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
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About

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
Scouting must rely on plant inspections!!

Inspect growth tips & leaf undersides (older first)

Honeydew (poop)

Distortion

Cast skins
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

**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

Do NOT id based on color

**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)
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

<table>
<thead>
<tr>
<th>Parasitoid</th>
<th>Green Peach</th>
<th>Melon</th>
<th>Foxglove</th>
<th>Potato</th>
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<tr>
<td><em>Aphidius colemani</em></td>
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<td><em>Aphelinus abdominalis</em></td>
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This is why it’s important to ID aphid spp. if purchasing wasps.

If you can’t tell what aphids you have send to an 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)

Commerially available & naturally occurring

Aphid ol “EAT” es – Eats Aphids
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)
Thrips Damage

- Silver patches with black dots (frass)
- Yellow flecking on fruits
- TSWV
Managing Thrips

Natural Enemies & Trap Plants

*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

Monitor thrips adults with sticky cards
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

*Phytoseiulus 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
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 in tunnels where soil does not freeze (results in June adults). Migrant moths (most common), July
Hornworms

Pupa

Damage

Defoliation

Egg

Frass (poop)

Fruit scarring
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)
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 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

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 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.
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

**Other Natives**

- *Coleomegilla maculata*
  - pink spotted
- *Hippodamia parenthesis*
  - parenthesis
- *Propylea quatuordecimpunctata*
  - checker spot ‘P-14’
- *Hippodamia variegata*
  - variegated
Other Nat. Enemies

- Predatory thrips
- Tachinid flies (parasitic)
- Ground beetles
- Assassin bugs
- Soldier beetles
- Robber flies
- Big eyed bugs
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
**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.

![Pie Chart Image]
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.

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