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TESTS WITH THE INSECT GROWTH REGULATOR, CIBA-GEIGY CGA-38531 AGAINST LABORATORY AND FIELD COLONIES OF RED IMPORTED FIRE ANTS[1, 2]

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ABSTRACT

The insect growth regulator (IGR), CIBA-GEIGY CGA-38531 was active against laboratory colonies of red imported fire ants, *Solenopsis invicta* Buren, shifting caste differentiation, suppressing egg-laying by the queen and causing death of 100% of treated colonies at 1 and 2 mg/colony. Only 50% of the colonies treated at 5 mg/colony died; however, our observations indicated

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[1] Hymenoptera: Formicidae.

[2] This paper reports the results of research only. Mention of a pesticide in this paper does not constitute a recommendation for use by the U. S. Department of Agriculture nor does it imply registration under FIFRA as amended.

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that the greater survival was probably a function of colony composition rather than differential response to dosage level. Reduced numbers of large major workers (repletes) or reduced storage capacity of repletes resulted in insufficient IGR being retained in the colony to produce mortality.

In field tests, rates of 4.76 to 15 g/ha eliminated ca. 72 to 87% of the active nests and reduced the total ant population index by 82 to 94%.

Key Words: Imported fire ants, *Solenopsis invicta*, insect growth regulators

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Several of the insect growth regulators (IGR), particularly the juvenile hormone analogues, have been shown to be active against the imported fire ants (IFA) *Solenopsis invicta* Buren and *Solenopsis richteri* Forel (Banks *et al.* 1978, Cupp and O'Neal 1973, Robeau and Vinson 1976, Troisi and Riddiford 1974, Vinson *et al.* 1974, and Vinson and Robeau 1974). Banks *et al.* (1978) reported that USDA A13-36206 (1-(8-methoxy-4,8-dimethylnonyl)-4-(1-methylethyl)benzene) killed 75% of treated colonies and was the most active of 26 IGR's tested in the laboratory. Subsequent field tests (Banks and Schwarz 1980) showed it to be equally effective against field colonies in a soybean oil bait broadcast at the rate of 4.75 g/ha (36.2 mg/colony) active ingredient (AI). In further studies we have found additional IGR's that are equal or superior to A13-36206 in their effects on IFA. We report here the results of laboratory and field studies against the red imported fire ant (RIFA), *S. invicta*, with one of these IGR's, CIBA-GEIGY CGA-38531.

MATERIALS AND METHODS

Laboratory Studies: CGA-38531 (1-(3-ethoxybutoxy)-4-phenoxy-benzene) was incorporated as a 400 g/liter EC into once-refined soybean oil and administered at rates of 1, 2, and 5-mg AI to laboratory colonies consisting of a queen, 5-15-ml of immatures (eggs, larvae and pupae) and 40 to 60 thousand worker ants. The colonies were reared from newly-mated queens by standard techniques (Banks *et al.* 1981) and were ca. 1 yr old when used in the tests. Three colonies were treated at each dosage; three untreated check colonies were given a quantity of neat soybean oil equivalent to the maximum volume (250-μl) given to the treated colonies. The oil solutions were offered to the ants in micro-pipettes from which the ants fed. The oil solutions were very acceptable to the ants and 100% of the material was consumed by every colony within 24 hours. After treatment the colonies were returned to the normal diet (Banks *et al.* 1981) and maintained in the laboratory at 27 ± 2 C.

Each colony was examined bi-weekly through 16 wk posttreatment and monthly thereafter until the colony died or recovered from obvious effects of the IGR. At each observation, the status of the queen, the type and quantity of brood (immatures), estimated worker numbers, and obvious morphological anomalies, were recorded.

Field Studies: Technical CGA-38531 was incorporated into once-refined soybean oil at 2.5% by weight. The oil solution was sprayed at 30% by weight of total formulation onto 8-30 mesh pregel defatted corn grits® (Lauhoff Grain Co., Danville, IL) as they tumbled in a small concrete mixer to produce bait

containing 0.75% AI.

Four plots of 0.85 ha each were established in non-grazed permanent pasture in Hancock Co., MS. The bait was broadcast with a tractor-mounted granular applicator to one plot each at rates of 0.635, 1.25, and 2.0 kg/ha. One plot was left untreated as a check. Three 0.1 ha circular sub-plots were established within each plot for pre- and posttreatment assessment of IFA populations. The entire area in each subplot was searched and every nest of fire ants was counted and given a nest index on the basis of worker numbers and presence or absence of worker brood as follows (Harlan *et al.* 1981).

No. Worker Ants	*Nest Index*	
	Worker Brood Absent	Worker Brood Present
<100	1	6
100-1000	2	7
1000-10000	3	8
10000-50000	4	9
>50000	5	10

The interaction of the number of nests and the nest index was then used to establish a plot population index that can be expressed mathematically by

$$\text{Population Index (PI)} = \sum_{K=1}^{10} K(N_k)$$

Where N_k = the number of ant nests in a given area comprised of nests having indices of K, where ($10 \geqslant K \geqslant 1$).

Effects of the treatment were determined by comparison of the number of active nests and the population index at each posttreatment interval with the pretreatment values. Mean percentage reductions were calculated for each treatment and the means were compared by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Laboratory Studies: CGA-38531 was very active against laboratory colonies of RIFA, with no substantial differences noted at the different dosages, except for increased colony survival at the 5.0 mg level (Table 1). All dosages caused a shift in caste differentiation, a phenomena that occurs with all juvenile hormone mimics that are active against IFA. The shift in caste differentiation resulted in the disappearance of worker brood within 4 to 6 wk after treatment with a concurrent appearance of sexual brood. Some adult sexuals, male or female or both, were present in all colonies by 6 wk posttreatment, however, the numbers were very small and most had deformed wings. Although we were unable to obtain exact numbers we estimated that more than 90% of the developing sexuals died or were killed before eclosion and were deposited by the workers in the boneyards.

CGA-38531 did not exhibit any acute toxicity or other detectable direct effect on the worker ants. There was a gradual decline in worker numbers that accelerated after 12-16 weeks posttreatment so that by 6 months most colonies contained only one to five thousand ants. Another 12-14 months was required, however, for the remaining workers to die in most colonies. Death of colonies treated with CGA-38531 probably can be attributed to the

Table 1. – Effects of CIBA-GEIGY CGA-38531 on laboratory colonies of red imported fire ants.

Dosage mg/colony	Number of colonies			Interval to colony death (wks)	
	Treated	Affected[a]	Killed	Range	Mean
1.0	2	2	2	82-84	83
2.0	6	6	6	36-78	54
5.0	4	4	2	28-70	47

[a]Effects noted in colonies include shift in caste differentiation, mortality of larvae, cessation or reduction in queen egg-production, morphological deformities.

same factors cited for other IGR (Banks *et al.* 1978). The lack of worker replacement coupled with natural mortality reduced worker populations to the point that food gathering, brood tending and general colony maintenance declined below minimal levels. These conditions led to death of the queen and eventually of the colony.

All colonies treated at 1 and 2 mg/colony died; however, two of the four colonies treated at 5.0 mg/colony resumed worker brood production. One colony resumed worker brood production by 20 weeks posttreatment and by 28 weeks had returned to pretreatment size and apparent normalcy. The other colony resumed brood production by 30 wk posttreatment but had regained only about 50% of the pretreatment size by 1 year posttreatment. Brood clutches were present in the colony only at sporadic intervals, indicating a possible chronic effect of the treatment on the queen.

It is uncertain whether the recovery of the two colonies at the 5 mg treatment level was dosage-related or whether the make-up of the particular colonies made them better able to overcome effects of an IGR treatment. Colony composition plays a very important role in long-term effect of the IGR since we (Banks and Schwarz 1980) have found that the larger workers in the colony (repletes) store the oil solutions of IGR in the gastral crop and recirculate them via trophallaxis through the communal stomach of the colony. Our studies indicate that death of IFA colonies as a result of IGR ingestion requires that the chemical be retained and redistributed over several months. Obviously colonies with few repletes or with repletes whose storage capacity was already filled would retain less IGR and would thus be better able to overcome effects of the treatment.

None of the untreated check colonies exhibited any of the effects noted in the treated colonies. Worker brood was present throughout the test and colonies expanded in size. Sexual forms were produced in some colonies but not to the exclusion of worker larvae and no morphological deformities were seen in any of the eclosed sexuals.

The results of the laboratory tests indicated that CGA-38531 is strongly active against RIFA, requiring only 1 mg/colony to completely shift caste differentiation and cause colony mortality. Administration of greater quantities, up to 5 mg/colony, did not produce effects not seen at the lower dos-

ages. Some colonies demonstrated the ability to overcome effects of the IGR, apparently by excretion, metabolism, or other means and return to normal. Other studies (Banks *et al.* 1978) have shown, however, that this ability is not peculiar to any IGR or dosage.

Field Studies: CGA-38531 was also active against field populations of RIFA. After 13 wk posttreatment all three rates of application had produced significant reductions in the number of active nests and in the population index (Table 2). The reductions in both number of active nests and in the population index became greater with increasing rate of application, however, with the small number of replications the differences were not statistically significant. The surviving nests on all plots were substantially reduced in size. The average nest index for the 4.76 g/ha rate was reduced from 9.09 pretreatment to 5.68 and only nine of the 17 surviving nests contained any worker brood. At the 9.44 g/ha rate the average nest index was reduced from 9.15 pretreatment to 2.44 and none of the nine surviving nests contained any worker brood. At the 15.0 g/ha rate the average nest index was reduced from 9.42 pretreatment to 5.14 with three of the seven surviving nests containing some worker brood at 13 wk. By contrast the nest index for the untreated check only dropped from 9.37 pretreatment to 9.19 at 13 wk. All but four of the 48 active nests contained worker brood.

The results of the field studies indicate that CGA-38531 will provide substantial relief from imported fire ants when applied as a bait. Even though not all nests were eliminated, most of those that survived did not contain worker brood. Observations have shown that such colonies do not actively maintain the mound nor actively forage and thus should pose much less problems than large normal colonies.

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Table 2. – Effects of baits containing CGA-38531 on field populations of red imported fire ants. Hancock Co., MS. 1980.

Application Rate		Number Active Nests		Population Index[a]		Mean Percentage Reduction[b]	
Bait Kg/ha	AI g/ha	Pretreatment	Posttreatment[c]	Pretreatment	Posttreatment	Number Nests	Population Index
0.635	4.76	60	17	545	96	71.7[a]	82.1[a]
1.26	9.44	39	9	357	22	76.9[a]	91.4[a]
2.0	15.0	53	7	499	36	86.8[a]	94.0[a]
Check	–	65	48	609	428	26.1[b]	29.7[b]

[a]Population index = sum of products of,no. of colonies in each index category X value of colony. This system is used to give weight to effects of compounds on reproduction as evidenced by lack of worker brood. See text for description of nest indices.

[b]Means in a column followed by a common letter are not significantly different at the .05 level of confidence by Duncan's Multiple Range Test.

[c]Posttreatment evaluations made at 13 wk after treatment.

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