PROCEEDINGS OF THE 1994 IMPORTED FIRE ANT CONFERENCE

MAY 9 - 11, 1994

ADMIRAL SEMMES HOTEL
MOBILE, ALABAMA

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THE IMPORTED FIRE ANT IN ALABAMA

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Alabama has the dubious honor of being the site of what is believed to be the initial introduction of the imported fire ant into the United States. It is generally accepted that the black imported fire ant, or Solenopsis richteri, was introduced first probably around 1918 from Brazil, Uruguay or Argentina. The red imported fire ant, or Solenopsis invicta was probably introduced between 1933 and 1945 from Brazil.

The black imported fire ant is now pretty much restricted to an area approximately 135 miles long in northeastern Mississippi and northwestern Alabama, while the more aggressive red imported fire ant occupies an area from North Carolina to Texas and from Tennessee to the coast.

The imported fire ant moved relatively slowly in Alabama until the late 1950's when it was found to be moving distances of 20 miles or so due to natural spread (nuptual flights) and artificial spread (nursery stock, and soil contaminated equipment).

The introduction into the Mobile Bay area proved highly beneficial for the imported fire ant. This area provided a niche which was apparently free from its natural enemies and once the niche was occupied the imported fire ant found a ready means of artificial distribution via a thriving nursery industry. Nursery stock from Mobile County was shipped throughout the Southeast and was apparently the major means of long distance movement.

The imported fire ant continued to spread in Alabama until in 1991 the last non-regulated area, northern Madison county, was found to be generally infested and was added to the quarantined area. All 67 Alabama counties were infested and subject to the requirements of the Federal Imported Fire Ant Quarantine.

Today Alabama has 650 certified nurseries, 163 (25%) of which are under a Federal Imported Fire Ant Compliance Agreement. There are 156 nurseries in Mobile County with 70 of those being under a Federal Imported Fire Ant Compliance Agreement. We enforce the conditions of the compliance agreements aggressively and because of this I can only recall one instance where infested nursery stock has been detected at destination. Alabama has a state Imported Fire Ant Quarantine which is more restrictive than the Federal Quarantine in that it requires that no regulated articles be moved from properties infested with imported fire ants. This applies to nurseries under a compliance agreement as well as those that are not. For this reason Alabama nurseries have a very low incidence of imported fire ants.

Approximately $289,000.00 is expended annually on the Federal Imported Fire Ant program. Approximately 60% of this is federal funds. We spend in excess of 13,000 hours annually on compliance activities and conduct more than 3,000 visits to establishments handling regulated articles.

Over the previous two years there have been numerous investigations into alleged movement of imported fire ant infested plant material into Tennessee. The vast majority of these investigations concern incidents which occurred over a year ago and many over two years ago. To date there has been no conclusive evidence that imported fire ants have moved into Tennessee via infested plant material from Alabama.

Homeowners for the most part have learned to live with this pest. There are a number of effective pesticides available to the homeowner and the Alabama Cooperative Extension Service has done an excellent job in educating the homeowner.

FIRE ANT MISSION TO THE AMAZON: USDA's Humanitarian Assistance to Envira, Brazil

Homer L. Collins[1], David F. Williams[2], and Dan G. Haile[2]

INTRODUCTION: The genus *Solenopsis* is widely distributed in South America (Creighton, 1930), and fire ants have been recognized as a serious problem to people living in the tropical rain forest of Brazil since 1876 (Bates, 1975). In his book entitled *The Naturalist on the River Amazons*, Walter Henry Bates stated that fire ants were a greater plague than mosquitoes, black-flies, or sand flies. Houses in the village of Aveyros were overrun by fire ants, and food items were suspended from the ceiling by balsam-soaked cords to keep the ants out. Apparently Aveyros was deserted at one point in time due to invasion and domination of fire ants. Similar problems still exist in this area, and several agencies cooperated in a humanitarian mission to a small village in Brazil in September 1993.

METHODS AND MATERIALS: Envira, Brazil has a population of approximately 10,000 people, and is situated in an extremely remote area of the Amazon basin along the Tarauaca River, one of the tributaries of the Amazon River. In 1992 the mayor of Envira, Louis Castro, sought assistance from the Brazilian counterparts of USDA (EMBRAPA and EMATER) in combatting fire ant problems in Envira. Expertise on fire ant control was not available within these

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agencies, and eventually a request for humanitarian assistance came from the American Embassy in Brasilia to the U. S. Department of Agriculture, Agricultural Research Service (ARS). Due to his numerous publications on fire ant control and previous research trips to Brazil, Dr. Dave Williams was asked to assemble a technical advisory team to travel to Brazil and render aid to the village. Because of the remoteness of the area, and communication difficulties, detailed information on the magnitude or exact cause of the "fire ant problem" was not available. The U. S. State Department, Office of International Cooperation and Development (OICD) provided funds for a team of USDA scientists to travel to Envira, Brazil, assess the situation, and take action to ameliorate the fire ant problem. Ciba Geigy Corporation (Greensboro, NC) donated 2000 pounds of LOGIC® Fire Ant Bait for the mission.

On September 6, 1993 a technical advisory team comprised of the authors (DFW, DGH, and HLC), departed Miami, FL for Manaus, Brazil. After arriving in Manaus, clearing customs, etc. the Brazilian military airlifted the advisory team, supplies, and equipment to Envira aboard a C-115 Buffalo aircraft. There are no roads or highways into Envira, therefore the village is accessible only by boat or chartered aircraft. The trip upriver from Manaus requires 20 days and cannot be made during the dry season when the rivers are low. Communications are very difficult since there are no direct telephone lines in, and only the mayor speaks English.

Perhaps our first impressions after arriving in Envira were that so many other problems such as black flies, malaria, open sewers, poverty, etc. were rampant that fire ants could not be of much significance.

However, as we learned more about the situation in Envira, those impressions were modified. Fire ant foraging tunnels were commonly observed in all areas devoid of vegetation, even though mounds were not always evident. Food items such as dead insects, scraps of food, etc. were quickly discovered by foraging workers. A nest survey in an open grassy field in the center of town adjacent to the church revealed that a population of 32 nests per acre was present. Several extremely large nests approximately 4-5 feet in diameter were observed and photographed. Bait station transects at 36 sites throughout the town indicated that few species other than fire ants were present. Our impressions and observations were that these fire ants were much more aggressive than *S. invicta* when the nests were disturbed. Because of this aggression, and the lack of proper protective equipment, we were unable to determine if the ants of Envira were polygynous or monogynous. We soon acknowledged that Envira was indeed infested with a large and aggressive fire ant population, which was later identified as *Solenopsis saevissima* (F. Smith). Identity of the species was confirmed by Drs. James Trager, Dan Wojcik and Roberto Brandao.

Several factors may have contributed to the development of the fire ant problem in Envira:

1. Rapid growth and expansion of the village; the population was only 1,000 people in 1980 versus 9,000 to 10,000 in 1993. This resulted in clearing the forest, expansion of the town, construction of streets, homes, etc., all of which altered the native environment.

2. Envira is located along the banks of the Tarauaca River. Annual flooding of dry river beds and all low lying areas concentrates the fire ant population in areas frequented by people such as their homes, stores, schools, churches, cemetery, etc.

3. The use of DDT on fire ant nests in conjunction with a malaria campaign was suspended about 3 years ago. The DDT treatments may have temporarily suppressed the fire ant population while in use.

4. Until recently, garbage was not discarded in a sanitary manner, but instead was dumped in back yards and other areas nearby creating a vast and easily accessible food supply for ants.

A control program was indicated, and was initiated with the aid of the Logic bait donated by Ciba-Geigy and the application equipment brought in by the advisory team. A farm tractor owned by the village was equipped with a Herd® GT-77 granular applicator. A deflector shield fashioned from sheet metal was used to direct bait flow to one side of the tractor so that by driving along street curbs, bait was applied to small front "lawns" of the houses. Areas inaccessible by the tractor were treated with hand seeders. Five hundred pounds of Logic were applied in this fashion, and local municipal employees were trained in all phases of bait application so that a second treatment could be applied in the wet season (January-February) when the ants are concentrated on high ground due to flooding of the river.

Correspondence with Mayor Louis Castro indicated that the wet season treatment was successfully applied. We have not returned to Envira to determine if the control efforts were successful. However, Mayor Castro has advised that the fire ant population has been greatly reduced in Envira.

<u>SUMMARY:</u> Bates (1975) documented fire ant problems in the village of Aveyros in the late 1800s, so the situation seen in Envira was not new or unusual. Aveyros is approximately 1000 miles due east of Envira, and many other small towns similar in size, culture, and construction occur throughout the Amazon Basin. It seems likely that fire ants may cause similar problems in most of these villages, but due to the remoteness of the area, and other third world dilemmas, fire ant damage has not been documented or publicized.

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The Variability of Red Imported Fire Ant Colony Densities in Similar Habitats: Contributing Factors

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University of Georgia

Tifton, GA 31794

INTRODUCTION- The number of active monogynous imported fire ant colonies in pastures varies from state to state, from county to county, from farm to farm, and from field to field. The number is easily determined, but the reason(s) for these density differences remains a mystery. The success of the founding queen undoubtedly plays a major role in the future level of infestation; however, the factors which influence the founding process are ill-defined (Lofgren et al. 1975). Biotic and abiotic factors probably govern the founding process, as well as the density level of established colonies. Soil type has been indicated to have an influence on population levels in sugarcane (Ali et al. 1986). Chemical control or a past history of chemical control may influence the population (Tschinkle 1986). Soil fertility may influence plant growth which may influence the arthropod population which may influence the fire ant population (Ali et al. 1986). Soil pH may effect the queen, eggs, or developing young and thus impact colony establishment. Competing insects, mainly other ants, may effect the population level (Urbani & Kannowski 1974, Apperson & Powell 1984). This study was undertaken to try to determine if any of the following variables influenced active established fire ant colony densities in pastures: (1) soil pH, (2) soil texture, (3) nutrient levels, (4) soil-borne arthropod densities, and (5) the presence and level of other ant species.

MATERIALS AND METHODS- Pastures in 18 Georgia counties representing 3 soil regions were surveyed (Figure 1). The Southern Piedmont, the Southern Coastal Plain, and the Atlantic Coast Flatlands were represented by 6 counties each. Bahiagrass (Paspalum notatum) hay fields and bahiagrass grazed pastures were included. Five 0.07 ha plots were examined in each of 3 randomly selected fields in each county. The plots were established diagonally across each field at 60 m intervals.

Soil samples were taken in a circular pattern 2 m from the center of each plot. A standard soil sample probe was used to extract the samples at a depth of 4-6". The samples were mixed, and a subsample was removed from the combined probe samples.

The presence of different ant species was examined using bait stations. Bait stations consisted of 1 teaspoonful of peanut butter on a weighboat (Urbani & Kannowski 1974). A line of 5 bait stations ran parallel to the plot line. One bait station was placed 15 m from the center of each plot and left in the field for 1 hour.

On the opposite side of the plot, 15 m from the center, a sampling of soil-borne arthropods was determined by soil flushing (Hudson 1989, Short & Koehler 1979). Approximately 30 ml of detergent was mixed in 8 l of water and poured into a 0.09 m^2 area. This solution forced the underground arthropods in the 0.09 m^2 area to the surface. All arthropods found on the surface within 3 minutes were collected in 70% ETOH and transported to the lab.

Active fire ant colony densities were determined by disturbing the mounds in the plot. A 15.24 m rope was attached to the plot's center marker. All of the mounds within the 0.07 ha circular area were examined. A colony was considered active if the ants in the colony exhibited a defensive behavior (Sheppard 1982). The number of active colonies in each plot was recorded.

RESULTS AND DISCUSSION- Figure 2 graphically displays the average densities found in the three regions, hay fields vs. grazed pastures, and all of the fields combined. The results from the 270 sites indicate an average of 66.6 active colonies per ha throughout the state. The results indicate relatively equal densities throughout the state, regardless of soil region. The Southern Piedmont region had an average of 68.3 active colonies per ha, the Southern Coastal Plain had an average of 67.3 active colonies per ha, and the Atlantic Coast Flatlands had an average of 64.2 active colonies per ha. The analysis of variance showed that the average number of active colonies in each region was not significantly different (P=0.9) from the active colonies in the remaining two regions (SAS 1989).

Grazed pastures and hay fields were used in the study. Almost identical results were recorded in the two habitats. The 41 pastures averaged 68.3 active colonies per ha, and the 13 hay fields averaged 64.3 active colonies per ha. The analysis of variance showed that the average number of active colonies in the two habitats was not significantly different [(P=0.6) SAS 1989].

Urbani & Kannowski (1974) observed ants at 89% of their tree trunk test sites one hour after bait placement. They observed non-S. invicta species at 78% of the test sites. Out of 270 pasture sites baited in the present study, ants were found in 34 (12.6%) of the bait stations. Only 7 (2.6%) bait stations contained ants other than S. invicta.

The number of arthropods and the weight of the arthropods was found to correlate significantly statewide (Pearson's Correlation Coefficient. SAS 1989). The number of arthropods and number of active colonies was found to be significantly similar also; however, one data point (Figure 3) may have influenced this correlation. This is supported by the fact that the weight of the arthropods and the number of mounds did not correlate significantly (Figure 4). Additional analysis will be used to determine the significance of these findings.

The results from the soil analysis shows that pH does not affect the colony densities statewide when analyzed by Pearson's Correlation Coefficient (SAS 1989). Figure 5 depicts all of the data points with pH as the independent variable and colony density as the dependent variable. However, when the data is graphed as a histogram, a trend is apparent. Most of the plots sampled in the study could be found in the 5.0-6.5 pH range (Figure 6). By far, a large majority of the colonies could be found in this range also (Figure 7). Figure 8 shows that when the average number of colonies is examined, the soil pH appears to have an influence in the 4.5-5.0 range. If this holds to be significant, this could indicate that acidic tolerant grasses maintained in low pH situations could decrease the colony densities in the pastures.

The remaining soil analyses are being examined. Results from these analyses will be forthcoming.

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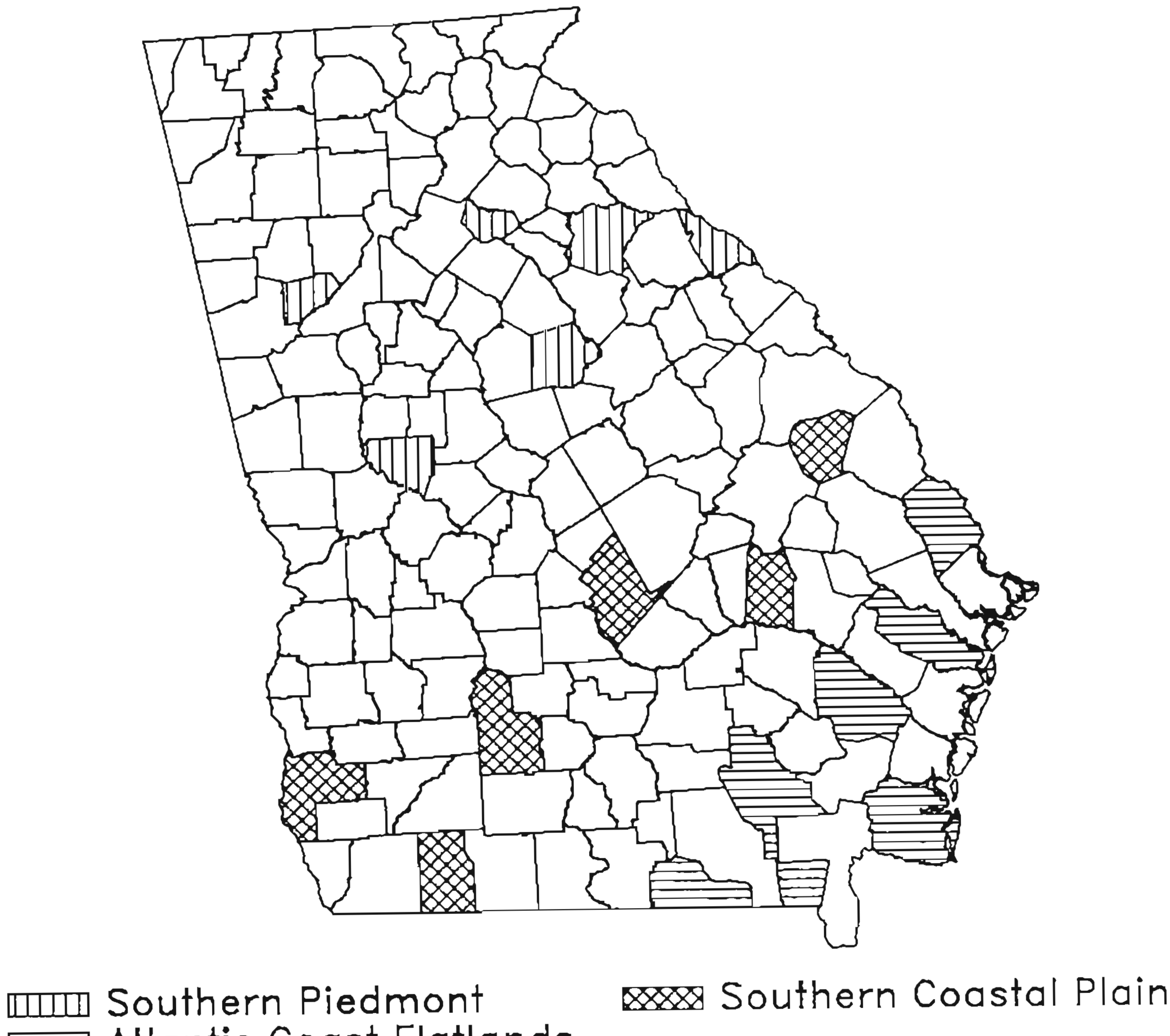
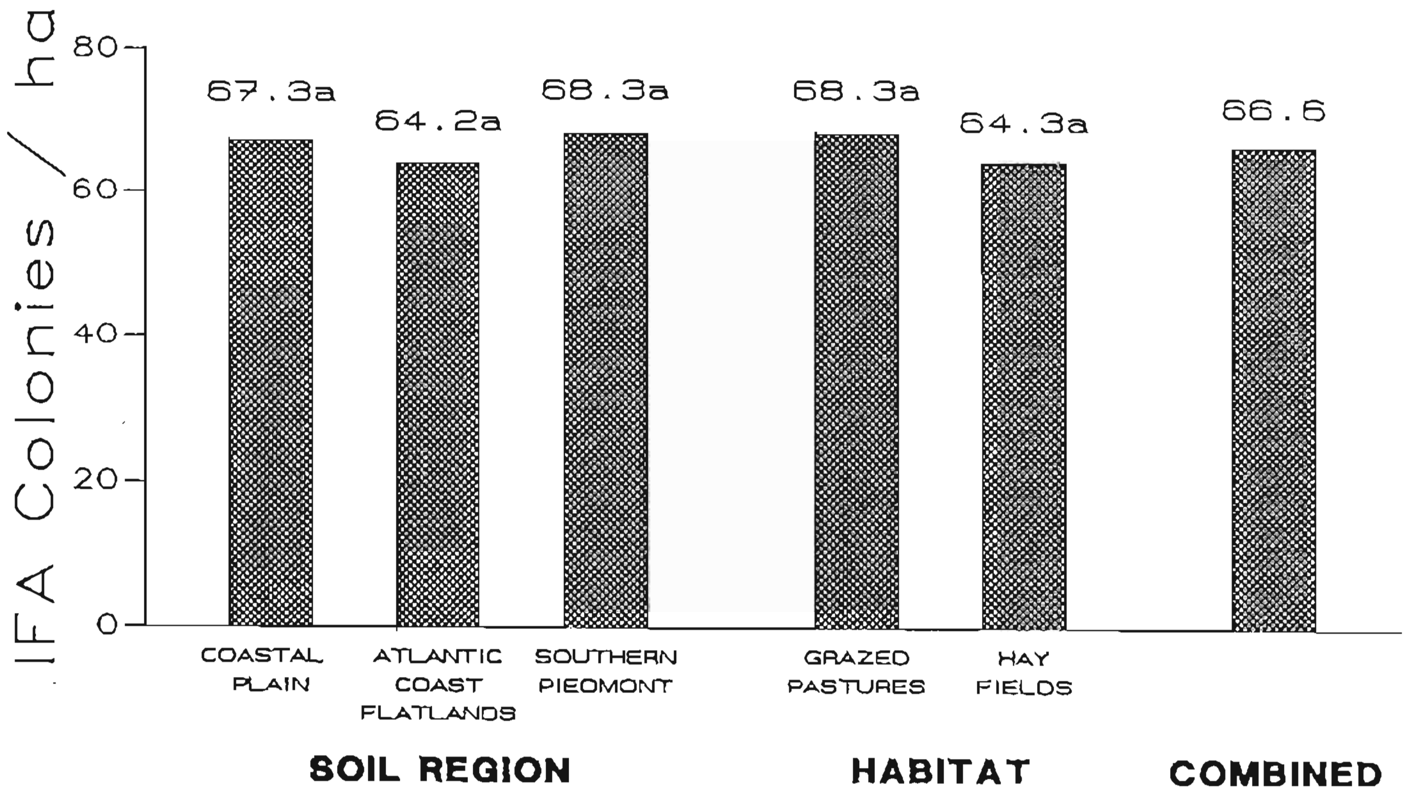
Fig. 1



Southern Piedmont
Atlantic Coast Flatlands
Southern Coastal Plain

Fig. 2


IFA Colonies / ha
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40
20
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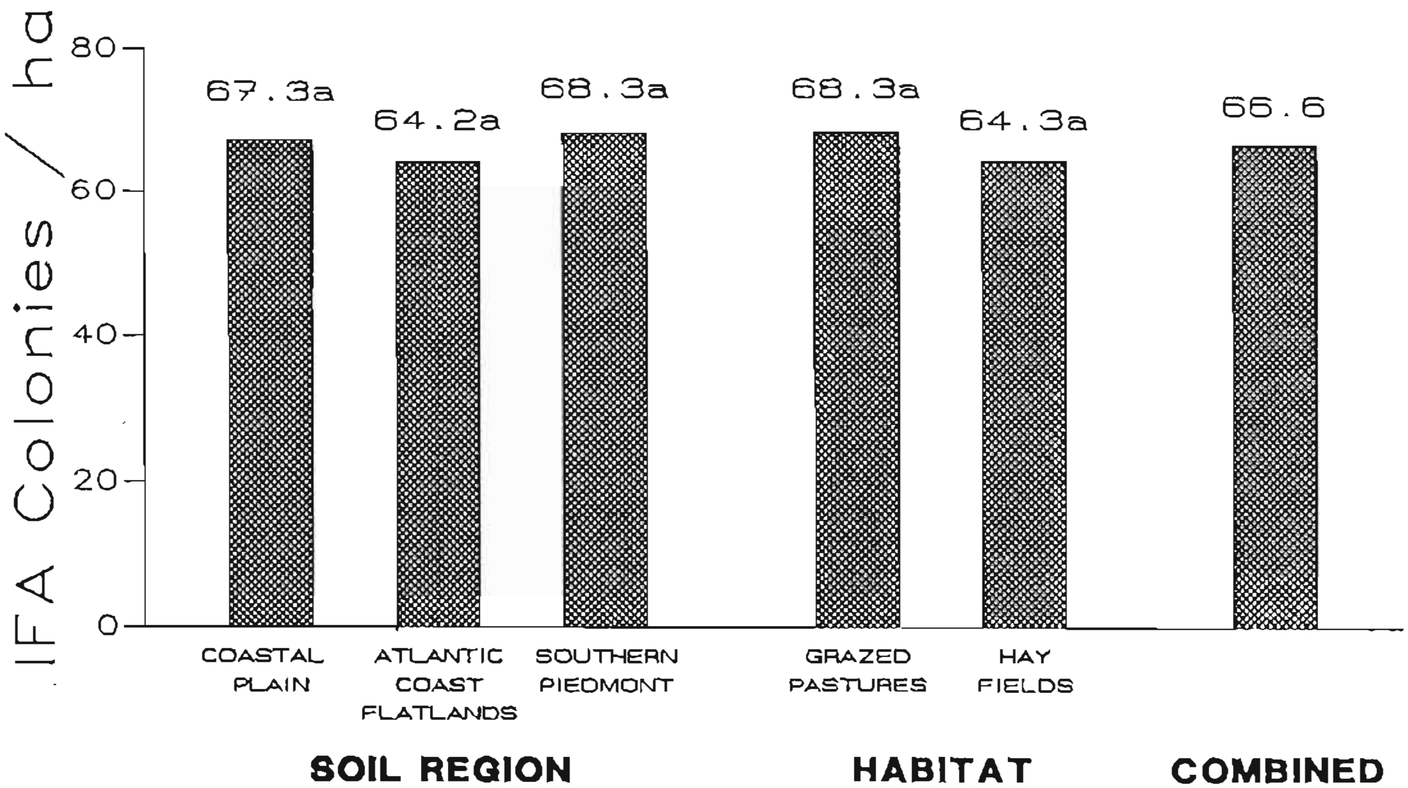
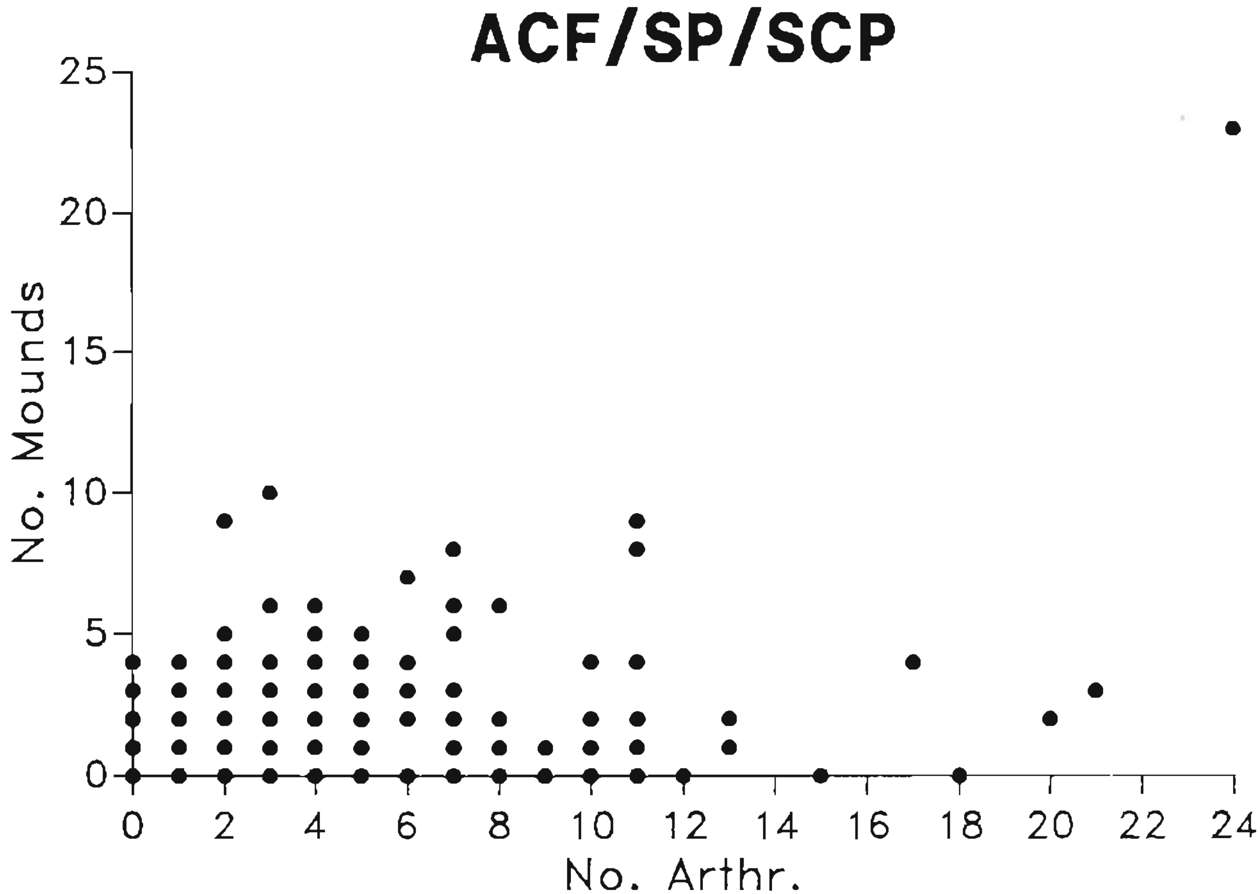
64.2a
68.3a
68.3a
64.3a
66.6
COASTAL PLAIN
ATLANTIC COAST FLATLANDS
SOUTHERN PIEDMONT
GRAZED PASTURES
HAY FIELDS
SOIL REGION
HABITAT
COMBINED

Fig. 2



IFA Colonies / ha
80
60
40
20
0
67.3a
64.2a
68.3a
68.3a
64.3a
65.6
COASTAL PLAIN
ATLANTIC COAST FLATLANDS
SOUTHERN PIEDMONT
GRAZED PASTURES
HAY FIELDS
SOIL REGION
HABITAT
COMBINED

Fig. 3



ACF/SP/SCP
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10
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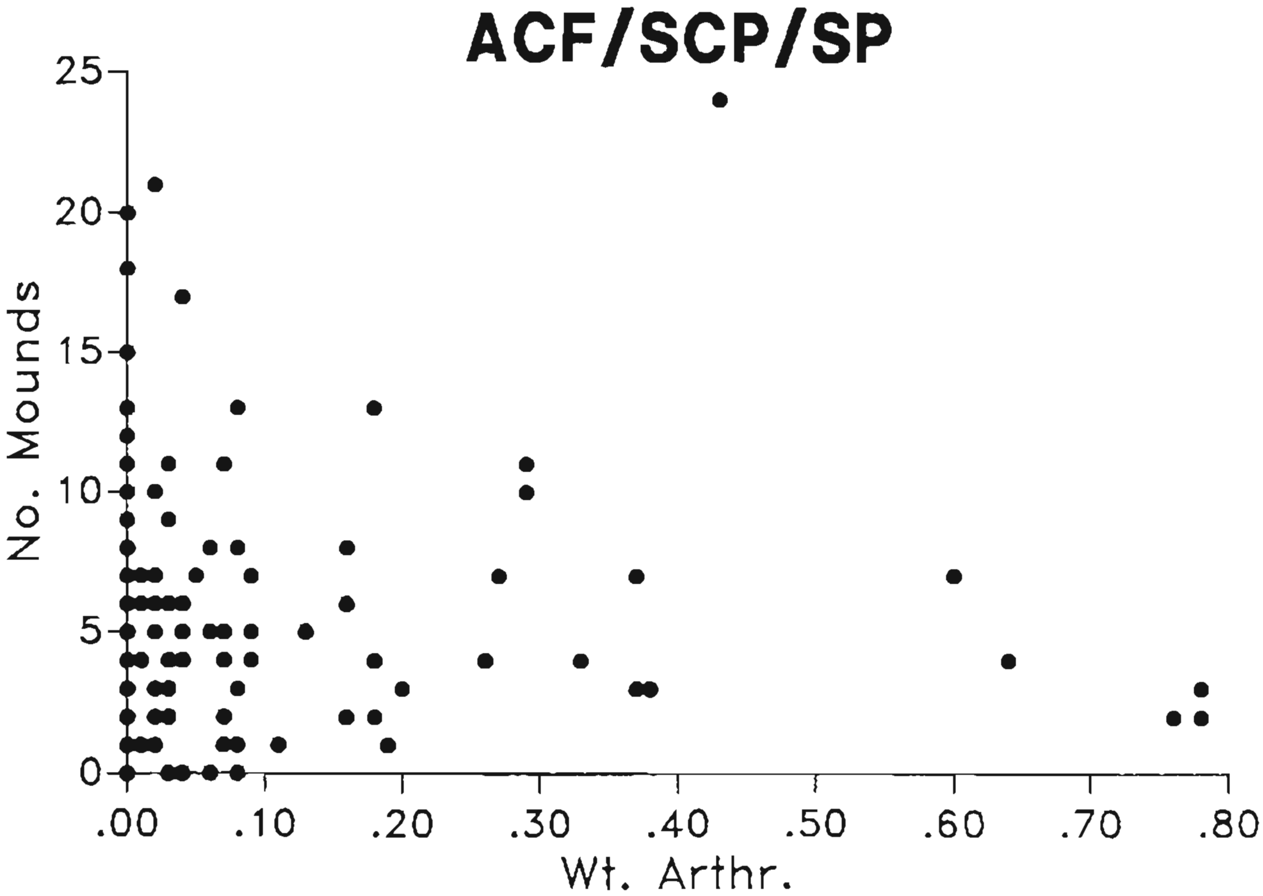
No. Arthr.

Fig. 4



ACF/SCP/SP
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Wt. Arthr.
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Fig. 5

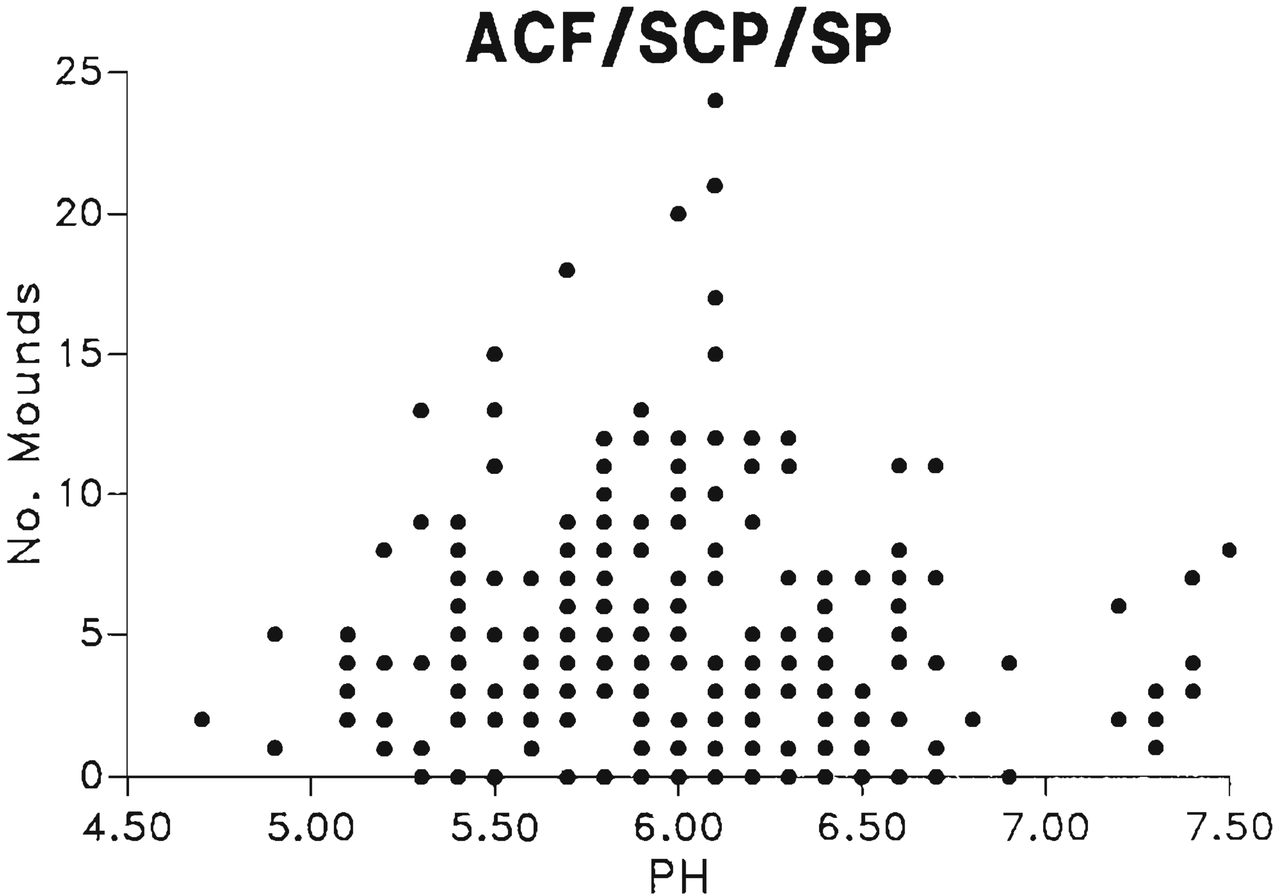


Fig. 6

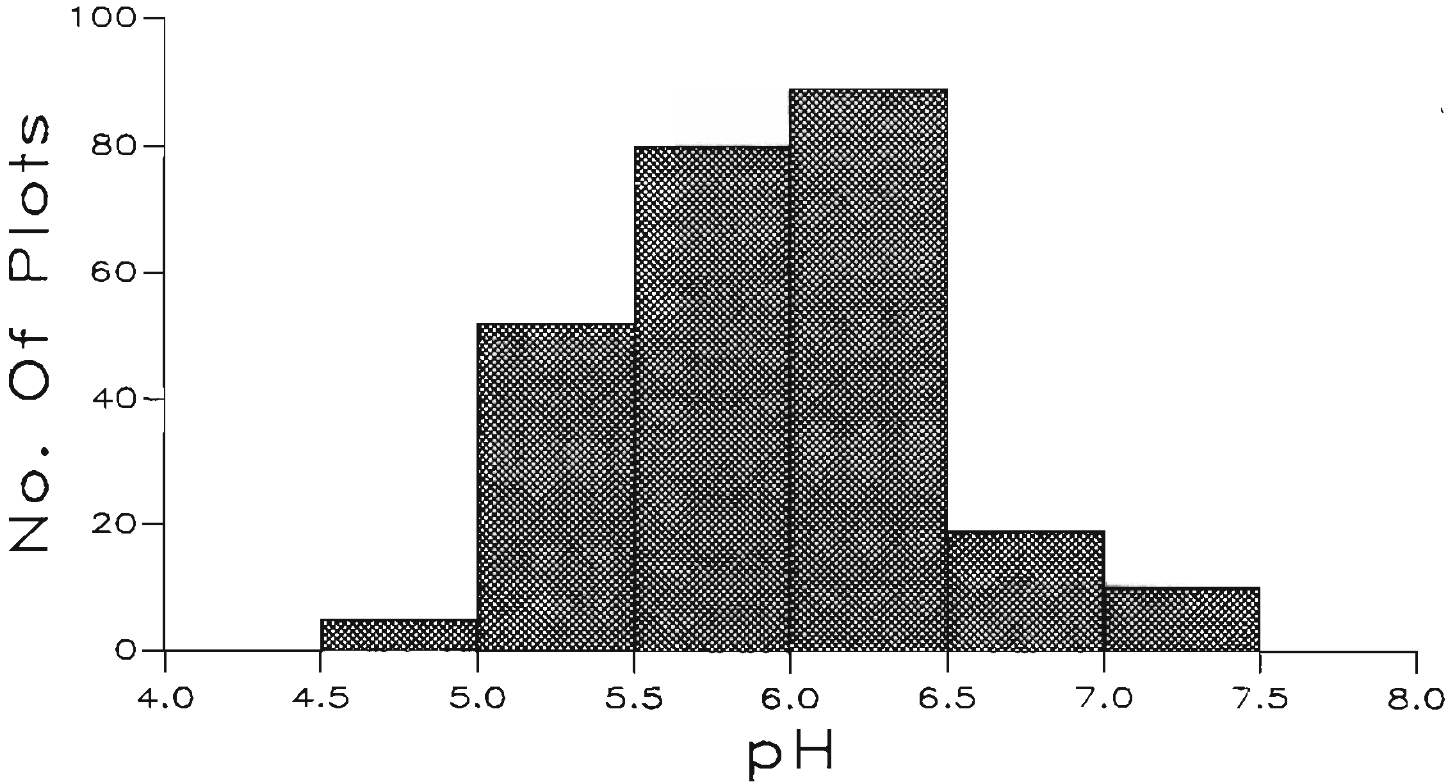
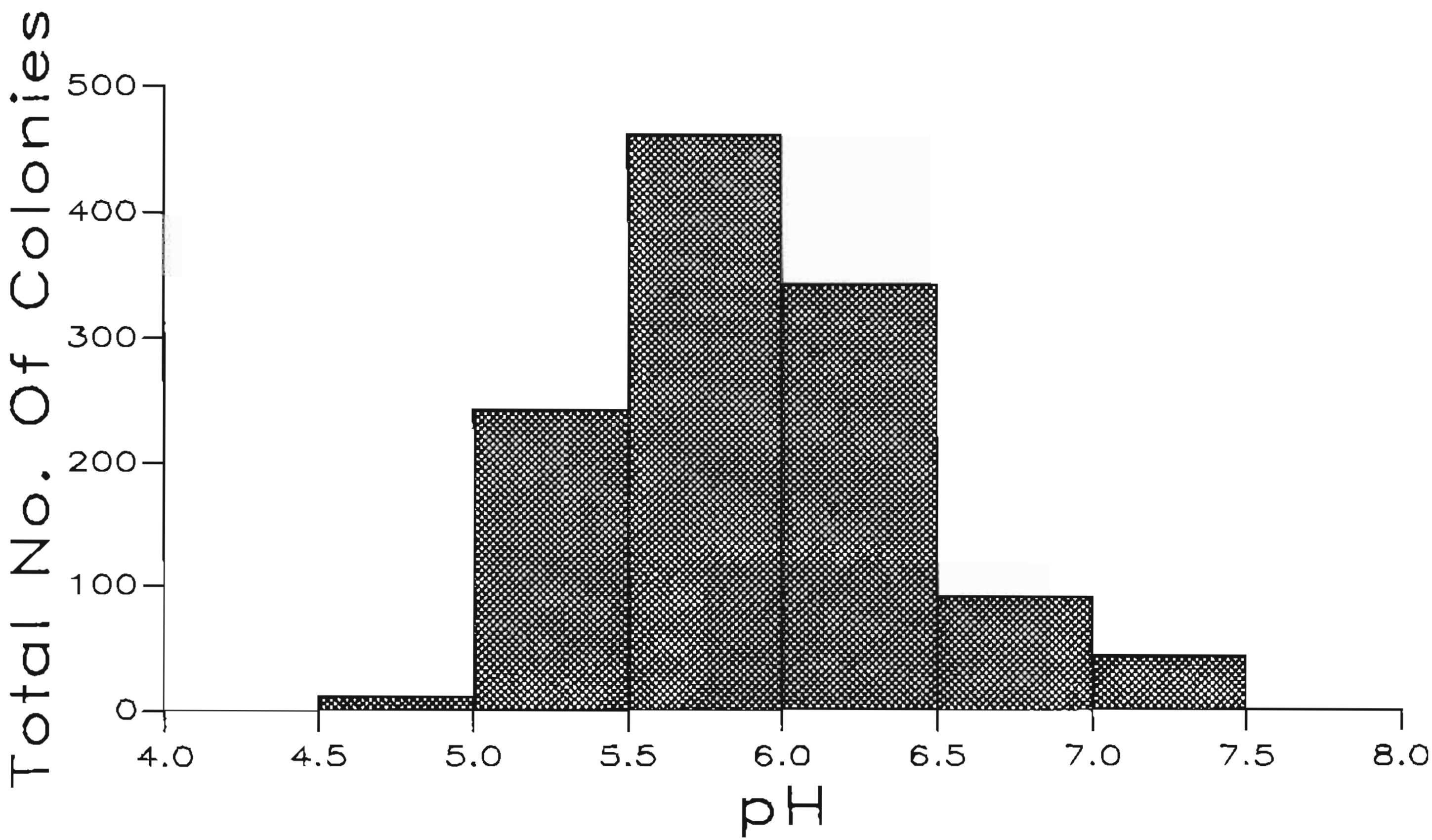


Fig. 7


Total No. Of Colonies
500
400
300
200
100
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4.5
5.0
5.5
6.0
6.5
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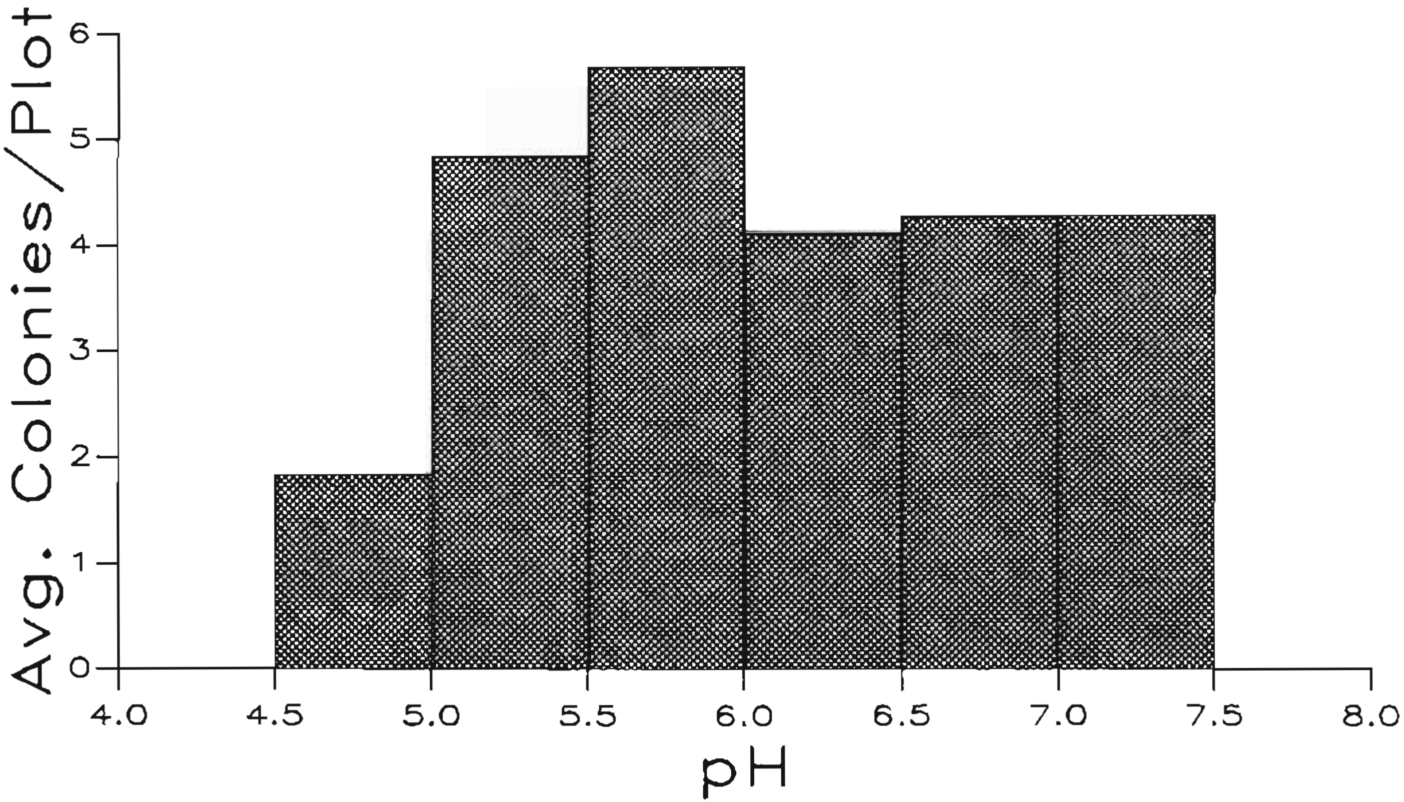
7.5
8.0
pH

Fig. 8



FIRE ANT IMPACTS IN ARKANSAS - RESULTS OF A SURVEY

Lynne Thompson, Professor
Doug Jones, Research Specialist

Red Imported Fire Ants (RIFA) [*Solenopsis invicta*] have been causing problems in the South ever since their introduction. These ants have exerted a pronounced and diverse effect on wildlife, crops, pastures, and most importantly, human welfare. On the good side, RIFA probably destroy many kinds of pest arthropods. They also aerate the soil with their tunneling. On the bad side, they prey on beneficial insects such as bees, lady beetles and many tiny animals that help improve our soil. They may also adversely affect young birds and other animals that can't escape their stings. RIFA mounds provide obstacles to efficient operation of equipment and their tunnels may undermine the foundations of roads and buildings. RIFA readily infest electrical equipment, sometimes causing equipment failures. For some people, RIFA stings are a severe medical risk due to allergic reactions. More often, RIFA impede every-day working and living conditions.

Efforts to control RIFA should be based on sensible biological, ecological, economic and social considerations. Therefore, it is imperative to assess impacts caused by RIFA.

RIFA impacts on human health and welfare consist mainly of stings. People usually consider stings as a nuisance not requiring medical attention. According to a survey conducted by Diffie et al. (1991) in Georgia, householders assessed the nuisance value of ants at $12 a year. When medical care was required, costs increased by $4 per household. Miscellaneous damage was identified as disfigured lawns, distressed pets, and other inconveniences. The data of Diffie et al. (1991) reflect genuine impacts of RIFA because they represent dollars that people actually paid to resolve RIFA problems.

The scientific literature is full of estimates describing RIFA losses to crops and livestock. Some of this information is qualitative, but most includes quantitative results (e.g., Adams et al. 1983, Banks et al. 1990). These reports provide the first step in calculating overall impact of RIFA, but they typically furnish fragmentary economic information, thus rendering an incomplete picture of total RIFA impact.

Surveys are commonly used to assess landowner beliefs about subjects and their extent (e.g., Lemke and Kissman 1989, Diffie et al. 1991). The survey of Diffie et al. (1991) was subsequently extended by Bass et al. (1992) to assess the impact of RIFA throughout Georgia. The results were astonishing, revealing $29 million dollars in total losses. Is Georgia typical of other states? We wanted to know, so we developed a complimentary survey to be administered in Arkansas. Our objectives were to corroborate the conclusions of Diffie et al (1991), and to expand the scope into agricultural impacts and insecticide usage. For this paper our intent is simply to report the results of this survey. Expanding these results to a larger scale will be reported elsewhere.

Methods

A mail survey was conducted in September of 1993 to assess the economic impact of RIFA in southern Arkansas. Residents were selected for participation by having the Cooperative Extension Service in Bradley, Drew and Miller Counties provide us with names of persons on their Agriculture, Horticulture, Home Economics and Livestock mailing lists (duplicates were removed). These counties were selected because they are representative of southern Arkansas, they have plenty of fire ants, and their residents are enthusiastically interested in fire ant control. Of 1250 questionnaires mailed, 325 (26%) were returned, with almost equal numbers from each county. The questionnaire (appended) requested information to obtain responses on economic questions. Inquiries were made about:

- the area, times treated, and costs of current RIFA control efforts.
- maximum amount one would spend to eliminate RIFA from various kinds of land uses.
- how many RIFA attacks (occurrences when stung one or more times) were suffered over the past year and who suffered them.
- source of information on RIFA control.
- source of insecticides for RIFA control.
- insecticides used.
- efficacy of treatments.
- costs of medical treatment for RIFA stings.
- nature of RIFA losses and dollar losses for each item.
- nature of RIFA benefits and dollar benefits for each item.

Data were input into a PARADOX database and verified, then loaded into SPSS/PC for analysis. Results were typically frequency distributions that were graphed using QUATTRO PRO.

Results & Discussion

Nature of landowners

Of 325 respondents, 9% owned less than one acre, 29% owned less than 10 acres, and 37% owned more than 100 acres. Yards (the area usually treated for RIFA) were typically (65%) less than 2 acres in size. For agricultural endeavors, pastures (56%) and hayfields (38%) were common land uses. Pastures (73%) were usually less than 100 acres, and most hayfields (49%) were less than 25 acres. Only 18% of respondents reported having cropland and 48% of these farmed less than 100 acres.

RIFA Information and Insecticide Usage

Almost 50% of respondents said they obtained their information on RIFA control from farm stores. County agents and other persons came in a distant second at 20%. Not surprisingly, most (78%) RIFA insecticides were also purchased from farm stores. Discount stores came in a distant second at 20%. Perhaps those in the RIFA education business should concentrate their efforts on farm stores.

Most (80%) insecticides were applied as individual mound treatments. Amdro was the insecticide of choice (20%), with Orthene (15%) and Diazinon (13%) close behind. Unfortunately, many (16%) people reported using motor fuels and other home remedies. Amdro and Orthene were used in combination with many other insecticides, suggesting general discontent with insecticide efficacy. This became obvious when we asked people if they were happy with the control they were getting; only 15% said yes. People were most happy with baits and least happy with contact insecticides. Motor fuels generally gave people some satisfaction, perhaps much of this was human vindictiveness.

Seventy-five percent of our respondents were unhappy with RIFA control when insecticide efficacy was 60-79%, and 10% were unhappy when efficacy was greater than 80%. This dissatisfaction with control implies that landowners have higher expectations for insecticides than can be reasonably expected considering the rapid recolonization and colony growth rates of RIFA. These results reveal that increased public education is needed to familiarize landowners with the biotic potential of RIFA and the limitations of short-residual insecticides.

Yard Treatments

Results showed that as yard size increased from less than 1 to greater than 5 acres, the application of insecticides for RIFA control decreased dramatically. Almost 74% of the insecticides were applied to yards less than 2 acres in size. Interestingly, the number of RIFA treatments ranged from 1 to more than 20, with 2 the mean. The cost per acre to treat yards ranged from $2 to $400, with $53 the mean. As might be expected, the amount spent to control RIFA was related to yard size (Figure 1).

Maximum Amount to Spend on RIFA Control

One important question requested the maximum amount a landowner would spend per acre per year to control RIFA, if they knew the expense would keep RIFA out of various kinds of land uses, including: yards, gardens, pastures, hayfields, croplands, and poultry operations. The results are shown in Table 1. These values reflect the actual economic impact of RIFA on these landowners since it measures the amount they would spend to prevent RIFA problems.

Table 1. Maximum amount ($) a landowner would spend per acre per year to keep fire ants out of various kinds of land uses in southern Arkansas.

Land use	N	Range	Mean	Std dev
Yard	212	0-500	$45	$60
Garden	81	0-100	20	20
Pasture	114	0-33	6	6
Hayfield	73	0-33	7	6
Cropland	25	0-25	6	6
Broiler	3	5-125	54	63

Based on the amount of complaining by respondents about damage caused by RIFA, we thought they would have spent more on RIFA control than indicated. The amount for broiler operations seems justified since they are typically small in acreage and fire ant control profoundly improves the welfare of humans cleaning up dead birds. We were most surprised in the amount of money likely to be spent in yards. Since yards are usually small, the amount of time and effort spent on control would be minimal compared to the relief obtained by effective RIFA population management.

Medical Impact

Few (13%) individuals in our survey reported consequences from RIFA stings that required medical treatment, even though most (92%) homes sampled had individuals who had been stung. Most individuals requiring medical treatment used home remedies that were inexpensive. Our question about who got attacked and stung by the RIFA showed that persons over 40 years-old received most of the attacks (45%), but that children less than 6 years-old were next highest (25%).

Overall Impact

We asked each respondent to list the kinds of damage caused by RIFA and then report the dollar value lost for the year for each damage. As expected, we received lots of complaints, however, many landowners were unable or unwilling to report dollar values for many of their complaints. Data from those landowners reporting damage were used to compile the following results.

Figure 2 shows the **number of households** reporting damage caused by RIFA. As expected, most complaints were about damage to lawns and lawn mowers. More surprising was the frequency at which RIFA was reported in buildings. However, people may have difficulty separating RIFA from other ants inside buildings, thus giving the RIFA a bad label.

Figure 3 shows the **mean dollar loss** for various loss categories suffered by 113 respondents who quantified RIFA damage. Row crop losses that reflect reduced yields were the greatest. Additional losses to row crop farmers would show up under the "combines & mowers" category. Farmers complain that soil from RIFA mounds clogs combines and that cleaning them necessitates down time, plus the misery suffered by persons digging out the soil and fighting the fire ants in the clogged area.

Most people undervalue their personal labor. Therefore, losses suffered in many categories would likely be higher if people valued their personal efforts at realistic levels. Gardens are an example of a problem where we received many complaints, but acquired few accounts of value losses.

Figure 4 shows the **total dollar loss** suffered to RIFA for various categories. Combines (for field crops) and mowers (for harvesting hay) moved to the top of this list at $15,000 because repairs were relatively expensive and they occurred more frequently. Evidently, losses of yields by farmers in hayfields and row crops are easier to document than similar losses suffered in gardens or other places. Reasoning suggests that perhaps farmers know the value of equipment and time better then non-farmers. Losses over all categories for the 113 landowners reporting losses ranged from \$2-7000 with a mean of \$503 ± 1048 (std dev). Our frequency count showed that 14 individuals reported total losses of \$100, 8 reported \$500, and \$20, \$50, \$200, \$300 and \$1,000 were reported by 5 individuals each. More than 50% of those quantifying damage suffered losses greater than \$200. These results demonstrate that RIFA has a substantial impact on southern Arkansas' landowners.

Benefits of Fire Ants

We asked if RIFA could be considered beneficial and the value of this benefit. Only 8% of respondents said RIFA provided some beneficial feature. Most positive responses (85%) said RIFA ate pests, such as ticks and fleas. However, few persons could placed a value on this benefit. Our experiences with landowners indicate that if they had a choice, they would take the ticks and fleas over the RIFA any day. This is because they believe they can control ticks and fleas, but not RIFA.

Acknowledgements

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Figure 1. Dollars per acre spent to control fire ants in yards in 3 southern Arkansas counties

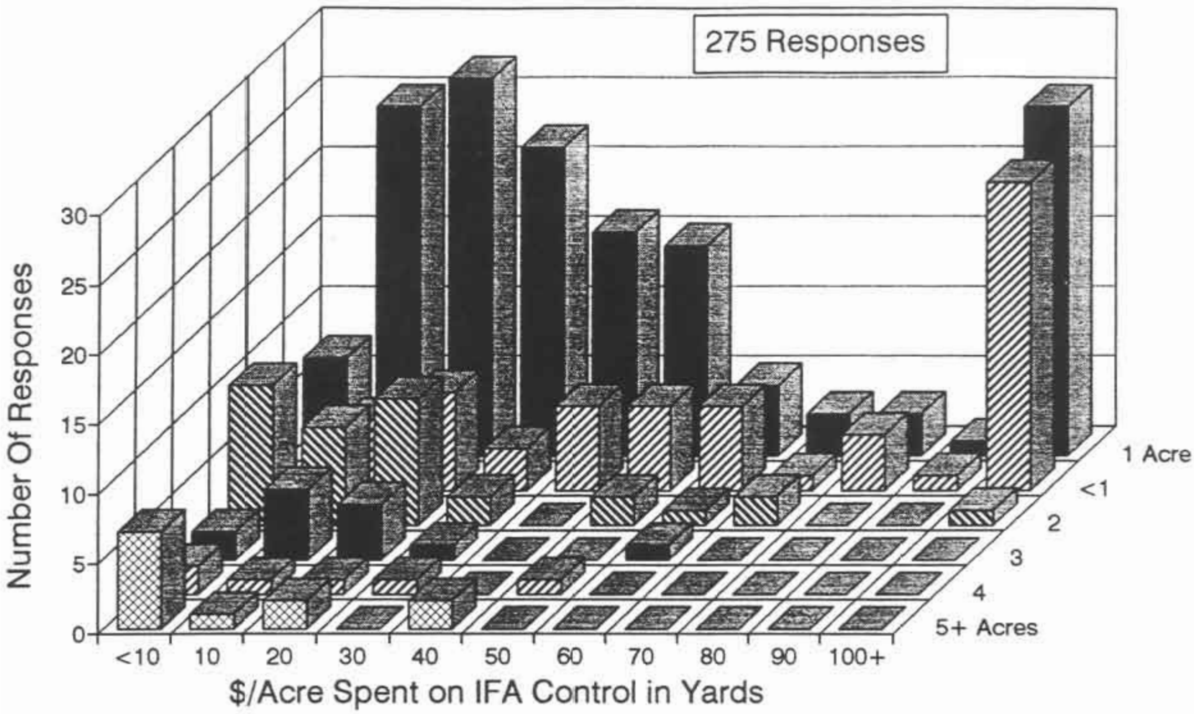


Figure 2. What kinds of problems do you have with fire ants (multiple responses possible).

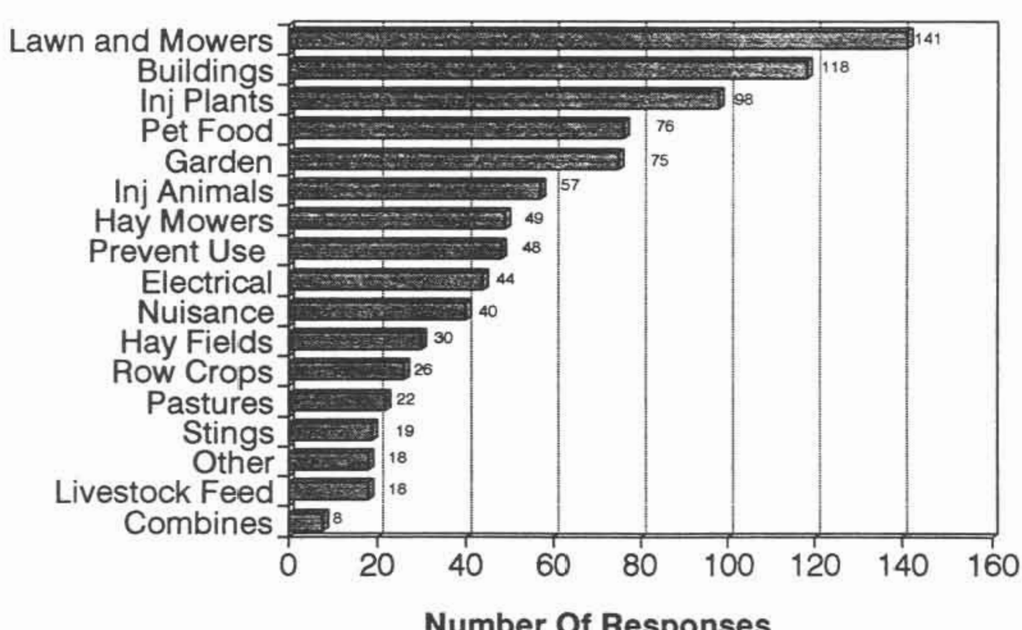


Figure 3. Average dollar loss by those who claimed damage by fire ants in 3 southern Arkansas counties.

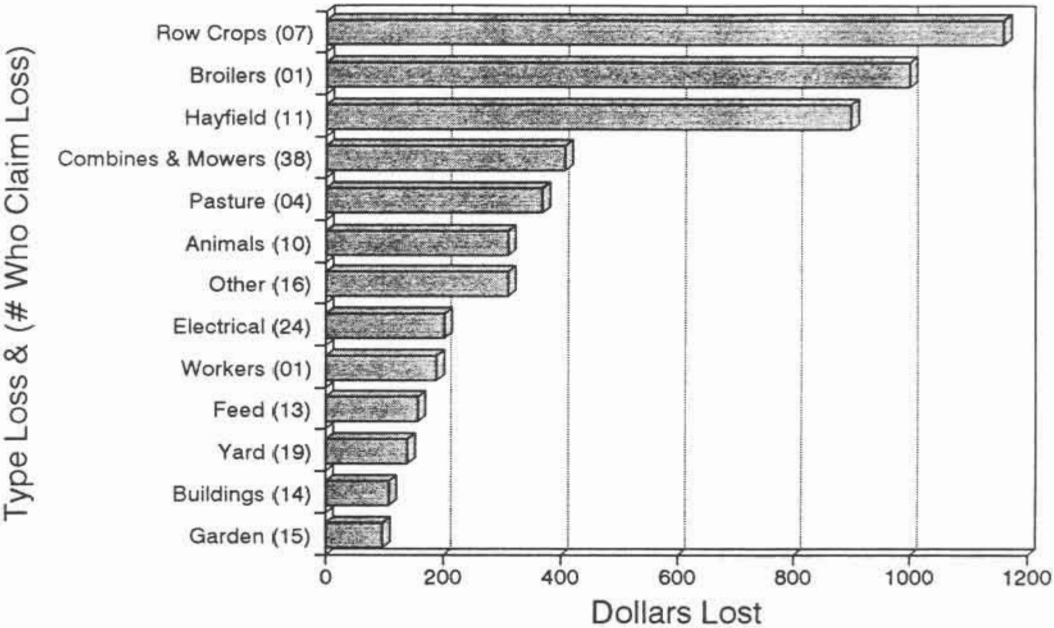
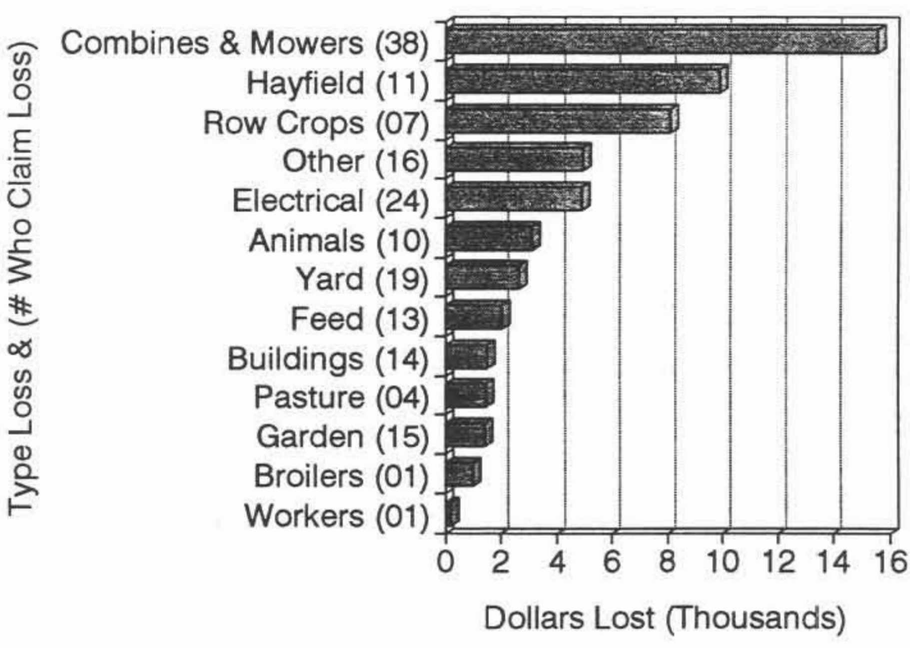


Figure 4. Total dollar loss caused by fire ants in 3 southern Arkansas counties.



Fire Ant Survey - Bradley County, 1993

1. How many acres do you have in each of these land categories?

____ yard	____ pasture	____ unused areas
____ garden	____ hayfield	____ other [name]
____ cropland	____ forest	________________________

2. How many total acres did you treat for fire ants this year? __________ acres

3. How much did you spend this year to control fire ants in your yard? $ _________

4. How many times this year did you treat your yard to keep fire ants under control? ____ times

5. How many non-yard acres did you treat this year? _______ acres

6. How much did you spend this year to control fire ants in non-yard areas? $ _________

7. How many times this year did you treat your non-yard areas to keep fire ants under control? ______ times

8. Assuming you could get excellent control, what would be the maximum amount you would be willing to pay per acre per year to keep ants out of each of these areas.

$_____ yard	$_____ pasture	$_____ unused areas
$_____ garden	$_____ hayfield	$_____ other [name]
$_____ cropland	$_____ forest	________________________

9. What do you currently use to control fire ants (please circle pesticides and methods)?

Insecticide		Method
	Logic/Award bait	
Amdro bait	Orthene powder	Broadcast
Diazinon	Other (name)	Mound treatment
Dursban	__________________	

10. How effective is this control? (circle) 0-40% 40-60% 60-80% 80-100%

11. Are you happy with this level of control? (circle) Yes or No

12. If you or anyone else in your household were stung by fire ants this year, how old were they and on how many occasions were they stung?

0 - 6 yrs, ___ occasions 7-12 yrs, ___ occasions 13-18 yrs, ___ occasions
19-25 yrs, ___ occasions 26-39 yrs, ___ occasions 40-59 yrs, ___ occasions
60+ yrs, ___ occasions

(continued on other side)

13. Did any members of your household need medications or see a Doctor to treat fire ant stings or allergic reactions caused by such stings? (circle) Yes or No

14. If so, how much was spent per case? $__________

15. Where do you get most of your information for making decisions about fire ant control? (please circle the most common source)

farm store	TV	neighbor	Other (name)
garden store	magazine	relative	__________
discount store	newspaper	county agent	

16. Where do you purchase or obtain most of your insecticide and the directions for their use? (please circle the most common source)

farm store	nursery	Other (name) __________
garden store	hardware	
discount store	relative or friend	

17. Besides stings, do ants cause other problems on your property? (circle) Yes or No

18. If so, briefly describe each kind of damage? (examples might include: damaged lawn or equipment, injured animals or plants, garden or crop losses, invade buildings, eat pet foods, prevent or reduce property usage, others [please name]):

19. Estimate the dollar value lost due to each damage. For each damage, give dollar loss and a basis for this estimate (an example might be yield losses or repair costs).

20. Do you consider fire ants beneficial in any way, like eating pest animals? (circle) Yes or No

21. If so, briefly describe this benefit?

22. Estimate the dollar value of this benefit, and give some basis for your answer.

Thank you for your help. Please return questionnaire in the stamped self-addressed envelope.

RESULTS FROM THE TEXAS VETERINARIAN SURVEY: IMPACT OF RED IMPORTED FIRE ANTS ON ANIMAL HEALTH

Charles L. Barr, Extension Associate
and
Bastiaan M. Drees, Professor and Extension Entomologist

The red imported fire ant (*Solenopsis invicta* Buren) is recognized as a major nuisance pest in the southeastern United States. With tens of millions of infested acres, there has also been a great deal of concern and anecdotal evidence about the ants' negative impact on livestock, pets and wildlife, however very little scientific data is available in regards to frequency and economic impact on animal health. With current fire ant suppression methods estimated to cost $10 per acre per year (Drees & Vinson 1993), there is a great need to justify the cost of these treatments in agricultural and ecological systems.

The red imported fire ant can cause temporary blindness (Joyce 1983) and occasionally death (Lofgren 1986) in calves and reportedly cause problems during hay harvesting because the tall, hardened mounds destroy machinery and the ants invade hay bales (Lofgren 1986). However, ant predation also suppresses ticks and related problems (Harris & Burns 1972, Fleetwood et al. 1984). Ants also prey on the immature stages of horse flies (Johnson & Hays 1973, Drees 1987) and other insects (Lofgren 1986).

To document fire ant related losses to the Texas animal industry, the Texas Agricultural Extension Service, in cooperation with the Texas Veterinary Medical Association, Texas A&M College of Veterinary Medicine, the Texas Veterinary Medical Diagnostic Laboratory and the Texas Agricultural Experiment Station, conducted a survey of the veterinarians in the state of Texas. Direct funding was provided by the American Cyanamid Corporation and program support funding was provided by Ciba-Geigy. The survey was designed to assess the frequency, severity, and economic losses associated with fire ant activity in relation to animal health.

The impact of fire ants on livestock production systems involves many factors including effects on animal and human health, equipment damage, possible forage loss and degradation, and increased labor costs. Eventually, it is hoped that an economic injury level can be developed, but to do so, a cost must be determined for each factor. Losses reported by veterinarians in this survey document **only a part** of the impact of fire ants in livestock production systems.

Materials and Methods

Specialists in entomology, agronomy, livestock production, agricultural economics, large animal veterinary medicine, veterinary toxicology and general veterinary medicine developed the survey. A mailing list was provided by the Texas Veterinary Medical Association. Surveys were mailed the week of 15 August 1993 to **all** listed members in postage-paid return envelopes. No attempt was made to exclude certain specialties, practice types or areas of the state. All surveys received on or before 15 December were included in the analysis.

A spreadsheet program, using SuperCalc 5.0, was developed to tabulate the survey results. In order to prepare the survey data for computer entry, all surveys were examined and results converted by hand to a standard format, if necessary. Each survey was given a reference number and all data from surveys reporting fire ant injury were entered into the spreadsheet. Those surveys reporting no fire ant related injuries had county(ies) of origin and written comments recorded, but no data entered into the spreadsheet.

Using the results of the Texas Veterinary Survey and statewide statistical information, an attempt was made to calculate, the impact of fire ant related animal health problems to Texas. Methods of extrapolation are presented in Barr, et. al. (1994). We have focused on cattle as an example, but similar methods can be applied to other animal groups. The major assumption in this calculation is that those veterinarians not responding to the survey experienced similar ant related problems as did respondents. No effort was made to contact these individuals to determine the reasons for not responding.

Results and Discussion

Figure 1 depicts the number of surveys returned from each county in Texas. Over 90 percent of the counties in the state were included in the respondents service areas. Some veterinarians reported problems with fire ants in counties not known to be infested with red imported fire ants, however they were not asked to report incidence by county so it is likely that their service areas included both infested and uninfested counties.

The number of surveys completed and returned was one of the most striking results of this survey: a total of 837 out of 2,499 for a return rate of 33.5 percent. On a detailed survey of this type, 15 percent is often considered adequate. Given the hectic nature and long hours of a veterinary practice, a response of this magnitude is indicative of the great interest in fire ants within the animal health community and, most likely, the general population. The map of county responses (**Figure 1**) shows the remarkably complete coverage of the state. Of the surveys returned (837) nearly two-thirds (522) were marked as "Yes," the veterinarians having treated animals for fire ant injury. The results reported in the sections below were obtained only from the 522 surveys on which veterinarians responded "Yes" to treating or witnessing fire ant related animal health problems.

I. Frequency and economic impact of ant related injuries and mortality

The frequency of fire ant related animal injuries, by species or animal group, is summarized in **Table 1**. With a total of 7,204 cases reported annually, the average number of fire ant related cases per respondent per year was 5.2. Of the animals affected by fire ants, small animals and pets accounted for more than half of all reported injuries. Next was injuries to cattle, 17.5 percent, and then wildlife, 12.1 percent. Considering the enormous areas that are not routinely contacted by man, and the difficulty in spotting an injured fawn or bird, fire ant impact on wildlife may be more significant than the survey indicates. If nothing else, these survey results document a need for further scientific research on fire ant damage to wildlife.

Results on the frequency and type of fire ant injuries and the average cost for treatment are summarized in **Table 2**. The average cost for treatment was $53.87, resulting in an annual total treatment cost of $726.904.53 in treating over 13,000 fire ant injuries. Dermatitis accounted for almost half of these reported cases with many instances of multiple injuries.

Only 110 respondents answered the section about animal mortality (21.1 percent of 522). A total of 2,649 animals were reported to have died from fire ant related injuries annually (**Table 3**), for a total loss of $3,486,047. Cattle, presumably mostly newborn calves, made up the largest group; 1,387 or 52.4 percent. It is difficult to establish a cause and effect relationship between fire ants and animal death since many animals are found only after they have been lying dead or incapacitated for an unknown length of time. Small animals and pets, while accounting for half the injuries, accounted for only 16 percent of the deaths. It is possible that time between human observation is a major factor in both determining and preventing fire ant related mortality. Results here are from those incidents where a veterinarian became involved. Undoubtedly, many, if not most, cases go unreported so these results are likely a very conservative estimate of mortality. **Figure 2** illustrates the disparity between animal types and occurrence of injury and mortality.

Ratites, flightless birds including ostriches, emus, and rheas, accounted for only 2.8 percent of the reported injuries and 8.0 percent of the deaths. However, ratite deaths accounted for over **$2.1 million** in losses, 61.6 percent of the total. This imbalance is the result of the value of these birds. The average cost of a single ratite loss was calculated at over $10,000. The cause of most losses is unclear, though. Despite the susceptibility of bird eggs to fire ant attack in the wild (Drees 1992), ratites are usually raised under almost sterile conditions. According to several reports, adult birds exhibited shock-like symptoms after fire ant stings. **Figure 3** depicts the disproportionate economic damage that ratite producers suffer from fire ants.

The monthly distribution of fire ant injuries is presented in **Figure 4**. Over 76 percent of all injuries were reported in the months April-September, supporting suggestions for fire ant management in livestock operations (Drees and Vinson 1993). Results should also encourage animal caretakers to pay particular attention to fire ant suppression during warmer months or reduce the potential of ant related health problems by scheduling birthing for the cooler months.

II. Opinions and perceptions

We felt it was important to know the prevailing attitudes of the veterinarians about fire ants and their control as well as their actual experiences. One concern is how much people think it costs to treat for fire ants and how much they think it should cost. The perceived annual cost per acre for fire ant treatment was an average of $13.87 per acre per year. The average economically justifiable cost was calculated at $4.42 per acre per year. Comparing the two averages, there exists a gap of $9.45. In other words, veterinarians think the cost of treatment is over three times as expensive as it should be. **Figure 5** illustrates the response breakdown to these two questions.

Potential cost is not the only factor involved in deciding to manage fire ants. In many instances, perceptions of the threat caused by the ants' presence play an equal or more important role. Over 69.5 percent felt that fire ants were a significant threat to domestic animal health. Over 81 percent felt that they were a threat to livestock health and a surprising 83 percent felt that fire ants might cause economic loss in livestock production. Over 59 percent of respondents felt it was not economically feasible to treat large areas such as pastures and rangeland, though 31 percent reported they were unsure. Over 46 percent reported that "calving pastures" were economically feasible. Over 77.4 percent felt it was feasible to suppress ants around feed storage areas, electrical equipment and stock tanks. Detailed responses to Opinions and Perceptions are presented in **Figure 6**.

III. Composition and Caseload

This section compared the frequency of fire ant related problems to the average practice caseload. In an average day the "average" veterinarian treats: 15 to 16 dogs and cats; 1 or 2 exotic small animals or birds; 7 to 8 cows; about 4 horses; about 1 sheep, goat, or pig; about 1 exotic large animal or ratite; only 1 or 2 fowl per week; and the occasional reptile, fish or other animal.

The percentage of fire ant related cases can now be estimated. For instance, if an average veterinarian sees 2,737 cattle per year (7.5 cattle per day x 365 days) and sees 6 cases of fire ant related animal health problems requiring treatment per year, only 0.22 percent of the cattle cases seen are fire ant related. **Table 4** lists a similar breakdown of injury frequency for all species.

IV. Extrapolation of Survey Results

Values calculated from the extrapolation of cattle losses to Texas are summarized in **Table 5** (Barr et.al 1994). Assuming similar results from non-responding veterinarians, the total statewide loss to cattle from fire ant related injuries and death is estimated at about \$2.2 million or \$0.07 per grazed acre. Though this amount is minor by itself, it is only a small part of the potential impact of fire ants on the cattle industry. The methodology used in the extrapolation can be applied to other species and animal groups with sufficient supporting economic data.

Conclusions

- Based on the rate and distribution of returns and question responses, there is considerable interest in and concern over the impact of fire ants on animal health in Texas.
- Small animals and pets are, by far, the most frequently treated type of animal for fire ant related health problems, with cattle second and wildlife a close third.
- This survey documented a conservative cost of \$750,000 per year to treat fire ant injuries with over 7,200 animals treated, most with multiple injuries.
- Fire ants cause three-fourths of their yearly injuries from April through September.
- This survey documented nearly \$4.5 million in death losses blamed on fire ants.
- The ratite industry suffered over \$2.1 million in losses, alone.
- The respondents felt, overwhelmingly, that fire ants pose a significant threat to animal health and livestock production economic loss.
- The respondents felt that fire ant treatments are more than three times as expensive than is necessary to make them economically feasible in a livestock operation.
- Few respondents felt it was economically feasible to treat large acreages, though many felt i feasible to treat "calving pastures" and most facilities.
- Though fire ant associated animal health losses are substantial and of great concern, they are relatively minor compared to the size of the livestock and pet industries.
- This survey documented only cases seen by veterinarians. It is likely that many more animals are affected, but are not taken for medical care.

- Given the great interest, particularly in areas not infested with the red imported fire ant, there needs to be increased targeting of information regarding effective fire ant management programs to veterinarians and livestock producers.
- Animal health professionals and the public need to be made aware of the seasonality of fire ant injury and educated on ways to take advantage of it with methods such as scheduled breeding and timing of fire ant treatments.
- With wildlife being third in the number of reported fire ant related cases treated by veterinarians, further research needs to be conducted to determine the impact of fire ants on wildlife, particularly deer.
- The ratite industry urgently needs a targeted program on fire ant management methods and pesticide label additions or clarifications regarding use in and around ratite facilities.
- Manufacturers and researchers will need to develop new chemicals and/or application methods to reduce fire ant treatment costs to make their use economically feasible in livestock operations.
- More surveys on economic loss need to be conducted among livestock producers and ranchers to help confirm the results found here and to justify the costs invested in fire ant treatments.

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Table 1. Number and percent of fire ant injuries occurring annually by species or animal group.

Species	No. responses (% of tot.)	No. cases (% of tot.)	Avg. cases/respondent
Small Animal	489 (35.3%)	3,715 (51.6%)	7.6
Bovine	225 (16.3%)	1,260 (17.5%)	6.0
Equine	213 (15.4%)	622 (8.6%)	2.9
Poultry	149 (10.8%)	335 (4.7%)	2.2
Wildlife	215 (15.5%)	872 (12.1%)	4.1
Ratites	56 (4.0%)	205 (2.8%)	3.7
Other Exotic	31 (2.3%)	182 (2.5%)	5.9
Other	5 (0.4%)	13 (0.2%)	2.6
Total	1383 (100%)	7,204 (100%)	5.2

Table 2. Incidence of fire ant injury type and associated costs.

Injury Type	No. responses	No. cases	Avg. cost	Total Cost
Blindness	209	2,717(20.1%)	$67.59	$183,642.03
Dermatitis	453	6,688(49.6%)	$52.24	$349,381.12
Secondary infection	249	1,948(14.4%)	$44.54	$86,763.92
Gastritis	76	440(3.3%)	$54.16	$23,830.40
Injury to convalescent animals	159	1,658(12.3%)	$48.39	$80,230.62
Other	12	43(0.3%)	$71.08	$3,056.44
Total		**13,494**	**$53.87**	**$726,904.53**

Table 3. Frequency and economic loss associated with animal mortality.

	No. Animals (% of total)	Avg. Loss/Animal	Total Loss (% of total)
Bovine	1,387 (52.4%)	$474.17	$657,670 (18.9%)
Equine	83 (3.1%)	$1,649.75	$136,930 (3.9%)
Poultry	381 (14.4%)	$44.17	$16,830 (0.5%)
Small/Animal	423 (16.0%)	$488.59	$206,675 (5.9%)
Ratite	214 (8.0%)	$10,029.42	$2,146,295 (61.6%)
Other Exotic	161 (6.1%)	$1,997.81	$321,647 (9.2%)
Total	**2,649**	**$1,315.99**	**$3,486,047**

Table 4. Composition and caseload analysis of respondent practices.

	Number of responses	No. of cases	Average cases per respondent	Fire ant related percent of caseload
Small animal				
Dog/Cat	462	7,092	15.4	0.19%
Avian/exotic	281	455	1.6	N/A
Large Animal				
Bovine	206	1,502	7.3	0.32%
Equine	215	903	4.2	0.27%
Poultry	106	34	0.32	2.64%
Sheep/Goat/Swine	154	124	0.81	N/A
Exotic	133	120	0.91	1.56%
Other	24	22	0.92	N/A

Table 5. Extrapolation from responses to statewide cattle losses.

0.069%	Percent cattle estimated to be treated for ant injury in Texas
0.076%	Percent cattle estimated to be lost due to ant related mortality in Texas
$203,736.34	Statewide value of cattle treated due to fire ant related health problems
$1,963,063.80	Statewide value of cattle lost due to fire ants
$2,166,800.00	Estimated statewide economic impact of fire ants on livestock health
$0.01	Per acre cost of fire ant related treatments to cattle in Texas
$0.06	Per acre cost of fire ant related death to cattle in Texas
$0.07	Total extrapolated per acre impact of fire ants of cattle health

Fig. 1 Veterinary Fire Ant Surveys Returned

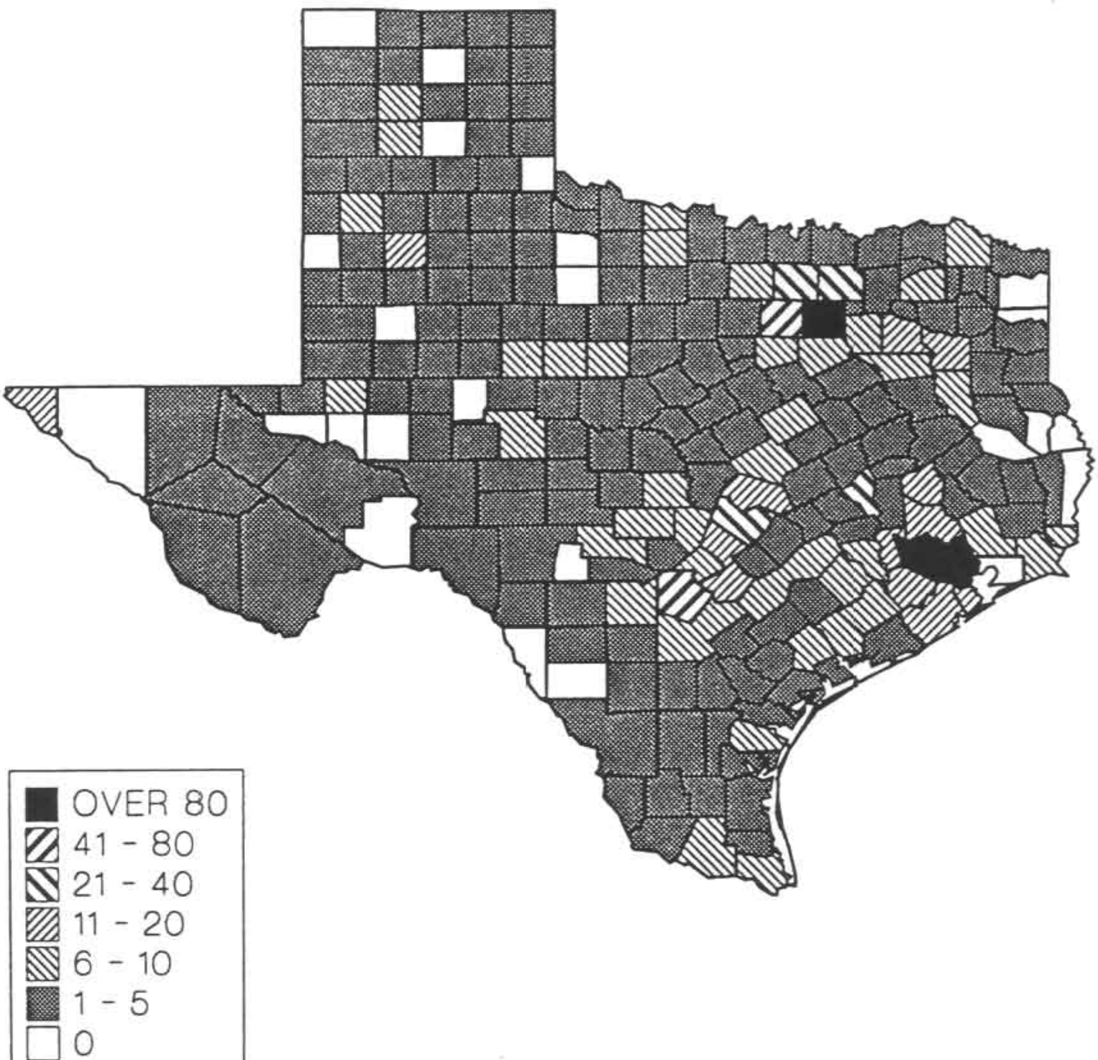


Fig. 2. Mortality vs injury frequency

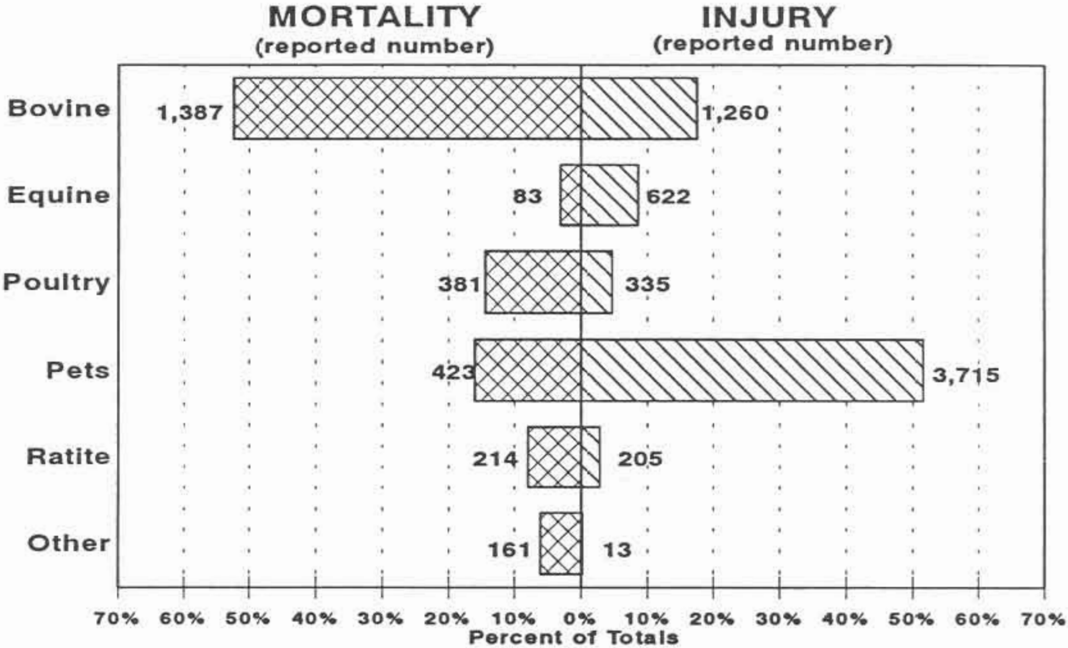


Fig. 3. Mortality vs economic loss

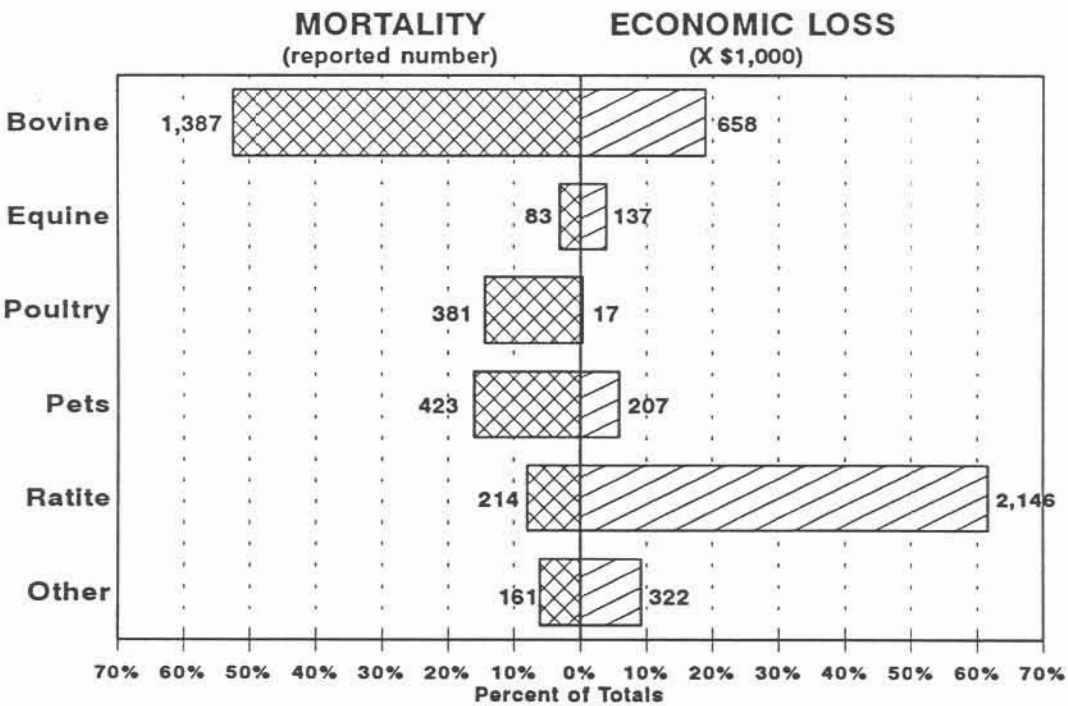


Fig 4. Seasonality of fire ant injury

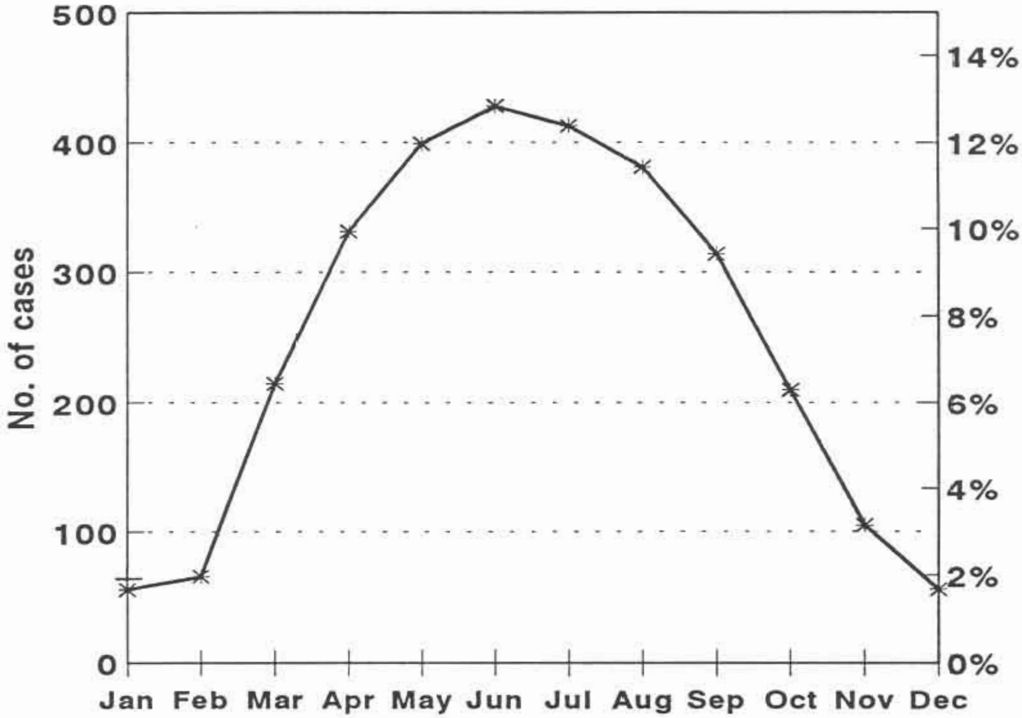


Fig. 5. Cost of treatment perceptions

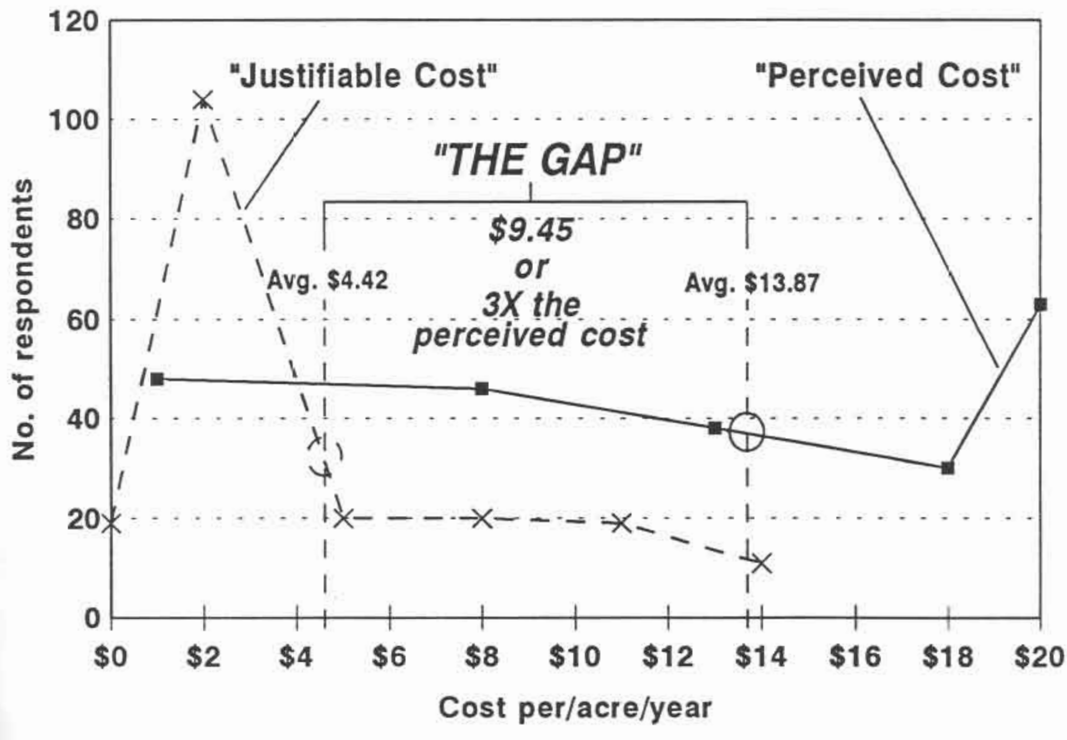
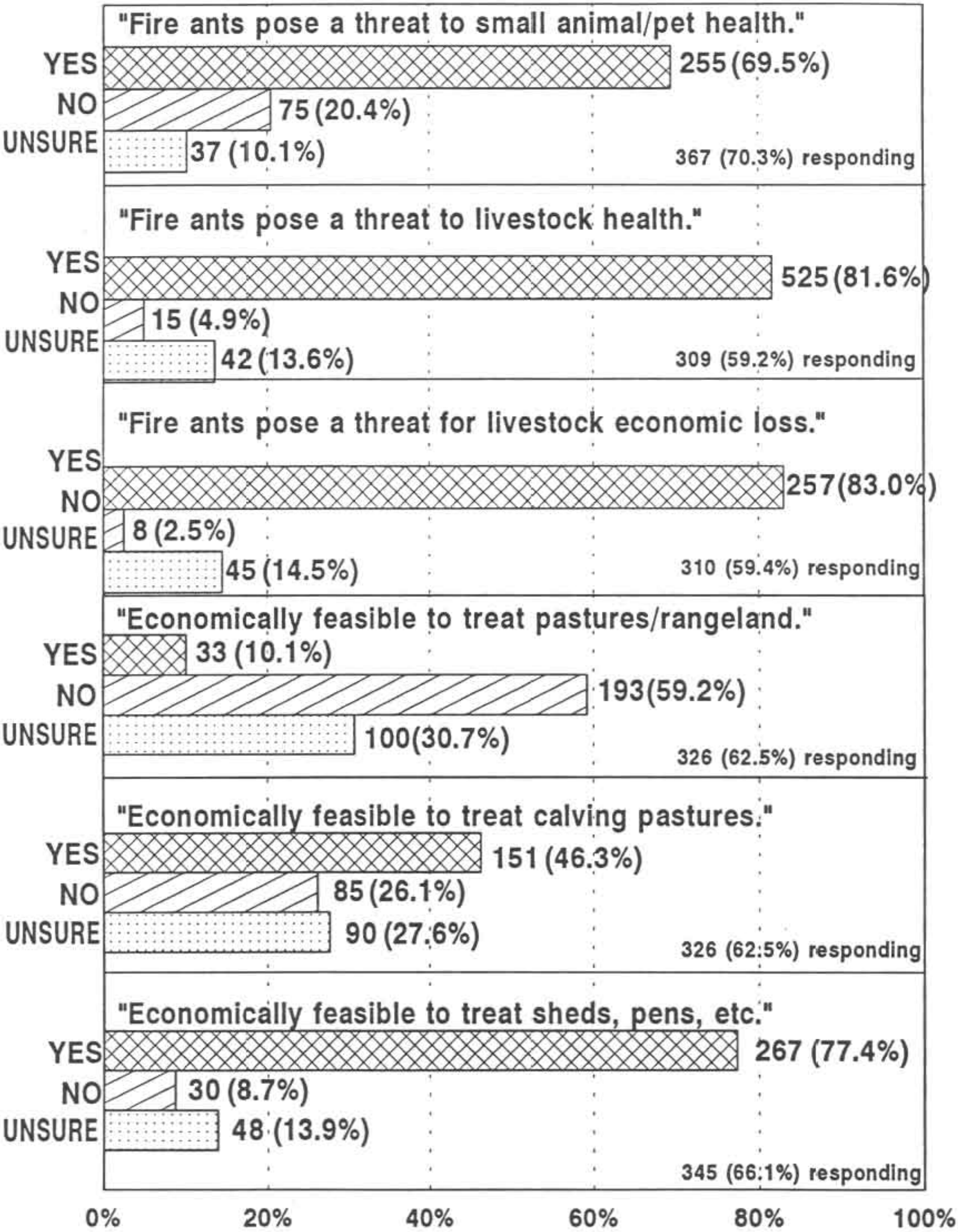


Fig. 6. Responses to opinions and perceptions section



ABSTRACT

MEDICAL CONSEQUENCES OF MULTIPLE FIRE ANTS STINGS OCCURRING INDOORS

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Stings by the imported fire ant almost always lead to dermal wheal and flare reactions followed by sterile pustules at sting sites. Less commonly, large local dermal reactions, pyoderma, anaphylaxis or neuropathy may occur. Such reactions have previously been associated with contact with the insects out of doors. We present two previously unreported cases of indoor attacks of individuals by imported fire ants. One patient experienced a cerebrovascular accident in association with the attack, while the second patient had no obvious sequelae. With these two reports, a total of four such indoor massive sting episodes have appeared in the recent medical literature. Physicians and other individuals living in areas indigenous to the fire ant should be aware that infestation of buildings with fire ants may be associated with attacks on humans indoors. Individuals with cognitive dysfunction seem to be especially at risk for attacks by fire ants.

IMPACT OF THE IMPORTED FIRE ANT ON DECOMPOSER COMMUNITIES IS DEPENDENT ON THE RESOURCE SIZE

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The invasion of the imported fire ant, *Solenopsis invicta* Buren, across the southeast United States has been relatively rapid, moving 20 to 30 miles per year into new territory not restricted due to cold or dry conditions (Hung and Vinson 1978, Moody 1981). This invasion has occurred at the expense of several "native" species of *Solenopsis* (Moody et al. 1981) and has been accompanied by a dramatic increase in the density of *Solenopsis*, particularly as the result of invasion of the polygynous form of *S. invicta* (Vinson 1993). Porter and Savignano (1990) reported that the polygynous form of *S. invicta* replaced not only native *Solenopsis* but many other ant species, monopolizing the food resources of an entire guild of omnivorous ant species.

The effect of the invasion of *S. invicta* on the ecosystem is both of concern (Mann 1994) and controversy (Vinson 1993). Part of the controversy is rooted in the available data concerning the impact of the imported fire ant, which presents a confusing picture (Lofgren 1986). According to some authors, the ant is either an aggressive predator that is beneficial in controlling certain pests (Adams et al. 1981, Reagen et al. 1972, Burns and Melancon 1977), or detrimental by their impact on beneficials (Vinson and Scarborough 1991, Lopez 1982, Tedders et al. 1990). However, in other reports the imported fire ant had no effect on specific arthropods under study in a particular community (Sterling et al. 1979, Rhoades 1963, Howard and Oliver 1978) and their impact on vertebrates is equally confusing (Vinson 1993).

One problem in determining the effect of the imported fire ant on arthropod communities is how to evaluate their impact. Porter and Savignano (1990) and Summerlin et al. (1984) compared arthropod density and species richness in infested and uninfested areas, but locating nearly identical areas with and without fire ants is difficult. Removal of ants by poison baits (Sterling et al. 1979, Howard and Oliver 1978) may affect other arthropods and many species may not rebound after the ants have been removed. Phillips et al. (1987) correlated species diversity and abundance with imported fire ant density, but it is difficult to know whether such correlations are based on a cause and effect or are due to indirect effects.

Vinson (1991) utilized a transient resource (decomposing fruit where ant access could be manipulated) to evaluate the impact of fire ants. Through these studies he evaluated the impact that fire ants were having in competition with other arthropods for the resource, as well as determining their ability to dominate the resource through both aggression and predation. The results demonstrated that *S. invicta* not only utilized the resource but successfully prevented colonization by other decomposers. When *S. invicta* was excluded, the native decomposers were abundant in numbers and diversity. If the resource was first colonized by native decomposers, upon exposure to *S. invicta* both the native decomposers and remaining resource were consumed by the ants. However, such activities may depend on the size of the resource, which is further investigated here.

MATERIALS AND METHODS

The methods generally followed those described by Vinson (1991). Aluminum pans (25 x 35 cm, 4 cm high) were filled with wet, washed sand (3 cm deep). Ripe muskmelons trimmed to 400 gm (approximately the amount used in the Vinson 1991 study). These quarters represent a medium resource. The center of one slice (40 gm) represented a small resource and ten slices (4000 gm) were used as the large resource. Each different resource size was placed on sand in a separate pan and these pans were placed in polygyne infested fields. Before placing the pans, a small area was cleared of grass and other objects and a wooden plate (25 x 35 x 2 cm) was placed on the ground. Three fluon (ICI America, Wilmington, DE) coated glass jars were next placed on the wooden plate to form a tripod on which the sand containing pan was placed. The fruit, pan, jars, and wooden base were covered with a quarter inch hardware cloth cage which was fastened to the ground (Vinson 1991). Access to the differing amounts of fruit resource by fire ants was provided by placing a 0.5 cm diameter dowel rod from the pan to the ground. Identical pans with differing resources but with no ant access served as controls. Pans with the differing amounts of resource and exposed to fire ants, and the pans where the ants were denied access were collected at 3, 6, 9, 12, and 15 days as described (Vinson 1991). The number of ants and other insects were collected and recorded. The study was replicated three times.

RESULTS AND DISCUSSION

The number of ants recruited to the three sizes of resource are shown in Fig. 1 for day three and six. As shown there is a 10-fold increase in the number of ants responding to the medium resource over the small resource at both times. However, the number of ants responding to the large resource is much less than predicted (Fig. 1) for both times. The results suggest that as the resource increases the ability of the ants to respond reaches some limit that is likely dependent on the size of the colony, as well as the resource. While this result might be predicted in monogyne populations where a colony is distinct and controls a certain area or territory (Wilson et al. 1971, Eisenberg 1972), such a result was not expected in polygyne areas where presumably ants could be recruited from several different mounds (Bhatkar and Vinson 1987). Although ants may move from mound to mound in a polygyne area (Bhatkar and Vinson 1987) and are polydomas, they may not recruit from different mounds to the same location or resource.

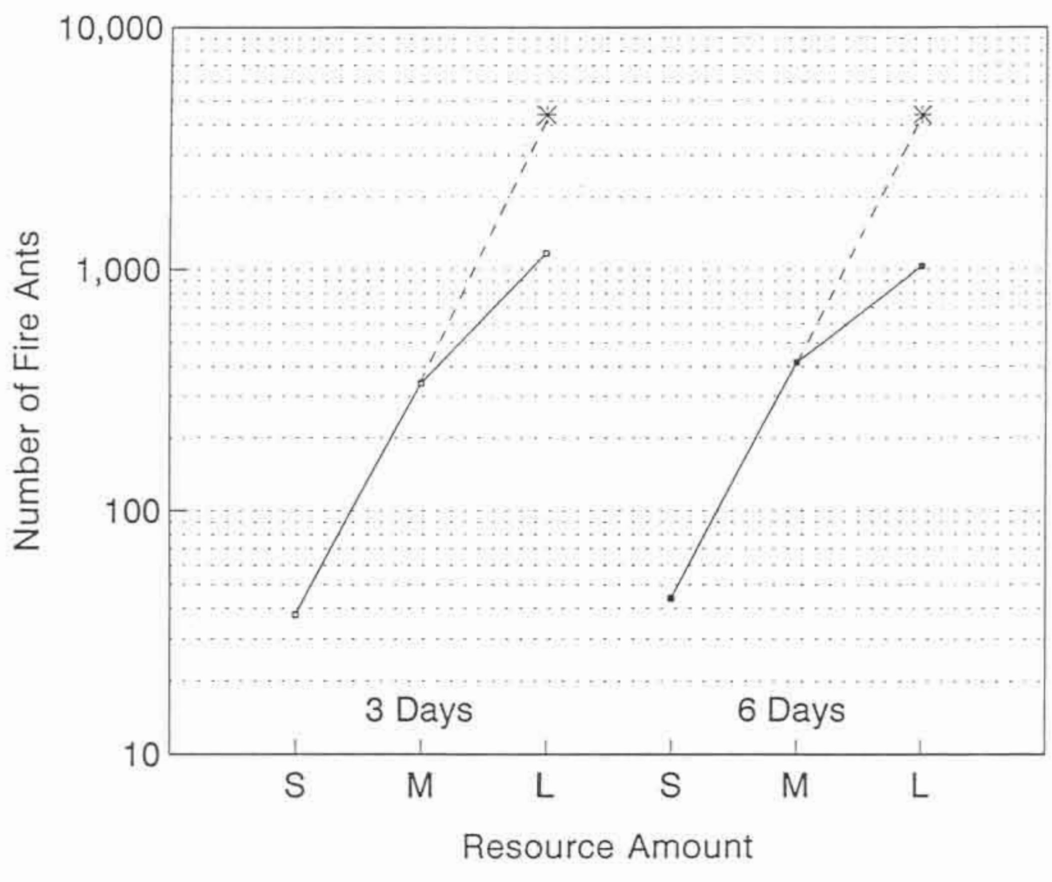

Figure 1. Number of imported fire ants recruited to the three resource sizes (S = small, M = medium, L = large) three and six days after field placement. The star is the predicted number of ants that should have recruited to the largest resource.

For convenience in this presentation, the number of decomposer insects in the samples includes both immatures and adults pooled regardless of the species. In the case of the samples exposed to the fire ant, the ants have been excluded from the count. As shown in Figure 2 the number of insects in or on the three sizes of resource differed whether ants were present or not. The initial difference in the decomposer population size from the small to large of the ant-free resources (solid line in Figure 2) was only 5 fold. These results suggest that the recruitment of most decomposers is substantially different from the fire ant.

The small resource supported the greatest number of decomposers on day 3 and then declined (Figure 2S). This decline appeared to be due to the resource drying out by day 4 and failing to recruit decomposers after day 3. Only a few immatures were able to develop and pupate, which began to occur by day 9 in the small resource after it dried up. The greatest number of arthropods in the medium resource occurred on day 6 and then declined as recruitment stopped. Many of the smaller immatures left the largely decomposed medium resource by day 9 to presumably search for other resources. The greatest number of arthropods on the large resource occurred on day 12. Recruitment slowly declined and the resource contained many immatures beginning to pupate while others were just hatching. By day 15 the large resource was beginning to rapidly decompose and the apparent intense competition for the remaining resource suggested that many of the younger immatures would fail to mature.

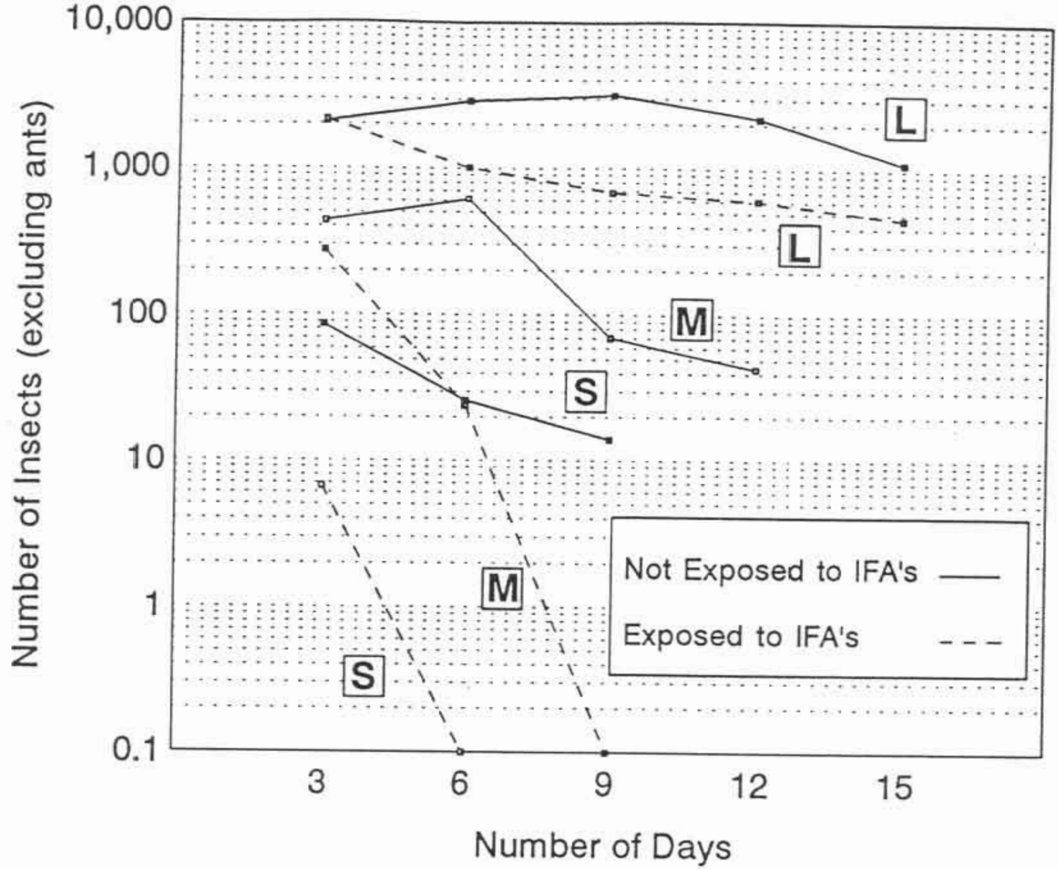

Figure 2. Number of decomposer insects excluding ants over time on the small (S), medium (M), and large (L) resource without fire ants compared to resources with fire ants.

The presence of fire ants drastically reduced the number of decomposers recruited to and remaining on the small and medium samples (dashed line in Figure 2) with most of the developing immature decomposers removed by day 6 and 9, respectively. The ants impact on the decomposers in the medium resource being similar to the decline reported by Vinson (1991). The ants effect on the decomposers in the large resource was much more moderated. Although there was a continual decline in the decomposer numbers in the ant access sample, the decline that began on day 9 of the ant-free resources was much steeper. Although this study was not carried beyond 15 days (these studies are in progress), the rapid steeper. Although this study was not carried beyond 15 days (these studies are in progress), the rapid decline in arthropods in the ant-free sample beginning at 9 days is due in part to the intense competition and death of many immatures, particularly the younger stages. The fire ants appeared to reduce this competition, resulting in a more moderate decline as the younger stages had access to unoccupied feeding niches.

These results suggest that the impact of the fire ant on the ecosystem may depend not only on the susceptibility of the resource to the ants, but on the abundance of the resource in relation to the colony sizes in a particular area.

ACKNOWLEDGMENT

Approved as TA __________ by the Director of the Texas Agricultural Experiment Station. Special thanks is given to Mrs. Sherry Ellison for her help in counting the insects in the decomposing samples.

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YEAST FLORA OF THE RED IMPORTED FIRE ANT

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Abstract

Yeast flora of the red imported fire ant, *Solenopsis invicta* Buren, was investigated beginning the winter of 1992. Ant colonies were collected from Beaumont, Huntsville, Waco, Stephenville and Abilene, Texas. These sites represent a transect along a moisture gradient from the southeastern to the northwestern part of the state. Ten colonies were randomly collected from each site during the winter, spring, summer, and fall months. Yeast species were identified using morphological, physiological, biochemical, and medical identification schemes. In addition, the dominant yeast species were identified based on their cellular fatty acid contents. The five yeast species isolated from the haemolymph of the red imported fire ant in decreasing abundance were as follow: *Candida parapsilosis, Yarrowia lipolytica, Candida rugosa, Candida guillermondii,* and *Debaryomyces hansenii. Candida parapsilosis* and *Yarrowia lipolytica* represented 90% of yeast isolates detected. *Candida. parapsilosis* was isolated from all sites and seasons, whereas, *Y. lipolytica* was isolated from four of the five sites. Comparisons of mean weights of colonies with and without yeast were made among locations and seasons using GLM procedures. Biomass of colonies with yeasts was significantly greater than colonies without yeasts from the Abilene site ($\underline{P}<0.05$). No significant differences were detected in weights of colonies with and without yeasts from the other four sites. In addition, colonies with yeasts were significantly greater in weight ($\underline{P}<0.01$) than colonies without yeasts collected during winter and spring. Yeast isolates were detected in 3.2% of the adult workers, 80% of the worker larvae, and 24.5% of the colonies. These data indicate that the presence of yeasts does not have a negative impact on colony weight. Because colony weight is an indication of vigor, yeast association with the red imported fire ant does not appear to be pathogenic. In addition, high prevalence of yeasts in larvae suggests a nutritional role.

Fire Ant Mortality Caused by an Alginate-Formulated Fungus.

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Various strains of entomopathogenic fungi may cause significant mortality within colonies of the red imported fire ant (RIFA). However, antagonistic activity of soil has reduced fungal efficacy (several references from Stimac, Periera, *et al.*, 1992, 1993). Bioassays of *Beauveria bassiana* against small RIFA colonies in soil in containerized nursery stock (Patterson, Thorvilson, Jouvenaz, and Sanchez, unpublished data) have indicated that non-sterile soil may have competitive factors to fungal pathogenicity.

Since the late 1980's, a sodium alginate pelletization process has been used to encapsulate mycoherbicides and fungal pathogens of various insects. The process may extend storage viability, ensure survival in various habitats, and improve pathogenicity in soil. The senior author learned the procedures of encapsulation from T. Poprawski and R. Humber while on an extended visit to the USDA-ARS, Plant, Soil, and Nutrition Laboratory on the Cornell University campus, Ithaca, NY. We encapsulated mycelia of a *B. bassiana* strain isolated in our TTU laboratory by Sergio Sanchez-Pena from *Atta* from Mexico.

Scanning electron micrographs revealed that mycelia, wheat bran, and alginate were homogeneously mixed within pellets. Red food coloring or orange, UV-fluorescent dye added to mixtures did not inhibit conidiogenesis after pellets were rehydrated, when compared to uncolored pellets. Fungal-induced mortality of RIFA's in non-sterile vermiculite (five replications of 12 ants per petri dish) was faster than in sterile vermiculite (approximate LT_{50} = 9 d and 13 d, respectively). The LT_{50} of ants in sterile potting soil was approximately 9 d; whereas, mortality was delayed in non-sterile potting soil ($LT_{50} \approx 15$ d). In each medium environment, colored pellets caused faster and generally higher mortality among ants. We plan to continue this line of research and to determine those factors of soil that antagonize entomopathogenic fungal development, viability, or infectivity.

THE EFFECT OF PRESCRIBED BURNING, CONTROLLED GRAZING, FLOODING AND INSECTICIDE USE ON THE RED IMPORTED FIRE ANT

Bastiaan M. Drees[1] and Charles L. Barr[2]

Abstract

Red imported fire ant mound densities were monitored in three sites: 1) Attwater Prairie-Chicken National Wildlife Refuge (Colorado County, Texas) areas under various prescribed burning and controlled grazing regimes for habitat management; 2) fallow rice fields in Colorado County, Texas, 0.5, 1.5 and 2.5 years after floodwater was drained; and 3) plots behind the dam at Lake Conroe, Montgomery County, Texas, where insecticide treatments had been applied. Results document the effect of land disturbance/use on fire ant mound densities. Prescribed burning and controlled grazing had no apparent effect on mound numbers although ant mounds were more easily detected shortly after burning. Fire ants colonized areas following flooding at a rate of 37 mounds per acre per year and 18 months after insecticide application, no significant differences between treatment and untreated plots remained.

The red imported fire ant, *Solenopsis invicta* (Buren), successfully colonizes disturbed lands (Summerlin et al. 1976). We conducted several studies to obtain in-field data to document the effects of prescribed burning and controlled grazing, flooding and insecticide use on fire ant mound densities under Texas coastal conditions. Results are intended to provide research-based information to support management suggestions discussed in Extension educational programs (Drees and Vinson 1993). Due to the potential of fire ant colonization following some types land disturbance the decision to implement fire ant suppression programs, particularly in biologically sensitive areas, must be carefully evaluated and justified on the documented or potential negatively effect of fire ants in these areas. If the suppression programs are not sustainable for extended periods of time, not initiating a suppression program may be the best management decision.

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Materials and Methods

Controlled burning and grazing practices. The Attwater's prairie chicken, *Tympanuchus cupido attwateri*, is a subspecies of the Greater prairie-chicken or Heath hen. The Attwater Prairie-Chicken National Wildlife Refuge was established in 1972 to preserve and restore critical habitat for this endangered subspecies and contains approximately 8,000 acres managed by the U.S. Fish and Wildlife Service. Native grasses and forbes of the prairie are critical components of prairie-chicken habitat. Management techniques to maintain and improve habitat include controlled grazing, prescribed burning, strip row cropping, mowing, pest plant control and predator control. Snakes, opossums, raccoons, coyotes, armadillos and especially skunks prey upon the eggs and young birds.

The red imported fire ant has been documented to prey on hatching eggs of several ground-nesting birds including waterfowl (Drees 1992) and quail (Travis 1938). 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.

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 four managed areas or plots under a rotational cultural management regime of prescribed burning, shredding and controlled grazing as described in **Table 1**. No management areas were burned during 1993. All were under continuous grazing throughout the year.

On March 16, 1991, four permanent subplot sites were established within each management plot using metal fence posts. They were arranged in transect lines originating from road intersections that separate managed 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 using the minimal disturbance method. This process was repeated on 12 March 1992 and 16 March 1993. Average density of fire ant mounds and the effect of cultural management practices were evaluated over the three year period. Data were analyzed across years for each managed area (plot) individually and together using analysis of variance (ANOVA) and Duncan's Multiple Range Test ($P \leq 0.05$).

Flooding. Rice production in Texas is characterized by permanently flooding fields through the summer months, then draining them for harvest during August through November. Fallow rice fields, which had been planted to rice and flooded during the summer 0.5, 1.5 and 2.5 years prior to surveying were selected (These fields were planted to rice in 1992, 1991 or 1990, respectively). Four sets each of fallow rice fields were surveyed in February 1993. Within each field, six 0.5 acre circular areas, selected as to avoid field margins and levees, were monitored for the presence of active fire ant mounds and the presence of reproductive larvae and pupae. Resulting mound numbers were analyzed using regression analysis and the Student's *t* test ($P \leq 0.05$). No attempt was made to determine whether the fire ants detected in fallow rice fields were monogynous or polygynous.

Insecticide use. This trial consisted of one-acre square blocks, 210 feet on a side, with a 30-foot buffer left between adjacent plots. Before treatment (June 11 and June 15, 1992) fire ant-active mounds were counted within an 83-foot radius circle (approx. 0.5 acre) in the center of each plot using the minimal disturbance method. Treatments were assigned by first ranking the plots from highest to lowest in active mound numbers. The highest six were blocked into the first replication, the next highest six the sècond replication, and so on to make four replications. Treatments were numbered from one through six and, using a random number table, were randomly assigned to plots within each block. The treatments were as follows:

1) Untreated Control
2) Logic, solid coverage (1.5 lbs total)
3) Logic, skip swath coverage (0.75 lbs. total)
4) Amdro, solid coverage (1.5 lbs. total)
5) Amdro, skip swath coverage (0.75 lbs. total)
6) Logic/Amdro (1:1 by weight) hopper mix, solid coverage (1.5 lbs. total)

The bait was broadcast using a tractor-mounted Herd® Model 77 seeder. Swath width was 35 feet. Six swaths were required to cover the solid coverage plots and four swaths were applied to the alternate swath plots, two on the outer edges and two roughly straddling the center.

Subsequent evaluations were made on 13 July, 13 August, 25 September, 1992; 13 January and 7 June 1993; and 5 January 1994 using the minimal disturbance technique. Data were analyzed using analysis of variance (ANOVA) and separated using Tukey's studentized range test (PC SAS) at $P \leq 0.05$.

Results

Controlled burning and grazing practices. Population densities of fire ants throughout this study were found to be within the range normally associated with areas inhabited by the single queen or monogynous form of the red imported fire ant (40 to 150 mounds per acre)(**Table 2**). These densities are dramatically lower than those associated with the multiple queen or polygynous form of this species (200 or more mounds per acre). Although mound numbers declined after 1991, no significant differences in mound density occurred in the analysis of combined data from the four managed areas over this 3 year study.

On 9 March 1991 fire ant mound numbers were found to be remarkably consistent between plots except in the recently burned Plot 4. There, mound density averaged 89 mounds per acre, 45 percent greater than in plots with forage cover and the higher density encountered through this 3 year study (**Table 2**). Apparently, the lack of cover allowed more mounds to be detected in these subplots.

The 12 March 1992 evaluation revealed that fire ant mound numbers had remained constant or declined from the previous year, even though plots 1 and 2 had recently been burned (**Table 2**). Mound numbers in Plots 3 and 4, burned in 1990 and 1991 and now supporting dense vegetation, were significantly lower than in 1991 (**Table 3**). Whether this decline resulted from the burn, weather conditions or ant mound monitoring ability can not be conclusively determined from these data. No significant changes in mound numbers occurred from 1992 through the last monitoring date, 16 March 1993 (**Table 3**). The only managed area (plot) in which a significant increase in mound numbers occurred over the three years was in Plot 2, where there was a prescribed burning in January 1992. These results indicate that this population of fire ants is rather stable.

Flooding. No red imported fire ant mounds were found in fields planted to rice the previous summer (**Table 4**). In 1.5 year fallow rice fields (1991), ant mounds averaged 45 per acre (ranging from 12 to 92) and in fields planted to rice 2.5-years earlier (1990), an average of 74 mounds per acre (ranging from 28 to 202) was detected. A significant linear regression (F = 97.695; P = 0.0001; d.f = 70) was found between the appearance of mounds over time: Y = 18.52X + -17.319, where Y = ant mound density and X = time (years, rounded off). The number of plots in which reproductive brood was detected also increased over time, with 8 of 24 plots in 1991-planted rice fields (1.5 years) and 18 of 24 plots in 1990 planted rice fields (2.5 years).

Insecticide use. Results of the first six months of this trial are presented in Drees *et. al* (1993). Effects of all treatments except for the skip-swath Amdro® application suppressed ant mound numbers relative to the untreated control plots for 12 months (**Table 5**). At that time, the Logic® + Amdro® treatment provided numerically greater suppression than other treatments. By 18 months after application, no significant differences between treatments remained. Although mound numbers in plots treated with Amdro® and Logic® 18 months after treatment were higher than pre-treatment levels, mound numbers in the untreated plots had also increased somewhat.

Discussion

Results of monitoring fire ant mound densities in Reichardt Prairie, The Attwater Prairie-Chicken National Wildlife Refuge, suggest that prescribed burning and the other cultural practices implemented did not affect fire ant colony density. During a short period following a burn, fire ant mounds may be more noticeable and more accurately sampled because of lack of cover vegetation. Shredding or grazing practices produced no noticeable differences in mound numbers.

Results of monitoring ant mounds in fallow rice fields in Colorado County, Texas documented fire ant colonization following flooding. Ant mound densities in this disturbed habitat were shown to increase at a rate of 37 mounds per acre per year. Over a three-year period, densities increased to 74 ($\pm$ 37.6) mounds per acre, exceeding densities in a stable habitat at the nearby Attwater Prairie-Chicken National Wildlife Refuge by 25 mounds per acre (34 percent).

Slow-acting fire ant bait products tested at Lake Conroe, Montgomery County, Texas, effectively suppressed fire ant mound numbers for 12 months. However, by 18 months after treatment, mound numbers were again equal to those in untreated plots. Results can not be directly compared to the other trials reported here from Colorado County because initial mound numbers in Montgomery County were higher, possibly representing the polygynous form of the fire ant. Therefore, statements regarding the speed at which fire ants colonize an area previously cleared of ants by flooding versus insecticide use can not be made from these data. Environmental conditions during the seasons also affect the frequency of mating flights and the success of colony founding by mated queens.

In areas with low and relatively stable red imported fire ant populations and where the red imported fire ant has not been documented to produce or potentially produce a negative impact, the best sustainable management decision may be not to implement a insecticide-based fire ant suppression program. The Attwater prarie-chicken produces one brood per year, with chicks hatching by mid-May. Seasonal predation patterns of the red imported fire ant (Drees 1992) in conjuction with the prairie-chicken's reproductive biology may allow this ground-nesting species to avoid heavy ant predation. Unfortunately, this theoretical escape mechanism has not been verified by field studies in the Refuge. Furthermore, fire ant mound densities at the Refuge are low relative to other fire-infested areas of Texas and particularly where the multiple queen form occurs (Porter et. al 1991). Maintaining monogyne populations rather than potentially allowing the polygyne form to colonize a previously treated or disturbed area may be the better strategy to maintain low red imported fire ant mound densities.

Acknowledgments

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Table 1. Management practices conducted in Reichardt Prairie, The Attwater Prairie-Chicken National Wildlife Refuge, Colorado Co., Texas.

Plot 1) 106 acres (this area contains a booming area)
- Not burned since 1979
- Burned 24 Jan. 1992
- Strips of this plot were shredded 14 to 18 September 1992

Plot 2) 137 acres
- Not burned since 1983/84
- Burned 24 Jan. 1992

Plot 3) 234 acres (this area serves as good nesting/brood habitat)
- Burned in 1990
- Shredded early August 1991
- Shredded, 11 to 14 August 1992

Plot 4) 175 acres (this area serves as a primary nesting habitat)
- Burned in February 1991
- Shredded early August 1991
- Strips of this plot were shredded 14 to 18 September 1992

Notes: All areas serve as nesting/brood habitat following a burn.

Table 2. Number of red imported fire ants per 0.46 acre subplots within culturally managed areas of the Reichardt Prairie, Attwater Prairie Chicken National Wildlife Refuge, Colorado County, Texas, 1991 through 1993.

Plot/management practices	No. fire ant mounds per 80 ft. radius circular Subplot 1	2	3	4	Mean[a]	
6 March 1991:						
1. not burned since 1979	19	24	22	23	22.0b	(48[b])
2. not burned since 1983/84	24	23	21	21	22.2b	(48)
3. burned in 1990	24	24	30	18	24.0b	(52)
4. burned in February 1991	34	50	40	40	41.0a	(89)
12 March 1992:						
1. not burned since 1979[c]	23	20	22	19	21.0ab	(46)
2. not burned since 1983/84[c]	32	23	16	29	25.0a	(54)
3. burned in 1990[d]	14	9	13	11	11.8bc	(26)
4. burned in February 1991[d]	9	17	14	15	13.8bc	(30)
16 March 1993:						
1. not burned since 1979[e]	14	24	27	19	21.0b	(46)
2. not burned since 1983/84	28	32	29	38	31.8a	(70)
3. burned in 1990[f]	17	17	9	12	13.8bc	(31)
4. burned in February 1991[e]	14	13	11	14	13.0c	(28)

[a] Means in columns for each monitoring date followed by the same letter are not significantly different using analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT)($P \leq 0.05$): 6 March 1991, $F = 19.328$, $P = 0.0001$; 12 March 1992, $F = 7.450$, $P = 0.0300$; 16 March 1993, $F = 14.788$, $P = 0.0003$.

[b] Number of mounds per acre

[c] Burned 24 Jan. 1992

[d] Shredded early August 1991

[e] Strips of this plot were shredded 14-18 September 1992

[f] Shredded, 11 to 14 August 1992

Table 3. Mean number of red imported fire ants per managed area (plot), Attwater Prairie Chicken National Wildlife Refuge, Colorado County, Texas 1991-1993.

	No. red imported fire ants per 0.46 acre[a] Managed area (plot)				
Year	1	2	3	4	Mean
1991	22.0a	22.3b	24.0b[b]	41.0b[c]	27.3a
1992	21.0a[d]	25.0ab[d]	11.8a	13.8a	18.0a
1993	21.0a	31.8a	13.8a	13.0a	19.5a
F	0.105	4.57	10.67	75.26	1.372
P	0.9017	0.0622	0.0106	0.0001	0.3345

[a] Means in columns followed by the same letter are not significantly different using analysis of variance (ANOVA) and Duncan's Multiple Range Test (DMRT)($P \leq 0.05$).

[b] Burned Feb. 1990

[c] Burned Feb. 1991

[d] Burned Jan. 1992

Table 4. Number of red imported fire ants per 0.5 acre circle area in fallow rice fields, Colorado County, Texas 1993.

	No. fire ant mounds per 0.5 acre circular plot				
	Field				
Sample site	A	B	C	D	A-D
		Planted to rice in 1992			
1	0	0	0	0	
2	0	0	0	0	
3	0	0	0	0	
4	0	0	0	0	
5	0	0	0	0	
6	0	0	0	0	
Mean	0	0	0	0	0
		Planted to rice in 1991			
1	28*	6*	46*	22	
2	40*	18	34	9	
3	25*	26*	26*	25	
4	12	24*	16	54	
5	10	25	13	19	
6	7	8	20	18	
Mean $\pm$ S.D.	20.3	17.8	27.5	24.5	22.5**
	$\pm$ 12.8	$\pm$ 8.9	$\pm$ 11.4	$\pm$ 15.4	$\pm$ 12.1
		Planted to rice in 1990			
1	41*	15	27	32*	
2	24*	48*	52*	44*	
3	14	33*	29	48*	
4	22	42*	52*	30*	
5	20	41*	101*	23*	
6	38*	26*	65*	22*	
Mean $\pm$ S.D.	26.5	34.2	54.3	33.2	37.0**
	$\pm$ 10.7	$\pm$ 12.1	$\pm$ 27.1	$\pm$ 10.7	$\pm$ 18.8

* Indicates presence of reproductive brood.

** Indicates means are significantly different according to the Student's t test ($P \leq 0.05$; d.f. = 46; t = -3.1681).

Table 5. Fire ant active mound numbers per 0.5 acre subplot within one acre treatment plots before and after June 24, 1992 treatments, Conroe, Texas.

Treatment	Pre-count	3-weeks	6-weeks	3-months
	Mean no. fire ant active mounds/0.5 acre*			
untreated control	61.25a	62.50ab	34.00a	52.50a
Logic® solid	60.25a	75.25a	22.50ab	17.50b
Logic® skip-swath	66.50a	61.75ab	21.25ab	13.75b
Amdro® solid	59.00a	20.25b	5.00b	9.50b
Amdro® skip-swath	59.00a	38.25ab	15.50ab	27.75ab
Amdro® + Logic®	59.75a	33.25ab	9.25b	10.25b
F	7.57	2.15	5.19	4.56
R-square	0.8016	0.5336	0.7345	0.7085
P > *F*	0.0004	0.0964	0.0031	0.0056

Treatment	6-months	12-months	18-months
untreated control	69.00a	66.75a	100.75a
Logic® solid	8.25c	14.75bc	70.50a
Logic® skip-swath	6.75c	14.75bc	55.00a
Amdro® solid	14.75c	22.25bc	87.75a
Amdro® skip-swath	41.25b	37.75ab	77.25a
Amdro® + Logic®	6.50c	6.75c	53.25a
F	13.44	8.74	0.99
R-square	0.8776	0.8233	0.4780
P > *F*	0.0001	0.0002	0.3466

* Means followed by different letters are significantly different using analysis of variance and Tukey's studentized range test (PC SAS)

WHAT'S HOT AND WHAT'S NOT IN FIRE ANT CHEMICAL ECOLOGY

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Several areas of research were covered. 1. Mating flight pheromones cover a broad range of possibilities from initiation of activity to how the females find the males. We have initiated investigation into the chemical ecology of worker alarm and recruitment activity during mating flights. Pheromones are produced by both male and female alates. The glandular source and chemical composition are being pursued. 2. Investigation into the cause of the alarm reaction when ants are breathed on led to the conclusion that air movement is not responsible and that elevated CO_2 levels in breath contribute to the activity but do not account for all the activity. Presumably, organic metabolites in breath can act as alarm substances. 3. Carbon dioxide was used to monitor the demise of fire ant colonies in the field; however, rains caused rapid microbial growth in the control areas making the background levels of CO_2 higher than the levels in the fire ant nests themselves. The lack of a comparable increase in CO_2 in the fire ant colonies is, in fact, support for the effectiveness of the venom alkaloids used by the fire ant for nest hygiene. 4. Additional progress was made in elucidating the nature of the fire ant's geomagnetic sense. This orientation mechanism does exhibit a circadian rythum that is unaffected by the day/night regimen. Further work in all of the above areas is planned for the coming year.

COMPARISON OF FLY PUPA AND CORN GRIT FORMULATED FIRE ANT BAITS

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Baits have been used to control the fire ant since mirex was discovered in the early 1960's. Because of serious concerns regarding residues in the environment mirex was removed from use in 1978. New baits developed in the early to mid-1980's were based on a formulation similar to that of mirex bait, that is, a chemical dissolved in once-refined soybean oil and applied to a corn grit carrier. Because the new toxicants degrade rapidly and leave no known residues, they are considered less hazardous to the environment. However, they still present other problems such as:

1) the attractiveness of the formulations to nontarget insects that also feed on the bait and are affected by the toxicants,
2) flowability and dispersal of the baits,
3) poor shelf-life of the formulations due to rancidity of the soybean oil, and of course,
4) high cost.

The development of formulations that eliminate or reduce the effects of fire ant baits on nontarget ants has been considered for a long time because of the important role that the native ant community plays. However, results have not been promising especially when cost and efficacy are compared to the standard formulations. Replacement or a reduction of the soybean oil, of course, must not be at the expense of reducing bait effectiveness.

Although this study was not conducted to address this issue, an elimination of soybean oil in toxic baits may lessen the impact these baits have on some of the nontarget ant species. Previous studies using house fly pupae as a carrier for fire ant toxicants indicated there may be less impact on nontarget ants (Williams et al. 1990). Therefore, the purpose of this study was to evaluate efficacy of bait formulations using Caribbean fruit fly pupae as an attractant-carrier system for some of the active ingredients available to control the red imported fire ant. Also, the impact of fly pupae baits and standard fire ant baits on nontarget ant species was compared.

Materials and Methods

Field tests were initiated in June, 1993 in Alachua Co., FL. Baits were either formulated using the standard pregel defatted corn grit (PDCG) or previously frozen and thawed Caribbean fruit fly pupae. Pupae were surplus production from the Department of Plant Industry's Caribbean Fruit Fly Rearing Facility and therefore were obtained at no cost. The following baits were formulated on grits: (1) Amdro (commercially available bait containing hydramethylnon [American Cyanamid]), (2)pyriproxyfen (MGK), (3)sulfluramid (Griffin Corp.), (4)Award (commercially available bait containing the insect growth regulator fenoxycarb [Ciba-Geigy]), and (5) control. The pyriproxyfen baits consisted of 1% AI, 29% once refined soybean oil and 70% PDCG by weight. The sulfluramid baits consisted of 0.55% AI, 29.45% once refined soybean oil and 70% PDCG. The control bait was 30% once refined soybean oil and 70% PDCG.

Pupae were immersed in a solution of 12% AI in acetone for 24 hours and allowed to air dry overnight. The active ingredients used in the pupae baits were: (1) pyriproxyfen, (2) fenoxycarb, and (3) sulfluramid. A control bait consisted of pupae soaked and dried in the same manner as described above, but without any active ingredient.

Approximately 1 lb. of formulated bait was applied per acre. Each treatment was applied to four plots in a randomized block design. Plots were 1 acre with 25 ft. borders between plots. Before and after determinations of imported fire ant population indices (Lofgren and Williams 1982) were done using 0.5 acre circle centered within each plot. After treatment evaluations were conducted at 4,8 and 12 weeks.

Pitfall traps were used to evaluate the impact of the treatments on nontarget ant species. One pitfall trap was placed near the center stake and at two distances (20 ft. and 60 ft.) from the center stake in the four cardinal directions. These traps consisted of a small test tube filled with a light solution of soapy water. Pitfalls were placed for 1 day and then recovered. All ant species and numbers were determined at -2,-1 and 4,8, and 12 weeks after treatment. Data from -2 and 8 weeks were reported.

For data analysis, data from the PDCG and fly pupae controls were combined. Population indices were analyzed using general linear models and Tukey's HSD ($P<0.05$) (SAS Institute 1993).

Results and Discussion

All bait applications were effective in reducing the red imported fire ant population indices by at least 80% throughout the duration of the study (Figure 1). At 12 weeks, although no statistical differences were observed, treatments with pyriproxyfen and sulfluramid reduced the population index greater when formulated on fly pupae than on grit.

The mean number of other ant species dropped from 5.1 at -2 weeks to 3.0 at 8 weeks after treatment, although the mean number of other species in the control plots did not change (Figure 2). In the sulfluramid and fenoxycarb treatments, there was a greater percent reduction in the mean number of ant species with the grit formulations than with the fly pupae.

Thus, the use of Caribbean fruit fly pupae as an attractant-carrier for toxicants for the control of the imported fire ant may be a means by which fewer nontarget ants will be affected when applying baits.

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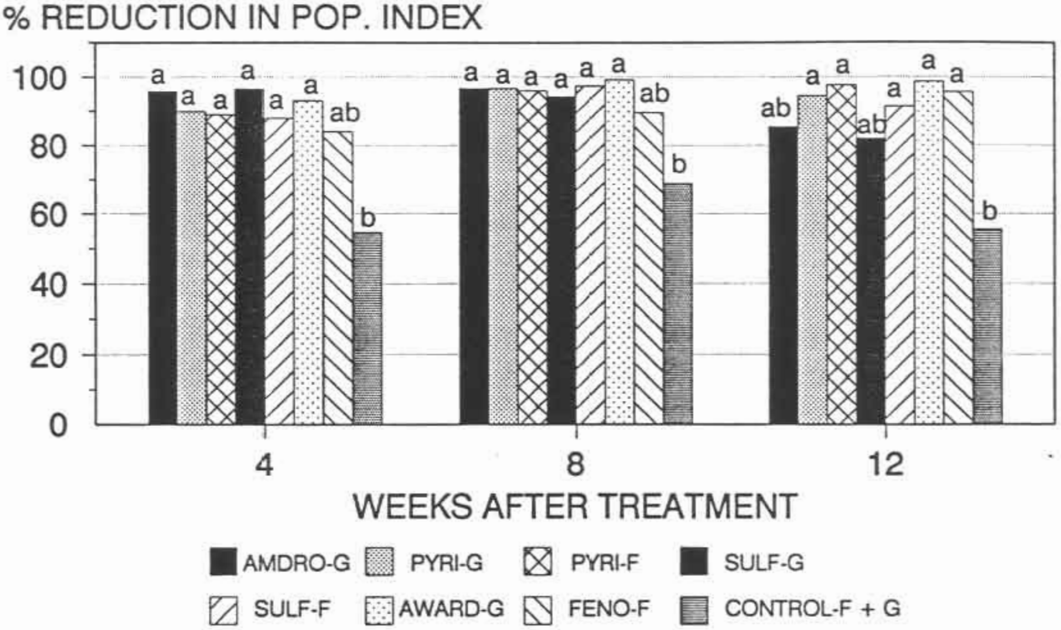

Figure 1. Percent reduction in IFA population index for standard grit (-G) and fly pupae (-F) bait applications (PYRI = pyriproxyfen, SULF = sulfluramid, & FENO = fenoxycarb). Mean separation tests performed with Tukey's HSD P<0.05.

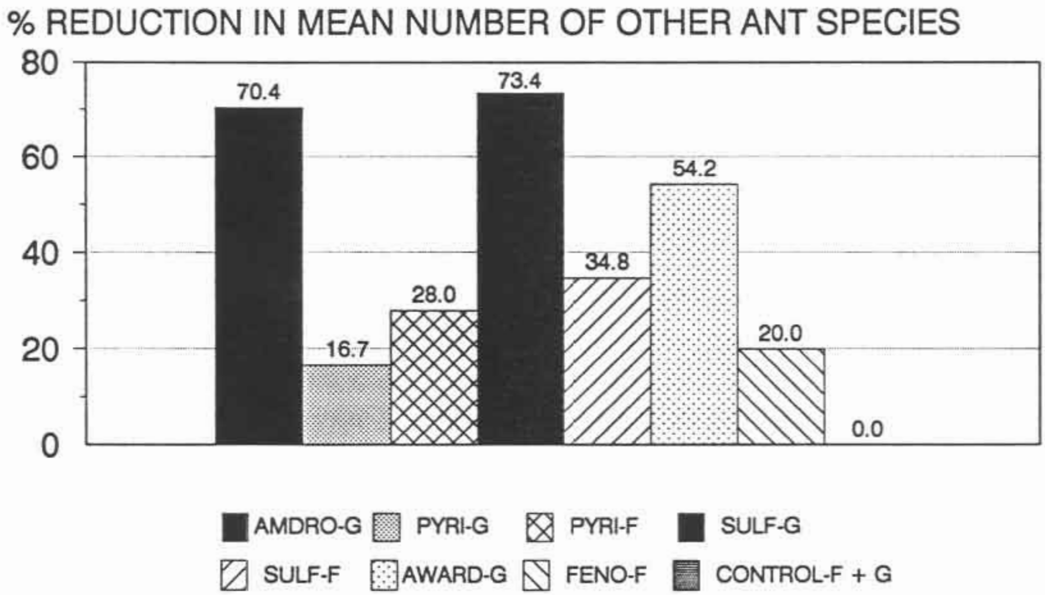

Figure 2. Percent reduction in the mean number of other ant species (not including IFA) for standard grit (-G) and fly pupae (-F) bait applications eight weeks after treatment (PYRI = pyriproxyfen, SULF = sulfuramid, & FENO = fenoxycarb).

Environmental Monitoring for the Imported Fire Ant Regulatory Program in APHIS, U. S. Department of Agriculture

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Environmental Monitoring for the Imported Fire Ant Regulatory Program in APHIS, U.S. Department of Agriculture

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A requirement to conduct environmental monitoring of the Imported Fire Ant (IFA) Regulatory Program has been codified in the Code of Federal Regulations. The IFA Program Manual prepared by Plant Protection and Quarantine of APHIS has been incorporated into the IFA Quarantine Regulations (7 CFR Part 301.81) both by reference and in part ("Regulatory Procedures" section), as an appendix, thereby making the Manual an integral part of the regulations. Within the Manual is a section entitled "Mitigative Measures" that lists activities which must be adhered to by the IFA Regulatory Program participants. Included in these measures is the commitment that; "An environmental monitoring plan, including monitoring procedures, must be implemented by APHIS. Monitoring must be conducted to determine if additional mitigative measures are necessary." This commitment to monitor is reaffirmed in the Environmental Assessment (EA) prepared for the Program in 1990, as well as in the Finding of No Significant Impact, signed by the Administrator of APHIS.

The question then, was what should be monitored? The only environmental concern identified in the EA was the possibility of Program pesticides leaving the treated areas in run-off water caused by rain, watering in of an application, or washing of equipment. IFA Program pesticides include bifenthrin, chlorpyrifos (DURSBAN®), diazinon, fenoxycarb (AWARD®), and hydramethylnon (AMDRO®). Highly sensitive organisms might be affected by exposure to residues of Program pesticides in water bodies receiving run-off from the treatment sites.

An interim environmental monitoring plan was incorporated into the EA by reference. This plan was designed primarily to investigate the potential for Program pesticides to reach surface water bodies. In addition, some well water samples were to be collected to verify the conclusion in the EA that Program pesticides do not leach into ground water.

The 1990 environmental monitoring plan calls for collecting water samples from water bodies located within 500 feet of treatment sites. To identify types and locations of water bodies for sampling, questionanires were sent to survey more than 2,000 nurseries that participated in the IFA Regulatory Program.

There were 1,087 nurseries that responded to the survey, as shown in Figure 1. Forty five nurseries were selected for monitoring, because within 500 feet of these nurseries there are water bodies located in areas which are considered more susceptible to effects by Program pesticides. These areas include wildlife refuges, natural wetlands, public drinking water sources, surface water impoundments, and wells located on sandy soils. Among the 45 nurseries, there are 18 sod farms or nurseries which grow stock in open fields and 27 other types of nurseries including greenhouses. Sod farms and nurseries which grow stock in open fields are considered in the EA as having a greater potential of causing surface run-off.

The 1990 environmental monitoring plan calls for collecting 145 water samples, including 135 surface water and 10 well water samples. It took two years of preparation to implement the plan. First sampling took place in 1992.

Results of sample collections during 1992 and 1993 are shown in Figure 2. Twenty two nurseries were monitored in each year; these included 8 sod farms and 14 other nurseries in 1992, and 14 sod farms and nurseries producing field-grown nursery stock and 8 other nurseries in 1993. Pre-treatment and post-treatment water samples were collected. Post-treatment water samples were collected one day after rainfall or after watering in of application. Samples were frozen as soon as possible after collection and shipped to National Monitoring and Residue Analysis Laboratory, Gulfport, MS for Program pesticide residue analyses.

In 1992, 23 water and 4 sediment samples were collected, and only 3 water samples were found to contain Program pesticides. These samples containing residues were collected from 2 ponds and one stream. In 1993, 29 water and 20 sediment samples were collected, and 2 samples were found to contain Program pesticide residues. One sample was collected from a well, and the other was collected from the sediment of a stream. Four of these five samples containing detectable IFA Program pesticides were collected after treatments at sod farms or nurseries which produce nursery stock in open fields.

The remaining samples collected in 1992 and 1993 were free from detectable Program pesticides.

The detection of Program pesticides in 5 samples indicates that probabilities do exist that IFA Program pesticides could be released off-site by run-off and that at least 5 water bodies, including one well were contaminated in 1992 and 1993. To determine whether there was any trend or pattern for off-site release of these pesticides, a non-parametric statistical test, namely the Kruskal-Wallis analysis of variance test, was performed to test the null hypothesis that samples collected in both years came from the same population. The test resulted in no rejection of the null hypothesis and suggests that the release of Program pesticidies off-site followed the same trend in both years.

If indeed there were contaminations of waters by Program pesticide applications during 1992 and 1993, then a question must be asked: Was there any adverse effect or impact on the environment? The answer may be "NO" because we did not observe or hear about any adverse effects on public health or wildlife resulting from Program pesticide applications. There were no special efforts conducted to monitor for adverse effects in either year.

Toxicity data indicate some potential exist for toxic effects on some aquatic organisms resulting from contamination of waters by Program pesticides. Table 1 shows residue levels in the 5 samples containing Program pesticides and the median lethal concentrations (or LC_{50}) of Program pesticides for aquatic species. According to the EPA criterion for ecological assessment, direct acute toxic effect can be expected in aquatic species when exposed to one-tenth the LC_{50}. Based on the residue levels in parts per billion (or ppb) detected, chlorpyrifos and diazinon might cause adverse effects to aqautic organisms. The 0.12 ppb of chlorpyrifos and 0.24 ppb of diazinon were higher than one-tenth the LC_{50} values and could affect daphnia. The 330 ppb of chlorpyrifos in the sediment when suspended in surface water could affect all species shown in the table. The 0.22 ppb of diazinon in one well water is unlikely to cause human health problem when consumed because it is below the Lifetime Health Advisory Level (HAL) of 0.6 ppb for diazinon. HAL is defined by EPA as the maximum concentration of a toxicant in water that may safely be consumed over an average human lifetime without producing cancer toxic effects.

These IFA Program pesticides are reported to be unstable in water, with half lives of less than 2 days. These detected residues could be degraded and cleared quickly in water. Thus aquatic organisms were possibly exposed for only a short time and no toxic effects or mortality resulted.

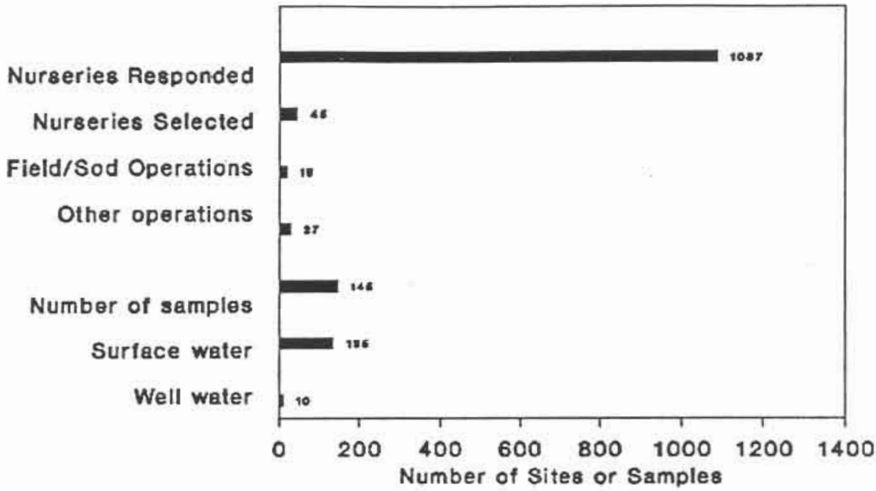
The absence of IFA Program pesticides in most water samples indicate that mitigative and protective measures implemented in nurseries were adequate for protecting the environment.

We realized there are deficiencies in procedures for sample collections and data documentation. For example, many water samples were collected too late after treatment and many samples were not accompanied with sufficient information about pesticides used, treatemnt dates, and dates of rainfall or watering in of applications. Applications of Program pesticides for non-IFA treatments were not recorded.

To improve future monitoring efforts, the environmental monitoring plan has been modified for '94 to conduct a more general survey of run-off potential. Instead of monitoring from the same 45 sites selected previously, any facility with a compliance agreement will be subject to sample collection. The number of sites to be monitored will be apportioned among the participating states and then randomly selected. The objective is to obtain an unbiased estimate of the potential for residues in run-off (a sample size of 152 will be required to have a 99% confidence level that if more than 3% of the sites generate offsite residues, at least one sample will be positive).

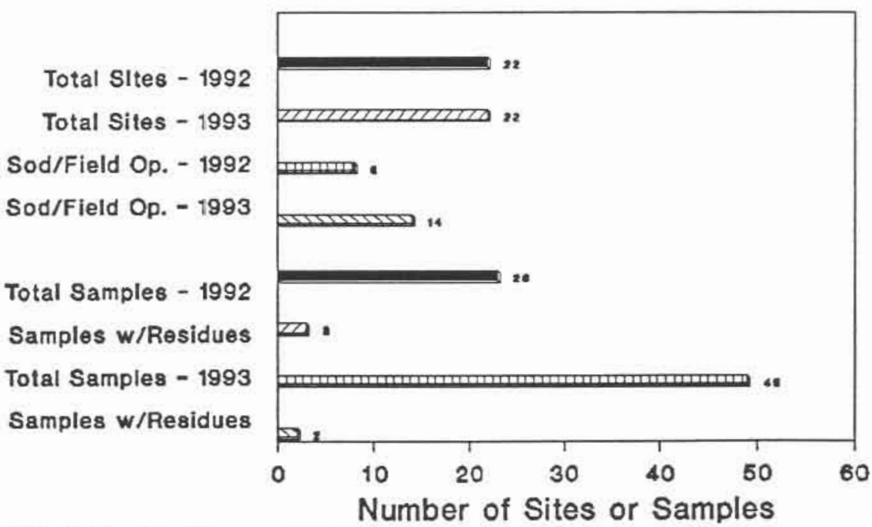
To interpret the results of residue analysis, a detailed description of the facility being sampled must be provided. The required descriptions are fully explained in the 1994 environmental monitoring plan. Briefly, the type of operation, Program treatments, how run-off occures and location of sample collections must be documented. Without such descriptions, the residue results will be of little value.

Fig 1. Planned Sampling Size -- 1990 IFA Environmental Monitoring Plan



Nurseries Responded: Number of nurseries which furnished survey data.
Nurseries Selected: for monitoring.

Fig 2. Samples Collected - 1992 & 1993 -- IFA Environmental Monitoring --



Sod/Field Op.: Sod Farm or Field Grown Nursery Stock Operation.

Table 1. IFA Program Pesticides Detected and Their LC50 Values for Some Aquatic Species

Pesticide	Residues(*) (ppb)	LC50 for Daphnia	LC50 for Bluegill Sunfish	LC50 for Rainbow Trout
Bifenthrin	not detected (a)	-	0.18	0.10
Chlorpyrifos	0.12 (b) 330.0 (c)	0.176	3.3	3.0
Diazinon	0.24 (d) 0.22 (e)	0.52	79.0	635.0
Fenoxycarb	0.36 (f)	-	1860.0	1600.0
Hydramethylnon	not detected	-	1700.0	160.0

*

(a) not detected in 1993 samples; not used in 1992.
(b) in 1 pond water sample collected in 1992.
(c) in 1 creek sediment sample collected in 1993.
(d) in 1 pond water sample collected in 1992.
(e) in 1 well water sample collected in 1993.
(f) in 1 stream water sample collected in 1992.

FIRE ANT REPELLENTS: DISCOVERY TO TECHNOLOGY TRANSFER

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Repellents are compounds that act through space and do not require contact by the responding organism. This is in contrast to deterrents, arrestants, and phagostimulants, which do require contact. Thus, a Y-tube olfactometer was designed that measures the response of fire ants to volatiles in the air stream. The assay detects attractants, repellents and compounds that are neutral. Using this assay we investigated the anecdotally reported ant repellency of Skin-so-Soft and determined which of the ingredients was responsible for the activity. In addition, we discovered many repellents with a variety of structural moieties, e.g. alcohols, carboxylic acids, alkynes, alkenes and esters. All of these compounds are volatile, which limits their usefulness. We have a Cooperative Research and Development Agreement with Hercon Environmental, Inc. to utilize their controlled release technology to increase the longevity of our fire ant repellents. This technology transfer has been successful and we now have bioactive formulations that have a projected active life of up to a year. These formulations are currently being field tested in electrical switch boxes.

SUSCEPTIBILITY OF MONOGYNE AND POLYGYNE IMPORTED FIRE ANTS TO INDOOR ANT BAITS

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Imported fire ants are not only a problem in agricultural and wildlife areas, but they also are a problem in the urban environment. In fact, fire ant infestations have been found inside buildings. The use of toxic baits is often recommended as a method to control ants because baits utilize the ants' behaviors of foraging and trophallaxis to distribute a toxicant throughout a colony. However, there are only a few commercially available ant baits that specifically list imported fire ants on their label and also are registered for indoor use. The objective of this study was to evaluate the efficacy of some of the commercially available indoor ant baits against monogyne and polygyne forms of the red imported fire ant, *Solenopsis invicta* Buren, under laboratory conditions. Bait evaluations were based on the presence of delayed mortality among worker ants and on the survivorship of colonies, both monogyne and polygyne, that were exposed to indoor ant baits. Delayed toxicity is one of the criteria of an effective ant bait. Delayed toxicity allows foraging ants to pick up a bait and then distribute the toxicant to the other members of a colony before they die. The toxicant should have a wide active dose range to ensure it will cause mortality despite the possibility of dilution as it is passed to other members of the colony (Stringer 1964). The survivorship or mortality of a colony provided a gross measure of the efficiency of spread and toxicity of the baits. Differences in worker mortality between monogyne and polygyne colonies for some of the baits were also examined with respect to worker size.

Materials and Methods

Delayed toxicity was determined by exposing approximately 1 g of a solid bait or 0.15 ml of a liquid bait to 20 worker ants in a 1 fluid ounce portion cup that contained a moistened castone (dental plaster) bottom to maintain high relative humidities. Ants were starved for 5 days before being exposed to the baits for 24 hours. After 24 hours, baits were replaced with a 1:1 (v/v) honey:water mixture. Dead ants were counted and removed at 1, 2, 3, 6, 8, 10, 13, and 14 days after baits were exposed. Percent cumulative mortality was determined to assess delayed toxicity for each bait.

Mortality responses over time were averaged over the same active ingredients. Baits containing orthoboric acid or borax were classified as boric acid baits. Worker ants were obtained from four monogyne and four polygyne colonies. Baits used in the test are listed in Table 1. All baits were registered for indoor use except Amdro which was included as a standard. Imported fire ants were not specifically listed on any of the bait labels except for Maxforce and Amdro.

Table 1. Commercially available indoor ant baits used in the delayed toxicity tests.

Ant Bait	Active Ingredient	Manufacturer
Pro-Control	0.5% Sulfluramid[a]	Micro-Gen Equip. Corp., San Antonio, Texas
Raid Max	0.5% Sulfluramid[a]	S. C. Johnson & Son, Racine, Wisconsin
Raid Ant Baits	0.03% Chlorpyrifos	S. C. Johnson & Son, Racine, Wisconsin
Maxforce	1% Hydramethylnon	The Clorox Co., Oakland, California
Terro II	5.4% Borax[b]	Senoret Chemical, St. Louis, Missouri
Ant-Kil	6% Orthoboric acid	Protexall Products, Maitland, Florida
Drax Ant Kil Gel	5% Orthoboric acid	Waterbury Co., Waterbury, Connecticut
Drax Ant Kil PF	5% Orthoboric acid	Waterbury Co., Waterbury, Connecticut
Amdro[c]	0.73% Hydramethylnon	American Cyanamid, Wayne, New Jersey

[a]N-ethyl Perfluorooctanesulfonamide
[b]Sodium tetraborate decahydrate
[c]Amdro is not registered for indoor use, but was included as a standard.

To assess differences in mortality among worker sizes and the monogyne or polygyne forms, the same procedures were used as described previously except for the following. Monogyne and polygyne worker ants from six colonies each were tested separately after a 2 week starvation period. Ants were grouped according to size, where ten major workers and ten minor workers were placed in each cup. Maxforce, Raid Ant Baits, Terro, Ant-Kil, Drax Gel, and a honey-water control were the baits used. After the tests were completed, the head widths were measured with a wedge micrometer (Porter 1983) to estimate ant sizes. Head widths that were smaller than 0.6 mm were recorded as 0.55 mm.

Colony survivorship or mortality was determined by exposing three laboratory colonies each, of either monogyne or polygyne fire ants, to the ant baits. Colonies contained approximately 29,000 ants and 29 ml of brood (immature ants), with 1 queen in the monogyne colonies and 3 queens in the polygyne colonies. Colonies were last fed a laboratory diet of honey agar, boiled egg yolk, and crickets 3 days before given access to 4 to 5 grams of baits alone. After 4 days, the laboratory diet was provided for the remainder of the study. The same baits listed in Table 1 were used except for Ant-Kil and Drax PF which were excluded, and Ascend (0.011% abamectin B_1, Whitmire Research Lab., St. Louis, Missouri) and Combat SuperBait (1% hydramethylnon, The Clorox Co., Oakland, California) were added to the test. Ascend was added because its label was changed to include indoor applications, and Combat SuperBait is readily available to the public. A population index (PI) was determined for each colony at weekly intervals for nine weeks to assess colony vigor. The PI was obtained by multiplying a rating value assigned to an estimated adult worker ant population with a rating value assigned to an estimated value of worker brood volume (Banks and Lofgren 1991). The average PI was reported for baits grouped according to their active ingredients.

Results and Discussion

For worker ants from the polygyne colonies, the sulfluramid and hydramethylnon baits resulted in delayed mortality where the mortality after 24 hours was less than 25% followed by a rapid increase in cumulative mortality. The chlorpyrifos bait had relatively high mortality of 78% at day 1 and was followed by less than a 13% increase in mortality thereafter. This suggested that toxicant distribution would be limited, because the ants that ingested the bait directly or by trophallaxis would die quickly and would not have a chance to distribute the baits to other ants. The boric acid baits had a gradual increase in mortality going from 3% at day 1 to 65% cumulative mortality after 14 days (Fig. 1). For the monogyne workers, similar results were seen with the sulfluramid baits and the hydramethylnon baits, however cumulative mortality was lower than the monogyne workers for the hydramethylnon bait. The chlorpyrifos and boric acid baits had cumulative mortalities that never exceeded 20%, which was 77% and 65% lower than the monogyne worker mortality, respectively (Fig. 2).

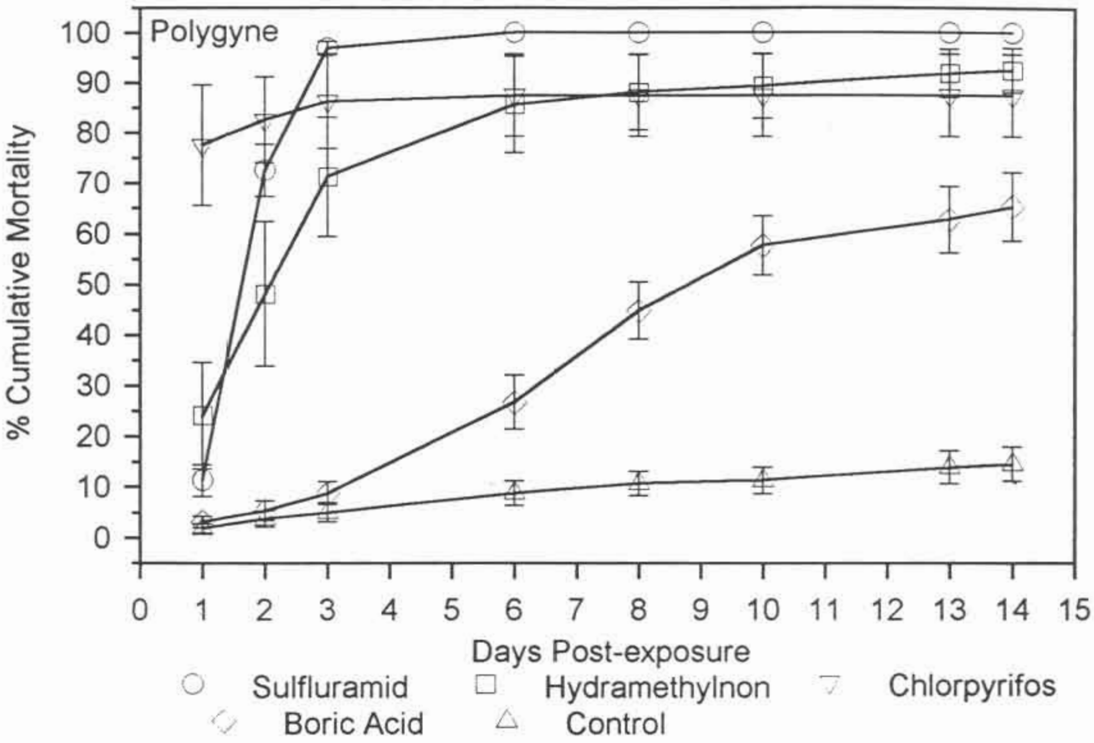

Fig. 1. Mean (±SE) percent cumulative mortalities of polygyne workers exposed to baits grouped according to active ingredient.

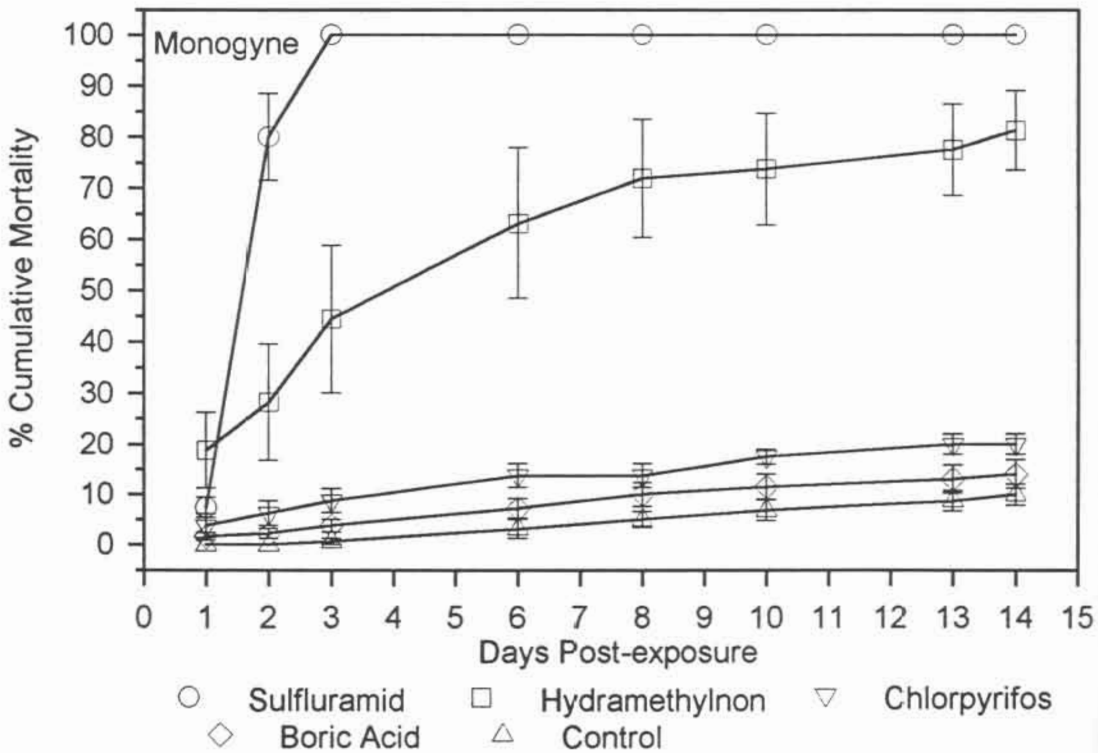

Fig. 2. Mean (±SE) percent cumulative mortalities of monogyne workers exposed to baits grouped according to active ingredient.

Worker size and colony type (monogyne or polygyne) were examined as possible factors of the differences in delayed mortality between the monogyne and polygyne workers exposed to the hydramethylnon, chlorpyrifos, and boric acid baits. Head widths of the major and minor workers did not differ significantly between the monogyne and polygyne workers among the baits tested (Fig. 3). In general, minor workers were more susceptible than major workers within a colony type (Figs. 4 and 5). Across colony types responses varied with the type of bait. For example, with hydramethylnon, the minor workers were more susceptible than major workers regardless of colony type. However with Terro, minor workers were more susceptible than the major workers only within colony types, and minor workers from polygyne colonies had similar susceptibilities to major workers from monogyne colonies (Fig. 5). The remaining baits (Drax Gel, Ant-Kil, Raid Ant Bait) had responses that were intermediate between the above examples.

In the colony tests, PIs from the monogyne colonies were near zero by the fourth week for the sulfluramid, hydramethylnon, and abamectin baits. Average PIs of the colonies exposed to the chlorpyrifos bait were less than the control, but these colonies were still active and not considered to be controlled. The boric acid treatments did not differ from the control (Fig. 6). PIs of the polygyne colonies declined more slowly and were more variable than the monogyne response. Colonies exposed to the sulfluramid, abamectin, and Amdro baits had PIs that were <10 by week 7. The remaining hydramethylnon baits (Maxforce and Combat) declined to an average PI of 11. The chlorpyrifos and boric acid baited colonies had lower PIs than the control, but these colonies were still active and not controlled (Fig. 7).

In summary, the indoor ant baits that exhibited the delayed toxicity, plus the abamectin bait, resulted in the mortality of laboratory colonies. Control of polygyne colonies was slower and more variable than monogyne colonies probably because of the presence of multiple queens and greater brood production.

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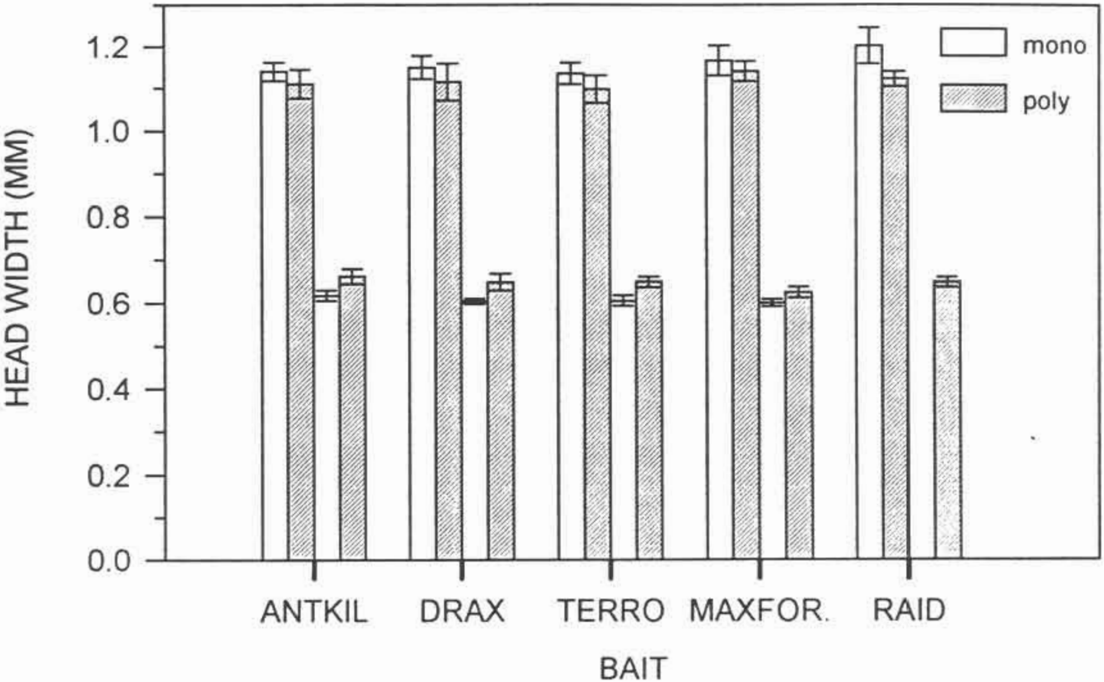

Fig. 3. Mean (±SE) head widths of major and minor red imported fire ant workers from monogyne (mono) and polygyne (poly) colonies. Head widths for monogyne minor workers exposed to Raid Ant Bait were not available.
Taller bars represent major workers; shorter bars represent minor workers

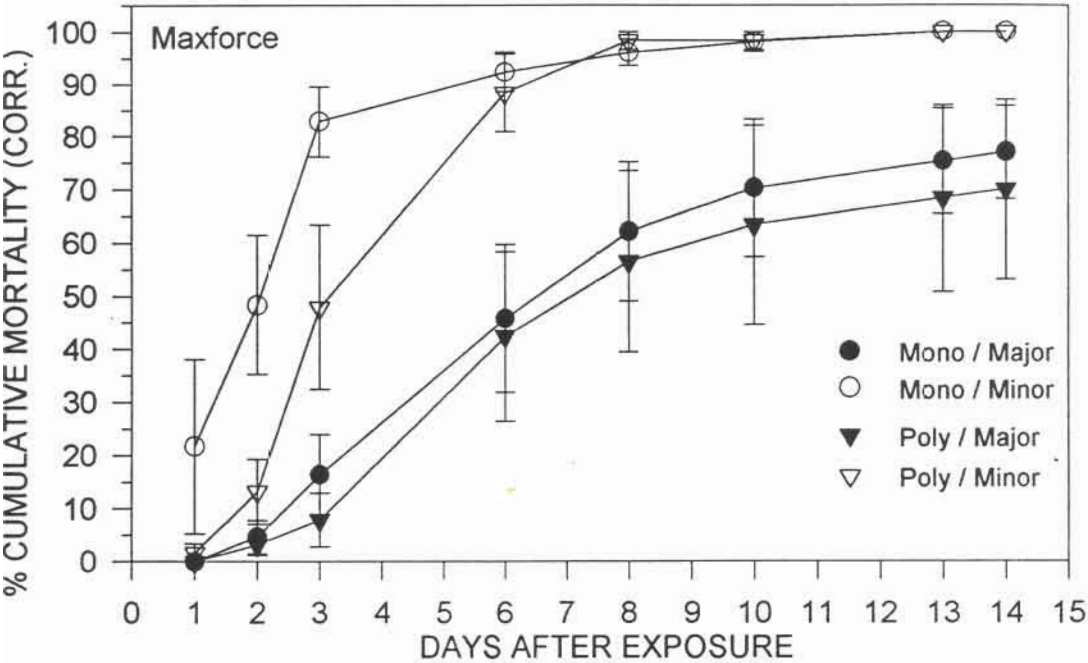

Fig. 4. Mean (±SE) cumulative mortalities (corrected for control mortality) among major and minor red imported fire ant workers from monogyne (mono) and polygyne (poly) colonies exposed to Maxforce.

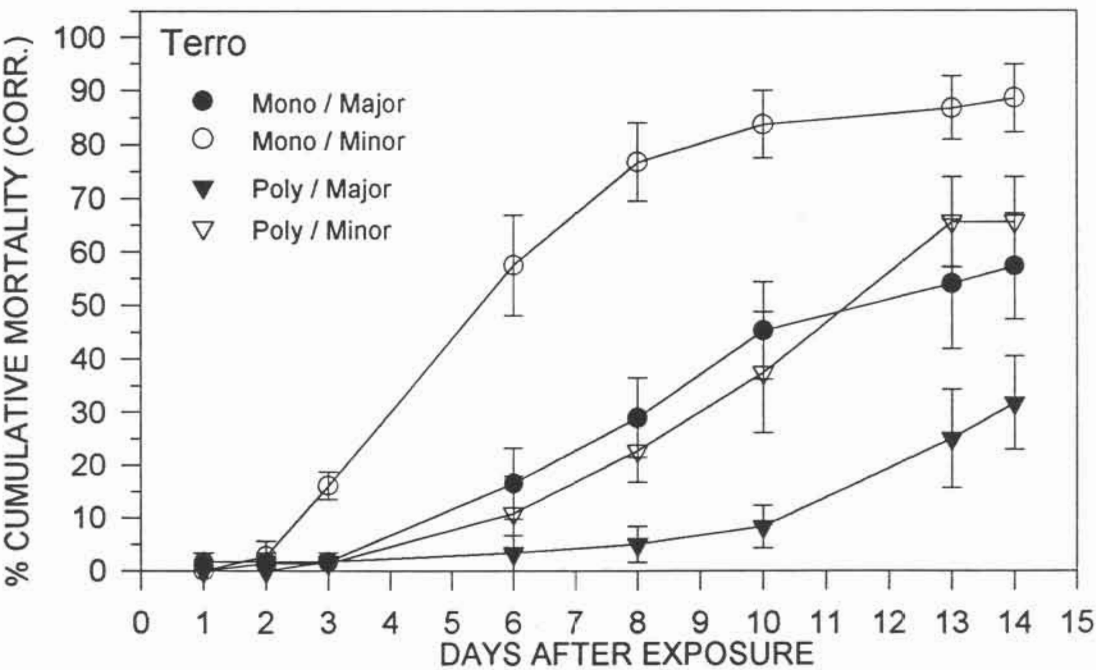

Fig. 5. Mean (±SE) cumulative mortalities (corrected for control mortality) among major and minor red imported fire ant workers from monogyne (mono) and polygyne (poly) colonies exposed to Terro.

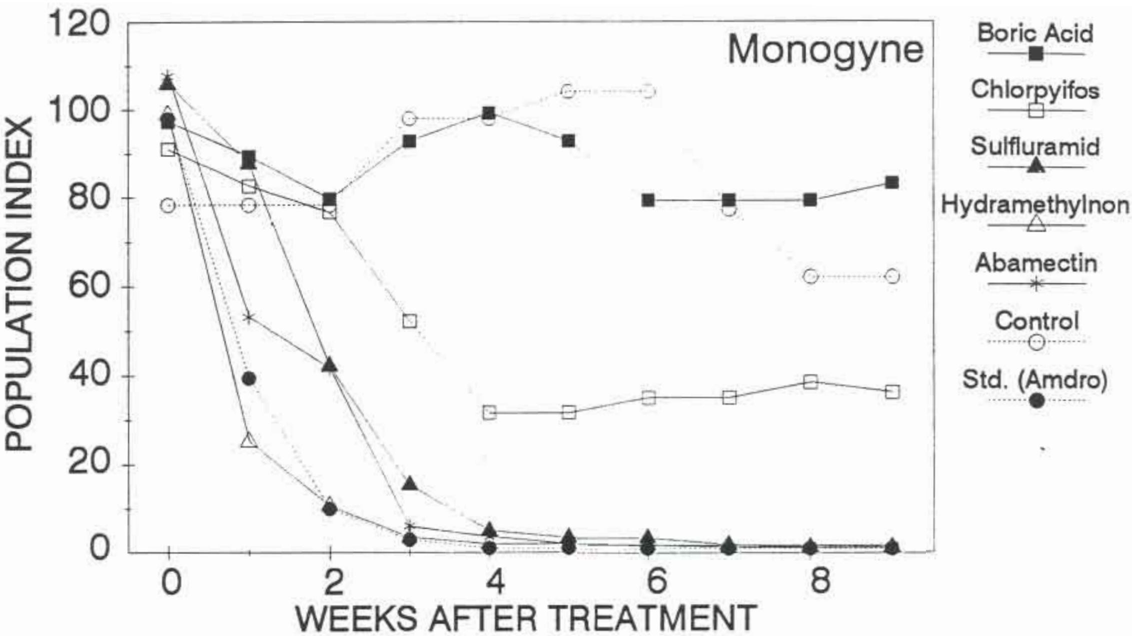

Fig. 6. Mean population indices for laboratory colonies of monogyne red imported fire ants exposed to baits grouped according to active ingredient.

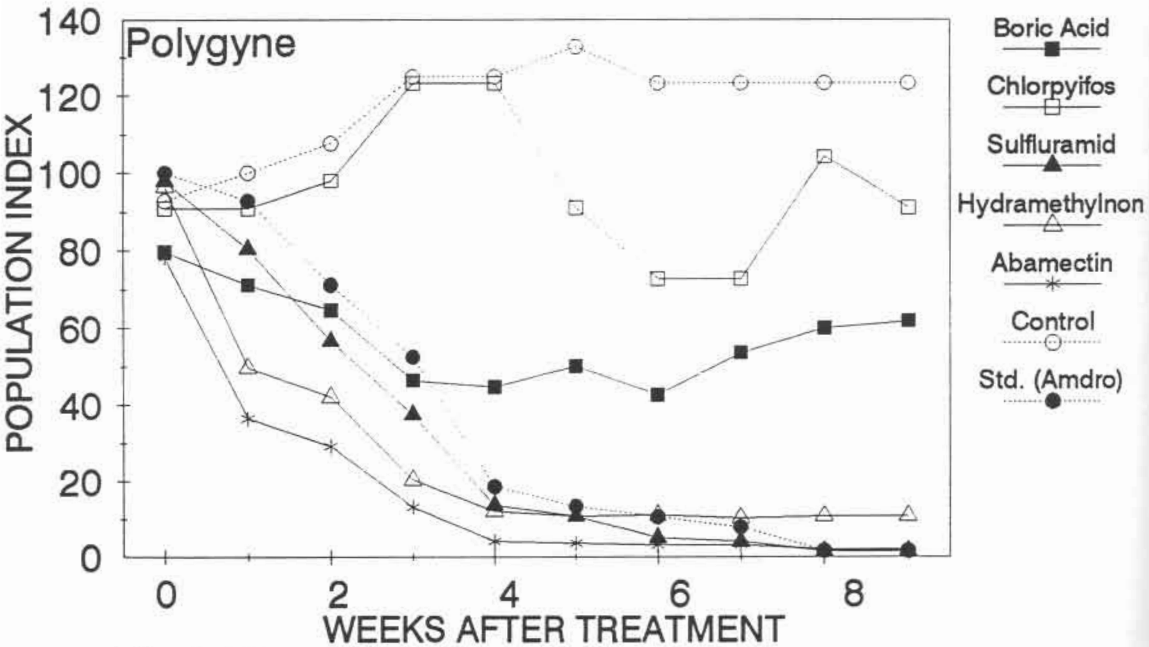

Fig. 7. Mean population indices for laboratory colonies of polygyne red imported fire ants exposed to baits grouped according to active ingredient.

DIATOMACEOUS EARTH, REPELLENTS, PYRETHRINS, AND FIRE ANT CONTROL

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The following research was carried out through a Cooperative Research and Development Agreement with Organic Plus, Inc. Albuquerque, New Mexico. Diatomaceous earth (DE) is composed of diatomite, fossilized sedimentary layers of the phytoplankton, diatoms. Freshwater DE is most desirable because it contains less crystalline silica, which can be a health hazard. The outer wax of insects is lost to DE by abrasion or absorption and the insect dies from desiccation rather than poisoning or suffocation. We have demonstrated that DE does kill fire ants whether it is dry or wet. Major workers were slower to die, probably due to their increased size. Exposure of fire ant workers to DE for as little as one minute was enough to give 100% mortality after 24 hours. Although DE does kill fire ants the problem of quickly getting the DE to all members of a colony has not been solved yet and therefore limits the direct use of DE in fire ant control.

DE has the unusual capacity to absorb large amounts of oil. Thus, DE can act as an excellent carrier for insecticides or repellents. Organic Plus, Inc. produces an organic insecticide formulation that consists of natural pyrethrins and piperonyl butoxide absorbed into DE. We discovered that this formulation prevents fire ant colonies from migrating into pots containing soil treated with the pyrethrin/DE formulation. Concentrations of 100ppm were 100% effective at keeping fire ants out of soil for over a year. In another area of research we have used DE as a carrier for some of the volatile repellents we have discovered. In our field bioassays a food bait is normally discovered within 15 minutes; however, treatment of the surrounding area with a DE/repellent formulation suppresses fire ant foraging activity, such that food baits are not discovered for up to 18 hours. The targets of this technology are those groups that do not want to use insecticides, such as homeowners who want to have a fire ant free family gathering and park systems that want to exclude fire ants from high human use areas at specified times. Work in these areas is continuing.

AN IMPORTED FIRE ANT CONTROL PROGRAM FOR A LOW-BUDGET COUNTY ATHLETIC FIELD

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INTRODUCTION

During 1989 a seasonal fire ant control program was initiated on a high school football field located in southwest Alabama. The emphasis of the demonstration was to control the fire ants with a minimal of costs. Fire ant mounds were high enough that football players complained about the stings. Initial mound count was 148 on this approximately 2.5 acre field.

In 1990 an adjacent practice field was added to the demonstration since it was a source for migrating reproductive fire ants.

MATERIALS AND METHODS

In 1989 the playing field received an area treatment followed by a contact insecticide. Affirm was applied at a rate of 10 ounces per acre in May. A mound treatment of Orthene 75S at a rate of one to two teaspoons per mound was applied one week later. Subsequent mound treatments with Orthene were applied in July, August, September, and November. In 1990, an application of Affirm at a rate of 10 ounces per acre was applied. For 1991 the playing field received one application of Affirm at a rate of 10 ounces per acre. In 1992, the playing field received one application of Award at a rate of 1.0 pound per acre.

The practice field was first treated in June of 1990. It received an application of Affirm at a rate of 1.0 pound per acre. The field was initially split. One half received only the area bait treatment of Affirm. The other half received the area bait treatment plus the contact treatment of Orthene one week later. In 1991, the practice field received an application of Logic at a rate of 1.0 pound per acre. For 1992 no treatments were made to the practice field.

RESULTS AND DISCUSSION

The playing field, saw a dramatic decline in mounds after the first application of the bait and mound treatment in May of 1989 (Table 1). Mounds per field declined from 148 to 4 in just over one month (Figure 1). During the remainder of 1989 mounds were treated individually with Orthene 75S in July, August, September, and November. The number of mounds did increase during this time period from 4 to 39. This increase was suspected to have originated from an adjacent practice field which was included in the demonstration in 1990.

During 1990 with both the playing and practice fields being treated, fire ant mounds were very low. In July of 1990 only 9 mounds were observed on the playing field. On the practice field only 2 mounds were observed at the same time (see Figure 2).

In July of 1991 the playing field had 46 mounds in July and was treated with an area bait treatment. By September, there were only 2 mounds observed on this field. The practice field had 15 mounds in July and 2 mounds in September. It was treated in July with a bait treatment as well.

During 1992 the playing field had no observed mounds in May. By September there were only 8 mounds on the field and it was treated with an area bait treatment at that time. In December, after the football season, there were no visible mounds on the field. The practice field had no observed mounds in May and was not treated.

The practice of using an area bait treatment plus a contact insecticide are very effective in controlling imported fire ants on these athletic fields. After initial treatments it was discovered that only an area bait treatment was necessary to control the fire ants. This was done with only one treatment per year and at a great savings. Furthermore, reports from coaches and players were that no stinging incidents occurred after initial high populations were brought under control.

Table 1. Imported Fire Ant Mound Counts, 1990 through 1992, Butler, Alabama.

Date	Playing Field	Practice Field
May 1989	148[1]	--
Sept 1989	19[2]	--
May 1990	0	13[1]
July 1990	9[3]	2[2]
July 1991	46[3]	15[3]
Sept 1991	2[3]	2
May 1992	0	0
Sept 1992	8[3]	0

[1]Area bait treatment plus contact insecticide applied.
[2]Contact insecticide applied.
[3]Area bait treatment applied.

Figure 1. Results of fire ant demonstration, playing field.

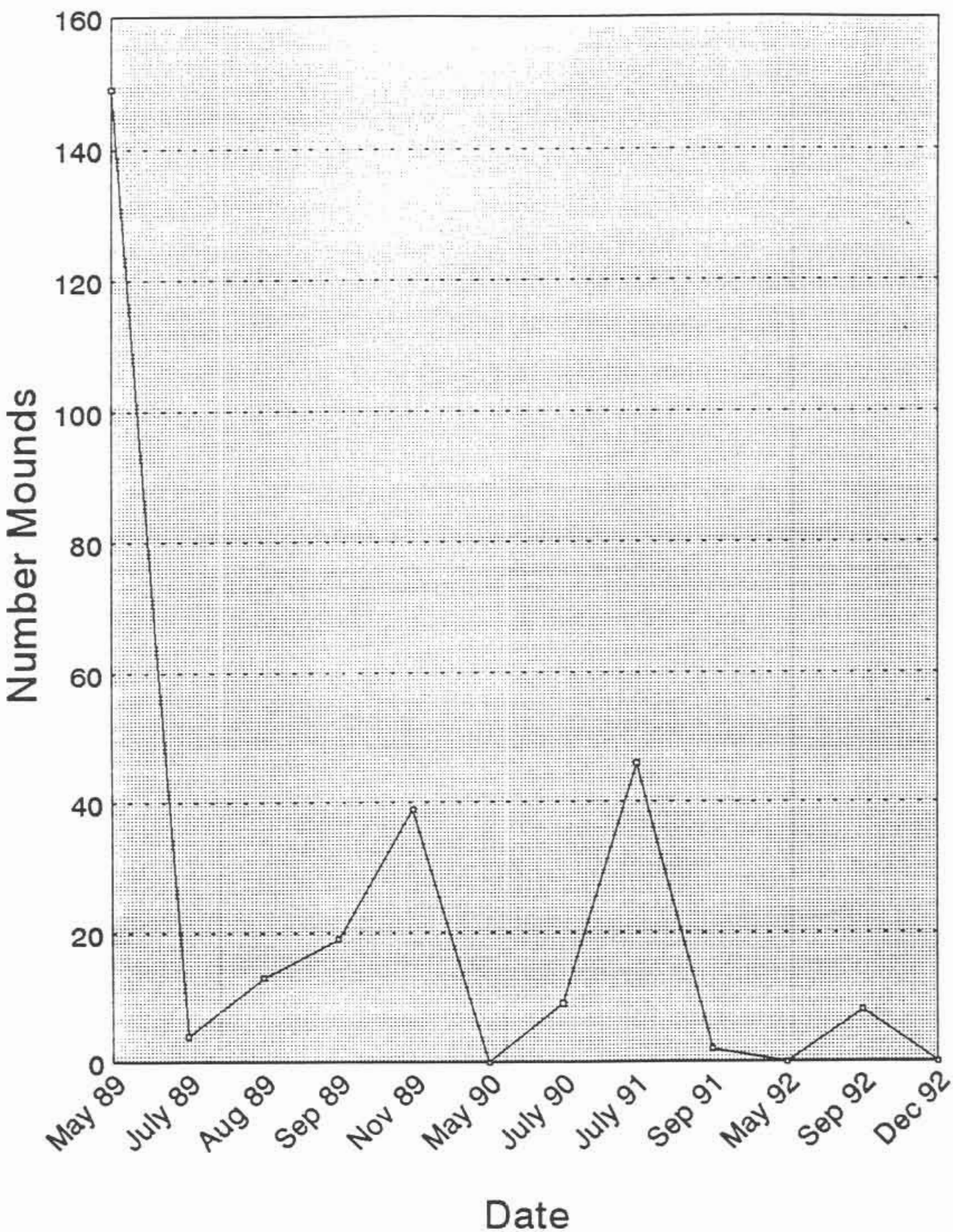
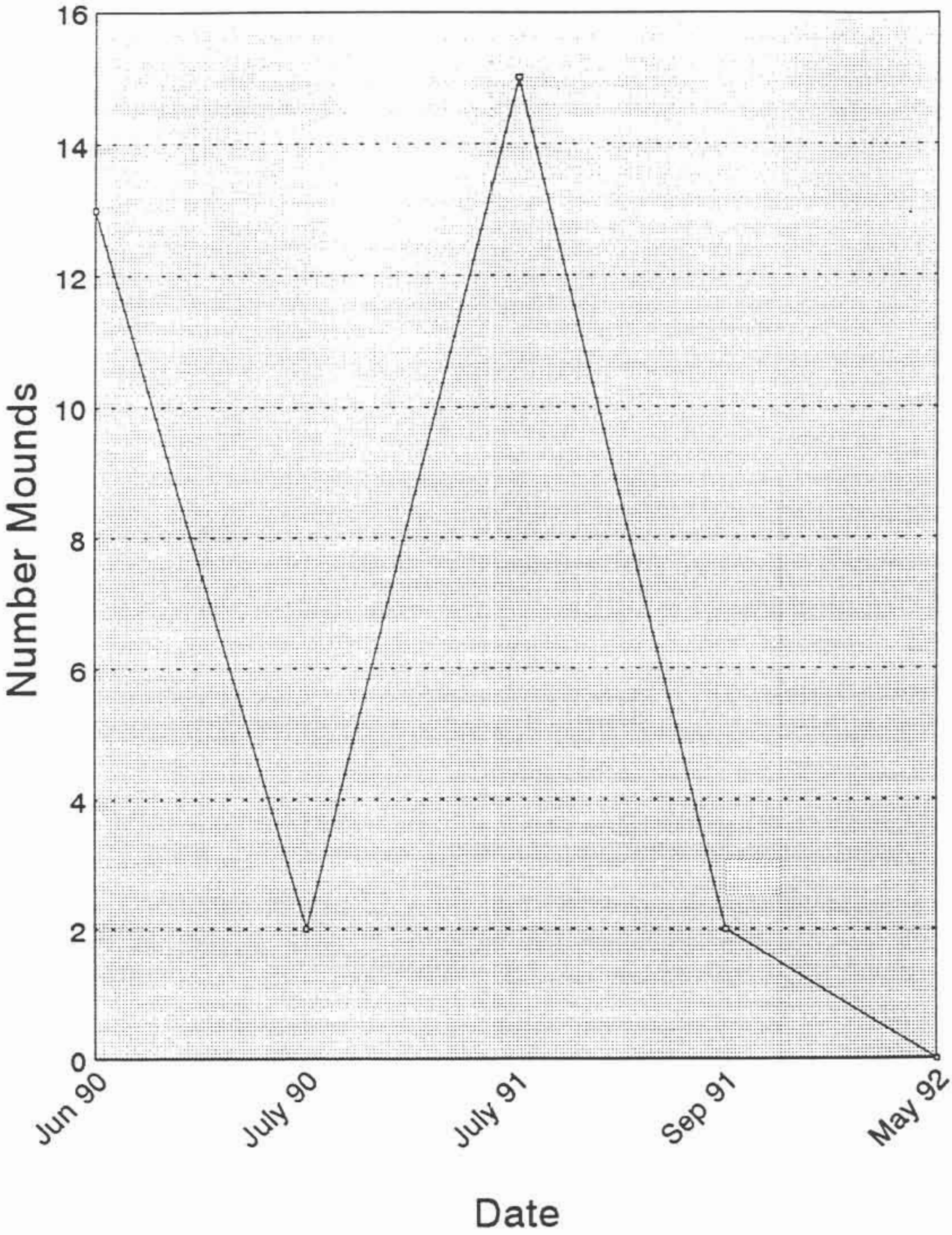


Figure 2. Results of fire ant demonstration, practice field.



1993 Field Trials for Control of Imported Fire Ants

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Introduction:

The red imported fire ant (RIFA), *Solenopsis invicta* Buren, has been the subject of numerous control and eradication efforts since its introduction into the United States. The first control effort, initiated in Baldwin Co., AL in 1937, utilized individual mound treatments: 48% calcium cyanide dust was applied to each RIFA nest by digging into the mound with a shovel, sprinkling the dust, and then covering it with soil (Eden & Arant 1949). Today, numerous insecticides, including acephate, bendiocarb, carbaryl, chlorpyrifos, diazinon, malathion, etc., are registered and marketed as drenches, dusts, granules or aerosols for individual mound or spot treatments of RIFA.

A large scale Federal control program began in the late 1950s, when heptachlor and dieldrin were applied at rates of 0.25-2.0 lb/acre to >2.5 million acres over a 5-year period (Brown 1961). Following this period, mirex, a toxic bait, which was used extensively until its cancellation in 1978 (Daniel 1990). Today, several baits are registered and marketed for control of RIFA, two of which are used frequently: Award™ which contains fenoxycarb (1.0% AI, Ciba-Geigy Corp., Greensboro, NC), and Amdro® which contains hydramethylnon (0.73% AI, American Cyanamid, Princeton, NJ).

In 1993, several studies were conducted by our lab pertaining to RIFA control and population suppression, two of which will be reported here; one on the impact of blending a RIFA bait into a controlled release fertilizer prior to application and one on the efficacy of individual mound treatments.

Materials and Methods:

Award™ + fertilizer study: Due to the low rate of application (1-1.5 lb/acre), all RIFA baits are difficult to apply with most commonly used granular applicators. Since most agricultural products, such as seed or fertilizer, are applied at much heavier rates, most granular applicators are designed for these heavier application rates and cannot be calibrated to deliver the low rates required for RIFA baits. One method of eliminating this problem would be to blend fire ant baits with fertilizer or grass seed and apply them as a "tank mix" of the two products. Past attempts to control RIFA with a blend of baits and conventional fertilizers were not successful (Collins et al. 1984). It was hypothesized that the loss in efficacy was due to dust granules from the fertilizer adhering to bait particles and rendering them unpalatable to the ants.

Polyon® polymer coated urea granules (Pursell Industries, Sylacauga, AL) containing 42% nitrogen (42-0-0), like other controlled release fertilizer formulations, are essentially non-dusty, and appeared to be compatible with RIFA baits. At the request of Pursell Industries, a small test to evaluate RIFA control with Award™ blended into Polyon® urea granules was conducted.

Trial I - Award™ was blended into the urea granules at a rate of 1.5 lb bait/100 lb fertilizer on June 3, 1992. An electric cement mixer (2.0 cu ft capacity) was operated for approximately 5 minutes per batch. This mixture was applied approximately 24 hours later at a rate of 101.5 lb/acre with a Herd®GT-77 granular applicator (Herd Seeder Co., Logansport, IN) mounted on a farm tractor. This equipment was operated on a 32′ swath at 4 mph. Control plots were treated with Award™ only at a rate of 1.5 lb/acre using a shop built granular application mounted on a farm tractor (Collins 1988). Untreated check plots were also established. All test plots were 1 acre, with a ¼-acre circular subplot located in the center in which population assessments were made by a team of 6 experienced ant hunters. Treatments were replicated three times. RIFA population assessments were made in all plots prior to application, and at 6, 12 and 18 weeks posttreatment. The population index system described by Harlan et al. (1981) and modified by Lofgren and Williams (1982) was used to determine treatment effects for each rating interval. Analysis of variance and Tukey's studentized range (HSD) test were used to determine statistical differences in treatment means at the P=0.05 level for each posttreatment rating interval (SAS Institute 1988).

Trial II - On June 27, 1992, Award™ was blended into polyon urea granules at a rate of 1.5 lb bait/100 lb fertilizer using an electric cement mixer. The mixed materials were resealed into original fertilizer bags and stored in the laboratory at ambient temperature and humidity. On May 7, 1993, this material was applied to four 1-acre plots at a rate of 101.5 lb/acre. Application and assessment methods were as described above. Four replicates were also treated with Award™ only, and four check plots were established.

Individual mound treatment study: The literature is replete with reports of insecticide trials in which investigators used individual mound or spot treatments to evaluate the efficacy of candidate pesticides, formulations, or dose rates. Virtually all trials conducted utilized various methods of marking treated mounds by tagging, flagging, and/or mapping. Many studies used small plots with or without buffer zones or various size boundaries around treated nests. However, colony movement or nest relocation in response to insecticidal treatment is a well documented phenomenon (Hays et al. 1982, Franke 1983, Williams & Lofgren 1983, Collins et al. 1992). Movement induced by the presence of an insecticide is usually over a relatively short distance (5 to 10'), but can be greater (pers. obs.). Colony movement or relocation in field trials can skew results when mortality data is based solely on survival of marked or tagged mounds, or in trials in which relatively small plots are used. This trial utilized an experimental design which compensated for colony relocation following pesticide application to individual RIFA mounds.

One acre test plots were established on November 3, 1993 and an experienced team of 6 investigators closely searched each test plot and flagged each active RIFA nest immediately prior to pesticide application. Treatments were applied per label instructions as either drenches or dusts to every mound within the plot. Treatments were replicated 3 times.

Products tested included Dursban® 2EC (chlorpyrifos, Rigo Co., Buckner, KY), Orthene® 75S (acephate, Valent U.S.A. Corp., Walnut Creek, CA), Optem® PT-600 (cyfluthrin, Whitmire Research Labs, St. Louis, MO), and Bengal® Fire Ant Killer Concentrate [(1R,3S) 3[(1'RS)(1',2',2',2'-tetrabromoethyl)]-2,2-dimethylcyclopropanecarboxylic acid (S)-alpha-cyano-3-phenoxybenzyl ester, Bengal Chemical, Inc., Baton Rouge, LA). Dursban®, Orthene® and Bengal® are registered for control of RIFA. Optem® is not registered for RIFA control, but was applied at a rated equivalent to the Dursban treatment. Formulations, application rates and methods were as follows:

Insecticide & Formulation	Method of Application	Rate of Application	
		Amount	g AI/mound
Dursban® 2EC	Drench	0.5 oz/gal H_2O/mound	3.54
Orthene® 75S	Sprinkled on dry	2 tsp/mound	0.54
Bengal® Fire Ant Killer	Drench	0.2 oz/pt H_2O/mound	0.24
Optem® PT-600	Drench	2.0 oz/gal H_2O/mound	3.54

Population assessments in established ¼-acre subplots, as described in the previous study, were conducted prior to application and at 1, 2, 4 and 8 weeks posttreatment.

<u>Results</u>:

<u>Award™ + fertilizer study</u>: Trial I - As shown in Table 1, there was no significant difference in population index reduction between the Award™ only and the Award™ + fertilizer plots at 6 and 12 weeks

posttreatment. This trial was terminated after the 18 week count because reinfestation had occurred. Reinfestation following any bait application is normal and expected at this time interval.

Trial II - After 10 months of storage, 18 weeks of excellent control was achieved with both the bait + fertilizer treatment and the bait only treatment (Table 2). At 24 and 30 weeks posttreatment, the Award™ only treatment provided >94% population control, but these means were not significantly different from the other treatment or the check. This was possibly due to reinfestation and the resultant variability in individual population indices used to determine treatment means.

Fertilizer blended with RIFA bait, and immediately applied, does not appear to enhance or degrade the efficacy of the bait. Fertilizer blended with bait and stored up to 10 months prior to application also provided excellent control for 18 weeks. Possible use patterns for a pre-mixed blend of fertilizer and RIFA bait would be for homeowners and golf course maintenance.

Individual mound treatment study: Observations made 1 wk after treatment indicated that, with the exception of Orthene® 75S, all treatments killed large numbers of worker ants, and surviving colonies were much reduced in size relative to the pretreatment population. All mounds which received a drench treatment (as evidenced by disrupted nest tumulus due to the effects of the drenching operation), were vacant, indicating that the colony had either succumbed to the treatment or had relocated the nest. Numerous freshly formed nests, much smaller in size were usually observed within 5-8′ of the treated nest, indicating that colony relocation had indeed occurred.

As shown in Table 3, Dursban® 2EC, Optem® PT-600, and Bengal® Fire Ant Killer significantly reduced the pretreatment population indices for 8 weeks after application, but the best control for these treatments occurred at 2 weeks posttreatment. Control with Orthene® 75S was not significantly different from the untreated check at any time. Colony mortality (i.e. % kill), ranged from ca. 65 to 80% at 2 weeks posttreatment (Table 4). However, by 4 weeks posttreatment colony mortality had declined to the 50% range. The decline in control at 4 weeks posttreatment can not be explained by reinfestation of the area by newly mated queens due to the biology of this insect (Markin et al. 1973, Callcott and Collins 1992). Nor can it be explained by invasion of the plot by untreated colonies from outside the plot due to the 76′ buffer provided by the plot design. More likely, colonies which were severely disrupted and decimated by the pesticide application were able to regroup and reform more visible nests 4 to 6 weeks posttreatment.

Recent isolated infestations outside the generally infested area in Virginia, Tennessee, Arkansas, and other states have led to renewed efforts to eradicate fire ants from small areas to prevent further spread. These eradication efforts generally are conducted by the affected state plant regulatory agency. Drench treatments in combination with broadcast bait applications are commonly used in these programs, and success of the eradication effort is dependent upon judicious use of the most effective insecticides available. Results of this study should aid in the selection of the most appropriate products for small scale eradication efforts, or other fire ant control programs. These results also clearly demonstrate the need to use spot treatments in combination with broadcast bait applications to achieve maximum population suppression.

The experimental plot design used in this trial was extremely labor intensive, requiring approximately 100 person hours to lay out plots, conduct pre and posttreatment population assessments, and apply treatments. Therefore, this one trial, evaluating only 4 candidate individual mound treatments, cost approximately $1550.00 (excluding capital outlays to program). Additional time was required for data analysis and report preparation. However, the results obtained are far more valid than other studies employing less vigorous plot designs.

Table 1. Efficacy of Award™ and Award™ + Fertilizer in Controlling RIFA Populations, Harrison Co., MS, 1992.

Treatment	% Change in Population Index at Indicated Weeks PT[1]		
	(6)	(12)	(18)
Fert. + Award	-92.4a	-95.8a	-67.8a
Award only	-83.8a	-98.6a	-31.2a
Check	-26.0b	+29.5b	+52.4a

Table 2. Efficacy of Aged (10 Months) Award™ and Award™ + Fertilizer in Controlling RIFA Populations, Harrison Co., MS, 1993.

Treatment	% Change in Population Index at Indicated Weeks PT[1]				
	(7)	(12)	(18)	(24)	(30)
Fert + Award	-94.8a	-98.2a	-95.6a	29.6a	-29.8a
Award only	-96.8a	-99.8a	-98.8a	-96.1a	-94.9a
Check	-32.1b	-40.4b	-33.9b	-37.3a	-62.3a

[1] Means within a column followed by the same letter are not significantly different according to Tukey's studentized range (HSD) test (SAS Institute 1988).

Table 3. Reduction in RIFA Pretreatment Population Index by Spot Treatments with Various Insecticides, Harrison County, MS, 1993.

Treatment	% Change in Pretreatment Population Index at Indicated Weeks Posttreat[1]			
	(1)	(2)	(4)	(8)
Dursban 2EC	-78.4a	-86.4a	-62.4ab	-83.4a
Optem PT-600	-73.5a	-81.5a	-54.6ab	-61.7ab
Bengal Fire Ant Killer	-57.3ab	-81.7a	-69.5a	-61.1ab
Orthene 75S	-27.9bc	-30.3b	-17.5b	-11.5b
Untreated Check	-25.2c	-39.2b	-16.2b	-11.8b

Table 4. Mortality of RIFA Colonies Due to Spot Treatments with Various Insecticides, Harrison Co., MS, 1993.

Treatment	% Decrease in Number of Active RIFA Colonies at Indicated Weeks Posttreat[1]			
	(1)	(2)	(4)	(8)
Dursban 2EC	68.7a	79.4a	52.5a	80.4a
Optem PT-600	70.4a	78.7a	51.4a	57.2ab
Bengal Fire Ant Killer	42.9ab	64.4ab	53.0a	40.6bc
Orthene 75S	16.5b	23.9b	2.0b	11.1c
Untreated Check	21.2b	40.0ab	10.3b	10.0c

[1] Mean based on three replicates. Means within a column followed by the same letter are not significantly different according to Tukey's studentized range (HSD) test, (SAS Institute, 1986).

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AN EVALUATION OF THE RATE OF LOGIC® FIRE ANT BAIT REMOVAL FROM TREATED TURF

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Logic® Fire Ant Bait contains the active ingredient fenoxycarb, an insect growth regulator and juvenile hormone analog that interferes with molting, maturation, and reproduction in insects. Logic® is currently labeled for use in the control of imported fire ants. Fenoxycarb has demonstrated a high degree of chronic toxicity to aquatic invertebrates under laboratory conditions. To evaluate the potential risk to natural aquatic systems, estimates of exposure are typically generated from computer simulations (e.g. PRZM, GLEAMS) which include meteorological, geographic, chemical and agricultural parameters. However, removal or consumption of fenoxycarb by fire ants should be an important consideration in the estimation of the amount of material available for off-target transport. Foraging fire ants retrieve the fenoxycarb bait, returning it to the mounds where it is consumed. Point-source bait acceptance studies have indicated that the rate of removal is quite rapid, with nearly all bait removed within 24 hours of placement (Ferguson, J. S. 1994).

After normal application to turf areas, the rate at which Logic® Fire Ant Bait formulation was removed by fire ants was estimated. The potential effects of this removal on estimates of aquatic environmental concentrations was considered.

Materials and Methods

The study was conducted at Ciba's Vero Beach Research Center, Florida in an established bahiagrass pasture. Three contiguous test plots (designated Blocks A, B, and C) were established within an area 160 feet by 250 feet. Test plots each measured 150 feet by 20 feet and were centered within the test area such that 50 feet of treated area bordered the test plots. Ten, 1 square foot sampling stations were located on each of two transects positioned longitudinally within the plots. Prior to application the test plots were surveyed for the presence of fire ant mounds and rated using the USDA fire ant rating scale (Lofgren, C. S. and D. R. Williams, 1982).

Logic® Fire Ant Bait was broadcast applied (November 3, 1993) at the maximum label use rate of 1.5 lbs/acre. The material was the standard formulation of corn grit, soybean oil and active ingredient, however, it was also treated with Uvitex dye (0.03% by weight) to cause the granules to fluoresce and aid in locating and counting granules after application. Counts of granules were made at approximately 1, 4, 12, 24, 32 and 48 hours after application. Battery powered ultraviolet lamps (Blak-Ray™ Longwave Ultraviolet Lamp 366 nm ML-49) were used in locating granules.

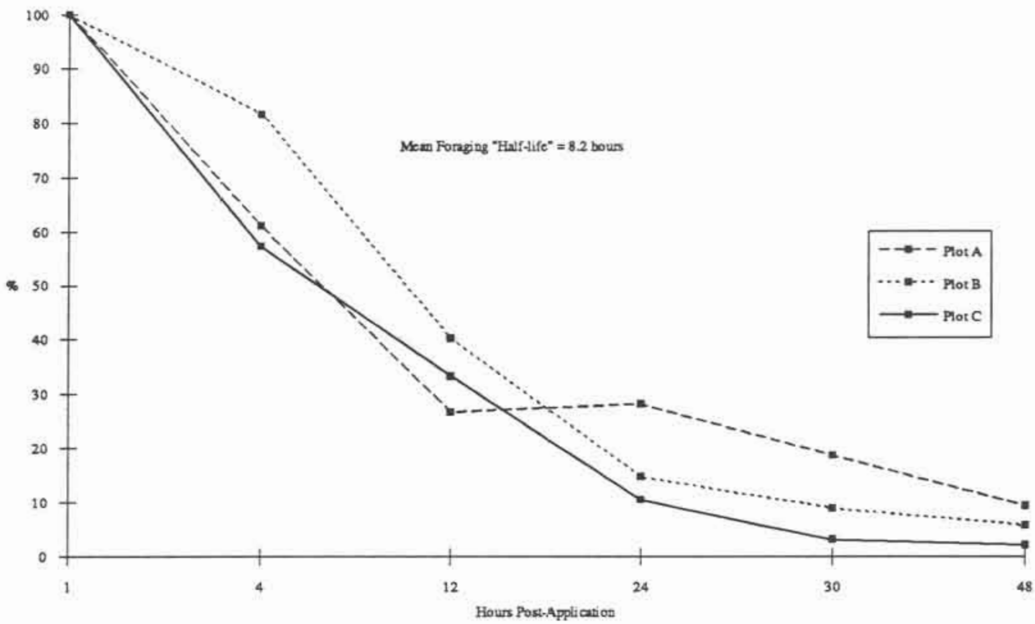
Three reference trays of approximately 1 square foot area and containing field soil planted with bahiagrass were established outdoors where they were exposed to the elements. Sixteen granules of Uvitex treated Logic® Fire Ant Bait were placed in each tray. Granule counts were made a 0, 4 and 24 hours after application to the test plots.

Results

Average mound ratings were 10.0, 8.8, and 9.4 for plots A, B, and C, respectively and population index values were 150, 115 and 220. An additional 9 mounds were located outside of the test plots but within the treated area. It was recognized that small, inconspicuous mounds were not included in the ant density estimates. Reference samples indicated that granules were physical stable, did not disintegrate, and that observers were able to successfully locate granules in turf vegetation after application.

Initial number of granules/station ranged from 0 to 15, and mean counts per transect ranged from 2.3 for transect C2 to a high of 10.0 for transect B2. The percentage of initial granules remaining at subsequent sampling points is presented in Figure 1. Foraging appeared to begin almost immediately after application and thus the rate of foraging was somewhat underestimated since the initial activity by the ants was not represented. Between 12% and 53% of the initial number of granules were removed from the transect stations within the 1 hour and the 4 hour samplings. Foraging proceeded quickly and from 0% to 6.6% of the initial number of Logic® granules remained after 48 hours. Transect values for each plot were combined and half-lives calculated using least-squares non-linear regression. Foraging half-lives for plots A, B, and C were 5.9 ($r^2 = 0.98$), 10.7 ($r^2 = 0.94$), and 8.0 hours ($r^2 = 0.94$), respectively. The mean half-life equals 8.2 hours. PRZM estimates of fenoxycarb pond water concentrations, adjusted for rapid foraging, were approximately 10% of the unadjusted values. Foraging thus appears to be an important factor in the assessment of the potential risk which Logic® may pose to aquatic organisms.

Figure 1.



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A City Fights Back Against Fire Ants- The Amdro Aerial Attack

Kyle Miller, American Cyanamid; Gerald Crossland, Arkansas Cooperative Extension Service; and Lendel Schutzman, American Cyanamid.

Broadcast applications of Amdro which requires a mere 1 to 1.5 lbs of product per acre has only recently been popularized after identification and testing of suitable equipment. As we know, broadcasting is generally a more effective way to control fire ants over the "search and destroy" individual mound treatment method, because small unnoticeable mounds are controlled. The thought of treating an entire city using the ultimate broadcasting method, "aerial application", was realized as a challenge that had to be met. Obtaining the support of the local government and citizens and working around sensitive issues such as toxicity to animals and humans, would be no easy task. The help of a guiding hand was needed. In this instance it was Mr. Gerald Crossland, county extension agent in southern Arkansas.

Junction City which lies on the border of Arkansas and Louisiana was identified as a suitable city for the pilot program. The city had a severe fire ant problem, was agriculturally oriented, of manageable size (two square miles) and most importantly, Gerald had a strong working relationship with the townspeople. After meeting with city council and holding a town informational meeting, acceptance was gained. The approach of controlling fire ants through aerial application is one that eliminates the "Hit and Miss" problem associated with one homeowner treating while adjacent neighbors do not. Using this technique the entire town would benefit.

An aerial photograph was taken of the treatment area to provide the applicator with detailed information concerning the application. This included the four corners of the treatment area, location of ponds, radio towers , and schools. Several days before the application, notices of the upcoming application were placed throughout the town and sent home with the school children. Plastic for covering active gardens and swimming pools was provided at city hall.

On October 5, 1993 the application was made to 1200 acres at a rate of 1 lb of Amdro per acre. Ten 1/4 acre plots installed the day before were inspected to determine uniformity of application.

The success of the program now hinged on the performance of the product. At four weeks following treatment, plots installed on October 4, were evaluated for ant activity.

Eighty percent control was found at this rating date. The townspeople's perception of control would be very important. Casual interviews were held with citizens and comments provided to city council members were documented. Overall, the townspeople felt that the fire ant level had been greatly reduced allowing them to safely enjoy outside activities without the threat of fire ants. The positive response to the program has prompted Junction City to commit to a spring application to further take control of the problem. Financing the spring application will be done through community fund-raisers and city government funding.

In order for this pilot program to have succeeded, the cooperation and commitment of the city government, townspeople, county extension service, aerial applicator and others was critical in working towards a common solution.

Residual Activity of Drench Candidates 1991-1993

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1994 Imported Fire Ant Research Conference
May 9-11, 1994
Mobile, AL

INTRODUCTION:

Drench treatment with insecticidal solutions is one of several options available to nurseries for quarantine treatment of nursery stock. It offers versatility for use as spot treatments, treatments immediately prior to shipping, and for short turn-around crops. Currently there are three available chemicals registered by EPA and approved by USDA, APHIS for drench treatment: Diazinon at 1 pint AG-500 or 1lb. 50 WP/100 gallons water; chlorpyrifos 4EC, 2EC, or 1EC at 4fl. oz. 4EC/100 gallons water or equivalent for 2EC and 1EC; and bifenthrin 10WP at 25 ppm based on dry weight bulk density of potting media. Certification periods are as follows:

chlorpyrifos	30 days
diazinon	10 days
bifenthrin	180 days

Testing of drench treatment compounds is an ongoing process at our laboratory. We routinely screen previously tested products at lower rates, new formulations of previously tested products, and new products as they are introduced. This paper is a compilation of the trials conducted over the last three years.

MATERIALS AND METHODS:

Materials and methods used were essentially the same for all three trials. The only exception was the media used. The first trial used media obtained from Flowerwood Nursery, Mobile, AL. which consisted of 19:3 pine bark and sand. The media used in the other two trials was produced at the IFA laboratory consisting of 3:1:1, pine bark, sand, and peat moss. Fifty-four 6" x 6" (trade gallon) nursery containers for each treatment were filled with untreated potting media. Drench solutions were applied at 400 ml of solution per container. The containers were then placed outdoors to weather naturally. A pulsating head type overhead irrigation system supplied ca. 1-1.5 inches of water per week. At monthly intervals, 3 pots from each treatment were composited and subjected to alate queen bioassay.

Bioassays were conducted in the laboratory by confining alate queens to treated soil placed in 2" x 2" plastic flower pots equipped with a Labstone® bottom. The labstone absorbs mixture from an underlying bed of damp peat moss. There were four replicates per treatment in each bioassay. Each pot (replicate) contained 50 cc of treated soil and five alate queens. Queen mortality was assessed after seven days of continuous confinement to the treated soil. Treatments which were effective at the first bioassay interval were aged and retested periodically.

Rates and compounds used in each trial were as follows:

TRIAL	PRODUCT	COMMON NAME	PRODUCER	RATES (ppm)
I	Talstar® 10WP	bifenthrin	FMC	10, 25 & 50
	Capture® 2EC	bifenthrin	FMC	25 & 50
	Karate® 1EC	lambda-cyhalothrin	ICI Americas	25 & 50
	Tempo® 2EC	cyfluthrin	Mobay	25 & 50
II	Demon® 40WP	cypermethrin	ICI Americas	50 & 100
	Commodore® 10WP	lambda-cyhalothrin	ICI Americas	50 & 100
	Talstar® 80 g/1F	bifenthrin	FMC	50 & 100
III	Bengal®	*	Bengal Chemical Co.	10, 25 & 50
	Fury® 1.5EW	zeta-cypermethrin	FMC	10, 25 & 50
	Fury® 1.5EC	zeta-cypermethrin	FMC	10, 25 & 50
	Prevail® 2EC	cypermethrin	FMC	10, 25 & 50
	Optem® PT 600	cyfluthrin	Whitmire Research Labs	10, 25 & 50

*[(1R,3S)3((1'RS)(1',1',2'2'-tetrabromoethyl)-2,2-dimethylcyclopropanecaroxylic acid, (S)-alpha-cyano-3-phenoxybenzyl ester]

<u>RESULTS</u>:

Trial I (1991)

Final results are summarized in Table 1. Both bifentrin compounds

(Talstar® 10WP and Capture® 2EC) maintained 100% mortality through 18 months. Karate® 1EC at 25 ppm maintained 100% through 11 months, while the 50 ppm rate maintained 100% mortality through 16 months. Tempo® 2EC was extremely variable with neither rate reaching 100% until 4 months posttreatment, nor maintaining it beyond 11 months.

Trial II (1992)

Results of this trial are summarized in Table 2. Both rates of Talstar® maintained excellent control for 18 months posttreatment. Commodore® at the 100 ppm rate also maintained 100% efficacy through 16 months, while the 50 ppm rate became less effective and erratic after 12 months of good control. Both rates of Demon® began to show erratic results at 7 months post-treatment.

Trial III (1993)

Preliminary results are summarized in Table 3. At 10 months post-treatment the 50 ppm rates of Bengal® and both formulations of Fury® have maintained 95% or better mortality. Bengal® at the 25 ppm rate has maintained 85% or better. Prevail® at the 50 ppm rate has maintained 70% or better and may prove to be effective at a slightly higher rate. All remaining rates of all formulations have either shown erratic results or have failed completely.

DISCUSSION:

Talstar® 10WP is currently registered under section 24C of FIFRA in most

IFA infested states for quarantine treatment. Other formulations of bifenthrin (Talstar® 80F and 2EC) are effective as drenches, but may not be good candidates for registration due to marketing practices. Other compounds tested that show promise for registration include Karate® 1EC, Commodore® 10WP, Bengal®, and Fury®. In general all formulations and dose rates of bifenthrin provided the most consistent and effective level of control of all candidates tested.

Table 1. Effectiveness of Drench Candidates, 1991. Test I.

Insecticide	Dose Rate (PPM)	Average % Mortality to Alate IFA Queens at Indicated Months Posttreatment (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Talstar® 10WP	10	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	25	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	50	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Capture® 2EC	25	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	50	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Karate® 1EC	25	100	100	100	100	100	100	100	100	100	100	100	85	60	80	35	25	95	100
	50	100	100	100	100	100	100	100	100	100	100	100	100	10	100	100	100	100	100
Tempo® 2EC	25	90	95	95	100	70	100	95	100	100	100	100	75	100	65	40	10	25	50
	50	100	85	85	100	100	100	100	100	100	100	100	90	100	20	5	5	25	15
Check		10	10	5	5	0	0	5	5	0	5	15	0	0	0	5	10	0	10

Table 2. Effectiveness of Drench Candidates, 1992. Test II

Treatment	Dose Rate (ppm)	Percent Mortality at Indicated Months PT																	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
Demon®	50	100	100	100	100	100	100	85	85	90	80	80	100	50	80	35	65	100	15
40WP	100	100	100	100	100	100	100	95	100	100	90	100	80	85	100	35	85	100	100
Commodore®	50	100	100	100	95	100	100	100	100	100	100	100	100	65	100	95	100	100	95
10WP	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	75	100
Talstar®	50	100	100	95	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
80 g/lF	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Check		0	10	20	0	0	5	5	0	15	0	5	10	5	5	10	0	0	0

Table 3. Effectiveness of Candidate Drench Treatments, 1993. Test III

Chemical	Dose Rate (ppm)	% Mortality of Alate Queens at Indicated Mths PT (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Bengal®	10	100	95	100	75	75	80	95	100	100	100
	25	100	100	90	85	95	100	100	100	100	85
	50	100	100	100	100	100	100	100	100	100	100
Fury® 1.5EW	10	100	100	90	10	45	5	0	45	40	---
	25	100	100	100	100	75	50	45	65	85	90
	50	100	100	100	100	100	95	100	100	100	100
Fury® 1.5EC	10	100	95	80	65	40	20	45	25	35	---
	25	100	100	100	100	80	85	100	100	95	90
	50	100	100	100	100	95	100	100	100	100	100
Prevail®	10	70	55	45	5	30	0	25	30	25	---
	25	95	90	40	45	55	20	15	40	50	---
	50	100	95	90	100	80	90	70	100	95	100
Optem®	10	15	0	0	---						
	25	20	20	10	---						
	50	5	10	15	---						
Check	-	0	5	5	10	25	5	10	0	5	5

Red Imported Fire Ant Control with Award:Fertilizer Blends -- A Progress Report

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INTRODUCTION

Fire ant bait products, including Award 1G formulation of fenoxycarb, are usually applied at low application rates of 1 - 1.5 pounds per acre. Many users have equipment capable of applying Award accurately. For others, this low application rate presents a challenge.

Previous studies with fire ant baits blended with agricultural grade fertilizers showed the dusty formulations rendered the baits unattractive to foraging fire ants. The studies reported on here were established to test the feasibility of blending Award 1G Fire Ant Bait with coated fertilizer products and applying through standard fertilizer application equipment.

Tests were initiated during 1992 and 1993 to test the effectiveness of Award:fertilizer blends for control of red imported fire ants (*Solenopsis invicta* Buren).

MATERIALS AND METHODS

The treatments evaluated were: (1) Award 1G custom blended with 41-0-0 Polyon polymer coated urea fertilizer at 1 lb. Award to 100 lb. of fertilizer, produced by Pursell Industries, Sylacauga, AL; (2) Award blended on site with Polyon 42-0-0 at 1.5 lb. Award to 100 lb of fertilizer and (3) Award blended on site with Scotts Super Turf Builder (35-3-5) at 1 lb Award to 100 lb of fertilizer. Approximately 100 lb/A of all mixtures were applied. In most cases, Award bait was applied alone as a standard treatment.

Studies were conducted by the individuals indicated in Table 1. The product used in studies conducted by Banks, Cobb, Lacy, Sparks, *et al.* and Thompson was custom blended by Pursell and that tested by Collins, *et al.* and Horton was blended on site. All tests were conducted in 1993 except for one of the trials by Collins, *et al.* which was applied in 1992.

RESULTS AND DISCUSSION

There were many variations from the base protocol for these trials. Therefore, each investigator's trial(s) will be covered separately.

Two trials were conducted and results are presented in Figure 1 and Figure 2. The Award rate in these trials was 1.5 lbs. per acre. The data in Figure 1 represents the effect of freshly blended Award Fire Ant Bait compared to Award alone on Red Imported Fire Ant population index ratings over 18 weeks. There was rapid reduction in population index with no significant differences between the fertilizer blend and Award alone at any rating time. There was significant reduction with both compared to the untreated check.

Reinfestation had begun at the 18-week rating and there was no significant differences among treatments at that date, even though the numerical difference was still favoring the Award treatments. At the 18-week rating, it appeared the fertilizer treatment was rebounding faster than the Award alone treatment.

The data in Figure 2. show the results with the Award:fertilizer blend which was aged for 10 months prior to application compared to Award alone. There was, once again, rapid reduction in the population index with no significant difference between the fertilizer blend and Award alone at any rating time. Reinfestation occurred at the 24-week evaluation and the fertilizer blend treatment appeared to rebound while the Award alone treatment remained effective. No significant differences were apparent at the last two rating dates, however.

Overall, Award blended with polymer coated urea fertilizer was equal to the bait alone and it is an effective means of applying Award Fire Ant Bait.

Al Banks, Florida

Banks was unable to initiate a trial in the Spring of 1993, so the protocol was adjusted and the trial was initiated in the Fall of 1993 and carried on into 1994. Two Award:fertilizer applications were made, one with product stored for 6 months in Alabama and the other with product in Florida for 6 months before application.

There were no differences in activity related to storage location and thus only data from the Alabama stored product is reported in Figure 3. Banks rated population index at 0, 6, 14 and 22 weeks. Award alone reduced the population index 83% at 6 weeks, 81% at 14 weeks and 84% at 22 weeks after treatment. The Award:fertilizer treatment was slower acting and showed faster recovery (14% reduction at 6 weeks, 79% at 14 weeks and 37% at 22 weeks). Banks reported that worker brood were still absent from mounds in Award alone plots after 22 weeks while worker brood had resumed in the Award:fertilizer plots by that time.

Banks suggested that the ants harvested a relatively limited amount of the Award bait from the fertilizer mixtures. The amount harvested was sufficient to temporarily suppress egg-production by the queens, which would account for the relatively high level population index reduction after 14 weeks. The amount taken in by the colonies, however, was insufficient to completely destroy fecundity of many of the queens or to continue to produce the caste shift from workers to sexuals in many colonies between

14 and 22 weeks. In this trial, it appeared that at least half of the colonies in the Award:fertilizer treatments will survive and recover from the treatment.

These results suggest that Award in the mixtures may have begun to reach the outer limits of its acceptability to the ants after the 6-months storage. Some of the fertilizer pellets were taken into the mounds and could still be found there at the 6 and 14-week counts. This suggests some transfer of oil from the bait to the pellets occurred.

Pat Cobb, Alabama

Award alone and Award:fertilizer (custom blended Polyon) treatments were applied to an open turf area at a state park in Elmore County, Alabama. Award alone was applied at 1 lb./A and the fertilizer mixture was applied at 100 lbs./A. Treatments were applied on May 27 and August 12, 1993.

Results from this study are shown in Figure 4. Activity was rated by inserting a wire into a mound and estimating the number of ants emerging within a minute. Award + fertilizer appeared somewhat slower than the Award alone treatment as shown by the 7/24 rating date. Ultimately, the fertilizer applications were as effective as Award alone and were continuing to provide good fire ant suppression at the last rating.

The Award + fertilizer treatment appears to be a viable application.

Beverly Sparks, *et al.*, Georgia

This trial was conducted at the Rock Eagle 4-H Center in Putnam County, Georgia. All Award applications were made at 1 lb./A and the Award + fertilizer was applied at 100 lbs./A. Ratings were based on number of active mounds at pretreatment and at 1, 2, and 3 months post treatment.

Results of this trial are shown in Figure 5. Award + fertilizer showed a slight faster response than Award alone in this trial. Award + fertilizer was equal to slightly more effective than Award alone for the duration of this study.

Award + fertilizer appears to be a viable application, based on these results.

Mac Horton, South Carolina

Award was blended on site with Scotts Super Turf Builder 35-3-5 fertilizer and activity on Red Imported Fire Ant was compared to Award alone. Award was applied at 1 lb/A and the Award:fertilizer mixture was applied at 100 lbs./A.

Results from this trial is shown in Figure 6. The Award + fertilizer treatments were somewhat slower than Award in this case as shown by the activity at 1 and 2 weeks. However, by 4 weeks and 8 weeks, there were no difference in the Award + fertilizer and Award alone treatments. No ratings were taken beyond the 8-week rating, so no rebound comparison can be made.

The decision to stop the ratings at 8 weeks was based on observing that an Amdro treatment in this test had rebounded to near original activity levels at that time (Figure 7). Future trials with Award should be rated over a longer time period to better determine if the fertilizer applications will hold as long as Award alone.

Award + fertilizer appears to be a viable application based on these results.

Lynne Thompson, Arkansas

Two sites were treated with the Award:Polyon fertilizer mixture compared to an untreated area in each case. Treatments were applied on September 30, 1993 and rated Oct. 29 and Nov. 23, 1993 and on April 5, 1994. No reduction in fire ant mounds relative to the untreated was observed in either comparison. The mound count in the untreated area dropped 59% and 60% for the two sites over the course of the study.

Since Award alone was not included in these trials, no conclusions can be drawn except that the fertilizer mixtures did not perform well under the conditions of these tests.

Tim Lacy, Alabama

Award:Polyon 41-0-0 urea fertilizer was custom blended and bulk applied to a total of 95 acres at three locations by Tim Lacy. The product was applied to a private estate and two golf courses. No specific data were taken but the turf managers at each location were interviewed by Tim Lacy. All three rated the treatment as effective and all three stated they would purchase the product in the future if it were available.

SUMMARY AND CONCLUSIONS

The overall conclusion from these varied locations is: Award blended with a relatively dust-free polymer coated fertilizer is an effective means of applying Award Fire Ant Bait. In some instances it is slower acting than Award applied alone. Also, in some cases the length of control appears less with the Award:fertilizer application. More variation in product performance occurred when the product had been stored for an extended period.

Overall the performance activity of the Award:fertilizer mixtures was good and suggests we should continue testing in 1994. Several test are planned.

TABLE 1. **Research Participants Award® Fertilizer Trials**

- Al Banks, Florida
- Pat Cobb, Alabama
- Homer Collins, et al., Mississippi
- Mac Horton, South Carolina
- Tim Lacy, Alabama
- Beverly Sparks, et al., Georgia
- Lynne Thompson, Arkansas

FIGURE 1.

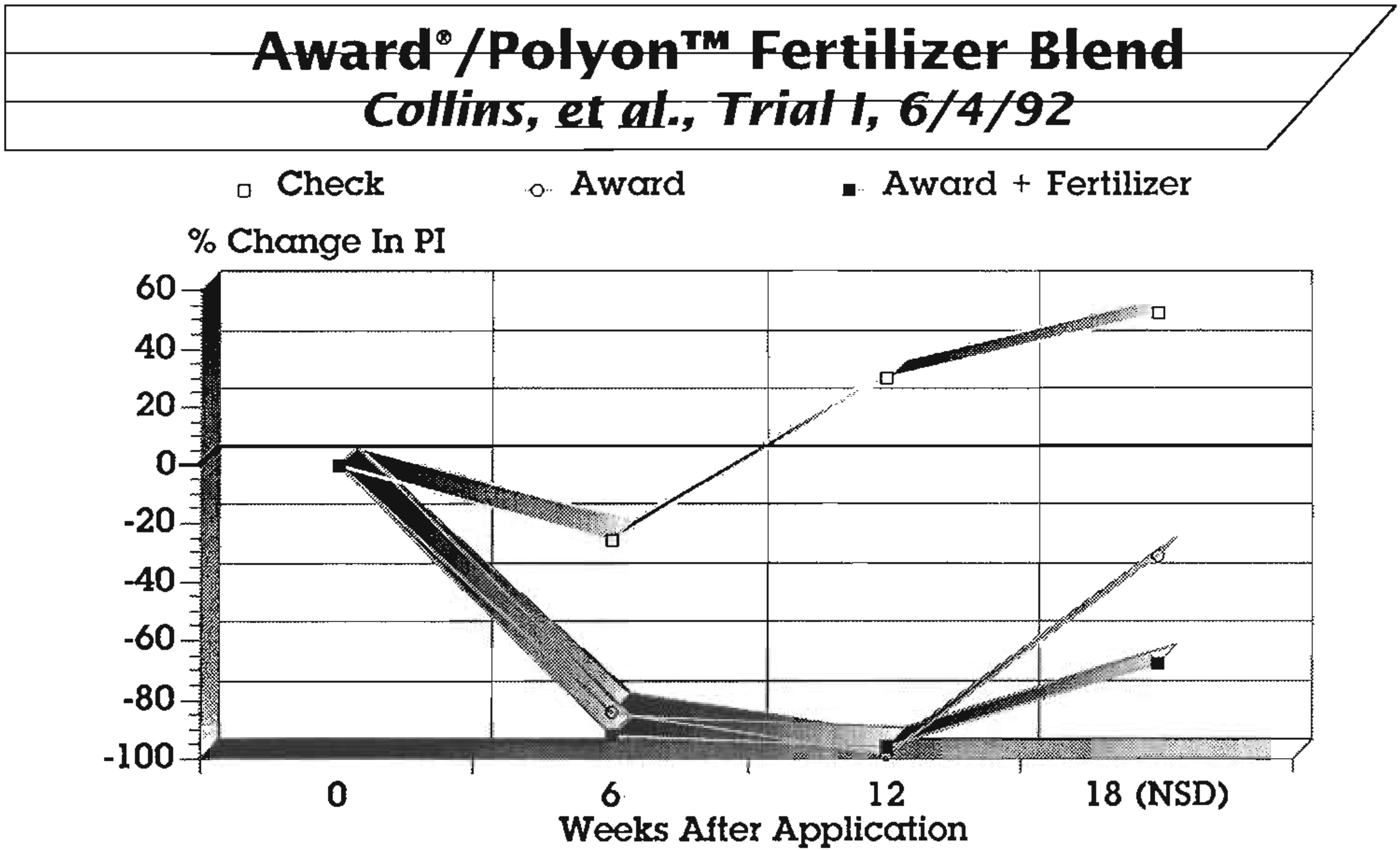
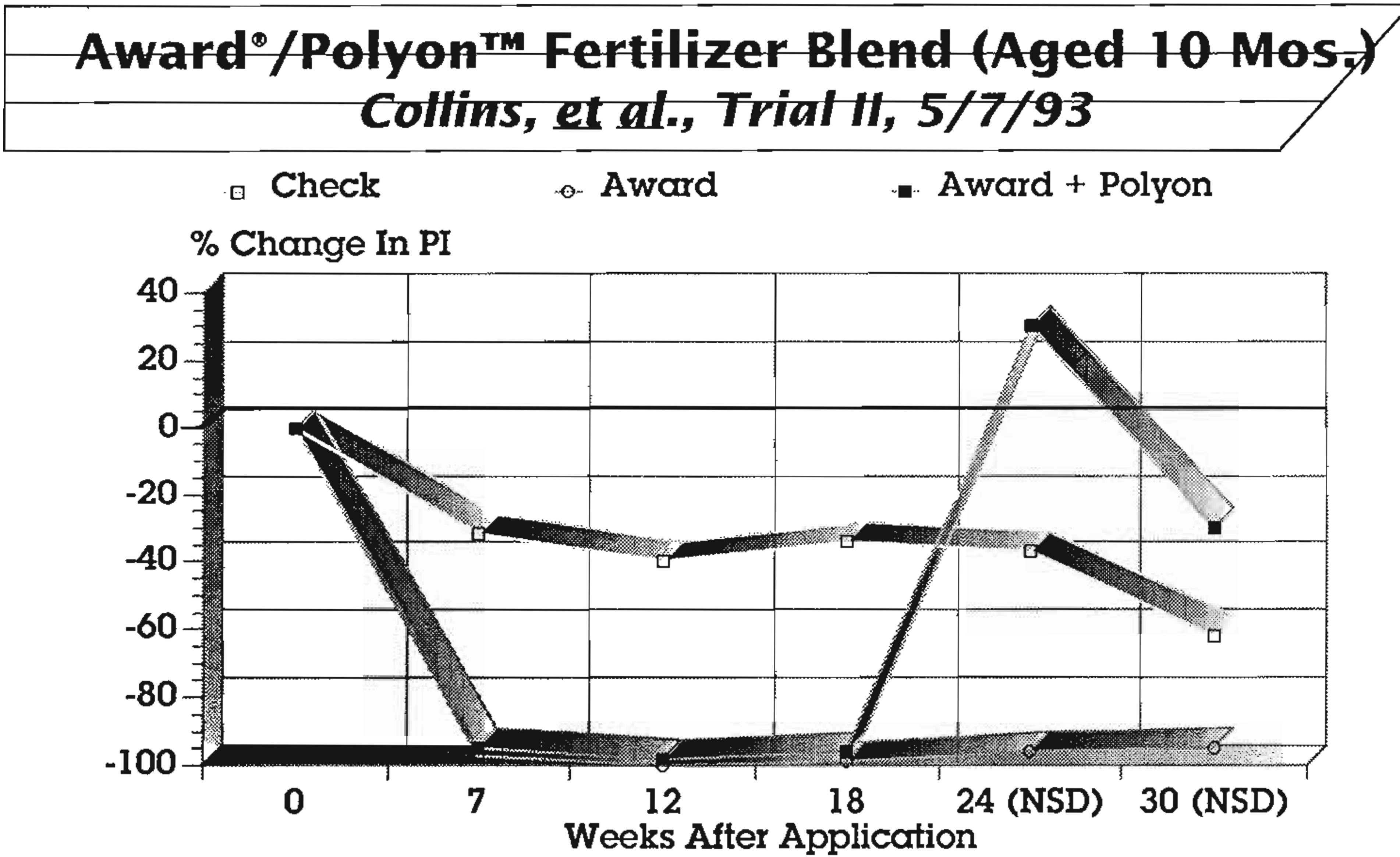
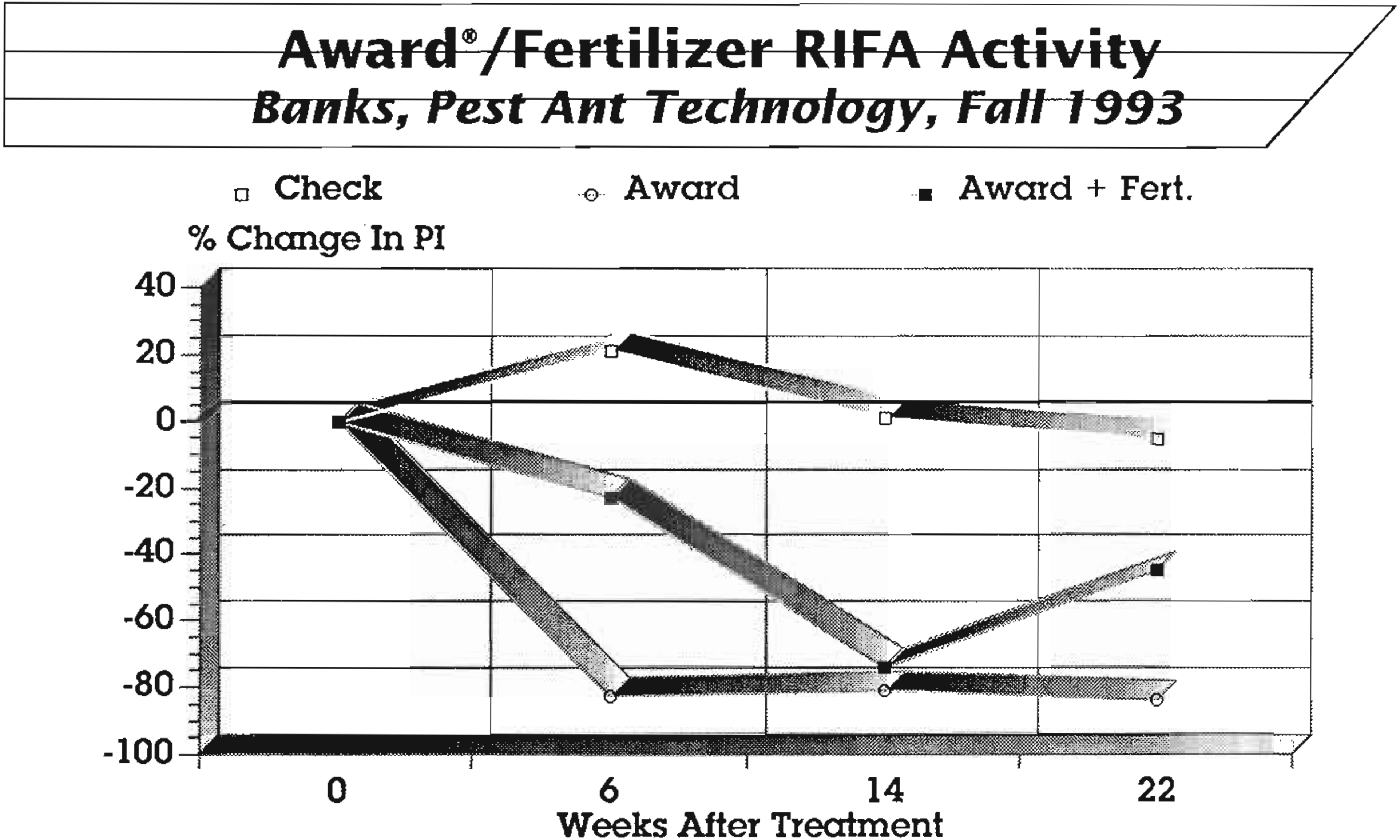

Award®/Polyon™ Fertilizer Blend
Collins, et al., Trial I, 6/4/92
Check
Award
Award + Fertilizer
% Change In PI
60
40
20
0
-20
-40
-60
-80
-100
0
6
12
18 (NSD)
Weeks After Application

FIGURE 2.



Award®/Polyon™ Fertilizer Blend (Aged 10 Mos.)
Collins, et al., Trial II, 5/7/93
Check
Award
Award + Polyon
% Change In PI
40
20
0
-20
-40
-60
-80
-100
0
7
12
18
24 (NSD)
30 (NSD)
Weeks After Application

FIGURE 3.

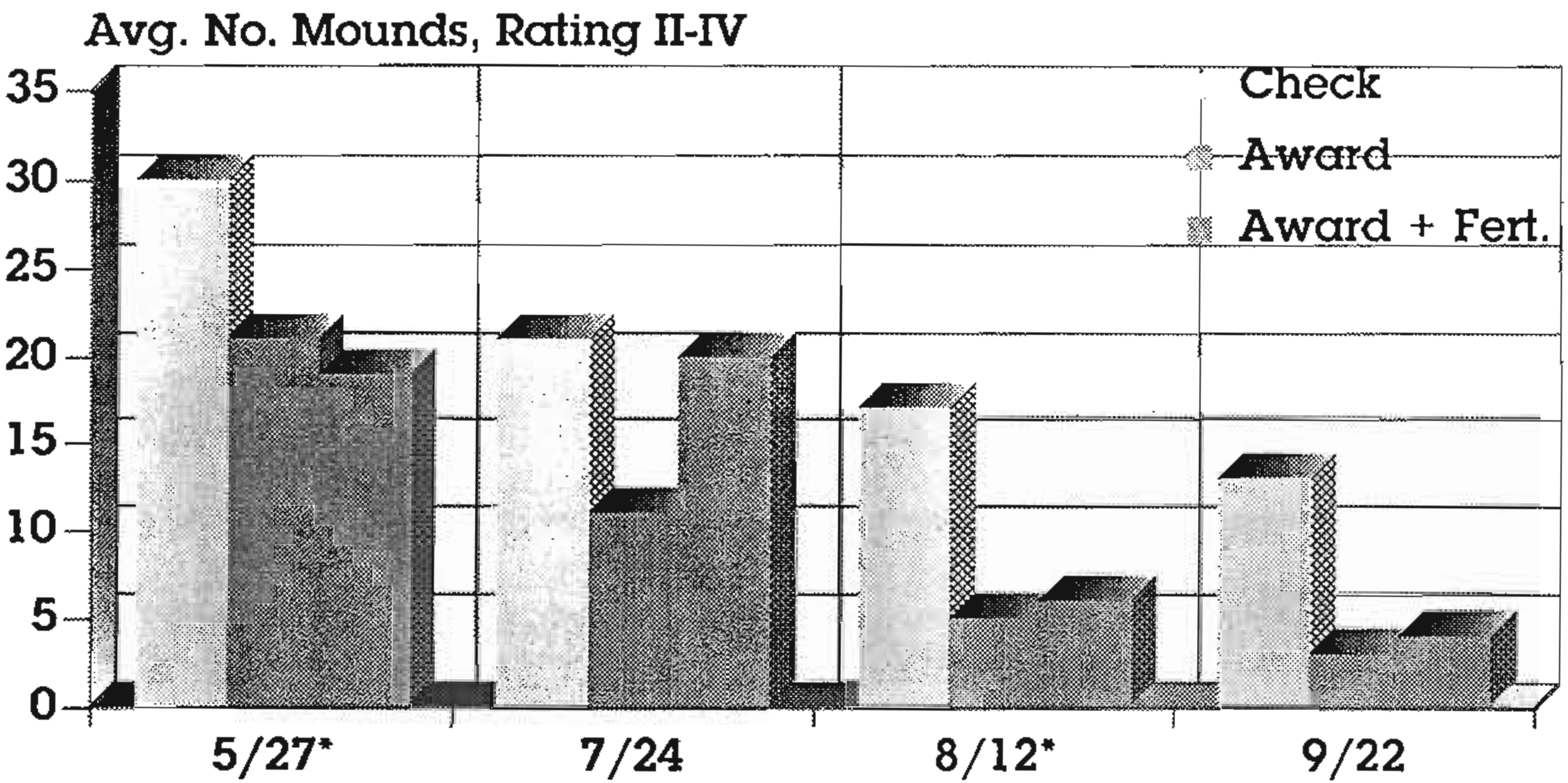


Award®/Fertilizer RIFA Activity
Banks, Pest Ant Technology, Fall 1993
Check
Award
Award + Fert.
% Change In PI
40
20
0
-20
-40
-60
-80
-100
0
6
14
22
Weeks After Treatment

FIGURE 4.

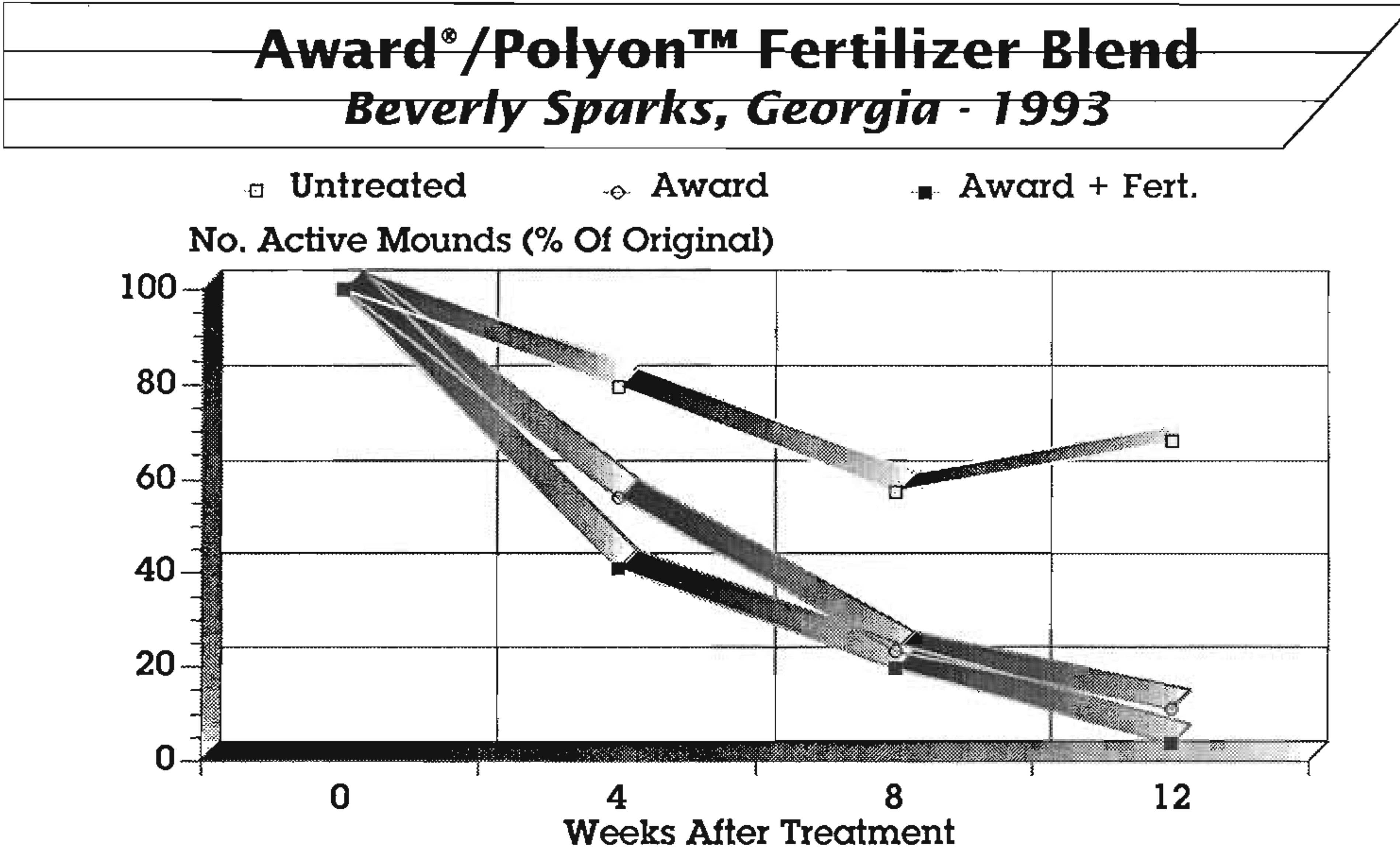
Award®/Polyon™ Fertilizer Blend

Pat Cobb, Alabama - 1993



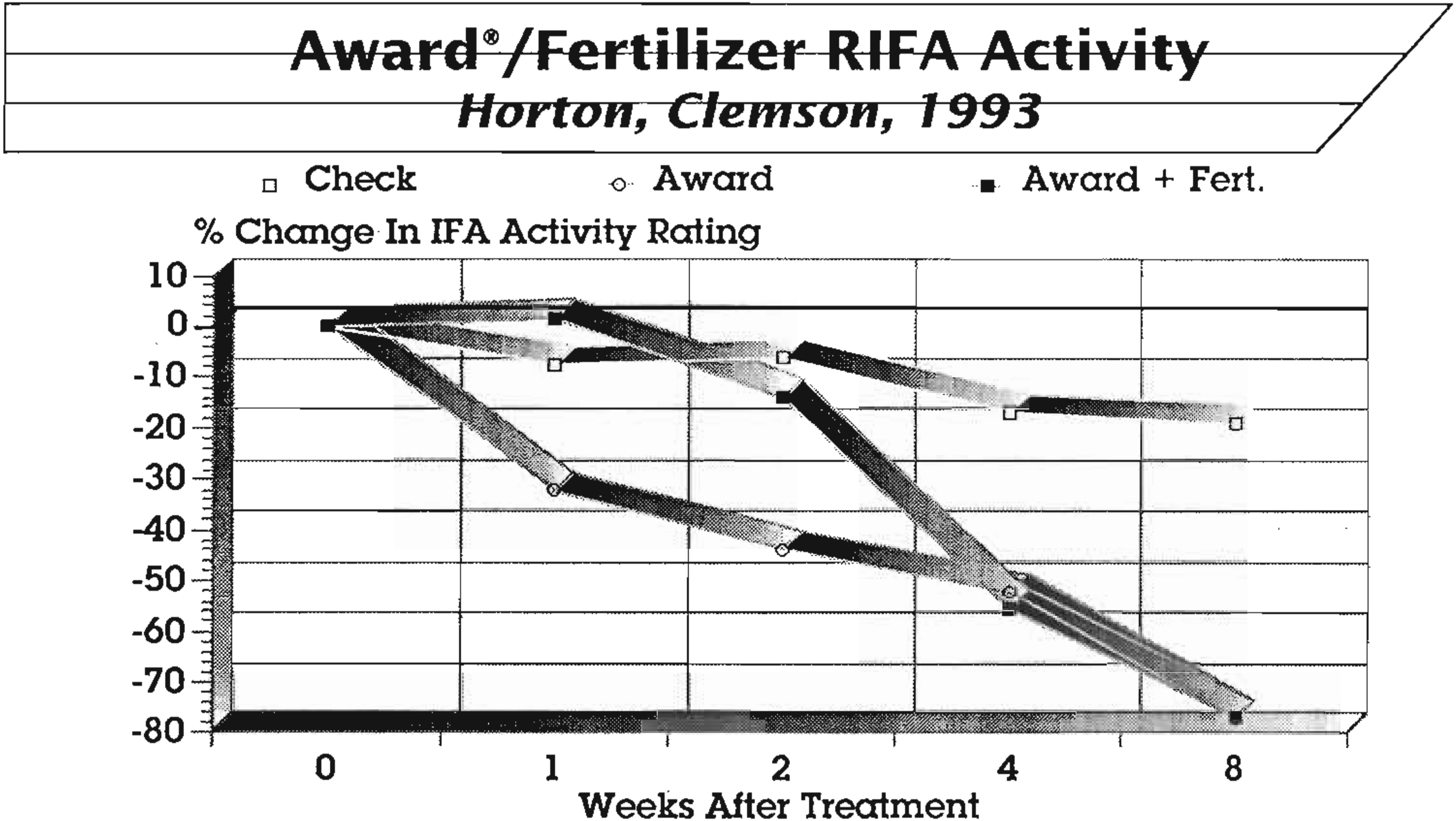
*Treated 5/27 And 8/12

FIGURE 5.



Award®/Polyon™ Fertilizer Blend
Beverly Sparks, Georgia - 1993
Untreated
Award
Award + Fert.
No. Active Mounds (% Of Original)
100
80
60
40
20
0
0
4
8
12
Weeks After Treatment

FIGURE 6.

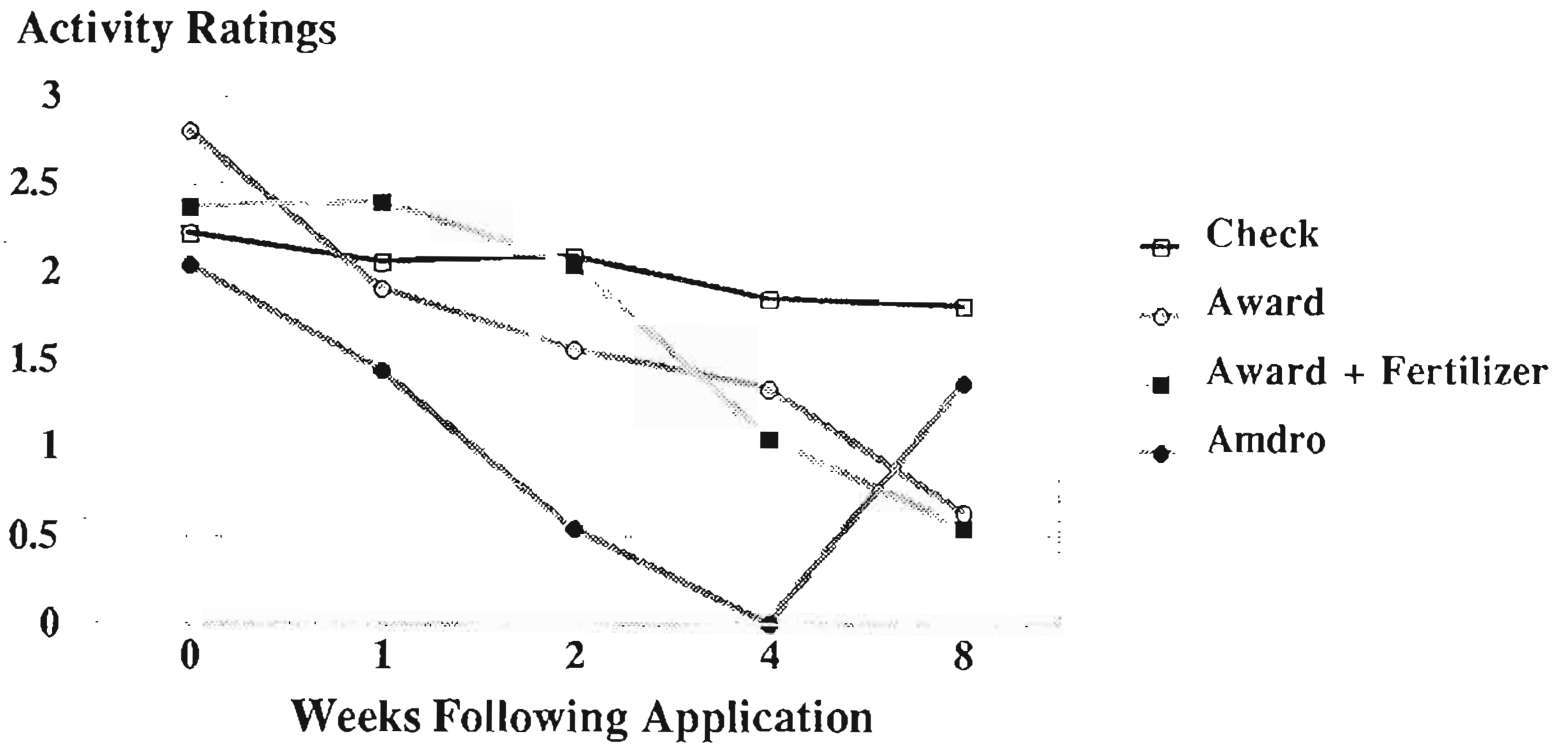


Applied 6/3/93
0= None, 1 = 1-100, 2=101-1,000, 3 = >1,000 Ants

FIGURE 7.

Award® + Fertilizer For RIFA Control

Horton, Clemson 1993



Ratings: 0 = No Ants, 1 = 1-100, 2 = 101-1,000, 3 = >1,000
Scotts Super Turf Builder 35-3-5

Who's Asking About Fire Ants and What Do They Want To Know?

By: James D. Miles
County Extension Agent

Who ask about fire ants? That's simple -- everyone in Mobile ask about fire ants, at one time or another.

Home owners -- what do they want to know? Another simple question -- what should I do? Concerns consist of children getting stung, baby caged pets, ie. rabbits & others, getting stung.

Landscape concerns involves turf, flower beds, vegetables, fruit (citrus), damage caused by fire ants, direct or indirect. Some environmentally conscious gardeners seek organic yet, economical controls.

Indoor invasions raise the question -- why are they migrating inside my home? Will there be health problems, structure damage, how to keep them from returning?

New comers to Mobile, from areas where fire ants are not a problem, want to know what is this stinging insect, is it common here and what to do about it?

Commercially, most people who have lived in Mobile for some time have learned to deal with it and live with it. Every now and then these veteran Mobilians inquire simply to check for new products or technology. Pecan growers continue to face problems during harvesting with equipment and personnel.

Athletic fields major problem is stings before mounds are seen in the spring. After the presence of fire ants are confirmed, control measures are taken.

Pastures remain on the agenda of the fire ants. Generally not a problem to livestock, however, young or wounded animals may experience numerous ant stings.

Ratite (Ostrich, Emu & Rhea) producers have not had a problem, thus far. Attributed to close management of helpless young chicks and heavy use of disinfectants around the hatchery.

Non-crop land problems range from forestry to airport landing strips. Airports suffer because the land surrounding it is the source of quick reinfestation.

Our county office receives about 130 calls a day on a horticultural subject. Normally, a very low percentage concerns the fire ant. However, explosions of calls occur after a media blitz that grits or other home remedies kill fire ants. The most asked question then is, "what brand or type of grits is best?"

Following this type of media attention, it's difficult to convince the public that their favorite anchor person or writer is giving out non-research based or even bogus information.

In conclusion, the types of research discussed here at this conference is necessary and helpful to Extension Agents in our mission to educate the public.

An Imported Fire Ant Control Program for Reduction of Labor Costs in a Commercial Landscape: A Preliminary Report

Patricia P. Cobb, Auburn University
William H. Cobb, Environmental Design Group, Birmingham, AL
David Bradford, Jefferson County Extension Office, Birmingham, AL

Treatment of red imported fire ants (RIFA) by commercial landscape managers is often expensive in labor and insecticide costs. Usually, a whole property is scouted regularly and visible mounds are treated. This practice consumes time that could be spent on other management duties.

The Colonnade is a 106-acre business complex including 54 landscaped acres in Birmingham, AL. The landscape is managed by professional horticulturists. RIFA control at the Colonnade before 1992 consisted of mound treatment only. One person required at least one working day weekly to treat mounds.

In 1992 the property was scouted, mapped, and test site (perimeter) treatments were done. Labor and insecticide costs within a 6-acre test area were reduced over a two-year period by applying baits to perimeters between heavily-infested landscaped and unmanaged land.

Materials and Methods

The property including the Colonnade grounds and adjacent unmanaged land was scouted in June 1992 in order to map areas most heavily infected with RIFA. A 6-acre tract within the landscape was selected for this study. Three perimeter test sites, each including a treatment plot and an untreated control plot, were selected. Plots ranged from 2,000 to 6,000 square feet. Strips 30 feet wide were treated in 1992 in adjacent, unmanaged areas from which RIFA were believed to migrate into the landscape. RIFA mound activity within plots was confirmed and active mounds were counted and recorded before treatment. In 1992, Affirm brand fire ant bait (avermectins, .011%) was applied at a rate of 1 lb bait per acre to the three treatment plots. Bait was applied 20 June 1992 (4:00-5:00 p.m.) with a Solo Mist Blower equipped with a granular converter. Air temperatures at application time was low 90's degrees F. Sunny calm conditions prevailed. One tenth inch rainfall occurred within 48 hours after application. Visible, active mounds within the bait-treated plots were treated within 5 days with Orthene Turf, Tree and Ornamental brand dust (75% acephate), 1-2 teaspoons per mound. Active mounds were counted again in August (7 weeks after bait application). The remainder of the 6-acre landscaped section was scouted and mound-treated as it had been in the past.

Bait application was similarly made to the same plots 13 August 1993. Award brand fire ant bait (1% fenoxycarb) was applied in 1993. The 30-foot strips in the adjacent unmanaged property were not treated in 1993 because RIFA mounds were absent in these areas. Rain (.75 inch) occurred in the area 3 hours after treatment. Active mounds in plots (including untreated control plots) were counted before treatment and again 5 April 1994.

Control costs reported for 1991 included labor and insecticide costs for the 6 acre tract. Costs reported for 1992 and 1993 do not include materials and time required for the test plots.

Results

6 August 1992 and 5 April 1994 active mound counts within treated sites (plots) are presented in Table 1 below:

Table 1. Number of active RIFA mounds within perimeter test plots before and 7 weeks after treatment, Birmingham, AL, 1992.

Location	No. active mounds before treatment	No. active mounds bait after treatment	Comments
Site 1: NW side; bordered by ravine, highway			
Treated plot: (4000 sq. ft.	15	24	(all new)
Untreated control plot: (4000 sq. ft.)	15	19	

Location	No. active mounds before treatment	No. active mounds bait after treatment	Comments
Site 2: NE tree & shrub beds. (6000 sq. ft.)	10	5	
Untreated control plot: (6000 sq. ft.)	3	8	
Site 3: Near NE entrance (2000 sq. ft.)	8	3	(original mnds)
Untreated control: (2000 sq. ft.)	3	2	(original mnds)

5 April 1994 active mound counts for sites described in Table 1 (plots treated 13 August 1993) are presented in Table 2 below:

Table 2. Number of active RIFA mounds before treatment on 18 August 1993 and 8 months after treatment (5 April 1994).

Location	No. active mounds before treatment	No. active mounds 8 mths. after treatment
Site 1:		
Treated	1	1 (New)
Untreated	4	11
Site 2:		
Treated	13	1
Untreated	9	5
Site 3:		
Treated	0	0
Untreated	5	0

Costs of RIFA control for the ca. 6-acre area surrounding the test site are summarized in Table 3.

Table 3. Costs of imported fire ant control in a 6-acre area of commercial landscape in Birmingham, AL, 1991-1993.

Year	Insecticide	Labor	Total
1991	$129.50 (10 lb)	$85.00	$214.50
1992	77.70	51.00	128.70
1993	12.95 (2 lb)	8.50	21.45

Discussion

In the 6-acre landscaped area of the Colonnade in Birmingham, AL, surrounding a total 24,000 square foot test area, costs of control of imported fire ants were reduced by 90% from 1991 to 1993. Test areas represented "perimeters" between landscape and unmanaged areas. The 6-acre section represented major "problem areas" for fire ant control within the managed property. More work needs to be done to determine the effective dimensions for perimeter treatments at this and other sites. Mapping and treating perimeters rather than total properties can result in savings in labor costs; and a reduction in pesticide usage.

EDWARD	ADAM	UNIROYAL CHEMICAL	1146 DUNCAN DRIVE	WINTER SPRINGS	FL	32708
MIKE	AMES	MERCK AgVet DIVISION	P.O. BOX 2000	RAHWAY	NJ	07065-0912
CHARLES	APPERSON	N.C. STATE UNIVERSITY]	BOX 7613	RALEIGH	NC	27695-7613
AMADOU	BA	TEXAS TECH UNIVERSITY		LUBBOCK	TX	79409
DENNIS	BARCLIFF	AL. DEPT. OF AGRICULTURE	1670 MT. VIEW ROAD	UNION GROVE	AL	35175
CHARLES L.	BARR	TEXAS AG. EXPERIMENT STATION	P.O. BOX 2150	BRYAN	TX	77806
JONATHAN	BERGER	WHITMIRE RESEARCH LABORATORIES, INC.	3568 TREE COURT INDUSTRIAL BLVD.	ST. LOUIS	MO	63122
RON	BERGER	USDA APHIS BBEP ISS	6505 BELCREST AVE.	HYATTSVILLE	MD	20782
JIM	BERRY	FLOWERWOOD NURSERY	P.O. BOX 7	LOXLEY	AL	36551
GEORGE M.	BETHURUM	THE BUSHWACKER ASSOCIATES, INC.	P.O. BOX 3456	GALVESTON	TX	77552
RALPH	BRAM	USDA, ARS	BARC-W, BLDG. 005	BELTSVILLE	MD	20705
JOHN	BRANNEN	ORGANIC PLUS	8023 VANTAGE DR., SUITE 600	SAN ANTONIO	TX	78239
JOHN	BRANNON	GEORGIA DEPARTMENT OF AGRICULTURE	820 WHISPERINGI PINE RD.	WINDER	GA	30680
TOM	BRIDGES	CIBA PLANT PROTECTION	P.O. BOX 18300	GREENSBORO	NC	27419
ROBERT L.	BRITTINGHAM	USDA-APHIS-PPQ	FED. BLDG. ROOM 640	HYATTSVILLE	MD	20782
ANNE-MARIE	CALLCOTT	USDA,APHIS,PPQ,IFA STATION	3505 25TH AVE. BLDG.16	GULFPORT	MS	39501
L. SCOTT	CARSON	TERRA, INT.	P.O. BOX 788	MONTGOMERY	AL	36101
STEVE	CARTER	ORGANIC PLUS, INC.	108 DALE AVE. S.E.	ALBUQUERQUE	NM	87105
CURTIS	CLARK	AMERICAN CYANAMID	1 CYANAMID PLAZA W-4	WAYNE	NJ	07470
PAT	COBB	AUCES		AUBURN UNIV	AL	36849
HOMER L.	COLLINS	USDA,APHIS,PPQ,IFA STATION	3505 25TH AVE. BLDG. 16	GULFPORT	MS	39501
ERNEST	COX		1602 ALLEN STREET	TALLADEGA	AL	35160
STEVE	DAVIS	ILLINOIS CEREAL MILLS, INC.	P.O. BOX 550	PARIS	IL	61944-0550
DAVID	DAVIS		P.O. BOX 12847	AUSTIN	TX	78711
STEVE	DEMARAIS	TEXAS TECH UNIVERSITY		LUBBOCK	TX	79409
CHARLES I.	DIAL	CLEMSON UNIVERSITY	BOX 340392	CLEMSON	SC	29634-0392
STAN	DIFFIE	COASTAL PLAIN EXPERIMENT STATION	P.O. BOX 748	TIFTON	GA	31793
WILLEY J.	DOUGHTY		3623 HAROLD DRIVE	BIRMINGHAM	AL	35215
BASTIAAN M.	DREES		P.O. BOX 2150	BRYAN	TX	77806
ROBERT (RICH)	EMERSON		605 AIRWAYS	JACKSON	TN	38301
DR. ROBERT E.	EPLEE	WHITEVILLE PLANT METHODS CENTER	P.O. BOX 279	WHITEVILLE	NC	28472

JAMES	FANGUE	R & D PROGRAMS	400 N OLIVE, LB 81	DALLAS	TX	75201
DR.	FAYE	SPHERE CORPORATION	RT. 4, BOX 172	GEORGETOWN	TX	78628
WHEELER	FOSHEE	EXTENSION ENTOMOLOGY	EXTENSION HALL	AUBURN UNIVERSITY	AL	36849
LLOYD	GARCIA	PLANT INDUSTRY DIVISION	P.O. BOX 27647	RALEIGH	NC	27611
KEN	GLENN	CLEMSON UNIVERSITY	BOX 340392	CLEMSON	SC	29634-0392
BOBBY	GREEN	DEPT. OF ENGINEERING TECHNOLOGY	TEXAS TECH UNIVERSITY	LUBBOCK	TX	79409
RANDY	HAMANN		1696 ROSS CLARK CIRCLE	DOTHAN	AL	36301
FRANK	HEERY	TN. DEPT. OF AGRICULTURE	6677 HARRISON HGTS. DR.	HARRISON	TN	37341
TOM	HELMS	MISS. AG & FORESTRY EXPT. STATION	BOX 9740	MISSISSIPPI ST.	MS	39762-9740
MILTON	HENDERSON	BUREAU OF PLANT INDUSTRY	P.O. BOX 5207	MISSISSIPPI ST.	MS	39762
DAVID E.	HERD	HERD SEEDER CO., INC.	P.O. BOX 448	LOGANSPORT	IN	46947-0448
GREGG	HODGES	ACES	ROOM 206-COURTHOUSE	CULLMAN	AL	35055
ALAN	HOSMER	CIBA	P.O. BOX 18300	GREENSBORO	NC	27409
CHIP	HOUMES	CIBA	6837 NICOLE COVE	BARTLETT	TN	38135
JACK	JACKSON	CLEMSON UNIVERSITY	BOX 340392	CLEMSON	SC	29634-0392
TIM	JOHNSON	AL. DEPT. OF AG & INDUSTRIES	1551 AL. HWY 36	MOULTON	AL	35650
GUY	KARR	AL. DEPT. OF AGRICULTURE	P.O. BOX 3336	MONTGOMERY	AL	36193
JOHN D.	KITSMILLER	UNIROYAL CHEMICAL	3003 CIRCLE GATE DRIVE	GERMANTOWN	TN	38138
COSTAS	KOUSKOLEKAS	GULF COAST SUBSTATION	8300 HWY. 104	FAIRHOPE	AL	36532
JIM	KRUGER	GOLD KIST	905 S. DEAN ROAD	AUBURN	AL	36830
VINCE	KRUSE	ELECTRIC POWER RESEARCH INSTITUTE	600 E.LAS COLINUS BLVD., SUITE 1550	IRVING	TX	75039
NEIL	LAPP	MERCK AgVet DIVISION	P.O. BOX 2000	RAHWAY	NY	07065-0912
GLYNN	LeBLANC	BENGAL CHEMICAL, INC.	P.O. BOX 40487	BATON ROUGE	LA	70835
DON	LESIEWICZ	ROUSSEL UCLAF CORP	95 CHESTNUT RIDGE ROAD	MONTVALE	NJ	
TSU H.	LIN	USDA, APHIS	FEDERAL BUILDING, ROOM 533	HYATTSVILLE	MD	20782
GENE	LUCIUS	CLEMSON UNIVERSITY	P.O. BOX 21792	COLUMBIA	SC	29221
PRISCILLA	MacLEAN	MERCON ENVIRONMENTAL CO.	P.O. BOX 467	EMIGSVILLE	PA	17318
THOMAS E.	MACOM	USDA-ARS MAVERL	P.O. BOX 4565	GAINESVILLE	FL	32604
JOE	MARES	GRIFFIN CORPORATION	P.O. BOX 1847	VALDOSTA	GA	31603-1847
LEE	McANALLY	USDA,APHIS,PPQ,IFA STATION	3505 25TH AVE. BLDG. 16	GULFPORT	MS	39501
ERNEST M.	McDONALD, SR.		1039 RIDGE ROAD	VALDOSTA	GA	31602
DUANE	MELTON	FMC	811 LAKE LAURIE DRIVE	VALDOSTA	GA	31602

BEN	MERIWETHER	AL. DEPT. OF AGRICULTURE	P.O. BOX 11626	MONTGOMERY	AL	36111
JAMES	MILES	ASSOC. COUNTY AGENT	1070 SCHILLINGERS ROAD	MOBILE	AL	36608-5298
KYLE J.	MILLER	AMERICAN CYANAMID COMPANY	14000 PRINCESS MARY ROAD	CHESTERFIELD	VA	23838
DR. AHMED	NASSER	PLANT SERVICES DIVISION	1602 N. 7TH STREET	PHOENIZ	AZ	85006
BEN	OATES	CU PEE DEE RESEARCH & ED. CENTER	RT. 1, BOX 531	FLORENCE	SC	29501-9603
DAVID H.	OI	USDA-ARS MAVERL	P.O. BOX 14565	GAINESVILLE	FL	32604
SHERMAN A.	PHILLIPS, JR	DEPT. PLANT & SOIL SCIENCES	TEXAS TECH UNIV.	LUBBOCK	TX	79409-2134
LEE	PORTER	INVICTA CORPORATION	P.O. BOX 26088	NEW ORLEANS	LA	70126
CRAIG	REGELBRUGGE	AMERICAN ASSOCIATION OF NURSERYMEN	1250 I ST. N.W. #500	WASHINGTON	DC	20005
JUAN A.	REYES		P.O. BOX 8359	HUMACAO	PR	00792
MICHAEL S.	RIFFLE	VALENT USA CORPORATION	2858 REMINGTON GREEN CIRCLE	TALLAHASSEE	FL	32308
BRIAN	SCHNEIDER	DOWELANCO	9330 ZIONSVILLE ROAD	INDIANAPOLIS	IN	46268
FRED	SINGLETON	CLEMSON UNIVERSITY	204B GUM STREET	SUMMERVILLE	SC	29483
DOUGLAS	SKOLAUT	ORGANIC PLUS	8023 VANTAGE DR.,SUITE 600	SAN ANTONIO	TX	78239
JOAN	SMITH	CU PEE DEE RESEARCH & ED CENTER	RT. 1, BOX 531	FLORENCE	SC	29502-9603
KENDRA	SMITH	BUREAU OF PLANT INDUSTRY	P.O. BOX 5207	MISSISSIPPI ST.	MS	39762
FRANK	SOBOTKA	FMC CORPORATION	BOX 8	PRINCETON	NJ	08543
BEVERLY	SPARKS	UNIVERSITY OF GEORGIA	200 BARROW HALL	ATHENS	GA	30602
GENE	STROTHER	EXTENSION ENTOMOLOGY	209 EXTENSION HALL	AUBURN UNIVERSITY	AL	36849
T.DON	TAYLOR	CIBA TURF AND ORNAMENTALS	P.O. BOX 666	ROANOKE	AL	36274
DONNIE	TAYLOR	VALENT	2314 SWEETWATER DRIVE	MARTINEZ	CA	94553
LYNNE	THOMPSON	SCHOOL OF FOREST RESOURCES	P.O. BOX 3468-UAM	MONTICELLO	AR	71656-3468
HARLAN	THORVILSON	TEXAS TECH UNIVERSITY		LUBBOCK	TX	79409
ROBERT K.	VANDER MEER	USDA,ARS	P.O. BOX 14565	GAINESVILLE	FL	32604
S.BRADLEIGH	VINSON	TEXAS A & M UNIVERSITY		COLLEGE STATION	TX	77843
LESLIE	VISSAGE	BUREAU OF PLANT INDUSTRY	P.O. BOX 5207	MISSISSIPPI ST.	MS	39762
J.T	VOGT		58 CAMPUS TRAILER COURT	AUBURN	AL	36830
FRANK	WAITS	AL. DEPARTMENT OF AGRICULTURE	295 CO.RD. 728	MONTEVALLO	AL	35115
KEN	WATKINS	ORGANIC PLUS, INC.	108 DALE AVE. S.E.	ALBUQUERQUE	NM	87105
GENE	WHITE	TEXAS TECH UNIVERSITY		LUBBOCK	TX	79409
DAVID	WHITEHEAD	VALENT CORPORATION	BOX 8025	WALNUT CREEK	CA	94596

DAVID	WILLIAMS	USDA ARS MAVERL	P.O. BOX 14565	GAINESVILLE	FL	32604
CHARLES H.	WILSON	MDAC/BPI	270 MONROE RD.	HATTIESBURG	MS	39401
WAYNE M.	WINNER	VALENT, USA	3003 LBJ FREEWAY,SUITE 110	DALLAS	TX	75234
DARRELL	WOOFTER	WOOFTER CONSULTANTS, INC.	3040 NASSAU DRIVE	VERO BEACH	FL	34960