Evaluation of Pesticide-Treated Spheres for Control of Apple Maggot Flies in 2003

Ronald J. Prokopy, Isabel Jácome, Everardo Bigurra, and Marina Blanco
Department of Plant, Soil, & Insect Science, University of Massachusetts

Bradley Chandler and Starker Wright
Pest Management Innovations Inc., Harpers Ferry West Virginia

In the two preceding articles in this issue of *Fruit Notes*, we described results of recent research aimed at optimizing (1) distances between odor-baited spheres on perimeter trees for control of apple maggot flies (AMF) and (2) placement of spheres within the tree canopy. These results were obtained using spheres coated with Tangletrap as the agent for capturing and killing arriving AMF. If odor-baited spheres are to be used extensively for AMF control in commercial orchards, a substitute for Tangletrap as fly killing agent must be found. One potential substitute that we began to develop in 1990 and have been refining ever since is a sphere whose surface has pesticide as fly killing agent and sugar as feeding stimulant to induce arriving AMF to ingest the pesticide.

In the 2001 issue of *Fruit Notes* and in a 2003 issue of the *Canadian Entomologist*, we described results of commercial-orchard tests of pesticide-treated spheres (PTS) for control of AMF. The tests were conducted in 2001 and 2002, respectively. Combined findings led us to conclude that sugar as feeding stimulant can best be maintained on the sphere surface via periodic seepage from a disc atop the sphere that contains a mixture of highly compressed sugar and paraffin wax.

Here, we describe results of tests conducted in 2003 that compare the version of PTS evaluated in 2002 with a new version of PTS developed in 2003 for AMF control. The 2002 version involved a plastic sphere coated with red latex paint containing a small amount of imidacloprid as fly killing agent, topped by a sugar-paraffin disc. The 2003 version involved an unpainted red plastic sphere topped by a sugar-paraffin disc that contained a small amount of spinosad as fly killing agent. This version relied on seepage of both spinosad and sugar from the disc onto the sphere surface under high humidity, dew, or rainfall.

Material & Methods

For the 2002 PTS version, the sphere was 3.5 inches in diameter and received a coat of latex paint containing 2% (a. i.) of imidacloprid (Provado). The disc atop the sphere was composed of 80% table sugar (sucrose) and 20% paraffin wax (200 grams total mass). It measured 3 inches in diameter x 1.5 inches tall. It was white in color, compressed under 20 tons of hydraulic pressure and embedded in a wire guard to protect it from consumption by rodents.

For the 2003 PTS version, the 3.5-inche sphere received no paint or pesticide on the surface. It was topped by a disc (similar to the 2002 version) that contained one of several different concentrations (ranging from 0.001 to 4.0% a.i.) of spinosad (Entrust) thoroughly mixed with the sugar.

In our first experiment, spheres were evaluated in six commercial orchards in MA, each of which contained four 1/2-acre plots of apple trees. Three of the plots received no insecticide after mid-June and were surrounded by either 2002-version PTS, 2003-version PTS (containing 4.0% spinosad), or sticky spheres placed 6-8 yards apart on perimeter trees. Spheres were deployed during the first week of July and remained for 12 weeks. Discs atop PTS were not

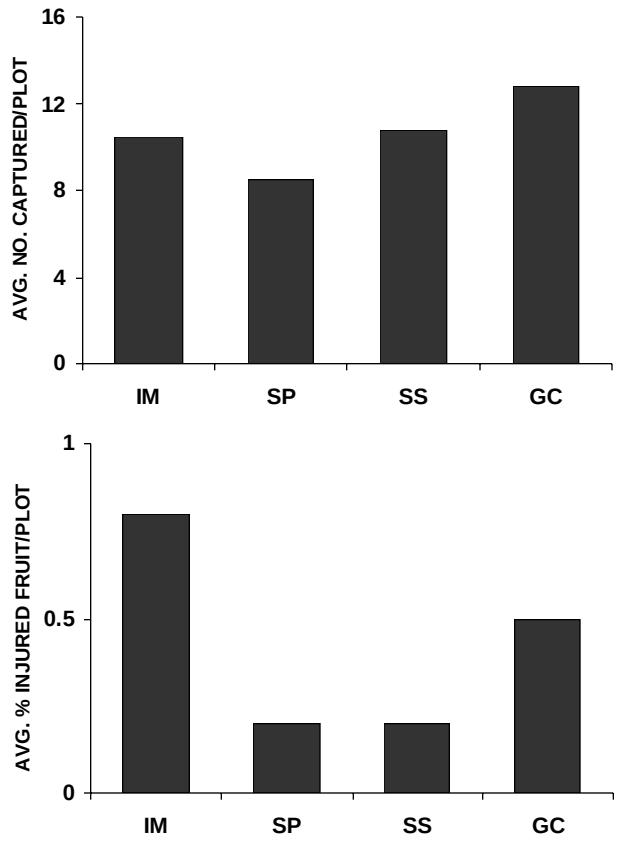

Figure 1. Captures of feral AMF on unbaited monitoring traps and percent fruit injured by AMF in 24 plots of apple trees in 6 commercial orchards in 2003. Plots with IM=imidacloprid-treated PTS, SP=spinosad-treated PTS, and SS=sticky spheres. GC= grower-sprayed plots.

replaced. Each sphere was baited with a vial containing a synthetic 5-component blend of attractive fruit volatiles. The fourth plot received two or three grower-applied sprays of organophosphate insecticide to control AMF. Treatment effectiveness was judged by comparing numbers of feral AMF captured on interior unbaited monitoring traps (four traps on central trees of each plot) and percent injury to fruit in samples taken at harvest (100 fruit per plot).

After 6, 9, and 12 weeks of sphere exposure, we retrieved two randomly-chosen PTS of each type from each of the six orchards and returned them to the laboratory for testing. We assessed the fly killing power of each retrieved PTS by exposing 10 walnut husk flies to each sphere (our supply of AMF was depleted, so we substituted adults of this other very closely related species). A single fly (deprived of food for 12-15 hours) was transferred gently to the sphere just below mid-height and allowed to remain up to 10 minutes, after which it was transferred to a small clear-plastic cup supplied with sugar and water. After 72 hours, we recorded whether the fly was dead or alive.

In our second experiment, we hung one sphere of each of six different types in each of six apple trees that received no insecticide in 2003. Sphere types per tree were as follows: one 2002-version PTS, four 2003-version PTS (topped by discs containing either 0.5%, 1.0%, 2.0%, or 4% spinosad), and one untreated (control) sphere. Spheres were deployed in early July and remained for 12 weeks. At 6, 9, and 12 weeks after deployment, two spheres of each type were brought to the laboratory and assessed for fly killing power using above procedures.

In our third experiment, we subjected 2003-version PTS to different amounts of artificial rainfall (1, 4, 7, or 10 inches) in a laboratory chamber. The chamber was designed to deliver

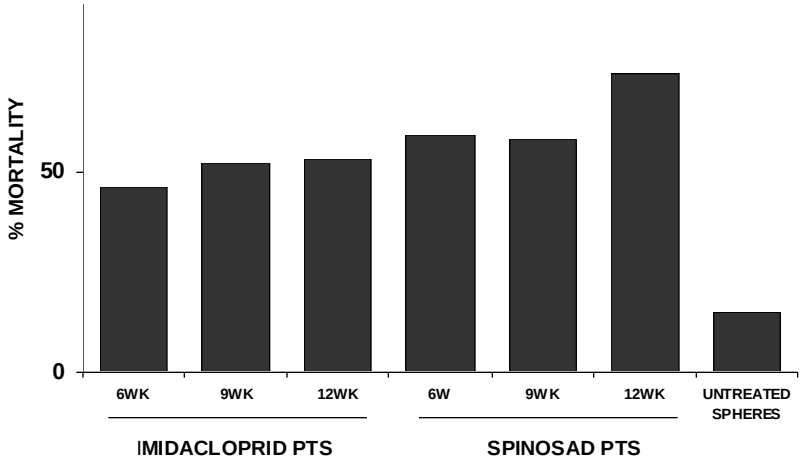

Figure 2. Percent mortality of flies 72 hours after exposure for 10 minutes in laboratory cages to PTS retrieved 6, 9, or 12 weeks after deployment in commercial orchards in early July. Each value is based on sphere exposure to 120 flies (10 per sphere x 2 spheres per orchard x 6 orchards).

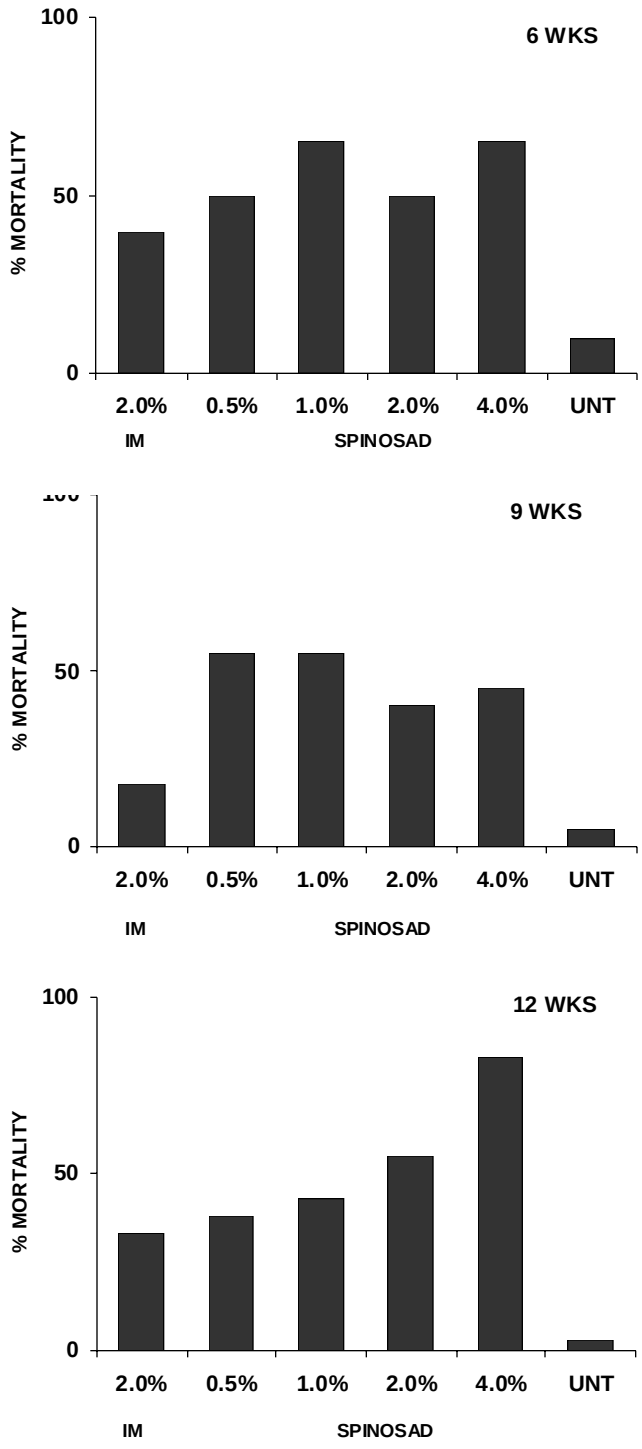

Figure 3. Percent mortality of flies 72 hours after exposure for 10 minutes in laboratory cages to PTS retrieved 6, 9, or 12 weeks after deployment in an unsprayed orchard in early July. Each value is based on sphere exposure to 20 flies (10 per sphere x 2 spheres per treatment). Treatments were: 2% imidacloprid (IM) in paint on sphere; 0.5, 1.0, 2.0, or 4.0% spinosad in discs atop spheres; or untreated spheres (UNT).

water at an intensity and droplet size approximating medium rainfall. Discs atop spheres contained either, 0, 0.001, 0.01, 0.1, or 1.0% spinosad. After each inch of artificial rain, a sphere was allowed to dry for 24 hours before the next inch was applied. Spheres were assessed for fly killing power using above procedures, accompanied by careful observation of fly feeding behavior during each 10-minute trial. A fly was considered to have fed if it remained still with proboscis fully extended for at least 10 seconds.

Results

Results of Experiment 1 (Figure 1) for commercial orchard plots show that, on average, the fewest AMF captured on interior monitoring traps and the fewest injured fruit in samples taken at harvest were in plots surrounded by 2003-version PTS topped by discs containing 4.0% spinosad. By each of these measures, 2003-version PTS outperformed both 2002-version PTS (whose surface was treated with imidacloprid) and insecticide spray for AMF control. When assayed in the laboratory (after retrieval from orchard plots) to AMF placed directly on the PTS, again 2003-version PTS containing 4.0% spinosad in the disc outperformed 2002-version PTS whose surface was treated with imidacloprid (Figure 2). Especially impressive was the finding (Figure 2) that 74% of adults died after placement on 2003-version PTS exposed for 12 weeks in commercial- orchard trees. During these 12 weeks, 18-22 inches of rain fell on the PTS.

Results of Experiment 2 (Figure 3) show that after 6 weeks of exposure in unsprayed orchard trees, 2003-version PTS topped by discs containing 0.5, 1.0, 2.0, or 4.0% spinosad were about equally effective in killing adults placed directly on the spheres (50-65% mortality). Results were nearly the same after 9 weeks of field exposure (40-55% mortality). After 12 weeks of field exposure, however, there was a consistent trend toward greater toxicity (from 38 to 83%) with increasing dose (from 0.5% to 4.0%) of spinosad in the disc. Imidacloprid-treated, 2002-version PTS were inferior to all

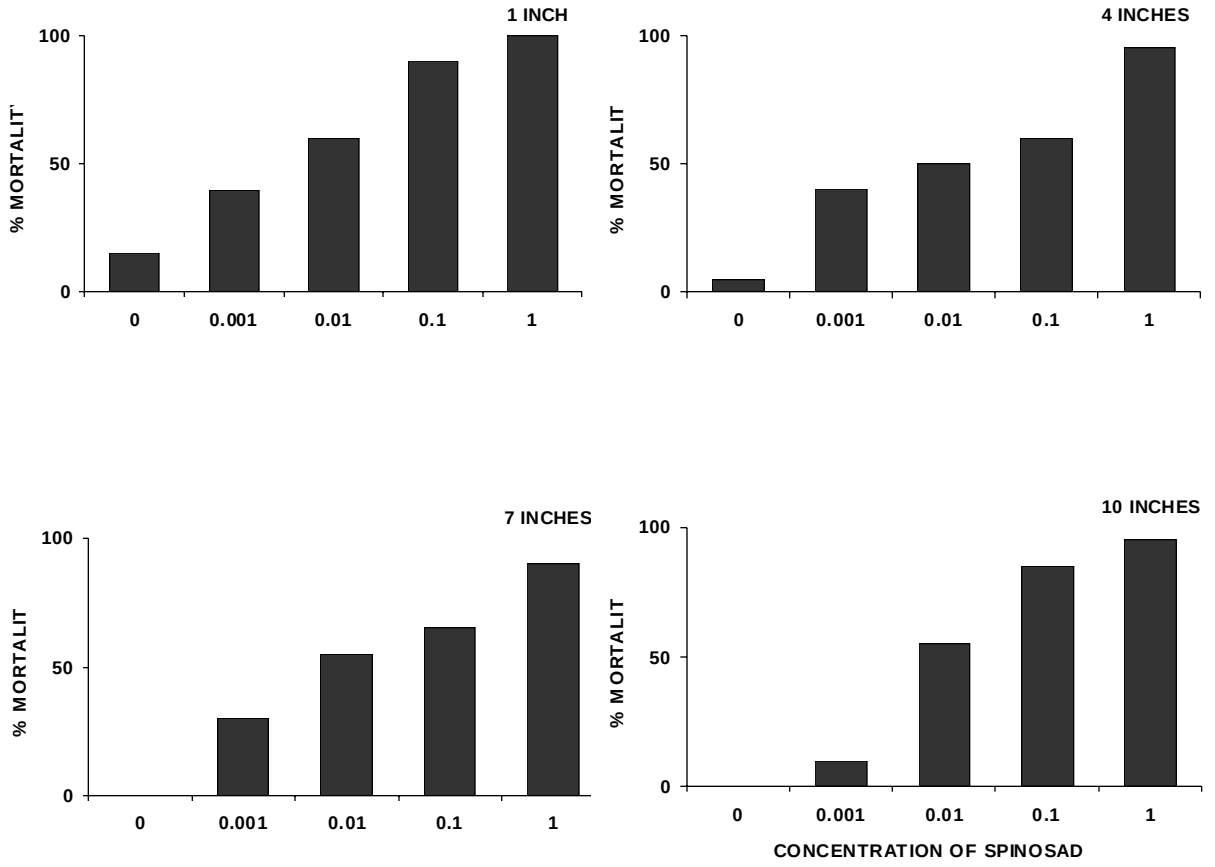

Figure 4. Percent mortality of flies 72 hours after exposure for 10 minutes in laboratory cages to spheres topped by discs that contained different concentrations of spinosad (0 to 1.0%) and received 1, 4, 7, or 10 inches of artificial rainfall before testing. Each value is based on sphere exposure to 20 flies (10 flies per sphere x 2 spheres per treatment).

2003-version PTS (regardless of dose of spinosad) at 6, 9, and 12 weeks of field exposure (Figure 3), during which cumulative totals of about 11, 13, and 21 inches of rain fell on the PTS.

Results of Experiment 3 (Figure 4) show that among adults placed on 2003-version PTS exposed to artificial rainfall of 1, 4, 7, or 10 inches, mortality of adults after 10 inches of rainfall was 0, 10, 55, 85, and 95% for spheres having discs containing 0, 0.001, 0.01, 0.1, and 1.0% spinosad, respectively. Additional results for spheres exposed to 10 inches of rainfall revealed that about 25% of adults placed on spheres moved onto the disc, irrespective of amount of toxicant in the disc (data not shown). Data in Figure 5 show that regardless of the dose of spinosad in the disc, 71-93% of flies that remained on the sphere surface (after placement there) fed for at least 10 seconds and 67-100% of flies that moved onto the disc (after placement on the sphere surface) fed on the disc. Mortality of flies that remained on the sphere surface (79-91%) or moved onto the disc (100%) was high for discs having 0.1 or 1.0% spinosad but was lower (50-56%) for discs having a 0.01% spinosad and very low (0-7%) for discs having 0.001% spinosad. Combined results from Experiment 3 suggest that after receiving 10 inches of artificial rainfall, disc-topped PTS receive enough sugar to stimulate a high proportion of adults to feed on the sphere surface but an insufficient amount of toxicant to kill a high proportion of adults at doses of spinosad of 0.01% or less.

Conclusions

Results of all three experiments conducted in 2003 pave the way for a new type of pesticide-treated sphere for control of apple maggot. The new type (our 2003-

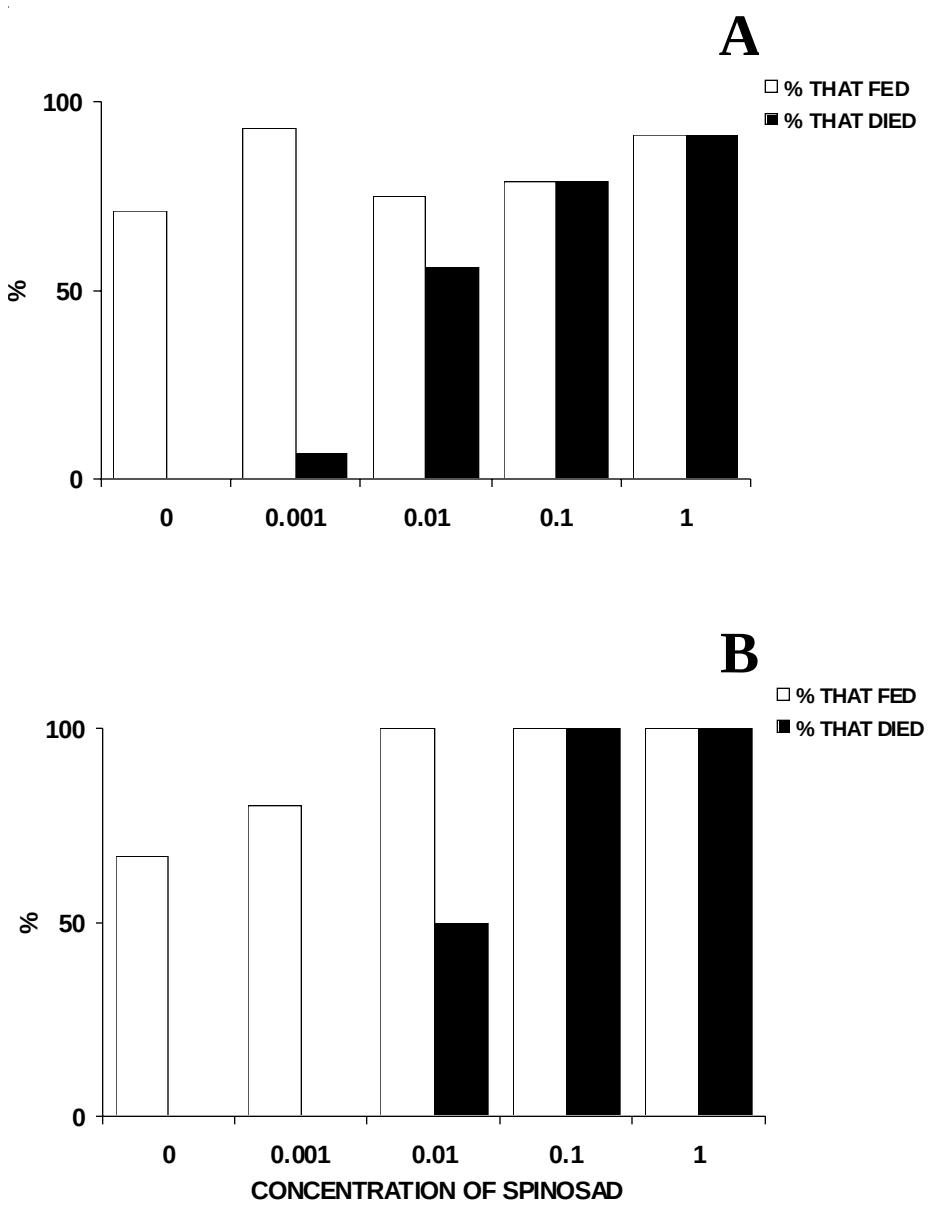

Figure 5. Among flies (from Figure 4) placed on spheres topped by discs that contained different concentrations of spinosad (0 to 1.0%) and received 10 inches of artificial rainfall before testing (A) percentage of those which remained on spheres that fed and died within 72 hours, and (B) percentage of those which moved onto discs that fed and died within 72 hours.

version) contains spinosad (Entrust) in the disc atop the sphere. Results of laboratory trials (Experiment 3) suggest that the concentration of spinosad in the disc needs to be at least 0.1% to be effective after 10 inches of artificial rainfall, whereas results of field trials (Experiments 1 and 2) suggest that a dose of spinosad higher than 0.1% may be needed to withstand amounts of natural rainfall that exceed 10 inches.

It is encouraging to know the University of Massachusetts (the financial supporter of a pending patent for this new type of PTS), Dow Chemical Company (manufacturer of Entrust), the EPA (which supervises registration of new products for orchard used), and Pest Management Innovations Incorporated (manufacturer of discs atop PTS) are jointly enthusiastic about this new technology of incorporating spinosad into sugar/paraffin discs atop spheres for managing AMF.

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