Title of project: Biocontrol in energy-saving cool temperature greenhouse production

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Abstract:

Background and Justification:
Energy costs for greenhouse growers continue to increase, with an associated negative effect on profitability for greenhouse growers. This has led to renewed interested in growing crops at cooler temperatures either by turning down the greenhouse thermostat or finishing a crop in an unheated high tunnel (Burnett et al., 2011; Beytes, 2010). In January 2011, Mattson made a presentation on recent high tunnel and cool crop production research at the Long Island Greenhouse School. On the program evaluation, 34 percent of respondents stated they would definitely plan on growing more crops under cool conditions, and 46% would consider growing more crops under cool conditions, as a result of the talk.

Research suggests that for some crops, reducing the growing temperatures can save growers money. Erwin, Rohwer, and Warner, in 2004, reported that reducing pansy night temperatures by 10 F saved 5% of fuel costs. However, there is very little information available on the effect of these lower growing temperatures on insect pests or on the beneficial insects used to manage them through biocontrol.

We are examining the interaction of pest, beneficial, temperature and crop will be examined in this project using fungus gnats as the pest and beneficial nematodes and a rove beetle, *Atheta,* as the beneficials to control the fungus gnats.

Fungus gnats are a common greenhouse pest, which cause direct feeding damage by the larvae and also have the potential to spread root rot diseases. Several of these root rot diseases are more severe at lower growing temperatures. Beneficial nematodes and *Atheta* are both recommended for fungus gnat control. The reported temperature range for *Steinernema* nematodes, considered cold adapted, is 54-86 F. *Atheta* is reported to prefer warmer temperatures, with a range of 54-95 F.

We are doing the initial research under controlled conditions in growth chambers at Cornell University. Results from these experiments will lead to an on-farm study in the spring of 2013 run at 3 greenhouses in NYS that have been using cold growing methods for some of their crops.

Objectives:
The long-range goal of this project is to provide greenhouse growers with tools for successful use of biocontrol of insect pests under the cool temperature production systems being adopted in ornamental and vegetable production. Success will be measured as acceptable quality of product relative to insect damage with associated lower energy costs

Procedures:

Preliminary tests

All preliminary tests were carried out in the greenhouse under ambient temperatures. All treatments were in 6 inch azalea pots and there were 6 replicates of each treatment. Moisture content readings were taken at the beginning, middle and end of the experiment.

In order to evaluate the attraction of the treatment to fungus gnats, clear sticky traps were placed on the surface of the pots and fungus gnats were released in the greenhouse near the trials. Traps were collected after 24 hours and each pot was evaluated 4 times.

In order to evaluate the reproduction of fungus gnats, fungus gnats were released in the greenhouse for 3 days after the end of the attraction experiment. Pots were then covered with mesh covers to prevent new fungus gnats from escaping. After 2 weeks, yellow sticky cards were placed in the pots, and fungus gnats were counted daily for 2 weeks.

We evaluated 4 species of bedding plants; dianthus, snapdragon, petunia and pansy, (control = pot with soil but no plant), to determine if there were differences in attraction of and production of fungus gnats.

We evaluated 8 soilless media with varying organic matter contents in pots without plants; Lambert and MetroMix (standard commercial mixes), Sunshine Mix #1, Sunshine Mix #4, Sunshine Mix PX-2 Cornell Organic, Vermont Fort Vee and Vermont Fort Light (higher organic matter mixes) (control = Metro Mix) to determine if there were differences in attraction of and production of fungus gnats.

Experiments

All experiments were carried out in growth chambers under constant temperature. The temperatures chosen for the research studies were 75 F and 55 F as being typical early spring greenhouse temperatures which growers might use under traditional and cool growing situations. There were 2 chambers at each temperature. All treatments were carried out in Bugdorms – small cages which each held 4 pots of a treatment. A Bugdorm = a block = a rep. Each trial will be run twice.

Fungus gnats were released in each Bugdorm on each of 5 days to reach approximately 200 each. Sticky cards were placed in each pot the following week and fungus gnats were counted 3 times a week for 5 weeks. Moisture contents of the pots were taken at the beginning, middle and end of each experiment.

Experiment 1: Effect of media and temperature on fungus gnat population development
The 3 soilless mixes used, determined by the preliminary tests, were Lambert, Cornell Organic and Vermont Fort Vee. There were 4 replicates per growth chamber (each rep = 4 pots).

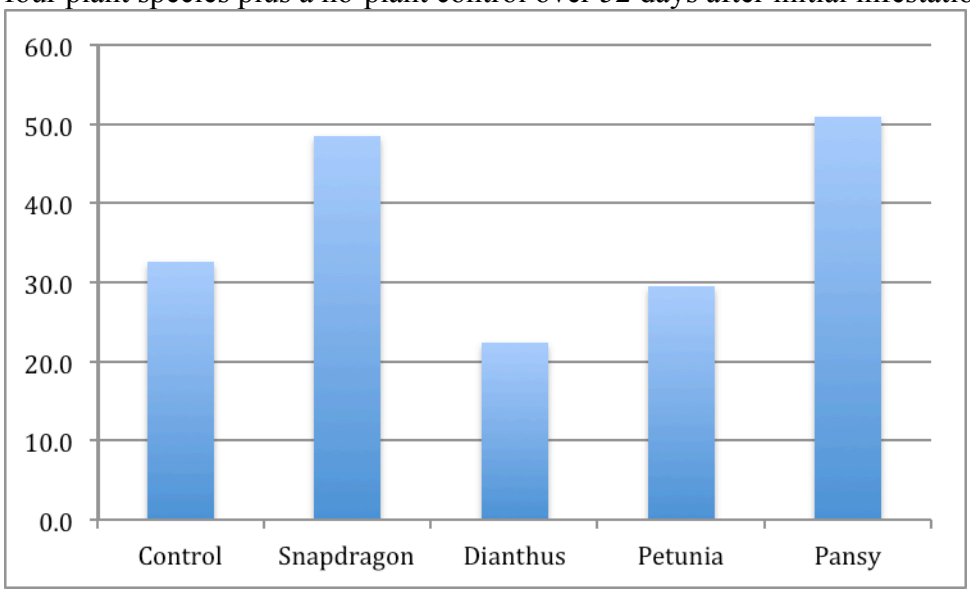
Experiment 2: Effect of temperature on biological control of fungus gnats
The 3 treatments were 1) no biological control, 2) Atheta released at 1 per pot at the beginning of the study, and 3) nematodes released at 50,000 per pot once per week for 2 weeks starting at the beginning of the study. There were 4 replicates per growth chamber (each rep = 4 pots).

Results and Discussion:

Preliminary tests

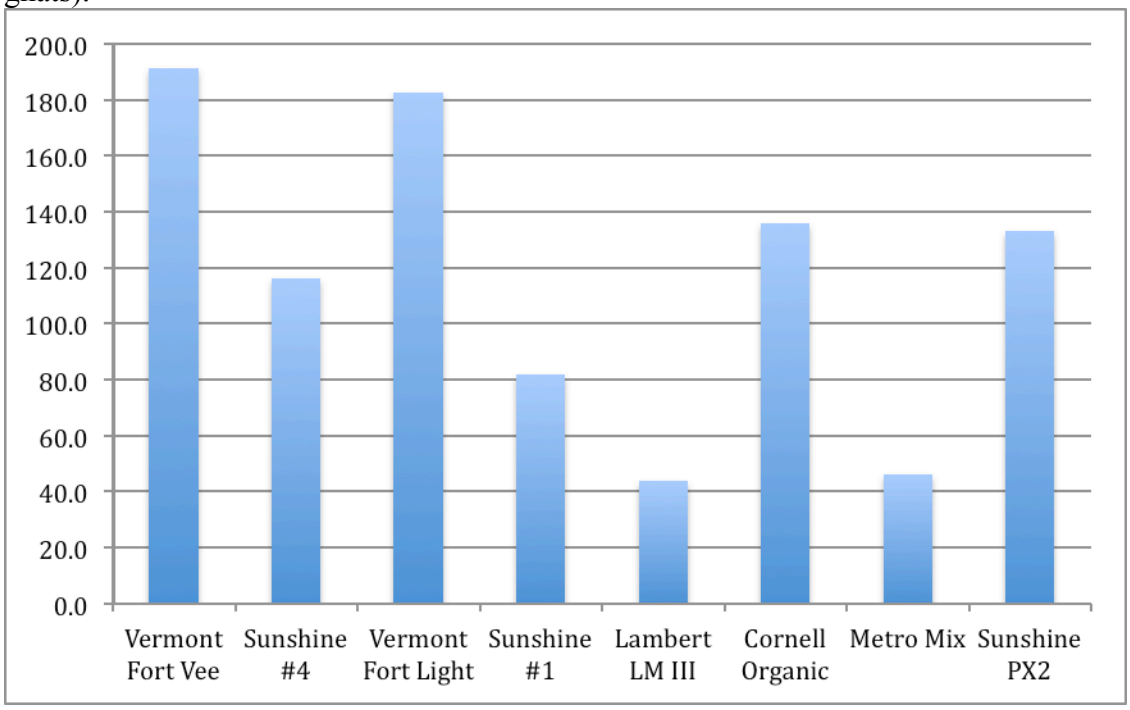
Plant species: Differences in attraction were small, but snapdragon and pansy produced nearly twice the number of fungus gnats as petunia, dianthus and the control (Graph 1). There may be some effect of plant size and its relation to dryness of the media, which cannot be evaluated separately in this experiment. Pansy was chosen as the test plant because of the fungus gnat production numbers and its tolerance of cool growing temperatures.

Graph 1. Average numbers of adult fungus gnats that emerged per pot planted with one of four plant species plus a no-plant control over 52 days after initial infestation.



Soilless media: Again, attraction did not vary dramatically among media. Production of fungus gnats was much higher in the media with higher levels of organic matter particularly the Vermont mixes (Graph 2). Lambert, Cornell Organic, and Vermont Fort Vee were chosen for the fungus gnat production experiments.

Graph 2. Average numbers of adult fungus gnats that emerged per pot of each of eight growing mixes over 58 days after initial infestation (see Graph 1 for initial numbers of fungus gnats).



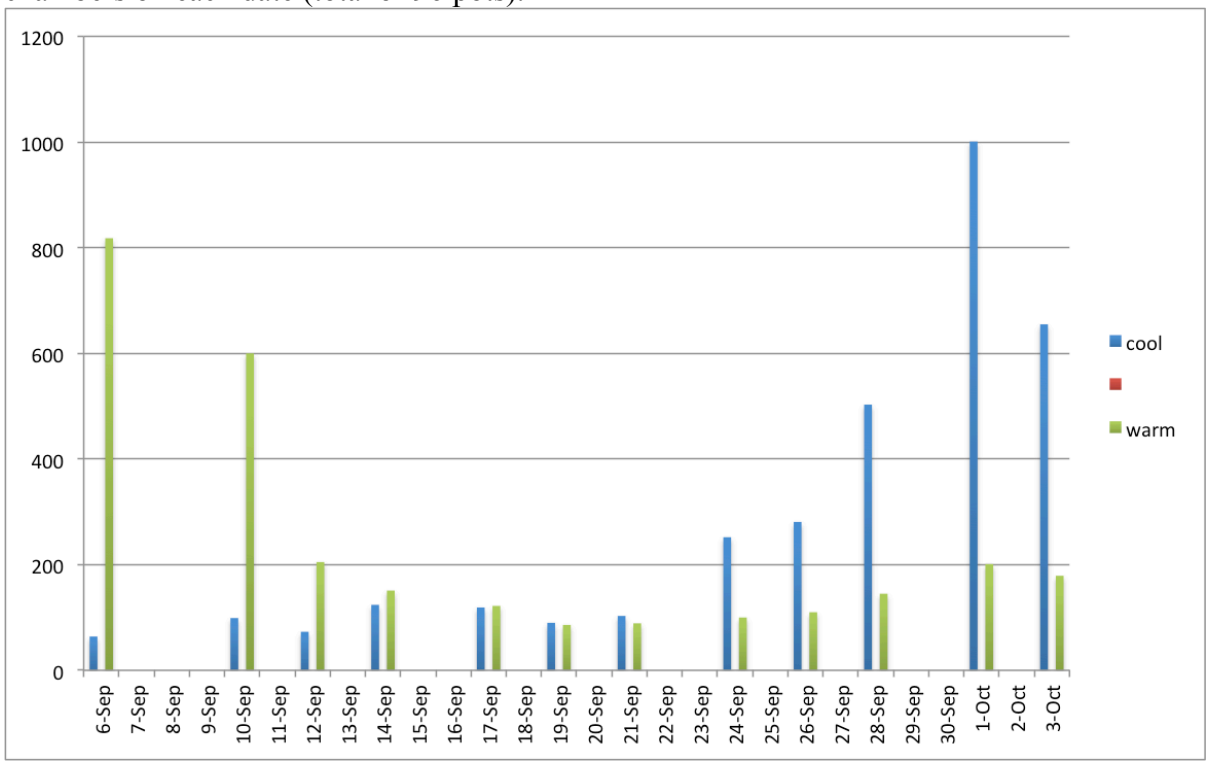
Experiments

To date, we have completed one set of each of the 2 experiments.

Experiment 1: Effect of media and temperature on fungus gnat population development

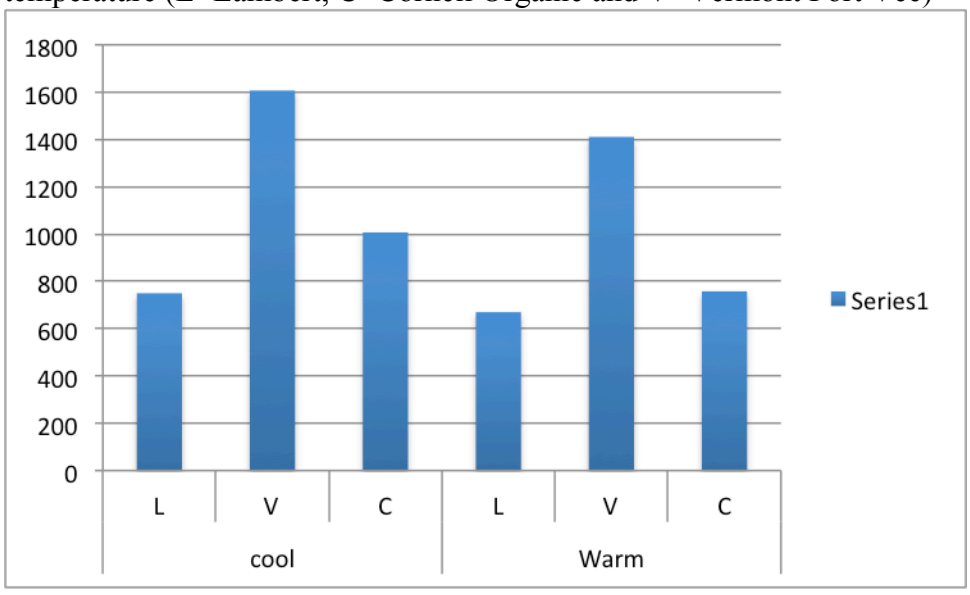
Temperature had its greatest effect on the timing of population development. While somewhat more fungus gnats were produced at the cooler temperature overall, the timing of peak production was approximately 1 month later under cool temperatures (Graph 3). The second small peak for the warm temperatures suggests that a second generation was beginning to emerge.

Graph 3. Total number of fungus gnats collected from sticky traps over all media and in both chambers on each date (total of 96 pots).



The organic content of the soilless mix seems to have the greatest effect on the production of fungus gnats (Graph 4). The pattern is the same regardless of temperature, although, again, there were slightly more fungus gnats produced in cooler temperatures.

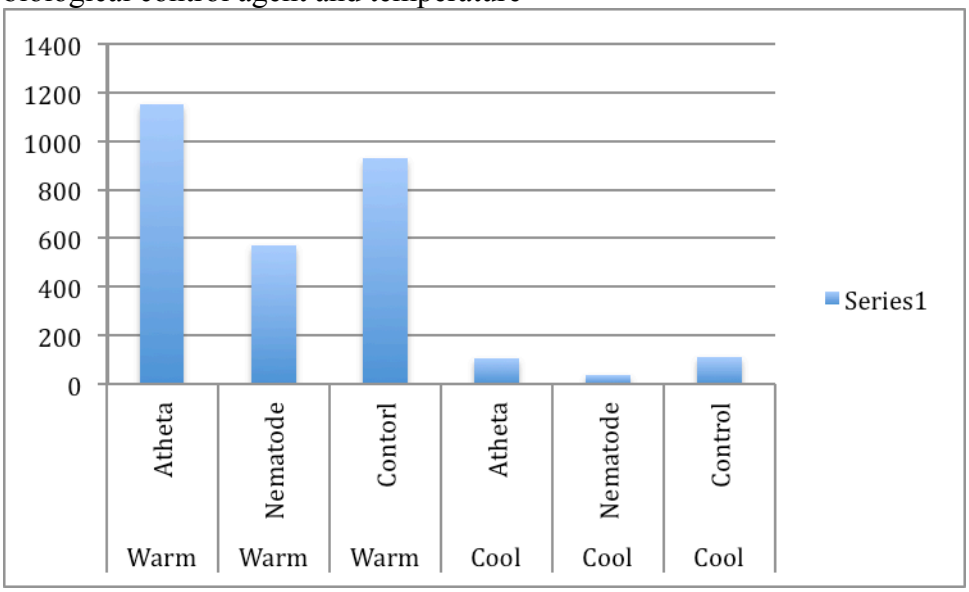
Graph 4. Total number of fungus gnats collected from sticky traps by soilless mix and temperature (L=Lambert, C=Cornell Organic and V=Vermont Fort Vee)



Experiment 2: Effect of temperature on biological control of fungus gnats

The total numbers of fungus gnats produced under cooler temperatures in this experiment is much lower than that produced under warm temperatures, and much lower than that produced in Experiment 1 under cool temperatures. There seemed to be no control of fungus gnats by Atheta at either temperature. However, the nematodes reduced the fungus gnat numbers by 40% under warm temperatures and 60% under cool temperatures.

Graph 5. Total number of fungus gnats collected from sticky traps by biological control agent and temperature



Implications:
We do not yet have enough data to determine if biological control of fungus gnats by Atheta or nematodes is effective or economically viable under cool temperatures. The association of organic matter level and fungus gnat production is interesting and may lead to further studies. While not enough on its own to change the media a grower is using, the results suggest education on storage of media to prevent fungus gnat infestations could be useful.