Biological Control is a pest management tactic that should be integrated into a comprehensive strategy including monitoring, cultural, environmental and chemical tactics.

Why Biological Control?
- Plants provide food source for pests.
- Using BCA's provide alternative options.
- Assist grower to produce quality crops.
- Focus on using IPM principles and practices.
- Improves over time with current rate of research and education available.

Reduces resistance pressure on traditional pesticides
VFGA’s Herbaceous Perennials
Production Update; Feb. 16, 2012

Review Stages for Integrating Biological Control

- **Stage 1**: Earliest efforts: Assessing pest management history and skills
- **Stage 2**: Laying the “groundwork” for implementation
- **Stage 3**: Implementation – BCA applications
- **Stage 4**: Evaluation and modification: Staying on course

Stage 1 - Integrating Biological Control

- Evaluate overall level of sanitation.
- Refine monitoring system for pests and BCA’s. ID and understand life cycle.
- Identify BCAs for use in the program.
- Determine necessary BCA quantities and schedule orders and releases.

Getting Started

**Assessing Pest Management**

- Focus on a key pest
- Difficult crop & pest
- Prioritize scouting
- Past pesticide history
- Persevere and remain committed
- Start early in production
1. At least one week prior to crop introduction install yellow sticky cards (at least 1 per 1000 sq ft) to monitor for winged aphids, fungus gnat and thrips adults.

2. Weekly plant inspections and forms for recording information agreed on.

3. Scouting begins by commitment to exclusion of incoming pests: Isolate plugs and liners on arrival.

<table>
<thead>
<tr>
<th>Month</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td></td>
<td></td>
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<tr>
<td>Feb</td>
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<tr>
<td>Mar</td>
<td></td>
<td></td>
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<tr>
<td>Apr</td>
<td></td>
<td></td>
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<tr>
<td>May</td>
<td></td>
<td></td>
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<tr>
<td>Jun</td>
<td></td>
<td></td>
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<tr>
<td>Jul</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**BCA’s and Sticky Cards**

**Yes**
- Aphelinus abdominalis
- Aphidoletes aphidimyza
- Aphidius spp.
- Encarsia formosa
- Eretmocerus spp.
- Feltiella acarisuga
- Hunter Fly (Coenosia attenuata)
- Orius
- Syrphid fly

**No**
- Predator Mites: Aphelinus andersonii, cucumeris, swirskii, Hyposaspis miles, Phytoseiulus persimilis
- Nematodes

**Minimizing Pesticide Risks to Natural Enemies**

- Determine list of compatible pesticides based on your BCA list.
- Records available for incoming plant material?
- Use lowest rates and least BCA toxic products that will give effective control. Spot treat where practical.
- Delay introduction of BCA’s after pesticide application when practical (several days or suggested intervals).

**Pesticide Compatibility with Selected Biological Control Agents**

<table>
<thead>
<tr>
<th>Pesticide Name</th>
<th>Species</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aphelinus abdominalis</td>
</tr>
<tr>
<td></td>
<td>Aphidius colemani</td>
</tr>
<tr>
<td></td>
<td>Fungus Gnat</td>
</tr>
</tbody>
</table>

**Stage 2- Laying the Groundwork**

1. At least one week prior to crop introduction install yellow sticky cards (at least 1 per 1000 sq ft) to monitor for winged aphids, fungus gnat and thrips adults.
2. Weekly plant inspections and forms for recording information agreed on.
3. Scouting begins by commitment to exclusion of incoming pests: Isolate plugs and liners on arrival.
Selection of BCA’s for Key Pests

- Review crop list to determine most likely insect and mite pests.
- Consider starting small:
  - Focus on a key pest such as fungus gnats or thrips.
  - Difficult crop & pest - herbs

Planning/Scheduling for Orders and BCA Releases

- More complex than chemically based program.
- Plan ahead for ordering- forecasting very important for BCA suppliers.
- Develop time table/schedule for ordering.
- Involve your supplier or consultant in planning orders.

Understanding BCA Quick Sheets

<table>
<thead>
<tr>
<th>Biological Control Products for Various Insect or Mite Pests</th>
</tr>
</thead>
<tbody>
<tr>
<td>Griffin Grower Services Professional (GGSPro)</td>
</tr>
<tr>
<td>General approach for Pest biological control:</td>
</tr>
<tr>
<td>General summary of GGSPro recommended BCAs for controlling</td>
</tr>
<tr>
<td>pests.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Product(s)</th>
<th>Packaging</th>
<th>Rate</th>
<th>Application</th>
<th>Viability</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lists all products for specific BCAs</td>
<td>Provides BCA numbers per package and ordering number</td>
<td>Suggested release rates</td>
<td>Tips for how to apply BCAs</td>
<td>How to be sure BCA products are alive</td>
<td>Important miscellaneous information</td>
</tr>
</tbody>
</table>
Overview of BCA
Program Using Fungus Gnats and Thrips

Early Crop Production - Fungus Gnats

- Calculate area in sq. ft. and determine quantities of Nemasys (Steinernema feltiae), Staphyline (Atheta-Rove beetle) & Hypoline (Hypoaspis miles).

Nematode calculation:
- 10,000 sq ft of floors to treat. 25% concrete walkways, 7,500 sq ft to treat with nematodes.
- From Nemasys label: 50 million treats 1,100 sq ft at 25-50 gallons per 1,000 sq ft. 375 gallons drench vol.
- 7 x 50 million nematodes = 350 million nematodes in 3.75 gallons of water injected at 1:100.

Choice of Nematode Product

<table>
<thead>
<tr>
<th>Product(s)</th>
<th>Packaging</th>
<th>For @ 350 million</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nemasys</td>
<td>5 x 50 mill 70-2460</td>
<td>2 packs</td>
</tr>
<tr>
<td></td>
<td>10 x 50 mill 70-2465</td>
<td>1 pack</td>
</tr>
<tr>
<td></td>
<td>5 x 250 mill 70-2490</td>
<td>5 packs</td>
</tr>
<tr>
<td></td>
<td>20 x 50 mill 31NEM20</td>
<td>4 packs</td>
</tr>
<tr>
<td></td>
<td>5 x 150 mill 31NEM1505</td>
<td>1 pack</td>
</tr>
<tr>
<td></td>
<td>16 x 150 mill 31NEM15016</td>
<td>1 pack</td>
</tr>
<tr>
<td>Nemashield</td>
<td>100 mill 70-6033</td>
<td>4 packs</td>
</tr>
<tr>
<td></td>
<td>500 mill 70-6034</td>
<td>1 pack</td>
</tr>
<tr>
<td></td>
<td>2 billion 70-6037</td>
<td>1 pack</td>
</tr>
</tbody>
</table>

Biological Control of Fungus Gnats

- Steinernema feltiae (Nemasys or Nemashield)
- Atheta coriaria (Staphyline)
- Hypoaspis miles (Hypoline)

Drench volume is important, fungus gnats occur throughout soil profile. Ambush nematode...
STEINERNEMA FELTIAE

**Timing Fungus Gnat Control with Nematodes**
- First six weeks of production is critical
- Apply preventative treatments as soon as possible after sowing seed or inserting cuttings.
- Takes about 2 weeks before the numbers of adult flies are noticeably reduced.
- Reapply at 3-6 weeks intervals to maintain protection.

---

**Nemasys Nematodes ~ Cost**

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>3,000 sq. ft. Greenhouse (50 M /1,100 sq. ft.)</td>
<td></td>
</tr>
<tr>
<td>3 x 50 million nematodes- $110.63 including freight</td>
<td></td>
</tr>
<tr>
<td>1-2 times per crop- 3.7 cents per sq ft/application</td>
<td></td>
</tr>
</tbody>
</table>

---

**Successful Nematode Application**
- Avoid high light (U.V)
- No tank mixing in concentrated stock solution
- Use cool water, gentle agitation and aeration in stock tank
- Remove screen finer than 50 mesh
- Insure adequate soil moisture
- Store 41°F 3-5 weeks

---

**Atheta coriaria – Staphyline c**

Fungus Gnat Larvae

Rove Beetle Adult

Rove Beetle Larvae
**Choice of Atheta (Rove beetle) Product**

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
<th>Order Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Staphyline c</td>
<td>500</td>
<td>SB0061-01</td>
</tr>
<tr>
<td></td>
<td>3000</td>
<td>SB0061-02</td>
</tr>
<tr>
<td>Introduce at least 2 predatory beetles per 10 ft².</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**7,500 sq ft / 10 sq ft = 750 x 2 beetles = 1,500 beetles**

Products: 3 pks 500 Staphyline c or 1 x 500 pkg plus 1 x 1,000 pkg IPM Labs

**Atheta (Rove beetle) ~Cost**

- 3,000 sq ft Greenhouse
- 600 beetles - $67.00 inc freight
- Once per crop: 2.2 cents per sq ft/crop

---

**Choice of Hypoaspis Product**

<table>
<thead>
<tr>
<th>Product</th>
<th>Quantity</th>
<th>Order Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoline M</td>
<td>25 K</td>
<td>SB0091-03 (1 liter)</td>
</tr>
<tr>
<td></td>
<td>125 K</td>
<td>SB0091-04 (5 liter)</td>
</tr>
<tr>
<td>10 – 50 mites/²</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7,500 sq ft x 25 mites (preventative) = 187,500 mites

Order 1 pkg of 125K + 2 or 3 pks 25K

**Hypoaspis miles ~Cost**

- 3,000 sq ft Greenhouse
- 75k mites $95.48 inc freight
- Once per crop: 3.2 cents per sq ft/crop

Considering cost: All 3 contribute to thrips control, Atheta and Hypoaspis also feed on shorefly larvae.
**Fungus Gnat Control Cost Comparison**

<table>
<thead>
<tr>
<th>BCA</th>
<th>Cost per sq ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypoaspis</td>
<td>3.2¢</td>
</tr>
<tr>
<td>Rove Beetle</td>
<td>2.2¢</td>
</tr>
<tr>
<td>Nematodes</td>
<td>3.7-7.4¢</td>
</tr>
</tbody>
</table>

Total: 9.1 - 12.8¢ /sq ft

Also helps control: shoreflies, thrips

**Chemical Cost per sq ft**

Safari drench: 12-24 oz per 100 gallons, 75-150 gallons drench volume per 3,000 sq ft house

18-36 oz Safari req’d = $169.74 - $339.48

2.83-11.32¢ per sq ft

Also helps control: aphids, shoreflies, whiteflies

* Used nematode drench volume of 75-150 gallons per 3,000 sq ft.

**Compatible Pesticides - FG’s**

<table>
<thead>
<tr>
<th>Pest</th>
<th>Commonly Used BCA’s</th>
<th>Compatible Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fungus gnats</td>
<td>Atheta coriaria, Hypoaspis miles, Steinernema feltiae</td>
<td>(No data for Atheta) Adept (slight effect on nematodes), Azatin, Citation, Distance</td>
</tr>
</tbody>
</table>

**Biocontrol of Shore Fly**

1. Atheta – Staphyline
2. Steinernema carpocapsae - Millenium

**SHOREFLY LARVAE VS. FUNGUS GNAT LARVAE**

**Target Shooting with BCAs**

- **Amblyseius cucumeris**
- **Amblyseius swirskii**
- **Steinernema feltiae**
- **Atheta coriaria**
- **Hypoaspis miles**
- **Orius insidious**

Image: North Carolina State University IPM Program
**Biological Control Agents for Thrips**

**General approach for thrips on foliage:**

- Inspect cuttings on arrival for all stages of thrips - not just adults!
- BCAs must be preventative and early.
- *Amblyseius cucumeris* and/or *Amblyseius swirskii* to control first stage larvae.

---

**Biological Control Agents for Thrips**

**General approach for thrips (cont.):**

- Nemasys – nematodes *Steinernema feltiae* to control pupae and pre-pupae.
- Orius, a predatory bug, is very effective for summer crops. *Atheta coriaria* and *Hypoaspis miles* are good for supplementing control by other BCAs.

---

**Steinernema feltiae (Nematode)**

- Florel use planned on many crop in pots and hanging baskets to prevent pre-mature bloom.
- Coordinate Amblyline cu, *(A. cucumeris)* orders with incoming propagation plugs, liners or pre-finished material.
- Begin weekly sprays of nematodes when first thrips turn up in scouting report.
- Determine area of treatment
- Select product(s)
  - Growing pot to pot allows for sachets for 4+ weeks of control
  - Bulk mites can be used, but must be applied weekly

---

**Early Crop- Thrips Program**
Example 1 - 30 x 96’ of bedding flats or potted material still pot to pot.

**Option 1** - Bugline cu (A. cucumeris) spaced 5” on center. 6 or 7 runs needed. Packed 6 x 525’. Need about 575’ per house. One unit would do almost 6 houses.

**Option 2** - One Std Breeding Sachet per 20 sq ft or ~125 per house depending on benching. Packed 260 sachets. One unit would do 2 houses.

**Option 3** - Bulk mites applied weekly 125 - 250 mites/sq. ft., mechanical application. Packed 50,000. Have ~3,000 sq. ft., need ~37,500 - 75,000.

**Thrips Scenarios**

**Sachets**

- Contain prey mites
- ~450 mites per week released
- Release predators over several weeks. (A. cucumeris 3-6 weeks, A. swirskii 2-3 weeks)
- Plants must be touching for spread.

**Variations of Sachets**

- **Gemini - Twin**
- **Standard sachet with hook**

**Bulk mites application**
**Thrips Scenarios**

Example 2- 30 x 96’ of large potted material and hanging baskets spaced out.

**Option 1** - Mini-sachets needed at a rate of one per pot. Plants spaced on 1’ centers, assuming 70% benching efficiency, 2016 pots plus 300 hanging baskets. Need 2316 min-sachets. Packed 1000 per unit, 3 units needed.

(Note: mini-sachets 10.8 cents each. (1.8 cents per week for 6 weeks.)

**Option 2** - Breeder piles of bulk mites, 2 tsp./10” basket (4.5 cents/teas/10-12” container)

---

**Mini Sachets**

- Reapplied every 4-6 weeks.
- Need to keep out of direct sun, north side of basket.
- Not in contact w/soil.
- More effective in cooler conditions

---

**Breeder Pile- A. cucumeris**

---

**Thrips- Nematode Sprays**

- Low population rate is 50 million nematodes in 10 gallons of water to treat 4,000 sq ft.
- It will take 2 x 50 million to treat ~3,000 sq. ft. each week.
- By refrigerating the extra nematodes upon arrival, use the 5 x 50 million package.
- Used in Europe, Canada, California and NE grower successfully.

---

**Foliar Application of Nematodes**

- Weekly applications from arrival of crop.
- Spray just enough to wet flowers and foliage (about 2.5 gal/1000 sq. ft.) - use capsil
- Spray exposed soil surfaces to target pupae!
Keeping nematodes agitated and aerated.

- 5-Tee compressor fittings, Plastic air hose, 2 as hose clamps,
- Air compressor hose, adjustable air valve

Drill or punch holes every ½-1”

Disease Prevention

Applying at night?

Some nematode compatible tank mixes:

- Chemical option: Daconil, Protect DF, Pageant
- Biological option: Cease, Companion, Actinovate

Amblyseius swirskii – Swirskiline as

Orius insidiosus - Predatory Bug

Orius Banker plants

‘Black Pearl’
**Early Crop Production Summary**

- A solid plan is in place. On-going formalized monitoring is vital to the program's success.
- Scouting must quickly detect and quantify developing pest populations.
- Scouting reports necessary for timing BCA releases, determining rates and deciding when to intercede with compatible pesticides.
- All pest management actions based on monitoring information!

**Stage 4:**

**Evaluation and Modification**

- On going process of monitoring pests relative to thresholds
- Pests reaching thresholds require intervention
  - Biological
  - Cultural
  - Compatible pesticides

---

**Mid Crop Production- Thrips**

Thrips at or below established thresholds, will continue weekly nematode sprays and:

- Bedding flats- Bugline or sachets of Amblyline cu (A. cucumeris) last 4-6 weeks, should be enough to finish crop.
- Smaller pots, now spaced- Breeder piles 1/pot or broadcast of bulk Amblyline cu (A. cucumeris)
- Larger pots and baskets- re-apply mini-sachets

---

**Mid Crop Production Continued**

**Fungus gnats:**

- Adult populations starting to rise again after dropping sharply 2-3 weeks after initial nematode drench.
- Scout notifies you of increase and decision is to retreat floors and containers with Nemasys to head off a bigger problem later.

---

**Compatible Pesticides- WFT’s**

<table>
<thead>
<tr>
<th>Pest</th>
<th>Commonly Used BCA’s</th>
<th>Compatible Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrips (WFT)</td>
<td><em>Amblyseius cucumeris, Amblyseius swirskii, Orius insidiosus</em></td>
<td>Aria, Azatin, Botanigard WP (slight effects to Orius short, &lt;5 day residual) Overture** (no data on mites, believed safe- no to some harm to Orius).</td>
</tr>
</tbody>
</table>

---

**Companion Plants used with Orius**

![Image of plants with Orius]
Home Stretch!

It's early May and crops are shipping out quickly. Two important decisions:

1. **Treatment thresholds will be raised somewhat higher given the time of year.**
2. If treatments are deemed necessary they will use BCA compatible pesticides because of the need for quick results.
   - Thrips: Overture
   - Fungus gnats – Distance sperench

---

### Biological Control Agents for Thrips

**Amblyseius swirskii**

<table>
<thead>
<tr>
<th>Products</th>
<th>Packaging</th>
<th>Rate</th>
<th>Application</th>
<th>Viability</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swirskiline</td>
<td>Bulk mixture of various mite stages</td>
<td>Swirskiline</td>
<td>Application 5000 mites/liter</td>
<td>25 - 100 mites/10 ft²</td>
<td>¼ - 1 tsp./10 ft², repeat applications weekly.</td>
</tr>
<tr>
<td>Bugline as Breeding system with prey mites</td>
<td>250 mites/sachet, each releases 3000 mites over 2-4 weeks</td>
<td>Bugline</td>
<td>Sachets release mites over a 2-4 week period. Space strips at 5 ft. Mites travel up to 3 ft. from sachet. Bugline as produces mites for 2-4 weeks. Mite dispersion requires plant to plant or container contact. Sachets are practical in pot to pot early production. Gemini for overhead irrigation. Sachets with 1 in every 6 sachets filled with mites (24&quot; apart). Place a few sachets on sticky cards and viable mites will come out, stick to the card and form a shadow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemini sachets</td>
<td>500 Gemini sachets</td>
<td>Gemini</td>
<td>Sachets release mites over a 2-4 week period. Bugline as with 1 in every 6 sachets filled with mites (24&quot; apart). Place a few sachets on sticky cards and viable mites will come out; stick to the card and form a shadow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemini with base</td>
<td>500 Sachets w/ hook</td>
<td>Gemini</td>
<td>Sachets release mites over a 2-4 week period. Bugline as with 1 in every 6 sachets filled with mites (24&quot; apart). Place a few sachets on sticky cards and viable mites will come out; stick to the card and form a shadow.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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### Biological Control of Whiteflies

**Amblyseius swirskii**

<table>
<thead>
<tr>
<th>Products</th>
<th>Packaging</th>
<th>Rate</th>
<th>Application</th>
<th>Viability</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Swirskiline</td>
<td>Bulk mixture of assorted stages of thrips</td>
<td>Swirskiline</td>
<td>Application up to 3000 mites/liter</td>
<td>25 - 100 mites/10 ft²</td>
<td>Repeat applications.</td>
</tr>
<tr>
<td>Bugline as Breeding system with prey mites</td>
<td>250 mites/sachet, each releases 3000 mites over 2-4 weeks</td>
<td>Bugline</td>
<td>Sachets release mites over a 2-4 week period. Space strips at 5 ft. Mites travel up to 3 ft. from sachet. Bugline as produces mites for 2-4 weeks. Mite dispersion requires plant to plant or container contact. Sachets are practical in pot to pot early production. Gemini for overhead irrigation. Sachets with 1 in every 6 sachets filled with mites (24&quot; apart). Place a few sachets on sticky cards and viable mites will come out, stick to the card and form a shadow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemini sachets</td>
<td>500 Gemini sachets</td>
<td>Gemini</td>
<td>Sachets release mites over a 2-4 week period. Bugline as with 1 in every 6 sachets filled with mites (24&quot; apart). Place a few sachets on sticky cards and viable mites will come out; stick to the card and form a shadow.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gemini with base</td>
<td>500 Sachets w/ hook</td>
<td>Gemini</td>
<td>Sachets release mites over a 2-4 week period. Bugline as with 1 in every 6 sachets filled with mites (24&quot; apart). Place a few sachets on sticky cards and viable mites will come out; stick to the card and form a shadow.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

### Conclusion

- Learn as much as possible
- Plan ahead – start early
- Take small steps at first
- Think of it like growing another crop
- Don’t give up!
- There's help if you need it.
BCA’s for Whiteflies

1) Eretline e – *Eretmocerus eremicus*
   a. Primary parasitic wasp that controls both GHWF & SLWF

2) Encarline f – *Encarsia formosa*
   b. Parasitic wasp controls only GHWF

3) Swirskiline as – *Amblyseius swirskii*
   c. Predatory mite that feeds on whitefly eggs when production temperatures are warm 65-80 °F

- Adult wasp is entirely yellow, green eyes and clubbed antennae
- Searches for host and inserts ovipositor nearby or beneath nymph to lay her eggs
- Eggs hatch and feed on nymph and pupate inside
- Nymph turns yellowish-tan color when parasitized
- Adult wasp emerge leaving visible exit hole

Blister packs improve survival
- Convenient to use
- Sold as 20 Blister packs (250 pupae)
- Preventative: 1 pack/1000 f²
- Low to Moderate Populations: 1 pack /250 - 500 f²
- Release weekly as needed

Additional notes about Encarline f
- High emergence rates, not glued to cards
- Females are almost always produced
- Feeds on 3rd & 4th instars
- Easy to see parasitism
- Will not control SLWF populations
- Temperature lower 64 ° day or 57 ° night will reduce emergence from cards
Amblyseius swirskii

- Feeds on several species, prefers thrips and whiteflies (eggs mostly). Also feeds on pollen and some on spider mites and tarsonemid mites.
- Needs higher temperatures @ 75 - 80°F.
- RH > 70%

Compatible Pesticides - Whiteflies

<table>
<thead>
<tr>
<th>Pest</th>
<th>Commonly Used BCA's</th>
<th>Compatible Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whiteflies</td>
<td>Amblyseius swirskii, Encarsia formosa, Eretmocerus spp.</td>
<td>Azatin, Botanigard WP, Endeavor, Judo, Kontos, Marathon, and Safari (drench only)</td>
</tr>
</tbody>
</table>

Parasitoids

- Aphidius colemani - Aphiline c
- Aphidius ervi - Aphiline e
- Aphelinus abdominalis - Aphiline a
- A. colemani + ervi - Aphiline ce
- A. colemani + ervi + abdominalis - Aphiline ace
Biological Control Agents for Aphids

General approach for aphid biological control:

- Application of BCAs should be preventative and early.
- Base program on wasps *Aphidius colemani* and *ervi*
- Treat hot spots with predatory midge *Aphidoletes aphidimyza* or compatible pesticides.
- Banker plants to stabilize and increase *A. colemani* populations in the absence of pest aphids.

Small vs. Large Aphids

Use *A. colemani* Use *A. ervi*

Above green peach; below melon aphid.
Above foxglove; below potato aphid.

Aphidius colemani

- Aphiline C
- Attacks small aphid species including: green peach, cotton (melon) and tobacco aphids

Aphid Banker Plants

- Designed to supply many aphid predators (*A. colemani*) over weeks at a low cost.
- Host plant is a cereal crop such as wheat or rye. Purchase started plants or sow seeds.

Scheduling Aphid Bankers

- 35 days from sowing seeds until banker is ready for the greenhouse. Sherman decided to start the bankers the last week of February to be ready for April 1st.
- Day 1- Sow seeds
- Day 7- Introduce cereal aphids
- Day 21- Introduce Aphiline C (*A. colemani*)
- Day 35- Aphid bankers ready for greenhouse
Creating Aphid Banker Plants

- Cereal aphids *Rhopalosiphum padi* used as food source for beneficials, they only feed on monocots. Used started banker plants as a source. Screen *A. colemani* out!
- Plant a section of the established banker plant into the recently started one.
- 7-14 days cereal aphids are established. Introduce wasps (*Aphidius colemani*)
- Banker plants must be protected from hyperparasites.

### Aphidoletes aphidimyza

- Predatory midge
- Adults small flies
- Larvae feed on aphids
- Rates:
  - 0.5-2 Aphidoletes/100' when aphids detected.
- Release under infested plants

**Aphidoletes aphidimyza** - *Aphidlinea aphidimyza*

- Blister packs improve survival
- Convenient to use
- Sold as 4 x 250 Blister packs
  (1000 cocoons)
VFGA’s Herbaceous Perennials
Production Update; Feb. 16, 2012

Compatible Pesticides—Aphids

<table>
<thead>
<tr>
<th>Pest</th>
<th>Commonly Used BCA’s</th>
<th>Compatible Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aphid</td>
<td><em>Aphidius colemani</em>, <em>Aphidius ervi</em>, <em>Aphidoletes aphidimyza</em></td>
<td>Aria (less than 1 wk residual effect on <em>A. colemani, ervi</em> unknown), Endeavor (less than 1 wk residual effect on all), Enstar II, Kontos, Marathon Safari (all 3 drench only)</td>
</tr>
</tbody>
</table>

Phytoseiulus persimilis – Phytoline p

- Only feeds on spider mites so must be released when mites are present
- Rapid development andmite control, but needs humidity > 65% and temperatures above 65°F
- Activity is often limited on crops with “hairy” leaves.

Phytoseiulus persimilis for spider mites

<table>
<thead>
<tr>
<th>Product(s)</th>
<th>Packaging</th>
<th>Rate</th>
<th>Application</th>
<th>Product Viability</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phytoseiulus</td>
<td>Nymphs &amp; Adults</td>
<td>Low populations: 5 – 10/10 ft²</td>
<td>Apply when spider mites are first detected.</td>
<td>Sprinkle mites and vermiculite on white paper.</td>
<td>Only feeds on spider mites so must be released when mites are present.</td>
</tr>
<tr>
<td>Phytoline</td>
<td>2,000 SB1201-01</td>
<td>200 ml tube</td>
<td>2,000 SB1201-02 50 ml tube</td>
<td>High populations: 20 – 30/10 ft²</td>
<td>Rapid development and mite control, but needs humidity &gt; 65% and temperatures above 65°F.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>500 ml tubes are preferred for larger areas. Not available as sachets. Apply to lower leaves if possible.</td>
<td>Sprinkle mites on lower leaves.</td>
<td></td>
</tr>
</tbody>
</table>

Amblyseius andersoni for Spider Mites

<table>
<thead>
<tr>
<th>Product</th>
<th>Packaging</th>
<th>Rate</th>
<th>Application</th>
<th>Product Viability</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amblyseius andersoni</td>
<td>Nymphs &amp; Adults</td>
<td>Preventative: 25 – 50/10 ft²</td>
<td>Slightly rotate horizontally &amp; vertically to uniformly disperse mites throughout vermiculite-bran carrier. Sprinkle mites on lower leaves.</td>
<td>Same as persimilis, mites are white – white to color.</td>
<td>Can survive on pollen and other pests. Active at much lower temps.</td>
</tr>
<tr>
<td>Anderline aa</td>
<td>25,000 SB0016-03 1 liter tube</td>
<td>Curative: 60–100/10 ft²</td>
<td>1 Gemini Sachet 10-100 ft²</td>
<td>Healthy mites move quickly and are easily observed.</td>
<td>Can be introduced earlier than persimilis. Feeds on many species of mites, thrips, pollen and honeydew. Active 43 – 100°F. Plants need to be touching for mites to spread from sachets.</td>
</tr>
<tr>
<td></td>
<td>125,000 SB0016-02 5 liter bag</td>
<td></td>
<td>1 Gemini Sachet 10-100 ft²</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>500 Gemini Sachets 250 mites each SB0016-01</td>
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</tr>
<tr>
<td></td>
<td>200 Mini Sachets 100 mites each</td>
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</tr>
</tbody>
</table>

Amblyseius andersoni – Anderline as

- Sachets
- Mini sachets
- Bugline aa

Biological Control Agents for Spider Mites

- General approach:
  - Early detection and release of mite predators is important.
  - Monitor trap crop: Bush beans
  - Monitor indicator crops including Buddleia, Dracaena spikes, Ipomoea, Mandevilla, New Guinea Impatiens, rose etc.

If mites are present, *Phytoseiulus persimilis* is preferred

*Amblyseius andersoni* can be applied prior to spider mite infestations.
## Compatible Pesticides - Spider Mites

<table>
<thead>
<tr>
<th>Pest</th>
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<th>Compatible Pesticides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spider Mites</td>
<td><em>Amblyseius andersoni</em>, <em>Feltiella acarisuga</em>, <em>Phytoseiulus persimilis</em></td>
<td><em>A. andersoni</em>—no data. Floramite (less than 1 wk residual effect on <em>P. persimilis</em>), Hexygon, Ovation</td>
</tr>
</tbody>
</table>

**ARE YOU READY?**