RED IMPORTED FIRE ANT
APPLIED RESEARCH/RESULT DEMONSTRATIONS
1990-1991

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Impact of Red Imported Fire Ant Predation on Low-nesting Colonial Waterbirds on the Rollover Pass Islands, Texas

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The National Audubon Society and the Texas General Land Office have had concerns over the invasion of the red imported fire ant, *Solenopsis invicta* Buren., into the waterbird rookeries along the Texas coast on natural and man-made "spoil" island, and, on 19 August 1988, requested that the Texas Agricultural Extension Service assist in an effort to control the ants on these sites.

The red imported fire ant has been documented to feed on hatching eggs (Johnson 1961, 1962, Mount 1981, Mount et al. 1981, Wilson and Silvy 1988). However, the impact of this ant behavior on egg clutch survival, nesting success and population density in fire ant-infested areas has remained largely undocumented. In the absence of this information, suppression programs using available control technology are not ecologically and economically justifiable. Current programs provide only temporary suppression and require repeated applications. Discontinuation of treatments can result in reinvasion of the ants to levels that may exceed those prior to initial treatment.

A three-year pilot program was conducted to document the impact of a fire ant suppression program, based on the use of environmentally acceptable management tactics, on fire ant foraging activity and waterbird production.

Materials and Methods

Heavily infested islands at Rollover Pass in East Galveston Bay were selected for this pilot program. These islands are colonized, from March thr9ough August, by more than a dozen ground- and shrub-nesting waterbirds including the great egret (Casmerodius albus; great blue heron, Ardea herodis; olivaceous cormorant, Phalacrorox olivaceus; snowy egret, Egretta thula; Louisiana (tri-Color) heron, Hydranassa tricolor; roseate spoonbill, Ajaia ajaja; laughing gull, Larus atricilla; gull-billed tern, Gelochelidon nilotica; and Forster's tern, Sterna forsteri.

Treatment regimes were based on a preliminary fire ant survey and the geography of the four Rollover Pass islands. Island 1 and the eastern half of Island 4 were treated on 27 February, 29 September 1989 and 28 September 1990 using the product, Logic® (fenoxycarb), an insect growth regulator, at a rate of 1.5 lbs. per acre to maintain low levels of fire ant activity. Island 3 and the west half of Island 4 were left untreated and had high levels of fire ant activity.

A preliminary survey of fire ant mound densities was made 27 February 1989 by counting the number of fire ant active mounds within a 0.25-acre circular plot in the center of Island 4. Thereafter, relative foraging ant activity between treated and untreated areas was monitored using olive oil-soaked index cards. Ten one-inch-square cards were positioned in a transect line across each island or island portion. The number of ants associated with each card was estimated after 0.5 to 24 hours of exposure (23-24 May and 29 September 1989; 21 April, 1 June and 28 September 1990, and 21 May 1991).

During periodic visits in 1990, 6 or more randomly-selected, egg-containing waterbird nests were marked in treated and untreated areas. Numbers of marked nests containing chicks were determined during subsequent visits. Percent mortality was calculated from these sets of marked nests and observations were made to determine cause of death.

During 1991 sets of nests containing eggs and young birds were marked with surveyors stakes and monitored regularly from May through July. Ten nests on the treated and untreated halves of Island 4 were marked 2 May and monitored on 12 May. On 21 May, an additional 10 nests on each half of Island 4 were marked and monitored 5, 13 and 19 June and 2, 9 and 19 July. On each visit, the presence of eggs, young birds with down, pinfeather and/or feathers was documented for each nest. From data obtained, the number of monitored nests occupied, percent of nests with successful brood, cumulative number of eggs and cumulative number of feathered offspring reared could be computed for each half of the island. Results of statistical analyses are not presented in this report.

Results and Discussion

A preliminary survey documented an estimated 180 active fire ant mounds per acre on Islands 1, 3 and 4. Island 2 was found to harbor primarily a native ant species, Monomorium minutum (Buckley), the little black ant. This island was left untreated. The effects of the 27 February 1989 Logic® treatments were not evident during the 1989 breeding season (**Table1**) due to either the use of improperly stored, rancid product or because of low foraging activity at the time of treatment.

September treatments, applied when the islands were unoccupied by migratory waterbird species, proved to be successful in reducing fire ant foraging and nesting activity by the following spring when birds began to arrive and nest. From 21 April 1990 through the remainder of the pilot program, ant activity on the Logic® treated half of Island 4 was reduced by 79-99 percent.

Survey of nesting waterbirds on 23-24 May 1989 provided little documentation of the impact of ant foraging on hatchling survival, although some chicks were observed being overwhelmed by red imported fire ants while hatching. In June 1989, hurricane Alison flooded the Rollover Pass Islands with a 5 ft. tide and 27 inches of rain. Adverse weather conditions eliminated bird nesting activities and all developing waterbirds. Hurricane Chantal produced 6 inches of rain on the islands on 1 August. Thus, no young developed on these islands in 1989.

On 21 April 1990, waterbird nesting was already in progress, preventing a spring broadcast Logic® application. The 29 September 1989 Logic® application to the eastern half of Island 4 had resulted in a significant 90 percent reduction in foraging activity on olive oil-soaked index cards.

Heavy rains and floods occurred in May 1990 and on 1 June, high tides caused flooding conditions, and many laughing gull and tri-color heron nests were submerged.

Although flood-related mortality of hatchling waterbirds was documented in April and May 1990, ant-related mortality on the fire ant-infested portion of Island 4 was not documented until after June 1. Mortality increased to 100 percent of marked nests through the remainder of the monitoring period (**Table 2**). Unfortunately, the monitoring of nesting success in the Logic® treated half of the Island 4 was discontinued after 1 June 1990.

During 1991, the breeding season began 15 to 30 days earlier than usual. On 28 April 1991, half of the tri-color heron population developing on the islands was lost due to high tides. Little ant-related mortality of hatchlings was observed prior to the end of May and only slight differences in the number of occupied nests were noted until mid-June. Thereafter, occupancy of marked nests on the untreated, fire ant-infested part of Island 4 decreased from 13 to 56 percent (Table 3). Nest on the treated part of the island were used up to three times during the monitoring period, often by different bird species. Successful brooding in marked nest sets, already about 70 percent reduced in the ant-infest area during May, declined to 0 by 19 June. No successful brooding occurred thereafter in the presence of fire ant predation.

Egg production in treated and ant-infested portions of Island 4 was never dramatically different (**Table 3**). However, the number of eggs present in the marked nest set on the untreated area was 6 to 11 percent greater than in nests within the treated area from 19 June through the remainder of the study. This difference resulted from 1) nests being occupied by young birds in the treated area and 2) from re-nesting attempts by adult birds in the untreated area.

The most dramatic statistics generated during this study were the cumulative number of offspring produced in nest sets on the ant-infested versus Logic®-treated parts of Island 4: 6 versus 72, a 92 percent reduction of waterbird production during this monitoring period. Even though these migratory colonial waterbird species appear to breed successfully from the end of February through the end of April in the presence of high red imported fire ant densities, late season success is dramatically reduced - even eliminated. Since weather-related nesting failures often occur during the early spring months, fire ants can become an important limiting factor in the reproduction of waterbird species attempting to nest from May through July.

Conclusions

1. Red imported fire ants can be sufficiently suppressed on rookery islands of the Texas coast using an annual fall broadcast application of Logic® insect growth regulator to reduce midsummer predation by ants on nesting waterbirds.

2. Little fire ant-related mortality of hatchling waterbirds was observed or documented from late February through mid May, but mortality of young birds increased to 100 percent in monitored nest sets during June and through the remainder of the nesting season (the end of July).

3. Weather conditions play a major role in the ability of both birds and fire ants to successfully nest on these islands.

Acknowledgements

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Table 1. Number of red imported fire ant workers associated with olive oil-soaked index cards, Rollover Pass Islands, Texas.

Average no. foraging red imported fire ants per olive oil-treated card

Date	**Untreated Island 4 East**	**Treated Island 4 West**	**Percent diff.**
23-24 May 1989	31.8	27.6	0
29 September 1989	14.0	18.0	23
21 April 1990	2.7*	27.9*	90
1 June 1990	0.2	180.0	99
10 July 1990	4.0	19.5	79
28 September 1990	3.6	46.0	92
21 May 1991	2.5	85.5	97

* Indicates first date for significant differences of means using the Student's t test (P0.05; d.f. = 18)

Table 2. Percent mortality of hatchling waterbirds on treated and untreated (fire ant infested) parts of Rollover Pass Island 4, Galveston Bay, Texas, 1990.

Percent mortality of hatchling waterbirds (number of marked nest observation in parentheses)

Date	Treated	Untreated
April 21* - May 6	14.3 (7)	50.0 (6)
May 6 - June 1	0.0 (4)	50.0 (4)
June 1* - June 15	10.0 (10)	--
June 15* - June 24	N/O	100.0 (?)
June 24* - July 3	N/O	100.0 (5)
July 3* - July 10	N/O	100.0 (3)
July 10 - July 20	N/O	100.0 (3)

*Dates when sets of nests containing waterbird eggs were marked for subsequent observation of hatchling success.
N/O = None observed

Table 3. Waterbird* rookery success in fire ant infested and treated halves of Island 4, Rollover Pass Islands, Texas, 1991.

	May 2	May 12	May 21	June 5	June 13	July 1	July 2	July 9	July 19
No. of nests monitored:	10	10	20	20	20	20	20	20	20
No. of nests occupied:									
Ants present	10	9	18	18	10	10	13	7	4
Ants removed	10	10	20	15	16	14	15	15	9
Percent diff.	0	-10	-10	+16	-38	-29	-13	-53	-56
Percent successful brood nests:									
Ants present	30	33	22	22	11	0	0	0	0
Ants removed	100	100	80	80	94	93	100	100	100
Percent diff.	-70	-67	-73	-73	-88	-100	-100	-100	-100
Cumulative # of eggs:									
Ants present	28	28	59	68	76	87	102	103	103
Ants removed	35	35	59	76	78	78	78	94	97
Percent diff.	-20	-20	0	-11	-3	+11	+15	+9	+6
Cumulative # feathered offspring:									
Ants present	0	0	0	5	6	6	6	6	6
Ants removed	0	0	28	28	37	39	43	61	72
Percent diff.	0	0	-100	-82	-84	-85	-86	-90	-92

* Colonial waterbird nest monitored: Great egrets, great blue heron, snowy egret, roseate spoonbill, tri-color heron, cormorant, gull.

Survey of Imported Fire Ant Mound Densities in Managed Native Prairies - the Attwater Prairie-Chicken National Wildlife Refuge

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The Attwater's prairie chicken, Tympanuchus cupido attwateri, is a subspecies, lik the Greater prairie-chicken, of the Heath hen. The Attwater Prairie-Chicken National Wildlife Refuge was established in 1972 to preserve and restore critical habitat for this endangered subspecies. Approximately 8,000 acres are currently managed by the U.S. Fish and Wildlife Service. Native grasses and forbes of the prairie make up the only habitat suitable to the prairie-chicken's needs.

The five-month mating season of the Attwater's prairie-chicken begins in late December when males congregate on courtship or "booming" grounds. Booming grounds vary in shape and size (usually 0.1 to 10 acres or less) and have short plant cover. Females are attracted to the booming grounds by the spirited fighting and booming of the males. Mating usually occurs there, and nest are normally located within one-half mile. Hens prefer to nest in medium to heavy grass cover and lay an average of 11 eggs which incubate for 28 days. Chicks are escorted from dense cover soon after hatching and can fly when they are two weeks old. The nesting occurs in April and is completed by mid-May.

The refuge is intensively managed for the preservation of the Attwater's prairie-chicken, one of the few National Wildlife Refuges designated specifically for an endangered species. Management techniques to improve habitat include: controlled grazing, prescribed burning, strip row cropping, mowing, pest plant control, and predator control. Snakes, opossums, racoons, coyotes, armadillos and especially skunks prey upon the eggs and young birds.

The red imported fire ant, Solenopsis invicta Buren, has been documented to prey upon hatching eggs of several ground-nesting birds including waterfowl and quail. However, no ant-related mortality of the Attwater's prairie-chicken has been documented. This survey was initiated to monitor fire ant mound nesting density in the managed native prairie to determine if management practices produced any changes in mound density over time.

Materials and Methods

The Reichardt prairie, a section of managed native prairie approximately 4,000 by 10,000 ft. (918 acres) and containing no internal fencing, was subdivided into plots under a three to four-year rotational management regime of prescribed burning and controlled grazing. On 6 March 1991, four plots were established: 1) 106 acres not burned since 1979 (this area contains a booming area); 2) 137 acres not burned since 1983/84; 3) 234 acres burned in 1990 (this area serves as good nesting habitat; and 4) 175 acres burned in February 1991 (this area serves as brood habitat). Within each plot, four permanent subplot sites were established using metal fence posts and were arranged in transect lines initiating from road intersections that separate plot areas within the prairie. The number of active red imported fire ant mounds within an 80 ft. radius (0.46 acre or 0.19 hectare) of these fence posts were counted.

This process was repeated on 12 March 1992 and will be repeated each spring (and perhaps fall) at roughly the same period of the year for the next 2 years. Average density of fire ant mounds and the effect of prescribed burning will be documented.

Results and Discussion

On 9 March 1991, the ambient temperature was roughly 85EF. Rain had occurred the previous week and ant mounds were highly visible and ants were active. Densities of fire ant mounds were remarkably consistent between plots except in the plot recently burned, where mound density averaged 89 mounds per acre – 45 percent greater than in plots with forage cover (averaging 49 mounds per acre). Apparently, the lack of cover allowed more mounds to be detected in these subplots. This difference was not interpreted to indicate that the controlled burn in February resulted in increased mound density. Surveying mound densities in the fall (November) after forage has regrown would reduce this sampling error. All of these density values are within the range normally associated with areas inhabited by the single queen or monogynous form of the red imported fire ant.

The evaluation made 12 March 1992, revealed that fire ant mound numbers had remained constant from the previous year in plots 1 and 2 which were burned in February 1991, and plots 3 and 4 which were burned on 24 January 1992. However, mound numbers in plots burned in 1990 and 1991 were found to have roughly half as many mounds as in the previous year. Whether this decline resulted from the burn or from weather conditions can not be determined from these data. Of interest are the relative differences in observed mounds in burned plot mound numbers appears to be consistent between the two years.

Table 1. Number of red imported fire ants per 80 ft. radius circular subplots within managed areas of the Reichardt Prairie, Attwater Prairie Chicken National Wildlife Refuge, Colorado County, Texas, 6 March 1991.

Number of fire ant mounds per 80 ft. radius circular

Plot/management	**Subplot 1**	**Subplot 2**	**Subplot 3**	**Subplot 4**	**Average**
6 March 1991:					
not burned since 1979	19	24	22	23	22(48)*
not burned since 1983/84	24	23	21	21	22(48)
burned in 1990	24	24	30	18	24(52)
burned in February 1991	34	50	40	40	41(89)
12 March 1992:					
not burned since 1979**	23	20	22	19	21(46)*
not burned since 1983/84**	32	23	16	29	25(54)
burned in 1990***	14	9	13	11	12(26)
burned in February 1991***	9	17	14	15	14(30)

* Number of mounds per acre
** Burned 24 Jan. 1992
*** Shredded early August 1991

Evaluation of Five Individual Mound Treatments for the Control of the Red Imported Fire Ant

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and Charles L. Barr, Extension Associate

Many products registered for the suppression of the red imported fire ant, Solenopsis invicta Buren are applied to individual mounds or ant hills. These methods of application are direct and often result in rapid elimination of ant activity. In this trial, five products were evaluated for control of fire ants when applied as mound treatments: sulfuramid, Amdro®, Logic®, Orthene®, and Spectracide®.

Sulfuramid is an experimental bait product and Amdro® contains the ingredient, hydramethylnon. Both chemicals act as metabolic inhibitors, preventing ants consuming these ingredients from converting food into energy. Logic®, containing the active ingredient fenoxycarb, is a carbamate insecticide that acts as an insect growth regulator. Queen ants fed this product become incapable of producing viable eggs. Larvae or brood developing in treated colonies become winged male and sterile winged female forms instead of worker ants. Decline of the colony occurs slowly due to natural mortality of worker ants present at the time of treatment.

The three bait-formulated insecticides evaluated are formulated on defatted corn cob grit coated with soybean oil. Although the active ingredients are viable for some time, the oil often degenerates (becomes rancid) over time when exposed to air. Two lots (1990 and 1991) of Amdro were tested from previously unopened containers to evaluate the shelf life of this bait product.

Orthene® Fire Ant Killer contains acephate formulated as a 75 percent powder. This organophosphate insecticide is a contact poison that rapidly kills ants. Rather than a bait, this product is applied as a dust treatment to the mound. Spectracide® contains the active ingredient diazinon in a granular form which is spread on the mound and watered in.

Materials were applied to individual fire ant mounds in discrete areas where all mounds were treated with the same products. Results from this experimental design are intended to evaluate 1) direct effects to treated mounds, and 2) whether treatments cause colonies to move or produce "satellite" colonies. Theoretically, if a treatment causes colony movement, the number of active fire ant mounds in a treated area will not be reduced relative to the number of mounds treated directly and in comparison with active mound numbers in untreated areas.

Materials and Methods

On 12 June, 1990 on mowed turf areas adjacent to the airport runway of Coulter Field, Bryan, Texas, circular plots were established to encompass 5 active red imported fire ant mounds. Four replications were established for each of seven treatments:

sulfuramid	5 tbsp/mound
Amdro® (hydramethylnon) lot-90	5 tbsp/mound
Amdro® lot-91	5 tbsp/mound
Orthene® Fire Ant Killer (75 % acephate)	2 tbsp/mound
Logic® (fenoxycarb)	3 tbsp/mound
Spectracide® (granular diazinon)	0.5 cup + 1 gal. water/mound
untreated check	

The location of the colonies within each plot was mapped, marked with number Ball® canning jar lids and rated for degree of activity. Activity was determined by observing the defensive movement of the ants following mound disturbance. This was done by slightly probing the mound with a thin metal wire and estimating the number of ants that came to the surface on a rating scale from 0 to 3: 0 = 0 ants; 1 = 1-100 ants; 2 = 101-1000 ants; 3 = >1000 ants. Colonies were rated prior to treatment and 2 days, 1, 2, 4, and 8 week post treatment.

In addition to the field trial, a preference test was conducted with fresh products, Amdro (lot 91), Logic, Black Flag© Fire Ant Ender (containing avermectin) and sulfuramid, in four laboratory red imported fire ant colonies. Each colony received cups containing approximately 2.232 g bait by volume (6 ml bait at roughly 0.372 g/ml), 24 June 1991. Colonies were monitored and exposure of the baits was terminated when one bait cup was emptied (three hours or less). The weight of bait remaining in cups was determined and results were analyzed using ANOVA and the Least Significant Difference test at P#0.05.

Results

All individual mound treatments except for Logic produced statistically similar reductions in ant activity ratings (Table 1). The 2-day post-treatment decline in ant activity in Amdro and sulfuramid treated mounds was surprisingly rapid for bait-formulated materials. Significant reduction in ant activity in Logic-treated mounds relative to untreated mounds did not occur until 8 weeks following treatment. Numerically, mounds treated with Spectracide and drenched with water resulted in the greatest reduction of ant activity.

Evaluation of treatment efficacy using the number of occupied ("active") mounds per plot (not the rating scale)for analysis provides similar results (Table 2). However, this analysis indicates that there is a numerical trend for the 1990 lot of Amdro to reduce mound activity more slowly than did the 1991 lot. Furthermore, the Spectracide treatment produced reductions significantly more quickly than did the 1990 lot of Amdro.

The turf area on which this test was conducted was mowed routinely by city services and was not watered. Drainage was excellent and resulted in a rather dry terrain even after heavy rains. The density of fire ant mounds on this site was rather low for this area, averaging 115 mounds per acre (ranging from 147 to 97) with an average mound diameter of 25.1 cm. Low mound density and dry conditions resulted in little migration of colonies and little detectable reinfestation of treated plots. The average plot size, containing 5 fire ant mounds, was 0.044 acre (24.8 ft radius).

Results of the bait product preference test are as follows:

Product	Active ingredient	ml bait remaining*
Amdro® (lot 91)	hydramethylnon	0.28b
Black Flag® Fire Ant Ender	avermectin	0.80b
Logic®	fenoxycarb	0.90b
sulfuramid	sulfuramid	1.93a

LSD (N=4; P#0.05) =0.634

* means followed by the same letter are not significantly different according to the Least Significant Difference test (P#0.05).

Ants removed significantly less sulfuramid bait from the cups than other product formulations tested. Numerically, ants removed the most Amdro.

Acknowledgment

We are grateful to Mr. Ed Ilschner, Division of Public Works (P.O. Box 1000, Bryan, Texas 77805; phone 409/361-3606) for permission to use this test site.

Table 1. Efficacy of individual mound treatments for the red imported fire ant, Coulter Field, Bryan, Texas, 1991.

Mean level of fire ant mound activity*

	Pre-treat.	**--------- -**	**--------- -**	**Post-treatment**	**--------- -**	**--------- -**
	12 June 0 day	**14 June 2 day**	**19 June 1 week**	**26 June 2 weeks**	**11 July 4 weeks**	**8 Aug. 8 weeks**
Untreated	2.4a	2.2a	2.1a	1.3a	1.2a	1.1a
Logic®	2.3a	2.0a	2.1a	0.9a	1.1a	0.4b
Amdro® 91	2.2a	0.5b	0.2b	0.2b	0.1b	0.2b
Amdro® 90	2.3a	0.6b	0.3b	0.5b	0.1b	0.1b
sulfuramid	2.2a	0.4b	0.0b	0.5b	0.0b	0.3b
Orthene®	2.3a	0.2b	0.2b	0.0b	0.1b	0.0b
Spectracide®	2.3a	0.2b	0.0b	0.0b	0.0b	0.0b
f	*0.3411*	*36.769*	*56.763*	*8.670*	*7.969*	*3.680*
P	*0.9059*	*0.0000*	*0.0000*	*0.0002*	*0.0003*	*0.0146*

* All mounds in circular plots, replicated 4 times and containing 5 fire ant mounds each were rated on a scale of 0 to 3 with 3 being most active upon disturbance. Mean values followed by the same letters are not significantly different according to ANOVA and the Duncan's Multiple Range Test (P#0.05).

Table 2. Efficacy of individual mound treatments for the red imported fire ant, Coulter Field, Bryan, Texas, 1991.

Mean level of fire ant mound activity*

	Pre-treat.	**----------**	**----------**	**Post-treatment**	**----------**	**----------**
	12 June **<u>0 day</u>**	**14 June** **<u>2 day</u>**	**19 June** **<u>1 week</u>**	**26 June** **<u>2 weeks</u>**	**11 July** **<u>4 weeks</u>**	**8 Aug.** **<u>8 weeks</u>**
Untreated	5.0	5.0a	4.8a	3.3a	3.3a	2.5a
Logic®	5.0	5.0a	4.8a	2.5a	2.8a	1.0b
	5.0	2.0bc	0.5bc	0.5b	0.3b	0.5b
	5.0	2.3b	1.3b	0.3b	0.3b	0.3b
	5.0	2.0bc	0.0c	0.3b	0.0b	0.5b
	5.0	1.0bc	0.5bc	0.0b	0.5b	0.0b
	5.0	0.5c	0.0c	0.0b	0.0b	0.0b
f	---	*14.653*	*69.909*	*8.2290*	*9.660*	*4.213*
P	---	*0.0000*	*0.0000*	*0.0002*	*0.0001*	*0.0080*

* All mounds in circular plots, replicated 4 times and containing 5 fire ant mounds each were rated activity upon disturbance. Mean values followed by the same letters are not significantly different according to ANOVA and the Duncan's Multiple Range Test (P#0.05).

Effect of Adding Amdro® (Hydramethylnon) to Fertilizer Formulations on Acceptance by the Red Imported Fire Ant

Charles L. Barr, Extension Associate and
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Amdro® (0.73 % hydramethylnon bait) has been shown to be an effective and popular material for the control of the red imported fire ant (Solenopsis invicta, Buren). American Cyanamid Corporation supplied four fertilizer formulations to which Amdro had been added. These tests were undertaken to determine if the attractiveness of Amdro bait to foraging worker ants was reduced when added to fertilizer formulations.

Previous studies have shown that the soybean oil component of the Amdro product is subject to oxidation which reduces the attractiveness of the bait to fire ant foragers. Rancidity of the oil can occur within a few days of bait exposure to air. The hypothesis tested here is that the fertilizer, being both an oxidizer and hygroscopic, causes a rapid degradation of the soybean oil into an unacceptable state.

Materials and Methods

Four samples of Amdro plus different formulations of granular fertilizer were tested using laboratory colonies of red imported fire ants. Colonies were large, averaging approximately 25,000 workers each, with very active foraging. They were kept at approximately 80 degrees Fahrenheit and 60% relative humidity and provided a feeding regime of frozen crickets, dilute honeywater and distilled water on a daily basis.

Preference Test 1. Fifty granules of Amdro bait were removed from each of the fertilizer formulations and placed in small, plastic scintillation vials. An additional 50 granules were obtained from a freshly purchased, unopened jug of Amdro and placed in similar vials. One vial of each of the five treatments was placed in each of six ant colonies. The mouths of the vials were rested on a test tube containing the ants' water supply. All of the vials was emptied. The vials were then frozen to kill any ants before the remaining of granules in each vial was counted and recorded.

Preference Test 2. To determine if the fertilizer was repellent to ants, ten grams of each formulation was placed in a Petri dish lid. The lids were randomly placed in a Fluon®-coated colony box. These boxes were placed adjacent to four ant-colony boxes with a cardboard bridge inserted between them. A honey-water cup was placed in the boxes containing the fertilizer formulations to stimulate ant foraging. Ants were observed for 24 hours.

Preference Test 3. To determine if ants were repelled by the fertilizer, a small area was cleared in the middle of each Petri dish lid from Test 2. Fifteen to twenty granules of fresh Amdro were placed in the center of the ring of fertilizer. Ant activity was noted for one hour.
Preference Test 4. To determine the time interval in which the fertilizer reduced the attractiveness of Amdro, two teaspoons of fresh Amdro were placed in a glass jar containing one-half cup of the fertilizer formula, RLC-101, and another containing one-half cup of SCU-101. Two teaspoons of Amdro were also placed in an empty jar. All three jars were tightly sealed and shaken vigorously to mix the contents thoroughly. After 24 hours, 50 grains of Amdro from each jar were removed and placed in plastic weighing containers. Additionally, 50 grains from a fresh, sealed, and refrigerated bottle of Amdro were added to a fourth weighing container. One each of the four containers were placed in six laboratory colonies of fire ants. All four containers were removed from a colony when most, or all, of the grains of one treatment were removed by the ants. Containers were frozen to kill any ants before the remaining granules were counted.

Results and Discussion

Preference Test 1. Tables 1 and 2 demonstrate clearly that Amdro bait had become unattractive to red imported fire ant foragers after being pre-mixed with fertilizer formulations. In each colony tested, ants removed all 50 particles of fresh Amdro bait within three hours. It was unclear whether this lack of attractiveness was due to repellency of the fertilizer or loss of attractiveness of the bait.

Preference Test 2. Ants established an active foraging trail across the bridge in each box within 30 minutes and crawled freely across the fertilizer particle in the dishes. A few ants were seen to apparently feed or lick on some of the granules. After three hours, no bait granules had been removed to the colony box, although a dozen or so bait particles and spherical, yellow fertilizer granules had been removed from the Petri dish lids. This test included the fertilizer as well as the bait. The ants showed no reluctance to cross the fertilizer granules themselves, but were still quite unattracted to the bait.

Preference Test 3. Foraging ants found fresh bait particles and were attempting removal within one minute of bait placement. Most of the fresh bait was removed to the colony box within half an hour. Despite the initial lack of attractiveness, it was noted, after two days, that most of the fertilizer-mixed bait granules had been removed from the lids. During this time, the ants had not been fed the standard dietary regime.

This test was performed to determine if the ants would accept fresh Amdro and if they would cross fertilizer granules to retrieve it. The extremely rapid location and removal of the bait suggested that the ants were both strongly attracted to fresh Amdro and not repelled by the fertilizer. It was concluded that the fertilizer had a definite effect on reducing the attractiveness of Amdro while demonstrating no repellent properties itself. Though the fresh Amdro was overwhelmingly preferred, the bait that had been in the fertilizer formulation was removed eventually, indicating that it was still somewhat attractive to the ants, at least under food stress condition.

Preference Test 4. This test was conducted to determine how fast the fertilizer caused a loss of attractiveness of Amdro bait to foraging fire ants. Tables 3 and 4 indicate that even over a relatively short period (24 hours), the attractiveness of Amdro was significantly reduced, though not eliminated. A surprising result of this last experiment was the significantly higher degree of attractiveness of the bait that had been shaken in a container and aged 24 hours. This treatment obviously removed some of the soybean oil from the bait particles onto the walls of the container and exposed the bait to air, both of which normally reduce a bait's attractiveness.

Although a theoretically convenient method of controlling fire ants, mixing Amdro with fertilizer appears to significantly reduce the bait's attractiveness to foraging fire ants in a very short time. Further studies will need to be undertaken to confirm this finding under field conditions. Furthermore, tests should be conducted to determine if the fertilizer also reduces toxic effects of Amdro and, thereby, reduces ant mortality, under both laboratory and field conditions.

Table 1. Number of Amdro® granules from four pre-mixed fertilizer formulations and fresh product remaining following exposure to laboratory colonies of red imported fire ants (Preference Test 1).

Number of granules remaining out of 50

		-------------	-------------	**Treatment**	-------------	-------------
Colony	**Exposure Time**	**RLC-101**	**RLC-102**	**SCU-101**	**SCU-102**	**Amdro**
1	2:55	50	50	50	42	0
2	1:55	47	43	50	50	0
3	1:55	45	46	43	50	0
4	3:00	47	35	48	50	0
5	1:25	49	48	50	50	0

Table 2. Analytical results from Preference Test 1. Average number of grains of bait remaining out of 50.

Treatment	**Average number of grains remaining***
SCU-102	48.4 a...
SCU-101	48.2 ab..
RLC-101	47.6 abc.
RLC-102	44.4 abc.
Fresh Amdro®	0.0 ...d

* Means followed by the same letter are not significantly different according to Analysis of Variance (ANOVA) at P # 0.05 and the Least Significant Difference (LSD) Test. The LSD value was 4.794.

Table 3. Number of Amdro® bait particles prepared and "aged" with fertilizer formulations remaining after 24 hours exposure to laboratory colonies of red imported fire ants (Preference Test 4).

Grains remaining of 50

Colony	Exposure Time	Aged	Fresh	RLC-101	SCU-101
1	2:15	1	0	12	9
2	1:15	0	6	30	19
3	0:53	3	4	20	28
4	2:45	0	14	45	42
5	2:12	0	8	13	22
6	3:20	0	37	35	37

Table 4. Analytical results of Preference Test 4. Average number of grains remaining out of 50.

Treatment	Number of grains
SCU-101	26.1667 a..
RLC-101	25.8333 a..
Fresh Amdro® (hydramethylnon)	11.5000 .b.
Aged Amdro (24 hrs)	0.6667 ..c

* Means followed by the same letter are not significantly different according to Analysis of Variance (ANOVA) at P # 0.05 and the Least Significant Difference (LSD) Test. The LSD value was 10.228.

Red Imported Fire Ant Treatment Program Evaluation

Charles L. Barr, Extension Associate and
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Suppression of the red imported fire ant, Solenopsis invicta Buren, in ornamental turf can be accomplished using a periodic application of a single product or by using a sequence of different insecticide products over time to achieve a given management objective. This trial was conducted to compare the results of a broadcast application of two bait-formulated products, Logic® (fenoxycarb) and Amdro® (hydramethylnon). In addition, results from a surface spray of Triumph® 4E, a contact insecticide, applied at the suggested rate of 1.0 pound active ingredient (AI) per acre and a sequential application program of Logic® followed 4 to 7 days later by a surface application of Triumph applied at a half rate were also evaluated. Because the application of Logic®, which performs as an insect growth regulator, results in a slow decline (5 weeks to 9 months) of fire ant colonies in a treated area, the addition of a low rate application of Triumph® to eliminate foraging worker ants was applied to increase the rate of colony decline.

Materials and Methods

This trial was conducted on the Wittig Grass Farm, Wharton County, Texas, located just off of FM 1301 approximately 9 miles southeast of Wharton. The site consisted of approximately 12 acres measuring 450 by 1150 feet. Although it had been used for turf production for some years, it had been abandoned for at least the last four prior to establishment of this trial. The turfgrass consisted primarily of St. Augustine with scattered areas of Dallis Grass and Bermuda Grass. No insecticide treatments had been applied to the area within several years. This site was fertilized in the spring of 1991. A rolling irrigation system was set up and operated during the second week of the test, and the area was mowed approximately weekly.

The test plots were established in adjoining columns, three plots wide and six plots long. Plots were 150 feet square, approximately 0.5 acre. Treatments were applied to the entire plot and mound numbers were determined by counting all active fire ant mounds within a 0.25 circle at the center of each plot. A string, approximately 58 feet long and anchored at the center, was used to circumscribe the circle. An active mound was defined when numerous ants rose to the surface within 5-30 seconds of light disturbance with a pointed tool handle.

The following treatments and application rates, replicated three times, were included in the test:

1) Untreated check
2) Logic® (fenoxycarb), 1.5 lbs. per acre
3) Amdro® (hydramethylnon), 1.5 lbs. per acre
4) Triumph® 4E (isozophos), 0.5 lbs. AI per acre
5) Triumph 4E, 1.0 lbs. AI per acre
6) Logic, 1.5 lbs. per acre + Triumph 4E, 0.5 lbs. per acre 4-7 days after Logic

Plots were established and treated on 13 August 1991. The bait treatments, Amdro and Logic, were applied by hand using a Cyclone Model 1C1 hand seeder between 6:00 and 8:30 p.m. when the weather was dry, slightly breezy and with a temperature of 80-85 degrees Fahrenheit. No rain occurred within 24 hours of application. Plots were monitored again on 20 August 1991 (one-week evaluation for Triumph). At that time, Triumph plots were treated between 5:00 and 7:00 p.m. soon after the plots had been mowed. The chemical was applied in 20 gallons of water per acre using a tractor mounted spray boom with a 38-foot spray swath. The area received approximately .15 inches of rain 48 hours later.

Plots were monitored again on 27 August, 3 and 24 September and 13 November 1991. Due to little rainfall, the plots were irrigated regularly. Thereafter, rainfall was sufficient until early, unseasonably cool weather rendered the grass dormant. By the three month evaluation, the grass was largely brown with only the low, sheltered leaves remaining green. One interesting note was that the grass surrounding active fire ant mounds, and, curiously, the marker plates, was considerably greener in almost every plot.

Data were analyzed using analysis of variance (ANOVA) and means were separated using the Duncan's Multiple Range Test (DMRT) at P # 0.05. Due to the high variability of mound numbers between plots, percent reduction values were calculated for each plot using Henderson's Formula (Henderson & Tilton 1955):

$$\text{Percent reduction} = 100 \times \left[1 - \frac{T_A \times C_B}{T_B \times C_A}\right]$$

where C_B and T_B are the number of mounds before treatment in the control and treatment plots, respectively. Pre-count data obtained 13 August were used for bait-treated plots while 20 August pre-count data were used to calculate percent reduction for plots treated with Triumph. These values were then transformed to arcsine before analysis using ANOVA and DMRT.

Results and Discussion

Numbers of fire ant active mounds varied greatly between treatment plots in this site despite its uniform appearance. Apparently, soil type across the test site may have had some influence on mound densities. Untreated plots contained significantly higher numbers of mounds throughout the trial. Few statistical differences were documented between treatment regimes (Table 2). However, maximum levels of suppression were achieved at different post-treatment intervals.

Maximum suppression in Triumph-treated plots occurred 2 weeks following application. Thereafter ant activity increased or resumed. The broadcast application of Amdro provided suprisingly quick results, producing a maximum level of suppression two weeks following treatment. Thereafter, active mound numbers increased. Logic applications provided fire ant suppression more slowly, with maximum suppression occurring three to seven months following application. March 1992 values are suspect since sod in several of the treatment plots had been harvested, causing this trial to be terminated.

Percent reduction values more clearly illustrate the relatively rapid effect of Amdro versus the slower decline of fire ant active mound numbers in Logic-treated areas. The additional application of 0.5 lb. AI Triumph following the Logic treatment significantly improved the rate of suppression two weeks following treatment as compared with a single Logic application. The 0.5 lb. AI treatment resulted in numerically less suppression of activity than did the 1.0 lb. AI treatment and ant activity resumed in these plots by the three month post-treatment evaluation date. Irrigation soon after Triumph treatment would have surely increased the rate of reduction for the 1 week post-treatment evaluation.

Literature cited

Henderson, C. F. and E. W. Tilton. 1955. Test with acaricides against the brown wheat mite. J. Econ. Entomol. 48:157-161.

Table 1. Mean number of active red imported fire ant mounds per 0.25-acre circular subplots, replicated three times each, before and following treatment regimes, Wittig Turf Farm, Wharton County, Texas, 1991-1992.

	---Mean no. mounds-0.25 acre*------------------------------------						
Treatment	**13 Aug.** **pre-treat** ******	**20 Aug.** **1 week** **pre-treat**	**27 Aug.** **2 weeks** **1 week**	**3 Sept.** **3 weeks** **2 weeks**	**24 Sept.** **6 weeks** **5 weeks**	**13 Nov.** **3 months**	**16 Mar.** **7 months**
Amdro®	18.3 c	2.7 d	1.7 b	4.3 b	5.3 b	9.7 b	9.3 b
Logic	20.3 c	19.0 cd	8.3 b	12.7 b	5.7 b	3.7 c	6.7 b
untreated	68.3	88.7 a	56.3 a	87.7 a	54.3 a	56.3 a	44.0 a
Logic® +							
0.5 Triumph®	45.0 b	65.3 ab	21.3 b	5.3 b	6.0 b	4.6 c	3.0 b
1.0 Triumph	33.0 bc	45.6 bc	12.0 b	3.7 b	11.3 B	19.3 bc	12.0 b
0.5 Triumph	21.0 c	31.7 bcd	7.7 b	6.0 b	12.7 b	20.7 b	20.3 b
f	*9.837*	*7.904*	*8.463*	*31.651*	*11.199*	*18.606*	*5.840*

* Means followed by the same letter are not significantly different according to ANOVA and the Duncan's Multiple Range Test (P #0.05).
** Amdro and Logic were applied 13 Aug. while Triumph treatments were made 20 Aug.

Table 2. Percent reduction of fire ant active mound numbers calculated using Henderson's Formula (Henderson & Tilton 1955), Wittig Turf Farm, Wharton County, Texas, 1991-1992.

	-------------------------------------Percent reduction*--						
Treatment	**13 Aug. pre-treat ****	**20 Aug. 1 week pre-treat**	**27 Aug. 2 weeks 1 week**	**3 Sept. 3 weeks 2 weeks**	**24 Sept. 6 weeks 5 weeks**	**13 Nov. 3 months**	**16 Mar. 7 months**
Amdro®	--	65.1 a	83.5 a	83.5 abc	65.1	47.8 abc	43.1
Logic	--	17.2 a	37.6 b	48.1 d	51.5	68.9 ab	62.6
Logic® +							
0.5 Triumph®	--	--	48.3 b	91.6 ab	76.5	83.6 a	89.6
1.0 Triumph	--	--	59.3 b	91.7 a	60.5	36.2 abc	54.3
0.5 Triumph	--	--	48.3 b	69.5 abc	54.2	5.6 c	33.3
f	--	*3.720*	*3.540*	*2.336*	*NS*	*3.0930*	*NS*

* Means followed by the same letter are not significantly different according to ANOVA and the Duncan's Multiple Range Test (P #0.05) on arcsine-transformed data.
** Amdro and Logic were applied 13 Aug. while Triumph treatments were made 20 Aug.

Evaluation of Acceptance and Toxicity of Cacodylic Acid Formulations to Laboratory Colonies of the Red Imported Fire Ant (Formicidae: Hymenoptera)

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and
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Cacodylic acid, or hydroxydimethylarsine oxide, is one of the organic arsenical herbicides. It is a white, crystalline solid, soluble in water. Like other arsenical herbicides it has a much lower toxicity than elemental arsenic. Its acute oral LD50 is 830 mg/kg. Cacodylic acid, $(CH_3)2AsOOH$ and its sodium salt are used as general contact sprays. They dessicate and defoliate a wide variety of plant species. Cacodylic acid is not translocated in plants. It is rapidly inactivated in soils, but continuous use over long periods of time may cause phytotoxic levels of elemental arsenic to accumulate. Cacodylic acid may act by interfering with phosphorous metabolism, complexing with sulfhydril-containing enzymes, uncoupling oxidative phosphorylation, or both (D. E. Stephenson, 1992, Pecos Valley Pest Management News, TAEX, 5(4):8-10).

Cacodylic acid (99.9% technical material), two bait formulations, 3 % and 11 %, as well as a non-toxic bait check material were tested as attractants for the red imported fire ant, Solenopsis invicta Buren. Since little or no information was available regarding cacodylic acid and fire ants, a series of test were performed to determine the most suitable formulation for ant acceptability, followed by a toxicity test based on the preference test results.

I. Formulation and evaluation of technical cacodylic acid:

Materials and Methods

Test #1 - Since fire ants are largely grease and oil feeders, an initial trial was performed to determine the acceptance of cacodylic acid in soybean oil, the most common toxicant carrier in fire ant bait-formulated insecticides. A sample of technical material was weighed and dissolved in soybean oil in serial dilutions. Oil solutions were drawn into 0.5 mm capillary tubes and mounted on a glass slide placed on a Petri dish lid. This arrangement allowed free and uniform and access while eliminating dripping or other loss of material. The length of the oil column was recorded for each sample. One tube of each sample was placed in each of six active ant colonies. When the oil in one tube of each set was fully consumed, all of the tubes were removed from that colony, frozen to kill remaining ants, then the columns were measured to determine the amount of oil consumed.

Test #2 - Due to the questionable solubility of technical cacodylic acid in soybean oil, the preference procedure was repeated using an aqueous solution of commercial honey dissolved in distilled water at a rate of 1 part honey to 4 parts distilled water. The technical cacodylic acid dissolved readily. A stock solution of 0.1 gram cacodylic acid in 10 ml honey water was made followed by serial dilutions, resulting in 10,000 ppm, 1.0 ppm and 0.1 ppb concentrations of cacodylic acid. These solutions were evaluated in the manner described for Test #1.

Test #3 - In an effort to detect an upper concentration limit and try to differentiate between soybean and honey-water solution attractiveness, 1.0 g of the technical material was dissolved in 1.0 ml of each carrier solution and placed in glass scintillation vials. Vials of both carriers alone and technical material alone were included as checks. The vials were then placed in active fire ant colonies and removed when one of the vials in each colony had been emptied.

Test #4 - Based on the information from the previous tests, an additional preference test was conducted using higher concentrations than in Test #2. The method was the same as in the first two tests.

Results and discussion

Test #1. All soybean oil formulations were attractive to the ants and differences between cacodylic acid concentrations were not significant (Table 1). The main problem encountered was the lack of solubility of technical cacodylic acid in soybean oil. During mixing, the solution had to be heated in boiling water to dissolve the material. Cacodylic acid may not have dissolved into the oil solution. Thus, the intended concentration of the dilutions were questionable.

Test #2. As shown in Table 2, all concentrations of cacodylic acid formulated in honey-water tested proved to be attractive to foraging worker ants, with no apparent upper limit of technical material reducing attractiveness.

Test #3. During this test, observations were made as to numbers of ants in each vial. Again, the honey-water check was the most attractive, followed closely by the oil check (Table3). The technical material in oil had 10-20 ants per vial while the technical + honey-water had 5-10 ants. The technical material alone even had two or three ants per vial, indicating that it had no repellent properties.

Test #4. All of the cacodylic acid concentrations were relatively attractive (Table 3). Differences were observed, however, between acceptability of 100,000 ppm and 500,000 ppm cacodylic acid solutions. Therefore, a concentration of 100,000 ppm cacodylic acid in honey-water (1 g toxin/10 ml honey-water) was determined to be the most effective concentration for use in evaluating the affect of cacodylic acid on fire and laboratory colonies.

Table 1. Evaluation of acceptability of cacodylic acid formulated in soybean oil to red imported fire ants (Test #1).

Amount consumed - mm before/mm after

Colony

Sample	1	2	3	4	5	6	Mean
Oil Check	34/3	33/9	33/0	33/8	33/3	36/9	33.7/5.3
Saturated	31/11	34/12	33/5	35/11	34/5	35/6	33.7/8.3
1.0 ppm	30/5	34/12	32/3	30/0	30/0	36/0	32.0/3.3
0.1 ppb	32/0	30/0	33/3	35/11	33/4	34/0	32.8/3.0
	Av. Before	Av. After	Av. % consumed				
Oil Check	33.7	5.3	84.3%				
Saturated	33.7	8.3	75.4%				
1.0 ppm	32.0	3.3	89.7%				
0.1 ppb	32.8	3.0	90.9%				

Table 2. Acceptability of cacodylic acid solutions in honey-water to red imported fire ants (Test #2).

Amount consumed - mm before/mm after

Colony

Sample	1	2	3	4	5	6
Honey-water	33/1	31/0	36/4	35/0	35/0	35/0
10,000 ppm	36/11	35/0	36/4	37/9	35/3	37/1
1.0 ppm	37/1	37/1	34/3	36/8	37/0	33/0
0.1 ppb	34/0	35/1	35/4	37/5	34/0	38/0
	Av. Before	Av. After	Av. % consumed			
Honey-water	34.2	0.8	98%			
10,000 ppm	36.0	3.0	92%			
1.0 ppm	35.7	2.2	94%			
0.1 ppb	35.5	1.7	95%			

Table 3. Evaluation of the attractiveness of cacodylic acid formulations to red imported fire ants (Test#3).

Weight of material removed (grams)

Colony

Sample	1	2	3	4	5	6
Dry technical	0.01	0.01	---	0.05	---	0.03
Tech. + Oil	---	0.06	0.02	---	0.04	0.07
Tech. + Honey-water	0.03	0.09	0.04	0.01	0.09	0.08
Oil Check	---	0.03	0.05	---	0.05	0.01
Honey-water Check	1.01*	0.17	1.02*	1.06*	0.75	0.64
Sample	Average weight removed(g)					
Dry Technical	0.017					
1.0 g Tech. + 1.0 ml Oil	0.031					
1.0 g Tech. + 1.0 ml Honey-Water (1:4)	0.057					
Oil Check	0.024 (large numbers of dead ants)					
Honey-Water (1:4) Check	0.775					

--- = greater ending weight than initial due to ants dying in the vials
* = all material removed from vial

Table 4. Evaluation of acceptability of cacodylic acid concentrations to red imported fire ants (Test #4).

Amount consumed - mm before/mm after

	Colony					
Sample	1	2	3	4	5	6
1,000,000 ppm	37/6	40/19	35/28	35/28	37/28	38/8
500,000 ppm	35/21	36/22	36/13	36/1	37/23	36/17
100,000 ppm	37/13	39/15	40/8	33/5	37/7	37/8
50,000 ppm	35/15	35/12	34/3	39/3	36/6	35/9
10,000 ppm	35/3	35/5	37/2	36/4	35/3	35/6
Honey-water Ck	36/2	38/3	38/3	38/2	39/5	38/4
Sample	Average amount consumed (mm)					
1,000,000 ppm	17.5					
500,000 ppm	19.5					
100,000 ppm	27.8					
50,000 ppm	26.7					
10,000 ppm	31.7					
Honey-water Ck	34.7					

II. Colony Mortality Test

Materials and Methods

Twelve fresh fire ant colonies were dug from the field, extracted from the soil, and placed in Fluon®-coated plastic boxes. Based on the results of Preference Test #4, a solution of 10% (100,000 ppm weight/volume) cacodylic acid in honey-water (1 part honey:4 parts distilled water) was made and offered to the ants in 20 ml test tubes plugged with cotton. One tube of the solution was placed in each of six colonies, providing them with a continuous supply of the toxin.

Six identical tubes, containing only honey-water, were placed in the remaining six colonies. A standard diet of frozen crickets was maintained as were the normal water tubes in all colonies. The normal daily additions of honey-water were discontinued due to the presence of the honey-water in test tubes. The colonies were observed periodically and rated as to approximate number of worker ants, relative amount of brood, and presence of queen ants.

Results and Discussion

Red imported fire ant colonies given unlimited access to the 100,000 ppm cacodylic acid 1:4 honey-water solution declined steadily during the 62 day trial period (Table 5). Total estimated number of ant averages declined steadily until only a few workers were left in two of the original six treated colonies. Queen ant decline was first noticed after 20 days of treatment initiation. Brood and queens were present in all untreated colonies throughout this trial.

Shortly following initiation of this trial (27 September), all cacodylic acid-treated colonies were observed to have ants evenly scattered across the floor of the colony box while ants in untreated colonies were concentrated in Petri dishes together with brood and queens as is normal for laboratory colonies. It appeared as if worker ants consuming cacodylic acid were avoiding returning to the colony.

Removal of untreated honey-water occurred at a higher rate than cacodylic acid-treated honey-water. By 30 September an average of 1.5 ml. cacodylic acid honey-water had been consumed. By 25 November, an average of 11.2 ml. had disappeared. Ants were seen to visit the cacodylic acid-containing tubes for only the first three days of the test. The remaining decrease in volume is believed to be due to evaporation.

By 30 September, small piles of dead ants were beginning to form in untreated colonies as is usual. In cacodylic acid-treated colonies, however, dead ants were observed to be scattered on the colony floors. Treated colonies were found to have an unusual acrid odor as well. Very small amounts of cacodylic acid-treated honey-water had been consumed (1-2 ml) while treated colonies also drank large amounts of water. Brood in treated colonies began to appear yellowish-brown and were noticeably fewer in numbers beginning 11 October, and had virtually disappeared by 22 October.

Summary

Cacodylic acid appeared no to be repellent to fire ants and was readily accepted when combined with the proper attractant. Soybean oil formulations proved to be attractive to the ants, but the toxin's solubility in oil was questionable. Honey-water formulations proved to be quite attractive to the ants, even at extremely high cacodylic acid concentrations. The baits, as formulated, were not attractive to the ants. [Other products formulated on this type of bait (Orthene® and Sevin®) have also been unattractive in past experiments.

The colony mortality experiment demonstrated that a very small amount of cacodylic acid caused extensive and continuing worker mortality beginning within a few days of ingestion, the cessation of brood production within three weeks, and complete colony death (including queens) within eight weeks. The treated colonies were, for practical purposes, non-functional after one month.

Cacodylic acid consumption quickly altered worker ant behavior. Affected ants were evenly scattered on the colony tray floor, displayed noticeable loss of appetite and increased water consumption. Later observations showed that the few remaining ants moved to the water tubes which provided a higher humidity environment and continuous access to water. These behaviors are indicative of ants under water stress.

Our experience has shown that it is unusual for most toxicants to cause the death of every ant in a laboratory colony. Though the cacodylic acid was somewhat slow in causing the complete death of the colony, it showed rather rapid and persistent worker kill with only a small dose. From these results, cacodylic acid appears to have potential as a fire ant insecticide, though its method of delivery needs additional investigation.

Table 5. Estimated number of ants, presence of queen and condition of brood in laboratory colonies of red imported fire ants treated with 100,000 ppm cacodylic acid + honey-water (1:4 honey:water), 1991.

		No. 1000 ants (± S.D.)/colony*		Percent untreated colonies with	
Date	Day	Treated	Untreated	brood	queens
Sept. 25	1	17.5 ± 5.2	32.5 ± 16.1	100	100
Sept. 30	6	11.3 ± 2.9	32.5 ± 16.1	100	100
Oct. 4	10	7.2 ± 3.1	32.5 ± 16.1	100	100
Oct. 7	13	3.7 ± 2.0	32.5 ± 16.1	100	100
Oct. 11	17	2.7 ± 0.5	32.5 ± 16.1	100	100
Oct. 14	20	2.3 ± 0.5	32.5 ± 16.1	83	100
Oct. 22	28	1.3 ± 0.5	33.3 ± 16.3	17	100
Oct. 28	34	0.7 ± 0.3	33.3 ± 16.3	0	100
Nov. 4	41	0.3 ± 0.2	32.5 ± 15.1	0	100
Nov. 13	50	0.1 ± 0.1	29.2 ± 12.4	0	83
Nov. 25	62	0.0 ± 0.0	29.2 ± 12.4	0	33

* All means (treated versus untreated) are significantly different (P # 0.05) according to the Student's *t* test (d.f. = 10; *t* = 2.1764, 3.1780, 3.7986, 4.3686, 4.5516, 4.6025, 4.7976, 4.8994, 5.2343, 5.7397, 5.7500).

Preliminary evaluation of D-20 Fire Ant Control: a Pyrethrins plus Diatomaceous Earth Mound Drench Product

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and
Charles L. Barr,
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The product, D-20 Fire Ant Control, contains 0.02 percent pyrethrins plus 98.7 percent inert ingredients composed of diatomaceous earth. Pyrethrins are synergized by 1.1 percent technical piperonyl butoxide. This product is widely registered for indoor uses for the suppression of ants, bedbugs, fleas, houseflies and other household pests. It was recently labeled for treatment of the red imported fire ant, Solenopsis invicta, Buren, as either an individual mound drench or as a powder or dust application.

The individual mound drench or "water method" uses 4 tablespoons of D-20 to one gallon of water. Directions for use are as follows: "For best results, saturate the perimeter of the mound first working toward the center of the mound in a circular motion. After mound is saturated, inject mixture into mound cavity in different places. (You may want the mixture to "puddle"). An ant mound 12-14 inches in diameter requires approximately one gallon of the mixture. You will begin to see results immediately. In approximately 20 minutes, you can expect a kill ratio of 85-95%."

We conducted a brief result demonstration to evaluate D-20 Fire Ant Control applied as an individual mound drench. No injection equipment was used. Since pyrethrins and diatomaceous earth are both effective only when in direct contact with insects, the mound drench method was selected to provide the highest probability of achieving suppression of ant activity in treated mounds.

Materials and Methods

This trial was initiated 11 September 1991 on the earthen dam of Lake Somerville, Burleson County, Texas. Test plots were located on the far southeast end of the dam, near the floodgate, in regularly mowed grassland. The area is controlled by the U.S. Army Corps of Engineers and access is strictly limited to maintenance and Corps personnel.

A pre-treatment survey of the three (0.083-acre) quadrants of a 58-foot radius (0.25 acre) circle was made during which fire ant active mounds were marked with surveyor's flags for easy location during application and evaluation. Evaluations were made by light disturbance of the mound site with a pointed stick. A mound was considered fire ant active if ants moved rapidly to the surface upon disturbance.

D-20 Fire Ant Killer was applied as a drench to every fire ant active mound located in the pre-treatment survey at a rate of 4 tablespoons of D-20 Fire Ant Control in one gallon of water per undisturbed mound. A garden sprinkler bucket was used to apply the solution to the mounds. Most of the volume was poured on top of the mound while about one third was sprinkled in a three foot diameter are around the mound site.

Following treatment, only the flagged (treated) mounds were evaluated (18 September and 7 October) until the last evaluation date (25 November), when the quadrants were surveyed for marked and "new" fire ant active mounds within the plots. New mounds located on this date represent either "satellite" colonies formed when originally treated colony survivors moved to a new site(s) or immigrant colonies moved into the plot from surrounding areas.

An additional set of three quadrants of a 0.25-acre circle were left untreated and served as a control plot. Fire ant active mounds were monitored 22 August, 21 October and 25 November. Resulting active mound numbers between D-20 and untreated quadrants (subplots) were analyzed using the Student's *t* test (P # 0.05).

Results and Discussion

We found D-20 Fire Ant Control easy to mix and apply. The formulation dissolved readily and had a non-offensive odor. The D-20 mound drench treatment eliminated ant activity in 72 percent of the mounds treated within on week. Compared to untreated plots, fir ant active mound numbers were significantly reduced by 75% within one month. Two and a half months following application, 91 percent of the treated mounds contained no live ants. However, numerous "new" fire ant active mounds were detected in areas where D-20 treatments had been applied. Thus, only 43 percent fewer active mounds were found in these plots relative to untreated plots. Since these plots were very small, reinfestation could conceivably have resulted from the immigration of untreated colonies. Further testing would be needed to determine if these new ant active mounds resulted from the formation of satellite colonies from the originally treated mounds.

Table 1. Average number (mean ± standard deviation or S. D.) Of fire ant active mounds per three 0.083-acre quadrants within 0.25-acre circular treatment and control plots. Mounds within quadrants were treated with D-20 Fire Ant Control (0.02 % pyrethrins + 1.1% piperonyl butoxide + 98.7 % diatomaceous earth) or left untreated in the control plot quadrants (Burleson County, Texas, 1991).

Mean number of fire ant active mounds per quadrant

----------------------Treatment----------------------

Date	**D-20 Fire Ant Control**	**untreated**
Pre-treatment:		
11 September	10.67 ± 0.58 S.D.	10.00 ± 2.65 S.D.
Post-treatment:		
18 September	3.00 ± 0.00	---
(1 week)		
10-21 October	2.67 ± 1.15*	10.67 ± 3.21*
(1 month)		
25 November		
(2.5 months)		
Treated mounds:	1.00 ± 0.00**	11.00 ± 3.61**
All mounds:	6.33 ± 0.58***	11.00 ± 3.61***

* Means are significantly different according to the Student's *t* test (d.f. = 4, $t = -4.06$; $P < 0.01$).

** Means are significantly different according to the Student's *t* test (d.f. = 4, $t = -4.80$; $P < 0.01$).

*** Means are significantly different according to the Student's *t* test (d.f. = 4, $t = -2.21$; $P < 0.05$).

Evaluation of Bushwhacker™ Fire Ant Killer,
a boric acid based bait product

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Texas A&M University System

Bushwhacker™ Fire Ant Killer, a product of Bethurum Research and Development, Inc. (P.O. Box 3456, Galveston, Texas 77552), is a formulation containing 18% boric acid as the active ingredient. The product is formulated as a bait composed of 45 ingredients, including cheese, milk, sugar and powdered dry shrimp (The Galveston News, July 26, 1989). Bushwacker was registered by the Environmental Protection Agency (EPA Reg. No. 59977-1) and the Texas Department of Agriculture (EPA EST. No. 59977-TX-1) in 1991.

Laboratory trials. There has been little research conducted to confirm the effectiveness of the product. S.D. Porter (unpusblished) conducted laboratory evaluation with the product at the Department of Zoology at the University of Texas. Boric acid baits were found to kill large numbers of fir ant workers and larvae. However, queens and pupae were not eliminated, and most treated colonies resumed brood production after 3 to 5 weeks. Porter concluded that "boric acid is not a suitable toxicant for large-scale or long-term control programs."

Background Field trials. Data supporting the performance of Bushwhacker treatments under field conditions was obtained by the Texas Department of Agriculture under the direction of Roger Mulder, Fire Ant Activity Manager of Pest Management Programs, by Agricultural Inspector Mel L. Clark (unpublished data provided by Bethurum Research and Development, Inc.) In an "unofficial" trial, several acres of fire ant infested land owned by Mr. Kenneth fielder in Dayton, Texas, were treated using three pounds Bushwhacker per acre during the week of June 16, 1988. Prior to treatment, 36 fire ant mounds were documented along six transects (16 without worker brood). By September 19, 1988, only 9 mounds (6 without worker brood) were documented along the same transects. No untreated control plots were reported to have been established or monitored during this trial.

A similar, "official," test was conducted on the Murff Turf Farms, Inc. in Harris County on April 26, July 20, and September 21 1989. In this trial, 10 acres were treated with 2 pounds Bushwhacker per acre. M. L. Clark (unpublished report and Bushwhacker Associates, Inc. videotape) reported the number of fire ant mounds along 48 transects for each date. The total of active fire ant mounds decreased from 498 to 45 and then to 13 through the ant mound monitoring dates. Again, no untreated control plot was reported to have been established or monitored.

To our knowledge (pers. Comm. Verne McFarlin, Efficacy Reviewer, EPA; 703/305-5407) and from personal communication with George Bethurum, these data were the only efficacy trials submitted to the Environmental Protection Agency to document product performance prior to obtaining registration.

The three trials reported here were conducted in an attempt to evaluate the effectiveness of Bushwhacker for suppressing fire ants using comparisons between Bushwhacker-treated and untreated plots or areas. The first test simulated large-scale applications using a broadcast treatment of 1 pound Amdro® (hydramethylnon) per acre as a treatment standard; the second simulated a small-scale, homeowner-type situation; and the third was an individual mound treatment.

Materials and Methods

All treatments made in these trials used material from Bushwhacker BATCH 1 07 5 1 91 (EPA Reg. No. 59977-1; EST. No. 59977-TX-1) in 1991.

Large-Plot Field Test. This trial was conducted on the J.B. Evans Turf Farm in Algoa, Texas. A standard treatment, Amdro, was compared to the labeled rate of Bushwhacker. On 31 July 1991, three, one acre, square plots were marked on an area of dense, managed turf. The untreated plot was centrally located and the insecticide treated plots were located more than 200 feet apart. Counts of mounds with fire ant activity were made using a 108 foot long string to circumscribe a circle within each of the test blocks. The total number of mounds with activity was recorded for each quadrant within each circle, approximating an area of 0.21 acre per quadrant subplot. Mound activity was determined by light disturbance with a wooden tool handle. Counts were taken during the morning hours while ants were active. Mound density was uniform, with roughly 100 mounds per acre across the site, indicating a moderate infestation of possibly polygyne (multiple-queen) fire ants. Subsequent evaluations (September 3, 1991, October 29, 1991 and March 16, 1992) were made in an identical manner.

Bushwhacker was applied at the labeled rate of 3 pounds per acre using two, hand-held, Cyclone® 1C1 broadcast seeders. One applicator took half the material and began crossing the plot in swaths approximately 8 feet wide. The other applicator began at the opposite corner and cris-crossed the plot in a direction perpendicular to the first. This method assured a very thorough and even application of the bait. An adjacent one-acre plot was treated with Amdro at a rate of 1 to 1.5 pounds per acre. The third plot was left untreated to serve as a control. Subplot data were analyzed for each ant mound monitoring date using Analysis of Variance (ANOVA). Mean (average) values were separated using the Least Significant Difference (LSD) separation of means at a probability level of 0.05.

<u>Small-Plot Field Test</u>. This trial was initiated on July 18, 1991 in a greenbelt park managed by the city of College Station, in the Raintree subdivision. The area is a power line right-of-way approximately 200 feet wide and is lined on both sides by homes. Four 0.25-acre circular plots were marked with a 15 foot buffer between plots. The plots were divided in half and the rectangle defined by the extremities of one of the semi-circles in each plot was treated with the material. The treatment area therefore, approximated yard-sized rectangles, 58 by 116 feet (0.154 acre or 6,728 sq. ft.). The other half of each plot was left untreated as a control. Bushwhacker was applied using a Cyclone 1C1, hand-held, broadcast seeder at the label rate of 3 pounds per acre. On July 23 a second, indentical application was made as directed on the label. All mound evaluations, (August 16, 1991, September 11, 1991, October 17, 1991, and March 18, 1992), were made by counting the active mounds in each quadrant of the 0.25-acre circle using the minimal disturbance technique. Resulting active mound counts were analyzed using the Students *t* test at P # 0.05.

<u>Individual Mound Treatment Field Test</u>. This trial was initiated on September 11, 1991 on the earthen dam impounding Lake Somerville in Burleson County. The area is well drained, mowed, native grassland with a moderate fire ant infestation. A 0.25 acre circular plot was marked and divided into quadrants. All mounds in each 2,642 sq. ft. (0.0606-acre) wedge-shaped quadrant were first counted, then treated with one heaping teaspoon of Bushwhacker per mound. A similar plot located more than 150 feet away from the treated plot was left untreated and used as a control. All mound evaluations (October 21, 1991, November 25, 1991, and March 17, 1992) were made using the minimal disturbance technique. Data were analyzed using the Students *t* test at P # 0.05.

Results

<u>Large-Plot Field Test</u>. Following treatment, no significant differences in the number of active red imported fire ant mounds were documented between the Bushwhacker and untreated plots (Table 1). The broadcast Amdro treatment significantly reduced active mound numbers 88, 68 and 83 percent at 5 weeks, 3 months and 7 months respectively following application relative to the untreated plot.

<u>Small-Plot Field Test and Individual Mound Treatment Tests</u>. No significant differences were documented between Bushwhacker and untreated areas throughout the monitoring period (Table 2 and 3).

Discussion

Bushwhacker Fire Ant Killer was difficult to apply as directed. Initially, a homeowner-type, wheeled broadcast fertilizer spreader with a rotating wire agitator was tested. The product was packed down by the wire and all flow was quickly blocked. A homeowner-type, wheeled fertilizer drop spreader was also tried, but it's flow could not be restricted enough to apply the label rate. Auger-type applicators as described on the product label are unavailable. Consequently, applications were made using Cyclone Model 1C1 seeders that have vibrating agitator gates. Application was difficult and required much agitation of seeders since the formulation was of uneven consistency and tended to cake up on the vibrating metering plate. Instructions for individual mound application are not provided on the current product label.

The product label states that effects of treatments should begin to occur from 6 to 8 weeks following treatment. No significant reduction in number of fire ant mounds was documented following Bushwhacker treatments throughout the monitoring periods of these three trials (Tables 1, 2, 3). Based on these results, Bushwhacker Fir Ant Killer had no effect in reducing numbers of active red imported fir ant mounds in treated areas. Fire ant activity is known to be extremely seasonal. During hot, dry periods of the year, fire ant activity is dramatically reduced. Further, population densities often fluctuate and the potential of various products to cause a significant reduction in ant populations can only be determined with the use of carefully controlled test.

Acknowledgment

The authors are grateful for the assistance provided by Mark Smith and Dr. William Johnson, County Extension Agents in Galveston County.

Table 1. Mean number of active red imported fire ant mounds per 0.21 acre subplot, J.B. Evans Turf Farm, Algoa, Texas, 1991.

Mean no. (± S.D.) active mounds*

Treatment	**Pre-count**	**5-week**	**3-month**	**7-month**
Bushwhacker	18.7500 a	27.2500 .b	26.0000 .b	39.5000 .b
Amdro	17.0000 a	4.5000 a.	5.7500 a.	5.5000 a.
Check	30.0000 a	37.2500 .b	18.2500 .b	32.7500 .b
F-ratio	*3.515*	*22.398*	*25.351*	*69.124*
Probability	*0.0976*	*0.0016*	*0.0012*	*0.0001*
LSD 5 %	*13.021*	*12.272*	*7.022*	*7.492*

* Means followed by the same letter are not significantly different using ANOVA and Least Significant Difference Test at P = 0.05.

Table 2. Mean number of active red imported fire ant mounds per 0.154 acre plot, Raintree Subdivision, College Station, Texas, 1991.

Mean no. (± S.D.) active mounds*

	pre-count	**4 weeks**	**9 weeks**	**13 weeks**	**8 months**
Control	10.375 ± 3.2923	10.875 ± 3.3991	10.000 ± 4.1404	15.625 ± 4.9262	23.000 ± 6.9898
Bushwhacker	12.125 ± 3.5632	12.125 ± 5.0267	8.250 ± 2.4928	13.250 ± 4.1662	26.500 ± 7.0508
t =	*-1.0203*	*-0.5826*	*1.0242*	*1.0412*	*-0.9971*
*Prob.**	*.1625*	*.2847*	*0.1616*	*0.1577*	*0.1678*

* Probability of greater than 0.05 indicates no significant difference using the Student's *t* test.

Table 3. Mean number of active red imported fire ant mounds per 0.0606 acre subplot, Somerville Lake, Texas, 1991.

Mean no. (± S.D.) active mounds

	pre-count	**5 weeks**	**3 months**	**6 months**
Control	9.250 ± 2.6300	10.250 ± 2.7538	10.750 ± 2.9861	18.500 ± 5.0662
Bushwhacker	12.500 ± 5.1962	12.250 ± 4.9917	9.500 ± 1.7321	17.250 ± 4.9244
t =	*-1.1161*	*-0.7016*	*0.7242*	*0.3538*
*Prob.**	*0.1535*	*0.2546*	*0.2481*	*0.3678*

* Probability of greater than 0.05 indicates no significant difference using the Student's *t* test.

Evaluation of Potential Attractants for the Red Imported Fire Ant

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The red imported fire ant, Solenopsis invicta Buren, is an omnivore, feeding on many organic substances. Foraging workers are also attracted to sources of moisture and fragrances. This laboratory assay was undertaken to determine the attractiveness, if any, of oil-based materials to foraging ants.

Materials and Methods

On January 13, 1992, tests were conducted to determine the relative preference of the red imported fire ant for the following products:

T.L.C.® Massage cream (TLC)
Soothe and Cool ® Massage cream (SC)
Mineral Oil (MO)
Glycerol (GL)

Test One was performed using five, freshly collected (January 10, 1992), multiple-queen, fire ant colonies. The colonies were collected from moist soil in five-gallon plastic buckets lined with talcum powder to prevent ant escape. The ants were immediately supplied with food and water. The preference test was conducted in the buckets and initiated at 9:30 a.m..

Test Two was performed using four colonies that had been collected in September, 1991 and kept in laboratory boxes. The ants were deprived of food and water from January 10 until the time of the test. The preference test was conducted by placing the test set-up in the colony boxes and was initiated at 9:30 a.m..

Test Three was identical to Test Two, but was initiated at 5:30 a.m., January 14, 1992 to take advantage of the fire ants' increased foraging activity at night.

The methodology for all tests involved placing a six inch square of 3/4 inch thick board in each colony to provide a level, stable base. A five by seven inch clear plastic lid was placed on top of each board to prevent the products from soaking into the wood. The materials tested were painted onto glass scintillation vials and one vial of each material was placed on the plastic lid in each colony.

A fourth test was conducted to determine the attractiveness of the material in question versus known food sources. Four plastic weighing boats containing 0.5 milliliters of the following substances were placed in each of the five fresh colonies at 5:45 a.m., January 14, 1992:

Soy bean oil (Soy)
1:4 Honey:water
T.L.C. ® massage cream (TLC)
glycerol

The attractiveness of the materials in all tests was evaluated by estimating the number of worker ants associated with each treated vial. Evaluations were made at fifteen minute intervals for two hours and fifteen minutes. The second set of tests were conducted in a darkened laboratory with a minimum of indirect light for set-up and evaluation.

Results and Discussion

In tests conducted with no known fire ant food source (Tests One through Three), glycerol attracted larger numbers of ants than other treatments. Intensified nocturnal (night-time) foraging was demonstrated by the relatively larger numbers of ants associated with this treatment in Test Three versus Test Two.

These results indicated that glycerol, an ingredient in the massage oils, attracted relatively more foraging fire ant workers than the oils themselves. Apparently additional ingredients such as fragrances, cause these products to be less attractive. Conversely, when know fire ant food sources (honey water and soybean oil) were offered to ant colonies, glycerol and massage oil were shown not to be attractive in Test Four.

In conclusion, results from Test One, Two, and Three indicate that T.L.C. ® massage oil was only slightly attractive to foraging fire ant workers. Test Four indicated that, in the presence of a known food source, the massage cream is unattractive. Even after 24 hours, it was noted that the massage cream remained unattractive in the test colonies even though the ants had been starved since the test was initiated.

Summary of Test Results - Average number of ants associated with treated vials and food sources

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Test One - Daylight, Fresh Colonies

Material

Elapsed Time	TLC	S & C	Min. Oil	Glycerol
0:15	2.2	1.0	1.0	6.6
0:30	2.2	1.8	1.0	7.8
0:45	1.4	1.0	0.8	5.6
1:00	1.2	0.8	1.0	4.2
1:15	1.6	2.0	0.6	2.4
1:30	1.2	1.0	0.8	4.2
1:45	0.8	0.6	0.8	2.0
2:00	0.8	0.2	0.8	2.4
2:15	1.2	1.2	0.2	1.6

Test Two - Daylight, Water-stressed Colonies

Material

Elapsed Time	TLC	S & C	Min. Oil	Glycerol
0:15	9.75	1.0	0.5	6.0
0:30	3.5	3.75	0.0	5.0
0:45	3.0	2.0	0.5	6.75
1:00	1.5	2.5	0.0	9.75
1:15	2.25	1.0	0.25	7.75
1:30	2.0	1.75	0.75	11.75
1:45	3.25	1.25	0.5	8.0
2:00	1.0	0.5	0.25	5.75
2:15	1.75	1.5	0.5	10.25

Summary of Test Results, continued - Average number of ants associated with treated vials and food sources

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Test Three - Night, Water-stressed Colonies

Material

Elapsed Time	TLC	S & C	Min. Oil	Glycerol
0:15	3.75	1.75	0.25	20.75
0:30	4.5	5.25	0.0	32.0
0:45	3.0	3.5	0.0	28.25
1:00	1.5	3.0	0.0	17.75
1:15	4.75	3.25	0.0	15.25
1:30	2.0	2.25	0.0	12.25
1:45	2.75	3.75	0.0	10.75
2:00	2.5	3.5	0.0	12.5
2:15	3.4	1.75	0.0	12.0

Test Four - Night, Fresh Colonies with known food sources

Material

Elapsed Time	Soy	Honey-water	TLC	Glycerol
0:15	9.4	18.4	0.2	0.0
0:30	20.8	37.6	0.0	0.8
0:45	50.0	75.2	0.0	1.0
1:00	51.2	80.0	0.0	0.2
1:15	62.2	90.0	0.6	0.4
1:30	63.2	Consumed	0.6	2.8
1:45	65.0	Consumed	0.4	0.8
2:00	86.0	Consumed	0.0	1.2
2:15	86.6	Consumed	0.0	2.4

Acceptance and Efficacy of Beuvaria bassiana Formulations to Laboratory Colonies of the Red Imported Fire Ant (Hymenoptera: Formicidae)

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The fungus, Beuvaria bassiana, has been shown to be parasitic on the red imported fire ant (Solenopsis invicta, Buren) under both laboratory and field conditions. A major drawback of the fungus as an effective control measure for fire ants has been the difficulty of applying viable fungus to ant mounds in the field and ensuring that it reaches enough wokers and brood to eliminate or reduce ant numbers within the mound. The Feremone Corporation aupplied a sample of B. bassiana impregnated on an easily applied granular formulation. A series of trials were conducted to determine if this formulation of the fungus would be fatal to fire ants in laboratory colonies.

Materials and Methods

Mortality trial. On 4 September 1991, eight fire ant colonies, contained in Fluon®-coated plastic boxes, were rated. The estimated number of ants, amount of brood and relative number of queens (or alates) was recorded for each colony. One-quarter teaspoon (0.80 grams) of the Feromone B. bassiana fungus-impregnated granules was scattered inside each of four ant colony dishes. The remaining four colonies were maintained as untreated controls. Colonies were maintained on a standard dietary regime consisting of frozen crickets, honey-water and water and rated at 24 hours and 6 days following treatment. At this time, an additional one-quarter teaspoon of granules was added to the colony dishes, but this time the material was watered in with approximately 10 ml. of distilled water. The colonies were maintained for an additional three weeks and rated periodically.

Preference trial. Six fresh, actively feeding laboratory colonies were used. Three small, plastic weighing dishes were placed in each colony. Each dish received one gram of one of the following: B. bassiana fungus-impregnated granules, Konsume® feeding stimulant, or fungus impregnated granules plus 2 percent Konsume. The dishes were left in the colonies overnight before the material was removed and the amount remaining recorded.

Results and Discussion

Mortality trial. Within 24 hours, the ants had removed the B. bassiana fungus-impregnated granules from the colony dish or formed it into a pile within the dish. By the end of one week no mortality was noted in either worker ants, brood or queens. The dry material that was sprinkled into the colony dishes appeared to have no affect on ant mortality and was simply removed from the dishes. With the application of water to the second granule treatment the ants were observed to be avoiding the dishes and/or areas with granules. They were unable to move the granules out of the colony dishes because they lacked structure. Results (Table 1 and 2) indicate that, compared to untreated fire ant colonies, the B. bassiana treatments caused little mortality to worker ants, brood, or queens. There was, however, a numerical decline in estimated ant numbers and brood 12 days following treatment.

Preference trial. The preference test given to both the fungus-impregnated granules and the feeding stimulant indicated that the ants were not repelled by these materials, thought they were not attracted by them either. No material was seen to be removed from the colonies and the experiment was discontinued after 24 hours.

Conversations with the manufacturer's representative indicated that the material that was supplied may not have contained viable fungus. Given the history of Beuvaria bassiana as a parasite of fire ants, these results would tend to support this conclusion

Table 1. Mean estimated red imported fire ant colony size following treatment twice with Beauvaria bassiana fungus-impregnated granules or left untreated.

Number of ants X 1000 ± S.D.

Colony	**Pre-count**	**24-hrs**	**6-days**	**12-days**	**21-days**
Treated 1-4	11.3 ± 4.4	11.3 ± 4.3	11.5 ± 4.0	6.0 ± 3.4	6.0 ± 3.4
Untreated 1-4	12.0 ± 5.4	12.0 ± 5.4	11.5 ± 5.7	10.3 ± 5.2	10.5 ± 5.1
t=	*-0.2159*	*-0.2159*	*0.0000*	*-1.3744*	*-1.4796*
P=	*0.4181*	*0.4181*	*0.5000*	*0.1092*	*0.0947*

Table 2. Red imported fire ant colony condition following treatment twice with Beauvaria bassiana fungus-impregnated granules or left untreated.

Condition of brood/presence of queens

Colony	**Pre-count**	**24-hrs**	**6-days**	**12-days**	**21-days**
Treated 1	- / ++	- / ++	- / ++	- / +	- / +
Treated 2	++ / ++	++ / ++	++ / ++	+ / ++	+ / ++
Treated 3	++ / ++	+ / +	+ / +	- / +	- / -
Treated 4	++ / ++	++ / ++	++ / ++	++ / ++	++ / ++
Percent:	75 / 100	75 / 100	75 / 100	50 / 100	50 / 75
Untreated 1	- / -	- / -	- / -	- / -	- / -
Untreated 2	++ / ++	++ / ++	++ / ++	++ / ++	++ / ++
Untreated 3	+ / +	+ / +	+ / +	++ / +	+ / +
Untreated 4	++ / ++	++ / ++	++ / ++	++ / ++	++ / ++
Percent:	75 / 75	75 / 75	75 / 75	75 / 75	75 / 75

Toxicity and Residual Evaluations of Selected Surface Treatment Compounds

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The red imported fire ant, Solenopsis invicta, Buren, occasionally infests structures such as wall voids, water meter casings and electrical equipment. Magnetic fields have been documented to cause ants to stop near the source. Occasionally, enough ants accumulate between the breaker points to cause electrical equipment to short circuit. Failure of this type of equipment, such as traffic signals, can lead to serious problems. The ants will also use casings and housings as nesting sites, moving soil into these areas and chewing on the insulation of wiring. Attempts to repair infested units becomes potentially dangerous to personnel.

Several specialty products have been developed to prevent or eliminate fire ant activity within structures. Most utilize common pesticides in a carrier that offers enhanced effectiveness, ease of application, increased safety, or extended residual effects. This trial was conducted to evaluate the residual activity of three products.

Materials and Methods

Three products tested included: 1) Stutton JS 685 Powder®: an aerosol spray of 4.00 % silica gel, 1.00 % piperonyl butoxide, and 0.10 % pyrethrins. The spray leaves a thick, white, powdery residue with little residual odor. 2) Insecta Latex Paint®: a latex paint containing 0.86 % chlorpyrifos. The paint is white, but dries clear and has a noticeable odor. 3) Suscon® granules: chlorpyrifos-containing plastic granules. The granules are the size of salt grains, have a translucent white color, and a powerful odor. This last product is not currently registered for use within structures.

To evaluate the products, a container was designed to isolate a food source (bait) and force foraging ants to cross a treated surface to reach it. Containers were removable and bait replaceable. Thereby, the success of a treatment in preventing ants from reaching the bait could be tested over time.

Containers were constructed from two tall, plastic Petri dishes glued together, bottom to bottom, with plastic model cement. The inner surface of one container was treated with Fluon® to prevent anst from crawling up the sides and around the treated area. A piece of aluminum foil approximately one inch wide was glued to the side of the dish so that it contacted both the bottom and lid of the Fluon®-treated Petri dish. A 0.5 cm. hole was melted in the bottoms of the two containers approximately an inch above the end of foil strip. Another hole was melted along the edge of the lid covering the treatment chamber to allow ant entrance. During testing a bait, such as artificial diet (1.0 cm cube) or a frozen cricket was placed in the non-Fluon-coated Petri dish and sealed with a lid to prevent ant entrance except across the treated surfaces and through the hole melted in the dish bottoms.

The treatments were applied to the foil as follows: 1) The Stutton JS 685 Powder was applied by fitting a paper shield around the inside of the treatment chamber so that the spray would contact only the foil. The spray was applied to an even thickness; 2) The Insecta Latex Paint was brushed on until complete coverage was obtained, and ; 3) The Suscon granules were spread an even layer so that the entire surface of the foil was covered. A fourth chamber was prepared and the foil left untreated as a control.

The four treatment containers were placed in random order within Fluon-treated plastic boxes similar to the colony boxes. A cardboard bridge approximately one inch wide and fourteen inches long was placed between the test boxes and laboratory fire ant colony boxes to allow ants to forage freely. During each trial, the ants were allowed access to the bait for 24 hours. After the bridge was removed, the percent bait removed and presence of dead ants was documented using the rating scale as follows:

Bait Removal:	Ant Mortality
0 = bait untouched	0 = <10 dead ants in container
1 = bait < 10% removed	1 = 10-50 dead ants in container
2 = bait 10-75% removed	2 = 50-100 dead ants in container
3 = bait entirely removed	3 = > 100 dead ants in container

Evaluations were made on 3 October 1990, shortly after applying treatments and 14 months later on 11 December, 1991.

Results and Discussion

Initially, all products gave very good protection of the bait, even under extreme feeding pressure. Ant mortality was not particularly great, probably due to the repellent properties of the insecticides. Death of ants in the check chambers is most likely due to ants being poisoned in an adjacent container and actually dying on the untreated surface. It must be noted that, in the first test, the colony box of Colony 6 was contaminated by the great number of ants that crossed into the treatment box. This colony was essentially dead two days after the bridge was removed.

After 14 months, it was apparent that the Insecta Latex Paint had lost some of its effectiveness, an average of 50 percent of the bait was removed as compared to none in the initial test. However, the increased number of dead ants in the container indicates that the product was still toxic to ants. The Stutton JS 685 Powder and the Suscon granules were still quite effective as both protectants and toxicants at that time.

Table 1. Removal of bait* and ant mortality** ratings resulting from ant exposure to insecticide-treated surfaces.

	----------------------Treatment--------------------			
Colony	**Untreated Check**	**Stutton JS 685 Powder®**	**Insecta® Latex Paint**	**Suscon® Granules**
Date: 3 Oct. 1990				
1	2* / 0**	0* / 0**	0* / 0**	0* / 0**
2	0 / 0	0 / 0	0 / 0	0 / 0
3	1 / 0	0 / 0	0 / 0	0 / 0
4	3 / 1	0 / 1	0 / 1	0 / 1
5	3 / 1	0 / 1	1 / 2	0 / 1
6	3 / 3	1 / 2	1 / 2	1 / 3
Averages:	2.0/0.8	0.2/0.7	0.3/0.7	0.2/0.8
Date: 11 Dec. 1991				
1	3 / 0	0 / 0	2 / 3	0 / 0
2	1 / 0	0 / 1	0 / 1	0 / 1
3	3 / 0	0 / 0	2 / 3	0 / 3
4	3 / 0	0 / 1	2 / 3	0 / 1
Averages:	2.5/0.0	0.0/0.5	1.5/2.5	0.0/1.25

Ratings:
* Bait Removal:

Bait Removal:	Ant Mortality
0 = bait untouched	0 = <10 dead ants in container
1 = bait < 10% removed	1 = 10-50 dead ants in container
2 = bait 10-75% removed	2 = 50-100 dead ants in container
3 = bait entirely removed	3 = > 100 dead ants in container

Detergent as a Method of Fire Ant Control in Floodwater

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The record flooding across large areas of Texas during the month of December, 1991 brought the fire ant problem home to many people in a previously unknown way. In its native environment in South America, the red imported fire ant (Solenopsis invicta Buren) is an inhabitant of flood-prone bottomland adjacent to rivers. The species has become adapted to surviving periodic flooding by floating in rafts composed of all members of the colony including brood (larvae and pupae) and then reinvading ant-free areas quickly after floodwaters recede. The ants can evacuate a flooded mound and float for some time until a tree or structure on which to climb has been encountered.

Residents of flooded areas have had to dodge these floating rafts while wading through high water and have returned to their homes and outbuildings to find them covered with thousands of fire ants. It was reported that some people were spraying the floating ant masses with detergent solutions and drowning them. This experiment was conducted to determine the quantity of detergent required to sink and kill a floating fire ant mass.

Materials and Methods

Test I. Nine tall, plastic Petri dishes were lined with talcum powder and filled with about 0.75 cup of tap water. From fire and colonies maintained in the laboratory, approximately one teaspoon of ants, including some brood and queens, was dropped onto the surface of the water in the Petri dishes. The ants immediately formed a tight, floating ball in the center of the dish.

Serial dilutions of Dove® dishwashing liquid (4,3,2 tablespoons, 1 tablespoon, 1, 0.5, 0.25, and 0.125 teaspoon liquid soap per gallon of water) were prepared. Using a trigger-spray mister, each solution was sprayed onto the ball of floating ants in the tall Petri dish. The sprayer was rinsed thoroughly with fresh water between the applications of each of the eight soap concentrations. The ninth dish was sprayed with tap water as a control. Each dish received approximately two milliliters of solution. Observations made at 20 minutes, 1 and 2 hours following treatment included 1) approximate percentage of sunken ants and 2) estimated number of ants that appeared dead. Notes on the general appearance of the floating ant masses were also made.

Test II. Five 5-gallon plastic buckets were filled with approximately 3 gallons of water. Five freshly dug colonies of fire ants were dripped out of the soil and transferred directly into the water-filled buckets. A solution of 2 tablespoons of dishwashing liquid in one gallon of water was sprayed onto the floating ant masses for 3-5 seconds with a hand pressure-sprayer. Total volume delivered was approximately 50 ml.

Results and Discussion

Test I. The degree and speed of fire ant mortality was shown to be directly proportional to the concentration of the soap solution sprayed onto the mass of floating ants (Table 1). As little as one teaspoon per gallon was enough to break the surface tension of the water and prevent raft formation, though one tablespoon per gallon was required to affect rapid ant death of 50 % or more.

Test II. This test was designed to better simulate the dilution factor that would be encountered in a flooding situation. Ant mortality ranged from 80-95 %, most of which occurred within 10 minutes of spraying.

NOTE: Results of this experiment are not intended to constitute a recommended fire and raft control practice in floodwater. Use of chemical solutions, including soap, for the control of insect pests must be approved by the Environmental Protection Agency.

Table 1. Effect of applying 2 ml. Dove® dishwashing liquid concentrations to floating rafts of the red imported fire ant in tall petri dishes.

Percent ants sunk/Percent dead

Concentration	20 min.	1 hr.	2 hr.	Observed raft structure
4 tbsp./gal.	70/90	90/98	90/100	spread near edges of dish
3 tbsp./gal.	60/80	75/90	95/98	spread on water surface
2 tbsp./gal.	50/75	75/80	80/90	spread on water surface
1 tbsp./gal.	30/50	50/75	50/75	spread on water surface
1 tsp./gal.	25/25	25/25	50/50	raft reformed after 1 hr.
½ tsp./gal.	20/25	20/25	30/30	loose ball, floaters alive
1/4 tsp./gal.	5/5	5/5	5/5	small ball, floaters alive
1/8 tsp./gal.	5/5	5/5	5/5	small ball, floaters alive
Check	1/1	1/1	<5/<5	tight ball, shed spray

Table 2. Effect of applying approx. 50 ml of 2 Tablespoon/gallon Dove® dishwashing liquid solution to whole red imported fire ant colonies floating in 3 gallons of water.

% of water surface covered by ants / % ants sunk / % dead

Colony	Initial	10 minutes	30 minutes	1 hour
1	98/0/0	15/80/90	10/90/90	10/90/95
2	100/0/0	40/80/90	30/80/90	30/80/95
3	80/0/0	40/70/85	40/70/90	30/80/90
4	85/0/0	40/80/90	25/80/90	25/80/95
5	70/0/0	40/60/80	35/70/80	30/75/85

Impact of a Broadcast Treatment of Logic® (Fenoxycarb) in Hillsboro City Park, Hill County, Texas

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Logic® and Award®, containing the ingredient, fenoxycarb, are bait-formulated products for the suppression of the red imported fire ant, Solenopsis invicta Buren. These products are synthetic analogs of insect hormones. Rather than acting on the nervous systems of animals, this ingredient is active only on the hormone/pheremone balance of arthropods. As formulated, these products are attractive to certain species of grease-feeding ants. Fenoxycarb affects the production of eggs by queen ants and redirects larval development so that no worker ants are produced in colonies where the ants have ingested this compound. Because of the mode of action, these products are often referred to as insect growth regulators. Since insect growth regulators are not toxic to adult forms, ant colonies are eliminated slowly as worker ants die from natural causes. Without worker ants, colonies are not maintained and developing brood and the queen ants are not tended. This process takes from several weeks to several months.

This demonstration was conducted to demonstrate the effect of a single application of Logic at a rate of 1.5 pounds product per acre.

Materials and Methods

This demonstration was conducted at Hillsboro City Park in Hill County, Texas. On 16 May 1991, an area approximating 2.0 acres was treated with 1.5 lbs. Logic per acre using a Cyclone® 1C1 Seeder. Prior to treatment, three 500 square foot subplot areas were established inside and adjacent to the treatment area. All fire ant active mounds were counted and recorded from these subplots. On 28 August 1991, these subplots were again inspected and active mound numbers were recorded. Data for these pre- and post-treatment evaluations were analyzed using the Student's *t* test (P # 0.05).

Results and Discussion

Prior to treatment, there was an average of 16.0 (± 4.0 S.D.) fire ant active mounds in untreated subplots while areas to be treated had 14.3 (± 3.2). These means were not significantly different (d.f. = 4; t = 0.5625; P = 0.3019). By 28 August, untreated mound numbers averaged 13.0 (± 5.6) while mound numbers in Logic treated subplots had significantly decreased to 2.3 (± 2.5)(t = 3.0237; P = 0.0195). This represents an 82.3 percent reduction in mound numbers relative to untreated subplot areas. For many areas, this level of suppression of fire ant activity is sufficient. However, where complete elimination of ants is desired, additional treatments may be necessary.

Impact of Chlorpyrifos (Lorsban®) Treatments of Pecan Tree Trunks and the Orchard Floor

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The red imported fire ant (Solenopsis invicta, Buren) is a known predator of many arthropod species including beneficial insects. In pecan production, the presence of entomophagous insects has been shown to be important in the suppression of damaging insects such as aphids. Fire ants have been shown to "tend" aphids, consume their honeydew, move them to new locations and protect them from natural enemies by consuming parasitized aphids and preying upon aphid predators such as green lacewing larvae. Consequently, the presence of foraging fire ants in pecan tree canopies is thought to aggravate aphid outbreaks. This study was undertaken in an attempt to document the impact of removing fire ants from pecan tree canopies on aphid and aphid predator densities.

Materials and Methods

On July 1, 1991, a block of pecan trees was selected for testing at the Royalty Pecan Orchard, in Burleson County, Texas. The areas consisted of three adjacent blocks, each measuring 9 trees across and 10 trees long. Tree spacing was 36 feet, giving a total ground area of approximately 8 acres. The varieties were mixed within each block and included: Cheyenne, Kiowa, Gracross, and Desirable.

The first, westernmost, block was treated by spraying the individual tree trunks with a Lorsban® 50W (chlorpyrifos) solution using a hand-carried pressure sprayer. The rate used was based on the registered concentration for treating peach tree borer (Lorsban 4E is registered for use at a rate of 3 qts. per 100 gal. Thus, Lorsban 50W rate was determined to be 6 lbs per 100 gal. or 0.96 oz. per gal.). A band from ground level to approximately 4 feet was sprayed to runoff on each tree. The second block was left as an untreated control and the third was treated with Lorsban 15G® (chlorpyrifos) at a rate of 6.7 lbs. per acre using a truck-mounted electric broadcast spreader to distribute the material across the orchard floor.

Fire ant activity was monitored using olive oil-soaked index cards measuring 1" x 1". These cards were stapled to selected trees and allowed to stand for approximately one hour before the number of ants were counted from each card. Cards on trunk-sprayed trees were placed above the spray line and on the ground. Cards in the other two blocks were placed approximately 3 feet above ground level except on Aug. 23 when ants were also sampled on the ground between trees. A minimum of 5 trees and/or ground locations were monitored for ant activity from each treatment area on July 17, 19, 23 and September 26, 1991. Resulting data were analyzed using the Student's *t* test (P # 0.05).

Because of their susceptibility to yellow pecan aphids, 'Cheyenne' variety trees were selected and marked for monitoring. Aphid counts were made by counting the number of aphids on 5 randomly-selected compound leaves from each of the five marked trees per treatment area. Aphid predators such as green lacewing larvae and adults and lady beetle larvae and adults were evaluated by counting the number of compound leaves it took to find three insects on each of the marked trees. Results were analyzed using Analysis of Variance (ANOVA)(P # 0.05) and means were separated using the Least Significant Difference (LSD) test.

Results and Discussion

Ant activity was found to be erratic and generally low during this trial resulting in high variability of monitoring result data. Thus, few statistical differences were documented. Lorsban 4E application to trunks of pecan trees on July 1 eliminated ant activity on July 17 and August 23:

Mean no. (± S.D.) fire ants on olive oil-soaked card

Date	**On tree trunk**	**On ground**
July 17	0.0	5.0 ± 8.7
August 23	0.0	5.3 ± 12.6

By September 26, ant activity on tree trunks has resumed.

Lorsban 15G applied to the orchard floor eliminated ant activity on August 23 (0.0 ants found on 6 cards versus 6.0 ± 10.3 on trunks in the Lorsban 15G treated area and 2.5 on the orchard floor in the untreated area). However, ant activity on tree trunks in the Lorsban 15G treated area was dramatically higher than in the untreated are on July 19 (Table 1). A possible explanation for these observations is that ants in mounds at the base of trees were not affected by the treatment. Since these ants could not forage on the treated orchard floor, foraging activity on tree canopies intensified. Since the focus of this trial was on aphids and aphid predators, ant activity was not monitored prior to treatment. Therefore, it is not possible to speculate on ant activity between treatment areas versus after treatment.

No significant differences were documented for aphid or aphid predator densities between treatments (Table 2). However, the trunk treatment area harbored numerically fewer aphids and the orchard floor treated area (where trees were found to have significantly more ant foraging activity) contained fewest aphid predators, July 16. These values are, at least, consistent with the theories about the impact of red imported fire ants on aphid outbreaks.

In summary, results presented here are inconclusive and do not clearly document fire ant aggravation of aphid outbreaks. Perhaps the treatments were applied too late in the season to have an affect on the early stages of an aphid infestation or high temperatures and dry conditions during the Texas summer months depressed the impact of the fire ants. Applications applied earlier in the season might have a greater impact. One interesting observation to be gained from this trial is that Lorsban 15G applied to the orchard floor may well aggravate fire ant foraging in pecan canopies. Such a treatment could be a useful tool in further investigations into the interrelationship between the red imported fire ant, yellow pecan aphids and aphid predators.

Table 1. Red imported fire ant activity on pecan trunks following Lorsban® (chlorpyrifos) treatments, Royalty Pecans, Burleson County, Texas, 1991.

Mean no. (± S.D.) ants on olive oil-soaked cards

Treatment	**July 17 (n=5)**	**July 19**	**Aug. 23 (n=6)**	**Sept. 26 (n=6)**
Lorsban 15G to orchard floor	37.0 ± 37.5	24.2 ± 15.9* (n=39)	6.0 ± 10.3	---
Lorsban 50W to tree trunks	0.0	---	0.0	2.6 ± 3.1
Untreated	16.2 ± 18.2	2.9 ± 3.3* (n = 13)	5.3 ± 4.3	8.3 ± 10.6

* indicates significant difference using the Student's *t* test)(P # 0.05).

Table 2. Aphid and aphid predator densities in pecan trees in red imported fire ant treatment areas, Royalty Pecans, Burleson County, Texas, 1991.

Mean number yellow pecan aphids per compound leaf

Treatment	July 5	July 16	Aug. 29
Lorsban 15G to orchard floor	12.20 a	1.72 a	1.28 a
untreated	10.92 a	1.88 a	3.68 a
Lorsban 50W trunk spray	9.64 a	0.48 a	3.72 a
f-ratio	*0.229*	*2.202*	*0.824*
P	*0.792*	*0.1216*	*0.4450*
LSD (SSD5 %)	*7.646*	*1.476*	*4.401*

Number of compound leaves needed to detect aphid predators

Treatment	July 5	July 16	Aug. 29
Lorsban 15G to orchard floor	4.45 a	1.53 a	1.93 a
untreated	7.13 a	3.07 a	1.93 a
Lorsban 50W trunk spray	6.33 a	3.07 a	2.73 a
f-ratio	*0.859*	*2.206*	*0.671*
P	*0.4343*	*0.1230*	*0.5194*
LSD (SSD5 %)	*4.276*	*1.515*	*1.634*