THE DEVELOPMENT OF FLUOROSULFONATE BAITS FOR THE CONTROL OF STRUCTURAL PESTS

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Abstract—A new class of chemistry, the fluorosulfonates, is being developed for the control of structural pests such as ants and termites. The novel bait chemistry has been found to be effective over a wide range of dose dependent concentrations over most structural pests. A brief review of the data is presented.

INTRODUCTION

Vander Meer et al. (1985) reported on a new class of delayed-action bait insecticides, the fluoroaliphatic sulfones, for the control of the red imported fire ant, (*Solenopsis invicta* Buren). Today this class of chemistry, the fluorosulfonates, is managed by an agreement between Griffin Corp. and FMC Corp. with global development plans which centre around pests in the near environment to man. The relative lack of repellency, the broad pest range, and the dose dependent mortality response makes the chemistry ideal for the development of highly effective, targeted baits. The discussion today will focus on the progress made using this bait chemistry to manage populations of the red imported fire ant, Pharaoh's ant, (*Monomorium pharaonis* (L.)), and the Eastern subterranean termite, (*Reticulitermes flavipes* (Kollar)). Comparisons with commercially available baits will be included where data are available.

The fluorosulfonates included in this discussion include: sulfluramid, and another class member, F1642. Sulfluramid is the only member of the class currently in the marketplace, and is sold both to the professional pest control industry and over the counter to homeowners.

The driving force behind the discovery of new slow acting toxicants seems to be the need to control fire ants. Since 1958, the USDA has tested more than 7500 compounds in the search for delayed toxicity against fire ants (Vander Meer *et al.* 1986). The very few compounds found to meet the requirement of delayed activity, the ability to be formulated in a matrix acceptable to the ant, and environmentally suitable could be easily listed as follows: mirex, chlodecone, hydramethylnon, abamectin, and the fluorosulfonates. Other compounds such as the unusual imidacloprid, and the IGRs, fenoxycarb, methoprene, and hexaflumuron are also in use or in development.

The delayed-toxicity is an important component because of the attempt to manage very large insect populations (150,000 fire ants per mound for instance) requires that the bait be introduced into the pest population where the insects continue to disperse the toxicant via regurgitation and grooming (Vander Meer *et al.* 1986). The length of time for the delay appears to depend upon the intensity of the bait program, accuracy of bait placement, and the type of bait used. Delay-action stomach poisons work right away (depending on dose) to kill workers and hopefully the queen(s). IGR type compounds typically do not kill adults at all but stop egg production in the queen (JHA) or kill immature pests as they moult (chitin inhibitors). IGR compounds can thus take longer to control a pest population (many weeks) or even result in the dispersal of the toxicant well beyond the property treated (Edwards, 1975; Moreland, 1992).

Fire Ants

This introduced pest infests most of the southern United States where it out-competes native ant species and constructs mound colonies in about any environment. The colony is highly aggressive which is manifested by a nearly instantaneous attack upon any organism disturbing the mound with up to hundreds of stings as a result. A small number of venom-sensitive people are killed by fire ants each year as are numerous pets. Control with conventional insecticides is often not effective and the disturbed colony frequently just moves. Bait toxicants have been found effective in managing fire ant populations through time.

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Fire ant baits typically consist of defatted corn grits which are coated with soybean oil containing the toxicant. The grit is placed around the base of the mound where the ants find and carry the grit into the mound and consume the oil (and the toxicant). If the queen dies, the colony dies out. Large geographic areas of the fire ant infested states contain multi-queen colonies which are harder to control. Characterizing the relative activity and brood content of a mound is used to measure efficacy through time. Reinfestation occurs through time either from new queens entering an area of colony movement (Lofgren and Williams, 1985).

Fire ant control programs have been conducted with the grit baits broadcast over large areas or sprinkled around the base of mounds. Significant suppression of fire ant populations has occured through the use of sulfluramid baits. In fact, sulfluramid has worked as well as the standards currently in use (Banks *et al.* 1992, Diffie *et al.* 1992 and Appel *et al.* 1990).

The following data from Diffie *et al.* (1992) are illustrative of the type of control obtained. Note that the IGR fenoxycarb requires additional time for control to begin to occur. The same initial slow control was also noted by Appel *et al.* (1990).

Grit Bait	% ai	Tablespoons Per Mound	Mean % Control at Week 2	6	15
sulfluramid	0.60	3	54	87	62
hydramethylnon	0.88	5	80	95	25
fenoxycarb	1.00	3	0	60	40

Pharaoh's ants

Pharaoh's ants are very tiny, non aggressive ants which can develop colonies consisting of several hundreds of thousands of ants. The primary concern with this ant species is their infestation of complex structures (hospitals) which presents mechanical vectoring of disease issues. The colonies contain dozens of queens and can easily fragment or move. Control is difficult and may require extensive baiting to be sure to kill all the queens (Hedges, 1992).

The following trial was conducted to compare sulfluramid ant bait to commercial standards under field conditions. Five replications were used per bait and ant activity monitored over 90 days. No difference in control was noted between sulfluramid and standard products (FMC,1992a).

Bait Station	% ai	Mean % Reduction at Day 3	7	14	28	60	90
sulfluramid	0.50	96	97	95	95	99	98
hydramethylnon	1.00	97	98	99	100	98	100

Eastern subterranean termites

Conventional control of termite activity involves the application of a termiticide barrier to provide structural protection. This technique generally works well but the termites are still nearby the structure and their random foraging may eventually result in addition infestation either through gaps in the termiticide barrier or through the degradation of the barrier through time. The use of baits as a means of termite control was noted by Kofoid (1934) where it was reported that straw dipped in a sugar/sodium arsenite solution was effective in the tropics against harvester termites.

As termites are cryptic by nature, a means of measuring termite activity is critical to determining the level of control achieved by baiting strategies. Researchers have managed to measure foraging areas of termites through the use of radioactive tracers (Spragg and Paton, 1980,), release-recapture (Esenther 1980), or by monitoring with rolls of toilet paper (Haverty et al. 1975). Release-recapture appears to be the method of choice of most researchers today.

Initial attempts to suppress termite activity have focused on the use of mirex treated wood blocks placed at regular intervals throughout a plot by Esenther and Beal, (1974; 1978; 1979), Esenther and Gray (1968), Paton and Miller (1980), Beard (1974), and Lin (1987). Additional researchers pursued the use of the IGR methoprene and fenoxycarb (Mauldin *et al.*, 1985; Howard and Haverty, 1978 and Jones, 1987) where termite mortality occurs but at a much slower rate than with stomach poisons such as mirex.

The first attempt to suppress termite populations around homes appears to be that of Ostaff and Gray (1975) where a regular pattern of mirex treated baits were maintained around 8 homes for 3 years. This program was largely successful in protecting the homes from Eastern subterranean termite attack.

A number of factors which probably influence the actual control obtained through bait activities include bait location, bait number, bait moisture content and the relationship between the bait toxicant concentration and the number of days required for mortality. Delaplane and La Fage (1989) noted that wood with high moisture content was the best bait for Formosan termites. Su *et al.* (1987) defined the effective lethal time (ELT 90) required to kill 90% of the termite population over a 14-day period for two stomach poisons and two conventional termiticides. The LT50 of a termite population can be adjusted by increasing or decreasing the dose with stomach poisons (barring repellency). IGR compounds present a different problem in that the dose response is not as pronounced and mortality can stretch out for weeks. Effective termite suppression has apparently been achieved at six locations with the use of the chitin inhibitor hexaflumuron (Moreland, 1992). Control time was reported to require several months which is typical for an IGR.

The fluorosulfonates have been found to be highly effective against both Eastern and Formosan subterranean termites where the dose dictates the LT50. Su and Scheffrahn (1988) reported an ELT 90 for sulfluramid as 5–10 ppm for *C. formosanus* and 100–250 ppm for *R. flavipes*. Additional laboratory work (FMC 1992b) indicated that F 1642 was also very efficacious against Eastern Subterranean termites at very low concentrations.

Filter Paper	Mean % Mortality of Colonies at Day			
PPM F1642	7	10	13	16
0.0	0	33	33	33
0.5	0	0	67	67
5.0	0	33	100	100
50.0	67	67	67	100
500.0	100	100	100	100

In all cases, filter paper was fed upon.

It would appear that the fluorosulfonates will serve as suitable bait toxicants whereby the LT50 can be adjusted through dosage to fit the needs of the termite management program.

The fluorosulfonates is a developing class of stomach poisons which are highly suitable for bait formulation development. Sulfluramid appears to have few toxicological issues, is highly efficacious across a wide variety of structural pests, and repellency issues have not surfaced. There is a need to develop the even more efficacious members of this class along with novel formulations and application methods for resistance management programs and to develop new tools for the management of urban insect pest populations.

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