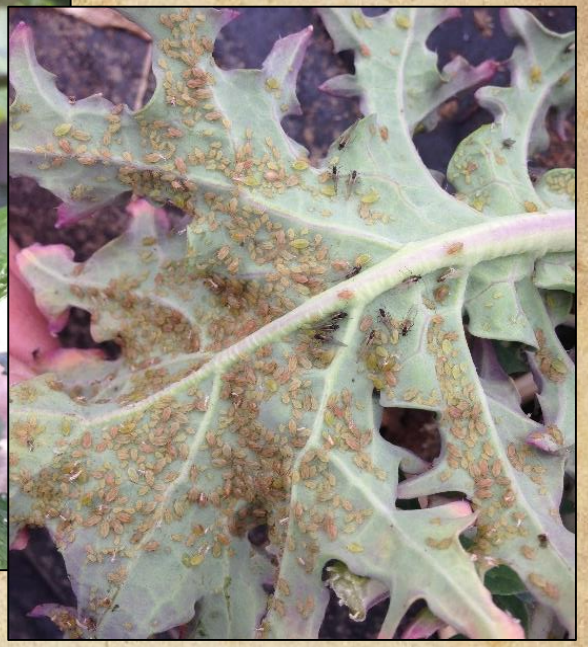
Preventing An Aphid Apocalypse



The Natural Way

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Biological Control in Greenhouses – Success is in the Details

Sturbridge, MA - January 12, 2016

Aphids & Their Nat. Enemies

Topics of Discussion

- The nature of the beast
- Management options
  - Natural enemies
  - Promoting nat. enemy establishment

Aphids

What's the deal?

- Order = Hemiptera (True Bugs)
- Soft bodied, pear shaped, 1-4 mm long
- Characteristic stovepipe-looking formation on rear ends (cornicles)
- > 30 different species attack greenhouse crops
- Cause significant crop & revenue loss
- Difficult to manage

Aphids Suck

What do they do?

- Piercing sucking mouthparts
- Insert stylets through plant tissue & remove sap from phloem
  - Distortion, stunting, viruses
- Poop all over the plants (honeydew) & cause sooty mold growth
- Scare customers away
  - Visual & food quality issue

Where Did They Come From?

They don't just magically appear!!!!

- Weeds
- Overwintered pet plants (continuous cropping)
- Hitchhiked on cuttings/stock
- The big outside world

The Nature of Aphids

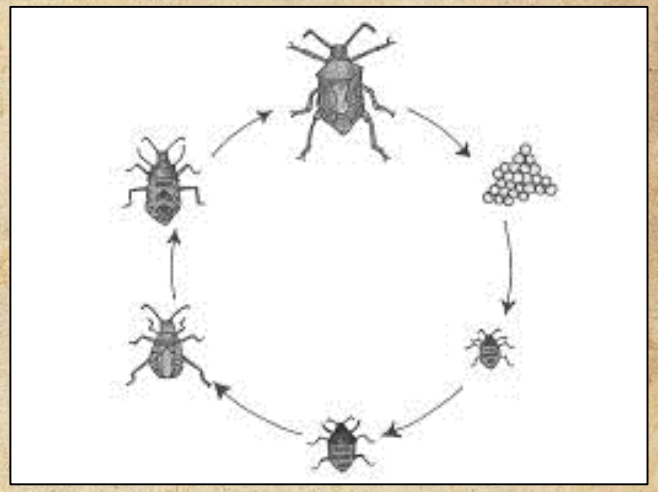
In order to manage pests, you should know about their LIFE CYCLES

- **What do their life stages look like?**
- **When in their life do they causes damage?**
- **What stages do natural enemies attack?**
  - **What are the life cycles of the natural enemies?**

They Just Want to Live Their Lives Like The Rest of Us

Life Cycle Basics

Immature insects are called either NYMPHS or LARVAE
What's the difference?

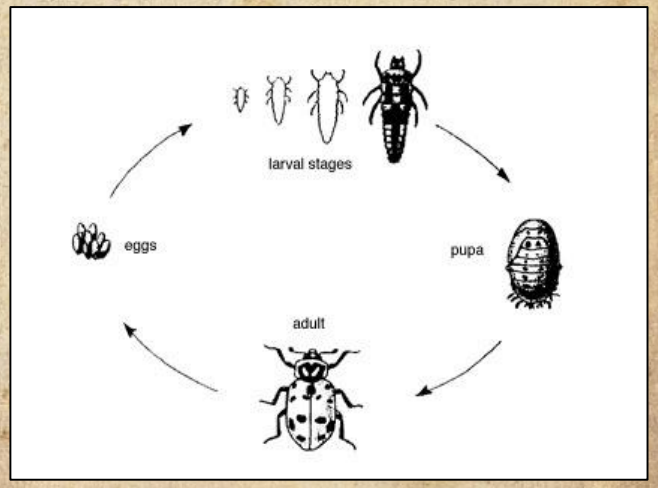


In the simplest terms….

METAMORPHOSIS (changes through molting/shedding their skin)

- Simple – Immatures - NYMPHS (similar body form as adult, not sexually mature & wingless)
  ex. Aphids & Stink bugs

- Complete – Immatures - LARVAE (look very different from the adult, go through a pupa stage).
  ex. Beetles & Flies



Life Cycle

How do aphids become a problem?

Inside greenhouses its simple……

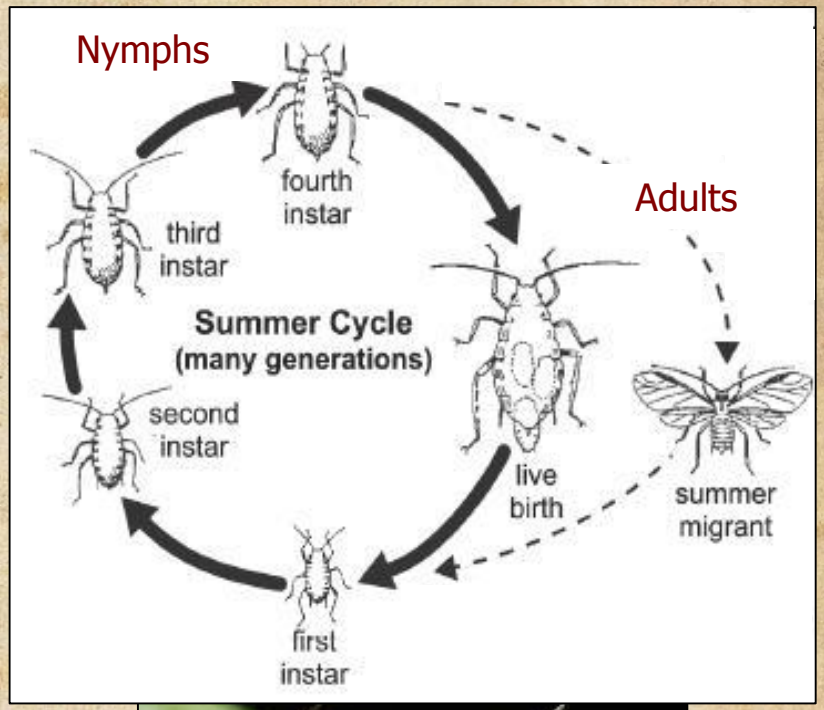
Incoming aphids finds a preferred host

Then they multiply FAST!!!!

- Asexual reproduction (Parthenogenesis)
  - All females
  - Live birth
  - No mating needed (clones)

Too crowded, No problem!

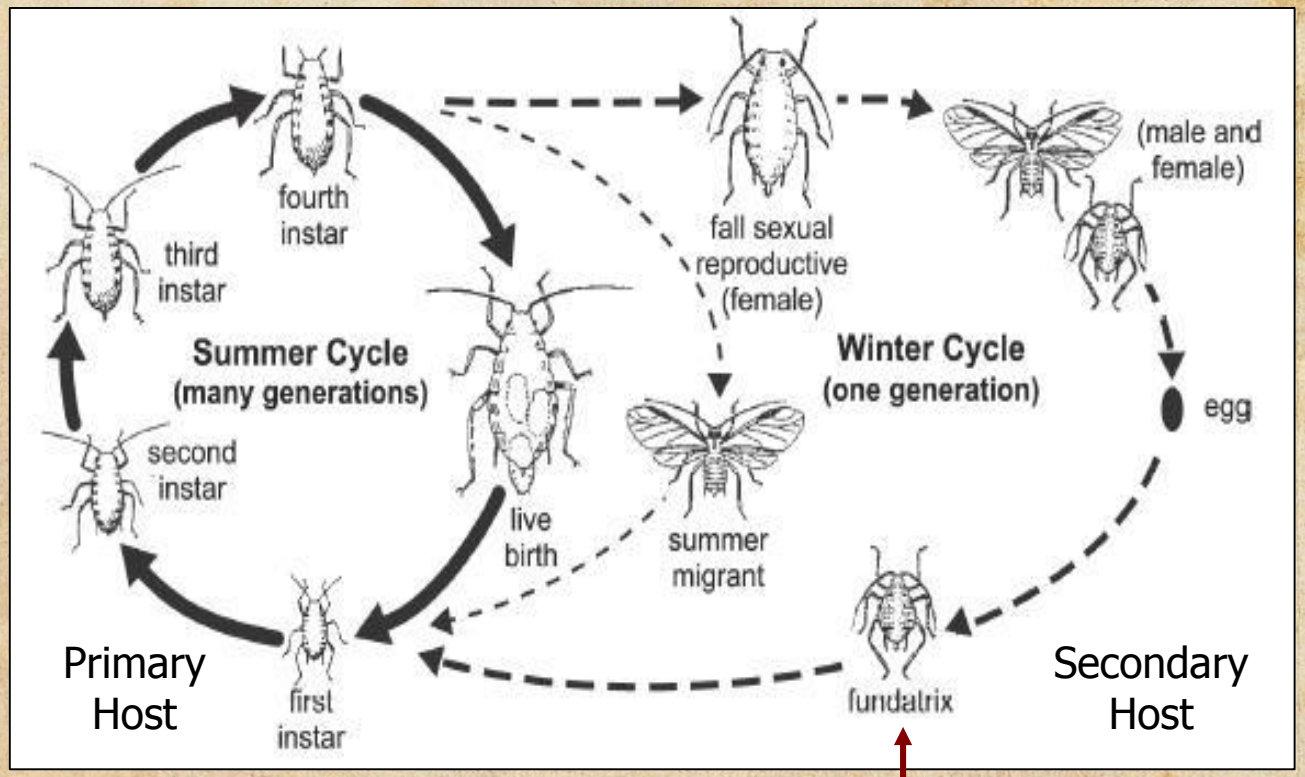
- Grow wings, fly to new host & repeat



Life Cycle

How do aphids become a problem?

Outside the greenhouse bubble, in the real world its more complicated!!



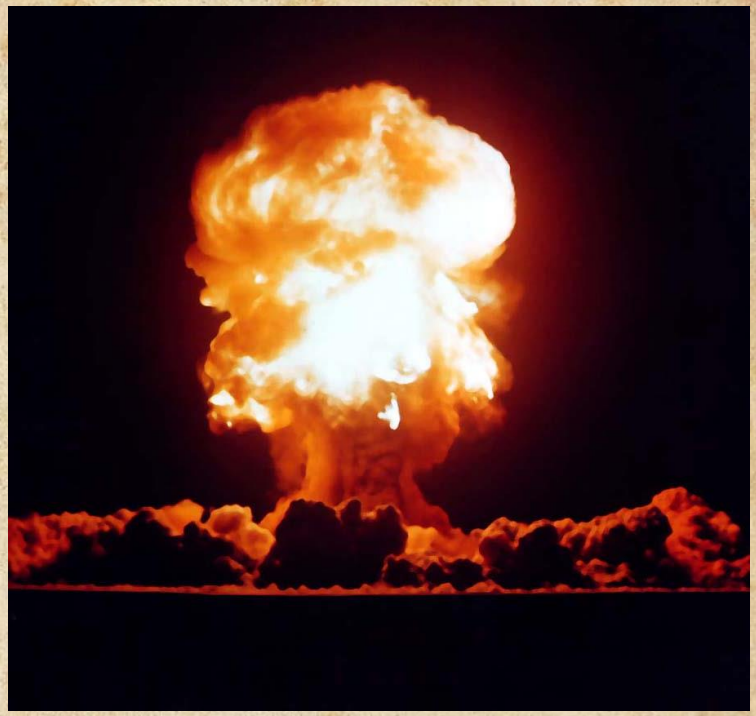
Overwintering phase

The MOTHER Aphid
start of the parthenogenic reproduction
(You really don't want this one to come inside…)

Aphids Can Explode!

How many you can get depends on:

- Host plant
- Climate
- Population density
  - Grow wings & disperse when overcrowded
- Disruptions – humans, natural enemies & pesticides



Life cycle facts to give you nightmares:

- 10-12 days to complete 1 generation
- Adults live approx. 20-40 days
- Each adult can produce 40-100 nymphs (3-10 per day)
- Female nymphs can mature after 6 days!
- Over 20 generations annually where conditions are favorable

Aphids Can Fight Back

They just explode into an army of warriors!

Defense mechanisms

- They have bodyguards
  - Ants defend their honeydew factories
- React to disturbances
  - Drop off plants
  - Dodge natural enemies
- Hide really well

You Don't Want An Aphid Army

How Can You Lower Your Risks?

Cultural Control + Scouting = 1st Line Defense

Scout/Monitor on regular basis

- Inspect incoming & existing plants for aphids (wingless forms)
- Sticky cards (winged forms only)

Avoid high nitrogen fertilization

- Aphids are N addicts (love luscious new growth)

Remove weeds

Avoid overwintering high volumes of plants & pet plants

Give fallow periods

How To Find Aphids

Find the wingless ones 1st

- Usually too late when show up on sticky cards

Visually inspect susceptible hosts (calibrachoa, fuschia, peppers, etc.)

- Focus on buds, stems, & lower leaf surfaces (sometimes roots)
- Cast skins
- Distortion & honeydew

Tap plants over white sheet paper to look for dislodged aphids

Cast skins - NOT whiteflies…

I Found Aphids! What Do I Do?

Depends! …. just what you wanted to hear

Pre-Management Critical Questions

- How many are there?
  - Have a low action threshold
- What time of year is it?
  - Early vs. late spring
  - Summer vs winter
- What crop is it?
- What aphid species is it?

Choosing Your Battle

Management Options

- Mechanical
  - Low infestation
  - Hand pick leaves, wash them off
- Biological
  - Low infestation
  - Preventative starting early season
- Chemical Control
  - Epic, damage causing infestation
  - Pre-sale cleanup
  - If all other options fail

You Decided To Use Biological Control!!!

Now What?

Good Choice! Way To Go!

Aphid Id

4 usual suspects on ornamentals. In high tunnels, more diverse

Does it even matter what kind they are?

- If managing chemically, not really
- If using biological controls, YES, It may!!!!
  - May nat. enemies are species-specific specialists
  - You could be using the wrong thing

Melon
Aphis gossypii

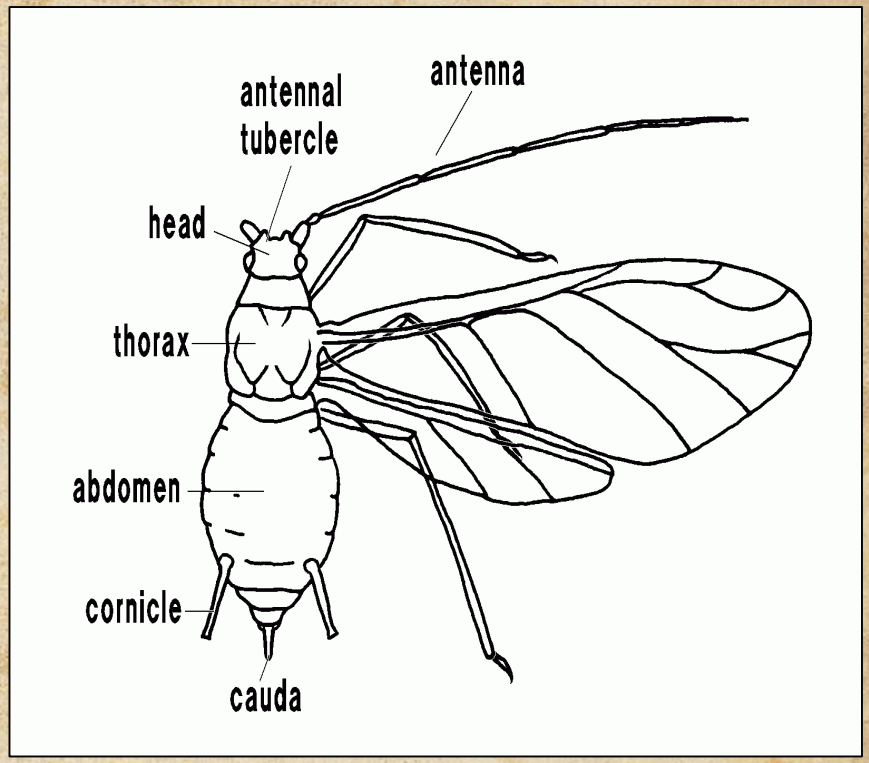
Green Peach
Myzus persicae

Foxglove
Aulacorthum solani

Potato
Macrosiphum euphorbiae

Aphid Id - Anatomy

- Two forms
  - Non-winged (Aptera)
  - Winged (Alate)
- Id based on several features:
  - Antennal tubercles (head shape)
  - Antennae length
  - Siphunculus/cornicles (stovepipes) length & texture

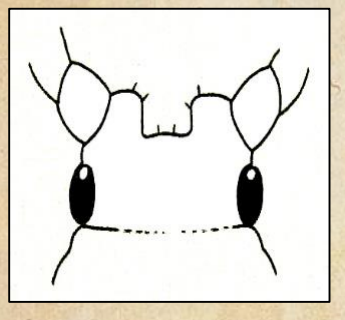


Do NOT ID based on color

Aphids can take on the color of what they feed on

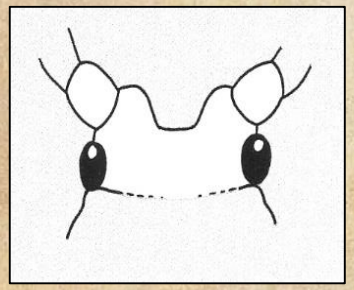
Aphid Id - Species

Foxglove



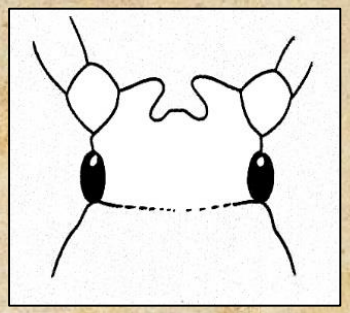

- Pale green, yellow & shiny color
- Parallel tubercles
- Dark spots at cornicle bases
- Tend to fall off plants when disturbed

Potato



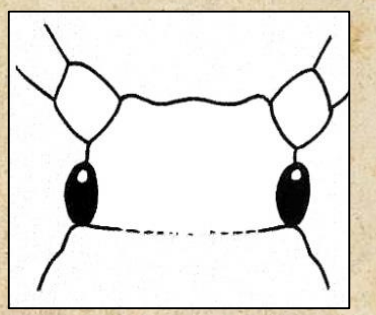

- Pink, green color
- Slightly diverging tubercles
- Slender, pear shaped body
- Very long cornicles

Green Peach




- Green, pink, orange color
- Tubercles converging inward (W)
- Long cornicles with black tips

Melon




- Green, yellow color
- Flat tubercles
- Short, dark cornicles

Getting Help With Id

When in doubt consult a specialist (extension agent/supplier/consultlant)

Helpful Hints

- Send a sample! (in alcohol) in crushproof, non-leaking container, double bagged in a box.
    - Difficult, sometimes impossible, for the experts to id off a picture
- Choose the biggest, fattest, most mature aphids (they have genital plates)
    - Aphids can have up to 12 different forms/morphs in their life
    - Many id keys focused on adult female forms
- Send a specimen army! (not 1 or 2 individuals)
- Indicate the host plant (not all aphids will attack your greenhouse plants)

Aphid Natural Enemies

Parasitoids, Predators & Fungi

Parasitoids

Aphidius spp.

(*colemani, matricariae, ervi*)

What do they do?

- Adults lay eggs inside aphids
- Larvae-pupae develop inside, turning aphid into 'mummies', killing them
- Adults feed on honeydew
- Work best in cooler temperatures

Adults

Appearance

- Species tend to be difficult to tell apart
- Adults
  - Long antennae & legs & small waist
  - 2-3mm in length
  - Black with brown/red highlights
- Larvae-pupae
  - Within golden brown mummies

Developing larva-pupa

Parasitoids

Aphelinus abdominalis

What does it do?

- Adults lay eggs inside aphids
- Larvae-pupae develop inside, turning aphid into 'mummies', killing them
- Adults feed on aphids & honeydew
- Works better in higher temperatures

Adult

Appearance

- Adults
  - Short antennae & legs
  - 3mm in length
  - Black & yellow
- Larvae
  - Within blackened mummies

Developing larva-pupa

Parasitoids

Not All Wasps Are Created Equal

Parasitoid	Green Peach	Melon	Foxglove	Potato
Aphidius colemani	X	X		
Aphidius ervi			X	X
Aphidius matricariae	X			
Aphelinus abdominalis			X	X

Predators

Aphidoletes aphidimyza

Aphidol "EAT" es – Eats Aphids

What does it do?

- Adults are midges (flies)
- Larvae (predatory maggots) eat **most types** of aphids
  - Inject them with paralyzing toxin & slurps them up
- Adults feed on honeydew & nectars
- Subject to diapause (need supplemental light early/late)

Larvae/Maggots

Adult

Appearance

- Adults (mosquito looking)
  - Pink/brown color
  - Long legs & antennae
  - Active at night
- Larvae (maggots) - Orange/red color
- Pupae - Oval & brown in the soil

Predators

Syrphid spp. - Hover/Flower Flies

What do they do?

- Adults are flies
- Larvae (predatory maggots) eat **most types** of aphids
- Adults feed on honeydew & nectars

Appearance

- Adults (look like bees)
  - Black/brown color marked bands/dots, white/yellow
- Larvae (maggots)
  - Pink, yellow, green & brown marked with white/black color
  - Slightly tapered at front
- Pupae - Oval & brown on plant/soil surfaces

Adults

Pupa

Larvae/Maggots

Predators

Orius spp.

What do they do?

- Predatory bugs (adults & nymphs)
- Generalist predators (also eats thrips, mites, pollen/nectars)
- Pierces & sucks pest juices
- Some undergo diapause
- Needs food source to establish early in season

Appearance

- Adults, black, grey, white & brown
- Nymphs red/brown

Adult

Nymph

Predators

Lady Beetles

What do they do?

- Predatory beetles (adults & larvae eat aphids)
  - Requires lots food to stick around
- Generalist predators (also eats thrips, mites & pollen)
- Does well year-round

Appearance

- Red, orange, yellow with black markings
- Larvae alligator-like
- Pupa attached to leaf surfaces

Adult

Larvae

Pupa

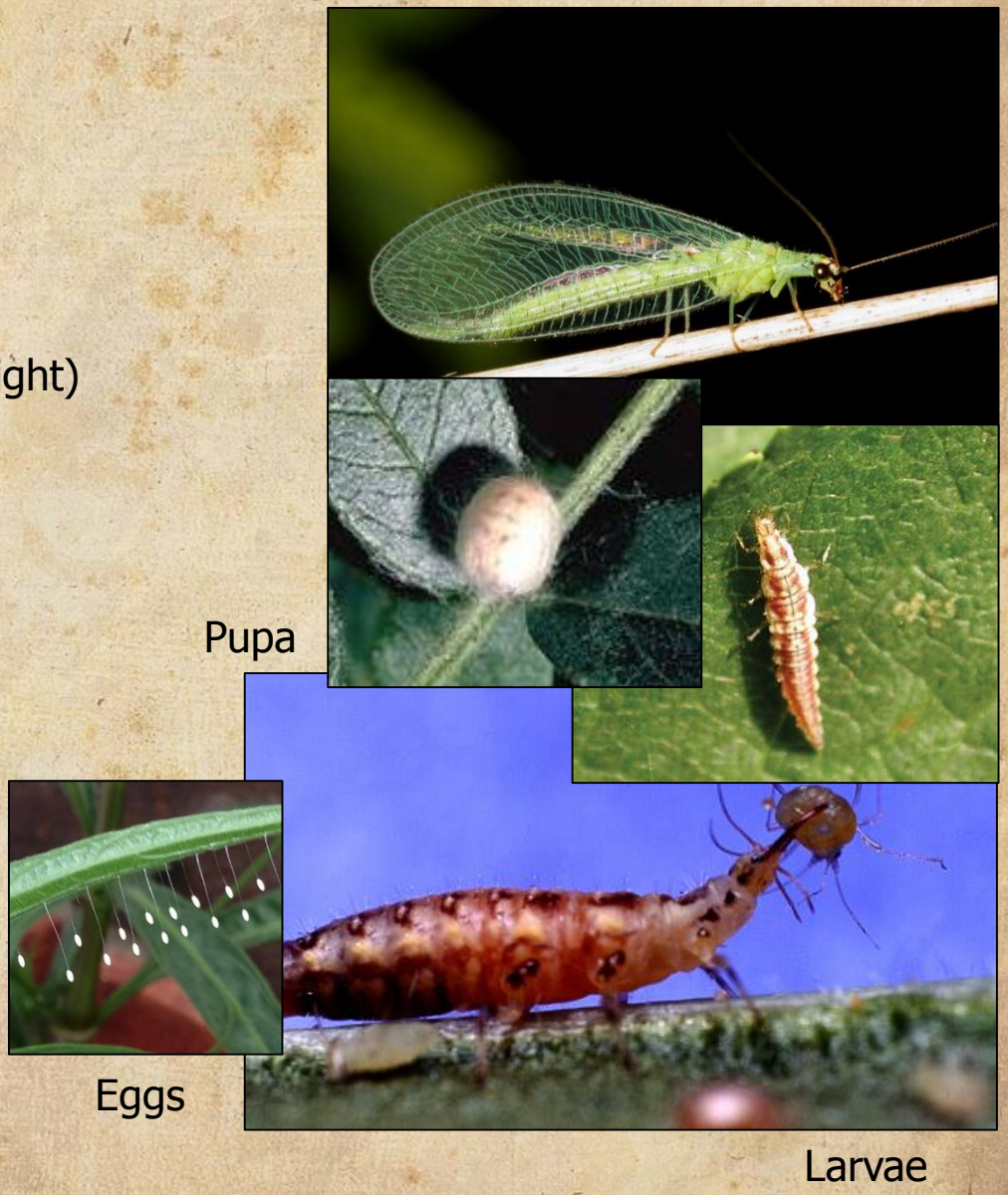
Predators
Lacewings

What do they do?

- Larvae are generalist predators
  - Can be cannibalistic
- Adults consume pollen & nectars (at night)
- Requires lots food to stick around

Appearance

- Adults green-brown
- Larvae alligator-like, brown
- Pupa cocoons on leaf surfaces
- Green lacewing eggs stalked on vegetative surfaces



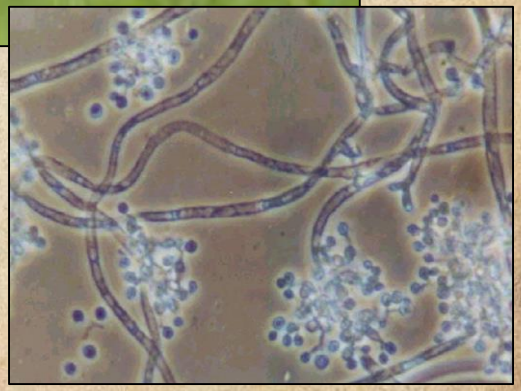
Insect Killing Fungi (entomopathogens)

What does it do?

- Insect killing fungus (entomopathogen)
  - *Beauveria bassiana*
  - *Isaria* (=*Paecilomyces*) *fumosoroseus*
- Broad host range (thrips, whiteflies, predatory beetles)
- Contact is necessary
  - Multiple applications usually required
  - Dense canopies challenging
  - Needs high humidity (>80%)

Mycelium (spore masses) on infected aphids

Spores



Promoting Establishment Of Natural Enemies

Natural enemies & shipping is expensive! Make Your Own!

Plant-Mediated IPM Systems - Plants (usually non-crop), used as a foundation, in combination with other IPM practices, to manage pests

- Site for nat. enemy releases
- Site to provide food & shelter to establish nat. enemies
- Attracts/maintains purchased & naturally occurring nat. enemies

Banker Plants

Plants that provide nutrition (usually a non-pest host insect or pollen) for an ongoing supply of nat. enemies

Habitat Plantings

Plant combinations that provide food & shelter to attract & sustain a complex of naturally occurring &/or released nat. enemies

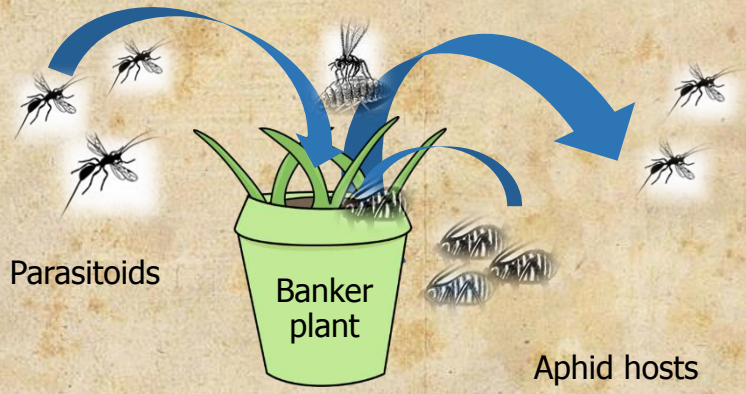
Plant-Mediated IPM Systems

Advantages

- Happy Bios: A proactive approach
  - ✓ Reduce starvation when prey absent
- Cost: Eliminates multiple orders
  - ✓ Shipping is a killer
- Better Quality: Fresh is best
  - ✓ Improved searching, longevity & reproduction
- Biocontrol Efficacy: Already established
  - ✓ Ready to roll & acclimated

Plant-Mediated IPM Systems
for the Aphid Parasitoids

Aphid Banker Plant System



Winter wheat/rye/barley is purchased infested with bird cherry oat aphids, *Rhopalosiphum padi*

A. colemani are released onto the system

Wasps reproduce within the system

Wasps disperse into crop to search for green peach or melon aphid

Promotes establishement of general predators

Plant-Mediated IPM Systems
for the Aphid Parasitoids

Success Tips

Plan Ahead!

Deploy when plants 1st arrive

Get on banker rotation schedule

Allow 6 weeks to establish

- Once inoculated with *A. colemani*, it takes approx. 4 wks for wasps to multiply

Minimum rate of at least 1/acre (43,560 sq.ft.)

- Cycle 1-2 new ABS in weekly

One ABS can last 10 wks

- Hide unsightly ones to allow remaining wasps to disperse

ABS containment box

Bouffant

Grow ABS in a secluded location, preferably in a different greenhouse & protect them. Parasitoids VERY good at finding hosts

Please view production guidelines handout

Plant-Mediated IPM Systems
for the Aphid Parasitoids

You Could Be an IPM Ambassador!!

VT grower teamed with local tech school to raise banker baskets

Reduces contamination from wasps

Passes IPM knowledge & methods to the next generation

Plant-Mediated IPM Systems
for the Aphid Parasitoids

Challenges

- Labor intensive with learning curve
- Hyperparasitoids reduce *Aphidius* efficacy
  - Examine mummy lids after wasp emerges
  - Do not keep systems into late summer
- Ants guard aphids & prevent parasitism
- Not recommended if Monocotyledons (Easter lilies, day lilies, ornamental grasses) are more than 10% of your crop

Aphidius smooth & no lid

Some hyperparasitoids have lids

Dendrocerus carpenteri
hyperparasitoid jagged & no lid

Plant-Mediated IPM Systems

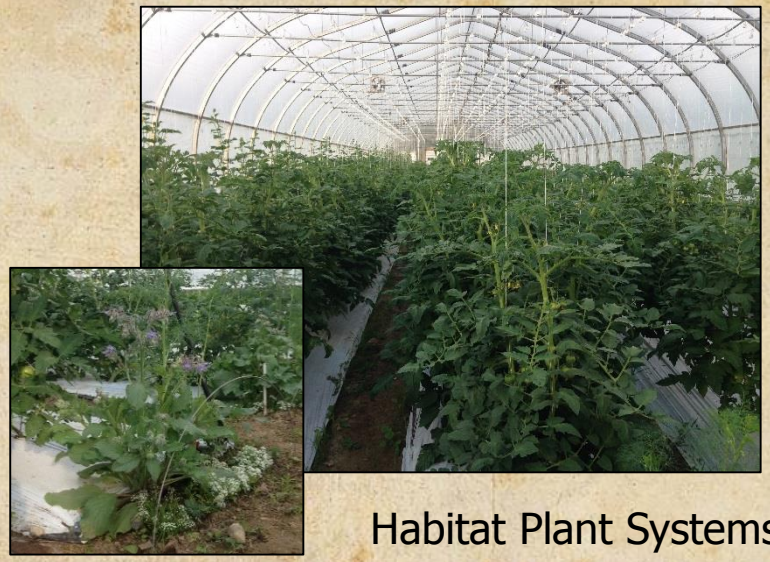
Current Study - Research Objective

Test **<u>two</u> plant-mediated IPM systems** that support biological control of aphids to determine their suitability and effectiveness for **<u>two</u> vegetable crop types** and **<u>two</u> cropping seasons** in high tunnels in the Northeast

Cool Season Crops
Leafy Greens: Winter

Banker Plant System

Warm Season Crops
Tomatoes, Peppers, Cucumbers: Summer

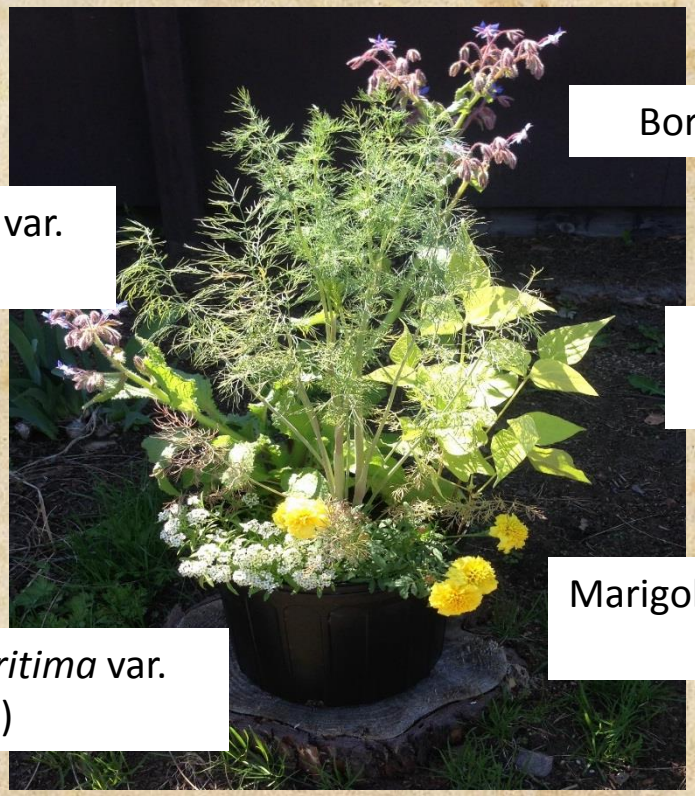


Habitat Plant Systems

Plant combinations that provide food & shelter to attract & sustain a complex of naturally occurring &/or released nat. enemies

Plant-Mediated IPM Systems

Current Study - Habitat Plant System Summer



Borage (*Borago officinalis*)

Dill (*Anethum graveolens* var. Bouquet)

Bush Bean (*Phaseolus vulgaris* var. Provider)

Marigold (*Tagetes patula* var. Little Hero Yellow)

Alyssum (*Lobularia maritima* var. Snow Princess)

Hard Red Spring Wheat Aphid Banker

Plant-Mediated IPM Systems

Current Study - Habitat Plant System Winter

Dwarf Calendula (*Calendula officinalis* var. Yellow Gem)

Alyssum (*Lobularia maritima* var. Snow Princess)

Marigold (*Tagetes patula* var. Little Hero Yellow)

Viola (*Viola tricolor* var. Helen Mount)

Bush Bean (*Phaseolus vulgaris* var. Provider)

Cold tolerant
Max. Height under 18in

More for spring time

Hard Red Winter Wheat Aphid Banker

Plant-Mediated IPM Systems

Current Study - What Are We Measuring?

3 States x 2 Sites x 3 Tunnels/Site

In A Nutshell:

- ✓ Aphid species & numbers
- ✓ Natural enemy types attracted
- ✓ Hyperparasitism
- ✓ Habitat/banker plant performance
- ✓ Costs

Plant-Mediated IPM Systems

Current Study - Preliminary Results

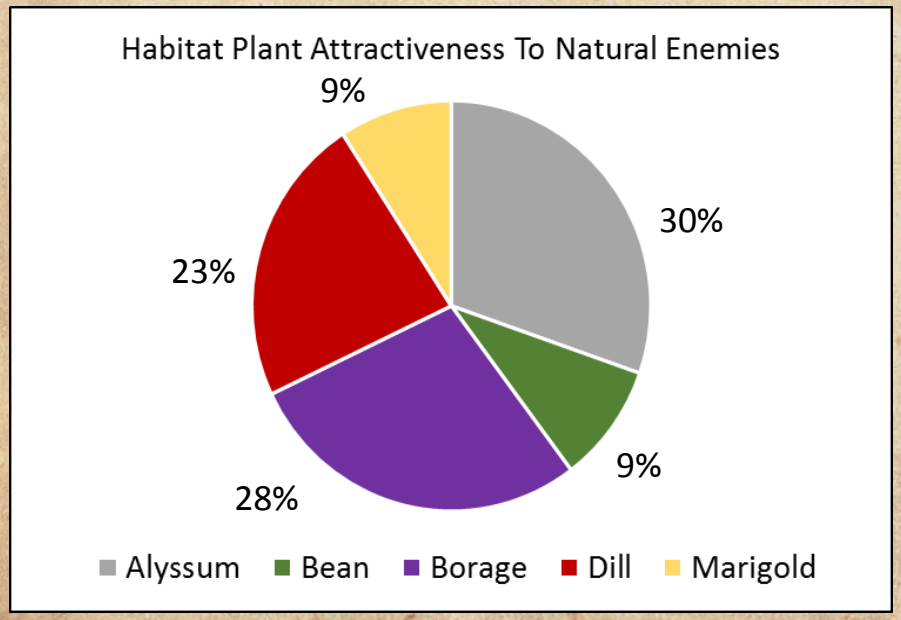
Year 1 Summer

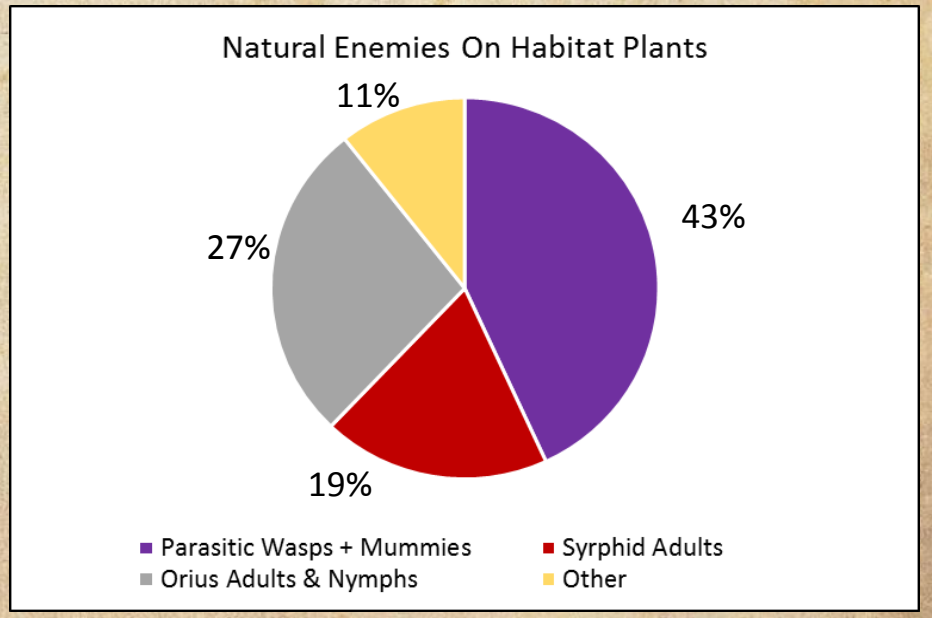
Over 700 individual natural enemies encountered

Borage, Dill & Alyssum attracted primarily parasitic wasps & mummies, *Orius* adults & nymphs & syrphid adults

Others include various lady beetle life stages, predatory maggots, assassin bugs, lacewing eggs and larvae, etc.

6 species of aphids attracted





Plant-Mediated IPM Systems

Current Study Images

All These Choices, What Now?

Success Tips

Contact/choose your supplier(s)

Establish schedule & program customized for YOU

- From scouting, you know:
  - Susceptible crops
  - When past problems popped up

Monitor nat. enemy quality upon arrival

- Grower Guide: Quality Assurance of Biocontrol Products
  http://www.vinelandresearch.com/sites/default/files/grower_guide_pdf_final.pdf

Establish monitoring program

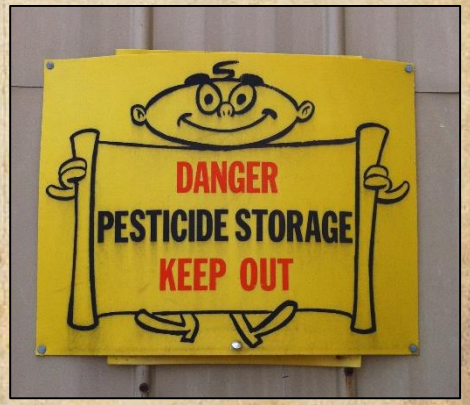
- Parasitism present?
- Larvae/nymphs present?

Avoid chemicals as much as possible

Bail Out Options

Chemical Considerations

- Choose least toxic chemistries & systemics over sprays
- Check side effects
  - Ask nat. enemy supplier
  - Side effects guides
    - **Biobest:** http://www.biobestgroup.com/en/side-effect-manual
    - **Koppert:** http://side-effects.koppert.nl/?_ga=1.71195792.123436521.1445879572
    - **Syngenta:** http://www.syngentaflowers.com/country/us/en/Bioline/Documents/Catalog/Bioline-Compatibility_Chart.pdf
- Coverage
  - Upper canopy easier to contact with sprays
  - Systemic most effective against those feeding on new growth
  - Older growth/lower canopy most difficult to kill chemically
    - Creates re-infestations on upper canopy



Remember, Timing Is Everything

Be Proactive, Not Reactive

Don’t be shy

Contact your support groups (Suppliers/Consultants/Univ. Extension Agents)

Good luck this spring!

Questions?

THANK YOU!!!

Visit our Website!
http://www.uvm.edu/~entlab/

This material is based upon work that is supported by the National Institute of Food and Agriculture, U.S. Department of Agriculture (NIFA), Crop Protection & Pest Management Program under Award no. VT-0067CG, Accession No. 1004273, and the NIFA Extension IPM Program Award no. 2014-70006-22577, CRIS no. 1004998. Any opinions, findings, conclusions, or recommendations expressed in this presentation are those of the author and do not necessarily reflect the view of the U.S. Department of Agriculture.