High Tunnel Tomato Pests & Their Natural Enemies

Cheryl Frank Sullivan & Margaret Skinner

Univ. of Vermont: Entomology Research Laboratory

Expand Your Tunnel Vision: High Tunnel Production Conference

Manchester, NH - December 14, 2016

About

The Entomology Research Laboratory

Dynamic research team of senior scientists, technicians & graduate students dedicated to finding practical IPM solutions to grower's real world problems.

Topics

Identification of common tomato insect pests & their associated natural enemies

Plant-mediated strategies for detecting pests & promoting nat. enemy establishment

The Challenge Between

High tunnels not fully open/closed system (not field, not greenhouse, bit of both)

Limited barrier to pests & nat. enemies, can favor ideal environments for both

High plant densities makes pest detection difficult = rapid problem spread

Conventional production has access to wide array of chemicals

- Organic production limited, relying almost solely on natural products
- Costly repeat applications usually required

Doing nothing creates revenue loss, may jeopardize future crops & stress

The Aphid Apocalypse

Identified as top insect pest issue in Northeastern high tunnel vegetables in recent grower surveys

Maybe You Shoulda Scouted?

Aphids

They Suck!!

Soft-bodied with piercing sucking mouthparts

- Consume sap from phloem
- Distortion, stunting, viruses, death

Poop all over the plants (honeydew) & cause sooty mold growth

Wide host range

- Peppers, Eggplant, Greens, Tomatoes

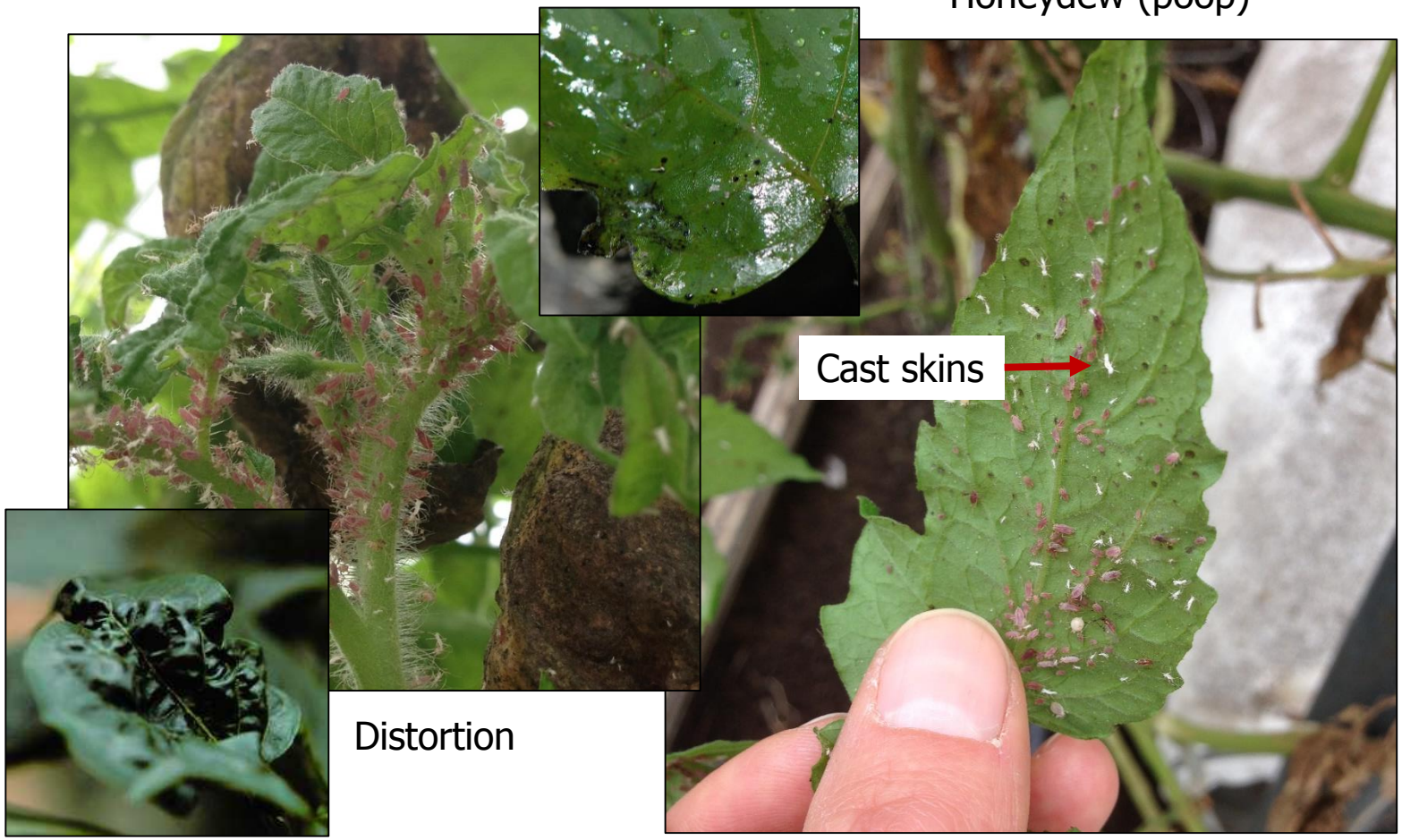
Scare customers away

- Visual & food quality issue

Aphid Damage

Scouting must rely on plant inspections!!

Inspect growth tips & leaf undersides (older first)



Aphid Id (usual suspects)

Potato, *Macrosiphum euphorbiae*
This one will decimate tomato crops

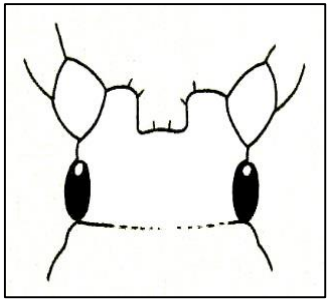
Green Peach, *Myzus persicae*
Occasional early season nuisance on tomato

Foxglove, *Aulacorthum solani*

Melon, *Aphis gossypii*

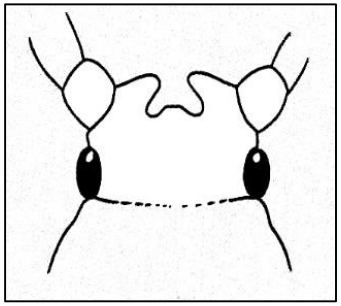
Aphid Id (usual suspects)

Foxglove



- Pale green, yellow & shiny color
- Developed, parallel-slightly divergent tubercles
- Dark spots at cornicle bases, reticulated (with lines)
- Tend to fall off plants when disturbed & at tips

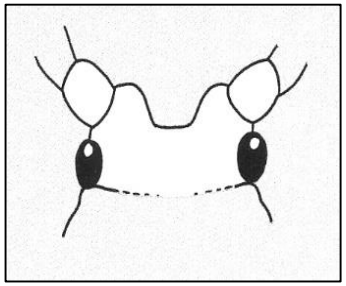
Green Peach



- Green, pink, orange color
- Developed, converging inward (W) tubercles
- Long cornicles with black tips
- Tend to be lower on plants

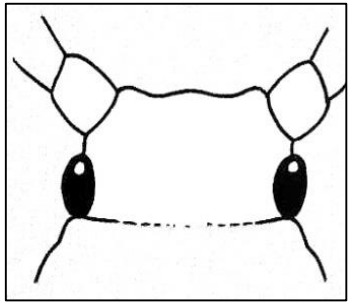
Do NOT id based on color

Potato



- Pink, green color
- Parallel-slightly divergent tubercles
- Slender, pear shaped body
- Very long cornicles, reticulated (with lines)
- Tend to infest growth tips, tend to fall off

Melon



- Green, yellow color
- Undeveloped, flat tubercles
- Short, dark cornicles

Natural Enemy 101

Predators: actively consume & kill hosts

- Usually larger than prey
- Predaceous in either immature stage, adult stage, or both
- Eat many prey during their life
- Fairly mobile to find & catch prey
- Most have fairly broad host range (generalists)

Parasitoids: kill host (parasites don't usually kill host)

- Slightly to substantially smaller than host
- Parasitic only in developing larval stage
- Each larva kills one host during its development
- Larvae not mobile in the environment (adults mobile and seek hosts)
- Eggs laid in or on host
- Usually host-specific (specialists)

Aphid Natural Enemies

Wasp Parasitoids

Several wasp spp. commercially available

- *Aphidius* (*colemani, matricariae, ervi*)
- *Aphelinus abdominalis*

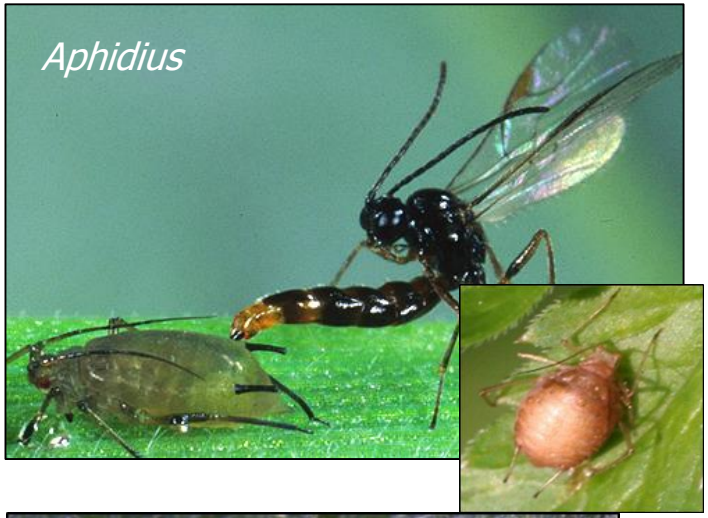
Many other naturally occurring spp.

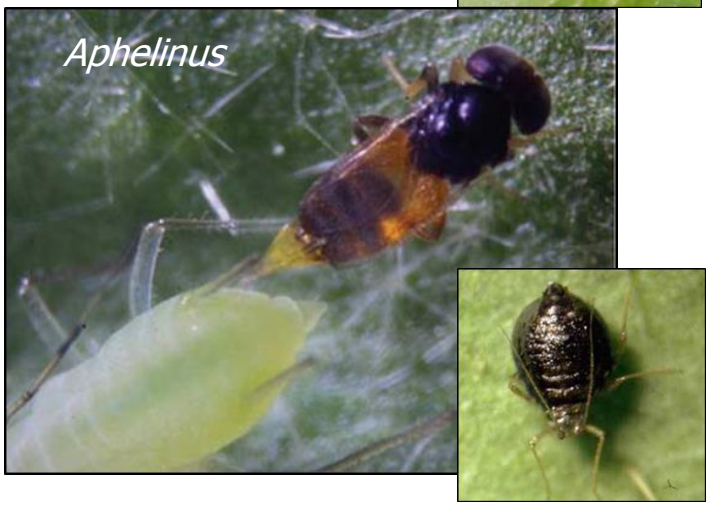
Adults lay eggs inside aphids

Larvae-pupae develop inside, turning the aphid into brown or black 'mummies'

Adult wasps feed on nectars, honeydew (*Aphidius*) & sometimes their hosts (*Aphelinus*)

Subject to hyper-parasitism (parasitism of parasitized hosts)





Aphid Natural Enemies

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

This is why it's important to ID aphid spp. if purchasing wasps.

If you cant tell what aphids you have send to a Ext. specialist & talk to your bio supplier

Aphid Natural Enemies

Aphidoletes aphidimyza

Predator specialist

Adults are midges (flies) - Feed on honeydew & nectar

Adults (mosquito looking) - Long legs & antennae - Active at night

Larvae (predatory maggots) eat **most types** of aphids

Subject to diapause (need supplemental light early/late if used year round)

Commercially available & naturally occurring

Aphid ol "EAT" es – Eats Aphids

Larvae/Maggots

Adult

Aphid Natural Enemies

Syrphid spp. – Hover flies

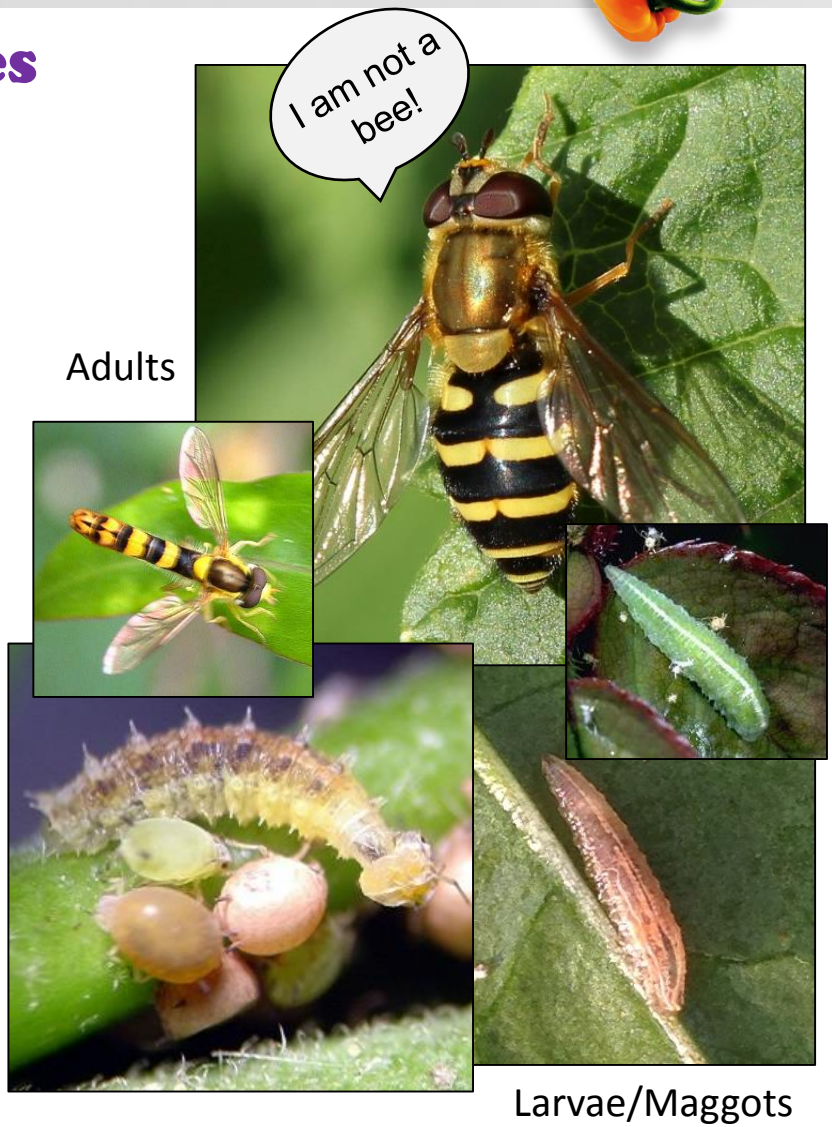
Adults are flies (look like bees)

- Black/brown color marked bands/dots, white/yellow
- Feed on honeydew & nectars

Larvae (maggots) are generalist predators & eat most types of aphids & other small insects

- Pink, yellow, green & brown marked with white/black color

Naturally occurring



Aphid Natural Enemies

Aphid Banker Plant System

Cereal grasses (wheat, barley, oat) support host specific cereal aphid (*R. padi*) to sustain *A. colemani* wasp for green peach/melon aphid management

Effective in ornamentals

Currently testing effectiveness in tomato & greens production

Effectiveness may be limited in HT

- Difficult to maintain aphid colony (predation)
- Labor intensive & time consuming to maintain

Thrips

Several species are pests

- Western flower thrips (*Frankliniella occidentalis*)
- Onion thrips (*Thrips tabaci*)

Small & slender (cigar shaped)

Adults & larvae found on leaf undersides & within flowers (hard to detect)

Above spp. pupate in soil

- Difficult to manage with contact insecticides (limited contact)

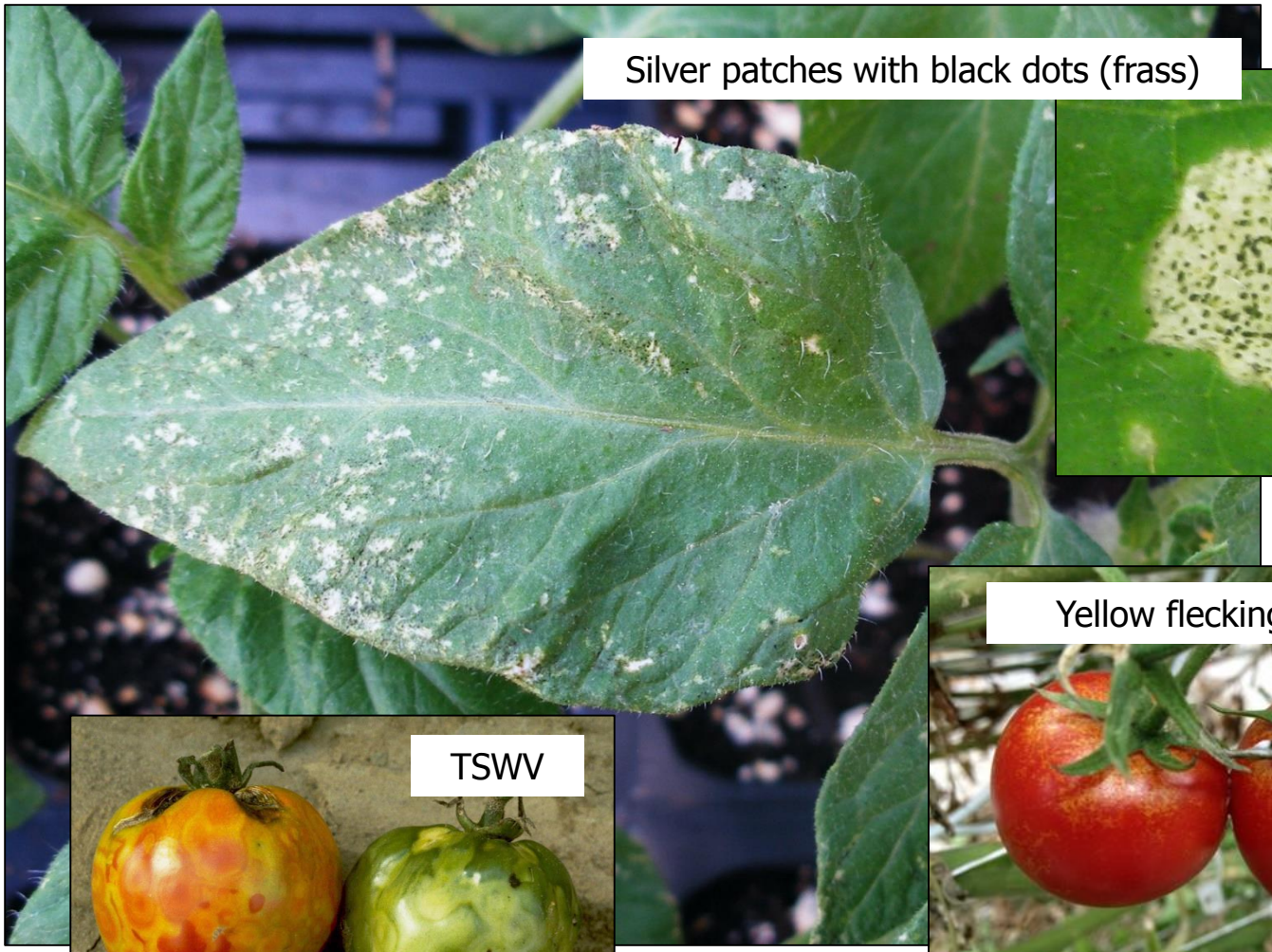
Wide host range

- Cucumbers, Eggplant, Tomatoes

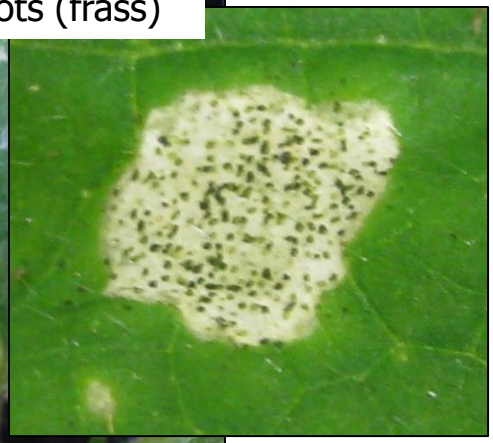
Both spp. above transmit virus to many plant spp. (tomato spotted wilt virus)

Older & younger larvae

Thrips Damage



Silver patches with black dots (frass)



TSWV

Yellow flecking on fruits

Managing Thrips

Natural Enemies & Trap Plants

Monitor thrips adults with sticky cards

Amblyseius (=Neoseiulus) cucumeris

- Generalist, beige colored, predatory mite
- Can survive on pollen & other small arthropods

Marigold Trap Plants (Hero Yellow)

- Pull thrips (trap them), pred. mites released onto marigold consume thrips
- Infested marigolds can also be disposed of
- Cheap, easy to produce, flower prolifically

Managing Thrips

Natural Enemies & Banker Plants

Orius spp. - Predatory bugs (adults & nymphs)

Generalist predator (also eats aphids, mites, pollen/nectars)

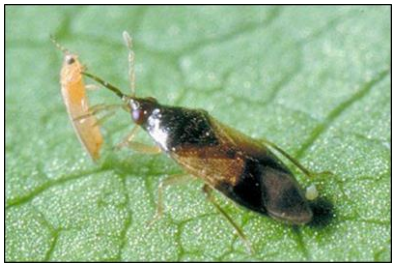
Adults black, grey, white & brown

Nymphs red/brown

Needs food source to establish early in season (if purchased)

Occur naturally mid-summer (undergo diapause in fall)

Alyssum/lobularia (clear crystal/snow princess) banker plants provide pollen when prey absent



Spider Mites

Green-yellow color with 2 dark spots on each side

Found on the underside of leaves

Wide host range (tomato, cucumber, eggplant, pepper)

Enjoy Hot & Dry conditions

Tend to overwinter inside tunnels near side walls & structures

Red phase overwintering phase

Spider Mite Damage

Yellow stippling visible on leaf surfaces

Webbing

Yellow flecking on fruits

Managing Spider Mites

Natural Enemies

Phytoseiulis persimilis

- Specialist: Eats only SM
- Tomato hairs limit dispersal requiring frequent release
- Needs high humidity (>60%)

Mite Generalists (pollen, other small insects)

- *Neoseiulus (Amblyseius) californicus*
- *Neoseiulus (Amblyseius) fallacis*

Predatory midge (fly) (*Feltiella acarisuga*)

- Yellow brown predatory larvae (maggot)
- Adults eat pollen/nectar
- Needs high humidity also (>60%)

Managing Spider Mites

Natural Enemies & Trap Plants

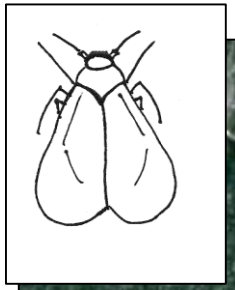
Bush bean trap plant (Provider)

Stratiolaelaps (Hypoaspis) scimitus

- Generalist predatory mite (soil dweller)
- Release around edges/structures early (gets overwintering mites) & other soil dwelling pests

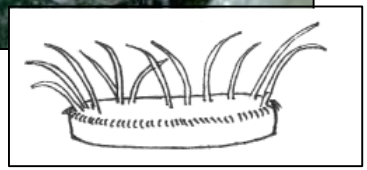
Whiteflies

Greenhouse
Trialeurodes vaporariorum



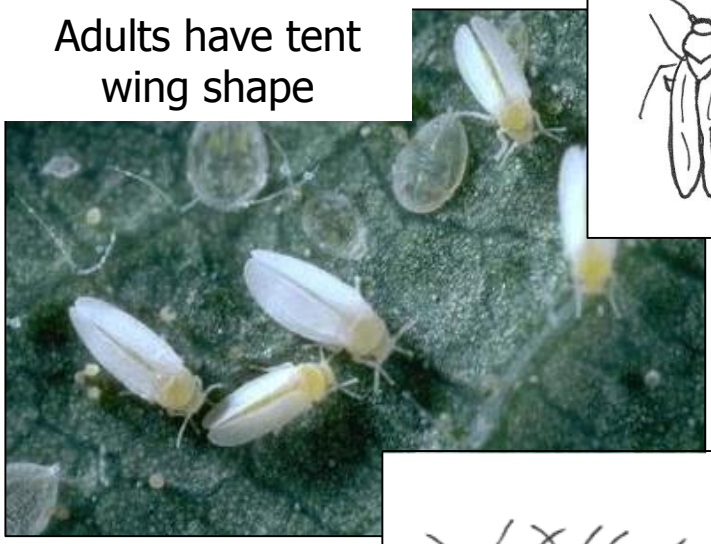
Adults have flat wing shape

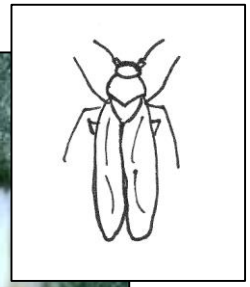
Nymphs cake shaped & hairy



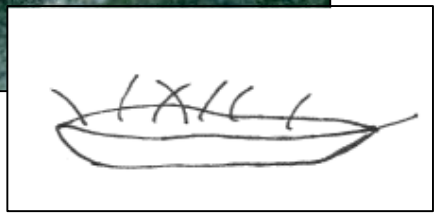
Silverleaf/Sweetpotato
Bemisia spp.

Adults have tent wing shape





Nymphs pancake shaped



Found on leaf undersides (check lower first)

Weaken plants & create honeydew & sooty mold

Both spp. vector tomato viruses (leaf curl & chlorosis types)

Whitefly Nat. Enemies

Wasp Parasitoids

Each have preferred host

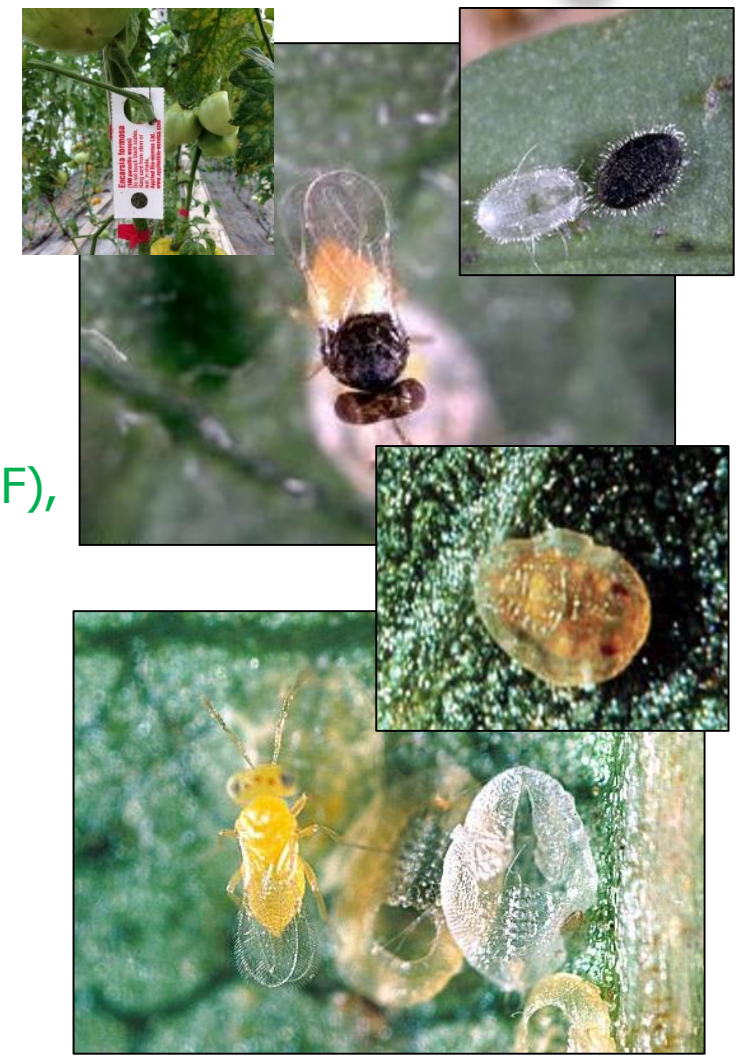
Encarsia formosa

- Adults black & yellow
- Prefers GWF, will attack SLW
- Parasitized pupae turn black (GWF), gold (SLW)

Eretmocerus eremicus

- Adults lemon yellow
- Prefers SWF, also attacks GWF
- Parasitized pupae turn gold

Both spp. host feed



Hornworms

Larvae (caterpillars) blend in with tomato foliage, hard to detect until extensive defoliation occurs – 90% occurs during final instar stage – July/August

Tomato Hornworm: *Manduca quinquemaculata* (Five-spotted hawkmoth)

- Horn usually black - 8 white V shapes
- Adult 5 orange spots

Tobacco Hornworm: *Manduca sexta* (Carolina sphinx moth)

- Horn usually red - 7 white lines
- Adult 6 orange spots
- Most common in N.E.

Adult moths feed on nectars

Overwinters as pupa (warm regions) or <u>in tunnels where soil does not freeze</u> (results in June adults). Migrant moths (most common), July

Tomato

Tobacco

Hornworms

Pupa

Egg

Frass (poop)

Damage

Cutworms

Many spp. (surface, climbing, army, subterranean)

Most are night feeding caterpillars (curl when disturbed)

Early season feed on stems cutting off transplants at the base or notch & cause wilting

- Black cutworm (*Agrotis ipsilon*)

Later in season others feed on foliage & fruit making holes

- Variegated cutworm (*Peridroma saucia*): climbing cutworm, day feeder

Adults (nocturnal) feed on nectar

Adults migrate in & some overwinter in soil/debris (various life stages, most as larvae)

Variegated

Cutworms

Black

Variegated

Cutworm Damage

Severed stem

External surface & neat holes on fruit

Cutworms

Yellow-striped armyworm/cotton cutworm (*Spodoptera ornithogalli*)

Uncommon pest in northeast

Foliage feeder, sometimes fruit

Overwinters as pupa in warmer regions, adults migrate in

Have one year, will see next

Tomato Fruitworm

Tomato Fruitworm aka Corn Earworm (*Heliothis zea*)

Major corn pest, sporadic on tomato in southern part northeast

Larvae variable

Does not overwinter in northeast

Moths arrive (July-August)

Late season pest (July-October)

Attacks fruits (usually inside), not foliage

Caterpillar Management

Bacterial agents (soil dwelling)

Btk (*Bacillus thuringiensis* subsp. *Kurstaki*)

- Caterpillars only
- Must be ingested by caterpillars
- Most effective on early larval stages

Spinosad *Saccharopolyspora spinose*

- Most effective when ingested, also contact

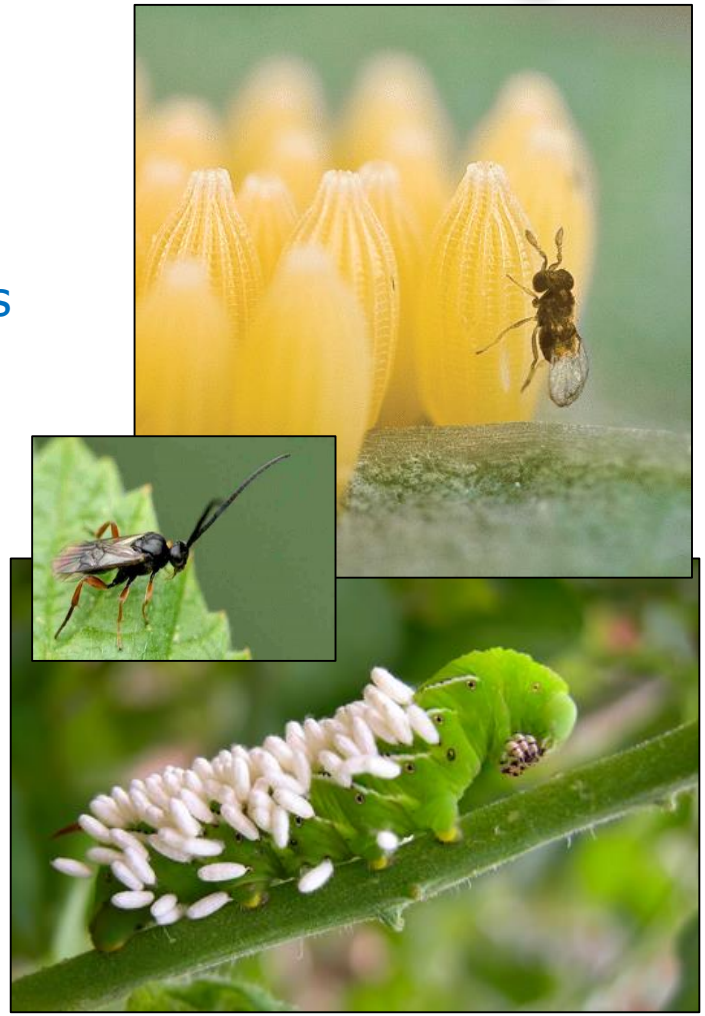
Trichogramma spp.

- Egg parasitoids
- Several spp. commercially available

Braconid wasp parasitoids

- *Cotesia* spp. (aka Apanteles)
- Naturally occurring

Trichogramma adult



Cotesia pupae on hornworm (after feeding within)

Stink Bugs

Common spp. (occasional pests)

- Green (*Acrosternum hilare*)
- Brown (*Euschistus servus*)
- Brown Marmorated (*Halyomorpha halys*) – emerging pest

Bugs suck & blemish (yellow) – cloudy spot & deform fruits

Biocontrol of difficult- Native generalist predators (spiders, ground beetles, assassin bugs)

Good Stink Bug

- Spined soldier bug (*Podisus maculiventris*)
- Predatory stink bug - generalist– very effective on caterpillars

Stink Bugs

Brown Marmorated Stink Bug

Halyomorpha halys

Green Stink Bug

Acrosternum sp.

Brown Stink Bug

Euschistus sp.

The bad bug

The good bug

The brown stink bug *(left)* and spined soldier bug *(right)* are similar to the BMSB but have more pointed 'shoulders' and lack the antennal stripes and clearly visible stripes on the abdomen.

Other Nat. Enemies

Green Lacewings

Chrysoperla spp.

Larvae are generalist predators (can be cannibalistic)

Adults consume pollen & nectars (at night)

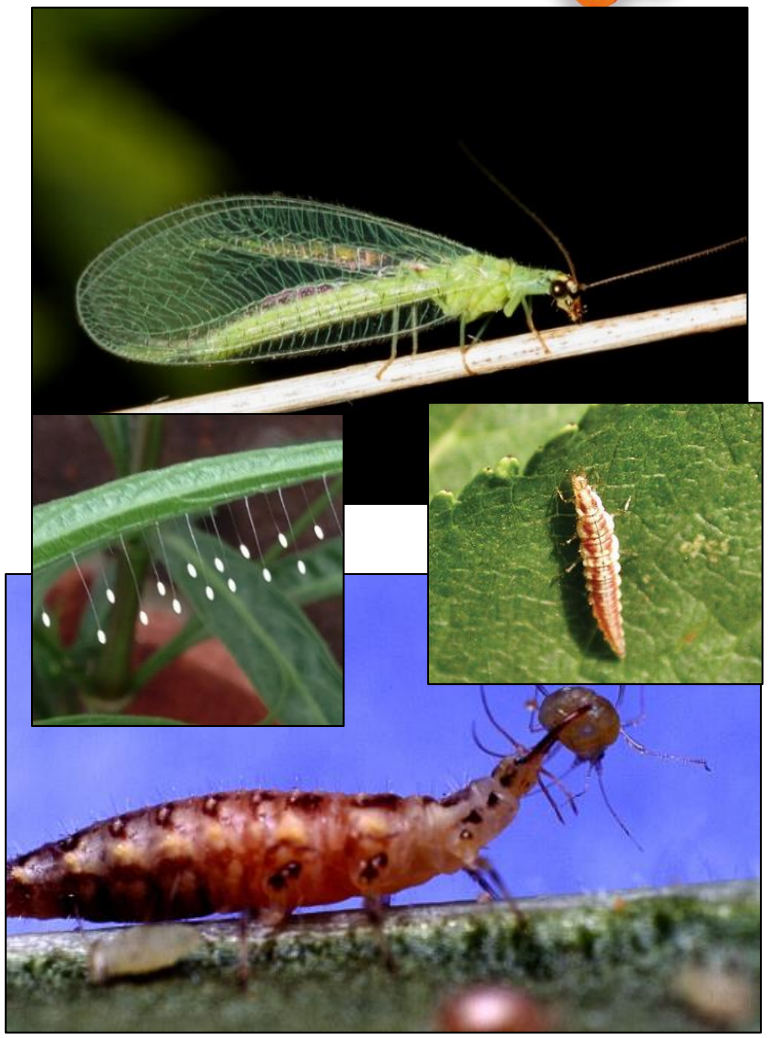
Requires lots food – great for pest hot spots (esp. aphids)

Adults are green-brown

Larvae alligator-like, brown

Green lacewing eggs stalked on vegetative surfaces

Commercially available (*Chrysoperla rufilabris*) & many naturally occurring



Other Nat. Enemies

Lady Beetles

Adults & larvae varying colors & patterns of red, orange, yellow & black

Larvae alligator-like

Generalist predators (also eats thrips, mites & pollen)

Some spp. commercially available

- *Hippodamia convergens* wild caught & native
- *Adalia bipunctata* insectary raised & native

Larvae

Adalia bipunctata
two-spotted

Hippodamia convergens
convergent lady

Other Nat. Enemies

Lady Beetles

Introduced

Coccinella septempunctata
sevenspotted ‘C-7’

Harmonia axyridis
Asian lady beetle

Propylea quatuordecimpunctata
checker spot ‘P-14’

Other Natives

Coleomegilla maculata
pink spotted

Hippodamia parenthesis
parenthesis

Hippodamia variegata
variegated

Other Nat. Enemies

Predatory thrips

Tachinid flies (parasitic)

Ground beetles

Assassin bugs

Soldier beetles

Big eyed bugs

Robber flies

Biocontrol Success Tips

Practice prevention (debris removal, fallow periods, etc.)

Understand your pest & nat. enemy

- Life stages that cause damage & are attacked & stage nat. enemy attacks in

Scout often & Monitor

Remember pest ID may be critical when using specialists

Plan ahead & Time it right (Release early in production cycle)

Get help - Talk to a supplier or consult an Ext. agent

Use generalist predators & release often

Be sure using nat. enemies are compatible with growing practices

- e.g. Heavy pruning lower leaves tends to remove nat. enemies (& pests)

Consider habitat enhancement strategies for nat. enemies

Current Research

Problem:

Aphids reduce tunnel crop yields, quality & revenues.

Aphids can increase rapidly in absence of nat. enemies.

Early intervention critical

Purchasing & shipping nat. enemies is expensive.

Growers need cost-effective way to support nat. enemy establishment.

Hypothesis: Including habitat plant systems within a high tunnel production ecosystems will increase the presence of nat. enemies.

Habitat Plantings

Plantings that provide food & shelter to attract & sustain naturally occurring &/or released natural enemies for a complex of pests

A whole-farm, ecological approach used primarily outdoors as hedgerows, borders, rows.

A whole-greenhouse approach to enhance biological diversity within an intensive artificial setting.

Research Overview

Testing in 4 states (ME, NH, VT, PA)

Most tunnels in year-round production (summer – tomato, pepper, etc. & winter – greens) with limited fallow periods

Testing combinations of borage, marigold, bush green bean, alyssum, calendula, dill & viola

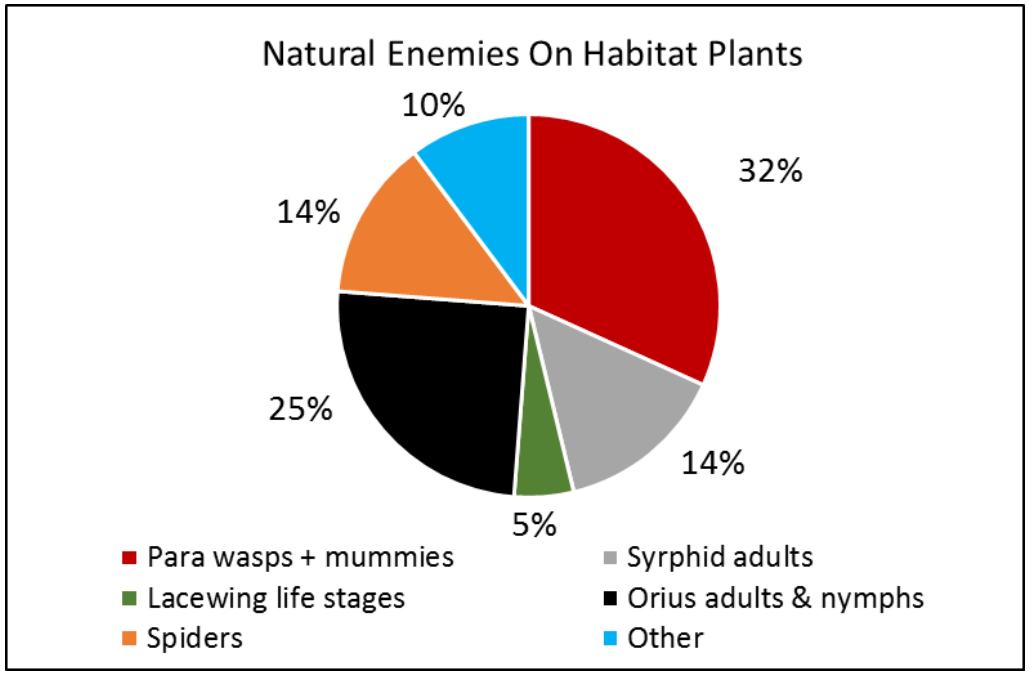
Results

Natural Enemies Attracted

Over 2,850 nat. enemy individuals visited habitat plantings

Parasitic wasps & mummies, Orius adults & nymphs & syrphid adults

Others include various lady beetle life stages, predatory maggots, assassin bugs, soldier beetles, etc.



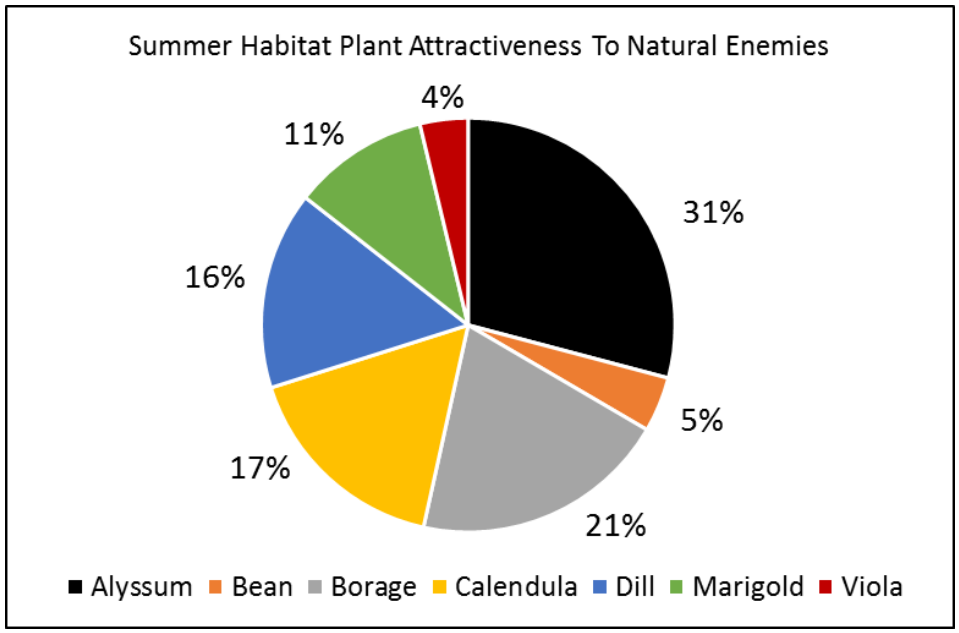
Results

Habitat Plant Attractiveness

Alyssum most attractive in summer 31% (& winter '41%' not shown)

Borage 2nd most attractive (21%) in summer followed by calendula, marigold & dill

Calendula & borage attracted a lot of pests (thrips, aphids), challenging to grow



Take Home Message

Start slowly and keep it simple!

Alyssum has highest value for a year-round habitat plant

1. Cheap & easy to produce
2. Tolerant to wide range of heat & cold temperatures
3. Prolific blooms all season long with low maintenance

In summer, addition of marigolds adds extra attractiveness for reasons 1 & 3 above.

The Best Things In Life Are FREE!

Thank You!

http://www.uvm.edu/~entlab/

Research presented herein was supported by the Northeast Sustainable Agriculture Research and Education Program, under award #LNE15-343. National Institute of Food & Agriculture, US Dept. of Agriculture, Crop Protection & Pest Management Competitive Grants Program, under award #2014-70006-22516, CRIS# 1004273. Any opinions, findings, conclusions, or recommendations expressed herein are those of the authors and do not necessarily reflect the view of the US Dept. of Agriculture.

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