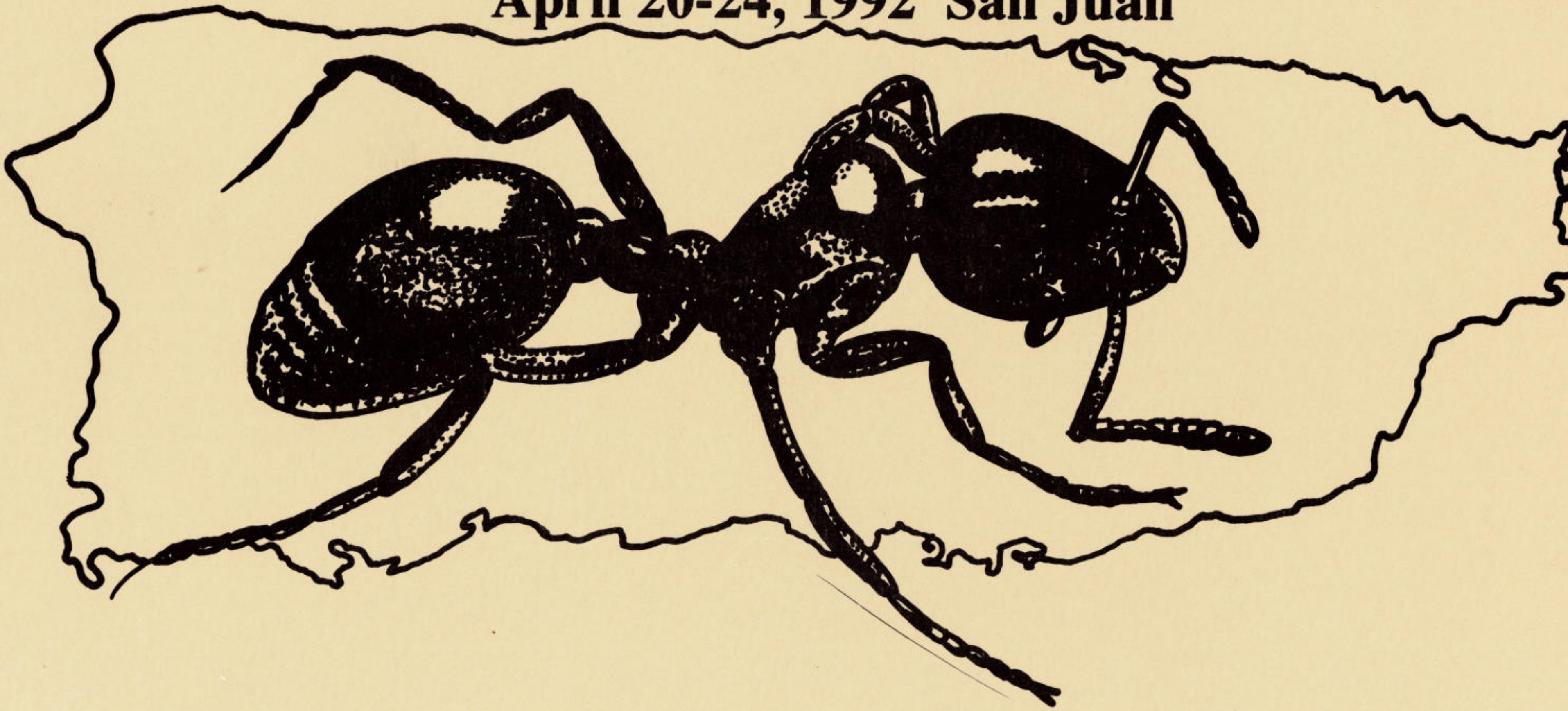
IMPORTED FIRE ANT CONFERENCE

April 20-24, 1992 San Juan



PROCEEDINGS OF THE 1992 IMPORTED FIRE ANT CONFERENCE

April 20-23, 1992

Condado Beach Hotel
San Juan, Puerto Rico

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Table of Contents

(NS = Not Submitted)

Table of Contents (cont'd)

Preliminary results of the impact of Red Imported Fire Ant reductions on wildlife populations

R. Scott Lutz, C. Allen, and S. Demarais, Dept. of Range and Wildlife Management, Texas Tech University, Lubbock, Texas 79409

Anecdotal information indicates red imported fire ants (RIFA) may negatively impact recruitment in many wildlife species (Lutz and Demarais 1990). Very few scientific studies have attempted to quantify the impact of the RIFA on wildlife. The increasing prevalence of polygynous RIFAs and continuing range expansion of RIFA warrants concern for those vertebrate species that occupy habitats invaded by RIFA.

A research project to determine the impact of RIFAs on wildlife was initiated in late 1990. Our objectives were to monitor deer fawn recruitment, northern bobwhite quail fall density, reptile and amphibian abundance, and small mammal relative abundance on each of 10 500-700 acre plots in Calhoun, Refugio, and Victoria Counties, Texas. Study plots included a mosaic of polygynous and monogynous RIFA and mound densities averaged ≈ 100 mounds/acre. Five plots were treated with the fire ant bait, AMDRO, and 5 plots were not treated and served as controls. Cooperators included U.S.D.A.-APHIS in Gulfport, MS, Texas Dept. of Agriculture, Houston Livestock Show and Rodeo Association, Quail Unlimited, American Cyanamid, and Texas Tech University.

RIFA populations were monitored at 6-week intervals using standard survey techniques (Lofgren and Williams 1982). Deer production was surveyed using spotlight count routes of ≈ 10 miles/plot. Quail densities were estimated using line transect methodology (Guthery 1988). There were approximately 20 miles of transect in each of the pastures. Small mammal relative abundance was estimated by sampling with ≈ 300 snap-trap nights (Riney 1982) in each plot. Herpto-fauna were surveyed using 2 drift net/pitfall arrays in each of the plots. Paired t-tests or ANOVA (RBD) were used to compare vertebrate abundance between treated and untreated study sites.

AMDRO was applied aerially at a rate of 1 1/4 - 1 1/2 pounds per acre in April and October 1991. RIFA population indices indicated that RIFA had been reduced an average of 82% on treated areas by 6 weeks post-treatment (Figure 1). Differences between RIFA population indices on treated and untreated pastures were evaluated with analysis of covariance and were statistically different ($P = 0.06$).

Response of wildlife populations in 1991 varied by species group (Table 1). Deer-fawn production was greater on treated sites in 4 of the 5 paired study areas and the difference was statistically different ($P = 0.04$). Quail fall densities were higher on the treated sites in 4 of the 5 pairs, but these differences were not statistically significant ($P = 0.30$). Small mammal relative abundance was similar ($P = 0.25$) on both treated and untreated sights. Few herpto-fauna were detected on the plots; there were too few captures to make comparisons.

A final treatment with AMDRO is planned for May 1992. RIFA will continue to be monitored at 6-week intervals after treatment in 1992. In June 1992, intensive small mammal trapping will be conducted to supplement our work planned for Fall 1992. The second season of deer and quail data collection is planned for 15 August to 17 November 1992.

Guthery, F. 1988. Line transect sampling of bobwhite density on rangeland: Evaluations and recommendations. Wildl. Soc. Bull. 16:193-203.

Lofgren, C. S., and D. F. Williams. 1982. Avermectin B_1a: Highly potent inhibitor of reproduction by queens of the red imported fire ant (Hymenoptera: Formicidae). J. Eco. Ento. 75:798-803.

Lutz, R. S., and S. Demarais. 1990. Impact of imported fire ants on wildlife: The need for research. Pages 39-42 _in_ M. E. Mispagel, ed. Proc. of the 1990 Imported Fire Ant Conf. Univ. Georgia, Athens.

Riney, T. 1982. Study and management of large mammals. John Wiley & Sons, New York, NY. 552pp.

Table 1. Wildlife population surveys after treatment with AMDRO in Refugio, Calhoun, and Victoria Counties, TX, 1991.

Pasture	Deer-fawn Production[a]	Bobwhite Quail Density[b]	Small Mammal Trapping Success[c]
Treated:			
Eastwood	47	0.4	11
Encino	88	0.1	8
Runner	81	1.1	9
Lake	84	6.2	19
Folley	48	1.1	18
$\bar{x}$	70	1.8	13
Untreated:			
Humble	50	0.2	7
Black	24	0	8
River	53	1.4	13
S. Register	29	0.7	10
Saddlehorse	11	0.5	9.5
$\bar{x}$	33	0.6	9.5

[a] fawns: 100 does

[b] Birds/acre

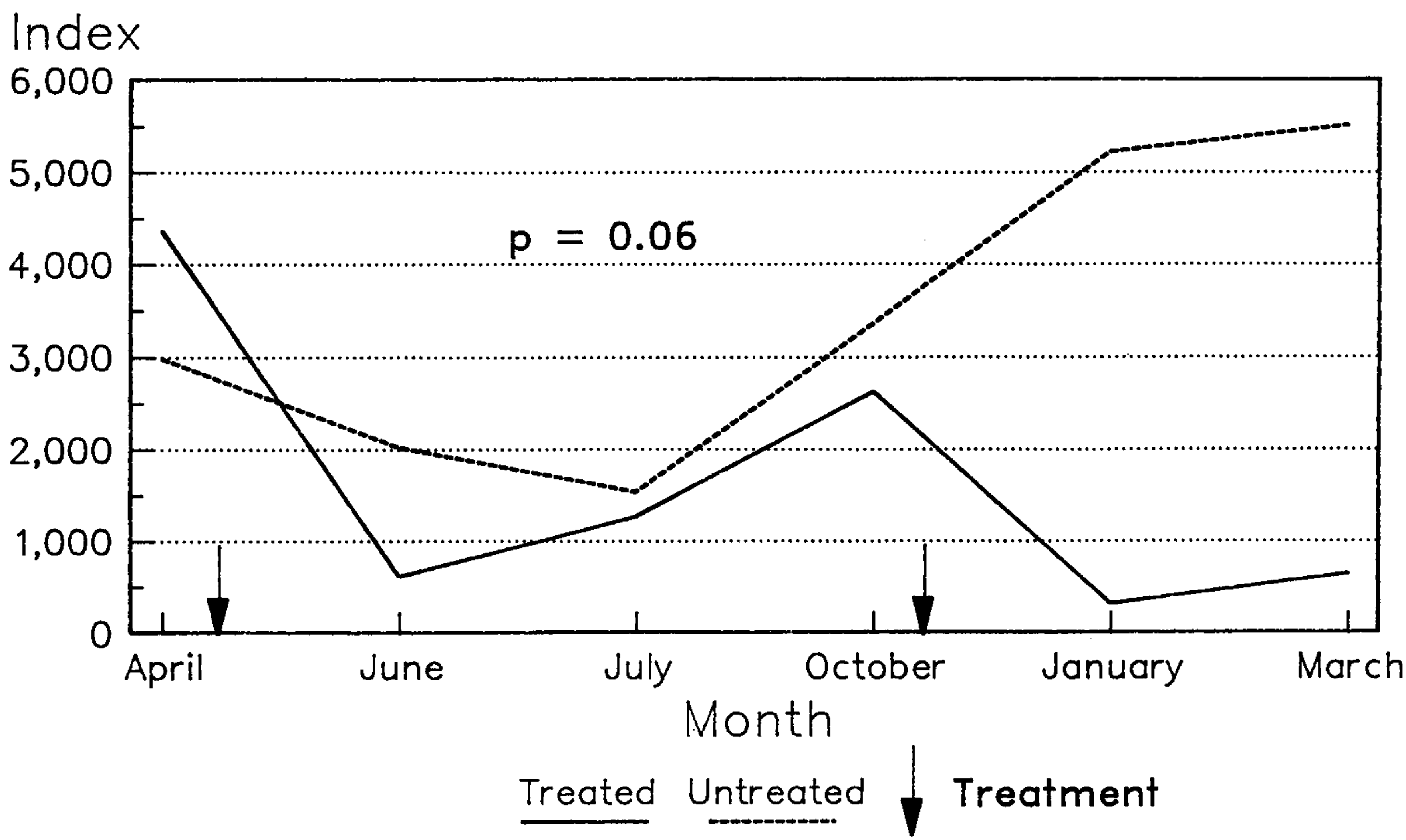
[c] % success

Figure 1. Red imported fire ant population indices on study areas in Refugio, Calhoun, Victoria Counties, TX, 1991.

Red Imported Fire Ant Indices

Adjusted Means

April 1991 to March 1992



Response of Native Ants to Red Imported Fire Ant Population Suppression.

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Texas Tech University

Mark Trostle, and Andy Feild
Texas Dept. of Agriculture

ABSTRACT

Bait-formulated Amdro was applied to one of each paired, 500-700-acre plots of rangeland by air at the rate of 1.25 - 1.5 lb/acre on 15-19 April 1991 and 22-24 October 1991. Five replications were established in a randomized complete block design. Red imported fire ant populations were evaluated using pitfall traps and by calculation of population indices. Foraging activities of native ant species were measured by pitfall traps. Analysis of variance of population indices did not detect significant differences at the $\underline{P} = 0.05$ level between untreated and treated plots; however, after the October treatment populations were more divergent, and populations in untreated plots had rebounded to levels greater than pretreatment counts. The number of ant species collected in pitfall traps ranged between 4 and 14, but numbers of red imported fire ants were highest.

INTRODUCTION

The impact of red imported fire ant (RIFA), Solenopsis invicta Buren, populations on native ants and wildlife has been of interest for several years. In Texas, studies have documented the effects on native ants (Camilo & Phillips 1990); however, impacts on endemic birds, rodents, and deer have not been thoroughly researched. In cooperation with the USDA-APHIS, the Texas Department of Agriculture, cooperating ranchers, and the Department of Range and Wildlife Management and the Department of Agronomy, Horticulture, and Entomology, Texas Tech University, a field study was initiated in 1991 near Victoria, Texas, to address these questions. The objectives of the research were to determine the effects of RIFA population suppression upon other ant species and wildlife in east-central Texas.

MATERIALS AND METHODS

Ten, 500-700-acre plots in five paired blocks were established on ranches of cooperating owners in March 1991. During the week of 1 April 1991, ten, 0.1 ha circles were established in each plot. All RIFA colonies within each circle were located and rated (Harlan et al. 1981 as modified by Lofgren & Williams 1982). The population index (P.I.) of each circle and the total P.I. of each plot were calculated. Also, 20 pitfall traps containing ethylene glycol were placed in two transects within each plot and left in place for 72 h. The collected arthropods were preserved in ethylene glycol and 70% ethyl alcohol for identification and enumeration in the laboratory at Texas Tech University. Therefore, a total of 100 circles and 200 pitfall traps were used to compare arthropod populations in plots on each sample date. The pretreatment collections were made approximately two weeks before the 15-19 April, 1991, application of a bait-formulated insecticide (Amdro) at the rate of 1.25 - 1.5 lb./acre to one plot of each pair.

Populations were measured on 3 June, 16 July, 18 October 1991, and 8 January, 20 March 1992. Collections will continue until at least autumn 1992. A second Amdro treatment was applied on approximately 20 October 1991, and a third application is planned for early May 1992.

Population indices of plots at each date were compared for differences using analysis of variance with $\underline{P} = 0.05$ as the critical level. The number of RIFA colonies and the numbers of RIFA's and other ant species in pitfall traps were compared with ANOVA.

RESULTS AND DISCUSSION

The total P.I.'s of insecticide-treated and untreated plots were not significantly different at the $\underline{P} = 0.05$ level (Fig. 1). The pretreatment (1 April) P.I. of plots that later received insecticide applications was greater, although not significantly, than the P.I. of untreated plots. The P.I. of plots treated in October 1991 was greatly affected but was not significantly different than that of untreated plots. The percent change in P.I. (Fig. 2) showed that treated plots have not yet recovered to that of pretreatment levels, whereas the P.I. of untreated plots has increased. The numbers of RIFA colonies and colonies per acre were not significantly different in untreated and treated plots (Figs. 3 and 4); however, the trend in treated plots was a decrease in number.

Red imported fire ant foragers were the predominant species collected in pitfall traps. RIFA's were collected in abundance in both untreated and treated plots, and numbers were not significantly different between treatments except in June (Fig. 5), probably because of large variations in samples. In general, ants of other species were collected in greatest abundance in untreated plots during early summer and in treated plots in October 1991 (Fig. 6). The total number of ant species collected in pitfall traps ranged between 4 and 14 (Fig. 7). No differences in number of ant species in plots were detected.

Although few significant differences in ant populations were detected between untreated and treated plots thus far, this study is on-going, and a spring 1992 insecticide application may affect later measurements. The difficulties in adequately sampling large plots is understood, and matching pairs of plots at each of five sites/blocks is problematic.

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Lofgren, C. S., & D. F. Williams. 1982. Avermectin B_1a: highly potent inhibitor of reproduction by queens of the red imported fire ant (Hymenoptera: Formicidae). J. Econ. Entomol. 75: 798-803.

Figure 1. Total Population Index of Untreated and Treated Plots (n=50 circles/trt).

Fig. 2. Percent Change in Population Index of Plots.

Fig. 3. Number of RIFA Mounds (n=50 circles/trt).

Fig. 4. Number of RIFA Mounds per Acre in Untreated and Treated Plots.

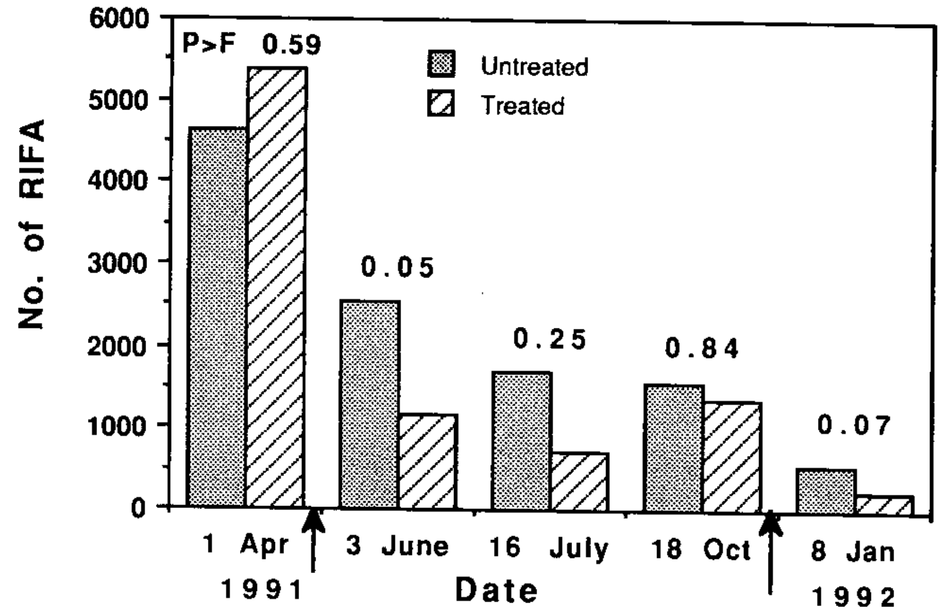


Fig. 5. Number of RIFA in Pitfall Traps (100/trt).

Fig. 6. Numbers of Other Ant Species in Pitfall Traps.

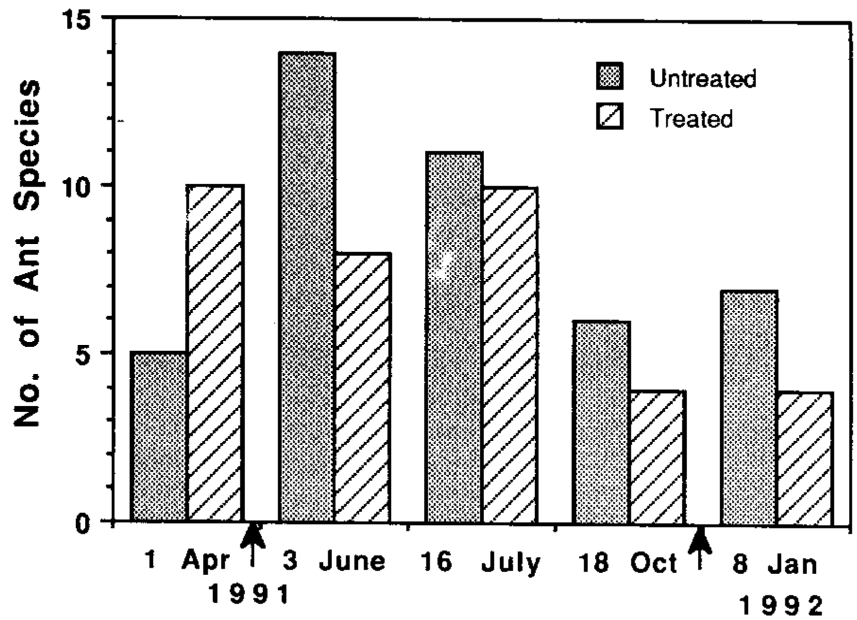
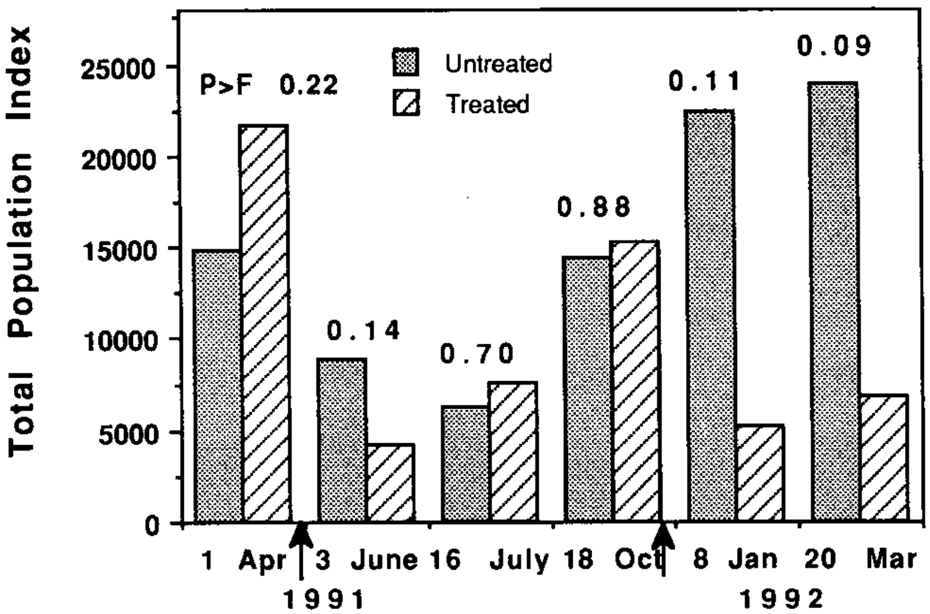
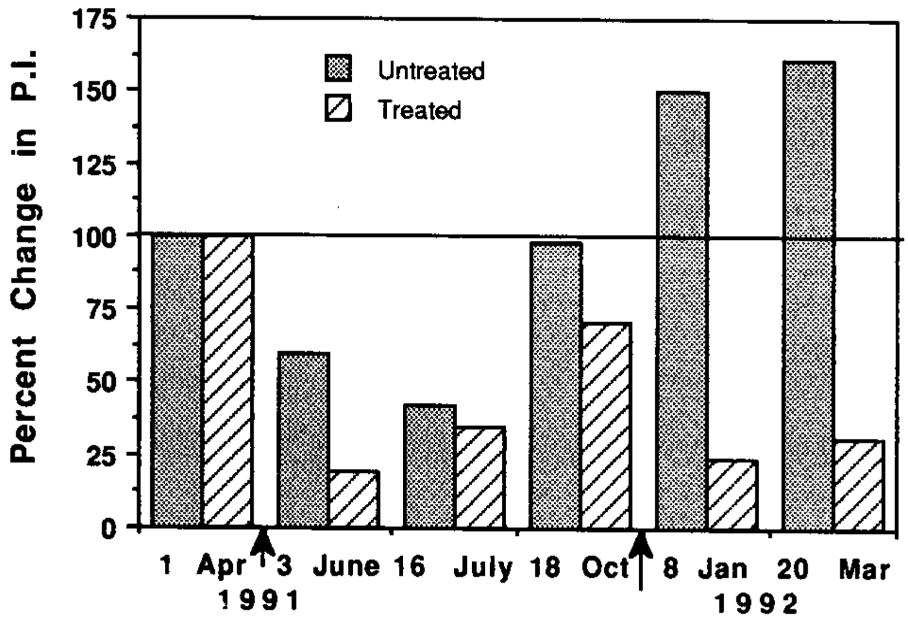


Fig. 7. Number of Ant Species Collected in Pitfall Traps.

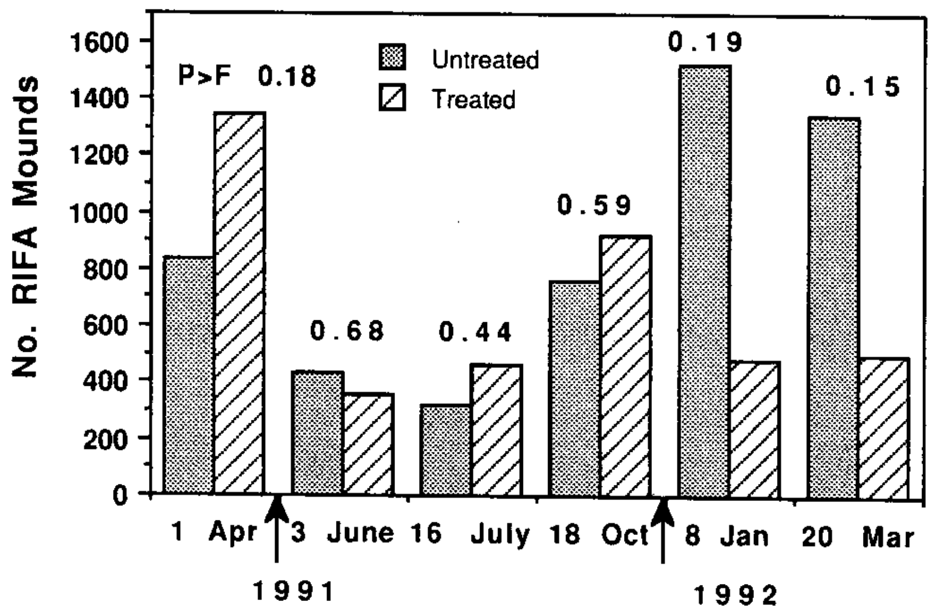
Total Population Index of Plots (n=50 circles/trt)

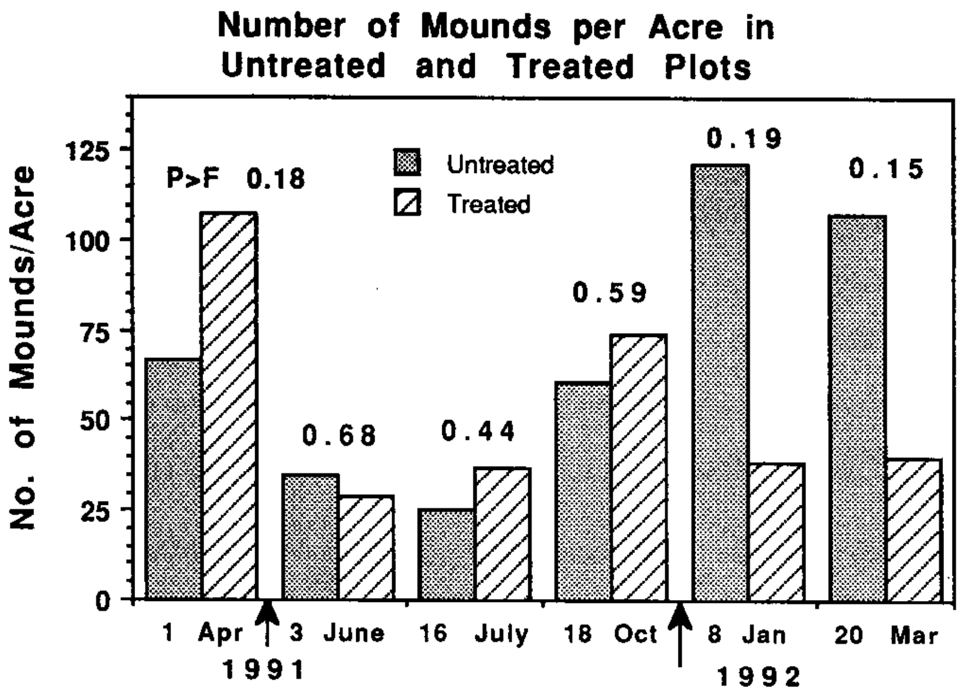


Percent Change in Population Index of Plots



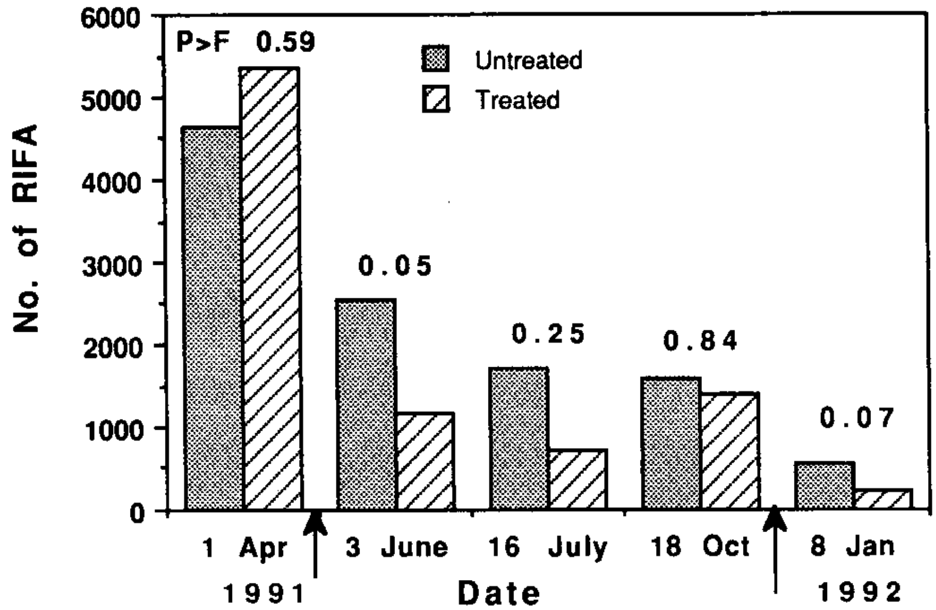
Number of RIFA Mounds (n=50 circles/trt)

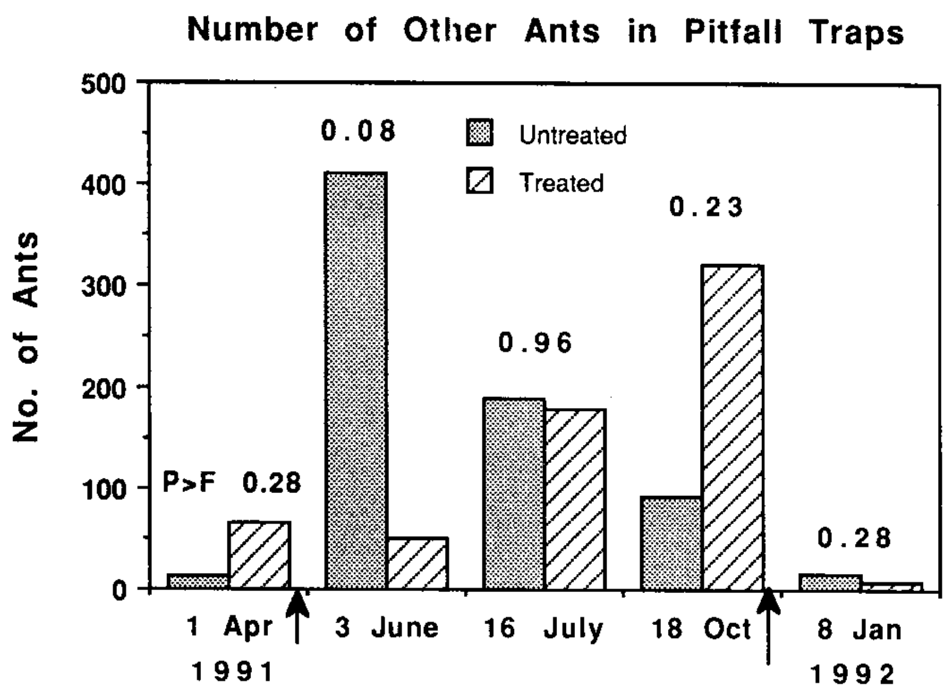


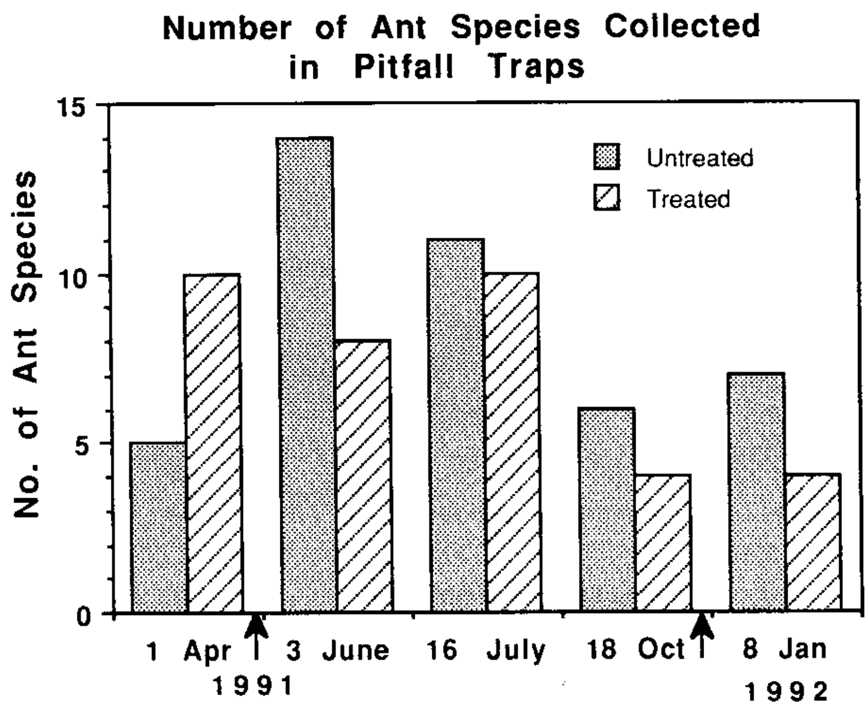


Number of Mounds per Acre in
Untreated and Treated Plots
No. of Mounds/Acre
0
25
50
75
100
125
P>F 0.18
0.68
0.44
0.59
0.19
0.15
Untreated
Treated
1 Apr
3 June
16 July
18 Oct
8 Jan
20 Mar
1991
1992

Number of RIFA in Pitfall Traps (100/trt)




Number of Other Ants in Pitfall Traps
No. of Ants
500
400
300
200
100
0
Untreated
Treated
P>F 0.28
0.08
0.96
0.23
0.28
1 Apr
1991
3 June
16 July
18 Oct
8 Jan
1992


Number of Ant Species Collected
in Pitfall Traps
No. of Ant Species
15
10
5
0
Untreated
Treated
1 Apr
3 June
16 July
18 Oct
8 Jan
1991
1992

FIRE ANT INFESTATIONS IN THE TIDEWATER AREA OF VIRGINIA

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INTRODUCTION

Since the introduction of the red imported fire ant, Solenopsis invicta Buren, into the southeastern United States in the 1930's, its range has expanded northward through reproductive flights and transport with nursery stock. The black imported fire ant, S. richteri Forel, which was introduced into Mobile, Alabama in the early 1900's, remains restricted near the northern border between Mississippi and Alabama, but a viable invicta x richteri hybrid has widely colonized Alabama, Mississipi and Georgia (Diffe et al. 1988). It is anticipated that colder temperatures will limit the spread of S. invicta and the hybrid into higher latitudes, but the northern boundary remains to be established. Recent infestations of fire ants in the Tidewater area of southern Virginia raise the possibility that they have become resident here.

HISTORY OF VIRGINIA INFESTATIONS

Two fire ant mounds were discovered by the Virginia Department of Agriculture on a golf course in Hampton, Virginia, in October 1989. These ants were probably imported with turf from Georgia in 1987, indicating that the ants had survived two cold winters in Virginia. A third mound located in Newport News, Virginia, contained reproductive alates in February 1990. Worker ants collected from the Newport News mound were analyzed for cuticular hydrocarbons by R.K. Vander Meer who determined the species to be S. invicta.

By May 1992, 391 fire ant mounds associated with 40 separate locations had been identified in and around the Tidewater area. The affected cities included Chesapeake, Hampton, Lightfoot, Newport News, Norfolk, Portsmouth, Virginia Beach and Yorktown (Table 1). Approximately one-fourth of the locations contained single mounds, one-half had 2-5 mounds and one-fourth had 7-172 mounds. The locations with 7 or more mounds, excluding Lightfoot, are illustrated in Figure 1. Although many of the nests appear to be associated with nursery plantings, several mounds in Newport News have no apparent nursery stock connection and may represent incipient colonies from local reproductive flights.

CONTROL PROTOCOL

Following the discovery of fire ants, the Virginia Department of Agriculture applies Amdro bait to the area for six weeks, and then drenches mounds with Dursban. The surrounding area is searched for visual evidence of other mounds. Mound treatment is delayed until spring if the ants are located in late fall or winter.

VIRGINIA AS A HABITAT FOR FIRE ANTS

The limits to fire ant cold tolerances are unclear. Ant mounds can recover following encasement in ice (Wojcik 1983), and workers of S. invicta can withstand supercooling to approximately -8.0° C (Francke et al. 1986). Fire ant response to colder climates is difficult to predict, because temperature preferences may be influenced by humidity and by acclimation to different temperatures (Cokendolpher & Francke 1985). Also, thermal gradients within nests may allow fire ants to tolerate cold surface temperatures (Francke & Cokendolpher 1986). Tidewater Virginia generally experiences mild winters, with only a few days dropping to -13.0°C in the past three years. The hot, humid summers in this region appear optimal for fire ant foraging activities and reproductive flights (Rhoades & Davis 1967).

FUTURE INVESTIGATIONS

Differences may exist in the cold hardiness of S. invicta and the invicta x richteri hybrid (Diffe et al. 1988). For this reason, fire ants will be collected from Virginia mounds for cuticular hydrocarbon analysis in R.K. Vander Meer's laboratory following the procedures outlined in Vander Meer (1986). Information on the viability of invicta and the hybrid in Virginia will be valuable in predicting patterns of future spread.

Pitfall traps and bait stations will be established in areas surrounding infestations to monitor local spread of fire ants and to locate mounds for treatment. Native ants collected in these studies will provide data on the resident ant community. This information will be useful in assessing the impact of fire ants should they become established here.

ACKNOWLEDGMENTS

I thank Jim Pierce of the Virginia Department of Agriculture for access to the records on fire ant sightings and treatment in Virginia.

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Francke, O.F., J.C. Cokendolpher & L.R. Potts. 1986. Supercooling studies on North American fire ants (Hymenoptera: Formicidae). Southwestern Naturalist 31: 87-94.

Rhoades, W.C. & D.R. Davis. 1967. Effects of meteorological factors on the biology and control of the imported fire ant. J. Econ. Entomol. 60: 554-558.

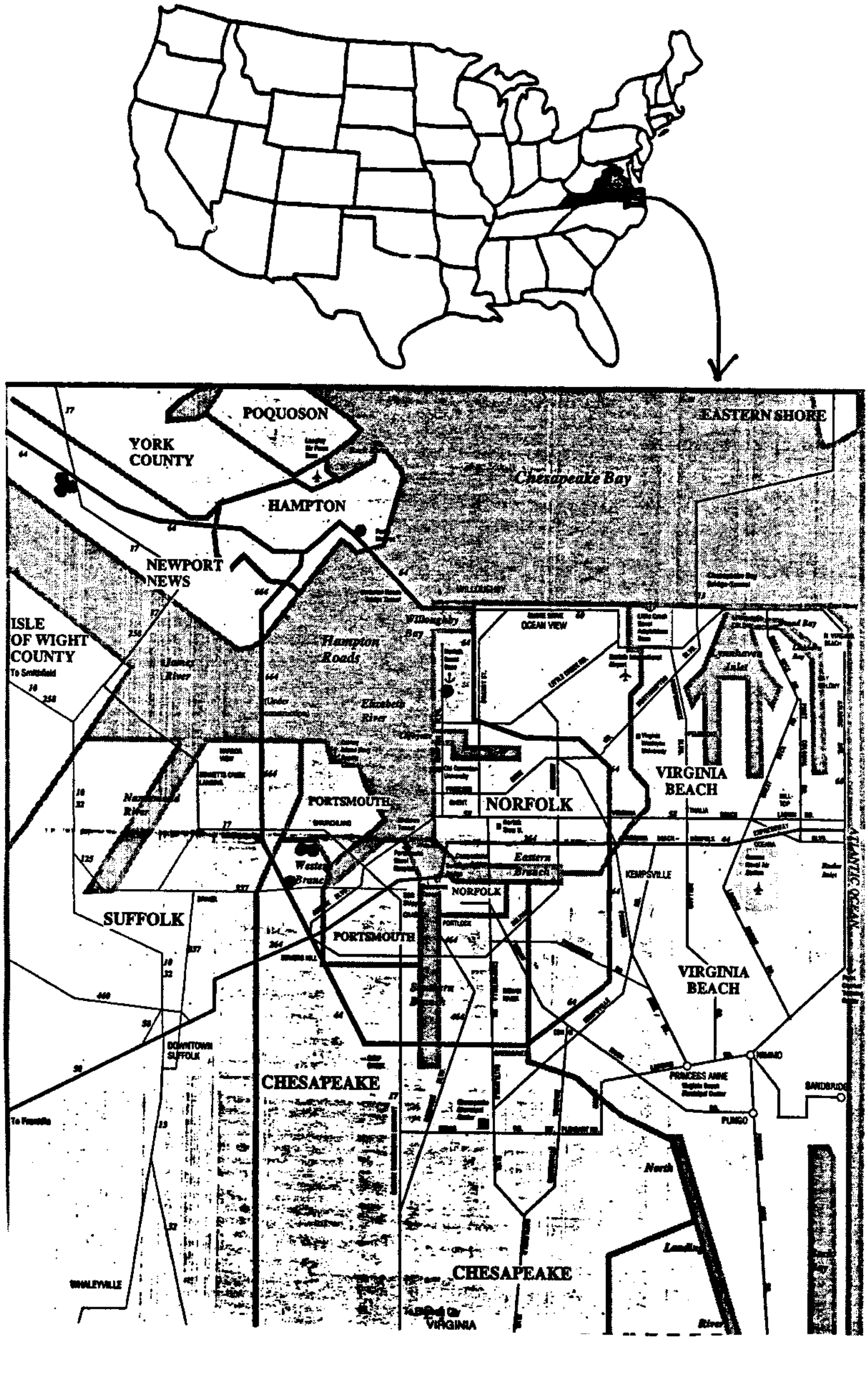
Vander Meer, R.K. 1986. Chemical taxonomy as a tool for separating Solenopsis spp. In: C.S. Lofgren & R.K. Vander Meer (eds.). Fire Ants and Leaf-Cutting Ants. Westview Press, Boulder, CO, pp. 316-326.

Wojcik, D.P. 1983. Comparison of the ecology of red imported fire ants in north and south America. Florida Entomologist 66: 101-111.

Table 1. Fire ant mounds discovered in Tidewater, Virginia, and surrounding areas from 1989 through 1992.

CITY	LOCATION	NUMBER OF MOUNDS
Chesapeake	private residence	1
	private residence	5
	shopping mall	172
	gas station	1
	private residence	1
	private residence	2
	private residence	1
	restaurant	49
	store	2
	bank	14
Hampton	golf course	3
	fitness center	5
	business	2
	golf course parking lot	8
Lightfoot	shopping mall	20
Newport News	business	2
	shopping mall	2
	bank	10
	fitness center	13
	business	1
	professional center	3
	private residence	4
	business	1
	restaurant	5
	restaurant	7
	restaurant	1
	vacant lot	4
Norfolk	automotive shop	3
	utility	1
	apartment building	18
	private residence	5
	apartments	*ants in two apartments
Portsmouth	private residence	3
	private residence	2
Virginia Beach	shopping center	3
	private residence	4
	private residence	2
	motel	5
	business	3
Yorktown	restaurant	1

FIGURE 1. Locations (circles) in Tidewater, Virginia, with seven or more fire ant mounds.


POQUOSON
YORK COUNTY
HAMPTON
EASTERN SHORE
Chesapeake Bay
NEWPORT NEWS
ISLE OF WIGHT COUNTY
Hampton Roads
James River
Elizabeth River
Willoughby Bay
OCEAN VIEW
VIRGINIA BEACH
NORFOLK
PORTSMOUTH
Eastern Branch
KEMPSVILLE
SUFFOLK
VIRGINIA BEACH
NORFOLK
PORTSMOUTH
CHESAPEAKE
DOWNTOWN SUFFOLK
PRINCESS ANNE
NIMMO
SANDBRIDGE
PUNGO
North
CHESAPEAKE
WHALEYVILLE
ATLANTIC OCEAN

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

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Texas A&M University System

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

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

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

Materials and Methods

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

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

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

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

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

Results and Discussion

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

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

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

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

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

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

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

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

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

Conclusions

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

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

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

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

Date	Average no. foraging red imported fire ants per olive oil-treated card: Untreated Island 4E	Average no. foraging red imported fire ants per olive oil-treated card: Treated Island 4W	Percent diff.
23-24 May 1989	31.8	27.6	0
29 September 1989	14.0	18.0	23
21 April 1990	2.7*	27.9*	90
1 June 1990	0.2	180.0	99
10 July 1990	4.0	19.5	79
28 September 1990	3.6	46.0	92
21 May 1991	2.5	85.5	97

* Indicates first date for significant difference of means using the Student's *t* test ($P \leq 0.05$; d.f = 18).

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

Date	Percent mortality of hatchling waterfowl (number of marked nest observations in parentheses) Treated	Untreated
April 21* - May 6	14.3 (7)	50.0 (6)
May 6 - June 1	0.0 (4)	50.0 (4)
June 1* - June 15	10.0 (10)	--
June 15* - June 24	N/O	100.0 (?)
June 24* - July 3	N/O	100.0 (5)
July 3* - July 10	N/O	100.0 (3)
July 10 - July 20	N/O	100.0 (3)

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

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

	--------May---------			----June-----		-------------July-------------			
	2	12	21	5	13	1	2	9	19
Number of nests monitored:	10	10	20	20	20	20	20	20	20
Number of nests occupied:									
Ants present	10	9	18	18	10	10	13	7	4
Ants removed	10	10	20	15	16	14	15	15	9
Percent diff.	0	-10	-10	+16	-38	-29	-13	-53	-56
Percent successful brood nests:									
Ants present	30	33	22	22	11	0	0	0	0
Ants removed	100	100	80	80	94	93	100	100	100
Percent diff.	-70	-67	-73	-73	-88	-100	-100	-100	-100
Cumulative number of eggs:									
Ants present	28	28	59	68	76	87	102	103	103
Ants removed	35	35	59	76	78	78	78	94	97
Percent diff.	-20	-20	0	-11	-3	+11	+15	+9	+6
Cumulative number of feathered offspring:									
Ants present	0	0	0	5	6	6	6	6	6
Ants removed	0	0	28	28	37	39	43	61	72
Percent diff.	0	0	-100	-82	-84	-85	-86	-90	-92

* Colonial waterbird nests monitored: Great egrets, great blue heron, snowy egret, roseate spoonbill, tricolored heron, cormorant, gull.

ABSTRACT

J. S. Johnston, D. Sebesta, and S. B. Vinson. Diploid sperm and triploid polygyne fireants in Walton Co. Georgia.

Colonies from a polygyne population of the red imported fire ant *Solenopsis invicta* Buren in Walton Co. Georgia have been shown by flow cytometry to contain not only haploid and diploid individuals, but also, large numbers of triploids. The triploids occur in all stages and castes, with an average of 4.5% triploidy in workers, 22.7% triploidy in females, and 30.8% triploidy in males. Triploidy is unique to this population. It was absent in 400 fireants assayed from nearby Walker County, Georgia and was found only twice among 3200 fireants from the remainder of the distribution of the species in Southern United States.

Ploidy is associated with higher body weight; triploidy is more common in the larger workers and in the larger, heavier males and females. While larger size may confer some competitive advantage, triploids are not fit. The head and thorax of dealate females were scored for ploidy level, and compared to the ovaries and stored sperm from the same individual. Triploid dealate females were sterile, containing only small, undeveloped, fibrous ovaries. Of the remaining fertile diploid females, 20% contained sperm which appeared normal in appearance and amount, but which was diploid.

These results demonstrate the unusual makeup of the polygyne population in Georgia. Fertile diploid males have not been demonstrated in colonial insects. However, in this population, males producing diploid sperm are successfully mating, and large numbers of triploid progeny are being produced. Of particular interest are the triploid dealate females, who are present in large numbers, but contribute no offspring to the population.

The presence of triploids presents a challenge to fireant workers. On the one hand, diploid sperm provides an effective genetic control mechanism, which we should be able to exploit to provide genetic control in other populations. On the other hand, we must be aware that the genetics of polygyne populations of the fireant is in large part based on this highly aberrant population, and may not be representative of the polygyne populations elsewhere in the Southern United States.

CHALLENGES TO A DETERMINATION OF THE ECONOMIC IMPACT OF THE IMPORTED FIRE ANT

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INTRODUCTION

Although the Imported Fire Ant, *Solenopsis invicta*, invaded the United States over fifty years ago, the economic impact of this invasion is poorly documented (1, 2). There are many reasons for this failing. One of the more important reasons is that no resources have been generated and directed toward obtaining the data needed to adequately evaluate the economic impact of the imported fire ant (IFA). Although some data is available (3, 4, 5) it has not been useful in determining the monetary impact of this pest. Thus, there remains an essential question that must by answered before any cost effective management program can be developed: is the expense required for research and management justified by the economic loss caused by this insect? Two types of data are required to answer this question: 1) what is the economic loss caused by these ants; 2) what is the expense of managing the ant to prevent an economic loss. I will concentrate here on the first of these two questions.

ECONOMIC LOSS DUE TO FIRE ANTS

To determine the economic loss due to the ant it is essential to collect nine specific types of data (Table 1). First is to document that the ant is the imported fire ant. This information is often not provided and it is difficult to determine if the problem was due to one of the native fire ant species or the imported species. Further, whether the problem is due to monogyne (single queen) or polygyne (multiple queen) colonies should be determined (5). For example, some data concerning the impact of fire ants on vertebrates has showed that fire ants have little impact while other data has indicated that fire ants are having an impact (6). Some of these discrepancies may be due to the different species of fire ants involved.

The third need is to provide a description of the problem(s) caused by the IFA, which should include quantitative data concerning the severity of the problem. In most cases, the information has been expressed in general terms that are characterized as mild, moderate or severe, and often the description is of a worst-case scenario. Such a subjective characterization provides little information that can be used to determine or extrapolate the economic loss over the infested areas. In many cases, methods to quantify the severity of the damage must be developed. The fifth type of data that is needed is quantitative data concerning the frequency of the problem, i.e. does the problem occur in subpopulations?, how often does the problem occur? Data should also be provided as to the size the potentially effected population. For example, Stewart and Vinson (7) reported the imported fire ant damaged 40-50% of the sunflowers in a drought-stressed location. While such information documents a problem and the severity that can occur, it does not provided data as to whether sunflowers were commonly produced in the area, the acres involved, or whether the problem frequently occurred in other fields in the area. However, such data is difficult to obtain. Adams et al. (8) examined the impact of fire ants on soybeans. They found that much of the county had been treated, thus making a determination of the frequency of the problem difficult. They, thus, selected a "moderately" infested field and a "non-infested" field and compared the effects of fire ants on soybean production in these two fields. But whether the problem in the moderately infested field was typical of fields in infested areas is unknown. Even in the Stewart and Vinson (7) report the fields were treated as soon as the problem was discovered preventing any further study.

A seventh type of data often not provided is the environmental conditions at the site at the time the problem occurred. For example, Adam (9) reported imported fire ant damage to eggplants, but whether the response was to drought conditions or not was not indicated and no data on the environmental conditions were given. Also, whether the problem was common in fire ant infested eggplant fields or even if other eggplant fields occurred in the area was not documented. Such data along with data concerning the biology of the ant at the time that the damage occurred can provide some insight into the economic impact fire ants may have (10). Such biological data is also not often provided. The last type of data needed to determine the economic impact is to document the loss in value of the commodity, object or situation affected by the ants, assuming the ants are left to continue to produce the damage (Table 1).

Table 1. Important data required to document the economic impact of the imported fire ant.

1. Identification of the species causing the problem.
2. Type of colony, monogyne or polygyne.
3. Description of the problem.
4. Severity of the problem in some quantitative way.
5. Frequency of the problem.
6. Size of potentially affected population.
7. Environmental conditions when the problem occurred.
8. Biological characteristics of the fire ant population causing the problem.
9. Loss in value of the commodity, object or situation.

CHALLENGES TO AN ECONOMIC LOSS DETERMINATION

Even with the best data, it is difficult to predict the real impact fire ants are having on our environment, crops, health or well being. One difficulty in making such predictions is the variability in the ant density over infested areas. Ants are naturally spotty in their distribution, heavily infesting one field but not another within close proximity. There are also several species of fire ants which are often considered together when evaluating the problems caused by fire ants. The densities of the native species are generally below 20 mounds per acre while the imported species may be much higher (11). A second factor influencing the density, particularly of the imported species, is whether they are of the single or multiple queen form. The infestations of the single queen form of the IFA generally range from 50 to 150 mounds per acre while infestations of the multiple queen form may have over 500 mounds per acre (11). Thus fire ant densities can vary from zero fire ants to high infestations of over five hundred mounds per acre, with each mound containing several hundred thousand fire ants. These areas may harbor over 100 million fire ants per acre. One would expect that the higher the density of ants, the greater their economic impact. This difference in fire ant density, which is rarely recorded, makes it a questionable practice to extrapolate data obtained for a particular or localized ant problem to a larger area.

A second factor making impact assessment difficult is whether the ant is uncontrolled, under partial management, or under aggressive management. There are also many products and approaches to fire ant management (12). Management records describing the ant control strategies historically applied to the land generally do not exist. Further, such differences as the agent used to manage the ant, the area over which it was used, the frequency of its use, and the amount used make any extrapolation as to the damage the ant may cause or any determination of the cost of management very difficult.

The problems caused by fire ants are influenced by environmental conditions (13) and the developmental stage of the ant colony (3, 10) which are also often not documented.

Even if documented, it is difficult to extrapolate to other locations and to other times where other environmental conditions exist or to other areas where the biological conditions of the ant colonies may differ.

Still another complication in regard to any economic impact assessment is that the ant may be considered beneficial in some situations while being detrimental in others. Occasionally the ant's impact is perceived by one group of people as beneficial while being perceived by another as detrimental. For example, fire ants damage seeds and seedlings of several crops (13, 14, 15) but also are good predators (3) and reduce pest insects (16, 17). Another example is the effects of fire ants on young cattle or deer which have been reported killed by fire ants (6, 18) and the ants reduction of tick populations (19, 20) which reduce tick borne animal diseases.

Lastly, many problems caused by fire ants are difficult or impossible to quantify economically. For example, the impact of fire ants on wildlife or the ecosystem is difficult to describe in economic terms (6, 21, 22). The effect of ants as a nuisance to people and pets, or the deterrence of outdoor activities due to the fear caused by the presence of stinging ants (23) is also impossible to evaluate in economic terms. Further, deaths due to the sting of fire ants have been reported (24, 25, 26), and the ants damage to equipment (27) can place the lives of people at risk and can place the activities and functions of certain aspects of society in jeopardy.

Although the problems caused by the IFA are not well documented (1, 3), many people have determined that they are a problem and have demanded a means to manage and control these insects. Private companies have responded to this demand and presently there are a number of products available to manage the ant problem in various ways (12). Thus, to determine the economic impact of the IFA depends on one's point of view.

Some people benefit economically from the IFA. For example the ants impact on electrical equipment, pets and people create jobs in the electrical repair industry, the veterinary and medical profession. Further, the pest control industry benefits both in the production and use of products for the management of IFA. One approach to determining the economic impact of the ant is to determine the ant's damage to objects in the environment. The second is to determine the cost of suppressing the ant numbers below those that cause any economic problems. However, since the economic problem cost and the management expense are often unknown, the cost of management may be higher than justified in these situations. Moreover, where the ant is under a poor management policy, i.e. management techniques are used at a cost, but fail to prevent the ants from causing an economic impact results is a much greater IFA total cost than there should be. The real cost of management and no management (ant impact) must accurately be determined. Without such information, a sound management strategy cannot be developed.

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1992 Imported Fire Ant Conference

Control of the Imported Fire Ant in Turf

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Introduction - Colonies of fire ants can be controlled or eliminated by the homeowner through any one of several methods using the currently labeled insecticides. Williams and Lofgren (1983) listed sixteen chemicals that had been reported to give over 80% control of imported fire ants. Drenches, powders, baits, fumigants, aerosols, and granules possess advantages and disadvantages for use in homeowner fire ant control.

The control of fire ants on large acreage areas such as pastures, golf courses, athletic fields, and turf farms is primarily a function of economics. Farmers cannot justify the expense of treating pastures to control fire ants. Parks and recreation directors, golf course superintendents, and turf farm operators can justify the cost. Baits are the primary choice for these latter situations because of cost and safety. However, baits possess several significant drawbacks: they take at least six weeks to reach maximum control, they have to be applied under stringent weather conditions and at certain times of the year to attain maximum effectiveness, and they do not provide any residual control to keep out new infestations. The alternatives to bait usage are the broadcast applications of sprays or granular insecticides. Sheppard (1982) achieved 70% mortality of fire ant colonies by broadcasting a 0.75% diazinon spray. Ant foraging was totally eliminated in this study after two sprays. Granular products have been shown to provide good control as well as some residual control. Diffie (Sparks & Diffie 1991a) found 5% chlorpyrifos or 5% diazinon granules broadcast at 132 lbs. per acre gave 93% and 100% control respectively one month after application. In a 1988 study, Diffie found that Oftanol 1.5G broadcast at 115 lbs. per acre gave 93% control two weeks posttreatment (Sparks & Diffie 1991b).

Even though some operations can justify the added cost of fire ant control, an examination of costs is always important in determining the choice of control strategy. Baits cost ca. $10 per acre for materials as compared to granules which cost from $60 to $180 per acre and sprays which cost $15 to $60. However, the advantages of using granules and sprays may justify this added expense. Some advantages are (1) they can be applied any day of the year regardless of temperature or rain (2) they provide faster control than baits and (3) they provide residual control over the treated area. One drawback may be that granules and sprays must be watered in after application to attain maximum efficiency. However, most golf courses, turf farms, and athletic fields irrigate on a regular schedule and should be able to work in a broadcast insecticide application immediately prior to irrigating.

Currently, chlorpyrifos granules are the only granules labeled for broadcast fire ant control. This study compares chlorpyrifos (Dursban®) granules with one experimental granular insecticide, acephate (Orthene®), and two other common granular insecticides, isazophos (Triumph®) and isofenphos (Oftanol®). These latter three insecticides are labeled for fire ant control in other formulations; therefore they were selected for this test.

Broadcast sprays are rarely used for the control of fire ants. This is probably because the spray must be delivered in several gallons of water (50 to 100) per acre, followed by additional irrigation. Chlorpyrifos (Lorsban®), acephate (Orthene®), isazophos (Triumph®), and isofenphos (Oftanol®) were used as sprays and compared in this study.

Materials and Methods - Nine one acre plots were established in a centipede grass field in Houston County, Georgia in July of 1991. Two 0.15 acre circular subplots were established and permanently marked within each plot. Pretreatment counts were made by counting the number of active mounds within the 0.15 acre subplots. These were made on 1 August, 1991. Pretreatment numbers ranged from 4 to 11 mounds per subplot with an average of 5.4 mounds per 0.15 acre. Plots were randomly assigned one of the following nine treatments: Dursban® 2.5G at 160 lbs. per acre, Oftanol® 5G at 40 lbs. per acre, Triumph® 1G at 140 lbs. per acre, Orthene® 5G at 50 lbs. per acre, Lorsban® 4E at 33 ounces per 55 gallons of water per acre, Oftanol® 2E at 130 ounces per 55 gallons of water per acre, Triumph® 4E at 33 ounces per 55 gallons of water per acre, Orthene® 75SP at 2 lbs. per 55 gallons of water per acre, and an untreated control.

Granular applications were made using a ground driven rotary spreader. The spreader was pulled by a John Deere 850 Tractor. Ground speed was approximately 3 miles per hour. Sprays were applied with a pull-behind 20 foot boom sprayer. Applications of the materials were made on 1 August, 1991, between 1:00 and 5:00 p.m. The area received 0.2 inches of rain during and immediately after the applications. An additional 1.0 inch of rain fell on the area within 24 hours.

Results - Posttreatment counts were made at one week, five weeks, twelve weeks, and eighteen weeks after application. Control by granules at one week was less than had been expected. In previous work (Sparks & Diffie 1991a), chlorpyrifos granules had given 70% control three days after treatment. In the present study only one treatment, Lorsban® 4E, provided at least 70% control after one week. However, no treatment was statistically different from others at one week posttreatment.

Five weeks after application, four products had completely eliminated fire ants in their respective plots. Dursban® 2.5G, Oftanol® 5G, Triumph® 1G, and Oftanol® 2E afforded 100% control. Orthene® 5G had above 70% control. The granular products were numerically superior compared to their EC counterparts, except for Oftanol®, in which case both formulations afforded 100% control.

The granular products continued to perform well twelve weeks after treatment. Three of the products continued to give 100% control. The fourth product, Orthene®, increased its apparent control from 73% to 82% from the fifth to twelfth week. Overall, the spray products appeared to be weakening in control effect. Three of these products decreased in their percent control while one gained slightly in effectiveness.

Eighteen weeks after treatment three granular products, Dursban®, Oftanol®, and Triumph®, were maintaining 100% control. The fourth granular product, Orthene®, was still providing over 70% control. Three of the four sprays appeared to lose some effectiveness.

Discussion - Imported fire ants cause serious aesthetic and mechanical damage in turf situations. In addition to mower damage, turf farms cannot tolerate the presence of fire ants in sod that is to be shipped outside the quarantine area. Golf courses strive to offer attractive facilities. They cannot afford unsightly mounds on the fairways or especially on the greens. Athletic fields cannot risk the danger of participants being seriously stung during a sporting event. Some homeowners may be willing to pay for a broadcast application if they are confident the insecticide will kill the fire ants that are present and will also keep out new infestations for a reasonable amount of time.

Baits offer the environmental safety desired today. When used in a well designed control program, baits can produce the control desired by the turf owner or manager. However, baits must be applied at certain times of the day and certain times of the year to give maximum control. A granular or spray product such as Orthene®, Oftanol®, Triumph® or Dursban® can be applied whenever it is convenient as long as irrigation occurs after application. Baits do not afford any residual control. Granules and sprays do provide a modicum of residual control.

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Table 1. Percent mortality of Imported Fire Ants at 1, 5, 12 and 16 weeks posttreatment.

Treatment		Percent Mortality			
		1 week	5 week	12 week	18 week
Dursban 2.5G	160 lbs/A	40a	100c	100b	100c
Oftanol 5G	40 lbs/A	50a	100c	100b	100c
Triumph 1G	140 lbs/A	55a	100c	100b	100c
Orthene 5G	50 lbs/A	64a	73bc	82ab	73bc
Lorsban 4E	33 oz/A	70a	50abc	40ab	30abc
Oftanol 2	130 oz/A	36a	100c	73ab	55abc
Triumph 4E	33 oz/A	44a	44abc	33ab	33abc
Orthene 75SP	2 lbs/A	15a	31ab	39a	23ab
Untreated control		0a	9a	18a	0a

Column means followed by the same letter are not significantly different (P=0.05, Duncan's multiple range test).

MANAGEMENT OF IMPORTED FIRE ANT POPULATIONS IN COMMERCIAL GRASS SOD

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Introduction:

Federal Quarantine 301.81 was promulgated May 6, 1958 in an effort to prevent or slow the artificial or man abetted spread of the imported fire ant (Canter, 1981). Certain regulated articles including soil, nursery stock, grass sod, and other items may not be moved outside the imported fire ant (IFA) infested area unless they have been certified to be free of infestation. Grass sod is currently certified for movement by use of granular chlorpyrifos applied broadcast to the sod surface prior to harvest. Rates of either 4.0 or 6.0 lbs. active insecticide per acre are approved by the U. S. Department of Agriculture, and a 10G formulation is registered for this use by Ford's Chemical and Specialty Company, Pasadena, TX. This treatment is used throughout the IFA regulated area because it is the sole option for certification of grass sod at this time.

In order to provide additional treatment options to sod growers, several trials employing multiple bait applications and residual contact insecticides were conducted by this laboratory. Most studies were done in Matagorda County, Texas in cooperation with the Texas Department of Agriculture.

Methods and Materials:

Trial I - August 29, 1989

A trial comparing the effects of annual, biannual, and quarterly applications of Logic® Fire Ant Bait (Ciba-Geigy Corporation, Greensboro, NC), was initiated on August 29, 1989 in a non-production field of common St. Augustine grass (Stenotaphrum secumdatum) near Wadsworth, Matagorda, County, TX. Plots were 210' x 210' (1 acre) with five replicates per treatment sequence arranged in a completely random design. Plots were mowed at irregular intervals, but other agronomic practices such as weed control, fertilization, and irrigation were not followed. All bait applications were made by Texas Department of Agriculture personnel using a Herd GT-77A™ bait applicator (Herd Seeder Co., Logansport, IN

46947) which was mounted on a John Deer AMT-600™ all-terrain vehicle. This equipment was operated on a 24-foot swath at approximately 10 mph. Treatments consisting of the following sequences were made at an application rate of 1.5 lbs of bait per acre:

1. Fall only (August 29, 1989)
2. Fall/spring (August 29, 1989 and February 27, 1990)
3. Spring only (February 27, 1990)
4. Fall/spring/fall (August 29, 1989, February 27, 1990 and October 23, 1990)
5. Spring/fall (February 27, 1990 and October 23, 1990)
6. Spring/fall/spring (February 27, 1990, October 23, 1990, and February 13, 1991)
7. Untreated check

All test plots were rated immediately prior to treatment and at bimonthly intervals thereafter using the population index system described by Harlan et al (1981), and later modified by Lofgren and Williams (1982). Plot ratings were discontinued when the appearance of many new incipient colonies signaled that reinfestation had occurred. Statistical differences between treatment means and the untreated control plots were determined for each rating interval using student's t-test ($P<0.01$).

Trial II - June 5, 1990

Suscon 10CR®, a controlled release formulation of chlorpyrifos produced by Incitec International, Brisbane, Australia, has provided multi-year activity against soil pests in Australia, New Guinea, and Indonesia. The Suscon formulation contains 10% chlorpyrifos in a slow-release plastic matrix and is sized as a 1.0mm particle. A trial to evaluate residual activity of this formulation against IFA was initiated on June 5, 1990 at the Pearl River Sod Farm, near Wiggins, Stone County, Mississippi. Plots were 148' x 148' (one half acre) with three replicates per treatment, and were located in a commercial planting of centipede grass sod (Eremochloa ophiuroides). IFA population counts were made prior to treatment and at 6, 12, 24, 28, 38, and 48 weeks posttreatment using the population index system referenced above. Analysis of variance and Duncan's new multiple range test (Duncan 1955) were used to determine statistical differences in treatment means at the $P <0.05$ level for each post-treatment rating interval. All treatments were applied with a Herd GT-77A granular applicator mounted on a farm tractor which was operated at 4.0 mph. This system provided a 20' swath. Suscon 10G was applied at a rate of 4.4 lb. AI/acre, and Lorsban 15G® (Dow Chemical, Midland, MI) was applied at 5.0 lbs AI/acre as a control. An untreated check was also included in this study.

Trial III - May 21, 1991

Efficacy of Suscon 10CR, Dursban 10G® (Ford's Chemical and Specialty Company, Pasadena, TX, and Talstar 10WP®, (FMC Corporation, Philadelphia, PA), were compared in a third trial which was initiated May 21, 1991. Test plots were located in a non-production field of common St. Augustine grass near Wadsworth, Matagorda County, Texas. Plots were 210' x 210' (1 acre), with 6 replicates per treatment arranged in a completely random design. IFA populations were assessed prior to and 4, 8, 12, and 20 weeks after application using the population index system referenced above. Analysis of variance and Duncan's new multiple range test (Duncan 1955) were used to determine statistical differences in treatment means at the $P < 0.05$ level for each post-treatment rating interval. Granular formulations were applied with a Herd GT-77A granular bait spreader mounted on a John Deere AMT 600 all terrain vehicle. Rate of application averaged 5.3 and 5.9 lbs AI/acre for Dursban 10G and Suscon 10CR respectively. Talstar 10WP was applied as a water based spray at a rate of 0.25 lbs AI/acre in 12.2 gallons of water. A roller pump boom sprayer comprised of five KSS-3 tips spaced 36" apart provided an overall swath of 16'. The system was pressurized to 14-18 PSI and towed behind a Honda 300® all terrain vehicle which was operated at approximately 4.6 mph.

Results:

Test I:

One application per year

As shown in Figure 1, a 90% reduction in the pretreatment population was achieved one month following a fall application, reaching maximum reduction (99.0%) nine months after application. Control in treated plots remained significantly different from the check plots from one to 11 months after application. Resurgence or reinfestation began 13 months after application, and the population increased rapidly thereafter, and surpassed pretreatment levels 15 months postapplication.

A spring application also rapidly reduced pretreatment population levels achieving 78% reduction one month after treatment with a maximum reduction of 99% five months after treatment (Figure 2.). However, resurgence was far more rapid than the fall sequence, occurring about six months after application and regaining pretreatment levels by the ninth month.

Two applications per year

As expected, two bait applications per year maintained population suppression longer than did single applications. A spring/fall sequence of bait applications maintained excellent control for 15 months following the first treatment, and resurgence did not occur until the twentieth month (Figure 3). Resurgence occurred much earlier in the fall/spring sequence (13th month), following 100% control in the 11th month as shown in Figure 4.

Three applications per year

Three bait applications per year were not superior to two applications. Although excellent population suppression was achieved, the additional expense of a third application would not be justified. Essentially no difference in the treatment sequence (fall/spring/fall versus spring/fall/spring) was apparent (Figures 5 and 6).

Trial II:

As shown in Table 1, excellent population suppression was obtained with Suscon 10CR for at least 48 weeks after application. The trial was terminated prematurely at this time because the owner treated the entire field with Dursban 2.5G in order to achieve certification prior to sale. Good control was initially achieved with Lorsban 15G, but reinfestation was evident 18 weeks after treatment.

Trial III:

Efficacy of Suscon 10CR was also demonstrated in Test III. All treatments were highly effective in reducing the IFA population for at least 20 weeks with no statistical differences among treatments. However, Suscon 10CR provided 99.4% control at 20 weeks which numerically, was far superior to all other treatments (Table 3).

Summary and Conclusions:

A single application of Logic bait applied in fall provided a longer period of population suppression than did a spring treatment. Two applications of Logic were superior to a single application, with spring/fall sequence providing longer suppression than the fall/spring sequence. Three applications per year were no better than two and would be impractical for economic reasons. Suscon 10CR, a controlled release formulation of chlorpyrifos provided excellent residual control of IFA in commercial grass sod in two separate trials.

Acknowledgements:

Numerous people contributed to this study. Avel Ladner, Tim Lockley, and Lee McAnally assisted with all field counts. Special thanks to Mark Trostle, Tavo Garza, and Andy Feild for pesticide application and assistance in field counts, and to Anne-Marie Callcott for data analysis and summarization as well as field counts.

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Table 1. Evaluation of Suscon 10CR for IFA Control in Commercial Turf. Pearl River Sod Farm, Wiggins, MS. June 1990.

Treatment	Pretreat Population*		Mean % Decrease in Pretreat Population Index ± SEM at Indicated Post-treatment Intervals (Weeks)*				
	Colonies/ plot	Mean pop. index	(6)	(12)	(18)	(24)	[illegible]
Suscon 10CR (4.4 lb AI/A)	13	150	100.0 ± 0.0a	95.3 ± 2.6a	100.0 ± 0.0a	98.3 ± 1.7a	[illegible]
Lorsban 15G (5.0 lb AI/A)	5.7	73.3	100.0 ± 0.0a	100.0 ± 0.0a	64.7 ± 14.8b	57.3 ± 13.2b	[illegible]
Untreated Check	8.3	117	11.0 ± 11.0b	13.0 ± 7.0b	0.0 ± 0.0c	0.0 ± 0.0c	[illegible]

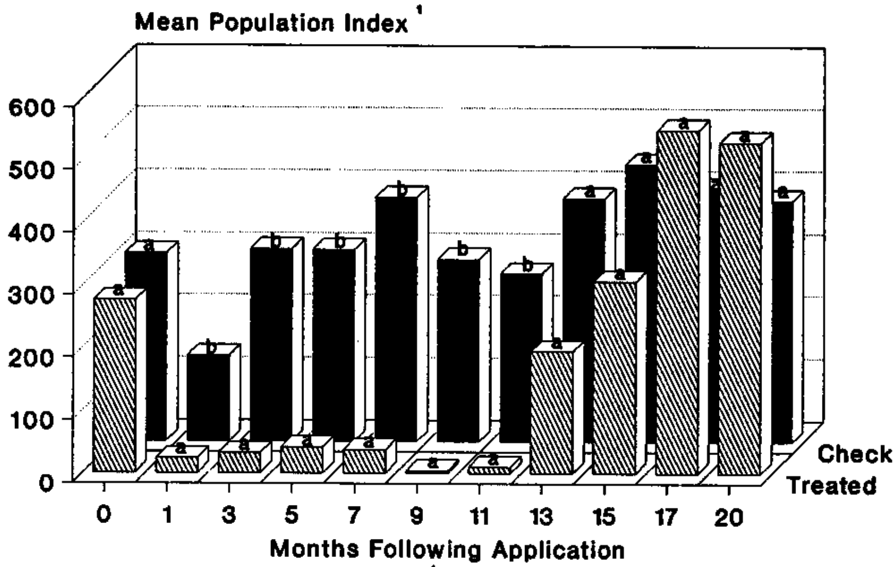
* Means based on 3 replicates/treatment. Means within a column followed by the same letter are not significantly different according to DNMRT P<0.05.

Table 2. RIFA Population Suppression in Commercial Grass Sod with Residual Insecticides.

Treatment	Pretreat Population*		Mean % Decrease in Pretreat Population Index ± SEM at Indicated Post-treatment Intervals (Weeks)*			
	Mean colonies/ subplot	Mean pop. index	(4)	(8)	(12)	(20)
Suscon 10CR (5.9 lb AI/A)	24	402	97.8 ± 0.5a	93.2 ± 1.9a	99.2 ± 0.6a	99.6 ± 0.4a
Dursban 10G (5.3 lb AI/A)	31	537	96.5 ± 2.2a	87.5 ± 5.9a	92.3 ± 3.8a	77.2 ± 9.1a
Talstar 10WP (0.25 lb AI/A)	21	367	92.0 ± 1.6a	95.2 ± 2.3a	87.2 ± 2.9a	82.8 ± 4.3a
Untreated Ck.	20	356	27.5 ± 7.2b	33.2 ± 11.3b	45.3 ± 11.8b	56.3 ± 8.0b

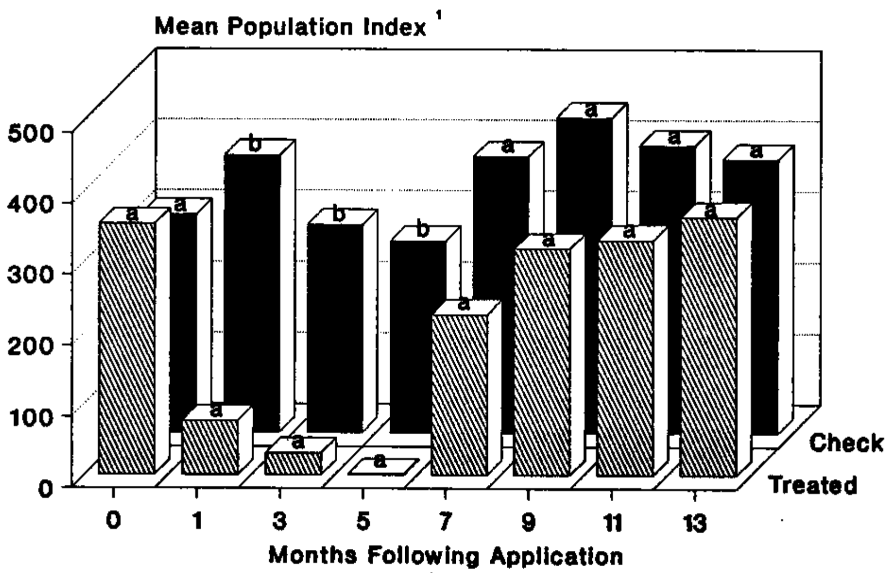
* Means based on 6 replicates/treatment. Means within a column followed by the same letter are not significantly different according to DNMRT P<0.05.

FIGURE 1
One Logic Application Per Year
Fall



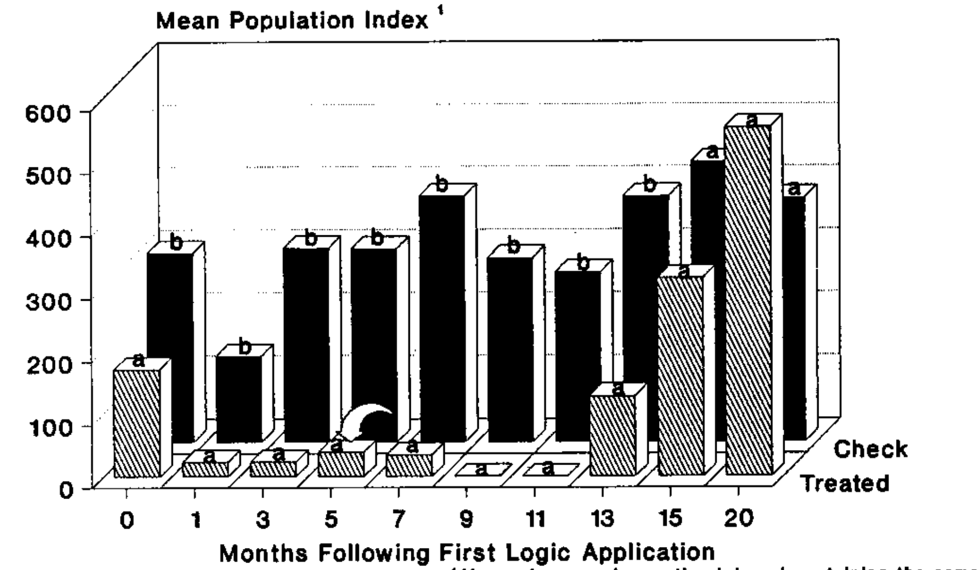
[1] Means for any given rating interval containing the same letter are not significantly different (t-test, P<0.01).

FIGURE 2
One Logic Application Per Year
Spring



[1] Means for any given rating interval containing the same letter are not significantly different (t-test, P<0.01).

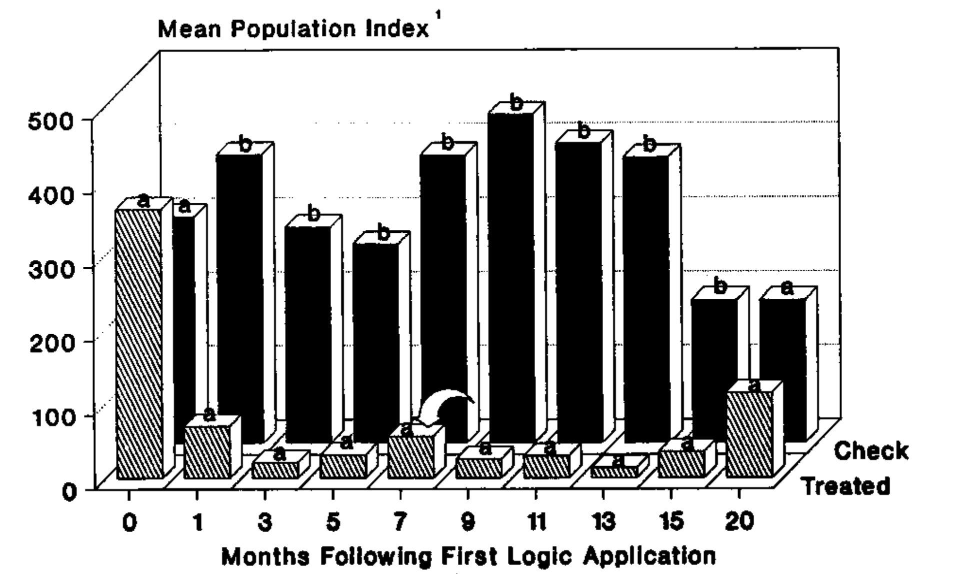
FIGURE 3
Two Logic Applications Per Year
Fall/Spring



Denotes second Logic application date

[1]Means for any given rating interval containing the same letter are not significantly different (t-test, P<0.01).

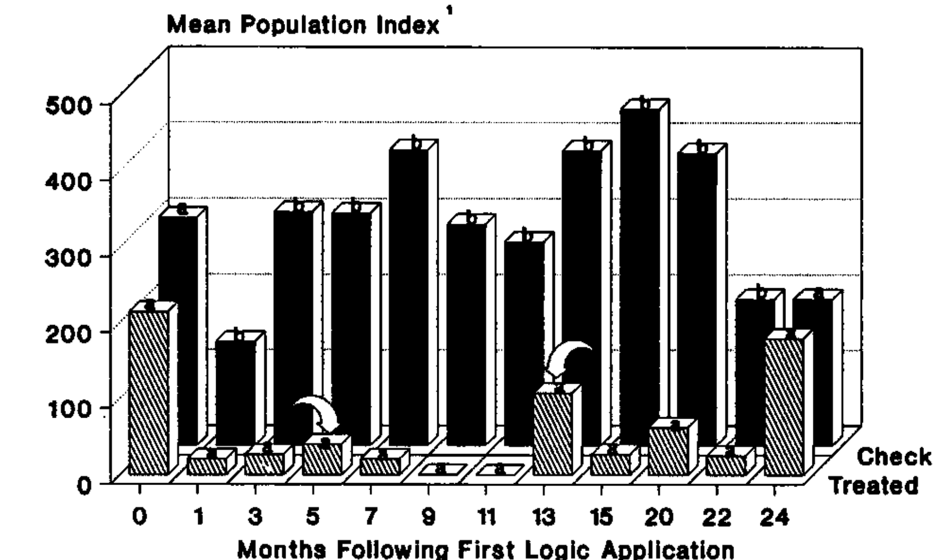
FIGURE 4
Two Logic Applications Per Year
Spring/Fall



Denotes second Logic application date

[1]Means for any given rating interval containing the same letter are not significantly different (t-test, P<0.01).

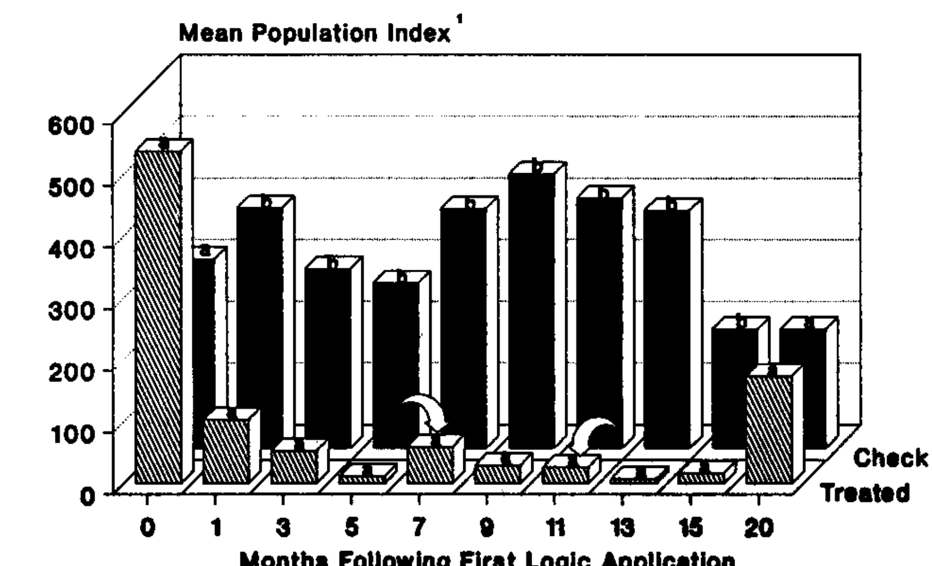
FIGURE 5
Three Logic Applications Per Year
Fall/Spring/Fall



Denotes second Logic application date
Denotes third Logic application date

[1]Means for any given rating interval containing the same letter are not significantly different (t-test, P<0.01).

FIGURE 6
Three Logic Applications Per Year
Spring/Fall/Spring



Denotes second Logic application date
Denotes third Logic application date

[1]Means for any given rating interval containing the same letter are not significantly different (t-test, P<0.01).

FACTORS INFLUENCING RESIDUAL ACTIVITY OF CHLORPYRIFOS IN NURSERY POTTING MEDIA

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The imported fire ant (IFA) quarantine was invoked May 6, 1958, and movement of certain regulated articles outside the quarantine area was prohibited unless that article was free of IFA infestation. Chlorinated hydrocarbon insecticides such as aldrin, dieldrin, heptachlor and chlordane were utilized for treatment of nursery potting soil from the quarantine's inception until chlordane was removed from the market December 31, 1979. From 1976-1979, the efficacy of chlorpyrifos against IFA was determined by the IFA Station in Gulfport, MS. Dursban®10G, when incorporated into a nursery potting media consisting of equal parts of sphagnum peat, river sand and ground pine bark, was highly effective against fragmented IFA colonies for 39 months (Collins et al. 1980). In January 1980, Dow registered FA-5, a 5% granular formulation of chlorpyrifos, which was subsequently withdrawn in late 1981. No insecticides were available for treatment of nursery potting media until Ford's Chemical Co. registered a 2.5G (granular) chlorpyrifos formulation in July 1984. Enforcement of the quarantine was relegated to the states in 1987 and increased the number of inspections which resulted in far more violations than previously detected. This activity led to questions regarding the efficacy of chlorpyrifos in nursery potting media.

In January, 1989, the IFA Station in Gulfport, MS began a lengthy series of trials to examine a variety of factors whose interaction with chlorpyrifos could promote enhanced degradation of the chemical. Factors included geographical location, media type, pesticide formulation, irrigation, pH of irrigation water, pesticide binding, leaching, enhanced microbial degradation, particle size, and percent organic matter of the various media tested.

Methods and Materials

All the trials basically followed the same protocol. Granular chlorpyrifos was incorporated into nursery potting media at a pre-determined rate, and treated media was then placed in standard one gallon plastic nursery pots and aged outdoors under simulated nursery conditions.

At monthly intervals, media from three pots of a treatment group was composited and subjected to a standard IFA alate queen bioassay, which is a slight modification of a procedure described by Banks et al. (1964). Bioassay test chambers were 2 X 2" plastic nursery pots equipped with a Labstone® bottom. The Labstone prevented escape through the drainage holes and also absorbed moisture from a underlying bed of peat moss to prevent desiccation of the ants. Approximately 50 cc. of treated media was placed in a test chamber and five alate queens introduced. Each treatment was replicated four times (i.e. four test chambers per treatment). Percent mortality of the queens was recorded after seven days of continuous confinement to the treated media and the mean of the four replicates calculated.

In the interest of brevity, all the trials initiated by the IFA Station will not be reviewed here, but rather representative studies of all factors involved in pesticide degradation will be covered. A brief description of each trial will precede the results presented, and the name of the principal investigator for the trial will be indicated in the text or in the corresponding results table.

Results

Confirmation of lack of efficacy:
A number of trials were initiated beginning in early 1989 to confirm efficacy of chlorpyrifos, and most examined the factors of geographical location, media type and application rate. The first trial, initiated by T. Lockley, examined the residual activity of Dursban 2.5G incorporated into various media and aged in various geographical locations (Table 1). Dursban aged at sites other than Gulfport, MS achieved less than four months of residual activity. This was the first study that confirmed that a problem with this treatment did exist.

In another trial initiated in May 1989, chlorpyrifos 2.5G was incorporated into various potting media at rates of 20, 40, 60, 80 and 100 ppm and aged in FL and MS (Table 2 & 3). No residual activity was noted after two months of aging. To determine whether pesticide binding was occurring, media from this trial was analyzed by gas liquid chromatography (GLC), preformed by the National Monitoring and Residue Laboratory (NMRAL) Gulfport, MS. Figure 1 shows the GLC analyses for the Strong-Lite® treated media aged in Gulfport, MS. These results are representative of the whole study, and indicate that the chemical is degrading over time and not being bound by the media.

An additional study to determine the residual activity of Lorsban®15G incorporated into various types of media at several rates of application and aged in Gulfport, MS was initiated in October 1989. No activity was observed after two months in the Baccto®, Sunshine® or Strong-Lite media (Table 4). However, chlorpyrifos in peat moss was active for 12 months, the duration of the trial.

Duplication of original efficacy trials:

The original efficacy trials, preformed in the late 1970's, utilized Lorsban 10G and the standard IFA laboratory potting media consisting of equal parts by volume of pine bark, sphagnum peat and sand, and a fragmented colony bioassay procedure was employed (Collins et al. 1980). Field collected IFA colonies were first separated from the nest tumulus by the floating technique (Jouvenaz et al. 1977) or through use of a desiccation tray (Markin 1968). The fragmented colony was then introduced into a pot of treated media and whole colony mortality assessed after 14 days. This procedure differed greatly from the current bioassay procedure using alate queens.

In the current study, residual activity of chlorpyrifos 2.5G and 15G incorporated into the original IFA laboratory media was determined using the fragmented colony, as well as the alate queen bioassay (Table 5). Twelve months of activity (the duration of the trial) was achieved regardless of formulation or bioassay type. Therefore, bioassay technique was eliminated as a possible reason for discrepancies in results of original and current studies.

Another trial was initiated in which the individual media components of the IFA laboratory media, and the complete media, were treated with Lorsban 15G. As indicated in Table 6, only the sand component had lost activity 17 months after treatment. Thus, the results of the original chlorpyrifos efficacy trials were substantiated: chlorpyrifos can last up to 17 months but only in a certain type of media or in one with certain characteristics.

Formulation:

A variety of granular formulations were used in the previously discussed trials. These granular products are also formulated on several types of carriers, including pecan hulls, cob granules and clay. A trial using these formulations showed no effective activity three months after incorporation (Table 7).

Other types of chlorpyrifos formulations are also available either commercially or experimentally through chemical companies. These include micro-encapsulated, controlled release (CR), emulsifiable concentrate (EC), dust and wettable powder (WP) formulations. Of these, only Empire®20, a micro-encapsulated formula applied as a drench, was effective for longer than two months (Table 8).

Irrigation:

A number of trials investigating variables associated with irrigation were undertaken. Chlorpyrifos is known to be relatively unstable in alkaline substances (Dow Chemical Co., Form No. 134-289-R585). Dursban 2.5G incorporated into Strong-Lite potting media and subsequently irrigated weekly with water with a pH of 7.9 (tap water), 9.0, or 11.0, provided activity for no longer than two months. Two chlorpyrifos formulations in Strong-Lite and irrigated with tap water or distilled water also provided less than two months residual (Table 9). Therefore, we concluded that pH of irrigation was not a factor in persistence of chlorpyrifos.

Leaching:
Chlorpyrifos has a very low solubility in water and therefore has a low leaching capacity (Dow Chemical Co., Form No. 134-289-R585). Strong-Lite potting media and the IFA laboratory media were treated through incorporation with Dursban 2.5G at a rate of 65 ppm. The treated media was placed in one gallon nursery pots and placed on racks in a greenhouse. One quart mason jars were placed below each pot to collect the leachate from individual pots. At monthly intervals, three pots from each treatment and their leachate (from the irrigation immediately prior to collection) were collected and bioassayed. Leachate was bioassayed by dipping a piece of filter paper (Whatman #1) in the leachate, placing the paper in a petri dish, and introducing five alate queens. The paper was kept moist by adding 0.5 ml. tap water per day. Mortality was recorded after seven days continuous exposure to the paper. The leachate from the IFA media was 98% effective at 24 hours post treatment, indicating some leachability, probably of dust particles from the chemical (Table 10). Dursban in Strong-Lite began losing efficacy after two months, while the IFA media showed excellent residual for four months (Table 11). These results confirm that leaching is not the mechanism by which chlorpyrifos degrades relatively rapidly in most media other than the IFA laboratory mix containing sphagnum peat (Smith 1966, Whitney 1967, Kuhr & Tashiro 1978 and Sharom et al. 1980).

Enhanced microbial degradation:
In order to study microbial degradation, Morris Magic Mix® potting media was placed in one quart mason jars, sealed, and steam sterilized at 17 psi for 1 hour on two consecutive days (Getzin 1981). Dursban 2EC was aseptically added to sterile and natural (unsterilized) media, and the media, treated and untreated, was aged under greenhouse conditions in open and closed containers. Only the closed treated media, sterile and natural, extended residual of the chemical (Table 12). This indicated that volatilization plays a role in chlorpyrifos degradation.

A more extensive trial utilized various combinations of fumigants, fungicides and bactericides to sterilize media (Table 13). No evidence of microbial involvement in chlorpyrifos degradation was evident. These results agree with numerous other reports that show that enhanced microbial degradation does not occur with chlorpyrifos (Hirakoso 1969, Miles et al. 1979, Getzin 1981 and Chapman 1982).

Enhanced residual:

After many different tests, we have determined that enhanced degradation is not occurring, but rather enhanced residual activity which may be caused by the presence of sphagnum peat moss. Several trials have been initiated to further explore this hypothesis.

The residual activity of chlorpyrifos incorporated into various volume to volume combinations of Strong-Lite potting and sphagnum peat moss, was extended proportionally with the amount of peat added (Table 14).

A trial similar to that described above, utilizing chlorpyrifos incorporated into the IFA laboratory media and media acquired from three commercial nursery operations was initiated. Greenleaf in El Campo TX, Flowerwood in Mobile AL and Windmill in Franklinton LA cooperated in this study. Characteristics of the media were determined by various laboratories: 1) percent organic matter by NMRAL, 2) cation exchange capacity and pH by the Agronomy Dept., MS State Univ., and 3) bulk density and particle size by the IFA laboratory. Results to date confirm that extended residual is achieved through the addition of sphagnum peat (Table 14).

Summary:

Results of early (1979) efficacy trials are repeatable if the same media (IFA laboratory media) is used. The difference in this media and other nursery potting media appears to be the presence of sphagnum peat, which we believe enhances the residual activity of chlorpyrifos. Efforts are now concentrated on the use of sphagnum peat as a carrier (in lieu of clay or cob granule) to enhance the residual of Dursban in all nursery media. Preliminary results with technical or EC formulated onto sphagnum peat and incorporated into various potting media has provided up to three months of residual activity. This trial will continue, and others have been started to demonstrate whether or not a peat based formulation of chlorpyrifos can be used to provide a long term residual insecticidal treatment for nursery potting media.

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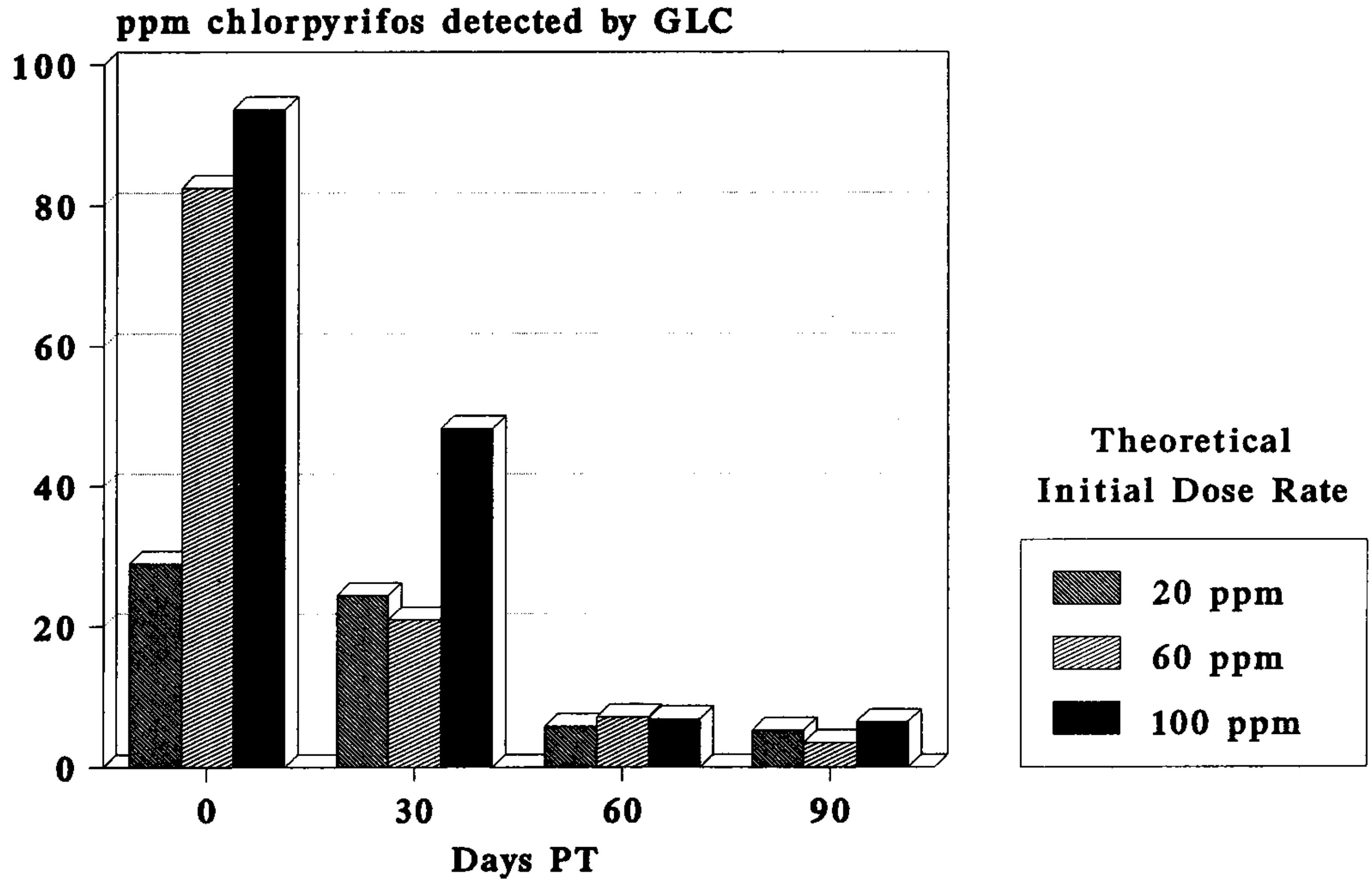
Figure 1. GLC Analyses of Strong-Lite Potting Media Aged in Gulfport, MS*



* GLC analyses performed by NMRAL, Gulfport, MS

Table 1. Residual activity of Dursban 2.5G incorporated into various potting media and aged at various geographical locations. January 1989. (Lockley)

MEDIA	LOCATION	% ALATE QUEEN MORTALITY AT INDICATED DAYS POST TREATMENT				
		(0)	(30)	(60)	(90)	(120)
Strong-Lite	Gulfport MS	100	100	100	100	100*
	Gainesville FL	100	100	100	100	20
	Winter Haven FL	100	100	20	15	40
	Miami FL	100	100	20	30	20
TuCo peat	Gulfport MS	100	100	100	100	100*
	Winter Haven FL	100	100	100	100	65
Morris Mix	Gulfport MS	100	100	100	100	70
	Miami FL	100	10	15	10	20

* dropped since other locations had decreased efficacy

Table 2. Residual activity of Dursban 2.5G incorporated into various media at various rates and aged in Miami FL. May 1989. (Lockley)

MEDIA	INITIAL DOSE RATE (ppm)	% ALATE QUEEN MORTALITY AT INDICATED DAYS POST TREATMENT (0)	(30)	(30)	(90)
Morris Mix	20	100	0	15	0
	40	100	0	25	5
	60	100	5	60	0
	80	100	20	15	10
	100	100	40	0	5
Atlas 3000	20	100	90	10	0
	40	100	50	45	0
	60	100	60	100	40
	80	100	40	100	5
	100	100	40	100	65
Strong-Lite	20	100	100	100	5
	40	100	100	15	0
	60	100	100	15	25
	80	100	100	100	35
	100	100	100	100	0

Table 3. Residual activity of Dursban 2.5G incorporated into various media at various rates and aged in Gulfport MS. May 1989. (Lockley)

MEDIA	INITIAL DOSE RATE (ppm)	% ALATE QUEEN MORTALITY AT INDICATED DAYS POST TREATMENT (0)	(30)	(30)	(90)
Morris Mix	20	100	95	10	0
	40	100	85	5	5
	60	100	100	15	0
	80	100	100	5	15
	100	100	100	0	15
Atlas 3000	20	100	25	15	30
	40	100	75	15	20
	60	100	100	10	10
	80	100	100	60	60
	100	100	100	60	60
Strong-Lite	20	100	100	20	0
	40	100	100	5	0
	60	100	100	10	0
	80	100	100	25	35
	100	100	100	5	25

Table 4. Residual activity of Lorsban 15G in various types of potting media. October 1989. (McAnally)

MEDIA	APPLICATION RATE (g AI/cu yd)	% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT					
		(1)	(2)	(3)	(4)	(5)	(6)
Baccto	11.34	100	10	30	*	-	-
	14.8	100	100	10	5	*	-
	Check	10	10	5	5	*	-
Sunshine	4.47	100	15	5	*	-	-
	11.34	100	20	10	*	-	-
	Check	10	25	5	*	-	-
Strong-Lite	6.94	100	15	15	*	-	-
	11.34	100	15	15	*	-	-
	Check	5	0	0	*	-	-
Peat Moss	6.25	100	100	100	100	100	**
	11.34	100	100	100	100	100	**
	Check	5	0	0	0	0	**

* dropped due to decreased efficacy
** continued effective for 12 months

Table 5. Residual activity of Dursban 2.5G and Lorsban 15G incorporated into original IFA laboratory potting media. December 1989. (McAnally)

BIOASSAY TYPE	FORMULATION	RESIDUAL ACTIVITY (months)
Alate Queen	2.5G	12
	15G	12
Fragmented Colony	2.5G	12
	15G	12

Table 6. Residual activity of Lorsban 15G in various potting media components. August 1990. (McAnally)

COMPONENT	% ALATE QUEEN MORTALITY AT INDICATED MONTHS PT									
	(1)	(3)	(5)	(7)	(8)	(9)	(11)	(13)	(15)	(17)

Sand	100	100	100	100	30	25	75	0	*	*
Peat Moss	100	100	100	100	100	100	100	100	100	100
Pine Bark	100	100	100	100	100	100	100	100	100	100
Mixture	100	100	100	100	100	100	100	100	100	100

* dropped due to decreased efficacy

Table 7. Residual activity of various granular formulation of chlorpyrifos incorporated into Strong-Lite potting media (11.3 g AI/cu yd) and aged at Gulfport, MS. July 1989. (Callcott)

		% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT				
INSECTICIDE	CARRIER/FORMULATOR	(1)	(20	(3)	(4)	(5)
Dursban 2.5G	pecan hulls/Ford's	100	100	100	10	10
Dursban 2.5G	corn cobs/Ford's	100	35	100	35	0
Lorsban 15G	clay/Dow	100	100	45	25	10
Check		10	30	0	20	10

Table 8. Residual activity of various chlorpyrifos formulations at application rates of 100 ppm in Strong-Lite potting media. November 1989. (Ladner)

FORMULATION	FORMULATOR	% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT					
		(1)	(2)	(3)	(4)	(5)	(6)
Empire 20%*	Dow	100	100	100	100	100	100
10G	Ford's	100	100	10	15	†	-
Suscon®10CR	Incitec Int.	100	100	25	5	†	-
2EC*	Dow	100	45	0	0	†	-
WDG 50%	Dow	100	20	10	0	†	-
1% Dust	Ford's	100	20	5	0	†	-
XRD 429	Dow	100	5	15	5	†	-
Lorsban 15G	Dow	100	5	0	0	†	-
50WP	Dow	100	0	0	0	†	-
2.5G	Ford's	70	5	5	5	†	-
Check		5	20	5	5	0	5

* applied as a drench rather than incorporated (8 oz 2E/100 gal water)
** continued effective for 13 months
† dropped due to decreased efficacy

Table 9. Effects of tap water vs. distilled water on residual activity of various chlorpyrifos formulations incorporated into Strong-Lite potting media. January 1990. (Callcott)

INSECTICIDE	TYPE IRRIGATION WATER	% ALATE QUEEN MORTALITY AT INDICATED MONTHS PT		
		(1)	(2)	(3)
Dursban 2.5G	Tap	100	30	0
	Distilled	100	10	10
Lorsban 15G	Tap	100	15	5
	Distilled	100	5	10
Check	Tap	0	15	5
	Distilled	10	0	0

Table 10. Activity of leachate from potting media treated with Dursban 2.5G. August 1991. (Callcott)

MEDIA	% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT*				
	(24 hr)	(1)	(2)	(3)	(4)
Strong-Lite	3.3	11.7	22.7	26.7	0
Check	5.0	5.0	0	5.0	0
IFA media	98.3	5.0	31.7	10.0	1.7
Check	5.0	5.0	5.0	20.0	0

* mean based on three replicates

Table 11. Residual activity of Dursban 2.5G in potting media. August 1991. (Callcott)

MEDIA	% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT*				
	(24 hr)	(1)	(2)	(3)	(4)
Strong-Lite	100	100	68.3	100	65
Check	5	15	0	10	0
IFA media	100	100	100	100	100
check	5	5	20	5	5

* mean based on three replicates

Table 12. Residual activity of Dursban 2EC in sterile vs. natural media and open vs. closed containers. December 1989. (Callcott)

TREATMENT/CONDITIONS	% ALATE QUEEN MORTALITY AT AT INDICATED MONTHS POST TREATMENT					
MEDIA/DURSBAN/CONTAINER	(1)	(2)	(3)	(4)	(5)	(6)
Sterile/treated/open	100	5	45	100	5	35
Sterile/treated/closed	100	100	100	100	100	100
Natural/treated/open	100	75	0	100	5	0
Natural/treated/closed	80	100	100	100	100	0
Sterile/untreated/open	5	5	5	5	20	0
Sterile/untreated/closed	0	0	0	10	25	5
Natural/untreated/open	5	0	0	20	10	0
Natural/untreated/closed	10	0	0	5	5	50

Table 13. Residual activity of chlorpyrifos incorporated into potting media treated with
various combinations of fungicides and bactericides. March 1991. (Collins)

TREATMENT	% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Strong-Lite + methyl bromide + 500 ppm benomyl + 500 ppm streptomycin sulfate + 65 ppm Dursban	100	100	50	10	*				
Strong-Lite + 500 ppm benomyl + 500 ppm streptomycin sulfate + 65 ppm Dursban	100	100	0	20	*				
Strong-Lite + methyl bromide + 65 ppm Dursban	100	100	30	35	*				
Strong-Lite + 65 ppm Dursban	100	100	65	35	*				
IFA lab media + 65 ppm Dursban	100	100	100	100	100	100	100	100	100
Strong-Lite + 50 ppm Talstar 10WP	100	100	100	100	100	100	100	100	100
Strong-Lite Check	40	10	25	30	5	5	5	5	0

* dropped due to decrease efficacy

Table 14. Residual activity of Dursban 2.5G incorporated into various volume to volume combinations of Strong-Lite potting media and sphagnum peat. March 1991. (Callcott)

MEDIA MIX	% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Strong-Lite only	100	100	55	30	5	*		
9:1 Strong-Lite:peat	100	100	35	45	10	*		
3:1 Strong-Lite:peat	100	100	100	100	45	95	45	100
1:1 Strong-Lite:peat	100	100	100	100	100	100	100	100
Peat only	100	100	100	100	100	100	100	100
Strong-Lite Check	30	10	25	30	5	5	5	5

* dropped due to decrease efficacy

Table 15. Residual activity of Dursban 2.5G incorporated into various nursery potting media and media/peat combinations. July 1991. (Collins)

MEDIA	TREATMENT	% ALATE QUEEN MORTALITY AT INDICATED MONTHS POST TREATMENT				
		(1)	(2)	(3)	(4)	(5)
Greenleaf	Dursban	100	100	35	35	0
1:1	Dursban	100	100	100	100	100
3:1	Dursban	100	100	100	100	100
5:1	Dursban	100	100	100	100	100
Greenleaf	Talstar 10WP	100	100	100	100	100
Greenleaf	Check	10	30	10	15	20
Windmill	Dursban	70	85	10	30	40
1:1	Dursban	60	50	0	55	30
3:1	Dursban	95	100	20	25	45
5:1	Dursban	65	50	40	20	5
Windmill	Talstar 10WP	100	100	100	100	100
Windmill	Check	20	40	10	20	5
Flowerwood	Dursban	100	100	100	60	0
1:1	Dursban	100	100	10	15	5
3:1	Dursban	100	100	15	20	10
5:1	Dursban	100	20	100	80	85
Flowerwood	Talstar 10WP	100	100	100	100	100
Flowerwood	Check	65	35	60	20	15
IFA media	Dursban	100	100	100	100	100
IFA media	Talstar 10WP	100	100	100	100	100
IFA media	Check	20	0	15	10	10
Peat	Check	20	10	20	0	10

Abstract: Annual Fire Ant Conference, May 1992, San Juan, Puerto Rico

Individual and colony Level Fire Ant Variation in Responsiveness

Robert K. Vander Meer

Research into fire ant homing orientation cues led to the testing of many fire ant colonies for their ability to find their way back to their nest and recruit workers to a food source. The data was derived from colonies reared in the laboratory from newly mated queens, thus there was no competitive pressure on these colonies. The data ranged from a low of 2 minutes to a high of 21 minutes. The within colony variation was small compared to the colony to colony variation. The question arises of whether or not colonies very slow to recruit to food would be at a competitive disadvantage in the natural setting. In fact, they may not survive. Field studies are planned to test this hypothesis. These data illustrate that not all colonies are created equal.

If we look within the colony there are three defined age related worker castes (temporal castes). Starting with newly eclosed workers, there are nurse or brood tending workers, then reserves who would normally maintain the colony structure, and foraging workers, who find food and recruit other workers to it if necessary. Foraging workers are often called the expendable caste because they are close to death. Anecdotal observations had been made indicating that foraging workers were not very sensitive to the queen pheromone. One hypothesis was that workers are most responsive to the pheromone systems they are currently experiencing. Thus brood tending workers are predicted to be most sensitive to brood and queen, whereas foraging workers are expected to be most sensitive to recruitment pheromones. We tested these hypotheses by studying the responsiveness of the temporal castes in three bioassays. Of the three temporal castes, brood tending workers were the most responsive to brood placed in their immediate vicinity. Foraging workers were significantly slower to respond. The same was true for a bioassay that measured the attraction and aggregation of the ants to a source of the queen pheromone. Thus, these two results support the hypothesis. Unexpectedly, similar results were obtained for olfactometer bioassays with the recruitment pheromone. The foraging workers were expected to respond better than their brood tending counterparts. Therefore our working hypothesis had to be modified as follows: as worker ants age their sensitivity to outside stimuli generally decreases as a result of senescence (old age). The moral of this story is that all workers within a colony are not created equal.

How will these observations affect our theories on the use of pheromones to enhance baits? Not much. After all, we are targeting the pheromone enhanced baits toward foraging workers! The situation is not unlike aging humans, who after a time require glasses, hearing aids, need to add more spices, etc. to clarify or intensify various stimuli. Concentration / activity studies with the three fire ant temporal castes have demonstrated that foraging workers respond very well to elevated quantities of pheromones. In baits, we may simply need a little more stimulus to effect the desired behaviors in foraging workers, but the end result will be the same.

Report at 1992 Imported Fire Ant Conference, San Juan, Puerto Rico

Red Imported Fire Ants in Poultry Operations: A Report of Control Programs Investigated in Barrow County, Georgia, 1991-1992

Beverly Sparks, Extension Entomologist, University of Georgia Cooperative Extension Service, Athens, Georgia and Stan Diffie, Research Technician, Coastal Plains Experiment Station, Tifton, Georgia

Purpose of Investigation: Red imported fire ants occasionally cause problems on poultry farms by attacking chickens and foraging into houses. Furthermore, the ants cause great concern to workers as they care for and harvest chickens. A few products are labelled for use in controlling fire ants nesting inside poultry houses (carbaryl). The purpose of this demonstration is to evaluate a cost efficient/long term control program for fire ants infesting grounds surrounding poultry houses.

Materials in Methods: Plots were established around three poultry houses belonging to Mr. Raymond Reynolds, Barrow County, Georgia, on June 6, 1991. Pretreatment evaluation of the fire ant populations were made by counting all mounds located within 20 feet of each house. In addition, twelve peanut oil soaked index cards were placed around the base of the outside of each house to serve as bait attractants for foraging ants. The bait cards were left in place for 45 minutes and then the number of ants found on each card was recorded. On June 6, 1991 the grounds surrounding the houses were treated with a broadcast application of Logic at the rate of 1.5 lbs/acre. The treatment was made using a Honda ATC vehicle with a Herd Seed Spreader adapted for application of fire ant baits. Five days following the Logic application, individual mounds found around the buildings were treated with Orthene 75S. Two teaspoons of the dry powder were sprinkled across the top of each mound.

Results: Results of this control program are based on a comparison of number of active fire ant mounds at pretreatment and posttreatment evaluations. In addition, the number of fire ants foraging around the perimeter of the poultry houses was recorded at both pretreatment and posttreatment evaluations. Table 1 presents the number of active mounds around each of the three poultry houses at pretreatment, 1, 2, 3 and 8 months posttreatment. Table 2 presents the number of ants found foraging around the perimeter of each house at pretreatment, 1, 2, 3 and 8 months posttreatment. Two months following the initial application of Logic, number of foraging fire ants collected on bait cards began to increase, particularly around house number 3. Following the two month evaluation, the decision was made to treat with a second broadcast application of Logic. One week after the Logic application, visible mounds were treated with Orthene.

Table 1. Number of active red imported fire ant mounds around Reynold's poultry houses at pretreatment and at 1, 2, 3 and 8 months following application of Logic and Orthene, Barrow County, Georgia, 1991.

		Number of Active Fire Ant Mounds (% Mortality)			
House	Pretrt	1 Month	2 Month	3 Month	8 Month
1	46	5 (89)	3 (93)	0 (100)	4 (91)
2	34	9 (73)	8 (76)	2 (94)	0 (100)
3	39	7 (82)	19 (51)	2 (94)	5 (87)

Table 2. Number of foraging fire ants recorded on 12 bait cards (after 45 minutes exposure) at pretreatment, 1, 2, 3 and 8 months following application of Logic + individual mound treatment with Orthene.

		Number of Foraging Fire Ants on Bait Cards			
House	Pretrt	1 Month	2 Month	3 Month	8 Month
1	326	52 (84)	22 (93)	0	0
2	560	36 (94)	139 (75)	1 (99)	0
3	472	66 (86)	631 (+33)	46 (90)	0

The Imported Fire Ant in Sugarcane Fields in Puerto Rico

Carlos Cruz and Sandra Castro
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1. Introduction:

The Imported Fire Ant (IFA) Solenopsis invicta was detected for the first time in Puerto Rico during May, 1981 by the late entomologist Dr. William F. Buren. Surveys conducted by APHIS people in Puerto Rico have determined that the Imported Fire Ant is already distributed in the south of the Island from Anasco to Yabucoa. It has been found in roadsides, in plantings of vegetables, making damage to cabbage and cucumber seedlings, in fruits making damage to small trees of avocado and mangoes, and in sugarcane fields in the municipality of Yabucoa.

Preliminary studies were conducted in an attempt to determine the spatial distribution, nesting, food habits and the interrelation with other ants or insects in the sugarcane fields in Puerto Rico.

2. Experimental plot:

The experimental plot was selected in a sugarcane field known to be infested with the IFA. It consisted of 35 x 40 m and the sugarcane plants were about 1 m height. The plot was divided into subplots of 4 x 1.52 m (250 subplots).

3. Results:

There were 52 active mounds of S. invicta (81%) and 24 (19%) nests of Pheidole fallax in the experimental plot. The average diameter and height of the IFA mounds was 40.7 and 12 cm, respectively. Average mound per acre was 150 and 69 for S. invicta and P. fallax, respectively. Seventy-eight percent of the IFA mounds were in the center of the row, associated with the sugarcane stump, while 83 percent of the nests of P. fallax nests were apparently made in abandoned mounds of S. invicta. Observations made from 8 to 10:00 a.m. during July 8 and 20, August 5, 8, 10 and 12, 1983, indicated that S. invicta was feeding on living specimens of annelids (earthworms), myriapods (millipede), mole crickets, scarabaeids (mostly Phyllophaga), homopterans, lepidopterans (adults and larvae), some spiders and other unidentified insects.

The greatest number of ants were found on annelids, Phyllophaga and mole crickets. Some small white grubs were found being carried away by S. invicta. Infestation of canes by the sugarcane borer Diatraea saccharalis was not observed in this sugarcane field. This insect is a serious pest in other sugarcane fields around the island.

Larvae of the sugarcane rootstalk weevil, Diaprepes abbreviatus, were buried near S. invicta mounds and were quickly found and killed by the ants. Furthermore, no symptom or damage by this or similar insects

(*Phyllophaga*) was observed in the experimental plot or sugarcane fields nearby.

No other ant species was observed in the experimental plot. However, two other ant species were found in the sugarcane field around the plot: *Paratrechina steinheili* and *Brachymyrmex heeri*.

4. Conclusions:

From this study we can make the following preliminary conclusions:

1) *S. invicta* is well disseminated in the sugarcane fields in Yabucoa, P.R.
2) It preferred to nest in association with the sugarcane stump.
3) It could be displacing other ant species in the area.
4) It could be favoring aphids and scale insects in the sugarcane fields.
5) It could be controlling the white grubs (*Phyllophaga* and *Diaprepes*) and the sugarcane borer (*D. saccharalis*).

This is only a preliminary trial and further studies should be conducted to determine the exact role of the imported fire ant in sugarcane fields and other crops in Puerto Rico.

ESTUDIOS PRELIMINARES DE *Solenopsis invicta* EN SIEMBRAS DE CAÑA EN PUERTO RICO

Por

Sandra Castro Alemán

INTRODUCCION

La hormiga brasileña Solenopsis invicta Buren fue encontrada por primera vez en Puerto Rico para el 28 de mayo de 1981 por el entomólogo William F. Buren, de la Estación Experimental Agrícola de la Florida. Posteriormente el Departamento de Agricultura Federal realizó un catastro a través de toda la isla finalizando el mismo para el verano de 1983, confirmando la presencia de la especie a lo largo de toda la zona sur, desde Yabucoa hasta Añasco. En el área de Yabucoa S. invicta ha sido encontrado en toda la zona urbana así como en zonas agrícolas e industriales. En la refinería Sun Oil Company, alegadamente hay grandes cantidades de hormigas que obstruyen el interior de tuberías y otro equipo imposibilitando ciertas tareas. También abunda en los cañaverales pertenecientes a la Central Roig y en siembras de plátanos y hortalizas. Hasta el momento de iniciado este trabajo no se habían realizado estudios básicos sobre aspecto alguno de S. invicta en zonas agrícolas en P. R. careciendo de toda información de utilidad en la toma de decisiones futuras.

Con el propósito de dilucidar algunos aspectos básicos sobre la presencia de S. invicta en el area de Yabucoa me trasladé a los terrenos de la Central Roig en el verano de 1983. Mis objetivos principales fueron:

1. Determinar la distribución espacial y observar los hábitos de anidamiento de *S. invicta* en un predio de caña.
2. Obtener información sobre los hábitos alimenticios de *S. invicta* a nivel del suelo y sobre el follaje de caña.
3. Observar posibles interrelaciones de *S. invicta* e insectos plaga en caña.
4. Obtener información sobre posibles interrelaciones entre *S. invicta* y otras especies de hormigas presentes en la zona cañera.

REVISION DE LITERATURA

La hormiga brava _S. invicta_ ("red imported fire ant") aparentemente fue introducida en los Estados Unidos con productos que llegaban por barco desde Sur América al puerto de Mobile, Alabama para 1940. Actualmente se encuentra diseminada en Florida, Louisiana, partes de Carolina del Norte, Carolina del Sur, Georgia, Alabama, Mississippi, Texas y Arkansas (Lofgren et al. 1975). Inicialmente fue clasificada como _Solenopsis saevissima_ Smith pero Buren (1972) demostró que esta clasificación comprendía dos especies diferentes, (_Solenopsis richteri_ Forel y _S. invicta_) una de las cuales no había sido descrita anteriormente. Con el objetivo de obtener información sobre la distribución de _S. invicta_ en Sur América, Allen et al (1974) realizaron un viaje determinando que el lugar de origen de _S. invicta_ lo era el estado de Mato Grasso, en la región sur central del Brasil en donde ésta fue encontrada solamente en áreas húmedas o protegidas. Baroni y Kannowski (1974) determinaron la densidad poblacional de nidos de _S. invicta_ en un área de pastos en el estado de Louisiana encontrando que los nidos presentaban una distribución agregada de 0.0096 nidos/m^2. De acuerdo al dueño de las tierras _S. invicta_ había invadido el área hacía unos 15 años atrás.

Buren (1982) informó el hallazgo de varios nidos de _S_. _invicta_ en el área de la playa El Tuque en Ponce, P. R. Otras especies colectadas en el área fueron _Solenopsis_ _geminata_ Fabricus, _Conomyrma_ _antillana_ Forel, _Pheidole_ _fallax_ _antillensis_ Forel y _Monomorium_ _destructor_ Jerdon. Lyle y Fortune (1948) informaron que los nidos de _S_. _invicta_ encontrados en el estado de Mississippi eran en forma de panal con gran cantidad de tuneles en el interior. Durante el invierno las hormigas permanecían en el área superior del nido moviéndose a las áreas subsuperficiales durante el verano. La cría fue hallada hacia el centro de los nidos y ésta era movida a diferentes áreas dependiendo del nivel del agua en el suelo.

_S_. _invicta_ ha sido descrita como una hormiga sumamente voraz tanto de cultivos como de animales domésticos y salvajes, pero existe poca evidencia científica al respecto. Wilson y Oliver (1969) demostraron experimentalmente que la dieta de las hormigas bravas está compuesta principalmente de insectos, arañas, miriapodos, gusanos de tierra y otros invertebrados menores. Glancey (1979) informa de daños causados por _S_. _invicta_ a plántulas de maíz en Mississippi luego de ocurrido el desbordamiento de un río sobre el área afectada. Por otro lado Charpentier y colaboradores (1967) reportaron a

S. invicta como uno de los depredadores principales de Diatraea saccharalis F. mientras que otros investigadores alegadamente han observado hormigas de este género alimentándose de la substancia dulce que eliminar áfidos, querezas y chinches arinosas (Bruce et al. 1949).

Se han investigado varias interacciones entre S. invicta y otras especies de hormigas. Whitcomb et al. (1972) reportaron que entre las especies presentes en campos de soya en Florida, S. invicta demostraba la mayor agresividad, encontrando mayor diversidad de especies de hormigas en áreas donde S. invicta nunca había estado presente. Adams et al. (1981) informaron que un complejo múltiple de predadores sin especies dominantes fue más efectivo en reducir y controlar D. saccharalis que un complejo simple donde la especie dominante lo fue S. invicta. En pruebas realizadas en el laboratorio Bhatkar et al. (1972) encontraron que la hormiga Lasius neoniger Emery ataca a S. invicta pero debido a la alta población de S. invicta los nidos de L. neoniger fueron destruídos luego de prolongadas batallas. O'Neil (1974) reporta haber observado un nido de S. invicta colonizado por la hormiga Neivamyrmex opacithorax Emery.

MATERIALES Y METODOS

Distribución espacial:

El área seleccionada para realizar este estudio está localizada aproximadamente a 750 metros al norte del área que comprende el molino de caña de la Central Roig en el pueblo de Yabucoa. De acuerdo con el agrónomo a cargo de los terrenos, (A. León, comunicación personal) al momento de arrendar las tierras en abril de 1982 ya *S. invicta* estaba presente en el área. Para mayo de 1982 las cañas fueron incendiadas y posteriormente cortadas a máquina. En ocasiones se ha utilizado Diazinón para controlar algunos nidos de *S. invicta*. El predio experimental fue delimitado a un espacio de 40 metros de largo x 35 metros de ancho con estacas de madera al comienzo y final de cada banco de caña. Los límites norte y oeste del predio están localizados contiguos a los callejones del cañaveral. Inicialmente los retoños tenían una altura aproximada de 1 metro y realizé una inspección visual del suelo encontrando dos tipos de nidos diferentes. Procedí a identificar las hormigas encontradas poblando los nidos comparándolas con otras muestras colectadas por los inspectores federales que realizaron el catastro de *S. invicta* a través de la isla. Estos me facilitaron orientación general y muestras de S. invicta y *Solehopsis geminata* Fabr. Con la ayuda del profesor Juan Torres, identifiqué la segunda especie de hormiga encontrada y procedí a localizar todos los nidos activos presentes en el predio experimental.

Realizé una búsqueda exhaustiva comenzando por el extremo del oeste del predio dividiendo el mismo en rectángulos de 4 x 1.52 m cuadrados resultando en 230 rectángulos consecutivamente enumerados. Al llegar al extremo sur del predio me desplazaba hacia extremo norte y comenzaba nuevamente. Al encontrar un nido en forma de montículo, procedía a; medir la altura del mismo; determinar el diámetro máximo y la forma general; grado de iluminación relativa a que se encontraba expuesto y su localización relativa con respecto al banco. La cepa más cercana a los nidos fue identificada con un pedazo de cinta adhesiva de color rojo o blanco dependiendo la especie encontrada poblando el nido. Los nidos en forma de cueva también fueron identificados. Todos los nidos fueron posteriormente localizados en un mapa (Figuras 1 y 2).

En adición a esto me trasladé al área periferal de una pieza de caña adulta que se encontraba a una distancia aproximada de 800 metros al norte del predio experimental y observé los nidos encontrados a lo largo de 70 metros, posteriormente destruír los mismos para identificar la especie que poblaba el nido.

<u>Hábitos alimenticios de S. invicta</u>:

En horas entre 8 a 10 A:M: de los días 8 y 20 de julio y 5, 8, 10 y 12 de agosto respectivamente me dediqué a observar los hábitos alimenticios de

S. invicta en el suelo y en el follaje de la caña. Me desplazé mayormente en forma no -a la sar a través de la zona periferial del predio experimental adyacente a los callejones del cañaveral, y en algunas ocasiones a lo largo de los surcos dentro del predio. En algunos casos utilizé cinta adhesiva para pegar la hormiga a la misma y observar con una pequeña lupa las presas encontradas. Las larvas encontradas fueron coleccionadas en frascos de cristal con mezcla KAAD previamente preparada en el laboratorio y posteriormente identificadas.

S. invicta y otras especies:

Observé la actividad en los alrededores de un nido de P. fallax localizado a poca distancia, un nido de S. invicta dentro del predio experimental durante horas de la mañana y la tarde. En adición distribuí 3 carnadas de tuna a la zona sombreada del bancó y 2 en el surco durante horas de la mañana para observar interacciones entre diferentes especies y el factor luz. Otras carnadas de tuna fueron colocadas en las inmediaciones de nidos S. invicta y de P. fallax respectivamente.

Insectos plaga en caña y S. invicta:

Con el propósito de observar el comportamiento de S. invicta hacia larvas de la vaquita de la caña Diaprepes abbreviatus (Fabr.) conseguí larvas de 1.5-2.5 cms. de largo críadas en el laboratorio y coloqué las mismas en perforaciones de 2 cms de profundidad en la zanja que rodeaba el predio experimental en horas de la mañana de los días 3 y 4 de agosto. Luego de tapar los mismos con tierra procedí a observar el comportamiento de la hormiga hacia las larvas. Para obtener información sobre la presencia de insectos chupadores asociados a S. invicta realizé 10 observaciones de 5 minutos de duración en el follaje de cepas directamente asociadas a los nidos de la hormiga.

Aspectos adicionales

Varios vuelos nupciales fueron observados durante la mañana del 3 de agosto entre 11:00 A.M. y 12:30 P.M.

Luego de observar la presencia de "cementerios" S. invicta situados a lo largo de surcos y zanjas, procedí a recoger el contenido de 10 de éstos, trasladándolos al laboratorio y examinando su contenido bajo el estereoscopio.

Para tener una idea de la profundidad de los nidos de S. invicta asociados a los bancos, destruí aproximadamente 12 nidos a lo largo del área periferial de la pieza de caña de retoño. Además destruí otros nidos encontrados en los lados de los caminos. Aproveché para observar y recoger huevos, pupas y adultos de las diferentes castas presentes. Los trabajadores fueron colectados colocando en frascos de cristal de 6 cms de altura a los cuales se le añadió polvo talco. Las hormigas aladas fueron colectadas humedeciendo la punta del dedo en alcohol' Al hacer contacto con las alas, éstas se pegaban al dedo y procedía a echarlas en frascos con alcohol al 70%.

RESULTADOS Y DISCUCION

Distribución Espacial y Hábitos de Anidamiento:

En el área estudiada fueron encontrados un total de 52 nidos de S. invicta activos. La distribución espacial de estos nidos en la caña de retoño está representada en la Figura 1. A simple vista se observa una agregación de nidos en el área periferal al noroeste en los primeros 240 m^2. La Figura 2 muestra la distribución espacial de los nidos de P. fallax. Se observa que los nidos de P. fallax están dispersos a través de todo el predio en forma no uniforme. No hay nidos de P. fallax localizados en los primeros 240 m^2 del área periferal en donde hay concentrados 24 nidos de S. invicta para una densidad aproximada de 0.100 nidos/m^2 (Figura 1 y 2) Apärentemente hay una tendencia de agregación en esta área lo cual contrasta con la presunción de que S. invicta exhibía comportamiento territoralista. Otra posible explicación sería que varios nidos forman parte de una misma colonia.

Más de 3/4 partes, todos los nidos de S. invicta dentro del área experimental se localizan hacia el centro de los bancos y asociados directamente a la cepa de caña mientras que la gran mayoría de los nidos de P. fallax estaban localizados a los lados del banco y solo un 4.17% se encontraban asociados directamente a la cepa.

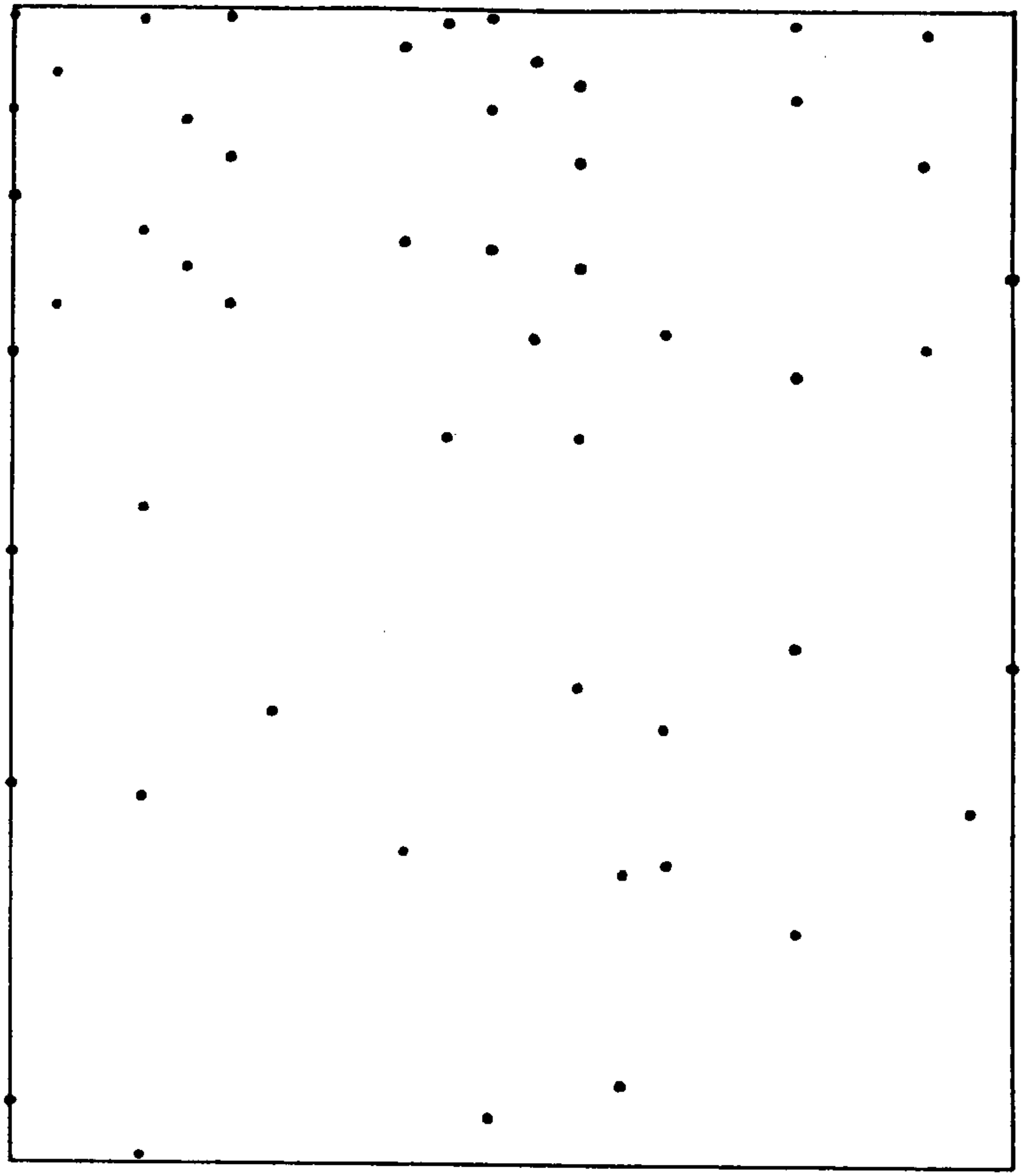

Figura 1:

Mapa de la distribución de los nidos de *S. invicta*.

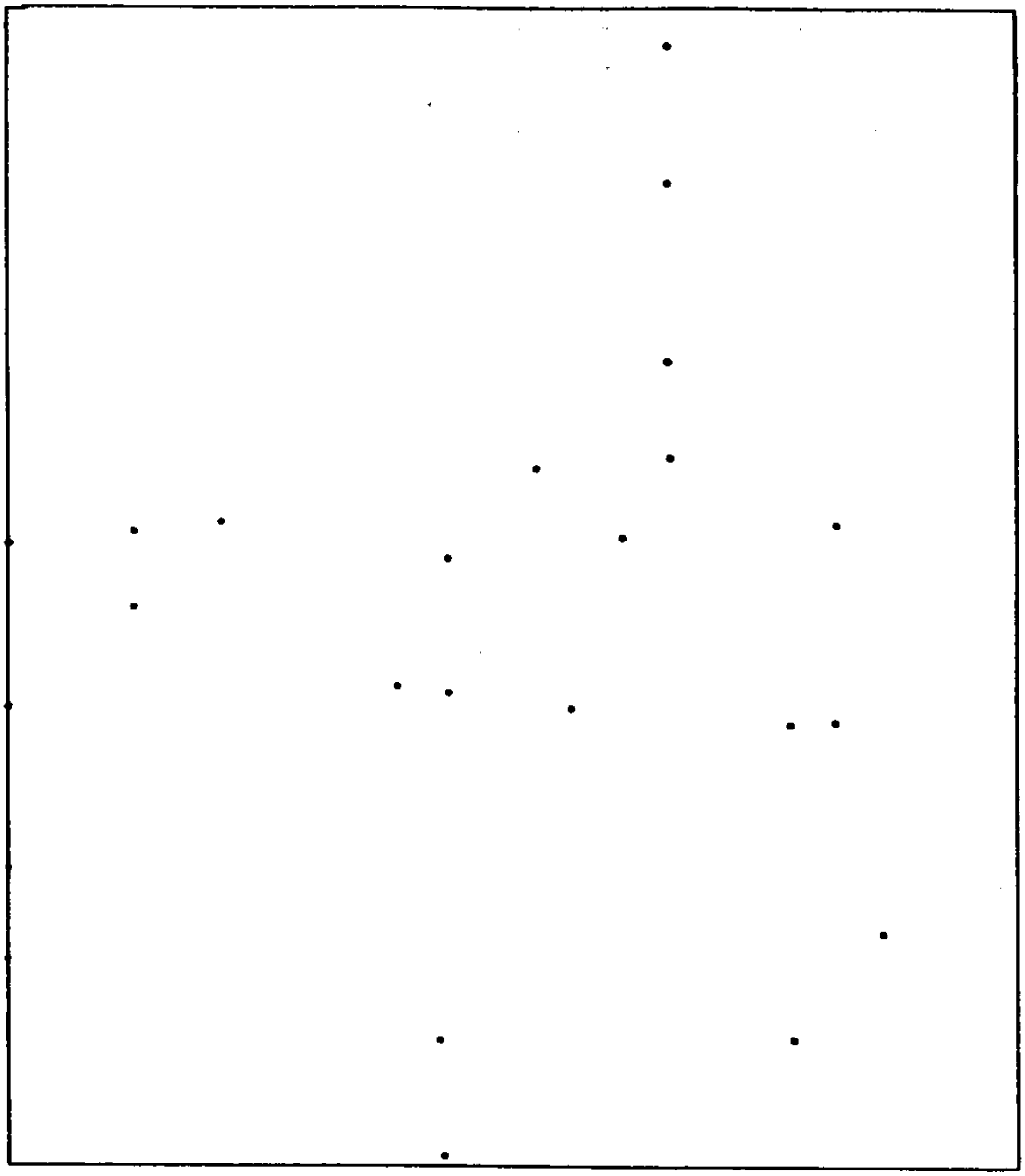

Figura 2:

Mapa de la distribución de los nidos de P. fallax.

Los nidos de ambas especies presentan formas muy diferentes. A primera vista los nidos de S. invicta aparecen como montículos sin aberturas aparentes. Este puede ser alargado, circular o irregular, (Tabla 1), presentando gran variabilidad.

La gran mayoría de los nidos de P. fallax presentaban forma de cueva pero fueron encontrados dos nidos en forma de montículo habitados por esta especie (Tabla. 8). Aparentemente estos nidos fueron abandonados por S. invicta, por lo cual existe la probabilidad de que S. invicta esté afectando la dispersión P. fallax.

Los nidos de S. invicta encontrados a lo largo de la zona periferal de una pieza de caña adulta estaban mayormente asociados al lado del banco (Tabla 3). La hormiga Paratrechina steinheili fue encontrada poblando 4 nidos localizados a los lados de los bancos. Aparentemente los nidos habían sido abandonados por S. invicta, por lo cual ésta parece estar afectando la dispersión de P. steinheili.

Hábitos alimenticios de S. invicta:

En horas de la mañana fue S. invicta encontrada atacando mayormente insectos adultos, anelidos y miriapodos. S. invicta fue encontrada atacando 33 escarabajos adultos, 31 de los cuales eran Phyllophaga spp. y al momento de ser atacados la gran mayoría de estos se encontraban vivos. También fue hallada atacando a D. abbreviatus muerto y a otro curculionido vivo.

Tabla 1. Características principales asociadas a los nidos activos de *S. invicta* en el predio experimental con caña de retoño.

Nido	Altura (cms)	Diámetro (cms)	Forma general	Asociado a
1	15.24	30.48	c[1]	cbc[4]
2	10.16	20.32	i[2]	cbc
3	17.78	22.82	i	cbc
4	7.62	12.70	a[3]	cbc
5	3.81	32.00	a	cbc
6	12.70	40.64	a	cbc
7	10.16	27.94	i	cbc
8	5.08	30.48	i	lb[5]
9	10.16	66.04	a	lb
10	17.78	60.96	a	cbc
11	10.16	20.32	c	lb
12	10.16	17.78	i	lb
13	2.54	30.48	i	cbc
14	28.0	69.85	a	cbc
15	7.62	27.94	i	cbc
16	4.13	12.70	c	cbc
17	9.00	24.13	a	cbc
18	7.62	60.96	c	cbc
19	7.62	76.20	a	cbc
20	26.67	91.44	a	cbc
21	12.70	43.18	c	cbc
22	20.32	106.68	a	cbc
23	20.32	60.96	a	cbc
24	20.32	50.80	i	lb
25	20.32	50.80	i	cbc
26	15.24	50.80	i	lb

Cont. Tabla 1:

Nido	Altura (cms)	Diámetro (cms)	Forma general	Asociado a
27	8.89	45.72	a	cb[6]
28	7.62	30.48	a	cb
29	20.32	40.64	a	cbc
30	10.16	20.32	c	cb
31	5.08	5.08	c	cb
32	7.62	30.48	i	cbc
33	5.08	38.10	i	cbc
34	12.70	25.40	c	cbc
35	7.62	30.48	c	cbc
36	20.32	55.88	c	cbc
37	10.16	20.32	c	cbc
38	6.00	38.00	i	lb
39	10.16	30.48	a	cbc
40	10.16	60.96	a	cbc
41	15.24	30.48	c	cb
42	7.62	30.48	c	lb
43	5.08	12.70	c	cbc
44	15.24	40.64	c	cbc
45	17.78	58.42	c	cbc
46	6.32	59.69	a	cbc
47	10.00	30.00	c	cbc
48	26.00	97.00	a	cbc
49	10.00	30.00	i	cbc

Cont. Tabla 1:

Nido	Altura (cms)	Diámetro (cms)	Forma general	Asociado
50	22.00	50.00	c	cbc
51	10.00	25.00	i	cbc
52	12.00	40.00	c	cbc

1. c = circular
2. i = irregular
3. a = alargado
4. cbc = centro del banco asociado a la cepa
5. lb = lado del banco
6. cb = centro banco

Tabla 2. Características principales asociadas a los nidos de *P. fallax* en el predio experimental con caña de retoño.

Nido	Forma general*	Grado de iluminación*	Asociado a*
1	c[1]	it[3]	lb[5]
2	c	it	lb
3	c	it	lb
4	c	it	cb[6]
5	c	sp[4]	lb
6	c	sp	cb
7	m.a.[2]	sp	cbc[7]
8	c	sp	lb
9	c	sp	lb
10	c	sp	lb
11	c	sp	lb
12	m.a.	sp	lb
13	c	sp	lb
14	c	sp	lb
15	c	sp	lb
16	c	sp	lb
17	c	sp	lb
18	c	sp	lb
19	c	sp	lb
20	c	sp	cb
21	c	sp	lb
22	c	sp	lb
23	c	sp	lb
24	c	sp	lb

1. c = cueva

2. m.a. = montículo alargado

3. it = iluminación total

4. sp = sombra parcial

5. lb = lado del banco

6. cb = centro del banco

7. cbc = centro banco asociado a la cepa

Tabla 3: Características principales asociadas a los nidos de *S. invicta* a lo largo de la zona periferal de una pieza de caña adulta.

Nido	Forma general	Asociado a	Especie de hormiga poblando el nido	Comentarios
1	i[1]	cbc[3]	S[5]	pocas hormigas
2	i	cbc	S	nido activo
3	a[2]	lb	S	pocas hormigas
4	i	lb[4]	S	presentes adultos y pupas. Hormigas no agresivas, movimiento rápido.
5	i	lb	P[6]	
6	i	lb	P	" "
7	i	lb	P	" "
8	i	lb	-	nido abandonado
9	a	cbc	S	
10	i	lb	S	
11	i	lb	S	
12	i	lb	P	presentes pupas y adultos

1. i = irregular
2. a = alargado
3. cbc = centro del banco asociado a caña
4. lb = lado del banco
5. S = *S. invicta*
6. P = *Paratrechina steinheili*

Tabla 5. Promedios de los datos obtenidos para *S. invicta* y *P. fallax* en el espacio experimental

Especie	Altura promedio	Diámetro promedio	Densidad promedio
S. invicta	12.02 cms	40.67 cms	0.0371 nidos/m^2
P. fallax	-	-	0.0171 nidos/m^2

Tabla 6. Porcientos de la posición relativa de los nidos de *S. invita* y *P. fallax* en el predio experimental con caña de retoño.

Especie	Nidos localizados centro del banco	Nidos localizados en el centro del banco y asociados a la cepa	Nidos localizados a los lados del banco
S. invicta	11.54%	77.81%	10.65%
P. fallax	12.50%	4.17%	83.33%

Tabla 7. Porcientos relativos de las diferentes formas de los nidos de *S. invicta* en el predio experimental con caña de retoño.

Circulares	Irregulares	Alargados
36.54%	28.84%	34.61%

Tabla 8. Porcientos relativos de diferentes formas de los nidos de *P. fallax* en el predio experimental con caña de retoño.

Cueva	Montículo alargado
83%	17%

Tabla 9. Grado de iluminación relativa a que se encontraban expuestos los nidos de *S. invicta* y *P. fallax* en el espacio experimental.

Especie	Iluminación total	Iluminación parcial
S. invicta	-	100%
P. fallax	16.7%	83.33%

Tabla 4. Materiales atacados o colectados por <u>S. invicta</u> en áreas cañeras pertenecientes a la Central Roig desde Julio hasta Agosto de 1983.

Clase de material	Número colectado	Lugar de hallazgo	Estado al momento de encontrados
Fragmentos no identificables	37	-	-
Fragmentos de insectos	29	s[3]	-
Anelidos	46	s	35v[5], 11m[6]
Miriapodos	31	s	26v, 5m
Changas (a[1])	33	s	t.m.[7]
Lepidopteros (a)	2	s	t.m.
Scarabaeidae (a)	3	s	24v, 9m
Dípteros (a)	4	s	t.m.
Homopteros (a)	14	s	-
Odonatos (a)	2	s	t.m.
Curculiónidos (a)	3	s	2m, 1v
Lepidóptera (l[2])	7	s + c[4]	5v, 2m
Coleópteros (l)	2	s	-
Arañas	2	s	t.m.

1. a = adulto
2. l = larva
3. s = suelo
4. c = cepa
5. v = vivos
6. m = muertos
7. tm = todos muertos

En una ocasión las hormigas atacaban un coccinélido. Varias larvas de lepidopteros fueron observadas atacadas por S. invicta en el follaje de la caña. En el suelo encontramos a S. invicta cargando con pequeñas larvas de coleopteros que aparentemente pertenecen a la familia Carabidae. Las larvas de lepidopteros parecen pertenecer a las familias Noctuidae y Hesperiidae.

Interacciones entre S. invicta y otras especies:

Obreros mayores de P. fallax eran continuamente atacados en las inmediaciones del nido por obreros de S. invicta siendo los primeros inmovilizados. La carnada de tuna localizada a corta distancia de la entrada del nido de P. fallax fue encontrada por ésta y rodeada por un gran número de obreros mayores protegiendo la misma de S. invicta. Finalmente P. fallax desmenuzó el pedazo de tuna logrando llevarlo al interior del nido. En ocasiones S. invicta llegó hasta la entrada del nido de P. fallax pero se retiró rápidamente.

Las carnadas de tuna localizadas en bancos parcialmente sombreados fueron descubiertas inicialmente por hormigas de la especie Brachymyrmex heeri, pero éstas fueron desplazadas por obreros de S. invicta pocos segundos despúes. B. heeri se mantuvo en los alrededores del área retornando al punto donde fue colocada la carnada cuando los obreros de S. invicta se alejaron finalmente. Las 2 carnadas colocadas en surcos totalmente iluminados fueron descubiertas por B. heeri a los pocos segundos de ser colocadas. S. invicta se percató de la presencia de la carnada a los 19 minutos y gran número de obreros procedieron a atacar la misma desplazando a B. heeri. Al crear sombra artificialmente sobre parte de la carnada, las hormigas se aglomeraban bajo el área sombreda y disminuían su velocidad de movimiento. Luego de desmenuzar la carnada los obreros de S. invicta se alejaron caminando a través de pequeños tuneles hasta llegar al banco. Las carnadas de tuna colocadas en las inmediaciones de un nido de S. invicta fue descubierta por esta misma.

Insectos plaga en caña y S. invicta:

Las larvas de D. abbreviatus fueron desenterradas por S. invicta y atacadas vorazmente procediendo luego a descuartizar las mismas.

En todas las cepas de caña asociadas a nidos de S. invicta se encontraban grandes cantidades de áfidos chupando en la superficie inferior de las hojas y querezas de la familia Pseudococcidae.

Aspectos adicionales

Los nidos a donde fueron observados los vuelos nupciales presentaban pequeñas perforaciones de aproximadamente 0.7 cm. Decenas de individuos alados subían a través de las hojas hasta llegar a la parte superior, desde donde emprendían vuelo. Observe hembras fecundadas en el suelo desprendiéndose la alas y procediendo a buscar lugar para esconderse. Una de estas fue atacada por obreros menores de S. invicta que se encontraban en el suelo. Algunas hormigas aladas fueron atrapadas en telas de araña al emprender el vuelo.

El contenido de los cementerios de S. invicta fue el siguiente:

a) Gran cantidad de obreros de S. invicta de menor tamaño y en menor cantidad de hembras con las alas desprendidas.

b) Trabajadores mayores de P. fallax en menor cantidad.

c) Elitros de D. abbreviatus y de coccinélidos en menor cantidad.

d) Gran cantidad de elitros de otros coleópteros y una cantidad menor de alas membranosas.

e) Hormigas pertenecientes al género Odontomachus y un gran número de partes de insectos.

f) Algunas arañas.

La mayoría de los nidos destruídos tenían una profundidad aproximada de 40 cms y todos contenían individuos alados por lo que podemos asumir que eran nidos establecidos hace algún tiempo.

Nido de *S. invicta* asociado a caña adulta.

Nido típico de *P. fallax*.

Vista parcial la escavación de un nido de S. invicta asociado a la cepa.

Nido de S. invicta asociado a malezas.

Hormigas forrajeras _S. invicta_ atacando a _Phyllophaga spp_ sobre el suelo.

Hormigas forrajeras atacando un gusano de tierra.

Hormigas forrajeras S. invicta atacando una larva en el follaje de la caña.

Hormigas aladas de *S. invicta* en proceso de esconderse en el suelo luego de ser removidas drásticamente del nido.

Perforaciones encontradas sobre nidos *S. invicta* poco antes de un vuelo nupcial.

Caminos construídos por *S. invicta* debajo de pedazos de caña caída en los surcos.

Cementerio de *S. invicta* en un surco.

Hembras de S. invicta listas para emprender el vuelo nupcial.

CONCLUSION

La hormiga brasileña S. invicta se encuentra ampliamente diseminada en los terrenos de caña pertenecientes a la Central Roig. En el espacio experimental S. invicta mostró preferencia por anidar en bancos de tierra construyendo el nido alrededor de la cepa de caña. S. invicta muestra una densidad poblacional mayor que P. fallax y esta segunda anida mayormente en los lados de los bancos. Ambas especies se encuentran interaccionando continuamente y S. invicta se muestra agresiva hacia P. fallax. Durante horas del día gran cantidad de obreros de S. invicta se encuentran en búsqueda de alimento sobre el suelo haciendo presa de material animal mayormente y compitiendo ventajosamente con otras especies de hormigas presentes en el suelo. B. heeri es continuamente desplazada por S. invicta; P. steinheili y P. fallax pueden encontrarse colonizando nidos aparentemente abandonados por S. invicta por lo cual ésta puede estar afectando positivamente la diseminación de las dos especies. La gran cantidad de áfidos cuidados por la hormiga pueden tener un efecto negativo sobre el rendimiento de la caña.

RECOMENDACIONES

1. Realizar un estudio detallado sobre los posibles factores que afectan la distribución espacial de *S. invicta* zonas cañeras.
2. Realizar estudios profundos de las poblaciones de hormigas siendo afectadas por *S. invicta*.
3. Realizar estudios para determinar si existe correlación entre la presencia de *S. invicta* en caña y rendimiento obtenido.
4. Realizar un estudio más detallado sobre los hábitos alimenticios de *S. invicta* en zonas cañeras y determinar el grado en que ésta interacciona con los insectos plaga de la caña.

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Update on mating flight studies, 1991-1992

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This project is a cooperative effort by the USDA, ARS, J.L. Knapp, Citrus REC, IFAS, UF, Lake Alfred, and R.H. Cherry, Everglades REC, IFAS, UF, Belle Glade, FL. Flight traps were placed over 10 red imported fire ant mounds in Belle Glade, Lake Alfred, and Gainesville, Florida. All of the mounds monitored were located within the same acre and were occupied by single-queen colonies.

A trap, consisting of a wire frame, screen cone, cake pan, plastic dome, tiedown, and fluid preservative, was placed over a fire ant mound with a minimum of disturbance. The traps were emptied weekly, and the number and sex of the alate fire ants determined. When a colony moved from under the trap, the trap was moved to the new mound.

The traps were monitored from January 1991 to March 1992 (Fig. 1, 2, 3). Seasonal flight patterns were basically similar, which was contrary to expectations. Flights in Belle Glade were predicted to be uniform over the entire year.

The sex ratio of the mounds sampled was highly skewed to male production with Belle Glade, Lake Alfred, and Gainesville yielding 97.1%, 86.4%, and 84.4% total males, respectively. This predominance of male production is unlike any sex ratios previously reported for RIFA. The variations in sex-ratio shown by individual mounds in this study are consistent with previous studies. The sampling will be continued through January 1993 to obtain 2-full years samples.

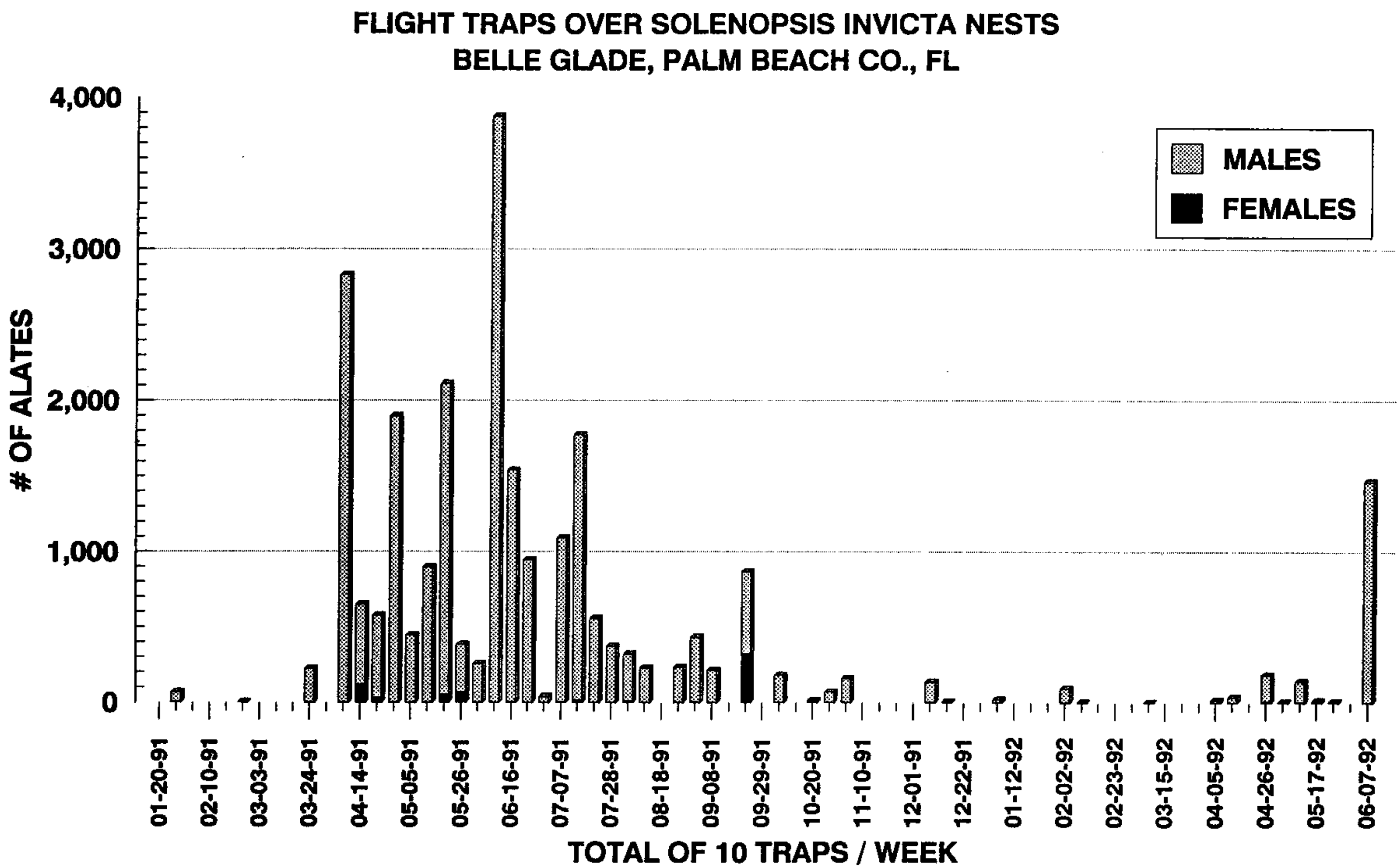

Figure 1. Total numbers of red imported fire ant alates captured in 10 traps from Belle Glade during each sample period.

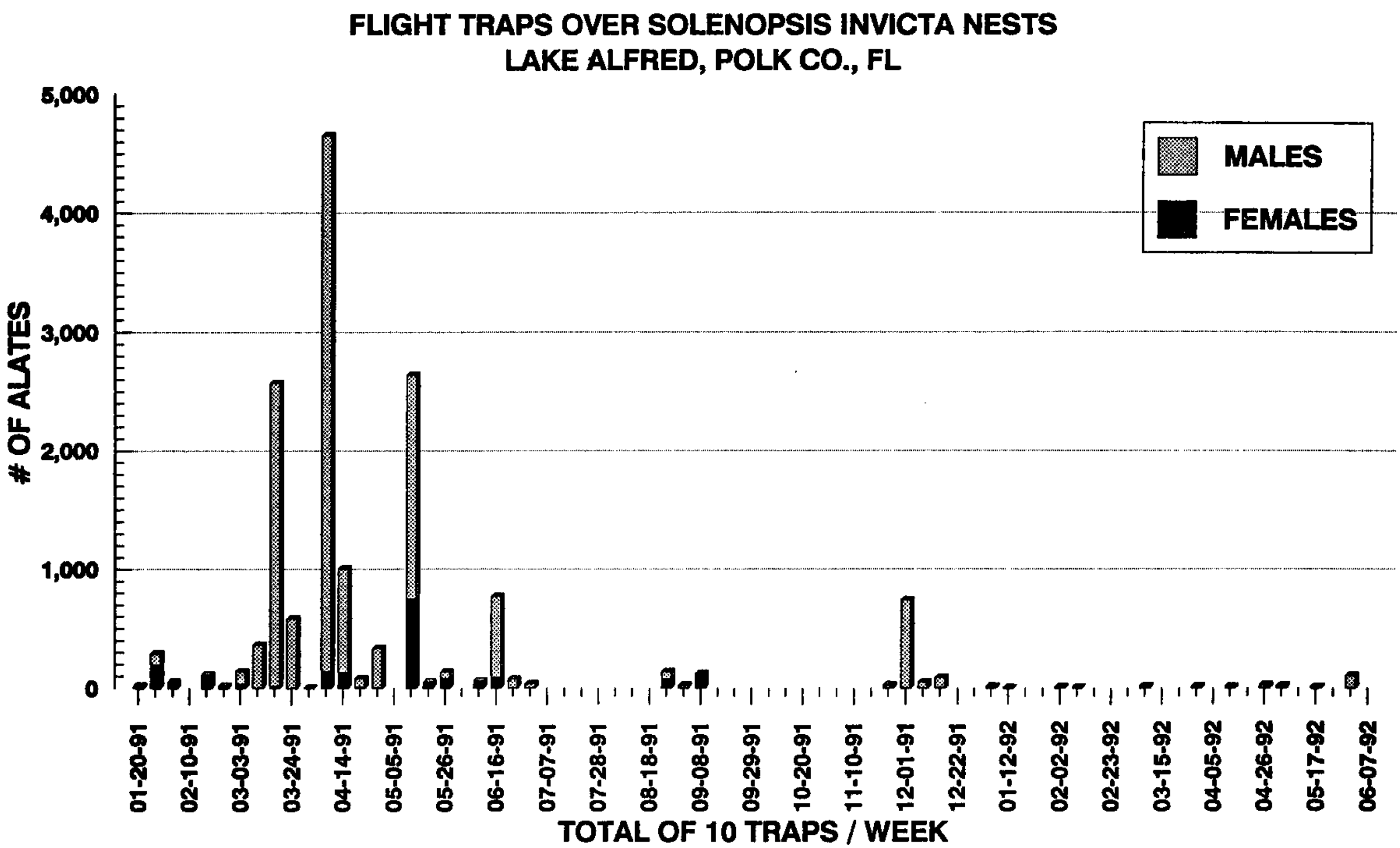

Figure 2. Total numbers of red imported fire ant alates captured in 10 traps from Lake Alfred during each sample period.

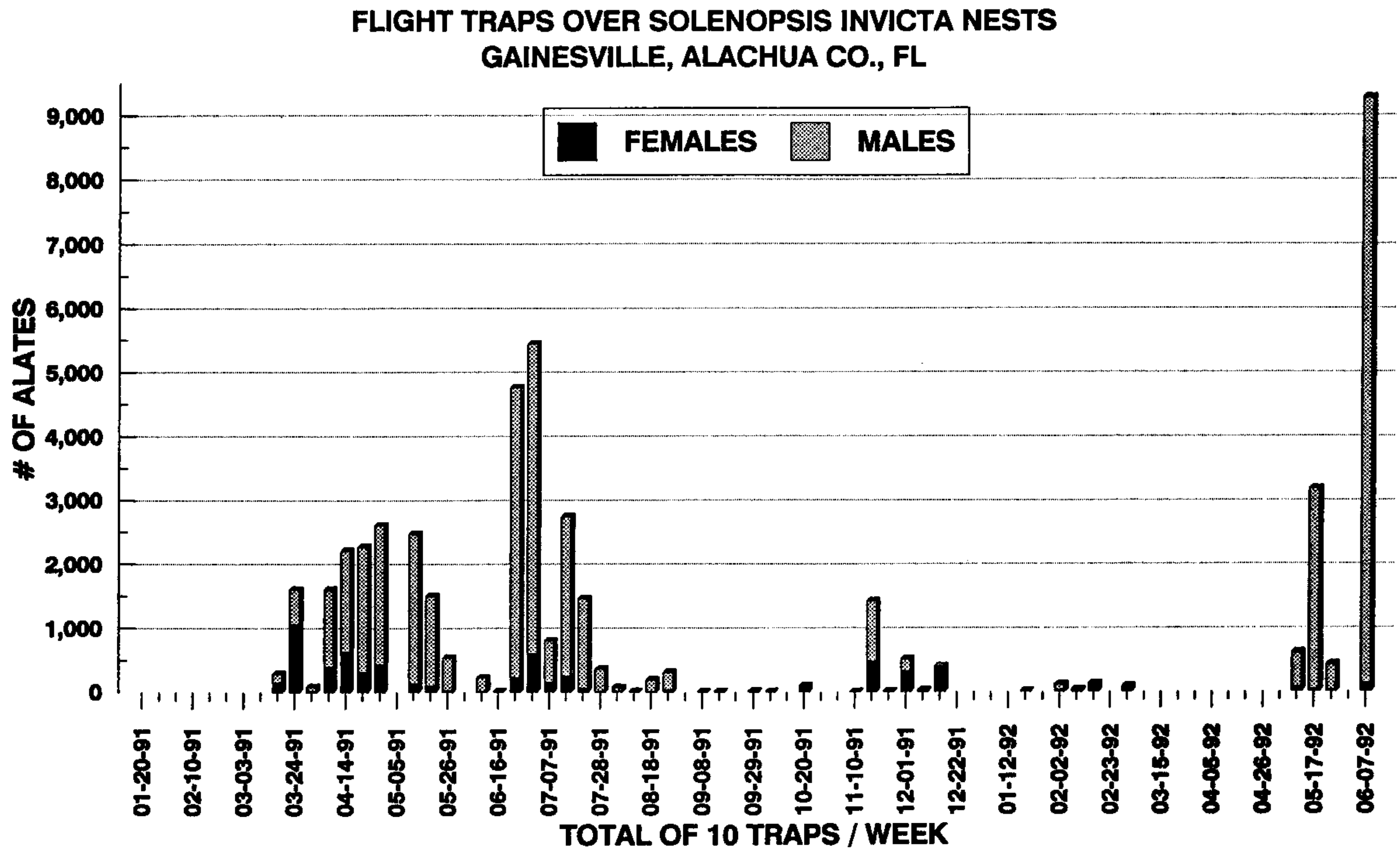

Figure 3. Total numbers of red imported fire ant alates captured in 10 traps from Gainesville during each sample period.

THE EFFECTS ON NON-TARGET ANTS OF PRE- & POST-MATING FLIGHT TOXICANT APPLICATIONS FOR FIRE ANT CONTROL.[1]

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Area-wide treatment for fire ants has usually been applied before the primary mating flight episodes in the spring. Initially it was considered necessary to treat the mounds before the alates flew in the spring mating flights. Delaying the treatments until after the spring mating flights would allow the fire ants and nontarget ants to kill newly-mated queens in their foraging territories. The delayed treatments should also allow nontarget ants to conduct mating flights.

Three registered insecticides were applied for control of imported fire ants on a ranch in Alachua County, Florida before and after mating flights. Amdro and Logic baits were applied as a broadcast treatment using a tractor-mounted applicator at the label-recommended rate of 1.7 kg bait/ha (1 lb/acre). The dursban (Cessco[R] instant Fire Ant Control) was applied by hand directly into the fire ant mounds using the probe supplied with the container at the label-recommended rate. All blocks were treated according to the schedule shown in Table 1. Each block was 0.7 to 1.1-ha (1.8 to 2.6 acres). Woods and paved roads provided a physical barrier on 3 sides of the treatment blocks. An untreated check block was set up along the western boundary of the treatment blocks.

Evaluation was made by examination of all colonies within 3 circular subplots established in each treatment block. The circular plots had a radius of 17.8 m (58 ft 6 inches) yielding a 0.1 ha (1/4 acre) plot. The plots were checked by 2 or more persons moving along with a measuring tape, opening each fire ant mound with a shovel, and examining the colony for worker ant brood. The number of ants in the mound was estimated in the field and the population index calculated (Banks et al. 1988). Pretreatment counts and posttreatment counts were made at the weekly intervals shown in Table 1.

Both baits gave the initial expected levels of control of fire ant populations as measured by nest index and mound counts. The Logic after-mating flights gave the longest lasting control as measured by reductions in population index and mound counts (Fig. 1 & 2).

[1] This article represents the results of research only. Mention of a proprietary product does not constitute an endorsement or recommendation for its use by the USDA.

The effects of the treatments on non-target ants were monitored with pitfall traps. Each trap consisted of a 12.8 cm length sleeve (5 inch) of 7.5 cm diameter (3-inch) PVC pipe, a plastic 414 ml (14-oz) beverage cup, approximately 350 ml (12-oz) of preservative (1/4-ethylene glycol, 1/4-water, 1/2-isopropanol), and a rain-cover (23 cm (9-inch) square of plywood with a nail in each corner). The traps were filled with preservative and left open for 1 week. The contents of the traps were removed and the ants were separated, identified, and counted.

The pitfall traps were placed groups of 40 (10 to a row, 4 rows) in the approximate center of the treatment block. Pretreatment counts and posttreatment counts were made at the weekly intervals shown in Table 1.

The 24 species of ants in 17 genera collected in the pitfall traps are shown in Table 2. Non-target ants were not adversely affected (Fig. 3, 4, 5, 6, 7, 8, 9) by 41-30 weeks post-treatment. By 41-30 weeks posttreatment, fire ant populations, as monitored by pitfall traps, had not returned to pretreatment levels in spite of the increases shown with the fire ant population index or mound counts. The test will be monitored for at least another year.

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Table 1. Dates of treatments, plot evaluations, and pitfall collection dates.

DATE	TIME IN WEEKS	
	PREFLIGHT	POSTFLIGHT
15-22 March 1991	pretreatment	pretreatment1
25 March	treated	--
21-28 May	8	pretreatment2
12 June	--	treated
22-29 July	17	6
16-23 Sept	25	14
12-20 Nov	33	22
6-13 Jan 1992	41	30
2-9 March	49	38
27 April-3 May	57	46
22-29 June	65	54
17-24 Aug	73	62
13-20 Oct	81	70
8-15 Dec	89	78
1-8 Feb 1993	97	86
29 March-5 April	105	94
25 May-1 June	113	102
19-26 July	121	110

Table 2. Total number of specimens for each species of ant collected by pitfall traps to date.

SPECIES	TOTAL SPECIMENS COLLECTED	PERCENT
Aphaenogaster ashmeadi (Emery)	11	0.06
Aphaenogaster near rudis	197	1.14
Brachymyrmex depilis (Forel)	7	0.04
Camponotus floridanus (Buckley)	715	4.15
Cardiocondyla emeryi Forel	89	0.52
Conomyrma bureni Trager	62	0.36
Crematogaster clara Mayr	5	0.03
Cyphomyrmex rimosus (Spinola)	2081	12.07
Hypoponera opaciceps (Mayr)	249	1.44
Odontomachus brunneus (Wheeler)	583	3.38
Paratrechina faisonensis (Forel)	40	0.23
Paratrechina vividula (Nylander)	2	0.01
Pheidole dentata Mayr	2793	16.19
Pheidole metallescens Emery	102	0.59
Pheidole moerens Wheeler	184	1.07
Pheidole morrisi Forel	9	0.05
Prenolepis imparis (Say)	17	0.10
Pseudomyrmex brunneus	15	0.09
Solenopsis geminata (F.)	2427	14.07
Solenopsis invicta Buren	7304	42.35
Solenopsis (Diplorhoptrum) sp.	241	1.40
Strumigenys louisianae Roger	54	0.31
Tetramorium simillimum (F.Smith)	32	0.19
Trachymyrmex septentrionalis (McCook)	24	0.14
TOTAL ANTS	17247	102.46
TOTAL NON-TARGET ANTS	9943	57.65

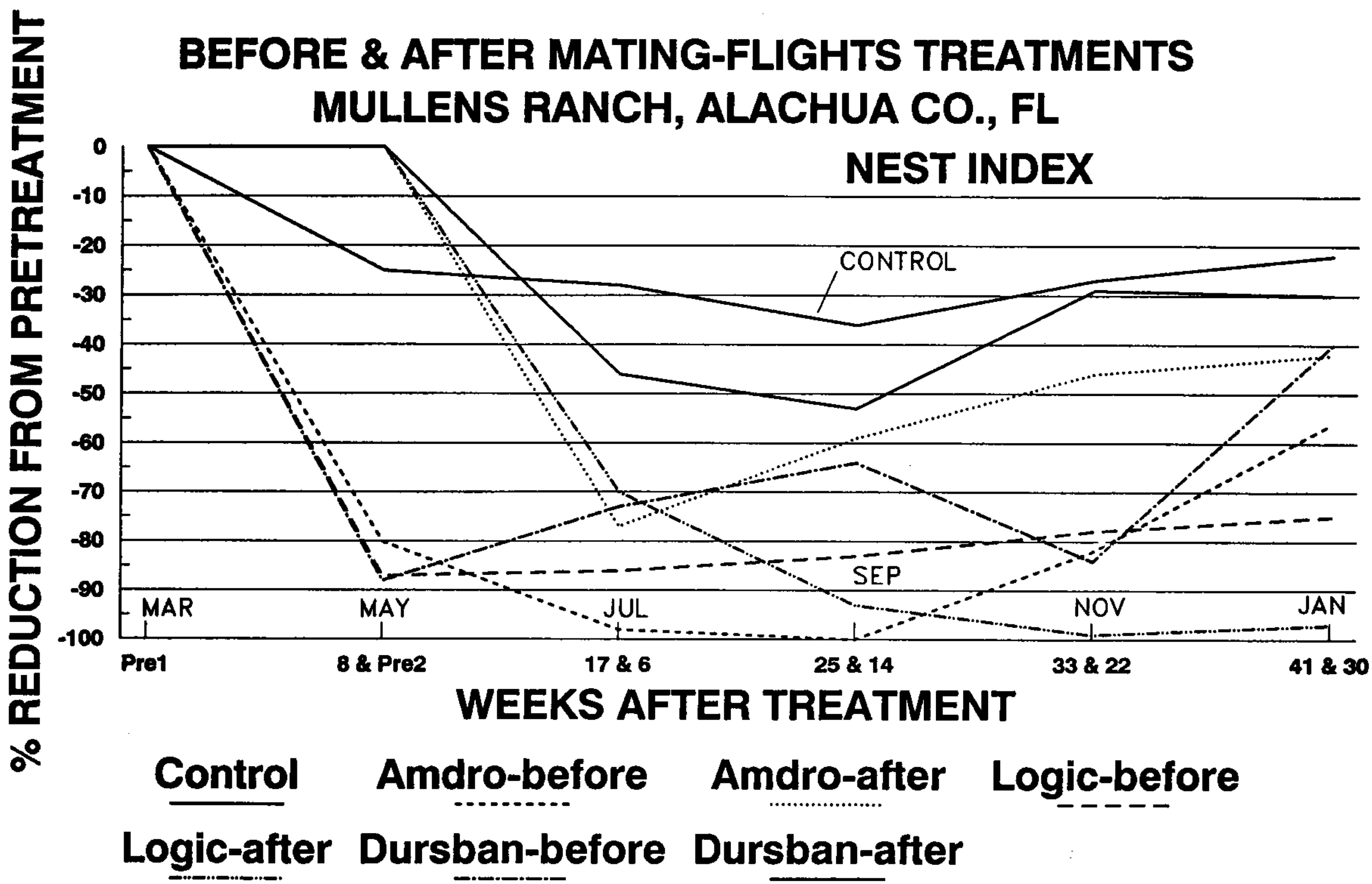

Figure 1. Percent reduction from pretreatment in population index of Red Imported fire ant (Solenopsis invicta) with before- and after-RIFA mating flights treatment with Amdro, Logic, or dursban.

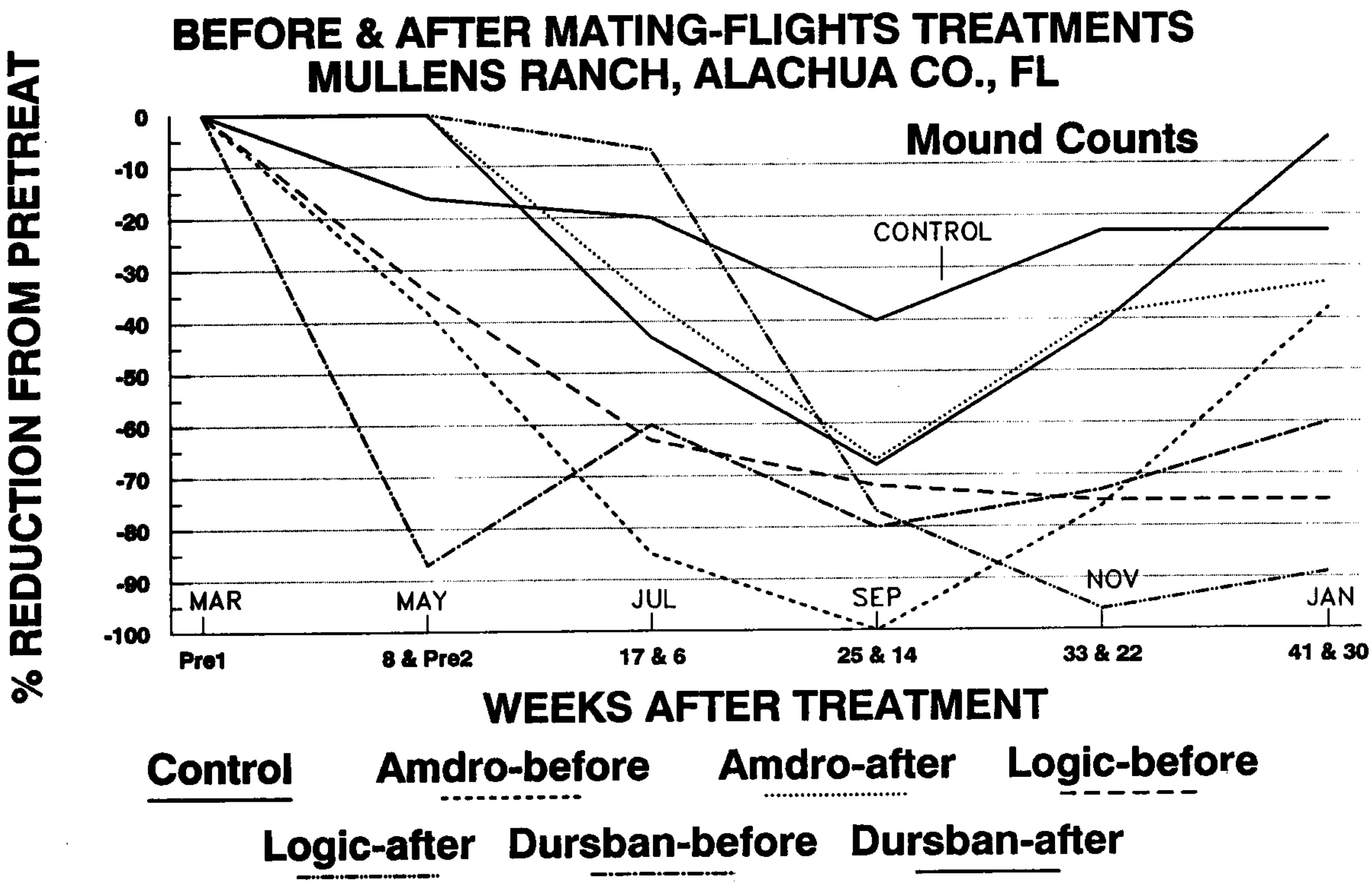

Figure 2. Percent reduction from pretreatment in mound counts of Red Imported fire ant (*Solenopsis invicta*) with before- or after-RIFA mating flights treatment with Amdro, Logic, or dursban.

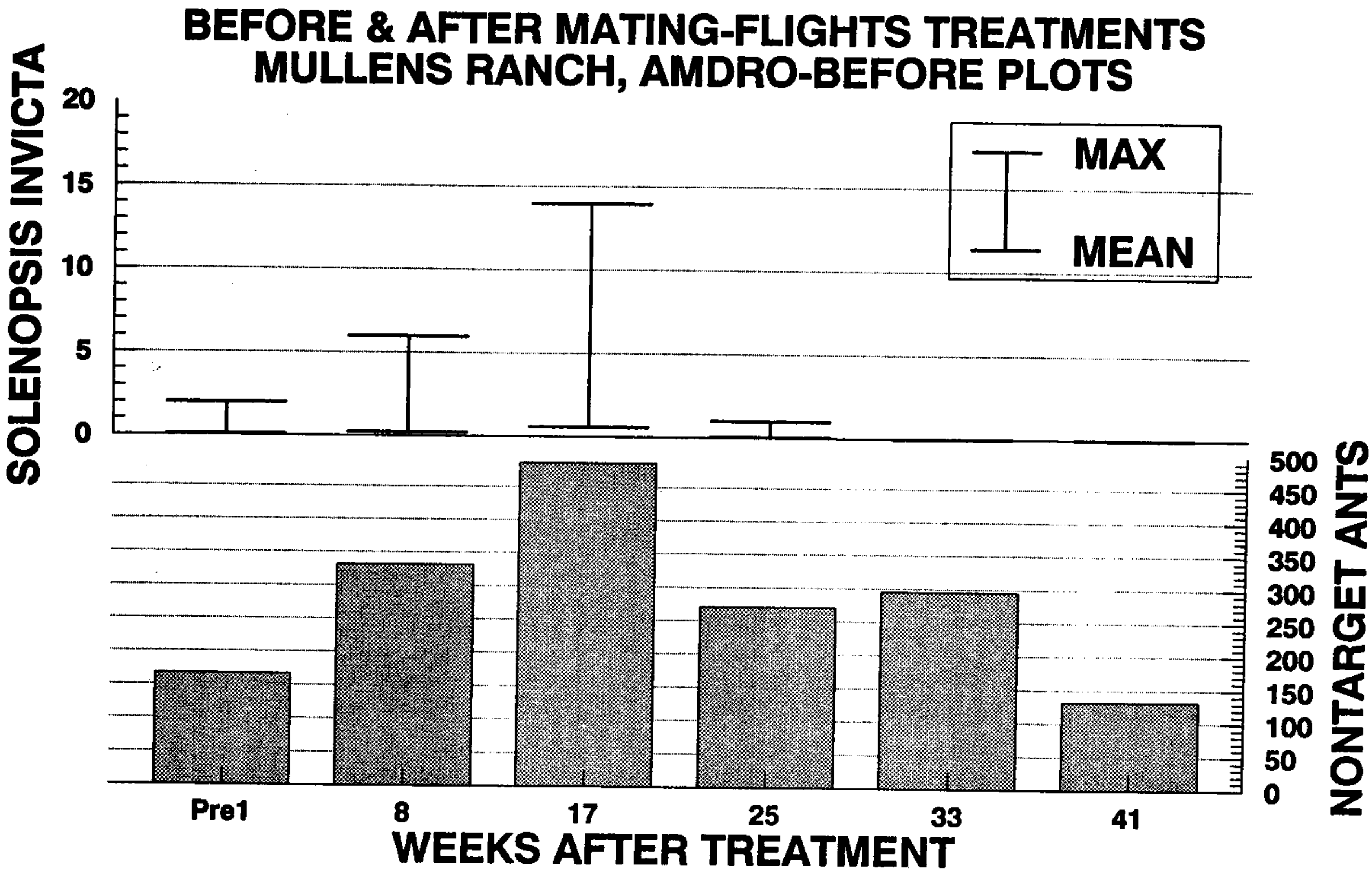

Figure 3. Numbers of RIFA and non-target ants collected in pitfall traps after treatment with Amdro before-mating flights.

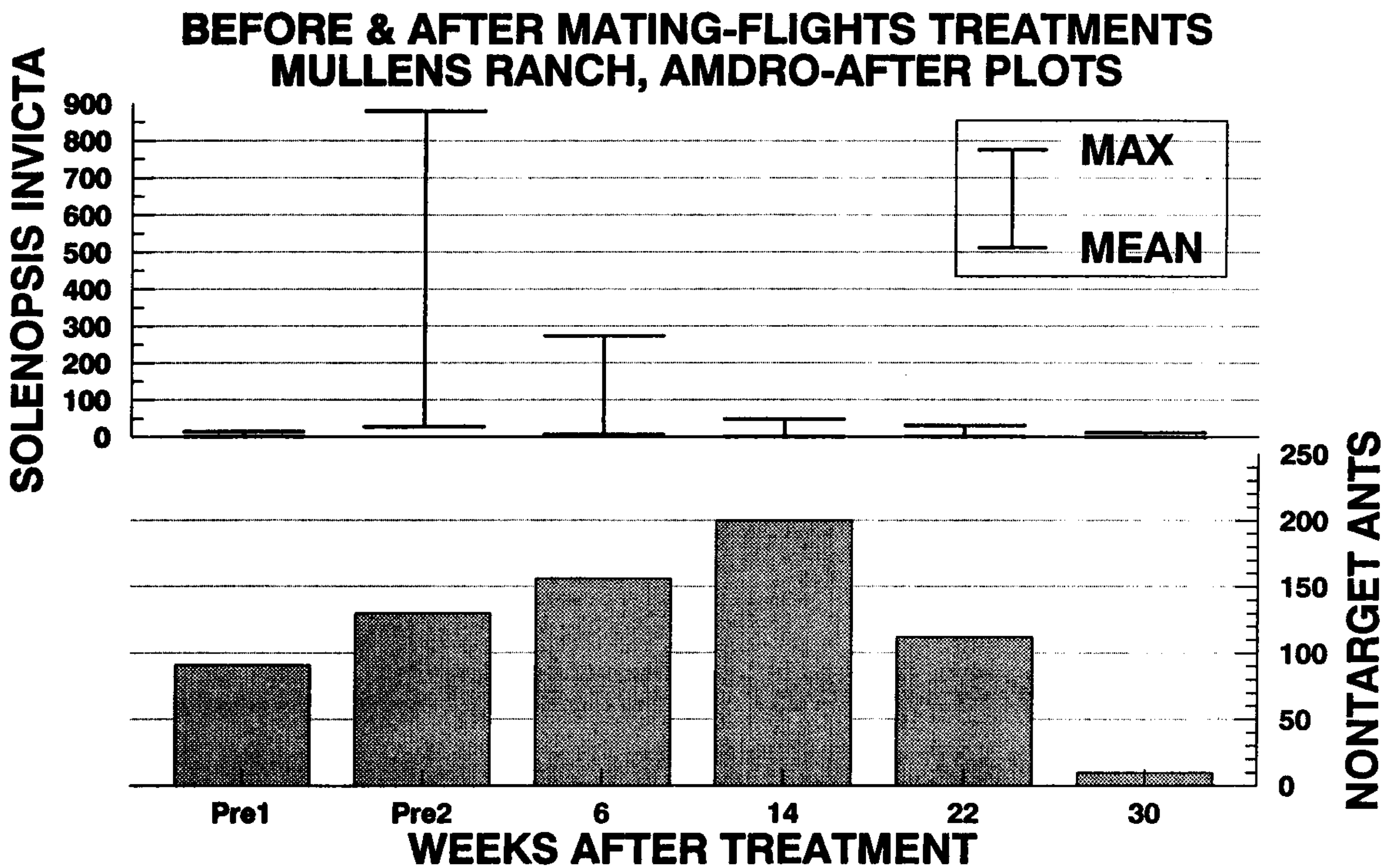

Figure 4. Numbers of RIFA and non-target ants collected in pitfall traps after treatment with Amdro after-mating flights.

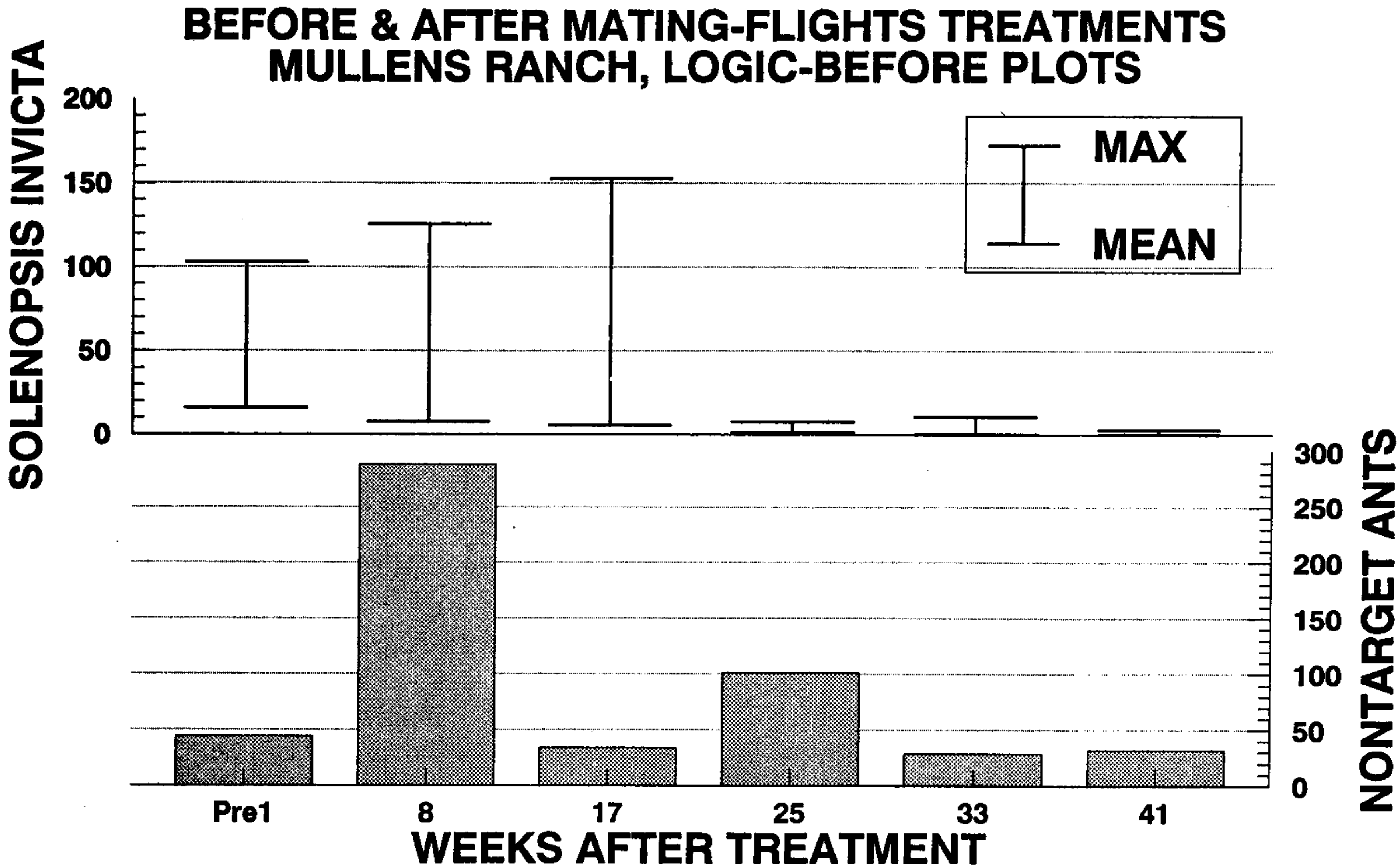

Figure 5. Numbers of RIFA and non-target ants collected in pitfall traps after treatment with Logic before-mating flights.

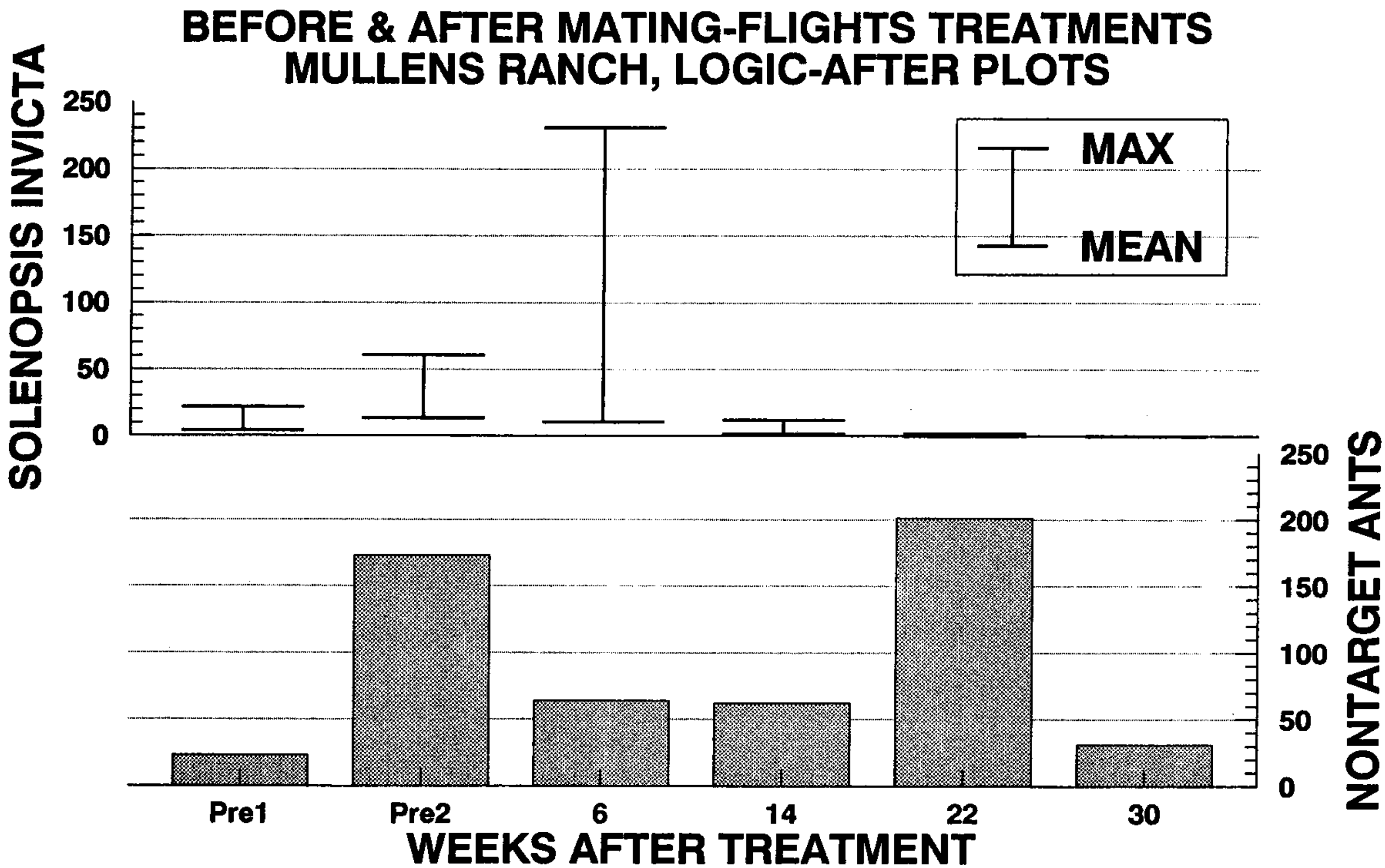

Figure 6. Numbers of RIFA and non-target ants collected in pitfall traps after treatment with Logic after-mating flights.

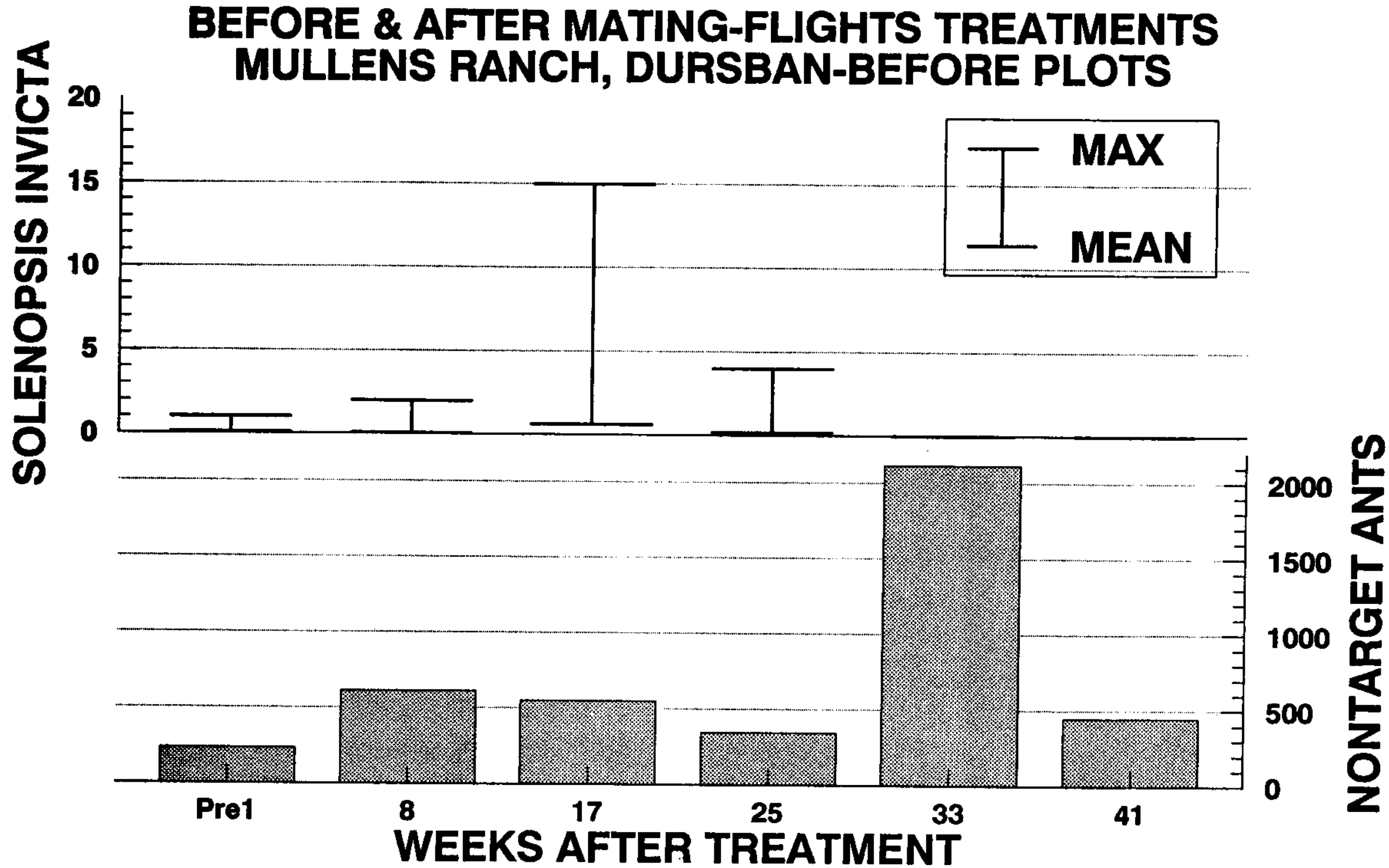

Figure 7. Numbers of RIFA and non-target ants collected in pitfall traps after treatment with dursban before-mating flights.

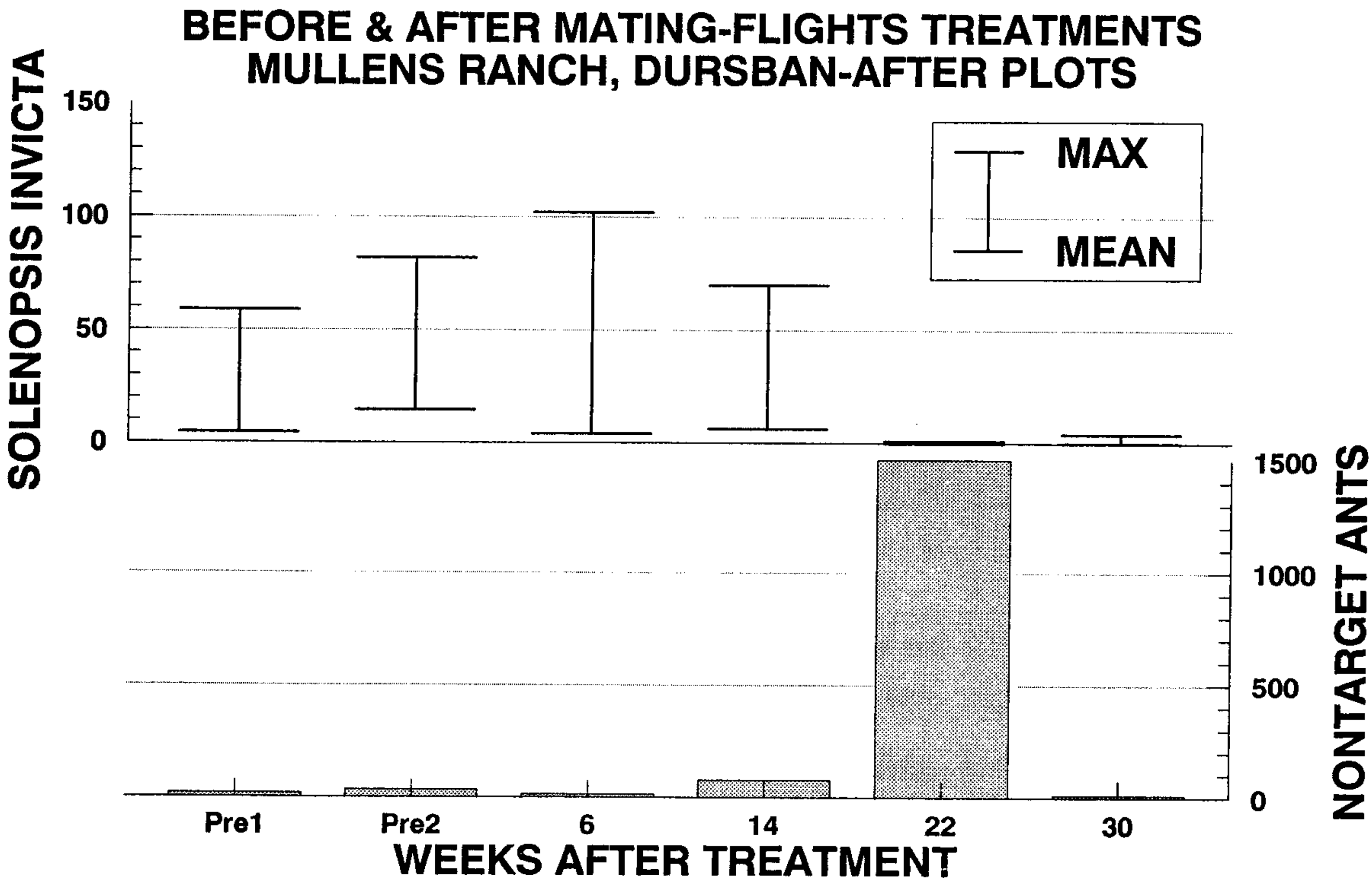

Figure 8. Numbers of RIFA and non-target ants collected in pitfall traps after treatment with dursban after-mating flights.

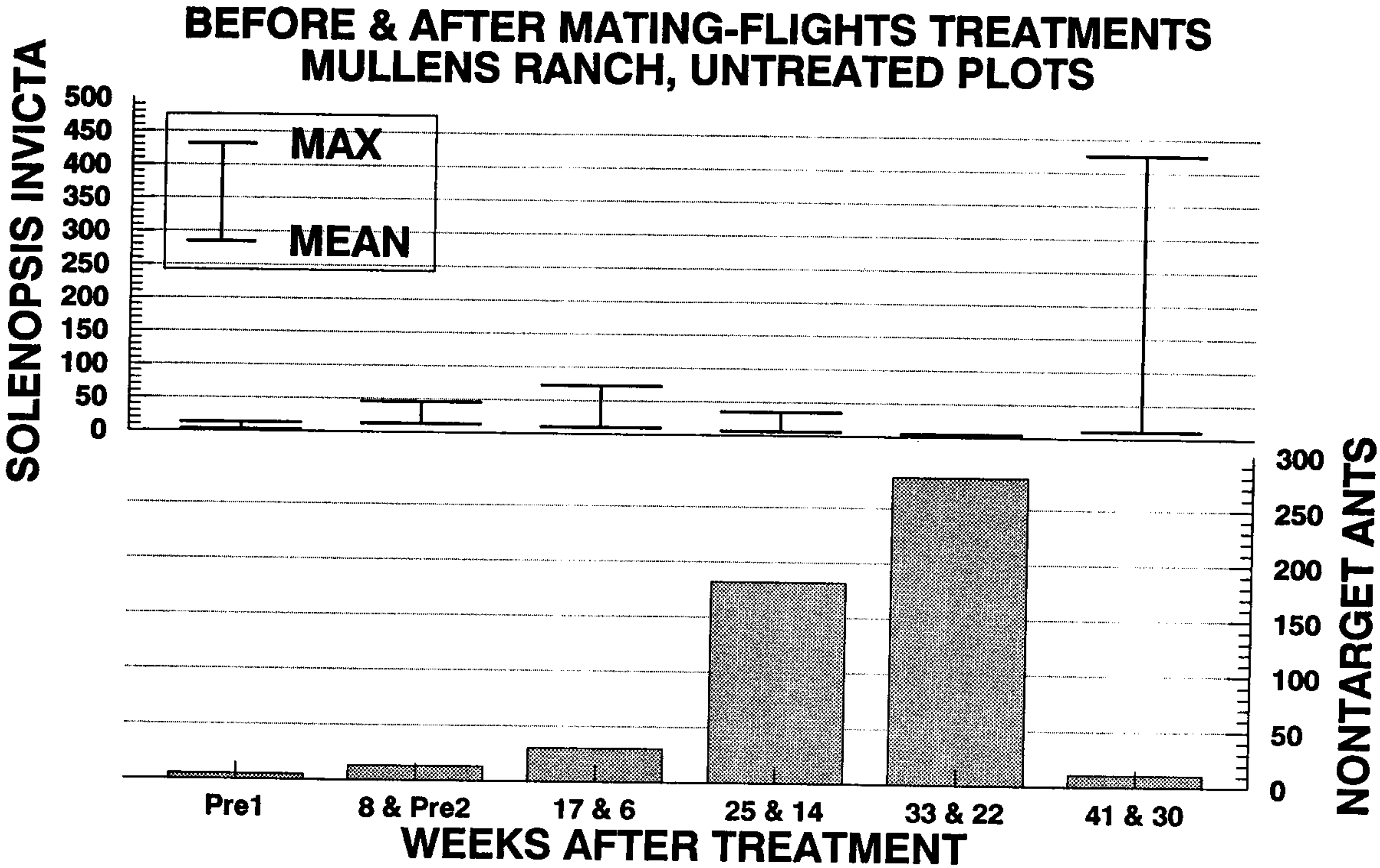

Figure 9. Numbers of RIFA and non-target ants collected in pitfall traps from the untreated block.

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