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FIELD TRIALS WITH AC-217,300 A NEW AMIDINOHYDRAZONE BAIT TOXICANT FOR CONTROL OF THE RED IMPORTED FIRE ANT[1/2/]

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ABSTRACT

A new bait toxicant, AC-217,300, (tetrahydro-5,5-dimethyl(2(1H)-pyrimidinone[3-[4-(trifluoromethyl)phenyl]-1-[2-[4(trifluoromethyl)phenyl]-ethenyl]-2-propenylidene]hydrazone) demonstrated good potential for control of red imported fire ants, Solenopsis invicta Buren, in tests in Alabama, Florida, Georgia, and Mississippi. In field tests, baits formulated on extruded corn pellets generally produced highest levels of control in Alabama and Mississippi but baits formulated on corncob grits produced up to 99% control in tests in Georgia. The toxicant was highly effective in eliminating colony queens, but it did not kill all worker ants.

INTRODUCTION

Registrations for all products containing mirex were cancelled in 1978 by the Environmental Protection Agency (Johnson 1976). This action left no chemical available for use in large area control of the red imported fire ant (RIFA) Solenopsis invicta Buren and the black imported fire ant (BIFA), Solenopsis richteri Forel. Recently, Williams et al. (1980) reported that AC-217,300, (tetrahydro-5,5-dimethyl(2(1H)-pyrimidinone[3-[4-(trifluoromethyl)phenyl]-1-[2-[4-(trifluoromethyl)phenyl]-ethenyl]-2-propenylidene]hydrazone) one of a group of amidinohydrazones produced by American Cyanamid Company, was very effective against laboratory colonies of RIFA. The chemical killed the colony queen within 1-4 wk posttreatment and, depending on colony size, killed the entire colony in 2-24 wk.

Reported here are results of tests to determine the effectiveness of this chemical against natural field populations of RIFA.

MATERIALS AND METHODS

Two series of tests, each at 3 locations, were conducted in 1978 with baits formulated by the American Cyanamid Company. For tests Series I, AC-217,300 was

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1/ Hymenoptera: Formicidae
2/ This paper reflects the results of research only. Mention of a pesticide does not constitute a recommendation for use by the USDA nor does it imply registration under FIFRA as amended.
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dissolved at 2.5, 5.0, and 10.0% by weight in once-refined soybean oil with oleic acid. The oleic acid was added at 50% of the weight of the toxicant to aid in solubilizing the AC-217,300. Corncob grits (CCG, 12-30 mesh) were impregnated with the oil solutions at 15% by weight of total formulation to produce baits containing 0.375, 0.75, or 1.5% active ingredient (AI). Extruded corn pellets (ECP, 6-10 mesh) were impregnated with the oil solutions at 30% by weight of total formulation to produce baits containing 0.75, 1.5 or 3.0% AI. The CCG baits were applied at rates of 4.03 and 8.07 kg/ha and the ECP baits at rates of 2.02 and 4.03 kg/ha in May 1978 to 1.21-ha test blocks in Autauga County, AL and Hancock County, MS. The CCG baits also were applied at 4.03 and 8.07 kg/ha to 2.02-ha blocks in Lee County, GA. Mirex 10-5 bait (Banks et al. 1976) was applied as a standard for comparison in all tests. All applications were made on nongrazed permanent pasture with tractor-mounted granular application equipment.

Three 0.15-or 0.2-ha plots were established in each block for pre- and posttreatment counts of the number of active nests of RIFA.

For test Series II, AC-217,300 was dissolved at 1.25, 2.5, and 5.0% by weight in once-refined soybean oil with oleic acid as a cosolvent. Corncob grits were impregnated with the oil solutions at 15% by weight of total formulation to produce baits containing 0.1875, 0.375, or 0.75% AI. The ECP were impregnated with the oil solutions at 30% by weight of total formulation to produce baits containing 0.375, 0.75, or 1.5% AI. The CCG baits were applied at 2.8 and 5.6 kg/ha and the ECP baits at 1.4 and 2.8 kg/ha in October and November 1978 to 1.21-ha blocks in Forrest and Stone Counties, MS and in Polk County, FL. Three 0.2-ha check plots were established in each treatment block for pre-, and posttreatment counts of the number of active nests of RIFA.

We determined the % control in both series of tests by making posttreatment counts of the number of active nests at predetermined intervals with standard procedures (Banks et al. 1973b). The entire area of each check plot was examined and each nest on every plot was opened with a spade and examined for live ants. Any nest containing 20 or more live ants was considered active. The % control was then determined by comparing the number of active nests at the posttreatment interval with the number pretreatment. Analyses of variance and linear regression analyses were made of the data. The method of evaluation was not entirely satisfactory, however, because laboratory studies have shown that AC-217,300 is very effective in killing the colony queen even though it does not always kill the entire worker ant population in large colonies (Williams et al. 1980). Since normal colonies of IFA should contain worker brood during the warmer period of the year, the absence of worker brood is strong evidence that the colony does not contain a queen. Therefore, we rated colonies in 2 of the field tests as to the presence or absence of brood and projected additional control on the assumption that broodless colonies would eventually die. Results of other studies (Banks et al. 1973a) have shown that ultimate control often exceeded projected control which suggests that such abnormal colonies do in fact die.

RESULTS AND DISCUSSION

Series I. The treatments in Series I produced very erratic results from site to site. (Table I) Although there were some exceptions, in general the compound gave about the same level of kill at all dosages on a particular carrier at a given location. The CCG baits gave good kill at all rates and concentrations in Georgia although kill at the lowest rate of application with both the 0.375 and 1.5% concentrations was somewhat reduced. The performance in Mississippi followed the same pattern although at a lower level of control. The CCG

TABLE 1. Effectiveness of Baits Containing AC-217,300 for Control of Red Imported Fire Ants in Alabama, Georgia, and Mississippi. Spring 1978.

Formulation	Application rate		% Control in indicated state[a/]		
	bait(kg/ha)	AI(g/ha)	Alabama	Georgia	Mississippi
Corncob grits					
0.375%	4.03	15.1	0	61	38(57)[b/]
	8.07	30.2	0	98	68(84)
.75%	4.03	30.2	0	87	65(88)
	8.07	60.5	0	99	69(85)
1.5%	4.03	60.5	0	73	44(79)
	8.07	121.0	0	93	48(76)
Extruded corn pellets					
0.75%	2.02	15.1	84	NT[c/]	NT
	4.03	30.2	47	NT	NT
1.5%	2.02	30.2	37	NT	72(91)
	4.03	60.5	35	NT	75(84)
3.0%	2.02	60.5	49	NT	49(76)
	4.03	121.0	42	NT	72(91)
10-5 Mirex bait (standard)	1.12	1.12	100	100	92(92)

a/ Data corrected for check mortality with Abbott's formula. Results are for 16 wk posttreatment for Alabama and Mississippi, 18 wk for Georgia.
b/ Figures in parentheses indicate control if queenless colonies died.
c/ NT = Not Tested.

were ineffective at any level in Alabama.

The ECP baits were somewhat more effective than the CCG baits in Alabama but both produced about the same level of control in Mississippi.

The 10-5 mirex bait standard gave >90% control at all 3 locations.

Series II. The results of treatments on Series II in the fall of 1978 were somewhat more consistent (Table 2) than those in the spring tests. The CCG baits gave relatively good control in Stone County, MS and in 1 of the treatments in Florida.

Overall, the ECP baits in Series II were more effective than the CCG baits. The best results were obtained in Stone County, MS, although the results with the ECP baits were not significantly different in Florida. Control ranged from 69 to 98% in Stone County, MS, from 66 to 87% in Florida, and from 40 to 85% in Forrest County, MS. The 10-5 mirex standard gave 79, 88, and 90% control in Forrest County, MS, in Florida, and in Stone County, MS respectively.

As the data indicate, the results obtained in these tests varied somewhat from plot to plot at a given site but more so from site to site. Despite the sizable differences noted in some cases, analyses of variance and linear regression analyses failed to show significant differences between test locations or between response to different concentrations of the chemical in the bait. Differences obtained with varying rates of application were significant at the 0.05 level of confidence. The ECP formulations were significantly more effective (0.01 level of confidence) than were the corncob grit formulations.

The variation in the results may be due to 1 or more of the following factors: 1) fluctuations in the number and size of colonies from plot to plot at a site and between sites; 2) variation in hunger of the ants as related to the abundance and distribution of natural foods; and 3) variations in ground cover and weather factors that affected ant foraging. The relatively narrow range of delayed toxicity (0.05-5.0 as compared to 0.0025-3.0% for mirex) and increasing repellency with increasing concentration in the soybean oil (Williams et al. 1980) also may have influenced the effectiveness of the chemical to some extent. The reader's attention is directed to Banks et al. (1977) for a more detailed discussion of factors affecting performance of bait toxicants. Some of the differences noted between the CCG and ECP baits can be attributed to the higher oil content of the ECP baits and to the fact that the oil can be more easily extracted by the ants from the ECP than from the CCG baits.

We recognized early in the field studies that simply counting the number of active nests would not give an adequate indication of the effectiveness of AC-217, 300 against the fire ants, thus, we used the absence of worker brood as an indicator that the colony queen had been killed and that the colony would ultimately die. Reliable data for such evaluations can only be obtained when the colonies should normally be producing large quantities of worker brood. Also, such data cannot be obtained before at least 8 weeks posttreatment, since it may take that long for the last eggs laid by the queen to develop into adult ants. Our data were taken at 16 or 26 wk posttreatment. In the 1st test, the treatment eliminated 38 to 75% of the active colonies in Mississippi, but if the broodless colonies also died control would have been 57 to 91% (Table 1). In the 2nd test, 47 to 97% of the colonies on the Florida plots were killed, but if the broodless colonies also died, control would have been 71 to 100% (Table 2). On the mirex-treated plots, all the surviving colonies in Mississippi and 96% of those in Florida contained worker brood. Field colonies without a queen possibly may adopt a new queen after a mating flight, since laboratory colonies will sometimes accept new queens. However, because our examinations showed that so many of the field colonies were still without worker brood after 16 or 26 wk, queen adoption by these workers seemed unlikely. At any rate, even if the surviving colonies did eventually accept a queen, we estimated that there was a 75-90% reduction in

TABLE 2. Effectiveness of Baits Containing AC-217,300 for Control of Red Imported Fire Ants in Mississippi and Florida. Fall 1978.

Formulation	Application rate		% Control in indicated state[a/]		
	bait(kg/ha)	AI(g/ha)	Mississippi[b/]	Mississippi[c/]	Florida
Corncob grits					
0.1875%	2.8	5.25	28	68	61(71)[d/]
	5.6	10.5	40	88	72(92)
.375%	2.8	10.5	1	88	47(85)
	5.6	21.0	57	94	65(97)
.75%	2.8	21.0	45	74	70(89)
	5.6	42.0	33	90	88(100)
Extruded corn pellets					
0.375%	1.4	5.25	40	98	59(90)
	2.8	10.5	85	81	96(100)
.75%	1.4	10.5	61	95	81(97)
	2.8	21.0	73	88	85(100)
1.5%	1.4	21.0	42	91	84(100)
	2.8	42.0	47	69	97(100)
10-5 Mirex bait (standard)	1.37	1.37	79	90	88(92)

a/ Data corrected for check mortality with Abbott's formula. Results are for 26 wk posttreatment for all locations.
b/ Forrest County, MS.
c/ Stone County, MS.
d/ Figures in parentheses indicate control if queenless colonies died.

the population of these colonies; this reduction accompanied by a corresponding reduction in mound size would have greatly reduced their impact on man and the environment for 6-12 months.

Although the available data failed to show significant differences due to toxicant concentration, the higher levels produced slightly lower levels of control, which suggests that repellency at the higher toxicant concentrations in the bait may have reduced consumption, or that rapid kill of the foragers prevented complete dispersal of the toxicant throughout the colonies.

When the data from all tests were combined, the results showed (Fig. 1) that 10-15 g/ha AI was optimum and that, at the optimum level, the ECP formulations were decidedly superior to the CCG formulations.

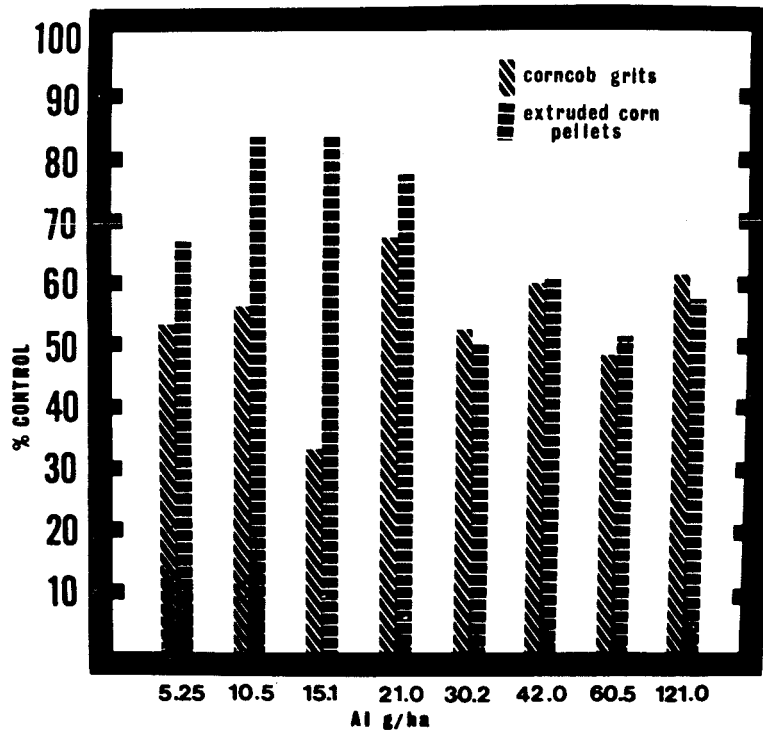

FIG. 1. Comparative effectiveness of indicated g/ha of AC-217,300 in corn cob grit or extruded corn pellet bait in controlling red imported fire ants.

Although the data obtained in these field tests did not show that AC-217,300 provided consistent high levels of control of RIFA, the results did show that the chemical has potential as a bait toxicant. The high % of queen mortality shown in laboratory colonies (Williams et al. 1980) was confirmed in these field tests. The results obtained in both the laboratory and the field indicate that additional research with AC-217,300 is warranted. Obviously, additional studies are necessary to clarify the variations in results from location to location. Particular attention must be paid to the effects of population levels and colony size, the effects of natural food abundance on acceptance of the bait, and the influence of climatic factors. Differences noted in performance when the chemical was formulated on different carriers suggest that additional research must be conducted to determine the optimum carrier. In addition, we have not, as yet, determined the proper concentration of toxicant in the bait for maximum effectiveness. We do have some data that indicate increased control can be obtained

with a 2nd bait application 5-8 wk after the first. We must evaluate this approach further, as well as the effects of yearly applications in the spring or fall.

Finally, we must evaluate the need to kill the entire colony. We have noted that when a majority of the workers is killed and reproduction stops, the remaining workers do not maintain the mound or actively forage for food. Since man's contact with the fire ants is primarily through disturbance of active, aggressive colonies, partial control may provide adequate relief in many instances.

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LITERATURE CITED

Banks, W. A., B. M. Glancey, C. E. Stringer, D. P. Jouvenaz, C. S. Lofgren, and D. E. Weidhaas. 1973a. Imported fire ants: eradication trials with mirex bait. J. Econ. Entomol. 66:785-9.

Banks, W. A., D. M. Hicks, J. K. Plumley, D. P. Jouvenaz, D. P. Wojcik, and C. S. Lofgren. 1976. Imported fire ants: 10-5, an alternate formulation of mirex bait. J. Econ. Entomol. 69:465-7.

Banks, W. A., C. S. Lofgren, D. P. Jouvenaz, D. P. Wojcik, and J. W. Summerlin. 1973b. An improved mirex bait formulation for control of imported fire ants. Environ. Entomol. 2:182-5.

Banks, W. A., C. S. Lofgren, C. E. Stringer, and R. Levy. 1977. Laboratory and field evaluation of several organochlorine and organophosphorus compounds for control of imported fire ants. USDA, ARS-S-169. 13 pp.

Johnson, E. L. 1976. Administrator's decision to accept plan of Mississippi Authority and order suspending hearing for the pesticide chemical mirex. Fed. Regist. 41(251):56694-56704.

Williams, D. F., C. S. Lofgren, W. A. Banks, C. E. Stringer, and J. K. Plumley. 1980. Laboratory studies with nine amidinohydrazones, a promising new class of bait toxicants for control of red imported fire ants. J. Econ. Entomol. 73 (in press)