Tests of Imidacloprid-treated Spheres for Controlling Apple Maggot Fly

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In the 1996 and 1997 Spring issues of *Fruit Notes*, we reported on studies aimed at development of pesticide-treated spheres (PTS) as a substitute for sticky spheres for direct control of apple maggot flies. In concept, a PTS would be coated with a mixture of insecticide, fly feeding stimulant, and residue-extending agent. A fly landing on such a sphere would feed, ingest insecticide, and die before laying any eggs. The need to use labor-intensive sticky substances (such as Tangletrap) to capture alighting flies would be eliminated. Several earlier trials indicated that dimethoate was the most effective among orchard-labeled insecticides for use on spheres, but its high human toxicity poses too great a risk to the handler. In 1996, we found that the newly-labeled insecticide imidacloprid was a safer alternative to dimethoate and was seemingly as effective.

Sucrose (table sugar) has proven to be, by far, the most effective fly feeding stimulant. However, while mixing with latex paint preserves the residual activity of the insecticide, all sugar is lost from the sphere surface following rainfall. We have taken two separate approaches to preserving residual activity of sucrose: (1) development of a method in which the activity of sucrose is extended on reusable wooden spheres, which are annually coated with a mixture of sucrose, insecticide, and latex paint; and (2) development of a method in which the entire sphere body is constructed of a mixture of sucrose, flour, and glycerin, coated with a mixture of insecticide and latex paint so as to create a biodegradable sphere. Here we report on two experiments leading to refinement of residue-extending agent, fly-killing agent, and evaluation of each sphere type for direct control of apple maggot flies in commercial orchards.

Materials & Methods

In our first experiment, we evaluated in laboratory studies three formulations of imidacloprid (EC, WP, technical grade) in combination with each of three formulations (flat, semi-gloss, gloss) of each of four commercial brands of red latex paint (36 treatments in all). We found the EC and WP formulations of imidacloprid in Glidden Red Latex Gloss Enamel paint to be the most promising. We then placed wooden spheres coated with two concentrations of each formulation of imidacloprid in orchard trees and evaluated them for their ability to kill apple maggot flies at 0, 3, 6, 9, and 12 weeks after placement.

In our second experiment, two sphere types were assessed in an attempt to extend the residual activity of sucrose on the sphere surface. Each wooden PTS was fitted with a 3-cm-diameter ring of specially formulated caramelized sucrose around the hook at the top of the sphere. The sucrose spread down the sides of the sphere after each rainfall, continually replenishing the sugar supply on the sphere surface. This type of sphere was developed as a replacement for spheres tested in 1996 in which holes were drilled and filled with sucrose prior to painting, as described in the Spring 1997 issue of Fruit Notes. Further testing of the 'spheres with holes' revealed that construction was far too costly and time consuming to be of practical value. For sugar/flour biodegradable spheres, the following composition of ingredients proved best: sucrose/fructose syrup (25%), pregelatinized corn flour (25%), wheat flour (25%), glycerin (10%), and water (15%). After hardening in the laboratory, such spheres emit a continuous supply of sugar to the surface, irrespective of rainfall amount.

We then compared the effectiveness of our best wooden PTS and our best sugar/flour PTS with sticky-coated spheres for direct season-long control of apple maggot flies in commercial orchards. In all, we used eight orchards, each having four blocks of medium-sized trees (49 trees/block). Each block receiving spheres was surrounded by 26 spheres of the same type, five yards apart, each baited with butyl hexanoate.

Table 1. Residual activity of two different formulations and two different concentrations of imidacloprid in latex paint on sucrose-treated spheres hung in orchard trees and exposed to weather.

Weeks of Exposure	0.5% EC	1.5% EC	0.5% WP	1.5% WP	Check
	Fly mortality (%)*				
0	97a	97a	96a	98a	0b
3	96a	93a	90a	95a	3b
6	70b	92a	85a	94a	5c
9	60b	90a	80a	90a	0c
12	45c	87ab	75b	90a	5d
	No. eggs laid in artificial fruit*				
0	0a	0a	0a	0a	26b
3	0a	0a	0a	0a	28b
6	2a	0a	2a	0a	25b
9	1a	0a	2a	0a	21b
12	1a	0a	0a	0a	24b
	Median lethal feeding time*				
0	30a	20a	30a	20a	-
3	80b	40a	75b	35a	-
6	182b	45a	180b	40a	-
9	240b	50a	210b	45a	-
12	300c	100a	240b	60a	-

* Three replicates of 20 flies per treatment. Numbers within rows followed by different letters are significantly different at odds of 19:1.

Table 2. Control of apple maggot flies by odor-baited wooden pesticide treated spheres (PTS), sugar/flour PTS, sticky spheres or three applications of azinphosmethyl in blocks of apple trees in commercial orchards.

Mean % maggot-injured apples*			
Wooden PTS	Sugar/flour PTS	Sticky Spheres	Azinphosmethyl
0.56b	0.32ab	0.32ab	0.11a

* Total of 2800 fruit per treatment (100 fruit per block on each of four sampling dates-2 weeks apart-from late July until harvest). Numbers followed by a different letter are significantly different at odds of 19:1.

Results

Laboratory bioassays revealed (Table 1) that after 12 weeks of exposure to outdoor sunlight and 11 inches of natural rainfall, wooden spheres treated with 1.5% a.i. imidacloprid WP in Glidden paint killed 90% of arriving flies. Such treatment also rendered all flies incapable of laying eggs after feeding and required that a fly feed on the sphere surface for a median time of only 60 seconds to ingest enough toxicant to die. Performance of wooden spheres treated with 1.5% imidacloprid EC was slightly but not significantly inferior, killing 87% of arriving flies. At lower concentrations (0.5% a.i.), neither the WP nor EC formulation performed as well (75% and 45% kill, respectively) as the 1.5% a.i. WP formulation.

In our second experiment (Table 2), sugar/flour PTS coated with 1.5% imidacloprid WP in Glidden paint performed as well as sticky spheres in providing direct control of apple maggot. Wooden PTS coated with 1.5% imidacloprid in Glidden paint and fitted with a 3-cm-diameter sucrose ring were inferior. Two-to-three insecticide sprays resulted in the least damage.

Conclusions

Our first experiment provided us with the formulation of a low dose of a safe and highly effective insecticide (1.5% a.i. imidacloprid WP) that can be combined with a particular type of paint (Glidden Red Latex Gloss Enamel) which offers very long and effective residual activity of imidacloprid under field conditions.

Although all sphere types used in the second experiment performed quite well in the face of high fly pressure, shortcomings need to be addressed and improvements need to be made before future use of PTS for controlling apple maggot in commercial orchard IPM blocks. Regarding wooden PTS, the caramelized sucrose rings melted away before the end of the field season, contributing to the reduced effectiveness of these spheres. Some of the sugar/flour PTS were eaten by birds and rodents while others were overgrown by fungi on the sphere surface, thus reducing the number of effective spheres comprising the barrier to fly entry into some blocks.

For 1998 deployment of wooden PTS, we plan to reformulate the sucrose ring atop the sphere to improve residual effectiveness of the

spheres. For sugar/flour biodegradable PTS, we will evaluate various bird/rodent-feeding deterrents and various fungicides incorporated into the body of the sphere.

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