Title: Effective aphid management in greenhouse crops by optimizing biological control and nutrient inputs – Progress report

Project leaders:	Dr. Neil Mattson, Horticulture, Cornell University
	Dr. John Sanderson, Entomology, Cornell University
	Dr. Elizabeth Lamb, NYS IPM
	Brian Eshenaur, NYS IPM
	Nora Catlin, CCE Suffolk County
	Elise Lobdell, The Plant Keeper
	Karen Dean Hall, KDH Agricultural Services
Cooperators:	George Zerillo, Zerillo Gardens
	Carl Gabrielsen, Gabrielsen Farms
	Mark Zittel, Amos Zittel and Sons
	Steve Lockwood, Lockwood's Greenhouses and Farm
	Reenie Sansted, Bakers Acres
	Heather Genrich, Genrich's Garden Center

Abstract:

NYS greenhouse growers have reported that aphids are among their greatest pest problems. They are seeking biological control alternatives in part to increasing public pressure to stop using neonicotinoids, the most commonly used insecticide for aphids. Climbing fertilizer prices and potential state legislation regulating nitrogen has increased greenhouse grower interest in reducing fertilizer inputs. Slow release fertilizers (SRF) can reduce nutrient leaching but more work is needed to determine effective application rates for bedding plants and vegetable transplants. The objective of this project is to develop, field-test, and share an integrated pest management approach for managing greenhouse aphids using beneficial insects and reduced fertilizer inputs.

From the first year on-farm trials, we learned several adaptions necessary to the effective use of slow release fertilizers in the production of bedding plants. There were insufficient aphid populations to evaluate aphid response to differences in fertility program. The first year research results showed that aphid numbers appear to be affected by plant size, which is affected by nitrogen level but also by plant species and architecture.

The second year research and on-farm trials were developed to examine the interaction of aphids, fertilizer sources and biological control.

Background and justification:

Greenhouse operations are large consumers of pesticides and fertilizers due to intensive production methods and consumer demand for products free of cosmetic damage. Aphids remain among the most troublesome greenhouse pests for ornamental and vegetable producers. The most common greenhouse aphid pests, green peach and foxglove aphids, are among the greatest targets of greenhouse pesticides used. Intense pesticide use leads to problems with resistance, the environment, and worker safety. Nationally, the use of neonicotinoid pesticides (such as imidacloprid, the most common material for aphid control in NYS) is under public scrutiny due to a potential connection with decline in bee populations. Further, the NYS DEC has proposed eliminating the neonicotinoids on Long Island, in part, due to their detection in test wells. Therefore it is critical to develop, and deliver to growers, effective sustainable alternatives for aphid control. Beneficial insects can be used, but applications must work effectively, reliably, and cheaply. The mix of aphid species in NYS greenhouses has changed dramatically over time with foxglove aphid infestations increasing. Unfortunately the natural enemy that is most cost-effective against green peach aphid is not effective against foxglove aphid. Thus we seek to evaluate a combination of natural enemies as an effective and simple way to control common aphid pests.

It has been estimated that greenhouse operators supply 1,000-2,000 lbs. of N per acre per year (Weiler, 2003). The majority of greenhouse operations do not capture runoff from their operations and therefore the N and P released by conventional water soluble fertilizers (WSF) are a non-point source of pollutants. Draft legislation has recently been circulated in the NYS Senate and Assembly that aims to increase the oversight of N use on Long Island. To respond to increasing fertilizer prices and regulatory pressure, NYS greenhouse producers are interested in voluntarily adopting reduced fertilizer input strategies for growing their crops such as slow release fertilizers (SRF) or reduced rates of WSF. In preliminary work by N. Mattson, SRF reduced N and P leaching of potted chrysanthemums by 5-10 fold vs. WSF controls. However, more work is needed to determine application rates for other common bedding plants and vegetable transplants. Plant fertility also affects aphid populations. High WSF applications promote increased populations and faster population growth of green peach aphids (Jansson, 2003) and cotton aphids (Davies et al, 2004). No work has been done to determine the effect of SRF fertilizers on aphid populations, but we hypothesize that use of SRF will reduce luxury fertilizer consumption by the plant, leading to reduced aphid numbers thereby making biocontrol easier.

Objectives:
The objective of this project is to develop, field-test, and share an IPM approach for managing green peach and foxglove aphids based on biological control and reduced fertilizer inputs.

Results and discussion:

This is an update from the 2015 annual report on the same project.

Cooperator trials: In spring 2016, trials were conducted for a second year at 6 commercial cooperators. The objectives for year 2 trials were to 1) assess use of a biocontrol program for aphid management on spring bedding plants and vegetable transplants commonly susceptible to aphids and 2) determine whether controlled release fertilizer (CRF) impacted aphid control and plant performance as compared with constant liquid fertilizer (CLF).

Genrich's

Calibrachoa 'Superbells Apricot Punch' was selected for this year's experiment. Calibrachoa was chosen as it is quite susceptible to aphids and growers have reported little success with biocontrols in the past. Forty plants received their standard CLF (control) and forty plants received Osmocote Bloom CRF. The plants receiving controlled release fertilizer were a bit smaller than the liquid fed plants (control) by the end of the experiment. But both fertilizer treatments had a similar number of flowers and were considered commercially marketable. Aphid control was initially with parasitic wasps (*Aphidius colemani*). Foxglove aphids were noted on a few plants from each treatment in April and by May mummified aphids (signifying effective biocontrol) were observed. Plants were considered saleable and free of aphids by the market day in mid-May however the grower also did use insecticide treatments to help control aphids.

Bakers Acres

Geraniums were selected for this year's trial based on previously noted problems with aphids. Geraniums in hanging baskets received either the standard CLF regime (control) or CRF (Osmocote Classic 14-14-18). Treatments were established in March and monitored weekly through May. Biocontrols were provided as parasitic wasps (*Aphidius colemani*) on banker plants to control for green peach aphids, and lady bugs (released twice during the trial) to control for both green peach and foxglove aphids. CRF plants were slightly smaller than CLF plants however all were considered marketable. Throughout the trial, foxglove aphids were noted in similar numbers in both the CLF and CRF treatments but no green peach aphids were seen. Mummified green peach aphids were noted on weeds below the trial plants (indicating there were parasitized), but not on the geraniums as part of the trial. In general, the beneficial control regime appears to be insufficient or not appropriate to the aphid species to keep up with aphid numbers in the trial, though it may have helped to avoid excessively high aphid numbers.

Amos Zittel and Sons

Peppers (highly susceptible to aphids) were selected for the experiment. Peppers were grown in 6-packs with either Osmocote Bloom CRF or their standard CLF fertilizer regime. Aphid control was with parasitic wasps (*Aphidius colemani*). The plants were established in the treatments on April 5 and monitored weekly for aphids and plant growth. No aphids were detected in either treatment throughout the 7-week experimental period. While plant size of CRF was, on average, similar to control CLF plants, the plants with CRF were quite variable in size and some were also chlorotic. By the end of the experiment, CRF plants were given a liquid feed treatment to green them up prior to transplanting in the field. The results indicate that CRF may not be an appropriate choice for plants growing in very small container sizes due to difficulty in mixing the fertilizer uniformly into the potting mix, which we noted in last year's trials at Bakers' Acres.

Lockwood's

Osmocote Bloom CRF was compared to their standard CLF fertilizer regime for Calibrachoa 'Rhino Oh So Orange' and 'Double Pink'. Calibrachoa were chosen due to their susceptibility to aphids. The treatments were established on April 20 and monitored weekly through May 19. Aphid control was with parasitic wasps

(*Aphidius colemani)*. Plant size/quality was similar regardless of fertilizer treatment. Extensive aphid infestation occurred on both sets of plants, but it occurred first and in greater numbers on the CRF plants. Because the trial was at a commercial producer and not replicated we cannot be certain whether the higher infestation on CRF plants was actually due to the fertilizer treatment or due to location in the greenhouse. Green peach aphids were most prevalent in the trial, but later on foxglove aphids were noted on several plants and potato aphids on a couple plants. A few mummified aphids were noted (indicating there were parasitized), but in general, the beneficial control regime appears to be insufficient or too late due to the high aphid numbers.

<u>Zerillo Gardens</u>

Osmocote Bloom CRF was compared to their standard CLF fertilizer regime for pansies growing in 6-packs. Plants/treatments were established in early April and sold in late April. Plant quality of CRF was as good as their CLF counterparts in terms of plant size (height and width). The CRF plants were also sold out first (but it is not known whether this is because they were of higher quality or simply because they were grown in a different greenhouse. No aphids were observed on any plants during the experiment, and because these were a quick-turn crop the grower decided not to apply any biological controls. In general, the results indicate CRF could produce plants of similar quality to CLF.

<u>Gabrielsen Farms</u>

Four types of bedding plants were chosen for the trial: argyranthemum, Ipomoea (sweet potato vines), Wave petunias, and coleus. In April, plants were established in 6-inch pots and fertilized with either Osmocote Bloom CRF incorporated into the substrate or their standard CLF fertilizer regime (control). Plants were monitored weekly until their sales in May. No aphids were noted in any treatments during the trial. Plant size was assessed by measuring height and width of representative plants. For the Wave petunias plant size was greater for CRF treatment, for all other plants CRF plants were similar in size to CLF. The results indicate that CRF can be successfully used in place of liquid feed for the 4 crops used in this trial.

In summary, CRF (Osmocote Bloom) applied at a medium label rate, could be successfully used to grow a variety of crops of similar quality to CLF (calibrachoa, pansy, geranium, argyranthemum, Ipomoea, petunia, and coleus). However due to issues with uniformity, CRF is not recommended for growing in small cell-packs (such as described for peppers). Materials with a smaller granule size or more uniform mixing may help. Regarding aphid control, <u>Aphidius colemani</u> appeared at least partially effective for control in calibrachoa in 1 trial (Genrich) but not effective in another trial with greater insect pressure (Lockwoods). As part of this project, experiments are on-going at Cornell University to look at use of mixed species of parasitic wasps as well as different application rates for control of both green peach and fox glove aphids. In separate experiments, Co-PI Sanderson is further testing different methods to achieve successful aphid biocontrol in calibrachoa.

Results of aphid biocontrol and fertility experiments analyzed to date

One of the base questions for this project is whether fertility level affects beneficial insects in the same way it affects the aphids those beneficials are meant to control. There is some direct feeding by the beneficial wasps in addition to the parasitism so higher nutrient levels in the aphids from the plants could result in more vigorous wasps, or the aphid population could be growing so rapidly with more nutrients that it outpaces the biological control.

For these studies, plants were fertilized with either liquid feed at 75 ppm or Osmacote (slow release fertilizer) at 58 g/ft2. Plants were grown in small cages (green peach aphid) or in a small greenhouse (foxglove aphid – the cages caused the aphids to fall off the plants) and infested with aphids which were allowed to develop for 10 days. Green peach aphid were treated with *Aphidius colemani* (a parasitic wasp) or *Aphidoletes aphidimyza* (a midge). Foxglove aphids were treated with *Aphidius ervi* or *Aphidoletes aphidimyza.*

The results have been tabulated for foxglove aphid on pansy and pepper and for green peach aphid on pansy with 2 levels of fertility. In all three cases, there was no effect of the interaction of biocontrol and fertility. The significant effect of biocontrol for foxglove aphid was due to the reduction in aphid numbers by *Aphidius ervi r*elative to either the control or *Aphidoletes aphidimyza*. For green peach aphid on pansy, both *A. colemani* and *Aphidoletes* resulted in lower aphid numbers than the control.

Current research trials

The third step planned to determine whether fertility level affects biological control of aphids is to use a more real-world evaluation method. Green peach and foxglove aphids are both introduced into mixed plant populations in small greenhouses to compare how successful a variety of beneficial insects are at controlling the aphid population and if there is any benefit of combining biocontrols. This trial is in progress.

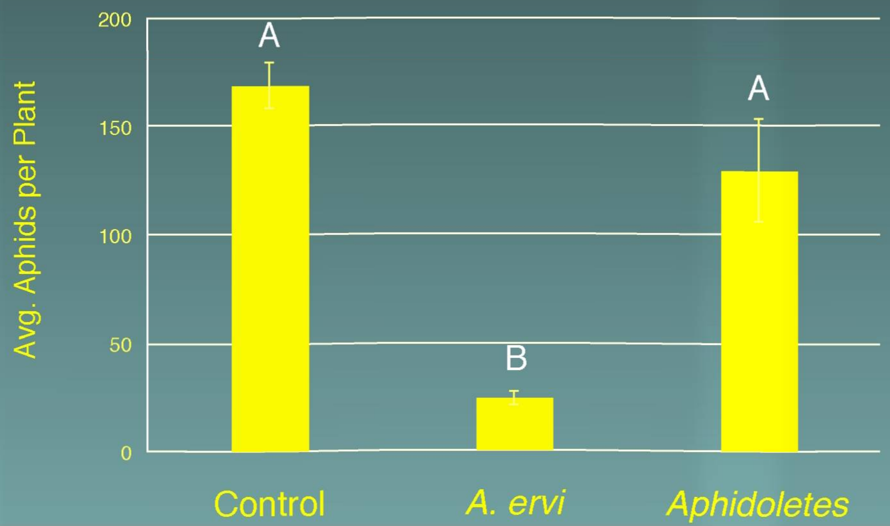
An additional study is comparing aphid populations on different sized pepper plants to see if plant size affects how the aphid populations develops.

ANOVA: FGA on Pepper

Source	F ratio	Prob > F
Fert. treatment	0.89	0.35
Biocontrol treatment	32.70	<0.0001
Biocontrol treatment x Fert. treatment	0.67	0.51

- No effect of fertilizer treatment on number of FGA/plant
- No interaction of fertilizer treatment and biological control treatment
- Significant effect of biocontrol treatment

Biocontrol agent effects on avg. no. foxglove aphids across all fertilizer trts. on pepper



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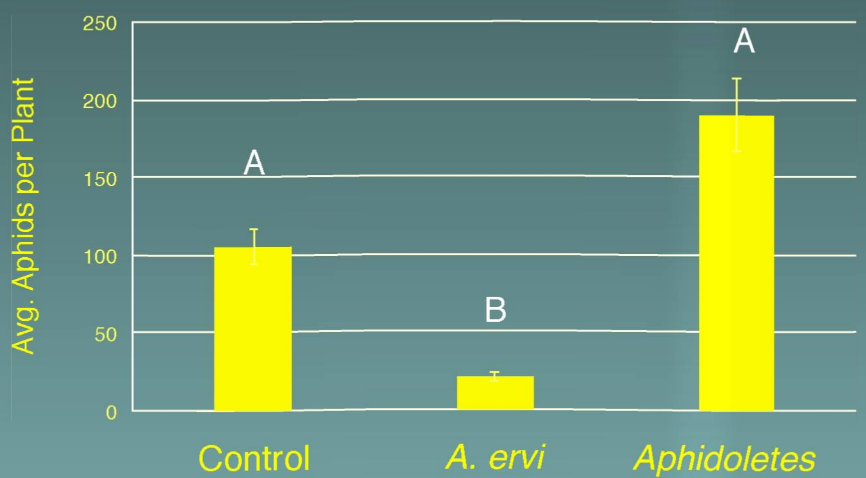
ANOVA: FGA on Pansy

Source	F ratio	Prob > F
Fert. treatment	0.13	0.72
Biocontrol treatment	105.66	<0.0001
Biocontrol treatment x Fert. treatment	0.21	0.81

- No effect of fertilizer treatment on number of FGA/plant
- No interaction of fertilizer treatment and biological control treatment
- Significant effect of biocontrol treatment

Biocontrol agent effects on avg. no. foxglove aphids across all fertilizer trts. on pansy



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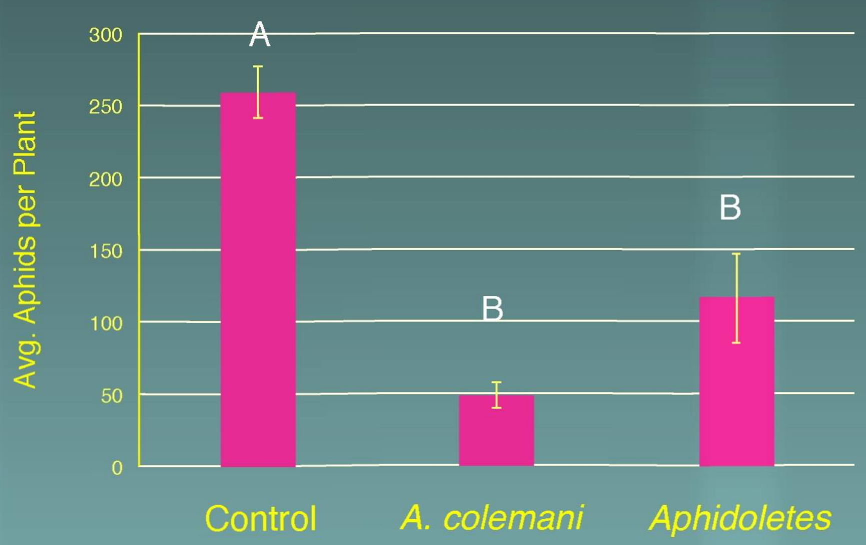
ANOVA: GPA on Pansy

Source	F ratio	Prob > F
Fert. treatment	0.0611	0.80
Biocontrol treatment	18.37	<0.0001
Biocontrol treatment x Fert. treatment	0.2646	0.77

- No effect of fertilizer treatment on number of GPA/plant
- No interaction of fertilizer treatment and biological control treatment
- Significant effect of biocontrol treatment

Biocontrol agent effects on avg. no. green peach aphids across all fertilizer trts. on pansy



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