TOXICITY OF CHEMICAL BAITS AGAINST THE RED IMPORTED FIRE ANT, SOLENOPSIS INVICTA[1]

R. LEVY[2], J. F. CARROLL[2], Y. J. CHIU[2], AND W. A. BANKS[3]

ABSTRACT

Toxic baits of 402 chemicals were evaluated in the laboratory to determine their effectiveness in controlling the red imported fire ant, *Solenopsis invicta* Buren. No chemical bait was as consistently as effective as mirex for the control of the red imported fire ant, although compounds ENT-27931, ENT-27932, ENT-27933, ENT-27934, ENT-27935, ENT-27936, ENT-27937, and ENT-62469 were promising and exhibited relatively consistent delayed action over a 10 to 99-fold dosage.

Mirex has been found to be the most effective toxicant for use in baits against the red and black imported fire ants, *Solenopsis invicta* Buren and *S. richteri* Forel, respectively (Lofgren et al. 1962, 1963, 1964, 1967; Stringer et al. 1964). Despite an extensive program for laboratory evaluation of alternate bait toxicants, no other compound has been found to possess mirex's consistent delayed action over a 100-fold or greater dosage range (i.e. Class V compound) (Lofgren et al. 1967, Levy et al. 1973, Wojcik et al. 1973). Levy et al. (1973) reported that although Shell SD23687 exhibited Class V mortality against the imported fire ant when cold-aged before testing, the compound was not consistently as effective as mirex in repeated laboratory tests. Field tests have shown that it is ineffective against natural infestations of the fire ant (Banks et al. unpublished).

Only 11 chemicals out of a total of more than 1500 tested toxicants have demonstrated delayed action over a 10-fold to 99-fold dosage range (i.e. Class IV compounds) (Lofgren et al. 1967, Wojcik et al. 1972, and Levy et al. 1973). Most of these compounds have been mirex analogs and have not shown consistent delayed toxicity in the laboratory and/or field tests.

This paper summarizes the mortality data of 402 bait toxicants which have been evaluated in the laboratory to determine their potential for controlling the red imported fire ant.

METHODS AND MATERIALS

Toxicants were tested in once-refined soybean oil at concentrations of 0.01, 0.1, and 1.0% against red imported fire ants collected from several mounds in the Gainesville, Florida area. The evaluation procedures described by Lofgren et al. (1967) and modified by Levy et al. (1973) were used for the tests.

All chemicals, with the exception of those compounds identified by Entomology Number (ENT) are listed by item number according to their chemical name and structural formula in USDA Agricultural Handbook No. 340 (1967). The chemical names of compounds identified by ENT are given.

[1] Florida Agricultural Experiment Station Journal Series No. 5099.

[2] Department of Entomology and Nematology, University of Florida, Gainesville, Florida 32611.

[3] Insects Affecting Man Research Laboratory, USDA-ARS, Gainesville, Florida 32601.

Bait toxicants were classified by the following system (Lofgren et al. 1967). Delayed toxicity was defined as less than 15% mortality after 24 hrs 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 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.

Results and Discussion

Results from the tests are shown in Table 1. No chemical bait was as consistently as effective as mirex (5008) for the control of the red imported fire ant, although compounds ENT-27931, ENT-27932, ENT-27933, ENT-27934, ENT-27935, ENT-27936, ENT-27937, and ENT-62469 were promising and exhibited relatively consistent delayed action over a 10 to 99-fold dosage.

The similar structures of the 7 phosphorothioic acid bait toxicants from Hebrew University indicated that ortho, para, or meta substitution of one or more bromophenyl or fluorophenyl radical(s) on the basic benzene configuration did not increase delayed toxicity over a wider range of concentrations. No significant additive or synergistic effect resulted when several of these compounds were mixed at a 1:1 dilution at the 3 test concentrations. In addition, these compounds, as well as ENT-62469 are basically phosphatic and should not exhibit the environmental persistence (i.e. slow environmental [ecological] degradability) that has been attributed to mirex and other chlorinated hydrocarbon insecticides.

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

Mortality Class	Toxicant Item Number
Ia	0102 0105 0122 0180 0181 0184 0205 0273 0279 0280 0326 0351 0434 0561 1001 1209 1340 1360 1362 1368 1374 1391 1392 1395 1398 1400 1404 1406 1540 1550 1552 1753 1756 1758 1759 1761 1990 1995 2003 2080 2183 2185 2193 2311 2315 2316 2320 2326 2332 2340 2342 2344 2348 2349 2351 2630 2632 2644 3163 4181 4207 4260 4891 4896 4898 4902 4905 4907 4909 4913 4918 4922 4924 4925 4929 4930 4932 4936 4938 4992 4993 5039 5091 5284 5437 5470 5541 5670 5671 5681 5683 5684 5686 5687 5689 5693 5694 5697 5698 5699 5702 5713 5822 5839 5841 5844 5848 5853 5858 5859 5860 5868 5879 5881 5895 5896 5897 5898 5899 5905 5906 5907 5908 5912 5913 5914 5916 5923 5926 5927 5932 5933 5939 5940 5942 5944 5947 5956 5960 5961 5963 5970 5971 5973 5974 5980 5984 5986 6002 6042 6048 6068 6070 6073 6074 6096 6100 6101 6105 6112 6114 6116 6117 6122 6124 6125 6130 6133 6135 6144 6145 6146 6147 6148 6150 6153 6157 6165 6207 6214 6227 6239 6240 6248 6252 6268 6269 6273 6276 6296 6301 6348 6353 6355 6356 6358 6361 6365 6366 6367 6368 6373 6374 6377 6380 6383 6384 6391 6404 6413 6414 6416 6417 6419 6420 6424 6425 6426 6427 6428 6433 6436 6438 6439 6444 6445 6462 6468 6708 7112 7119 7132 7138 7144 7310 7346 7540 7575 7576 7577 7651 7655 7674 7686 7980 8047 8048 8056 8057 8100 8101 8102 8110 8114 8115 8117 8139 8144 8150 8152 8169 8170 8184 8186 8210 8215 8373 8399 8408 8470 8549 8703
Ib	0107 0177 0178 0179 0182 0187 0271 0276 0282 0291 0310 0321 0335 0592 0917 1889 1989 2377 2518 2641 2913 5189 5615 5666 5849 5865 5891 5917 5934 5941 5946 5965 6045 6046 6049 6102 6108 6134 6164 6168 6293 7246 7495 8145 8402

Table 1. (Continued)

Ic	0101 0126 0269 0281 0340 1244 1281 1368 1390 1410 2220 4068 4972 5189 5845 5856 5874 5931 5997 6005 6043 6126 6218 6237 6270 6278 6322 7519
IIa	2647 5921 6225 6288 6309 6343 6431 6433 6434
IIb	5991 5993 6113 6118 6136 6193 6199 6204 6286
IIc	6199 6343
IIIa	1889 5962 6018 6057 6067 6069 6079 6094 6129 6170 6172 6228 6305 7618
IIIb	5955 6013 6169 6200 6307
IIIc	5990 6019 6053 6111 6197 6223 6260 6295 6329
IV	ENT-27931[a] ENT-27932[b] ENT-27933[c] ENT-27934[d] ENT-27935[e] ENT-27936[f] ENT-27937[g] ENT-62469[h]
V	5008

[a]Phosphorothioic acid, *O*-(*p*-bromophenyl) *O,O*-dimethyl ester (R. S. 11 Hebrew University)
[b]Phosphorothioic acid, *O*-(*m*-bromophenyl) *O,O*-dimethyl ester (R. S. 12 Hebrew University)
[c]Phosphorothioic acid, *O*-(*o*-bromophenyl) *O,O*-dimethyl ester (R. S. 13 Hebrew University)
[d]Phosphorothioic acid, *O*-(*p*-fluorophenyl) *O,O*-dimethyl ester (R. S. 14 Hebrew University)
[e]Phosphorothioic acid, *O*-(*o*-fluorophenyl) *O,O*-dimethyl ester (R. S. 15 Hebrew University)
[f]Phosphorothioic acid, *O*-(2,5-dibromophenyl) *O,O*-dimethyl ester (R. S. 16 Hebrew University)
[g]Phosphorothioic acid, *O*-(2,4-dibromophenyl) *O,O*-dimethyl ester (R. S. 17 Hebrew University)
[h]Phosphoric diamide, *N,N,N′,N′*-tetramethyl-*p*-propyl-[PHT-2066GD (PCRB)]

Although many phosphorothioic acid compounds have been tested against the imported fire ant in toxic baits (Lofgren et al. 1973), Nemacide® (Phosphorothioic acid, 0-2, 4-dichlorophenyl *0,0*-diethyl ester), was the only chemical in this group of compounds that has shown effective Class IV delayed action in the laboratory. Field tests with Nemacide® gave poor control of the imported fire ant (Lofgren et al. unpublished).

Since an alternate compound that can replace mirex for extended field application is greatly needed, all bait toxicants exhibiting effective toxicity (i.e. compounds exhibiting consistent Class IV or greater delayed action) will be considered potential candidates for control of the red imported fire ant.

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