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Comparison of Several Sulfluramid Bait Formulations for Control of the Red Imported Fire Ant (Hymenoptera: Formicidae)[1,2]

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Medical and Veterinary Entomology Research Laboratory, USDA-ARS
Gainesville, FL 32604

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ABSTRACT Various bait formulations containing 0.3% or 0.6% of the fluoroaliphatic sulfone, sulfluramid, were evaluated for control of the red imported fire ant, *Solenopsis invicta* Buren, in field tests in Florida and Georgia. No significant differences were indicated in the effectiveness of sulfluramid baits containing 19.4, 24.4, 29.4 or 29.7% once-refined soybean oil; all gave control equivalent to that given by the hydramethylnon (Amdro®) standard in all tests. Sulfluramid baits were slightly more effective when applied in spring or summer than in late fall. Although higher rates were slightly more effective, differences in rate of application of formulated bait or active ingredient did not significantly affect effectiveness of the treatments in any given test. Rates of 2.52 - 13.44 g/ha of active ingredient or 0.84 to 1.68 kg/ha of formulated bait resulted in population index reductions of 80-99 percent.

KEY WORDS *Solenopsis invicta,* Red Imported Fire Ant, Sulfluramid Bait.

The development of effective baits for control of the imported fire ants, *Solenopsis invicta* Buren and *S. richteri* Forel, has required the evaluation of a wide variety of chemicals as toxicants. More than 5700 compounds were tested from 1958 to 1981 (Williams 1983), and since 1982, we have evaluated an additional 1356 compounds. Effective bait toxicants must exhibit delayed toxicity, effectiveness over a range of dosages, good acceptance by the ants, stability, easy formulation with food attractants and carriers, and environmental safety (Stringer et al. 1964, Banks et al. 1977, Williams 1983). Because of these stringent requirements, only five chemicals, mirex, hydramethylnon (Amdro®), abamectin (Affirm®), fenoxycarb (Logic®), and 1-(8-methoxy-4, 8-dimethyl nonyl)-4-(methylethyl) benzene (Prodrone®) have been used commercially in fire ant baits.

Insecticidal activity of the fluoroaliphatic sulfones, a new class of chemicals that meet most of the requirements for an effective bait toxicant, was reported by Vander Meer et al. (1985). Griffin Corporation, Valdosta, GA. has been licensed by the U.S. Department of Commerce to develop this class of chemicals as insecticides. In studies against the red imported fire ant (RIFA), several of the chemicals caused high mortality of worker ants after 20-35 days, eventual death of the queen in treated laboratory colonies and produced good control of natural field populations (Williams et al. 1987). Although several of the chemicals were equally effective

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

[3] Griffin Corporation, P.O. Box 1847, Valdosta, GA 31601.

against RIFA, consideration of such additional factors as availability, acceptance by the ants, and ease of formulation led to selection of the sulfone compound designated as USDA A13-29757, and now known by the common name sulfluramid, for commercial development. Sulfluramid also has shown excellent activity against other ant species and cockroaches and is currently marketed, under license, by S. C. Johnson Co. in Raid® Max Ant Bait for house-infesting ants and Raid® Max Roach Bait for cockroaches. Commercial baits for fire ant control are under development.

We report here the results of additional field tests in Florida and Georgia to evaluate various bait formulations of sulfluramid, and to develop additional data on the effectiveness of the chemical against field populations of RIFA.

Materials and Methods

Tests were conducted in October 1985 and 1988 in Polk Co., FL, May 1986 in Lowndes Co., GA, and July 1987 in Marion Co., FL. The following four bait formulations were tested in one or more of the trials: (1) 70% pregel defatted corn grit (PDCG), 29.7% once-refined soybean oil (ORSBO), 0.3% sulfluramid; (2) 70% PDCG, 29.4% ORSBO, 0.6% sulfluramid; (3) 80% PDCG, 19.4% ORSBO, 0.6% sulfluramid; and (4) 75% PDCG, 24.4% ORSBO, 0.6% sulfluramid. The baits for the 1985 and 1986 tests were prepared in our laboratory using soybean oil-cosolvent solutions, supplied by Griffin Corporation, that contained 1.0, 2.0 or 3.0% active ingredient (AI). The 1.0 and 2.0% solutions were adsorbed at 30% and the 3.0% solution at 20% by weight of total formulation onto pregel defatted corn grits to produce baits containing 0.3 or 0.6% AI. Formulated baits (0.6%) were supplied by Griffin for the 1987 and 1988 tests. Plots established in nongrazed permanent pasture (0.3 ha plots for the 1985, 1986, and 1987 tests and 0.8 ha for the 1988 test) were treated broadcast with a tractor-mounted auger applicator (Williams et al. 1983). Application rates of the baits for the various tests are shown in Table 1. Three plots were treated with each rate in a given test. Commercially-formulated Amdro® (0.88%) was applied at 1.12 kg/ha to three plots as a standard and three plots were left untreated as controls in each test. Pre and posttreatment determinations of ant population indices (Harlan et al. 1981, Lofgren and Williams 1982) were made on circular subplots (0.1 ha in the 0.3 ha plots and 0.15 ha in the 0.8 ha plots) in the center of each plot. This evaluation method consists of opening, with a shovel, every nest within each subplot and assigning each active nest a rating of 1-25 based on colony size (no. of workers ranging from <100 to >50,000) and the presence or absence of worker brood. The total of the ratings for all colonies on a plot yields the "population index" (PI) for that plot. Efficacy of the treatments was based on percentage reduction in the population indices. Posttreatment evaluations were made after 6, 13, and 26 wk in 1985; 6, 13, and 20 wk in 1986; 6 and 13 wk in 1987; and 6, 13, 20 and 26 wk in 1988. Data were analyzed with general linear models (GLM) and means were compared with Duncan's multiple range test (SAS Institute 1985).

Results and Discussion

Effectiveness of sulfluramid baits against field populations of RIFA in all four tests was similar to that reported by Williams et al. (1987). In test 1, the highest

Table 1. Effects of baits containing sulfluramid on field populations of red imported fire ants in Florida and Georgia.

	Application Rate		Mean Pretreatment		mean % reduction in pop'n index at indicated wk after treatment[2]			
Formulation[1]	Bait (kg/ha)	AI (g/ha)	No. Nests	Pop'n Index	6	13	20	26
				Test 1 (1985)				
1	0.84	2.52	8.7	205	65.7 a	81.1 a	—	80.5 ab
	1.12	3.36	8.3	178	64.6 a	82.0 a	—	78.8 ab
	1.68	5.04	8.3	188	75.5 a	83.6 a	—	79.4 ab
2	0.84	5.04	8.6	203	78.0 a	80.5 a	—	78.1 ab
	1.12	6.72	9.0	205	82.8 a	83.7 a	—	78.4 ab
	1.68	10.08	8.6	200	89.1 a	93.5 a	—	79.1 ab
3	0.84	5.04	9.0	198	57.4 a	84.0 a	—	66.3 b
	1.12	6.72	8.6	198	80.5 a	84.7 a	—	78.2 ab
	1.68	10.08	8.6	183	88.2 a	91.4 a	—	93.5 a
Amdro (std)	1.12	9.86	8.0	187	82.1 a	82.7 a	—	77.0 ab
Control	—	—	13.6	300	+ 4.4 b	13.3 b	—	17.4 c

Table 1. Continued.

Formulation[1]	Application Rate		Mean Pretreatment		mean % reduction in pop'n index at indicated wk after treatment[2]			
	Bait (kg/ha)	AI (g/ha)	No. Nests	Pop'n Index	6	13	20	26
				Test 2 (1986)				
2	1.12	6.72	9.3	177	99.0 ab	94.6 a	77.8 a	—
	1.68	10.08	9.0	193	98.3 ab	99.7 a	92.4 a	—
3	1.12	6.72	9.3	191	89.4 b	86.7 a	64.8 a	—
	1.68	10.08	10.0	210	99.3 a	99.8 a	78.9 a	—
Amdro (std)	1.12	9.86	9.3	194	96.3 ab	87.5 a	83.3 a	—
Control	—	—	11.3	234	12.5 c	13.6 a	2.8 b	—
				Test 3 (1987)				
2	1.12	6.72	15.7	295	96.7 a	85.9 a	—	—
	2.24	13.44	10.0	208	76.5 a	74.6 a	—	—
Amdro (std)	1.12	9.86	14.7	286	94.9 a	86.7 a	—	—
Control	—	—	10.7	233	37.4 b	14.0 b	—	—
				Test 4 (1988)				
4	1.12	6.72	14.3	343	80.7 a	94.2 a	96.4 a	96.9 a
Amdro (std)	1.12	9.86	13.3	323	71.8 a	90.9 a	94.5 a	95.9
Control	—	—	10.7	335	+73.8 b	+75.9 b	+70.4 b	+79.1 b

* Formulations were as follows: (1) 70% pregel defatted corn grit (PDCG), 29.7% once-refined soybean oil (ORSBO), 0.3% sulfluramid; (2) 70% PDCG, 29.4% ORSBO, 0.6% sulfluramid; (3) 80% PDCG, 19.4% ORSBO, 0.6% sulfluramid; (4) 75% PDCG, 24.4% ORSBO, 0.6% sulfluramid.

† Means within a column followed by the same letter are not significantly different (P = 0.05, Duncan's Multiple Range Test [SAS Institute 1985]). Means preceded by a plus indicate an increase in the population index.

levels of population index reduction (ca. 80-94%) were achieved with most rates and formulations at 13 weeks after treatment. Although the population index reductions were slightly higher with the higher rates of application of the 0.6% baits, there were no significant differences between any sulfluramid formulation or rate of application at 6 and 13 wk. At 26 weeks, the highest and lowest rates of the 0.6% formulation made with the 3.0% toxicant solution differed significantly from each other, but not from any other formulation or rate of sulfluramid. All formulations and rates of application of sulfuramid gave results comparable to the Amdro standard at every evaluation.

The levels of control in tests 2 and 3 were somewhat higher (ca. 89-99%) and were evident more quickly (6 wk) than in test 1. This was not unexpected because the treatments were applied in May and July. We have found in studies with other baits (Lofgren et al. 1964, Banks et al. 1972) that speed of kill is faster and overall mortality is generally higher during the spring and summer than during the fall and winter months. In test 2, the two rates of 0.6% bait formulated with the 3.0% toxicant solution differed significantly from each other, but not from any other formulation or rate of sulfluramid or from the standard at 6 wk. At 13 and 20 wk, there were no significant differences among any of the treatments. There were no significant differences among treatments in test 3 at either evaluation. Reductions in the efficacy of the treatments in test 1-3 after 13-26 wk were the result of reinfestation by colonies moving into the plots from the adjacent untreated area or by new colonies arising from mating flights in the untreated area.

In test 4, there was no significant difference between the sulfluramid bait and the Amdro standard at any evaluation period. This test also was applied in late fall and maximum reduction was noted at 26 wk after treatment.

The results of the four field tests confirm that sulfluramid is an efficacious bait toxicant at rates of ca 2.5 to 10 g/ha AI in a variety of formulations for control of field populations of imported fire ants.

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