Imported Fire Ants: Eradication Trials with Mirex Bait[1,2]

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ABSTRACT

Large-scale trials were conducted to evaluate mirex bait for eradication of imported fire ants. Two sites in Georgia-South Carolina and Florida infested with the red imported fire ant, *Solenopsis invicta* Buren, and a 3rd site in Mississippi, infested with the black imported fire ant, *S. richteri* Forel, were used as test areas. Three applications of bait at 1¼–2½ lb/acre eliminated all pretreatment colonies except in 2 instances. One surviving colony was found in a large assembly building in the city of Savannah, Georgia, and several colonies were found in the Florida test area near television transmission antennae that had interfered with electronic guidance signals for application aircraft. Aside from the colony in the assembly plant, no colonies, incipient or mature, were found in the central portion of the Savannah test area during the 2 years of posttreatment surveys. Incipient colonies were found 3–6 months after the 3rd application of bait on the periphery of the Savannah and Florida areas and throughout the Mississippi area. It was impossible to determine with certainty whether these incipient colonies had arisen from flights from colonies within or from outside the trial areas. However, the patterns of reinfestation definitely suggested that they resulted from mating flights originating in colonies outside the areas. These data offer the 1st proof that queens can disperse up to 12 miles during nuptial flights.

The results demonstrated a very high degree of effectiveness of mirex bait but did not conclusively prove that it can be used to eradicate the red and black imported fire ants. Nevertheless, these were the first fullscale attempts to totally eliminate ants from given areas. Since no insurmountable technical problems were detected, total elimination from large isolated areas may be technically feasible.

Lofgren et al. (1961, 1962, 1963, 1964) and Stringer et al. (1964) reported that a single application of mirex bait consistently gave reductions of 90–100% in the number of active colonies of imported fire ants (IFA) (previously listed in the literature as *Solenopsis saevissima richteri* Forel, now known as 2 species, the red imported fire ant, *S. invicta* Buren, and the black imported fire ant *S. richteri* Forel, (Buren 1972)) on small plots and in larger blocks treated by aerial application. This bait, which consists of corncob grits, once-refined soybean oil, and mirex, was developed in 1960–61 in the Methods Improvement Laboratory of the Plant Protection and Quarantine Programs, Animal and Plant Health Inspection Service, USDA, Gulfport, Miss., by the aforementioned authors. In 1962, the mirex bait replaced heptachlor as the standard control agent for imported fire ants and since has been applied to several million acres in the infested States by the USDA and the cooperating State agencies. Control of the ants has been excellent in every usage. However, since in many cases only a single application was made or timing of multiple applications was incorrect, the areas quickly became reinfested.

The Agricultural Appropriations Subcommittee of the U.S. Senate in 1967 requested that the USDA determine whether fire ants could be eradicated with mirex bait. Cooperative tests were begun in the fall of 1967 between the USDA and the States of Georgia, South Carolina, Florida, and Mississippi to determine whether eradication was possible in selected areas. This paper reports the results of these tests.

Methods and Materials.—The test areas were chosen to represent a variety of ecological and environmental conditions. The 1st area surrounding Savannah, Ga., was a coastal site with average annual rainfall of ca. 46 in. and average January temp of 50–52°F. Here the ants have a seasonal reproductive cycle, thus, production of workers and sexuals ceases during the colder months. The 2nd area, in central Florida near Tampa and St. Petersburg, is semitropical, has 50–55 in. of rainfall annually and has temperatures high enough that workers and sexuals are produced the year around. The 3rd area, in northeastern Mississippi, is inland, has moderate rainfall (47–52 in. annually), and winter temperatures of 46–47°F (January average) with many days of subfreezing temperatures. Reproduction in this area is also seasonal. The Savannah infestation was isolated from other heavily infested areas, while the other 2 areas were adjacent to high-density infestations that remained untreated throughout the test. The Georgia and Florida test areas were infested with the red imported fire ant, while the Mississippi area was infested with the black imported fire ant.

Our surveys of the areas after the 1st application showed only a few surviving healthy colonies. This fact, coupled with our knowledge of the biology of the ant, indicated that a minimum of 3 applications would be required to eradicate the ants. Lofgren and Weidhaas (1972) showed in a theoretical appraisal that eradication could require from 3 to 9 applications, depending on the efficacy of a given application of bait, but in these tests we used the minimum number of applications they suggested. Mirex Granulated Bait 4X® was used: this formulation consists of 85% corncob grits, 14.7% soybean oil, and 0.3% mirex.

The test areas were subdivided into 2 or 3 blocks so we could evaluate different rates of application as follows.

Savannah.—The bait was applied to the Savannah test area in September–November 1967, April–May 1968, and September–October 1968. The test area (Fig. 1) contained ca. 2,131,244 acres and included all or portions of 7 counties in Georgia and 3 in South Carolina. The area was divided into 3 blocks with the following acreage and rates of application.

(A) 266,240 acres—2.5 lb/acre for each of the first 2 applications and 1.25 lb/acre for the 3rd.

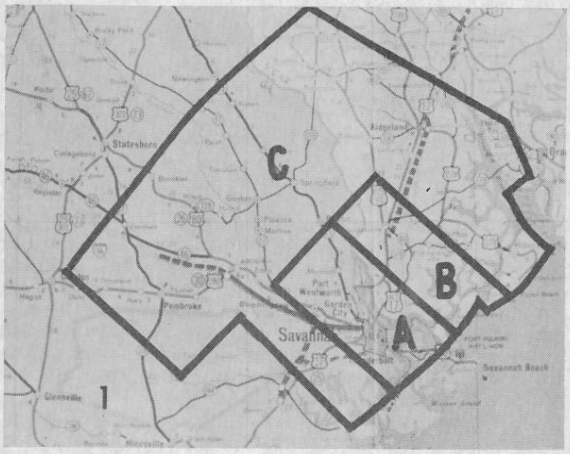
(B) 183,040 acres—2.5 lb/acre for the 1st application and 1.25 lb/acre for each of the last 2.

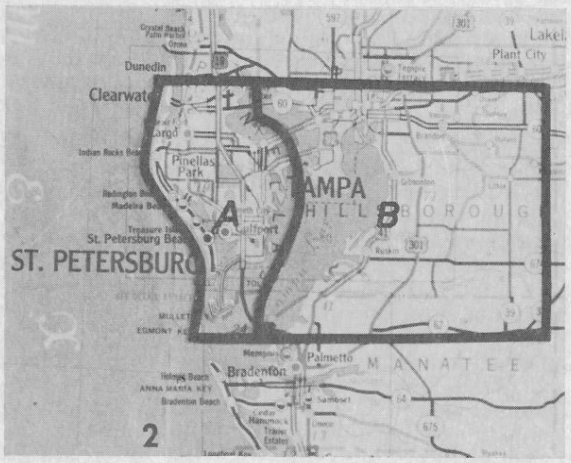
(C) 1,681,964 acres—1.25 lb/acre for each of the 3 applications.

Tampa–St. Petersburg.—The bait was applied to the Florida areas in September–October 1968, January–February 1969, and May–June 1969. (The interval between treatments in this area was shorter than in the

[1] Hymenoptera: Formicidae.

[2] This paper reflects the results of research only. Mention of a pesticide commercial or proprietary product does not constitute recommendation or endorsement by the USDA. Received for publication Dec. 13, 1972.





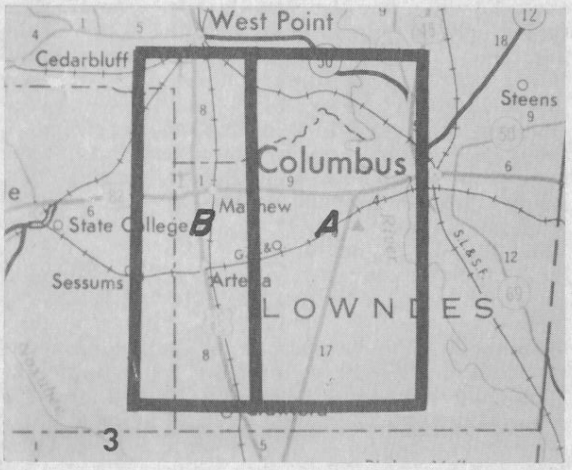


FIG. 1.—Savannah eradication test area. Treated with 0.3% mirex bait as follows: A, 2 applications at 2.5 lb/acre, 1 at 1.25 lb/acre; B, 1 application at 2.5 lb/acre, 2 at 1.25 lb/acre; C, 3 applications at 1.25 lb/acre.

FIG. 2.—Tampa–St. Petersburg eradication test area. Treated with 0.3% mirex bait as follows: A, 1 application at 2.5 lb/acre, 2 at 1.25 lb/acre; B, 3 applications at 1.25 lb/acre.

FIG. 3.—Northeastern Mississippi eradication test area. Treated with 0.3% mirex bait as follows: A, 2 applications at 2.5 lb/acre, 1 at 1.25 lb/acre; B, 3 applications at 1.25 lb/acre.

other 2 areas because of accelerated development of the imported fire ants in the warmer climate.) This test area (Fig. 2) contained ca. 626,808 acres in portions of 3 counties in central Florida. The area was divided into 2 blocks with the following acreage and rates of application.

(A) 133,175 acres—2.5 lb/acre for the 1st application and 1.25 lb/acre for each of the last 2 applications.

(B) 493,633 acres—1.25 lb/acre for each of the 3 applications.

Northeastern Mississippi.—The bait was applied to the Mississippi area in October 1968, April–May 1969, and September–October 1969. The test area (Fig. 3) contained ca. 256,000 acres in portions of 3 counties. This area was also divided into 2 blocks with the following acreage and rates of application.

(A) 153,600 acres—2.5 lb/acre for each of the first 2 applications and 1.25 lb/acre for the 3rd.

(B) 102,400 acres—1.25 lb/acre for each of the 3 applications.

Procedures.—All applications of the bait were supervised by USDA personnel and were made by commercial aerial applicators flying multiengine aircraft. The aircraft, Lockheed PV-1's and PV-2's and Boeing B-17's dispersed the bait through modified Transland Swathmasters, by air-thrust through fuselage and wing-tip tubes, or by continuous chain conveyers with outlets in the aircraft wing. All the aircraft, regardless of dispersal system, produced a similar swath with the overall width ranging from 190 to 220 ft. The operational swath spacing for all aircraft of the same kind on a given contract was set at 50 ft less than the overall swath of the plane having the narrowest swath. The aircraft were guided during the applications by electronic signal provided under contract by Decca Survey Systems, Houston, Tex., or Lorac Service Corp., Division of Seismograph Service Corp., Tulsa, Okla. Henderson (1966), Anonymous (1971), Paget-Clarke (1971), and Glancey et al. (1973) discussed use of these systems in applications of mirex bait.

Before the 1st application of bait, plots were selected in each of the blocks for posttreatment evaluation of the effectiveness of the treatment. These plots were randomly situated. However, none were placed less than 5 miles from the outer boundary of the treatment area in an effort to insure that queens flying into the block from the adjacent untreated area would not reinfest the evaluation plots. The number and size of the plots varied in each of the blocks. An effort was made to establish sufficient plots to provide a minimum of 3000 mounds in each block for evaluation; however, the total was slightly below this in 2 blocks.

Posttreatment evaluations were made in the Savannah and northeast Mississippi blocks ca. 5–6 months after each of the first 2 applications and at various intervals from 6 to 24 months after the 3rd application. In the Florida block, inspections were made ca. 3 months after all 3 applications. Not all the plots were checked after the 1st and 2nd applications, but after the 3rd application all the plots were evaluated except those that had been recently cultivated or otherwise disturbed. In the Savannah area, random inspections were made also, and comprehensive surveys of favored habitats were made in selected townships (road shoulders, pastures, city lots, and stream banks were checked). About 1.0% of the land area was checked in the township surveys. Additional intensive surveys were made also in the central portion of Block A of the Florida treatment area following the 3rd application.

During each evaluation, all the mounds were opened with a spade and examined for live ants. A mound was considered active if 20 or more live worker ants were present or, with less than 20 workers, if a wingless queen was also present. Mounds not meeting this criterion were considered inactive. Percentage reduction was calculated by comparing the pretreatment and posttreatment counts of active mounds.

Twelve months after the 3rd application of bait to the Savannah area, an intensive publicity campaign was initiated via spot announcements on radio and television and articles in the local newspapers to encourage public support and assistance in detecting and reporting any active mounds. A central station was established in each county to receive these reports. In addition, postal cards with a detachable report section were sent to rural landowners in each county. They were requested to return the report section to the county agricultural agent if any active mounds were found. Followup surveys were made to confirm each report received.

RESULTS.—Table 1 shows the results in each of the treatment blocks. The results after the 3rd application are shown only for the 3- or 6-month survey.

Savannah.—The initial application in all 3 blocks of the Savannah area was very effective, reducing the number of active mounds 92–98%. Application of the bait to Block A was made in late October and early November when temperatures were lower and the control obtained was slightly lower than in the other 2 blocks; however, the figures for projected control were about equal for all 3 blocks.

After the 2nd application, Block B was free of ants, and only a few live colonies remained in the other 2 blocks. The posttreatment survey made 6 months after the 3rd application revealed no ants in any of the subblocks.

The 12-month posttreatment survey was made immediately after the publicity campaign. The only mature colony in any block was found in a trailer-assembly building in Savannah as the result of a report by an employee of the firm. This colony was situated in its entirety within the building and was apparently living on insects drawn through open doors to the lights which burned 24 h/day. The colony represented a unique situation, and such a colony would likely survive regardless of the number of bait applications made. Aside from this colony which was immediately treated with mirex bait, no fire ants were found within the central core of the test areas (the city of Savannah and suburbs).

Numerous incipient colonies were found during the 12-month survey in Block C at 10 locations surrounding Ridgeland, S. C. These colonies were probably developed by queens flying into Block C from a small infestation (found in the spring of 1969) just outside the treated area near Coosawatchee, S. C. The 2-yr posttreatment survey (January 1971) revealed additional small colonies around Ridgeland, and also east of Hardeeville, S. C. The colonies near Hardeeville apparently developed from queens from a previously undetected infestation near Beaufort. In addition, small colonies were found at 2 points within 3½ miles of the southern boundary of the eradication area. The land adjacent to this boundary had also been treated. However, the 1st application was not made until the spring of 1968. Thus the area received the 2nd treatment at about the same time as the test block received the 3rd and final application. Therefore, colonies surviving the 1st application in the area S of the boundary could have provided the queens for reinfestation flights back into the eradication test area just before the 3rd application. Also, small colonies were found in 1 location in northwestern Effingham County, Ga., near the Screven and Bullock County lines. This location was also near the boundary of the eradication area and a few miles from a newly detected infestation outside the treatment area in Bullock County. Queens from this infestation may have flown into the test block.

While these small numbers of incipient colonies were found, it is important to note that they all occurred within 5 miles of the outer borders of eradication Block C except in South Carolina. Also, except for the 1 colony in the assembly plant in Savannah, no colonies were found in Blocks A and B.

Tampa–St. Petersburg.—The results in the Florida

Table 1.—Average percentage reduction in number of active IFA colonies after each of 3 applications of mirex bait in 3 areas in 1967–69.

Block	Rate of application lb/acre	% actual and projected[a] reduction in number of active colonies after indicated application							
		1st			2nd				3rd
		Actual		Projected	Actual		Projected		Actual
				Savannah					
A	2.5+2.5+1.25	92.4	(1945)[b]	99.87	99.9	(2980)	99.9	(3044)	100
B	2.5+1.25+1.25	98.3	(3002)	100	100	(3032)		(3032)	100
C	1.25+1.25+1.25	96.8	(2476)	98.83	99.9	(2778)	99.9	(2778)	100
				Tampa-St. Petersburg					
A	2.5+1.25+1.25	94.3	(2979)	98.4	99.2	(2984)	100	(2989)	99.7
B	1.25+1.25+1.25	77.0	(2412)	86.8	98.1	(2412)	98.7	(2217)	99.5
				Northeastern Mississippi					
A	2.5+2.5+1.25	85.4	(1162)	92.7	99.85	(2003)	99.9	(3099)	100
B	1.25+1.25+1.25	68.5	(1075)	81.0	99.75	(2030)	99.75	(3011)	100

[a] Projected reduction was calculated by adding to the number of colonies actually killed that number of colonies which would have probably died without additional treatment (see Lofgren et al., 1964).

[b] Figures in parentheses indicate pretreatment count of active colonies on which percent reduction was calculated. These varied from 1 application to another, since some plots could not be checked after each application.

area after the first 2 applications were comparable to those obtained in the Savannah area. The slightly lower kill for Block B occurred because several mature colonies survived in the vicinity of several television transmission antennae. No mounds were found elsewhere in either block that would likely have survived the 2nd application.

Surveys made 3 months after the 3rd application revealed numerous small new colonies on and near evaluation plots along the northern part of each block. The number of mounds was greatest nearest the northern boundary and diminished with distance into the treated area (Table 2). Some colonies were found as much as 12 miles from the northern boundary. The intensive surveys made in Block A (St. Petersburg) failed to detect any live colonies at distances of more than 12 miles from the outer boundaries.

Northeastern Mississippi.—The treatments in this area produced results comparable to those obtained in the other 2 test areas. Control was somewhat lower after the 1st application because of poor flight patterns and failure of adjacent flight charts to overlap at the edges. These problems were corrected on the 2nd and 3rd applications. Thus, results after the 2nd application were about the same as those obtained in the Savannah area. After the 3rd application, no active ant colonies were found anywhere within the treated area.

An evaluation made ca. 15 months after the 3rd application showed small new colonies appearing at many points throughout the treated area.

DISCUSSION.—The tests showed that mirex bait was very effective at the dosages tested, and they demonstrated that it has potential for totally eliminating established infestations of both species of the imported fire ant provided that large areas are treated. The colony at Savannah survived because its feeding pattern afforded no access to the bait. This demonstrates that imported fire ants can survive in very unusual circumstances and illustrates the need for and the effectiveness of public cooperation in detecting imported fire ants in an eradication program. Survival of colonies around the TV antennae near Tampa was anticipated after the guidance charts showed deviation from the proper tracking of the aircraft for each application in this area. The value of the guidance charts for the aircraft was demonstrated in pinpointing this area of survival so that it could be followed up and treated with ground equipment.

The new colonies in the Florida and Mississippi areas were expected, because the areas were adjacent to high-density infestations that were not treated. In a full eradication program such areas would be progressively treated and the sources of reinfestation eliminated. The data from the Florida area provide the 1st evidence that ant queens, during mating flights, may travel as far as 12 miles.

The new colonies in the Savannah area almost certainly resulted from reinvasion by newly mated queens from colonies just outside the treated block. This type of reinfestation demonstrates the necessity of adequate survey to fully delineate the infested area so that no ants will be missed and thus serve as a source for reinfestation of the area.

Lofgren and Weidhaas (1972), in a theoretical appraisal of the technical feasibility of eradication of the imported fire ants, calculated that with density levels or 1 or 10 mounds/acre and a 5-fold rate of increase from year to year, elimination of an imported fire ant infestation from a 2,000,000-acre area would require a 99.9–99.99% reduction in the number of mounds with each application. Direct comparison of actual and theoretical control is difficult in these tests, because the complete effectiveness of any single treatment was not determined before the succeeding application was made. We used a figure for projected control to compensate. However, in most instances where we have been able to evaluate single treatments completely, we have obtained better control than the projected figures have indicated. Thus, the control in our trials may have been better than recorded. On the other hand, if it was not, it is encouraging to note that elimination of pretreatment populations did occur though the levels of reduction were not always above 99.9%. The basic objective of our research was to determine whether imported fire ants could be eradicated with mirex bait. Obviously, all problems could not be anticipated, and the fact that problems did occur and were detected illustrates that constant surveillance is a prerequisite to success of any insect control or suppression program. We feel that the technical problems we did encounter are surmountable and, therefore, total elimination of imported fire ants from large isolated areas may be technically feasible.

Table 2.—Results of survey to determine pattern of imported-fire-ant reinfestation in the St. Petersburg treatment area.

Distance from north border (miles)	No. mounds per acre at indicated location[a]					
	1	2	3	4	5	Average
0.5	6	129	18	65	35	51
1.0	24	35	10	0		17
1.5	0	52	0	8		15
2.0	5	42				23
2.5	0		0			0
3.0		15				15
3.5	0	14				7
4.0	0	30				15
4.5	0	0	25			8
5.0	0	9				5
5.5	0		0			0
6.0	0	2				1
6.5	0	4				2
7.0	4	0	1			2
7.5	3	9	3			5
8.0	0	0	6			2
8.5	6	6				6
9.0						
9.5	1	20	0			7
10.0		0				0

[a] Locations: (1) Alt. U.S. 19, (2) U.S. 19, (3) Belcher Rd., (4) Fla. Highway 593, (5) Fla. Highway 590.

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REFERENCES CITED

Anonymous. 1971. Electronic track guidance in the USA. Agric. Aviation 13: 29–30.

Buren, W. F. 1972. Revisionary studies on the taxonomy of the imported fire ants. J. Ga. Entomol. Soc. 7: 1–26.

Glancey, B. M., C. E. Stringer, Jr., P. M. Bishop, C. H. Craig, and B. B. Martin. 1973. Evaluation of an electronic guidance system for aircraft for bait application in the imported fire ant program. Agric. Aviation. (In press.)

Henderson, D. K. 1966. Decca system looks good for large scale ag operations. Am. Aviation 30(3): 30–34.

Lofgren, C. S., and D. E. Weidhaas. 1972. On the eradication of imported fire ants: A theoretical appraisal. Bull. Entomol. Soc. Am. 18: 17–20.

Lofgren, C. S., F. J. Bartlett, and C. E. Stringer. 1961. Imported fire ant toxic bait studies: The evaluation of various food materials. J. Econ. Entomol. 54: 1096–1100.

1963. Imported fire ant toxic bait studies: evaluation of carriers for oil baits. Ibid. 56: 62–66.

Lofgren, C. S., F. J. Bartlett, C. E. Stringer, Jr., and W. A. Banks. 1964. Imported fire ant toxic bait studies: further tests with granulated mirex-soybean oil bait. Ibid. 57: 695–8.

Lofgren, C. S., C. E. Stringer and F. J. Bartlett. 1962. Imported fire ant toxic bait studies: GC-1283, a promising toxicant. Ibid. 55: 405–7.

Paget-Clarke, C. D. 1971. Electronic guidance system used in fire ant eradication programmes. Agric. Aviation 13: 89–90.

Stringer, C. E., Jr., C. S. Lofgren, and F. J. Bartlett. 1964. Imported fire ant toxic bait studies: evaluation of toxicants. J. Econ. Entomol. 57: 941–5.

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