# Final Project Report to the NYS IPM Program, Agricultural IPM - 2007

**TITLE: DEVELOPING A BIOCOMPATIBLE MANAGEMENT STRATEGY FOR ONION MAGGOT FLIES**


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**ABSTRACT:**

The current goal of our research is to develop a biocompatible management strategy for onion maggot flies that would replace the use of foliar applications of broad-spectrum pesticides. Foliar sprays are used in an attempt to kill onion maggot flies before they lay eggs in onion fields. However, there is no evidence that this strategy is worthwhile and there are multiple disadvantages. As an alternative, insecticide-baited devices could be used in onion fields to "attract and kill" onion maggot flies. In 2006, we evaluated the efficacy of spinosad-baited spheres in a commercial onion production area near Elba, NY. These spheres, which were nearly the same size and color as a softball, contained a low concentration of the insecticide active ingredient spinosad (<1.0%) plus sucrose. Spheres were hung about 18 inches from the ground and placed along onion field edges. We estimated that 45 to 60% of the flies that visited a sphere were killed. Based on fly visitation rates, we also predicted that one spinosad-baited sphere would kill approximately 182 flies (147 males and 36 females) during the onion-growing season. In 2007, we wanted to evaluate the performance of these spheres by assessing the level of protection they would provide to onion plants in commercial fields. Unfortunately, we did not observe a reduction in onion plant damage in field plots of onions where spinosad-baited spheres were placed. Examination of these spheres in the lab revealed that they failed to kill flies. Some of these spheres were rinsed with water and scrubbed lightly and the trial was repeated. This time, 56 to 72% of flies confined within cages containing the "recharged" spinosad-baited spheres died within 72 hrs. Therefore, it is likely that the poor field performance of the spinosad-baited spheres for protecting the onion crop was due to a problem with the spheres not making the spinosad available. We believe that extremely dry weather was responsible for this phenomenon. Additional research is being discussed for dealing with this trap design issue under dry conditions.


**BACKGROUND AND JUSTIFICATION:**

Onion maggot, *Delia antiqua* (Meigen), is a major pest of onion and populations are becoming more difficult to control due to insecticide resistance. In onion fields where onion maggot infestations are particularly difficult to manage, foliar applications of organophosphate, carbamate and pyrethroid insecticides are used in an attempt to control flies before they lay eggs in the field. This tactic is used early in the season to enhance onion maggot control provided by the insecticide application at-planting and again late in the season to prevent maggots from infesting bulbs at harvest. The major limitation of using foliar sprays to kill flies is that flies must be contacted directly with the spray. Therefore, sprays must be timed when flies are active within onion fields, which is difficult because flies spend only brief periods within onion fields

— primarily during dawn and again at dusk when they are laying eggs. Also problematic is that flies often disperse away from the spray rig as it approaches, reducing the number of flies contacted by the toxicant. A potential unintended side effect of this strategy also may occur such as mortality of beneficial insects, which may reduce natural mortality of onion maggot populations. Developing biocompatible control measures for insect pests such as the onion maggot that minimizes environmental, health and economic risks ranks high among the IPM and NY onion industry research priorities.

To circumvent the limitations associated with foliar sprays, onion maggot could be targeted with an insecticide bait that would "attract and kill" flies. An example is to deploy pesticide-treated sphere traps**.** This approach has significantly reduced damage by blueberry maggot in blueberries and apple maggot in apples. In principle, pesticide-treated sphere traps consist of (1) a reusable base tailored to the visual cues (e.g., color, shape, and size) used by the target pest, and (2) a sustained-release cap of feeding stimulant (sucrose) and toxicant. Linking the toxicant to a feeding stimulant allows maximum lethality at a minimum dose by increasing the likelihood of pest exposure to the toxicant. In current trap designs, the feeding stimulant and toxicant are dissipated under rainfall or heavy dew and they are replaced by dissolution from a source on top of the trap. In apple orchards, spinosad (Entrust)-bearing spheres were active against apple maggot for 12 weeks, despite 10 inches of cumulative rainfall.

During 2005, we conducted several preliminary studies to assess the efficacy of spinosad against onion maggot and to identify the most attractive color, shape and size of trap. Spinosad was active against onion maggot flies and large, white traps were the most attractive; shape did not matter. However, we prefer to use sphere-shaped bait dispensers because they are already commercially available through Pest Management Innovations, LLC. These spheres could be placed along onion field edges where onion maggot flies are most active and where they would not interfere with normal onion growing practices (e.g., spraying, cultivation, etc.) **(see Figure 1).** Our preliminary results suggest that spinosad-treated spheres will be an excellent alternative to foliar insecticide sprays for managing onion maggot flies.

We realize that any efficacy afforded by this technique would not be a stand-alone method to combat onion maggot in high-infestation production areas. Ultimately however, when combined with other techniques such as insecticide seed treatments, an environmentally friendly and sustainable production system can be approached

**FIGURE 1.** Proposed placement of "attract and kill" spinosad-baited spheres in onion fields.

**OBJECTIVES:**

1) Compare onion maggot damage levels in untreated onions where spinosad-baited spheres, white sticky cards or no control devices are placed.
2) Compare onion maggot damage levels in untreated onions where spinosad-baited spheres and white sticky cards are accompanied with Delia lure.
3) Evaluate performance of project through discussions with the NY onion industry as well as with other extension entomologists who work with onion maggot.

**PROCEDURES:**

Objectives 1 and 2. Both objectives will be addressed in the same experiment. There will be six treatments: (1) insecticide-treated onions only [=positive control], (2) non-insecticide treated onions only [=negative control], (3) white sticky cards only, (4) white sticky cards + *Delia* lure, (5) spinosad-baited spheres only, (6) spinosad-baited spheres + *Delia* lure.

Rationale for treatments:

(1) Negative and positive controls are needed to estimate onion maggot pressure and levels of control using standard practices, respectively.

(2) Spinosad-baited spheres will not kill 100% of the flies that visit them, while sticky cards will kill 100%. Comparing damage between these treatments measures the effectiveness of spinosad compared with an "ultimate" form of fly control.

(3) A previous study in 2005 showed that onion maggot flies were attracted equally to white spheres and white cards, which had identical surface area. Thus, shape is not an important visual cue for onion maggot flies. This allows us to use any shape for our type of control treatment. Because sticky cards are much easier to work with than Tanglefoot-covered spheres, we will use sticky cards.

(4) Spinosad will be included at a 0.5% rate in the spheres (=0.4 g). The 2006 study showed identical control of flies exposed to 0.5% and 1.0% spinosad over 16 weeks.

(5) *Delia* lure should attract at least 2X more flies than treatments without this lure. However, it is possible that the lure will attract more flies into the area, resulting in a greater level of damage in plots.

The main treatments will be type of control and odor attractant. The experiment will be a 2 (type of control) x 2 (odor attractant) factorial with a positive and negative control arranged in a RCBD replicated 4 times. There will be 2 replications in the same onion field for a total of 2 fields. Plots will have 6 to 8 rows and each row will be 30-ft long. Plots will be separated by a minimum of 100 ft. Data will be collected from two middle rows. Row spacing will average 15". Seeding density will be 9 seeds per ft.

To determine if spheres will reduce damage, baseline plant stand counts will be taken about three weeks after planting in May. Similarly, a final plant stand count will be taken in early July at the end of the first onion maggot generation. The number of plants dying due to onion maggot feeding will be recorded on a weekly or bi-weekly basis beginning at the first sign of maggot damage until after the end of the first generation in early July. Seedlings containing maggot larvae or those clearly dying from maggot feeding (but larva not present) will be recorded as killed by onion maggot and then removed from the plot. Near harvest, all onions in the 2 middle rows will be pulled and inspected for onion maggot damage. Any bulb damaged will be considered "killed", because it is not marketable, and the number added to the number of plants killed to provide us with the total number of killed plants. Data will be analyzed using an analysis of variance procedure of SAS (PROC Mixed) and treatment means will be compared using a Fisher's Protected LSD at $P < 0.05$. Data will be transformed using a $\log_{10}(x + 1)$ to stabilize variance.

Objective 3. Results of this project will be discussed frequently with onion growers, CCE educators, other onion industry personnel and extension entomologist colleagues who work with onion maggot. These discussions will occur informally as well as at onion twilight meetings, onion industry council meetings, NY Fruit &Veg EXPO, and at the Entomological Society of America's Annual Meeting in San Diego, CA.

## Results and Discussion

Spinosad-baited spheres and sticky cards failed to protect onions from onion maggot **(Figure 2)**. Inclusion of *Delia* lure with these control tactics similarly had no impact on protecting plants from maggots **(Figure 2).** Despite large numerical differences among some treatment means, high variation coupled with low replication resulted in non-significant differences among means. Number of damaged plants in many of the treatments varied substantially, resulting in no significant differences among the treatments. Specific comparisons then were made between treatments and groups of treatments. The mean number of plants killed by onion maggot in the positive control plots (insecticide treated) were significantly lower than the mean number of plants killed in all of the other treatments combined (i.e., no insecticide used at planting) **(Table 1)**. Other treatment comparisons were not significant **(Table 1).**

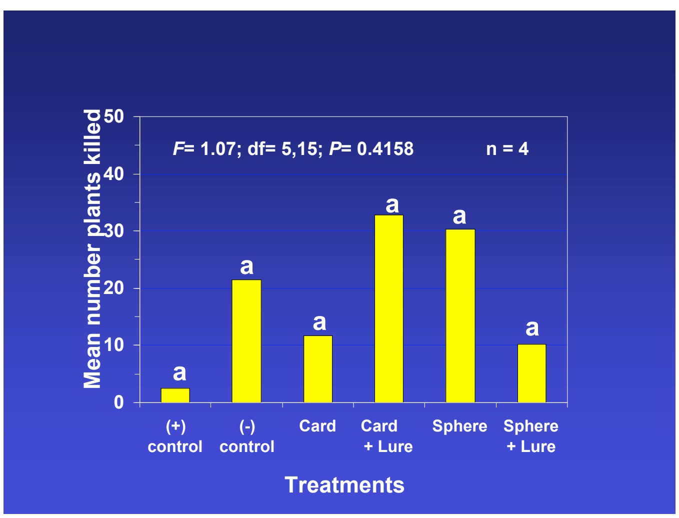



**Figure 2**. Mean number of onion plants killed by onion maggot in field plots containing yellow sticky cards or spinosad-baited spheres with or without Delia lure in Elba, NY.

| Contrast | *F* | df | *P* |
|---|---|---|---|
| (+) control vs. others | 14.2 | 1, 3 | 0.0328* |
| (-) control vs. others | 0.0 | 1, 3 | 0.9914 |
| Card vs. Sphere | 0.0 | 1, 3 | 0.8810 |
| Lure vs. no Lure | 0.00 | 1, 3 | 0.9636 |
| (-) control vs. Sphere + Lure | 0.58 | 1, 3 | 0.5007 |

* Significant difference observed (P<0.05; Proc Mixed)

**Table 1**. Specific comparisons between treatments to determine differences in mean number of onion plants killed by onion maggot in field plots containing yellow sticky cards or spinosad-baited spheres with or without *Delia* lure in Elba, NY.

Onion maggot pressure in most onion fields throughout New York was low because conditions were extremely dry at the time flies were laying eggs. Consequently, onion plant damage levels were atypically low. Nonetheless, we still expected to observe low damage levels in the spinosad-baited sphere and white sticky card treatments. If the spinosad-baited spheres were not lethal to flies, this could explain this observation. To address this question, a sub-set of spheres were removed from the field after 1, 2, 3 or 4 months. These spheres then were placed in cages in the laboratory that contained 20 flies (10 of each sex) and the number of flies surviving was recorded up to 72 hrs **(Figure 3)**.

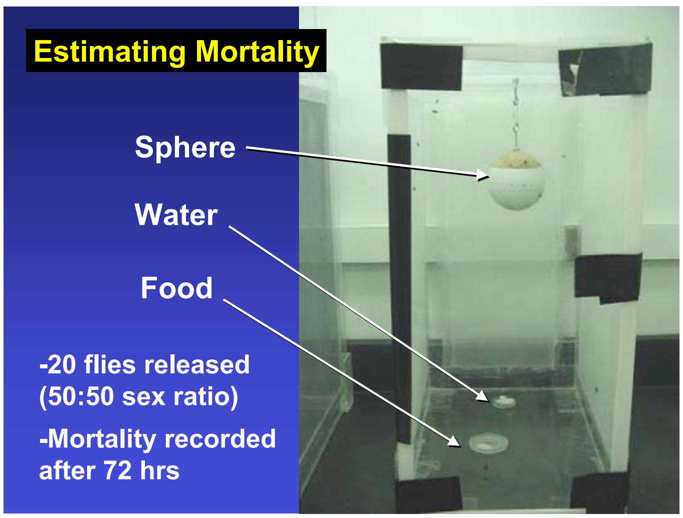



**Figure 3**. Mean number of onion plants killed by onion maggot in field plots containing yellow sticky cards or spinosad-baited spheres with or without Delia lure in Elba, NY.

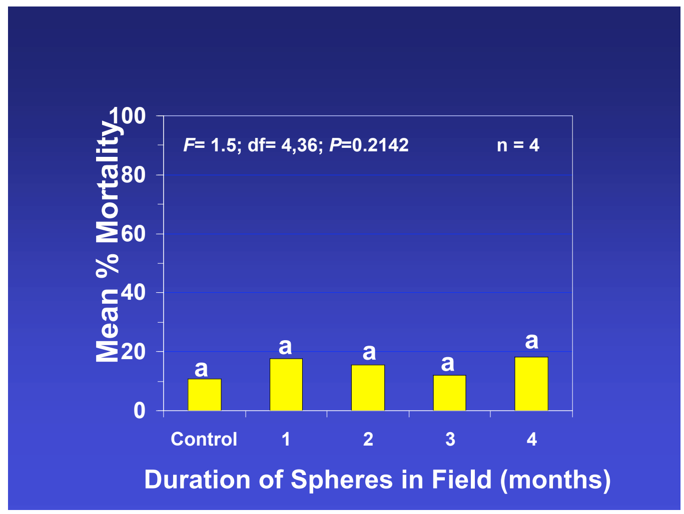



**Figure 4**. Mean % fly mortality (both sexes) after 72 hrs for flies confined in cages containing spinosad-baited spheres that had been in the field for 1 to 4 months.

The spheres were not effective against the flies **(Figure 4)**. Mortality of flies exposed to these spinosad-baited spheres did not differ from mortality of flies not exposed to spinosad **(Figure 4).** These results indicate that flies either did not feed on the spheres because the feeding stimulant (=sucrose) was no longer attractive or that the toxicant (=spinosad) was not active. Both may have occurred as a result of the extremely dry weather during the field season.

To answer these questions, an additional lab experiment was designed. First, a subset of spheres used in the 2007 trial were rinsed thoroughly with distilled water, scrubbed lightly and then allowed to dry. Our thinking is that this procedure would “recharge” the spheres. To ensure that flies would feed on spheres, some spheres were sprayed with a 10% sucrose solution. Also, because the spinosad should be most concentrated and available on the underside of the cap, the cap was included as an additional treatment. All treatments in this trial are illustrated in **(Figure 5).**

The “recharged” spinosad-baited spheres and sphere caps were lethal to flies **(Figure 6).** These results indicate that the sucrose and spinosad contained within the spinosad-baited spheres had been unavailable to flies in the field, but was “reactivated” and made available to flies after the thorough rinsing with water. Consequently, mortality levels of flies exposed to the sphere only were nearly identical to mortality levels observed in the 2006 experiment. Mortality in the treatments sprayed with 10% sucrose solution was lower than those only sprayed with water, suggesting that flies fed on the new source of sucrose rather than the original solution of sucrose and spinosad contained within the sphere cap.


**Figure 5**. Treatments examined in second lab experiment in 2007.

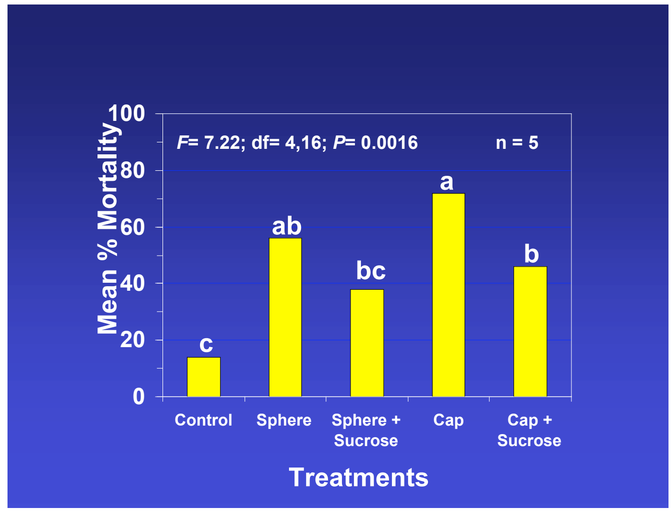



**Figure 6**. Mean % fly mortality (both sexes) after 72 hrs for flies confined in cages containing spinosad-baited spheres or inverted sphere caps that were sprayed with either distilled water or 10% sucrose solution.

## SUMMARY

The spinosad-baited sphere is a promising tool for controlling onion maggot adults and has many advantages over spraying broad-spectrum insecticides to control flies. Spinosad-baited spheres are safe to the user and environment and each sphere dispenses only a small quantity of a bio-based insecticide. Potentially, this technology could replace the use of a broad-spectrum insecticide on over 1,000 acres of onions in New York alone. Although we do not anticipate that this technology would replace all insecticide use targeting the onion maggot, it could supplement the at-plant insecticide that is used for maggot control in fields where this pest is a severe problem and would be the only effective tool for controlling second and third generation flies. We also suspect that these spheres will control seedcorn maggot flies, *Delia platura*, a sporadic pest of onion.

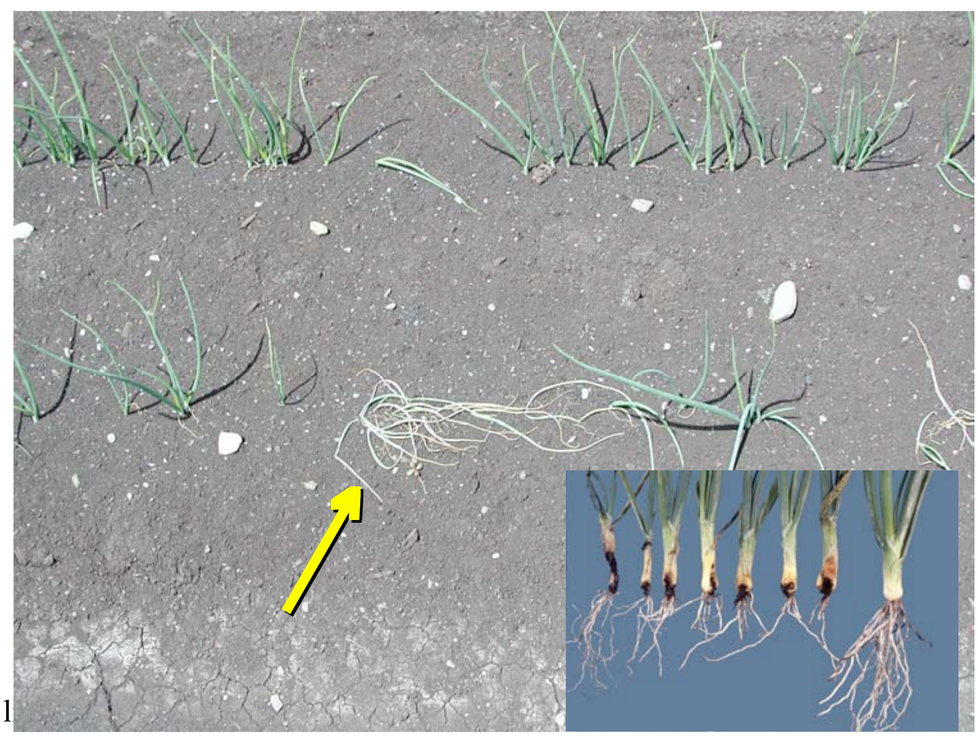
Results from this experiment will be presented to NY's onion industry. Additionally, results will be discussed at the Entomological Society of America's Annual Meeting in San Diego.

The next phase of this project requires demonstration that deployment of spinosad-baited spheres can effectively reduce onion maggot damage to onion plants in the field. Our intention is to repeat this experiment in 2008. Demonstration of onion maggot damage reduction will be important for this technology to be accepted by onion growers and for the manufacturer to market them.

**USEFUL PHOTOGRAPHS:**

Spinosad-baited sphere examined for onion maggot control in 2007.

Onions killed by onion maggot, *Delia antiqua*.



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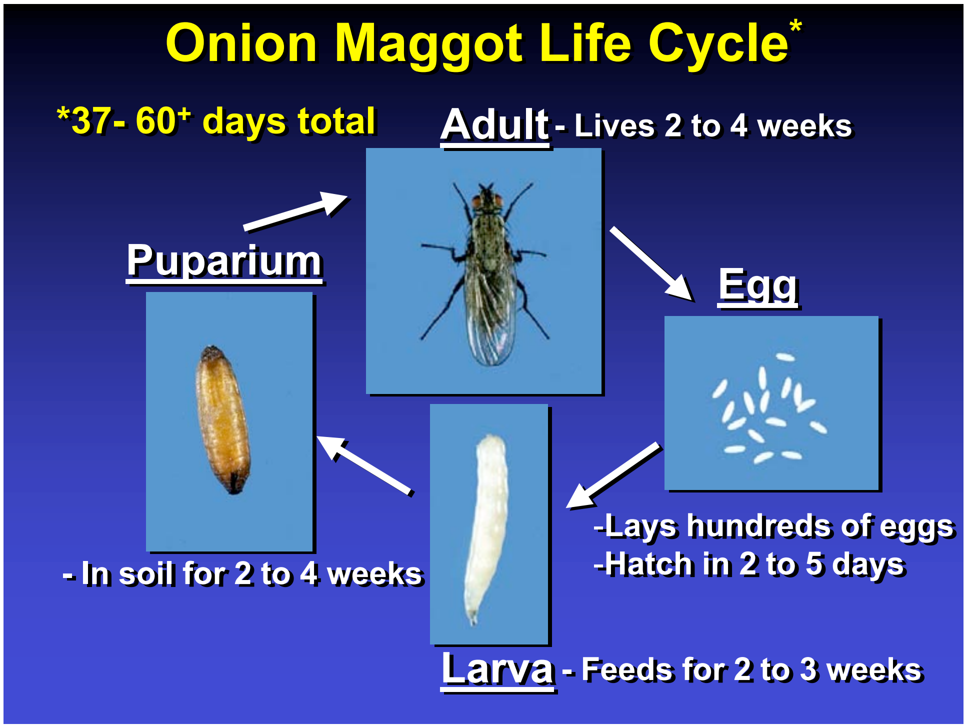
Onion Maggot Life Cycle*
*37- 60+ days total
Adult - Lives 2 to 4 weeks
Egg
-Lays hundreds of eggs
-Hatch in 2 to 5 days
Larva - Feeds for 2 to 3 weeks
Puparium
- In soil for 2 to 4 weeks