EVALUATION OF VARIOUS INSECTICIDES AND HOME REMEDIES FOR CONTROL OF INDIVIDUAL RED IMPORTED FIRE ANT COLONIES[1,2]

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ABSTRACT

Fast-kill drenches of Sevin 80WP, Dursban 4E and Spectracide 2E provided ca. 80 - 90% control of treated colonies for 112 days. The Orthene 75S dust application was as effective as the drenches and easier to use.

Leaded gasoline was the only home remedy tested which provided adequate control; ca. 90% control for 42 days posttreatment. However, it is an illegal application as law specifically restricts its application to soil. Of the slow-kill insecticides, Affirm W002 gave better control of singly treated RIFA colonies over a longer period than did Amdro. Colony relocation after treatment was a problem frequently encountered; the mound fumigant Cleanite caused the highest incidence of colony movement.

Key Words: Red imported fire ant, *Solenopsis invicta,* insecticides, baits, Synerid.

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INTRODUCTION

Numerous studies have been conducted to find the most successful application method and chemical for treatment and control of individual colonies of the red imported fire ant (RIFA), *Solenopsis invicta* Buren (Hymenoptera: Formicidae), (Hillman 1976, 1977; Morrill 1977; Francke 1983; Williams and Lofgren 1983). Much of this research began after the EPA banned mirex the broadcast bait formulated for control of RIFA in 1977.

Francke (1983) found that Dursban® (chlorpyrifos), Ficam® (bendiocarb), Knox-Out® (microencapsulated diazinon), Sevin® RP-2 (carbaryl), and Sevin® SL gave 90% or better control of treated mounds for four weeks posttreatment. The baits Amdro® (hydramethylnon) and Bant® (phenylenediamine) were also effective, providing at least 90% control through eight weeks posttreatment. Phillips et al. (1984) showed that single mound drenches of fenvalerate provided 100% and 67.7% control after eight weeks at 0.73 and 1.46 grams AI per mound, respectively. In contrast, the same chemical provided little control of RIFA colonies when applied from the air. Williams and Lofgren (1983) applied ten pesticides either as baits, drenches or fumigants to individual RIFA colonies. They reported that drenches of acephate (8 or 15.6% EC), carbaryl (23% suspension), bendiocarb (76% WP),

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chlordane (72% EC), and diazinon (25% EC) at application rates of 2.2 to 3.4, 2.7, 4.6, 4.0, and 7.5 g of AI per mound, respectively, were the most effective against RIFAs. In addition, Amdro bait (0.88% AI) was very effective at rates of 0.1 and 0.2 g per mound. However, in all studies relocation of some treated colonies was a problem.

In addition to commercially available toxicants, many home owners have used various household materials for control of RIFA colonies. Examples of materials perceived by the public to be efficacious for RIFA control include: epsom salts, gasoline, grits, hot water, and Clorox® (Lemke 1986). Tschinkel and Howard (1980) showed that three gallons of hot water poured slowly on mounds provided excellent control in eight of fourteen cases, whole mounds treated with cold water remained normal.

The objectives of this study were: to evaluate selected registered insecticides and home remedies for initial control of RIFA individual colonies, and to determine residual efficacy and relocation of treated colonies for treatments tested.

MATERIALS AND METHODS

A cattle pasture located near Santee, (Summerton County) SC was selected as the study site. The soil type was a Leaf-Flint-Wahee-Cahaba association (Craddock and Ellebre 1965) and the vegetation was primarily Bermuda grass. The number of active RIFA mounds averaged 112 per ha.

Between 25 May and 3 June 1984, 80 circular plots measuring 30.5 m in diameter were delineated and the locations of active RIFA mounds in each plot were mapped using the modified plane table procedure (Horton et al. 1982). Each plot was separated from the next plot by a buffer zone of 6.1 m, and all plots contained at least five active mounds. One treatment was randomly assigned to each plot using a random numbers table. Treatments were comprised of 18 chemicals and controls of either water or no treatment. Chemicals were divided into three categories: fast-kill, slow-kill, and home remedies. There were eight fast-kill insecticides tested (Table 1). For materials applied as drenches, 3.78 liter of solution were used for active mounds $\leq$ 0.305 m in diameter and 7.56 liter for active mounds $>$ 0.305 in diameter. Of the fast-kill insecticides 4 were applied as drenches, 1 as a dust, 2 as aerosol injections and 1 as a fumigant (Table 1).

Table 1. Fast-kill insecticides and rate of application used for single-colony treatments against the red imported fire ant in field tests.

Trade name	Active ingredient (AI)	AI%	Application method	Application rate
Sevin® 80WP	carbaryl	80.0	drench	22.7 g/3.78 liter
Cleanite®	1,1,1,trichloroethane	94.0	fumigant	59 ml/mound
Spectracide® 2E	diazinon	23.0	drench	30 ml/3.78 liter
Cessco® Accudose Aerosol	pyrethrin	0.7	injector	5 g/mound
Cessco® Accudose Aerosol	chlorpyrifos	1.0	injector	5 g/mound
Orthene® 75S	acephate	75.0	dust	24.4 g/mound
Synerid®	erythrosin B	87.0	drench	0.579 g/3.78 liter
Dursban® 4E	chlorpyrifos	44.4	drench	38.0 ml/3.78 liter

Four baits (slow-kill) were tested (Table 2). Each bait was placed on the ground surrounding the mound at a distance of 15 cm from its base.

Table 2. Slow-kill insecticides (baits) and rate of application used for treating single colonies of red imported fire ants.

Trade name	Active ingredient	AI(%)	Application rate (grams per mound)*
Amdro®	hydramethylnon	8.8	27.2
Pro-Drone®	†	1.2	12.4
Pro-Drone®	†	1.2	31.0
Synerid®	erythrosin B	85.0	20.0
Affirm® A003	avermectrin B_1	0.011	21.0
Affirm® W002	avermectrin B_1	0.011	21.0

* All treatments were applied within 15 cm of the base of the mound.
† Active ingredient is (1-(8-methoxy-4,8-dimethyl-nonyl)-4(1-methylethyl)benzene).

Four home remedies were tested. The application rate for each treatment was determined arbitrarily by the senior author. Rates of 950 ml for mounds $\leq$ 0.305 m in diameter, and 1900 ml for mounds $>$ 0.305 m in diameter were used with Clorox and gasoline treatments. Rates were used which would keep the cost of these treatments relatively equal to the insecticide treatments. Instant grits (27 g) were applied to colonies 15 cm from the base of the mound. This rate was comparable to the Amdro application rate (27.2 g). Epsom salts (53 g) application rate was determined from a survey of homeowners (Lemke 1986).

Each treatment was individually applied to all active mounds in four plots, so that a minimum of 30 active colonies was treated with each product. Activity of a RIFA colony was determined by slightly probing the mound during the early morning hours with a thin metal rod. Probing was conducted in the center of a mound as well as on two sides. A mound was considered active if ants came to the surface in response to the disturbance created by the probing action.

Relocation of treated colonies in each plot was also recorded. Colonies were considered to have relocated if a new colony appeared within 5 m of a treated active colony which had since become inactive. After 21 days following treatment, the presence of new active colonies in plots was attributed to the development of completely new colonies.

All treatments were made from 3 June to 4 June 1984. Posttreatment evaluations of fast-kill materials and home remedies were conducted on every treated colony in each plot at 2, 7, 21, 42, 56, 84, and 112 days posttreatment. Slow-kill insecticides were evaluated 21, 42, 56, 84, and 112 days following treatment. The data represented the number of colonies which became inactive following application of the treatment. Colonies which relocated following treatment and remained viable in their new location throughout the study were still considered active and thus unaffected by the chemical treatment. These data were corrected for mortality in the control plots using Abbott's formula (Abbott 1925) and then subjected to an analysis of variance (ANOVA) at the $P = 0.05$ level followed by a least square difference test.

RESULTS AND DISCUSSION

Spectracide 2E, Dursban 4E, and Sevin 80WP drenches provided ca. 90% control for 6 weeks following treatment (Table 3). This was consistent with the findings of Francke (1983) who evaluated efficacy of carbaryl, diazinon, and chlorpyrifos for 4 weeks posttreatment. Morrill (1977) and Hillman (1976, 1977) showed that chlorpyrifos and diazinon provided effective control when applied as drenches to individual colonies. The application rate of 7.56 liters of water per colony made drenches cumberson and difficult to handle.

Cessco Accudose Aerosol, containing chlorpyrifos, provided an average of only 77.2% control of treated colonies throughout the study period. These results differed from Horton et al. (1982) who obtained > 90% control using the same product. Therefore, this material (applied using an injector) which was easier to use did not provide a viable alternative to drenches in this study. Also, the aerosol was considerably more expensive to use than drenches when treating numerous colonies.

Another alternative to the drenches was Orthene 75S applied as a dust directly on top of the colony. However, there was a one wk delay in the activity of this material before obtaining ca. 100% control with this material. Gardener (1980) found that effective control of mounds treated with Orthene 75S drenches did not occur until 7 days following treatment. Thus the delay in control when using the dust may have been due to Orthene 75S being a slower acting compound than the other insecticides. The delay could also relate to the natural but slow penetration of the insecticide into the mounds through dew and rainfall. Another problem with this material was that some of the dust was still evident on the surface of the mounds 21 days posttreatment. This could lead to the potential problem of human beings and pets becoming contaminated with the pesticide.

The only home remedy to prove effective was regular leaded gasoline applied to the tops of active mounds. It provided ca. 90% control for 56 days posttreatment. Unfortunately, gasoline burned the grass on top of treated mounds leaving brown spots for 56 days posttreatment. Gasoline is not recommended for RIFA control since it is a significant environmental contaminant and law specifically restricts its application to the soil.

The results obtained with Cleanite and Cessco Accudose Aerosol (pyrethrin) differed from previous work. Scarborough (1979) found that Cleanite provided 93.8% control for approximately 5 weeks posttreatment. In this study, Cleanite gave only 64.2% control 7 days posttreatment and its effectiveness then continued to decline until the study was terminated at 112 days posttreatment. Horton et al. (1982) achieved effective control (> 80%) with Cessco Accudose Aerosol containing pyrethrin. The pyrethrin aerosol, in this test, gave 61.6% control of treated colonies at 7 days posttreatment but control decreased to approximately 39.1% at 112 days posttreatment when a large number of mounds became reoccupied.

Relocation of treated colonies was a problem in this study as it had been in other studies (Bass and Hays 1982; Francke 1983). All treatments caused some colony movement in the first 21 days posttreatment with the exception of epsom salts, grits, and Orthene 75S (Table 4). Cleanite and the two Cessco Accudose Aerosols caused over 22% of the colonies in treated plots to relocate within 5.0 m of the treated mound. Thus, this relocation may explain the poor control obtained with Cleanite and both Cessco Accudose Aerosols, since colonies that vacated old mounds which had been treated only to build new mounds still remained viable.

Table 3. Control of individual red imported fire ant colonies using either fast-kill insecticides or home remedies.

Treatment	Total no. mounds treated	Mean percent reduction of active colonies days posttreatment*						
		2	7	21	42	56	84	112
Spectracide® 2E	32	90.6 a†	90.6 ab	90.1 ab	87.8 a	79.8 a	80.0 a	80.0 a
Leaded gasoline	30	91.9 a	91.9 ab	91.9 ab	91.9 a	89.1 a	83.2 a	78.9 a
Dursban® 4E	33	88.9 a	94.6 ab	92.1 ab	91.3 a	84.4 a	84.4 a	87.7 a
Sevin® 80WP	33	85.6 a	93.3 ab	90.6 ab	88.2 a	85.4 a	81.6 a	81.6 a
Cessco®-Dursban	31	70.5 b	82.8 b	82.3 ab	64.2 b	79.3 a	79.5 a	77.2 a
Orthene® 75S	31	71.3 b	98.0 a	98.0 a	94.9 a	84.7 a	82.8 a	82.8 a
Cessco®-Pyrethrin	34	42.7 c	61.6 c	76.9 bc	66.6 b	50.1 b	41.8 bc	39.1 bc
Cleanite®	32	37.3 c	64.2 c	64.2 cd	63.3 b	54.2 b	51.4 b	51.4 b
Clorox®	33	47.8 c	59.3 c	55.2 d	60.8 c	41.2 b	35.9 bc	35.8 bc
Synerid®	32	12.8 d	19.6 d	12.1 e	25.8 c	15.7 c	25.6 cd	25.6 cd
Epsom salts	33	0.0 d	3.1 e	11.8 e	18.0 cd	9.4 c	3.3 de	2.4 de
Water	32	0.0 d	0.0 e	2.2 e	0.0 d	0.0 c	0.3 e	0.3 e
Grits	30	0.0 d	0.0 e	5.8 e	8.2 cd	1.6 c	7.2 de	7.2 de
Control	31	0.0 d	0.0 e	0.0 e	0.0 d	0.0 c	0.0 e	0.0 e

* All treatments were made between 4 June and 5 June 1984.

† Means within the same column, followed by the same letter, are not significantly different ($P > 0.05$) according to the Least Squares Difference test. Analysis was conducted on actual number of inactive colonies, but for clarity mean number of colonies which became inactive following treatment have been reported as the percent of treated colonies which became inactive. The total number of colonies which became inactive following treatment have been corrected for mortality in control plots using Abbott's formula. Colonies which relocated and remained active throughout the test were recorded as still being viable and thus unaffected by the treatment.

Table 4. Comparison of relocation of colonies singly-treated with either a fast-kill insecticide or a home remedy.

Treatment	Total number of colonies treated	Percent of colonies relocated*
Cleanite®	32	29.6 a
Cessco®-Pyrethrin	34	24.1 ab
Cessco®-Dursban	30	22.3 ab
Spectracide® 2E	32	12.0 bc
Clorox®	33	10.8 bc
Sevin® 80WP	33	10.3 bc
Leaded gasoline	30	9.4 bc
Dursban® 4E	33	5.4 c
Synerid®	32	5.0 c
Water	32	3.8 c
Epsom salts	33	0.0 c
Orthene® 75S	31	0.0 c
Grits	30	0.0 c
Control	31	0.0 c

* Means followed by the same letter are not significantly different (P > 0.05) according to the Least Square Difference test. Treatments made 3 June to 4 June 1984. For clarity the mean number of treated colonies which relocated has been changed to the percent of colonies which relocated.

As anticipated, baits were slower acting than the other materials, and the control was low (Table 5) when compared to other studies (Francke (1983; Williams and Lofgren 1983). Affirm W002 controlled a higher percent of treated colonies than the other baits. Pro-Drone began to offer > 50% control at 84 days posttreatment, which was not significantly different (P > 0.05) from that provided by the faster acting Affirm W002. From a homeowner's standpoint, the length

Table 5. Field evaluation of baits used as single colony treatments for control of red imported fire ants.

Bait	Total no. mounds treated	Percent reduction of active colonies days posttreatment*				
		21	42	56	84	112
Amdro®	31	71.2 a†	55.1 abc	53.1 a	50.3 bc	44.3 c
Affirm® A003	30	46.4 a	67.1 ab	66.9 a	36.3 c	38.1 c
Affirm® W002	30	59.6 a	85.4 a	75.2 a	83.4 a	78.3 a
Pro-Drone® (31.0 g)	33	15.7 b	22.0 cd	40.4 a	53.5 bc	53.3 bc
Pro-Drone® (12.4 g)	30	14.0 b	26.8 cd	48.5 a	73.8 ab	73.8 ab
Synerid®	30	53.3 a	48.2 bc	43.8 a	7.8 d	8.7 d
Control	31	0.0 b	0.0 d	0.0 b	0.0 d	0.0 d

* Treatments were made 4 June 1984.

† Means within the same column, followed by the same letter, are not significantly different (P > 0.05) according to the Least Squares Difference test. Analysis was conducted on the actual number of colonies which became inactive following treatment, but for clarity the percent of colonies becoming inactive has been reported. The number of inactive colonies have been corrected for mortality of colonies in control plots using Abbott's formula. Colonies which relocated and remained viable throughout the test were recorded as still being viable and thus unaffected by the treatment.

of time it takes Pro-Drone to work is too long to justify its use as a single mound treatment in yards; but it may have usefulness for long-term suppression.

Relocation of colonies following the use of baits was minimal. Amdro was the only bait to cause colony relocation, with 9.7% of the treated colonies relocating.

In summary, Sevin 80WP, Dursban 4E and Spectracide 2E provided excellent control for up to 112 days posttreatment. Orthene 75S when applied as a dust was a good alternative to the use of drenches. Gasoline proved to be the only effective home remedy for control of RIFAs on a single mound basis. However, it is harzardous to handle and should not be used for RIFA control. All fast-kill treatments caused a certain amount of relocation of treated colonies.

Amdro bait provided less effective control than anticipated. Affirm W002 appears to offer a viable alternative to Amdro since it provided better control over a longer period of time with minimal relocation of treated colonies. Pro-Drone was too slow acting to provide adequate control of RIFAs by single-mound treatments.

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