by directing the minimum amount of slow-acting toxicant to the target organism (French, 1988). In contrast, a conventional treatment for subterranean termites requires the application of a toxic soil barrier around the home, which may allow termites to continue foraging near the treatment barrier (Su and Scheffrahn, 1988).

Initial studies on termite baits used sugar coatings (e.g. honey or cane sugar) as an attractant (Randall and Doody, 1934). However, these additives were quickly determined to be more deterrent to termites than attractive, and because the toxicants available at the time (sodium arsenite or arsenic) were relatively fast acting only a few members of a colony were killed (Randall and Doody, 1934). A slower-acting toxicant combined with a more attractive bait was formulated using mirex and fungus-infected wood (Esenther and Gray, 1968). However, in 1976, when mirex was banned in the United States, other slow-acting bait toxicants were sought. In addition, attractants that utilized physical aspects of the food source (Esenther *et al.*, 1980; Delaplane and La Fage, 1991a; French, 1988), and stable, inexpensive chemical additives, that enhanced termite feeding on a substrate (Ritter and Coenen-Saraber, 1969; Amburgey and Smythe, 1977; Grace, 1991, Delaplane and La Fage, 1991b; Henderson *et al.*, 1994) were investigated. Since food choices are almost always available to termites in nature, bait attractiveness is critical to bait performance.

Several field demonstrations on *Reticulitermes flavipes* (Kollar) showed great promise in the ability of baits to suppress termite population numbers (Esenther and Gray, 1968; Esenther and Beal, 1974, 1978; Beard, 1974; Ostaff and Gray, 1975). However, demonstrating suppression in the field proved difficult, and some reports on colony suppression due to baiting were later suggested to possibly only indicate bait repellency (Su and Scheffrahn, 1991), or were determined to be inconclusive (Su *et al.*, 1982). More recently, by using mark-recapture methods, claims of colony elimination using termite baits were reported (Su, 1994, Su *et al.*,, 1995). Although mark-recapture methods are a valuable tool for estimating foraging termite numbers (Esenther, 1980; Forschler and Henderson, 1995), because of the cryptobiotic nature of termites the lack of termite activity at bait sites still may simply represent the result of a shift in foraging activities to different sites (Su and Scheffrahn, 1991).

The determination of termite bait efficacy in the laboratory also has proven to be difficult. For example, laboratory termites tolerate insecticides differently depending on the techniques used (Esenther, 1978), length of time kept in the laboratory (French and Robinson, 1983), colony origin

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and worker biomass (Su and La Fage, 1984), season in which the testing takes place (French and Robinson, 1983), termite behavior (Grace, 1991), and the nutritional status of the termites (Esenther, 1978). The best situation for testing termite mortality agents is found in natural field conditions (Esenther, 1979).

We investigated the efficacy of termite baits against Formosan subterranean termites (*Coptotermes formosanus* Shiraki) in naturally-infested trees in the field. Formosan subterranean termites readily infest living trees (Dai and Luo, 1980; La Fage, 1987; Lai *et al.*, 1983), and the trees along the Calcasieu River in Lake Charles, LA, harbor captive colonies that cannot escape (except for alates) due to being surrounded by water (Waller and La Fage, 1988; Delaplane *et al.*, 1991). Louisiana, and other southeastern states in the United States, are experiencing an ever increasing problem with Formosan termites (Henderson and Delaplane, 1994). In New Orleans a 1200 percent increase in Formosan termite alate numbers was recorded between 1989 and 1995 (Henderson, 1995). *C. formosanus* is the most destructive of 201 termite species in its native China (Lin, 1987).

Aside from providing a novel field evaluation site for baits, termite-infested trees cause concern to homeowners living nearby because they can constitute the primary natural reservoir for Formosan termites (La Fage, 1987). In addition, we investigated termite baiting of trees in New Orleans, Louisiana, to document the feeding phenology of Formosan termites on untreated baits in an urban setting relative to season. Since the first infested tree (Chinese elm, *Ulmus pumla* L.) in New Orleans was discovered in 1967, there has been great concern in protecting trees from infestation and for the increased likelihood of tree-infesting termites invading nearby homes (Beal, 1987). Wooden structures next to a tree-dwelling colony of Formosan termites are clearly a potential target. Indeed, a colony of *Coptotermes acinaciformis* (Froggatt) may occupy up to 16 living trees at one time, and presumably also timber in buildings (Greaves, 1962). Gay (1946) was first to show that a tree-dwelling colony of *Coptotermes* (*C. frenchi* Hill) could infest a building 23 meters away.

Also, to follow-up on some results of these field studies, in the laboratory we evaluated the dose mortality effects of some toxic baits to Formosan termites.

MATERIALS AND METHODS

Baiting trees in the Calcasieu River

Between 1991 and 1995, we used naturally occurring Formosan subterranean termite-infested bald cypress (*Taxodium distichum* (L.) Rich) and tupelo gum (*Nyssa aquatica* L.) located along the Calcasieu River in Lake Charles, Louisiana, to evaluate 12 different toxicant baits. Trees selected in the baiting studies met two criteria: 1) they were surrounded by water throughout the year, and 2), harbored populations of Formosan subterranean termites. All trees selected were over six meters in height and had to be accessed by boat. Termite infestations in these trees were easily observable from a distance of 10 m due to the extensive amount of Formosan termite frass deposited on the outside of the bark. Although foraging population estimates were not made on populations in these trees, using a mark-recapture method (Esenther, 1980) on two similar trees in the Calcasieu River provided foraging populations of over 250,000 termites (Henderson and Wells, unpublished data).

Once a tree was selected for baiting, a 2 cm hole was drilled into the heartwood of the tree trunk approximatley 50 cm above the water-line using a generator-powered drill. If the hole exposed a termite gallery or carton nest and termites came to the hole it was immediately fitted with a 15-30 cm length of heavy duty polyvinyl chloride (PVC) pipe (serving as a termite access bridge) that snugly fit the hole and extended at least 8 cm into the tree and 8 cm outside of the tree. In most of the trees more than one hole was drilled to locate active termites. Two removable PVC bait traps (15 cm by 7.5 inner diam each) fixed onto a T-joint were placed on the proximal end of the access brige (Fig. 1). For some of the trees (all of the hexaflumuron-baited trees and some of the abamectin-baited trees), two single bait traps were placed within 0.5 m on the trunk of the tree instead of the T-joint bait trap. Into each bait trap, a pre-weighed 50 gram roll of corrugated-cardboard was placed to encourage termite foraging. Traps were inspected every two weeks until foraging termites and cardboard consumption was recorded. Once untreated cardboard rolls were attacked a tree was cosidered for testing.

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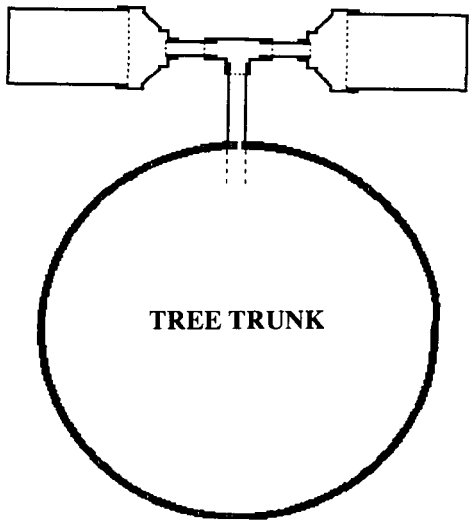

Figure 1. Arrangement of PVC baits in T-joint placed at a height of 50 cm above water line into termite-infested trees in the Calcasieu River in Lake Charles, Louisiana

The 12 toxicants tested included: abamectin (Whitmire Research Laboratories, St. Louis, Missouri), avermectin (Merck & Co., Rahway, New Jersey), an experimental juvenoid and chitin inhibitor (922 and 928, respectively (Zoecon Corp., Dallas, Texas), deltamethrin dust (Roussel UCLAF, Paris, France), GX326 (similar to sulfluramid) and sulfluramid (Griffin Corp, Valdosta, Georgia), hexaflumuron (DowElanco, Indianapolis, Indiana), compound X (proprietary information), mirex (furnished by Allied Chemical Co. to Dr. J. P. La Fage), Bay NTN-33893 (Miles, Kansas City, Missouri), and permethrin dust (FMC Corp., Princeton, New Jersey). Several concentrations were tested for some of the toxicants (noted in the results section). For avermectin (25 ppm), GX326, sulfluramid, deltamethrin dust, permethrin dust, mirex (at 200 and 1000 ppm), and NTN, acitve ingredients or solutions were applied to 50 g corrugated-cardboard rolls. For 922, 928, avermectin (10,000 ppm), and mirex (10,000 ppm) only 5 g cardboard squares were used for the paired comparison of treated and untreated baits. Acetone served as the carrier for all formulations prepared in the laboratory except the dusts, which were directly applied to the cardboard. Abamectin, hexaflumuron, and compound X, were supplied directly by the companies in already formulated treated and untreated baits. Also, for these three materials, instead of monitoring bait efficacy with untreated 50 g cardboard rolls we used wood sandwiches. Sandwiches were comprised of ten, 2-mm strips of weathered white pine (4 cm x 12 cm) separated by 2-mm diameter wooden dowel sticks and held together with plastic cable ties. Sandwiches were oven-dried at 70°C for 48 h before and after exposure to termites to standardize weight determinations.

To test a toxic bait within each tree, one side of the T-joint (or one of the single bait traps) received a treated bait while the other side received a bait without toxicant. Determination of treatment placement was randomized by a flip of a coin. Treatment bait consumption versus untreated bait consumption was used to assess repellency of the tested toxicant. After being left in place for a minimum of two weeks, the toxic and untreated bait were removed simultaneously from each tree and returned to the laboratory for drying and weighing. Trees baited with hexaflumuron, compound x and abamectin received the toxicant and paired untreated baits on four different dates (see "number of toxic baits used" in results), all other trees were provided with the toxicant only once. Once the toxicant baits were removed for the last time, and for the rest of the study, trees received only untreated baits (50 g rolls of corrugated cardboard or wood sandwiches), and consumption was determined by collection and weighing of baits every two weeks for a minimum of three months and a maximum of 9.6 months depending on the combination of toxicants under evaluation. For example, evaluation of the chitin inhibitor, hexaflumuron, required a longer inspection period because of its relatively slow action.

Untreated cardboard consumption after toxic baits were removed was the most important determinant of bait efficacy. Observations of termite activity also were made during toxic bait and cardboard replacements. If untreated baits showed zero consumption, trees were further inspected by breaking carton nest material (if exposed) and shelter tubes in areas having past activity for a minimum of ten minutes. Tree colonies were determined to be eliminated only after a minimum of three inspections showed no bait consumption or termite activity.

On six different dates, a series of different termite baits in various formulations were simultaneously evaluated. For each series of toxic-baited trees evaluated, one to four trees baited only with untreated cardboard served as checks. However, although each colony-infested tree had common elements, each tree also was unique, and tree bait efficacy was considered on an independent basis (see Beard, 1974). As such, only baits in which infestations were completely eliminated were determined to be effective and no statistical analysis for comparison of cardboard consumption between trees was applied.

Laboratory evaluation of termite bait repellency

To address termite consumption differences of toxic versus nontoxic baits in the field, we designed a no-choice laboratory feeding bioassay to determine dose mortality effects of sulfluramid baits to Formosan termites. Standard 1000 ml canning jars (Ball, wide mouth; n = 30) were filled with sterilized #4 blasting sand. Centrifuge tubes (50 ml) containing a pre-weighed (3.9 g) roll of corrugated-cardboard impregnated with either 0 ppm, 10 ppm, 25 ppm, 50 ppm, or 100 ppm sulfluramid (dissolved in acetone), were driven into the sand such that the centrifuge tube was in the middle of the jar and its lid sat below the jar's opening. There were six repetitions of each treatment (n = 30). Centrifuge tubes had eight, 3-mm holes distributed evenly over its surface to allow termite entry (centrifuge tubes and technical grade sulfluramid were supplied by FMC Corp., Princeton, New Jersey). To each jar, 1,000 termites (determined by weight) recently collected from a colony in New Orleans were added. Sand and cardboard rolls were moistened with distilled water and experimental units were placed in an incubator at 29°C. Daily checks of termite activity were recorded and water was added to sand when dry. After eight days, cardboard rolls were removed, dried, and weighed to determine termite consumption for each treatment concentration. A one-way ANOVA was used to determine significant differences in cardboard consumption between treatments (EXCEL 5.0, Microsoft Corp., 1993).

Seasonal changes in untreated bait consumption of termite infested trees in New Orleans

Twelve termite-infested live oak (*Quercus virginiana* Mill) trees located in New Orleans, nine harboring *Coptotermes formosanus* and three infested by *Reticulitermes* spp., were provided with one to three 50 g untreated corrugated-cardboard rolls contained in PVC sleeves as previously described starting in November 1993. Recordings of termite activity and cardboard bait weights started in December 1993 and ended in March 1995. Some cardboard baits were attached to trees as described for the Lake Charles study above, and some were positioned underground around the base of the trees. Every two weeks baits were inspected and, if fed on by termites, baits were returned to the laboratory for drying and weighing to determine percent consumption. New 50 g rolls of untreated corrugated-cardboard replaced any cardboard rolls removed. This study continued for 16 months. Mean cardboard consumption was determined for all trees by month, and consumption between months analyzed using a one-way ANOVA (EXCEL 5.0, Microsoft Corp., 1993).

RESULTS AND DISCUSSION

Baiting trees in the Calcasieu River

Three bait toxicants proved to effectively eliminate tree-infesting Formosan termite colonies: hexaflumuron, mirex, and sulfluramid (Table 1). Hexaflumuron-baited trees were given toxic baits on four different occasions and required 42 to 292 days before elimination of the colony was

recorded. In most instances, treated and untreated bait had been completely removed at the time of inspection. However, because the placebo (untreated) baits weighed less than the hexaflumuron-treated baits, there was more treated bait removed then untreated bait (see toxic vs. untreated; Table 1). DowElanco is now marketing hexaflumuron baits in a baiting strategy called the Sentricon Total Elimination System. Mirex was effective at all concentrations and appeared to actually increase the attractiveness of the cardboard bait. Elimination time increased as mirex concentration decreased. However, registration on mirex was withdrawn by the Environmental Protection Agency in 1976 when it was found to bioaccumulate in birds and other wildlife, even when as little as a few grams per hectare was used (Metcalf and Metcalf, 1993). Sulfluramid baits eliminated colonies in 49 to 151 days when tested at 1000 parts per million (ppm) and 200 ppm, respectively. Two trees (# 41 and 42) treated with 100 ppm sulfluramid baits did not show reduced activity after 3.1 months. However, these trees were used in the next series of tests with sulfluramid and with very little feeding on the toxic bait were eliminated (# 44 and 46, respectively). It is probable that the 100 ppm sulfluramid baits had an affect. This can also be said for tree number 27 which had previously been fed NTN with no apparent colony affect. Unlike the hexaflumuron and mirex baits, sulfluramid-treated baits seemed to have some repellency associated with it. Treated bait consumption for all sulfluramid trees averaged 4.3 g±3.8, whereas the paired untreated bait consumption averaged 17.8±14.9. In July 1995, FMC Corp. received a 24(C) allowance for sulfluramid bait use against subterranean termites when properly placed in above and below ground bait stations in and around homes, buildings, trees, and underground cables in Louisiana.

All other baits tested were not effective in eliminating the colony. Avermectin-treated baits showed repellency even as low as 25 ppm. Abamectin at 0.0001% and 0.0005% showed little if any repellency but did not appear to effect the colony. Similarly, other toxic-baits tested were either repellent or did not affect the colony at the concentrations tested.

Laboratory evaluation of termite bait repellency

Termites immediately entered the centrifuge tubes containing cardboard (CB) at all sulfluramid concentrations tested and in all replicates. There was no overt repellency of sulfluramid at the concentrations tested. The amount of CB ingested and sulfluramid ingested is shown in Figures 2 and 3, respectively. Results showed significant CB consumption differences among treatment concentrations ($F = 18.83$, $df = 4$, $p < 0.001$). A similar, but reversed difference was observed in the amount of actual sulfluramid ingested. It took five days for 1,000 termites feeding on 100 ppm sulfluramid to die. However, the termites showed obvious signs of sickness previous to day five. It required six days for colony death at 25 and 50 ppm, and 8 days at 10 ppm. Termites fed 0 ppm sulfluramid (controls) were still healthy at day 30. Bait consumption was obviously affected by the colonies increased sulfluramid concentration. Actual sulfluramid ingestion however, increased with concentration increases and more sulfluramid got to the colony in a shorter time at the higher concentrations. CB consumption differences were directly attributable to colony health and not to bait repellency. Repellency of sulfluramid baits as determined by field studies using bait consumption as a measure, therefore, needs reconsideration. It is well known that the social Hymenoptera show site fidelity to a feeding site, i.e., once entrained to a foraging site, individuals will forage exclusively to that site. In the laboratory, subterranean termites also show site fidelity (Forschler, unpublished data), and reduced feeding at a toxic bait site may reflect a die-off of site-specific foragers. With a die-off of individuals that show site fidelity a concomitant decrease in trail pheromone would result. As argued by Grace *et al.*, (1988) termites encountering trails of low pheromone concentration might ignore these trails and follow well-traveled ones to reduce the probability of following old trails that possibly lead to unprofitable resources.

Seasonal changes in untreated bait consumption of termite infested trees in New Orleans

Bait consumption significantly varied in the 16 month study period ($F = 3.78$, $df = 15$, $p < 0.001$; Fig 4). Termite feeding at bait sites varies seasonally, being lowest during the colder months of winter and peaking just prior to the Formosan termite swarming period in May. In April and May, Formosan termite populations are at their peak numbers and foraging is necessarily increased at

Table 1. Results of chemically-treated baits against Formosan Subterranean termites infesting trees in Lake Charles, Louisiana. Baits showing the same duration of study were evaluated simultaneously.

Colony No.	Chemical and Concentration	Date of Initial Baiting	Number of Toxic Baits Used	Duration of Study (Months)	Total Consumption of Paired Toxic (T) and Untreated (U) baits (grams)	Total Consumption of Untreated Baits (grams)	Time to eliminate colony in days
1	922, 50 ppm	4/26/1991	1	5.3	T = 5 U = 5	264.50	
2	922, 50 ppm	4/26/1991	1	5.3	T = 5 U = 5	250	
3	928, 50 ppm	4/26/1991	1	5.3	T = 5 U = 5	250	
4	928, 50 ppm	4/26/1991	1	5.3	T = 5 U = 5	150	
5	Abamectin + Grey Wood Scrapings 0.0001%	8/4/1994	2	7.8	T = 58 U = 60	539.37*	
6	Abamectin 0.0005 %,	6/9/1994	4	9.6	T = 19.6 U = 90	951.46*	
7	Abamectin 0.0005 %	6/9/1994	4	9.6	T = 66.2 U = 120	730.62*	
8	Abamectin 0.0005 %	6/9/1994	4	9.6	T = 88.9 U = 117	1009.78*	
9	Abamectin 0.0005 %	6/9/1994	4	9.6	T = 44.6 U = 24.64	311.5*	
10	Avermectin, 25 ppm	2/2/1993	1	3.1	T = 5.5 U = 20	57.50	
11	Avermectin, 10000 ppm	4/26/1991	1	5.3	T = 0 U = 2.5	290	
12	Avermectin, 10000 ppm	4/26/1991	1	5.3	T = 0 U = 0	209.50	
13	Deltamethrin Dust, 5.0 g of 0.5%	11/30/1991	1	5.2	T = 0 U = 2.5	342.50	
14	Deltamethrin Dust, 5.0 g of 0.5%	11/30/1991	1	5.2	T = 0 U = 2.5	80	
15	GX326, 100 ppm	2/2/1993	1	3.1	T = 5.5 U = 1.5	145.50	
16	GX326, 100 ppm	2/2/1993	1	3.1	T = 7 U = 17	67	
17	Hexaflumuron 0.1%	6/9/1994	4	9.6	T = 180 U = 120	323.65*	292
18	Hexaflumuron 0.1%	6/9/1994	4	9.6	T = 90 U = 0,0*	42	
19	Hexaflumuron 0.1%	6/9/1994	4	9.6	T = 180 U = 120	249.58*	172
20	Hexaflumuron 0.1%	6/9/1994	4	9.6	T = 30.8 U = 4.5	56.5*	87
21	Compound X 0.3 %	6/9/1994	4	9.6	T = 43.51 U = 149.87	657.05*	
22	Compound X 0.3 %	6/9/1994	4	9.6	T = 32.43 U = 53.99	472.6*	
23	Compound X 0.3 %	6/9/1994	4	9.6	T = 75.15 U = 127.41	863.87*	
24	Compound X, 0.6 %	,6/9/1994	4	9.6	T = 116.20 U = 171.90	923.63*	
25	Compound X 0.6 %	6/9/1994	4	9.6	T = 57.53 U = 154.82	683.24*	
26	Compound X 0.6 %	6/9/1994	4	9.6	T = 44.49 U = 154.19	662.23*	
28	Compound X 0.6 %	6/9/1994	4	9.6	T = 42.19 U = 155.48	631.67*	
29	Mirex, 200 ppm	9/3/1992	1	5.0	T = 13.5 U = 23.5	78	142
30	Mirex, 200 ppm	9/3/1992	1	5.0	T = 37.5 U = 39.5	0	12

Table 1. (*Continued*)

Colony No.	Chemical and Concentration	Date of Initial Baiting	Number of Toxic Baits Used	Duration of Study (Months)	Total Consumption of Paired Toxic (T) and Untreated (U) baits (grams)	Total Consumption of Untreated Baits (grams)	Time to eliminate colony in days
31	Mirex, 1000 ppm	11/30/1991	1	5.2	T = 4.85 U = 0	0	41
32	Mirex, 1000 ppm	11/30/1991	1	5.2	T = 3.3 U = ?	29	73
33	Mirex, 10000 ppm	4/26/1991	1	5.3	T = 4.3 U = 0	21	17
34	Mirex, 10000 ppm	4/26/1991	1	5.3	T = 2.5 U = 0		11
35	NTN, 100 ppm	2/2/1993	1	3.1	T = 3.5 U = 11.5	114	
36	NTN, 100 ppm	2/2/1993,1	0	3.1	T = 2 U = 27	133	
37	NTN, 1000 ppm	9/3/1992,1	0	5.0	T = 0 U = 43	216	
38	NTN, 1000 ppm	9/3/1992	1	5.0	T = 0 U = 47.5	230.50	
39	Permanone 5.0g Dust	11/30/1991	1	5.2	T = 0 U = 2.5	84	
40	Permanone 5.0g Dust	11/30/1991	1	5.2	T = 0 U = 2.5	285.50	
41	Sulfluramid, 100 ppm	2/2/1993,1		3.1	T = 8 U = 19	124.50	
42	Sulfluramid, 100 ppm	2/2/1993	1	3.1	T = 7 U = 1.5	10	
43	Sulfluramid, 200 ppm	5/4/1993	1	4.8	T = 0 U = 12.5	0	49
44	Sulfluramid, 200 ppm	5/4/1993	1	4.8	T = 11.5 U = 16	0	49
45	Sulfluramid, 200 ppm	5/4/1993	1	4.8	T = 0.5 U = 1.5	0	49
46	Sulfluramid, 200 ppm	5/4/1993	1	4.8	T = 3 U = 9.5	0	49
47	Sulfluramid, 200 ppm	5/4/1993	1	4.8	T = 3 U = 50	0	49
48	Sulfluramid, 1000 ppm	11/30/1992	1	6.2	T = 3.7 U = 21.5	5.50	153
49	Sulfluramid, 1000 ppm	11/30/1992	1	6.2	T = 2.4 U = 28.5	5.00	111
50	Untreated	4/26/1991	0	5.3	U = 5 U = 5	164.50	
51	Untreated	11/30/1991	0	5.2	U = 23.5 U = 2	0.5	169.50
52	Untreated	11/30/1991	0	5.2	U = 0.45 U = 28	310	
53	Untreated	9/3/1992	0	5.0	U = 50	256.50	
54	Untreated	9/3/1992	0	5.0	U = 20	243	
55	Untreated	2/2/1993	0	3.1	U = 3.5	127.50	
56	Untreated	2/2/1993	0	3.1	U = 8.5	96.50	
57	Untreated	5/4/1993	0	4.8	U = 50	250	
58	Untreated	5/4/1993	0	4.8	U = 50	250	
59	Untreated	6/9/1994	0	9.6	U = 223.47 U = 244.75	460.58*	
60	Untreated	6/9/1994	0	9.6	U = 319.25	454.85*	
61	Untreated	6/9/1994	0	9.6	U = 172.76 U = 172.76	448.31†	

*Sandwich consumption; †Placebo consumption, all others CB consumption

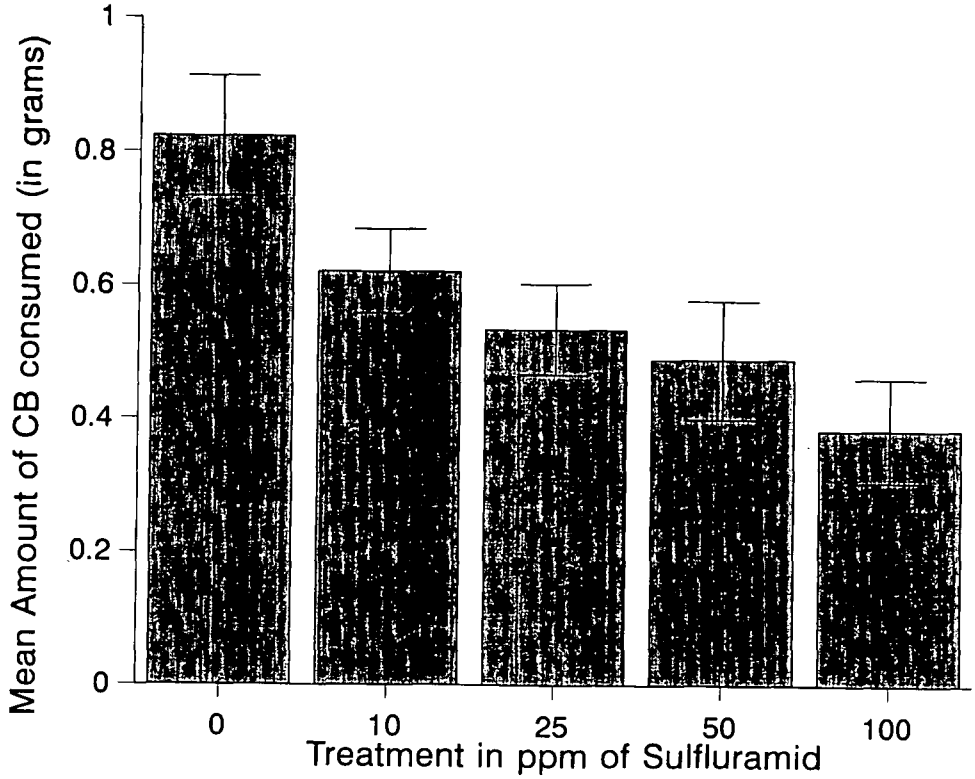

Figure 2. Bait consumption of cardboard (CB) treated with sulfluramid (plus control). Sulfluramid applied as a weight measure (parts per million, ppm).

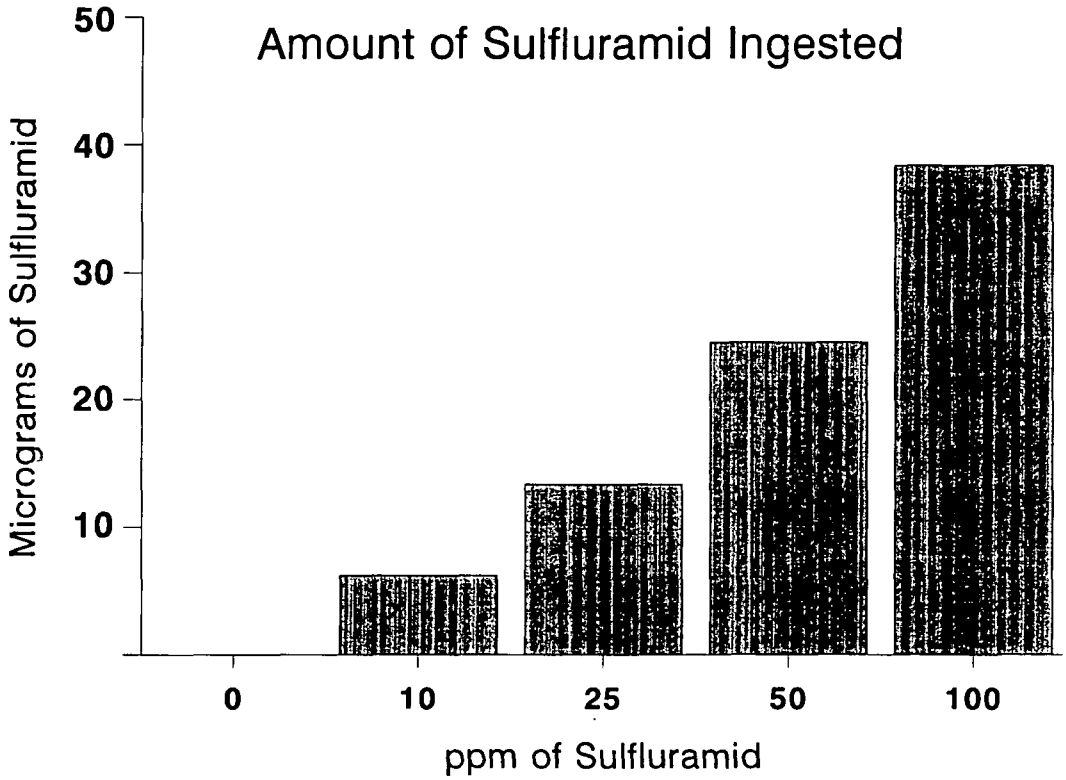

Figure 3. Actual sulfluramid ingested when applied to cardbord at different concentrations. Calculations of sulfluramid were made assuming equal distribution on the cardboard and determined from cardboard consumptions values deicted in Figure 2.

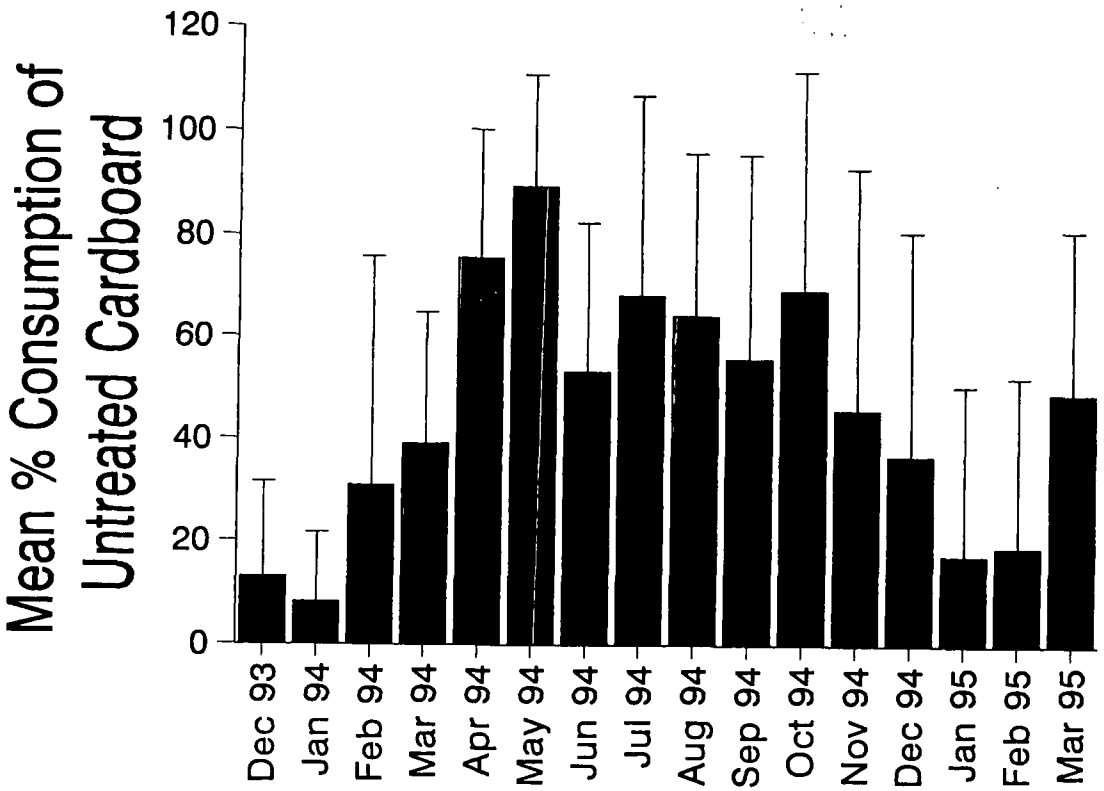

Figure 4. Seasonal variation in cardboard consumption fed to tree infesting subterranean termites in New Orleans, Louisiana.

that time. Seasonal variation in bait consumption means that baiting in the winter months will not be as effective as would baiting in the summer months. Also, this variation must be taken into account when determining bait results in the field. A reduced bait feeding at the onset of winter may not reflect bait efficacy.

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