EFFECTIVENESS OF EMULSIONS AND CONTROLLED-RELEASED GRANULES OF CHLORPYRIFOS AND ISOFENPHOS ON RED IMPORTED FIRE ANTS[1] IN CULTIVATED FIELDS[2]

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ABSTRACT

Controlled-release granules of isofenphos at 1.12 kg/ha AI produced a significant reduction in the number of fire ants trapped and in the number of stations with ant activity by 2-wk posttreatment. However, by 16 wk, levels of ant activity were comparable to that of the adjacent untreated check. Emulsions of isofenphos and chlorpyrifos and controlled-release granules of chlorpyrifos were ineffective in suppressing ant activity at 1.12 kg/ha AI.

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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 in imply registration under FIFRA as amended.

Key Words: *Solenopsis invicta*, imported fire ants, control, organophosphates, controlled-release

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The cancellation in 1978 of registrations for mirex (Holden 1976, Johnson 1976) left no effective chemical available for area control of red imported fire ants (RIFA), *Solenopsis invicta* Buren, in cultivated fields. Although Hillman (1976, 1977) and Morrill (1977) demonstrated that some of the organophosphates were effective as mound drenches, such methods are impractical for control of the ants on large areas with numerous nests. Because reports of crop damage or yield losses due to RIFA (Adams *et al.* 1976, 1977, Glancey *et al.* 1979, Harlan *et al.* 1980, Lofgren and Adams 1981) indicated a definite need for practical and economical control measures for cultivated areas, we began tests in 1978 to determine if some of the organophosphates, applied as a broadcast treatment, would provide sufficient control of the ants through a growing season to prevent crop damage and interference with harvest. The tests (Stringer *et al.* 1980) evaluated emulsions of acephate and chlorpyrifos applied to the soil surface at a rate of 1.12 kg/ha active ingredient (AI) and immediately disked into the soil. The insecticides were disked in on the hypothesis that (1) disking would destroy the mound and scatter the ants, particularly the queen and immatures, through the soil where they would be more likely to be directly contacted by the insecticide as it was applied; (2) incorporation of the chemical in the soil would ensure greater contact with the residues as the ants regrouped and rebuilt the mounds and as they constructed and utilized the foraging tunnels which radiate from the mounds at depths of 1 to 11 cm below the soil surface (Green 1967, Markin *et al.* 1975).

Results of these tests showed that the chemicals temporarily suppressed ant foraging but caused little mortality. The suppression of foraging for the first 1 to 2 weeks after treatment with a rapid return to pretreatment levels thereafter suggested that the chemicals volatilized or degraded so rapidly as to be ineffective against the ants.

Meanwhile, tests by Collins *et al.* (1980) of chemicals for use in treatment of nursery potting media showed that granular clay formulations of chlorpyrifos and isofenphos (1-methylethyl 2-[[ethoxy[(1-methylethyl)amino]-phosphinothioyl]-oxy]benzoate) provided long-lasting residual activity against RIFA when incorporated into the soil at the rate of 14.65 g ai/m^3. Controlled-release formulations gave somewhat longer activity against RIFA in small field plots than did formulations on conventional clay granules (Collins - personal communication).

Because of the results obtained by Collins, we conducted tests in 1980 to determine if controlled-release formulations of chlorpyrifos and isofenphos might be more effective than emulsions against RIFA in cultivated fields. The results of these tests are reported below.

MATERIALS AND METHODS

Five 0.5 ha plots were established on an ca. 4.0 ha sandy loam field in

Harrison Co., MS that supported an average infestation of ca. 100 nests/ha of RIFA at the initiation of the test. The field had been planted to corn in 1979 but had lain fallow from harvest of the corn to the initiation of these tests. Following the same rationale as in our previous test (Stringer *et al.* 1980) we disked the plots 3 times at weekly intervals in June 1980. Just before the third disking a Hercon® controlled-release granular formulation (Health-Chem Corportation, New York, N.Y.) containing 10% isofenphos or chlorpyrifos was applied to one plot each at a rate of 11.2 kg/ha (1.12 kg/ha AI) with a tractor-mounted granular applicator and immediately incorporated into the soil by a second tractor with a disk. The granules were prepared by Hercon using technology that incorporated the insecticide in the center layer of a three-layer polymeric system. The insecticide diffused slowly through the outer layers and from the granule edges at various rates dependent on the type polymer and also granule size. A single polymer type was used in our formulations, although the granule size varied greatly.

One plot each was also treated with an emulsion of isofenphos or chlorpyrifos at a rate of 233.7 liters/ha (1.12 kg/ha AI) from a spray boom fitted with three 8003 Teejet® flat fan nozzles and mounted atop the disk. The spray was dispersed onto the soil between the front and rear gangs of the disk so that it was immediately cut into the soil. One plot was left untreated as a check. No crop was planted on any of the plots although the seedbed was adequately prepared for planting to corn, soybeans, or peanuts.

The effectiveness of the treatments was assessed by placing baited traps at ca. 4.57 m (15 ft) intervals along one diagonal across each plot. The usual method of monitoring the efficacy of insecticidal treatments against RIFA is by establishing evaluation plots and making comparative pre- and post-treatment counts of the number of active mounds. (Banks *et al.* 1973). However, since the mounds in these tests were destroyed by the initial disking and were rebuilt relatively slowly, an alternate method of evaluation was required. Other studies (Glancey *et al.* 1976, Stringer *et al.* 1980) had shown that RIFA are strongly attracted to meat baits, thus, in this test traps baited with ground beef were used to capture foraging ants and provide a method for estimating changes in populations. Since the plots were within the same field and all subjected to essentially the same variables except the insecticides, the number of foraging ants trapped on given dates and compared to the untreated check and to pretreatment levels appeared to provide a viable mode of comparison of treatments. The traps were made from 29.6 ml (1 oz) clear plastic cups fitted with tightfitting snap caps. A hole (ca. 2.0 mm dia.) was opened in the side of each cup near the bottom and 1-2 g of ground beef was placed in the bottom near the hole. Each plot was sampled pretreatment, and at 1, 2, 5, 8, and 16-wk post-treatment. On each sampling date 25 traps were placed along the diagonal of each plot between 7 and 8 a.m. and allowed to remain for 1 hour. At the end of the exposure time each trap was collected, the hole was sealed with tape, and the trap was returned to the laboratory where the number of ants in each was determined. The total number of ants trapped for each treatment on each sampling date and also the percentage of stations where ants were trapped on each date was compared by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

None of the treatments produced any detectable reduction in the number of ants foraging after one week (Table 1). This was in direct contrast to the results we obtained with chlorpyrifos in the previous study (Stringer *et al.* 1980) when ant activity declined by 55 to 89% after one week. The exact reason for this apparent difference is unclear, however, it probably reflects differences in the rate of volatilization of the chemical from the treated soil. The rate of volatilization presumably varies dependent upon such factors as temperature, soil texture, soil moisture level and possibly others. The results of our previous study with chlorpyrifos (Stringer *et al.* 1980) indicated that the chemical was not very toxic to the ants at the applied rate but was repellent and suppressed foraging during the first 1 to 2 weeks. After the repellency dissipated, foraging returned to pretreatment levels. We have found in previous studies (Banks *et al.* 1977, Lofgren and Stringer 1964, Stringer *et al.* 1964) that some insecticides, particularly the organophosphates, are strongly repellent to fire ants and will severely retard or prevent foraging and/or feeding. Although many of these chemicals are very toxic to fire ants, because of their repellency they are avoided by the ants and thus cause little or no mortality unless the chemical has long residual toxicity.

Table 1. – Effects of application of isofenphos or chlorpyrifos as emulsions or controlled-release granules on populations of red imported fire ants in cultivated fields.

	Pretreatment	Posttreatment 1 wk	2 wk	5 wk	8 wk	16 wk
Isofenphos, E. C. 720 g/l						
Total No. Ants	2371^{a}	2222^{a}	4891^{ab}	6832^{a}	2925^{a}	5131^{a}
% Stn. with Ants	88.0^{ab}	92.0^{ab}	84.0^{a}	100^{a}	64.0^{b}	92.0^{a}
Isofenphos, 10% granular controlled-release						
Total No. Ants	1771^{a}	2044^{a}	3011^{b}	2485^{c}	2236^{a}	4794^{a}
% Stn. with Ants	96.0^{a}	80.0^{b}	60.0^{b}	56.0^{b}	48.0^{b}	92.0^{a}
Chlorpyrifos, E. C. 480 g/l						
Total No. Ants	2295^{a}	2174^{a}	5898^{a}	4347^{b}	1558^{a}	4799^{a}
% Stn. with Ants	76.0^{b}	92.0^{ab}	92.0^{a}	96.0^{a}	44.0^{b}	92.0^{a}
Chlorpyrifos, 10% granular controlled-release						
Total No. Ants	2827^{a}	2221^{a}	3960^{ab}	6848^{a}	1692^{a}	5513^{a}
% Stn. with Ants	92.0^{ab}	88.0^{ab}	60.0^{b}	92.0^{a}	52.0^{b}	96.0^{a}
Control, Disking only - no pesticide						
Total No. Ants	2068^{a}	2577^{a}	6129^{a}	6988^{a}	2852^{a}	4402^{a}
% Stn. with Ants	96.0^{a}	100^{a}	100^{a}	100^{a}	100^{a}	92.0^{a}

Values followed by a common letter in a column do not differ significantly at the .05 level of confidence from other values in that category by Duncan's Multiple Range Test.

When ant-infested areas are broadcast treated with such materials, the ants simply retreat into the nest and remain until the repellency dissipates and then resume foraging. The only effect of such a treatment then is a temporary suppression of foraging unless sufficient residual remains to kill the foraging workers. The results obtained in the present test indicated that the repellency of the emulsions of isofenphos and chlorpyrifos dissipated so rapidly that ant foraging, if ever reduced, had returned by 1 week to levels equal to that on the untreated check. There was no evidence that the emulsions of either chemical produced any appreciable mortality of foraging ants at any time during the test.

The controlled-release formulations were more active than the emulsions against the ants because the coatings retarded dissipation and kept the chemical available over a longer period. The slower rate of release is reflected in the fact that the number of ants foraging on the controlled-release plots did not show any reduction after the first week but was significantly reduced after 2 weeks on the isofenphos plot and was substantially reduced on the chlorpyrifos although the reduction there was not significantly lower than the check. Evidence of some activity of the controlled-release formulations during the first week was indicated by reductions in the number of stations where ants were trapped. Variation in distribution of particle size probably accounted for the reduction at some stations and not at others. The controlled-release isofenphos remained active against the ants through 5 weeks as evidenced by significant reductions in the number of ants foraging and the percentage of stations where ants were trapped as compared to the untreated check. It is not known whether the reductions reflect mortality of foraging workers or simply extended repellency of the chemical due to the release of the material over a longer period. In any case the controlled-release isofenphos did not provide full growing season suppression of the ant population as shown by the fact that by 16 weeks foraging ant populations and percentage of stations with ants were comparable on all treatments and the untreated check.

Activity of the controlled-release chlorpyrifos was very short-lived. The number of ants captured at 2 weeks was reduced, although not significantly, and the percentage of stations where ants were captured was significantly reduced. However, both the number of ants captured and the percentage of stations with ants was comparable at 5 weeks to that on the untreated check indicating that the chlorpyrifos was no longer affecting the ants.

The data for 8 weeks posttreatment showed reductions in the number of ants trapped on all plots including the check and significant reductions in the number of stations with ants as compared to the check. These reductions are felt to be an artifact, however, caused by feeding of the ants on fall armyworms, *Spodoptera frugiperda* (J. E. Smith). Populations of the armyworms were heavy (30-40 larvae/m^2) and the ants were observed attacking worms on the soil surface and on weeds. Fire ants have been previously observed attacking and feeding on fall armyworms (Hays and Hays 1959, USDA 1958) although no information is available concerning extent of predation. Apparently in this test armyworms were more appealing to the ants as food than was the ground beef in the traps since ants were observed feeding on larvae near several traps although no ants entered the traps.

The results obtained in this test and in the previous test (Stringer *et al.* 1980) demonstrated that 1.12 kg ai/ha of acephate, chlorpyrifos, or isofenphos did not provide suppression of imported fire ants in cultivated land throughout a crop season. Controlled-release formulations, particularly with isofenphos, were slightly more effective against RIFA than the emulsions. They did not, however, provide sufficiently greater or longer lasting effectiveness to warrant the added cost of formulation. The principal effect of any of the treatments, as we have indicated, appeared to be suppression of foraging due to repellency of the chemicals to the ants. Sheppard (1981) reported reductions in numbers of active nests with 1.12 kg ai/ha of diazinon, however, it is uncertain whether these reductions represented actual mortality of colonies or extreme repellency of the chemical that caused the colonies to move completely out of the treated plot.

Heavier rates of application of the chemicals may be more effective in eliminating ants from cultivated areas, however, these have not been tested and may be cost prohibitive for the benefits obtained. Also, other studies (H. L. Collins - personal communication) have shown that by 90 days after disked-in applications of 5.6 kg ai/ha of chlorpyrifos or 11.2 kg ai/ha of isofenphos for ant control in grass sod, ants were again active on the treated areas. Nevertheless, broadcast applications of chemicals such as diazinon, acephate, chlorpyrifos, or other materials as suggested by Sheppard (1981) may be beneficial in certain instances. Harlan *et al.* (unpublished data) have found that corn is most susceptible to damage by RIFA during the first week after planting. Use of such chemicals at time of planting might afford sufficient protection for corn or other crops during the first critical days of life.

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