# Why delay when you bait and spray?

## UCR researchers test delayed toxicity on Argentine ants

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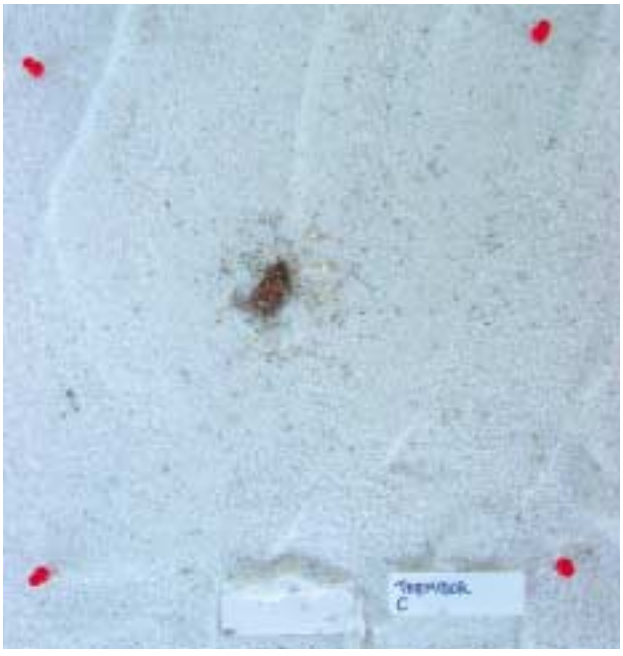
Delayed toxicity is such an obvious and fundamental requirement of ant baits that we forget that it was only 40 years ago that the concept was introduced by Stringer et al. (1964). As originally conceived, it applied to formulations of bait toxicants for red imported fire ants.

In their search for effective bait toxicants to replace Mirex, the United States Department of Agriculture evaluated more than 7,200 chemicals, of which only nine became or will become commercially available (Williams et al. 2001). This monumental task paid off: Today's baits formulated with corn grit and soybean oil are some of the most effective ant baits on the market for red imported fire and harvester ants.

Argentine ants present a new set of challenges in bait development. What soybean oil is to fire ants as a food attractant, sucrose water is to Argentine ants. Formulating baits with sucrose water, however, is difficult because most toxicants are oil-soluble. At UC Riverside, we have been experimenting with toxicants that have some degree of solubility in sucrose water. We have found that the optimal concentration of active ingredient in sucrose water is a delicate balance between its toxicity and attractiveness to the ants.



*Argentine ants forage across a fipronil-treated panel 15 minutes after the discovery of a cockroach (center).*

### CONCENTRATION COUNTS

The relationship between a bait's toxicity (measured as an $LT_{50}$) and attractiveness (measured by the amount consumed) can be graphed as a function of the concentration of active ingredient (see figure 1, next page). The area of the shaded rectangle in the graph represents the range of bait concentrations that have delayed toxicity and are readily consumed by the ants. The rectangle's height is specified by $LT_{50}$s that range from one to four days, and its width represents the optimal concentration range of the bait.

Both dimensions are critical: If the concentration of active ingredient is too low, the bait will be readily consumed, but it will not be lethal. If the concentration is too high, it will kill the ants too fast and only a small amount of bait will be consumed. Additionally, when ants share the bait with one another, the toxicant will be diluted. If its optimal range of activity is too narrow, the bait will lose its effectiveness.

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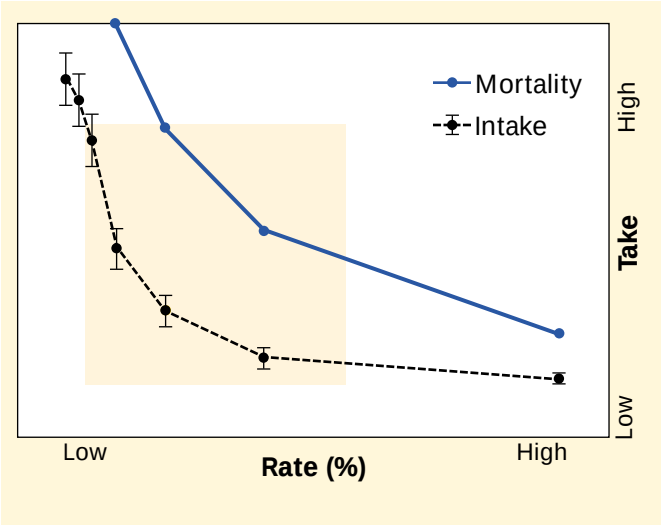


*Figure 1. The relationship between bait toxicity and consumption.*

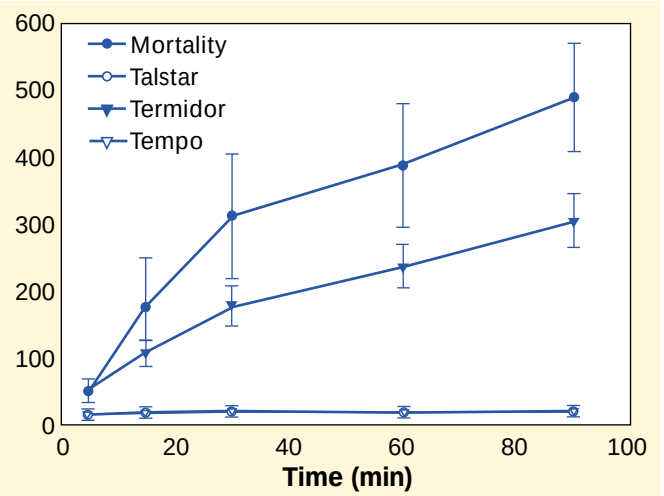


*Figure 2. Number of ants crossing the treated barriers. Barriers were treated at 50% the label recommended rate.*

Graphs of Argentine ant responses to three active ingredients dissolved in 25% sucrose water reveals important differences in the optimal range of activity. For example, thiamethoxam spans a15-fold range of concentrations from 2 x $10^{-5}$ to 3 x $10^{-4}$%, and imidacloprid a 13-fold range from 7.1 x $10^{-4}$ to 9.2 x $10^{-3}$%. Compared to boric acid, which spans only a 7-fold range of concentrations from 0.5 to 3.7%, thiamethoxam and imidacloprid are effective at ultra-low doses over a much wider concentration range. Thus, the "margin of error" for baits formulated with thiamethoxam and imidacloprid is much greater than those with boric acid.

Given that an Argentine ant typically feeds four to 12 other ants (Markin 1970), a liquid bait could eventually be diluted to a point where it is no longer effective. At the other extreme, evaporation from a bait delivery system could increase the concentration of toxicant to a level that is also outside the effective range. This can be particularly critical for baits formulated with boric acid, because of its narrow range of activity.

## DELAYED TOXICITY

Delayed toxicity can also be a beneficial attribute of residual insecticides. Spray formulations of nonrepellent, delayed-action insecticides might perform like baits (Vail et al. 2003). To validate this, we provided outdoor nests of Argentine ants with a cockroach placed in the center of a sand-covered panel that was treated with insecticide. If the spray is nonrepellent and has sufficiently delayed toxicity, the ants will recruit to the cockroach and maintain an active trail over the treated surface for several hours.

Just like tracking powder for rodents, the ants unwittingly trail across the treated surface picking up a lethal dose of insecticide. Not only does the individual forager that crosses the treated surface eventually die, but some ants in the nest that come into contact with the tainted forager die as well. The mechanism of this horizontal transfer of insecticide to other ants is unknown.

The behavioral response of Argentine ants to different active ingredients varies. When the panel is treated with cyfluthrin or bifenthrin, for example, the ants cannot form recruitment trails. These pyrethroids have fast knockdowns ($LT_{90s}$ = 4.7 and 8.2 min, respectively), so scouts cannot make it back to the nest. At lower concentrations, the lethal times increase sufficiently to allow some recruitment and limited trailing across the panels. The delayed action of fipronil ($LT_{90}$ = 114 min) is such that it allows the recruitment system to fully engage for several hours (see figure 2).

The beauty of these delayed-action bait toxicants and residual insecticides is that they exploit the recruitment process of ants. The active ingredient in baits is brought into the colony and distributed to other workers, brood and potentially even the queens. Greater numbers of workers contact barriers that have delayed toxicity, increasing their efficacy. Both baits and the nonrepellent sprays with delayed-action insecticides used as standalone or combination treatments will provide powerful new tools for Argentine ant control. **PC**

### *References*

*Markin, G.P. 1970. Food distribution within laboratory colonies of the Argentine ant, Iridomyrmex humilis (Mayr). Ins. Soc. 27: 127-158.*

*Rust, M.K., D.A. Reierson, and J. H. Klotz. 2004. Delayed toxicity as a critical factor in the efficacy of aqueous baits for controlling Argentine ants (Hymenoptera: Formicidae). J. Econ. Entomol. (in press)*

*Stringer, C.E., C.S. Lofgren, and F.J. Bartlett. 1964. Imported fire ant toxic bait studies: evaluation of toxicants. J. Econ. Entomol. 57: 941-945.*

*Vail, K.M., D. Bailey, and M. McGinnis. 2003. Perimeter spray and bait combo. Pest Control Technology 31(7): 96-100.*

*Williams, D.F., H.L. Collins, and D.H. Oi. 2001. The red imported fire ant (Hymenoptera: Formicidae): an historical perspective of treatment programs and the development of chemical baits for control. Amer. Entomol. 47: 146-159.*