AUGMENTATION BIOLOGICAL CONTROL IN GREENHOUSES

Read Ch 25
COMMERCIAL INSECTARIES SELL NATURAL ENEMIES FOR RELEASE

SUPPLIERS OF BENEFICIAL ORGANISMS IN NORTH AMERICA

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The Vedalia beetle, *Rodolia cardinalis* (Mulsant)
Koppert Biological is one of the oldest and largest insectaries producing natural enemies for use in greenhouses.
ISSUES AFFECTING SUCCESS

1. **Efficacy.** Does the agent consistently, and strongly suppress the pest?

2. **Cost.** Is the cost of the agent low enough that its use is affordable in the crop and competitive with other pest controls?

3. **Compatibility.** Does the use of the agent fit into the total crop pest control and management needs?
Whiteflies in greenhouse vegetable crops are one of the oldest, biggest volume and most effective targets for augmentative biological control.
In greenhouse tomatoes, whiteflies do not damage plants directly except at high densities (1000/leaf).
Rather, honey dew and associated sooty mold on fruit was the concern because it required labor to wash fruit.
Sooty mold on citrus fruit
For *Bemisia tabaci*, virus transmission (TYLC-tomato yellow leaf curl) to the crop is the major concern in areas such as Spain.
Encarsia formosa was accidentally found in English greenhouses and reared to suppress greenhouse whitefly, *Trialeurodes varpoariorum*, in the 1920s and again in the 1970s (by Koppert).
In addition to parasitism, host feeding is an important source of host mortality caused by *Encarsia formosa* to whiteflies.
Greenhouse whitefly pupae parasitized by *Encarsia formosa* (black, left) vs healthy pupa (cream, right)

*Encarsia formosa* emerging from greenhouse whitefly pupae
Encarsia formosa are reared in Trialeurodes vaporariorum pupae produced on tobacco
Tobacco leaf covered with pupae of *Trialeurodes vaporariorum* parasitized by *Encarsia formosa*
Leaf covered with pupae of *Trialeurodes vaporariorum* parasitized by *Encarsia formosa*. Note white exuviae—this indicates not all whiteflies are parasitized during rearing (implications for Q)
Harvested parasitized pupae are dosed by gluing to card with sticky spot of fixed size
In greenhouse vegetable crops in northern Europe, Canada and Japan (cold climates), use of *Encarsia formosa* has been widely adopted.
<table>
<thead>
<tr>
<th>Tomatoes</th>
<th>Poinsettia</th>
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<td>- Crop has high tolerance to pest density</td>
<td>- Low tolerance to pest density</td>
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<td>- Long crop duration allows time for host/parasitoid cycles</td>
<td>- Short crop- no time for host/parasitoid cycles</td>
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<td>- Not a closely timed crop</td>
<td>- Crop must be done by about December 10\textsuperscript{th}</td>
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<td>- \textit{E. formosa} can be used inoculatively</td>
<td>- Requires \textit{E. eremicus} used as keep down strategy</td>
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In poinsettia, whitefly is the major pest, but the biocontrol program used in vegetables is not successful.
In poinsettia, there is a different whitefly, *Bemisia tabaci*, both B and Q strains.
In poinsettia, whitefly is based on another parasitoid, *Eretmocerus eremicus*, that is better adapted to *B. tabaci* and has higher host feeding rates.
### Whitefly Control in Vegetables vs Flower Crops

#### Vegetables
- *Encarsia formosa* is used
- Seasonal inoculation works
- Control is based on host/parasitoid population cycles
- Timing of suppression is flexible and less suppression is needed

#### Flowers
- *Eretmocerus eremicus* is used
- Weekly mass release is needed (1 F/pl/wk in poinsettia)
- Supplemental control with insect growth regulator is needed
- Population cycles not acceptable. Pest must be suppressed continuously
Western Flower Thrips - a major greenhouse pest for which biological control is not satisfactory in flower crops.
Amblyseius cucumeris (Phytoseiidae)

This mite is mass reared on grain mites in buckets
A. *cucumeris* only provides about 50-75% suppression of western flower thrips larvae, even at 3-4X the recommended rate, in spring flower crops in MA (crop duration 6-10 weeks)
In peppers, *A. cucumeris* populations build up over the long crop season, feeding on pollen, and control western flower thrips.

In cucumbers, sachets (open rearing units) can be used to provide effective control.
Two-spotted spider mite (*Tetranychus urticae*) is an important greenhouse pest.
SPIDER MITE DAMAGE ON DIFFENBACHIA
(A FOLIAGE CROP)
For spider mite control, releases of the phytoseiid *Phytoseiulus persimilis* are successful.
But *Phytoseiulus persimilis* does not control broad mites, *Polyphagotarsonemus latus*
BROAD MITE DAMAGE. THIS SPECIES, UNLIKE SPIDER MITES, IS NOT CONTROLLED BY PHYTOSEIULUS PERSIMILIS
Broad mites can be controlled in Israel on pepper with *Amblyseius cucumeris*
Aphids are an important pest group in greenhouse crops

Cotton aphid (*Aphis gossypii*), one of 30+ species found in greenhouses
Aphidius colemani ovipositing in aphid
Mummified (parasitized) aphids

Mummy with parasitoid emergence hole
Banker plants are used as open rearing units to promote early and better aphid control by *Aphidius colemani*. Banker unit is a grain aphid on rye, not a pest to flower dicot crops.