AN INSECT GROWTH REGULATOR (PRO-DRONE) FOR EFFECTIVE MANAGEMENT OF THE RED IMPORTED FIRE ANT (HYMENOPTERA: FORMICIDAE)[1,2,3]

Sherman A. Phillips, Jr., David M. Claborn, and Harlan G. Thorvilson
Department of Entomology
College of Agricultural Sciences
Texas Tech University
Lubbock, TX 79409
(Accepted for publication April 24, 1985)

ABSTRACT

Pro-Drone, an insect growth regulator (IGR) with juvenile hormone activity, was aerially applied twice at the rates of 11.86 g AI/ha in large-scale field trials for control of the red imported fire ant, *Solenopsis invicta* Buren. Although Pro-Drone applications produced no significant effect at 3- and 8-months posttreatment, the IGR significantly reduced fire ant infestation after 10 months in southeastern Texas. This product represents the first registered, aerially applied IGR effective against the red imported fire ant.

Key Words: Red imported fire ant, *Solenopsis invicta* Buren, Pro-Drone, insect growth regulator.

J. Entomol. Sci. 20(2): 194-198 (April 1985)

INTRODUCTION

In 1977, the registration of mirex for use against the red imported fire ant (RIFA), *Solenopsis invicta* Buren, was cancelled because of harmful effects to non-target organisms and environmental persistence (Banks and Schwarz 1980). Since then, researchers have sought ecologically sound alternative methods of control.

Insect growth regulators (IGRs) offer one approach to the problem of controlling fire ants. In general, these compounds are non-toxic to *S. invicta* adults (Banks et al. 1978). However, IGRs do cause deformities which are expressed in adult ants (Cupp and O'Neal 1973). Other researchers have demonstrated that IGRs influence imported fire ant fecundity, metamorphosis, and caste determination (Troisi and Riddiford 1974; Vinson et al. 1974; Vinson and Robeau 1974; Robeau and Vinson 1976; Banks et al. 1978; Banks and Schwarz 1980; Banks and Harlan 1982; Banks et al. 1983). Death of a colony results from cessation of worker replacement due to IGR-induced deformities, death of developing larvae, and a shift in caste differentiation from worker to reproductive forms (Banks et al. 1983).

Banks et al. (1978) tested twenty-six IGRs for efficacy against laboratory colonies of RIFA. One of these experimental compounds (A13-36206) caused 75% mortality of the colonies. Therefore, large-scale field trials with this IGR [1-(8-methoxy-4, 8-dimethylnonyl)-4-(1-methylethyl)benzene] developed under the trade

[1] *Solenopsis invicta* Buren.

[2] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation by Texas Tech University.

[3] Contribution No. T-10-164, College of Agricultural Sciences, Texas Tech University. Partially supported by Interagency Agreement, No. 0853, Texas Department of Agriculture.

name of Pro-Drone (Stauffer Chem. Co., Westport, CN), were conducted in extreme southeastern Texas. This paper presents the results of our findings.

METHODS AND MATERIALS

A large-scale field test (ca. 53,000 ha) of Pro-Drone was conducted in Chambers and Jefferson Counties, TX. A standardized bait formulation (Stauffer Chem. Co., Westport, CN) was aerially broadcast at a rate of 11.86 g AI/ha during late October, 1983, and a second time during late March, 1984. The fall application was timed to weaken the colony before the onset of cold weather, whereas the spring application was timed to maximize product effect on colonies already weakened by the combined actions of the first application and the effects of winter. Based on accessibility and land owner cooperation, ten study sites were selected in grazed, coastal bermuda grass habitats; five sites in the treated area and five sites in the control area. Within each site, six 0.1 ha non-overlapping circles were randomly located. RIFA mounds within each circle were identified with an individual number and the pretreatment location of each mound was recorded according to compass heading (degrees) and distance (meters) between mounds. The control and treated circles contained a total of 289 and 291 RIFA mounds, respectively. Colonies were rated (Lofgren and Williams 1982) by opening the mounds with a shovel, estimating the number of observed workers, and noting the presence or absence of worker brood. The RIFA mound-rating system described by Harlan et al. (1981), as modified by Lofgren and Williams (1982), was used to obtain a population index for each circle.

The RIFA mounds were monitored for approximately one year. Each mound was rated pretreatment (21 - 22 Oct., 1983), and again at 3, 8, and 10 months after first treatment (27 - 28 Jan.; 18 - 19 June; and 30 Aug. - 1 Sept., 1984). The sum of all mound ratings within each circle was calculated and designated as the population index (PI) for each site. Analysis of the differences between pretreatment and posttreatment ratings of circles was by Student's paired t-test (Steel and Torrie 1980). Also during the 10-month posttreatment rating, all 0.1 ha circles were again surveyed to determine if the original mounds had fragmented, or if new mounds had been established by newly-mated queens.

RESULTS AND DISCUSSION

Control Sites

The 3- and 8-month posttreatment control ratings (Table 1) were each significantly different ($P < 0.01$) from the pretreatment control ratings. These differences were expected because the 3- and 8-month readings occurred during the winter and spring months, respectively. The lower ratings were likely caused by reduced brood rearing during the cooler seasons of the year. Even the low ratings at 8-months posttreatment (as evidenced by PIs) indicate that colonies had not yet recovered from the effects of winter. However, a general increase in PI from the 3- to the 8-month recordings was noted, indicating colony recovery at the control sites. Finally, the 10-month difference in individual mound ratings compared to pretreatment mound ratings was not significantly different ($P > 0.05$). This recovery would be expected, since the final mound ratings occurred during the same season (different year) as the pretreatment ratings.

Table 1. Large-scale field test results of aerially applied Pro-Drone against the red imported fire ant, *Solenopsis invicta*, in Jefferson and Chambers Counties, TX, 1983 - 84. Posttreatment population indices in control sites were compared to pretreatment population indices in control sites using Student's paired t-test.

No. mounds* (control)	Population index†	Population index†		
	Pretreatment	Posttreatment		
		3-months	8-months	10-months
(43)	198	87	451	100
(38)	265	125	211	76
(72)	788	201	218	782
(65)	628	173	437	712
(71)	865	249	538	785
		$t = 6.48$‡	$t = 2.93$‡	$t = 2.03$§

* Number of active mounds pretreatment within each 0.6 ha (0.1 ha × 6) location.
† Population indices for each 0.1 ha × 6 = 0.6 ha location.
‡ Highly significant: ($P < 0.01$; df = 29).
§ Not significant: ($P > 0.05$; df = 29).

Treated Sites

The 3-, 8-, and 10-month posttreatment ratings from the treated areas (Table 2) were significantly different ($P < 0.01$) from pretreatment ratings. Although the 3- and 8-month PIs were expectedly lower because of cooler winter and spring weather, the 10-month reading is also significantly ($P < 0.01$) lower than the pretreatment reading. Mound monitoring was unnecessary after the 10-month rating for the following two reasons: lower PIs would not be a function of treatment, but a function of colony phenology due to lower winter temperatures; and, effects of this IGR should be detectable within one year of initial treatment. Because colonies from the 10-month control locations (Table 1) fully recovered and the treated colonies (Table 2) had not recovered, the decline in PIs for the treated colonies is attributed to the treatment. In addition, 236 colonies in the treated area were dead, whereas only 70 dead colonies were recorded from the control area, resulting in 81.1% and 24.2% mortality, respectively. Colony death in the control area is attributed to natural mortality. Finally, no worker brood was detected in any of the treated colonies (0.0%), whereas 133 control colonies (46.0%) contained worker brood.

In conclusion, Pro-Drone significantly reduced the population index of the red imported fire ant, *S. invicta*, in Chambers and Jefferson Counties, TX. In addition, no fragmentation of treated colonies was detected 10-months posttreatment. These data demonstrate that aerial application of Pro-Drone lowered the level of infestation, indicating it may be an effective control tactic against the red imported fire ant.

Table 2. Large-scale field test results of aerially applied Pro-Drone against the red imported fire ant, *Solenopsis invicta,* in Jefferson and Chambers Counties, TX, 1983 - 84. Posttreatment population indices in treated sites were compared to pretreatment population indices in treated sites using Student's paired t-test.

No. mounds* (treated)	Population index†	Population index†		
	Pretreatment	Posttreatment		
		3-months	8-months	10-months
(42)	580	129	196	23
(95)	1087	337	171	9
(43)	428	115	103	18
(64)	626	210	327	25
(47)	364	138	196	8
		t = 6.9‡	t = 5.4‡	t = 7.8‡

* Number of active mounds pretreatment within each 0.6 ha (0.1 ha × 6) location.
† Population indices for each 0.1 ha × 6 = 0.6 ha location.
‡ Highly significant: ($P < 0.01$; df = 29).

ACKNOWLEDGMENTS

We thank James Johnson, Jeff Whitworth, and James Cokendolpher for their comments on the manuscript. In addition, the field help provided by Mark Brown and James Simpson is gratefully acknowledged. We also thank Stauffer Chemical Company for providing the funds necessary for this research and Joan Wright for typing the various drafts of this manuscript.

LITERATURE CITED

Banks, W. A., and D. P. Harlan. 1982. Tests with the insect growth regulator, CIBA-GEIGY CGA-38531, against laboratory and field colonies of red imported fire ants. J. Ga. Entomol. Soc. 17: 460-466.

Banks, W. A., and M. A. Schwarz. 1980. The effects of insect growth regulators on laboratory and field colonies of red imported fire ants. Proc. Tall Timbers Conf. Ecol. Anim. Control Habitat Manage. 7: 95-105.

Banks, W. A., C. S. Lofgren, and J. K. Plumley. 1978. Red imported fire ants: effects of insect growth regulators on caste formation and colony growth and survival. J. Econ. Entomol. 71: 75-78.

Banks, W. A., L. R. Miles, and D. P. Harlan. 1983. The effects of insect growth regulators and their potential as control agents for imported fire ants (Hymenoptera: Formicidae). Fla. Entomol. 66: 172-181.

Cupp, E. W., and J. O'Neal. 1973. The morphogenetic effects of two juvenile hormone analogues on larvae of imported fire ants. Environ. Entomol. 2: 191-194.

Harlan, D. P., W. A. Banks, H. L. Collins, and C. E. Stringer. 1981. Large area tests of AC-217, 300 bait for control of imported fire ants in Alabama, Louisiana, and Texas. Southwest. Entomol. 6: 150-157.

Lofgren, C. S., and D. F. Williams. 1982. Avermectin $B_{1}a$: Highly potent inhibitor of reproduction by queens of the red imported fire ant (Hymenoptera: Formicidae). J. Econ. Entomol. 75: 798-803.

Robeau, M. R., and S. B. Vinson. 1976. Effects of juvenile hormone analogues on caste differentiation in the imported fire ant, *Solenopsis invicta*. J. Ga. Entomol. Soc. 11: 198-202.

Steel, R. G. D., and J. H. Torrie. 1980. Principles and procedures of statistics, 2nd ed. McGraw-Hill Publishers, 481 pp.

Triosi, S. J., and L. M. Riddiford. 1974. Juvenile hormone effects on metamorphosis and reproduction of the fire ant, *Solenopsis invicta*. Environ. Entomol. 3: 112-116.

Vinson, S. B., and R. Robeau. 1974. Insect growth regulator effects on colonies of the red imported fire ant. J. Econ. Entomol. 67: 584-587.

Vinson, S. B., R. Robeau, and L. Dzuik. 1974. Bioassay and activity of several insect growth regulators on the imported fire ant. J. Econ. Entomol. 67: 325-328.