LABORATORY EVALUATION OF CANDIDATE BAIT TOXICANTS AGAINST THE IMPORTED FIRE ANT, *SOLENOPSIS INVICTA*[1]

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ABSTRACT

Toxic baits of 319 chemicals were evaluated in the laboratory to determine their effectiveness in controlling the imported fire ant, *Solenopsis invicta* Buren. No chemical was consistently as effective as mirex for the control of the imported fire ant, although 3 compounds showed some promise when cold-aged before testing.

Recent restrictions on the agricultural application of mirex bait for the control of the imported fire ant, *Solenopsis invicta* Buren (Ruckelshaus 1972) have stimulated an extensive research program in laboratory and field evaluations of candidate chemicals to replace mirex.

Three hundred thirty-four chemicals were screened in the laboratory by Lofgren, et al. (1967). Their results indicated that no toxic bait was as effective as mirex for controlling the imported fire ant. Wojcik et al. (1972) have continued this screening program and have evaluated 590 bait toxicants. Their results also indicated that no chemical was as effective as mirex for fire ant control.

Since the imported fire ant is considered to be an agricultural as well as public health problem (Metcalf et al. 1962) a continuing program for evaluating additional candidate toxic baits in the laboratory has been established.

METHODS AND MATERIALS

A portion of a colony containing mixed castes of the imported fire ant was collected from the Gainesville, Fla. area and maintained in large metal cans in the Insects Affecting Man and Animals Research Laboratory, USDA, from 48-72 hr before a test. This enabled the ants to adapt to the changes in temperature, humidity, and light.

Before a series of chemicals could be evaluated, 150-200 test chambers[4] for holding the ants and toxicants had to be prepared. This procedure was modified from Lofgren, et al. (1967). A 1/8 - 1/4 inch hole was drilled in the base of each plastic 1 oz medicine cup. These cups were 1 1/2 in. high and 1 1/2 and 1 1/4 inches in diameter for the top and bottom respectively. The chambers were then filled to a level of 1/8 in. with a 9 to 1 plaster of paris—cement mixture.

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[4]Dixie Cup™, American Can Co., Greenwich, Conn. 5000 No. P01-06.

Toxic baits were evaluated on mixed groups of major and minor workers in the laboratory. These ants were removed from the field collected colony with wooden tongue depressors and placed in groups of 20 into the disposable test chambers which were ringed with talc to prevent the ants from escaping. Each chamber was then covered with a cardboard disc, labelled with a chemical identification number, and placed in a tray on a layer of moistened peat moss. The small hole drilled in the bottom of each plastic chamber allowed sufficient moisture to be absorbed into the plaster-cement mixture to maintain the ants. The ants were maintained in the test chambers for 24 hr without food to assure acceptance of the toxicants as well as allow them to adapt to their new environment. Dead ants were replaced before addition of the toxicants.

Candidate toxicants were selected by item number from USDA Agricultural Handbook No. 340 (1967). Fifteen to thirty of these chemicals were tested weekly using 2 replicates in a soybean oil bait at initial concentrations of 1.0, 0.1 and 0.01%. A total of 319 compounds was tested. Chemicals that were insoluble in soybean oil were treated with heat, acetone, and/or tap water. The acetone and water were evaporated before testing. One percent monoglycerides of lard were added to hold several toxicants in suspension.

Equal volumes of a chemical at each concentration were pipetted into cotton-stuffed vial caps or applied to the cotton tip of 6 in. swab sticks.[5] The swab sticks were dipped into each concentration, broken off at the cotton tip, and placed into each test chamber in a vial cap. The latter procedure was found to reduce many problems.

Worker ants were allowed to feed on the candidate toxicant for 24 hr. The vial caps containing the toxicants were then removed and an interim period of 24 hr was allowed before providing pure soybean oil food for the duration of the experiment. Eight mortality counts were made at 1, 2, 3, 6, 8, 10, 13, and 14 days after exposure to the chemicals. All chemicals that caused complete mortality at the 0.01% level were further tested at the 0.001%, 0.0001%, or 0.00001% level to determine the lowest concentration for complete kill.

Fifteen to 30 soybean oil controls and 1-2 mirex standards were used to test the adequacy of each experiment. If control mortality for a test was greater than 20% or if the mortality of the mirex standard was significantly below Class V (Lofgren et al. 1967) the experiment was terminated and repeated the following week. The effectiveness of the chemicals was evaluated against mirex (Class V) according to previously established criteria, and the chemicals were categorized into mortality classes based on the percent mortality during the 14 day experiment.

Bait toxicants were classified by the following system (Lofgren et al. 1967). Delayed toxicity was defined as less than 15% mortality after 24 hr and more than 89% mortality at the end of the test period.

Class I.—Compounds that gave insufficient kill at the preliminary test concentrations (less than 90% kill at the end of the test period).

Class

Ia—Maximum kill 0 to 29%.

Ib—Maximum kill 30 to 59%.

Ic—Maximum kill 60 to 89%.

Class II.—Compounds that killed too fast at the higher concentrations but gave insufficient kill at the lower concentrations; that is, 15% or more kill after

[5]Johnson's™ Cotton Buds, No. 8762BH, New Brunswick, New Jersey.

24 hrs and 90 to 100% at the end of the test period at the higher concentrations but less than 90% kill with the lower concentrations at the end of the test period.

Class
IIa—Produced fast kill at 1.0%.
IIb—Produced fast kill at 0.1 and 1.0%.
IIc—Produced fast kill at 0.01, 0.1, and 1.0%.

Class III.—Compounds that show delayed action over a onefold to ninefold dosage range.

Class
IIIa—Delayed action occurred between 0.25 to 1%.
IIIb—Delayed action occurred between 0.025 to 0.1%.
IIIc—Delayed action occurred between 0.0025 to 0.01%.

Class IV.—Compounds that show delayed action over a tenfold to ninety-ninefold dosage range.

Class V.—Compounds that show delayed action over a hundredfold or greater dosage range.

Room temperature was monitored and ranged from 75-80°F. Room humidity was also monitored but did not indicate the humidity within the test chambers.

Results and Discussion

Results indicated that no chemical bait was consistently as effective as mirex for fire ant control (Table 1), although compound ENT-27916, seemed to show ant mortality comparable to mirex when aged for several weeks in a refrigerator before testing. Two other toxicants, compounds 6063 and 7215 (Fervenulin), also seemed to show delayed mortality against the imported fire ant when cold-aged but were not as effective as mirex (5008) or ENT-27916 in repeated tests.

Preliminary results indicated that these 3 compounds were unstable but promising for fire ant control under laboratory conditions. However, the possibility exists for aging the chemicals to obtain the necessary delayed action before field application. Only compounds ENT-27916 and 7215 were available in sufficient quantity for field testing and are presently being evaluated against the imported fire ant in large field plots in Plant City, Florida.

It must be understood that the percent mortality indicated by a class is not absolute but may be subject to variations due to the differences in diet and general "health" of the ants within a colony. For example, hungry field collected ants were observed to accept a greater amount of toxicant in a shorter time period than ants from a sufficiently fed colony. Therefore, this could affect delayed mortality and the subsequent mortality class assigned to a chemical at the end of a 14 day test.

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TABLE 1. CHEMICALS EVALUATED FOR CONTROL OF THE IMPORTED FIRE ANT.*

Mortality Class	Toxicant Item Number
Ia	067 068 069 0129 0132 0144 0161 0223 0237 0243 0272 0283 0292 0297 0344 0355 0495 0529 0593 0623 0724 0765 0885 0905 1016 1095 1096 1102 1127 1137 1143 1202 1208 1213 1226 1330 1331 1335 1418 1423 1535 1564 1620 1802 1830 1921 1936 1969 1982 2070 2099 2100 2108 2134 2197 2301 2431 2495 2506 2507 2540 2563 2601 2677 2683 2692 2694 2756 2861 2862 3101 3193 3206 3213 3214 3230 3242 3250 3263 3266 3281 3285 3287 3288 3289 3290 3292 3293 3319 3339 3342 3349 3369 3372 3373 3380 3383 3415 3430 3448 3482 3526 3585 3607 3608 3651 3676 3679 3694 3697 3700 3705 3710 3714 3720 3721 3750 3770 3773 3797 3803 3817 3820 3829 3888 3927 3994 4043 4047 4073 4179 4315 4353 4419 4496 4516 4608 4750 4818 4873 4984 5034 5044 5048 5081 5113 5260 5297 5303 5373 5506 5516 5631 5638 5669 5726 5788 5827 5857 6160 6246 6247 6402 6486 6560 6616 6704 6830 6836 6840 6846 6849 6860 6861 6884 6940 7100 7171 7181 7183 7238 7277 7351 7552 7556 7616 7631 7693 7696 7711 7715 7753 7827 7832 7914 7963 7976 7979 8001 8004 8006 8008 8205 8251 8680
Ib	0191 0251 0285 0312 0612 0628 1068 1182 1803 1841 1981 2067 2105 2502 2559 3217 3242 3267 3269 3272 3286 3324 3420 3523 3535 3543 3620 3635 3670 3703 3802 3818 3844 3912 3929 3930 4400 5290 5291 5295 5299 5300 5618 5877 6331 6393 6400 6403 6689 6793 6808 6847 7268 7272 7283 7363 7619 7702 7751 7778 7853 8671

*Chemical name and structural formulae for compounds are listed by item no. in USDA Handbook No. 340 (1967).

TABLE 1 (Cont'd). CHEMICALS EVALUATED FOR CONTROL OF THE IMPORTED FIRE ANT.

Mortality Class	Toxicant Item Number
Ic	0213 0215 0526 1188 1419 1747 1894 3432 3583 3982 5540 6245 6586 7172 7856 8160 8332
IIa	2152 2159 2165 3208 3799 3931 6050 7443 7373
IIb	6004 6120 6139 6238
IIc	6154
IIIa	3928 3972 4313 4610 5885 5856 6241 7692 7750
IIIb	1350 1733 3642 4866 5010 6167 6201
IIIc	6259
IV	6063** 7215†
V	5008, ENT-27916††

**Phosphoramidothioic acid, (2-mercaptoethyl)-, O, O-diethyl ester, S-ester with O, O-diethyl phosphorodithioate (Conoco E - 11 - 4).
†Pyrimido [5, 4-e]-as-triazine-5, 7(5H, 8H)-dione, 6, 8-dimethyl (Upjohn V-7118).
††Phosphonothioic acid, ethyl-, O-(7-chlorobenzofurazan-4-yl) O-ethyl ester (Shell SD 23687)

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LITERATURE CITED

Lofgren, C. S., C. E. Stringer, W. A. Banks, and P. M. Bishop. 1967. Laboratory tests with candidate bait toxicants against the imported fire ant. ARS 81-14. 25 p.

Metcalf, C. L., W. P. Flint, and R. L. Metcalf. 1962. Destructive and useful insects, 4th ed. McGraw-Hill Book Company, New York. p. 896.

Ruckelshaus, W. D. 1972. Products containing mirex; determination and order. Federal Register 37(130):13299-13300.

U. S. Department of Agriculture, Agricultural Research Service. 1967. Handbook No. 340. Materials evaluated as insecticides, repellents, and chemosterilants at Orlando and Gainesville, Fla., 1962-1964. Washington, D. C. 424 p.

Wojcik, D. P., W. A. Banks, J. K. Plumley, and C. S. Lofgren. 1972. Results of laboratory tests with additional candidate bait toxicants against the imported fire ant. USDA, Agricultural Research Service, Special Report 72-03W. 43 p.

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