

IPM for High Tunnel Vegetables: Practical Pathways for Organic Crop Protection

Focusing on Insect and Mite Pest Issues



MOFGA Farmer to Farmer Conference November 2019

Who Are We?

- **Margaret Skinner, UVM Entomologist**

Biological Control of Key Pests

Western Flower Thrips (greenhouses)
Aphids (high tunnel vegetables)



- **Ron Valentin, Bioworks, Technical Specialist**

Biological Control of Key Pests

Banker plants
Beneficials



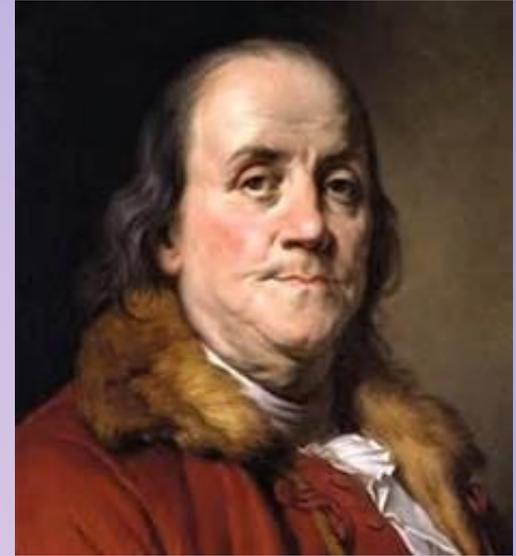
- **Pooh Sprague, Edgewater Farm, Grower
Owner/Operator**

Vegetable market garden
Greenhouse ornamentals



Who Are YOU?

Wisdom from Benjamin Franklin

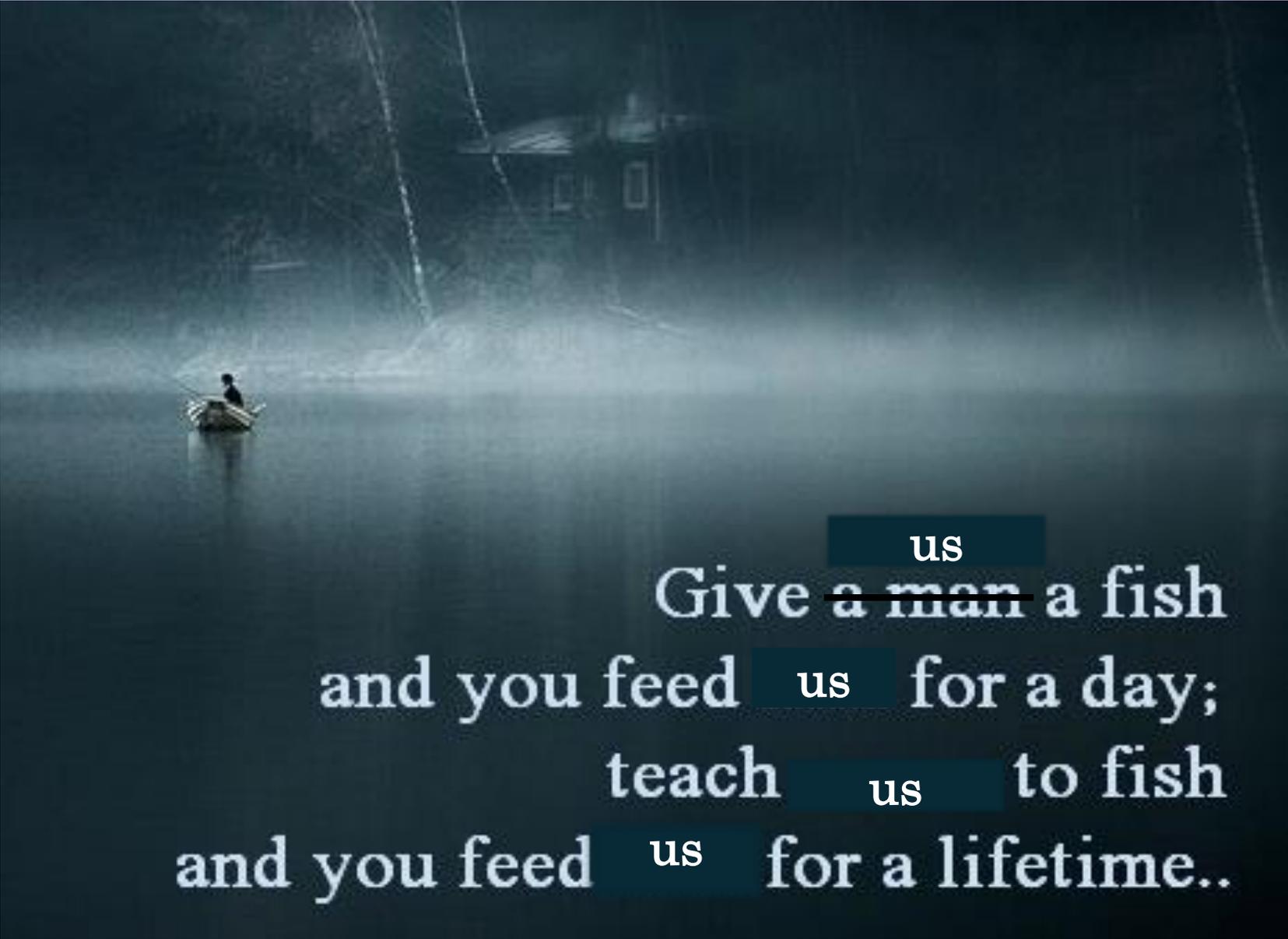


- TELL Me and I FORGET
- TEACH ME and I may Remember
- INVOLVE ME and I LEARN

Today's Multi-Faceted Program



- Step-by-step IPM approach to insect pests: Me
- Success with Biological Control: Ron
- Welcome to the “Real World”: Pooh
- Open discussion

A misty, atmospheric scene of a lake at dawn or dusk. In the distance, a traditional house with a tiled roof is partially obscured by the fog. In the middle ground, a person is seated in a small boat on the water. The overall mood is serene and contemplative.

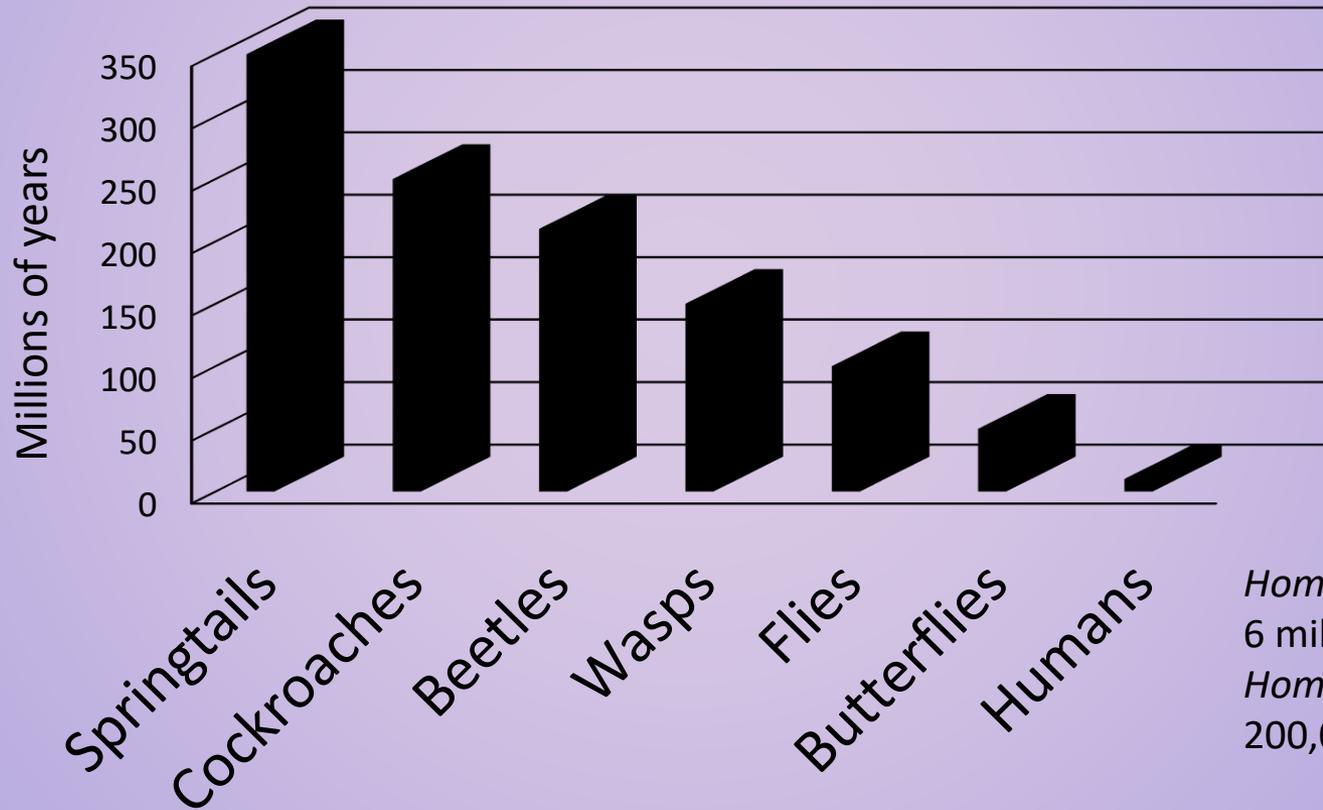
us

Give ~~a man~~ a fish
and you feed us for a day;
teach us to fish
and you feed us for a lifetime..

Lao Tzu, 4th Century BC



Appearance of Insects



Homo erectus:
6 million years
Homo sapiens:
200,000 years

So what?

HilariousGifs.com



So...

**How can we
DEAL WITH IT?**

IPM

What is IPM?

IPM = Integrated Pest Management

***Integration of several strategies
to reduce pests using
pesticides as little as possible***

***A Step-by-Step Process
for Tackling Pests***

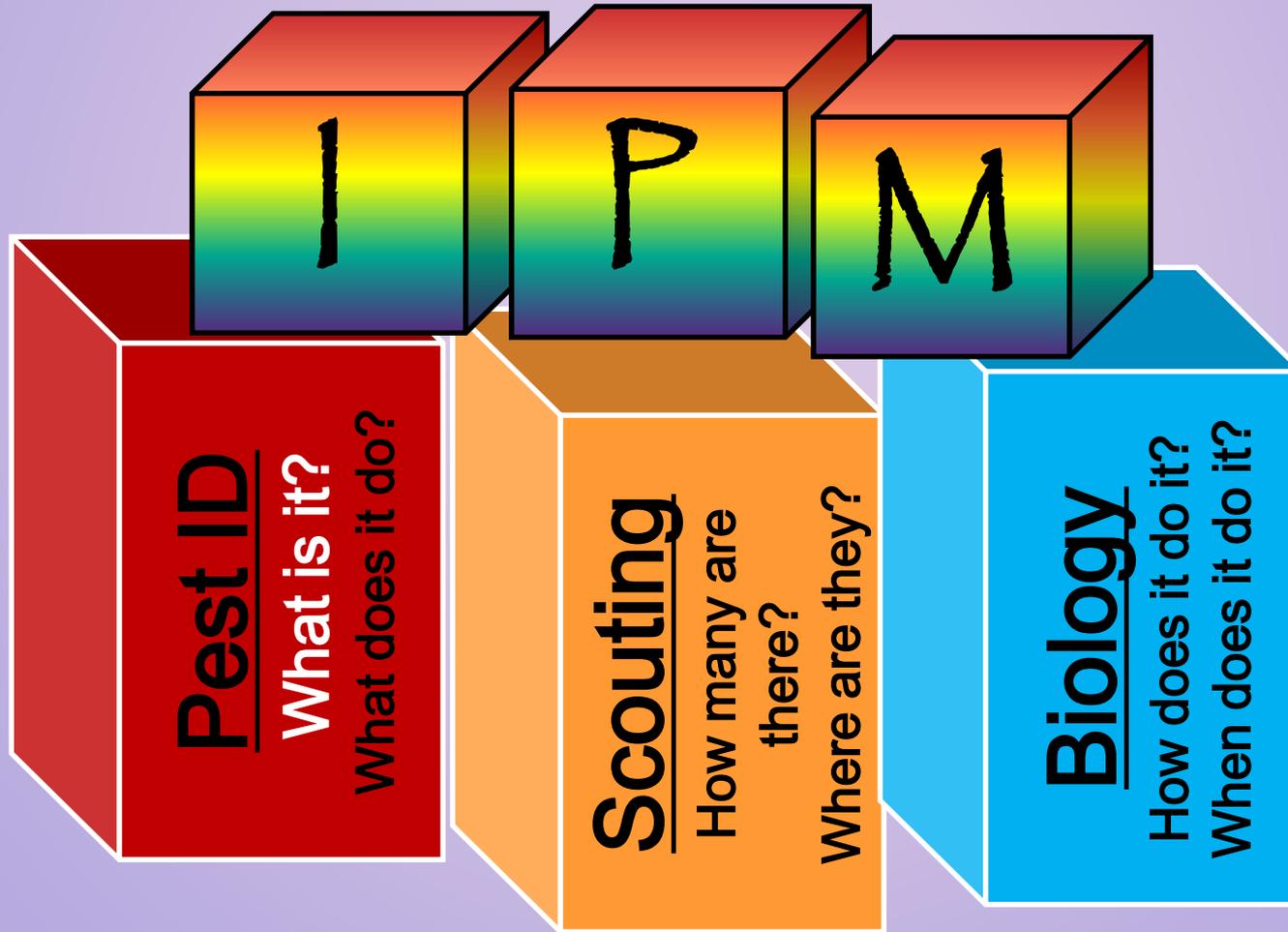
To succeed with IPM, follow
these words of wisdom:

Know your enemy
and know yourself
and you can fight a
hundred battles
without disaster.



Sun Tzu, 1753-1818

The Corner Stones



What's in a NAME?



- Class Insecta is separated into Orders
- Insect Orders are separated into FAMILIES
- Families are separated into GENERA
- Each Genus is separated into SPECIES

Scientific Name

Genus

Myzus

Species

persicae

Author

(Sulzer)

(Order Hemiptera, Family Aphididae)

Common Names

green peach aphid or peach-potato aphid



Some DEAD and
Some ALIVE

Know your friends and
your enemies.



Know the adults AND
the immatures.



**First,
Here are some of your
friends.**

Predatory Beetles

Lady beetles



Other beetles



Predatory Flies

Aphidoletes (midge)



Asilidae (Robber or Assassin fly)



Syrphid Flies (Hover Flies)



Predatory Bugs

Assassin bug



Predatory stink bug



Ambush bug



Pirate bug



Lacewings



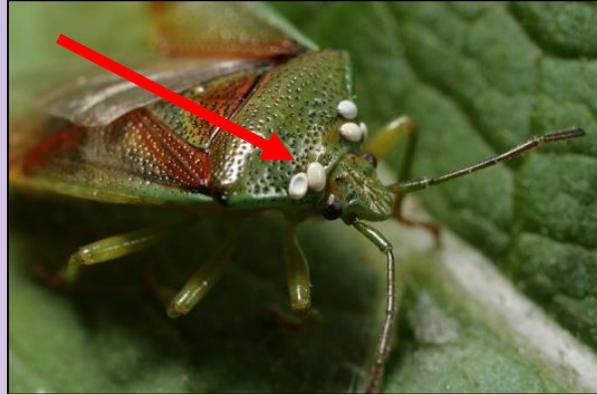
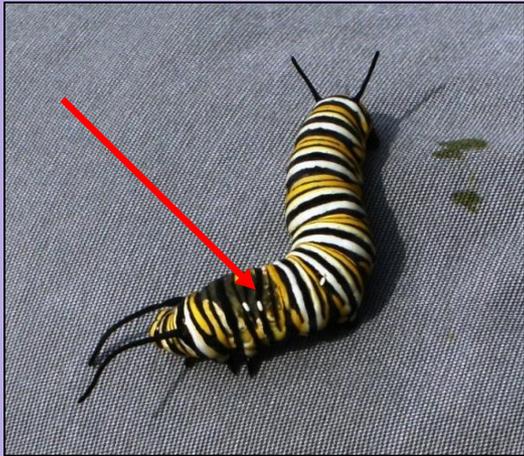
Parasitic Wasps



Hyperparasites



Parasitic Flies

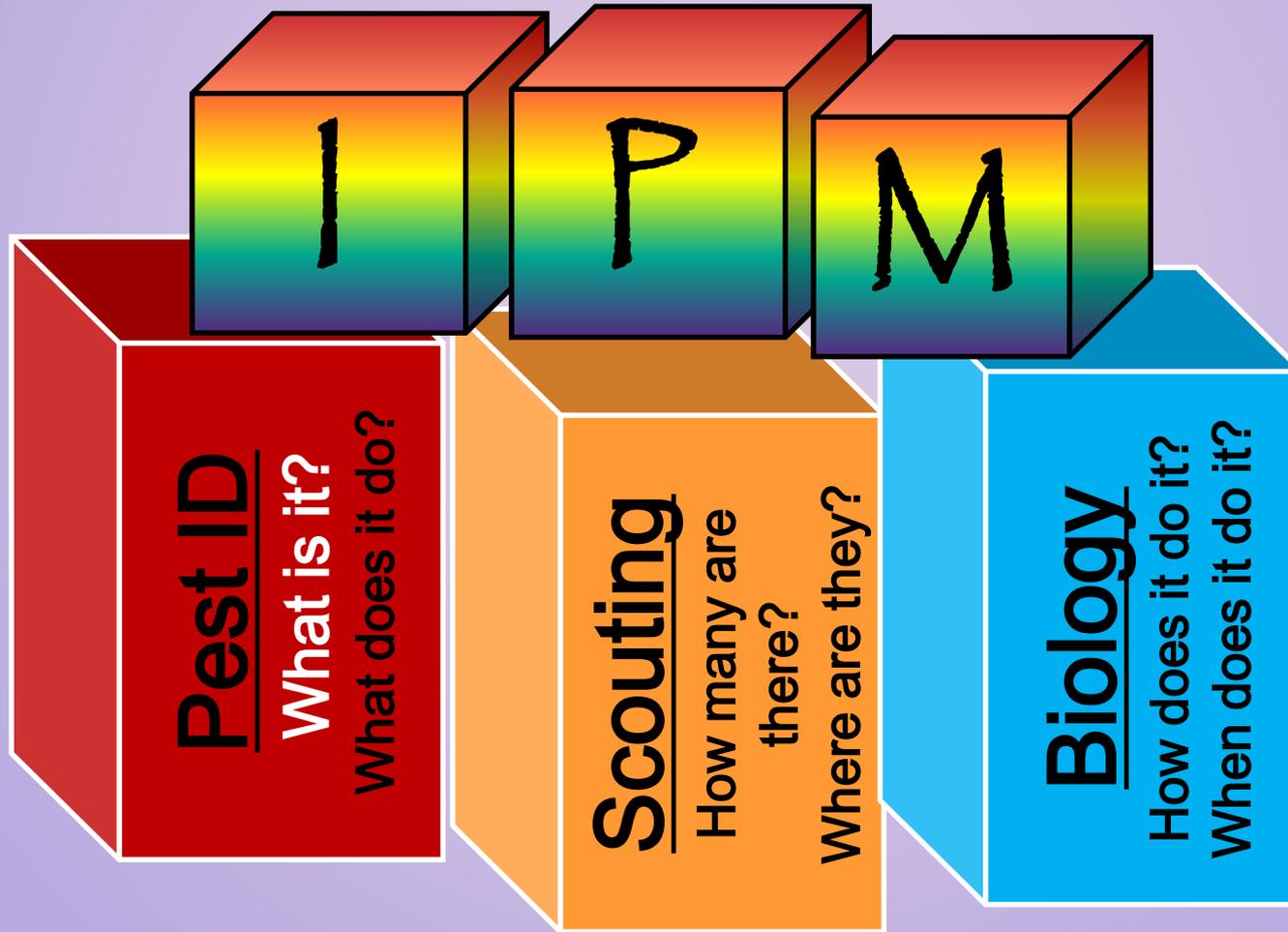


Drama in Real Life



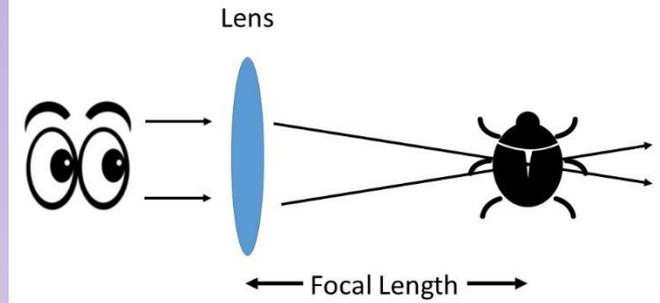
You need to know what the good ones look like too!

The Corner Stones



Scouting

- Use a hand lens properly
- Put up yellow sticky cards
- Start indicator plants early
- Inspect transplants before planting out



Adjust the distance between the specimen and the magnifier until the specimen is in focus



Inspect crops regularly

- Designate one person as the scout
- Look for pests AND beneficials
- Look for damage and droppings



Inspect your Crops Carefully

- ✓ Check undersides of leaves
- ✓ Inspect upper AND lower leaves
- ✓ Look inside flowers and plant crevices
- ✓ Tap plants on white laminated paper
- ✓ Train other staff to look out for pests

Record your results

Do it YOUR way!

Reproductive Potential

Ability of an insect to multiple

- # of eggs laid
- # of generations/season
- # of females



So What?

Differences in Reproductive Production



Parthenogenetic (thrips & aphids)

		I	II	III	IV
Male	0				
Female	2	200	20,000	2 million	200 million

Sexual

		I	II	III	IV
Male	1	50	2,500	125,000	6,250,000
Female	1	50	2,500	125,000	6,250,000
		100	5,000	250,000	12.5 million

The Building Blocks

I

P

M

Pest ID

What is it?

Scouting

How many are there?

Biology

How does it do it?

When does it do it?

Threshold

How much can I stand?

Management

What should I do?

How much will it cost?

When should I do it?

My Introduction to IPM



They came back!



Gooseberry sawfly, *Nematus ribesii*

- ✓ Up to 3 generations/year.
- ✓ Female lays eggs on undersides of leaves.
- ✓ Eggs hatch into tiny green larvae that make little round holes in the leaves.
- ✓ Caterpillars get bigger develop black spots. They feed on leaf margins.
- ✓ Mature caterpillars drop to the soil to pupate, emerging as an adult.
- ✓ They overwinter in the soil as pupae.



Where's the strong and weak links in this life cycle?

Their Strengths:

- ✓ Multiple generations/year.
- ✓ Female lays eggs on undersides of leaves.
- ✓ Eggs hatch into tiny green larvae that are hard to see.
- ✓ They overwinter in the soil as pupae.

Their Weaknesses:

- ✓ Larger caterpillars develop black spots. They feed on leaf margins.
- ✓ Mature caterpillars drop to the soil to pupate.
- ✓ They overwinter in the soil as pupae.

**How would you use your knowledge of
the life cycle to manage this pest?**

How would IPM to manage this pest?

Gooseberry sawfly

- ✓ Scout for the eggs in the early spring and pick off infested leaves. (Mechanical control) Repeat throughout the season.
- ✓ Spray leaves with insecticidal soap when larvae are small.
- ✓ *Bacillus thuringiensis* (BT) does NOT work.
- ✓ Cover with netting. Why could this be a problem?
- ✓ Treat the soil with nematodes for the pupal stage.
- ✓ Spray with a pyrethroid or pyrethrum-based pesticide registered for this crop.



Integrated Pest Management Worksheet

Date: _____ Crop: _____

Damage (When, Where, What type): _____

Pest Identification: _____

Common Name: _____

Pest Life Cycle:

How many generations/year? _____

How many eggs laid/female? _____

How long to complete one generation? _____

What are the ideal conditions? _____

Other key information on the biology: _____

Recommended Management: _____

Threshold for Action: _____

Cultural Control

Biological Control:

Natural Enemies (naturally occurring or commercially available):

Chemical Control:

Future Prevention:

**The IPM
Process**

Steps
towards
developing
a plan of
ATTACK

Management Strategy Record

Date: _____ Crop: _____ Pest: _____

Scouting Methods Used: _____

Results of Scouting: _____

Natural Enemies Present? Yes No Don't know _____

Action Threshold Reached? Yes No Don't have one _____

Action Taken: _____

Cultural Control: _____

Biological Control: _____

Chemical Control: _____

Future Prevention: _____

Level of Success: _____

Other Notes: _____

**Keeping
Track of
your
Success**

**Why
reinvent
the wheel?**

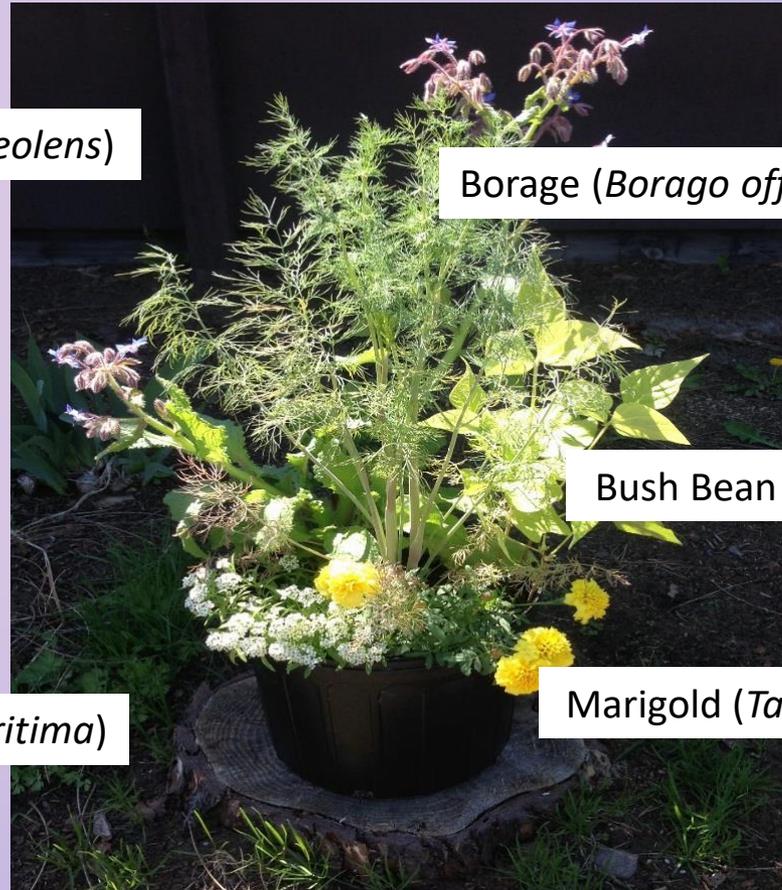
What YOU can do for Biocontrol?

Grow habitat plants!



Dill (*Anethum graveolens*)

Alyssum (*Lobularia maritima*)



Borage (*Borago officinalis*)

Bush Bean (*P. vulgaris*)

Marigold (*Tagetes patula*)

Habitat Plant Attractiveness

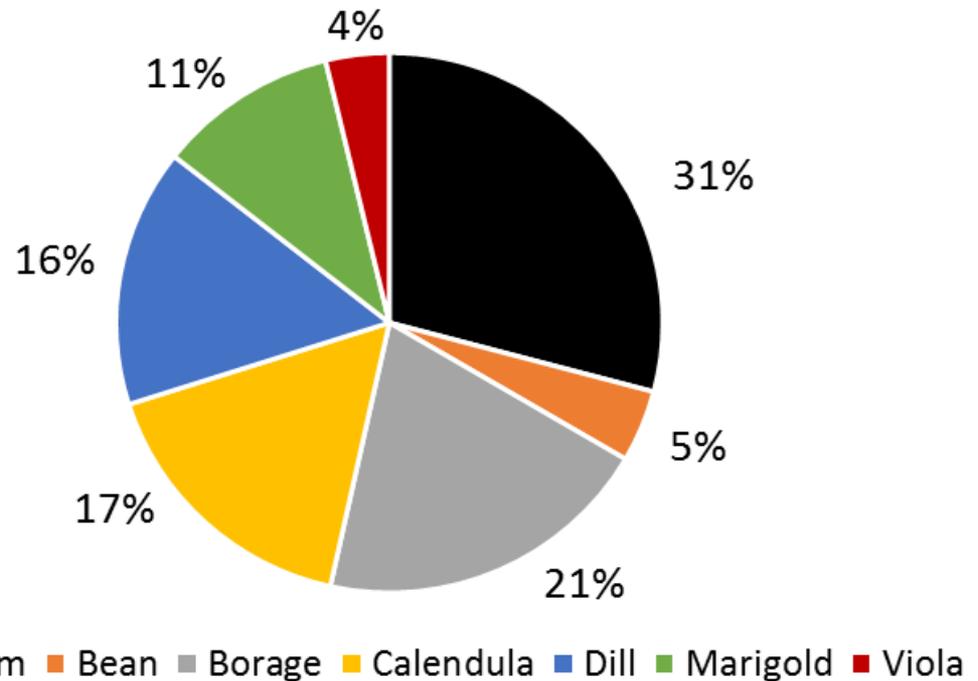
Alyssum most attractive in summer and winter

Borage 2nd most attractive in summer followed by calendula, marigold & dill

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



Summer Habitat Plant Attractiveness To Natural Enemies



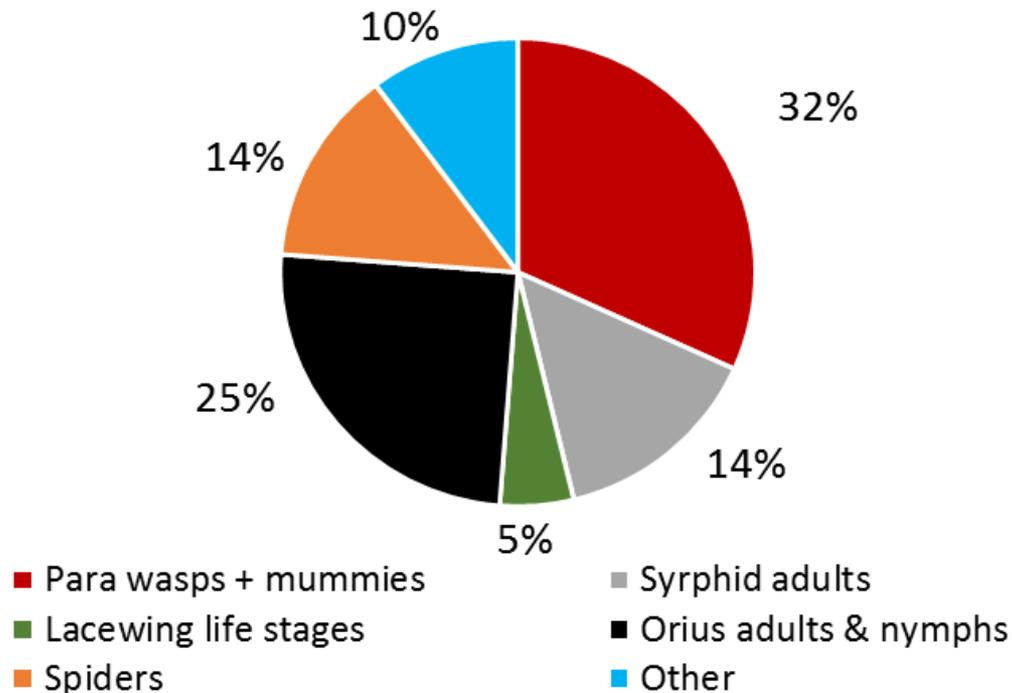
Natural Enemies Attracted

Over 2,850 individual natural enemy 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.

Natural Enemies On Habitat Plants



**Now,
What about the
Pests?**

The Aphid Apocalypse

Identified as #1 insect pest in Northeast high tunnel vegetables



Maybe You Shoulda Scouted?

Aphids

They Suck!!

Soft-bodied with piercing sucking mouthparts

- Suck sap from phloem
- Distortion, stunting, flower drop, viruses, death

Secrete sticky honey dew on leaves

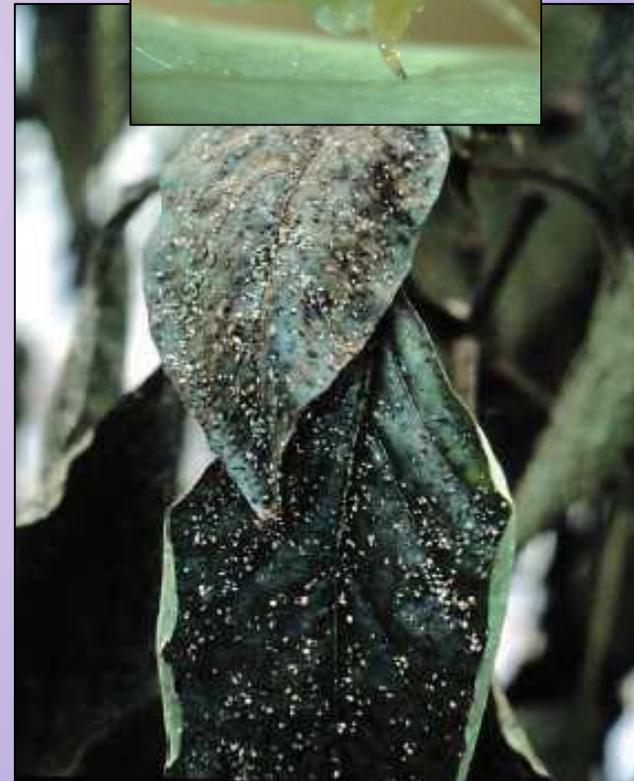
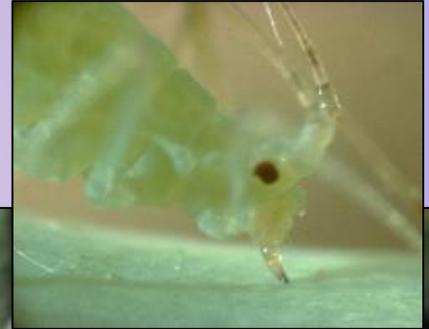
Sooty mold grows on the honey dew

Wide host range

- Peppers, Eggplant, Greens, Tomatoes

Scare customers away

- Visual & food quality issue



Aphid Damage

Scouting: Plant inspections!!

Inspect growth tips & leaf undersides (older first)

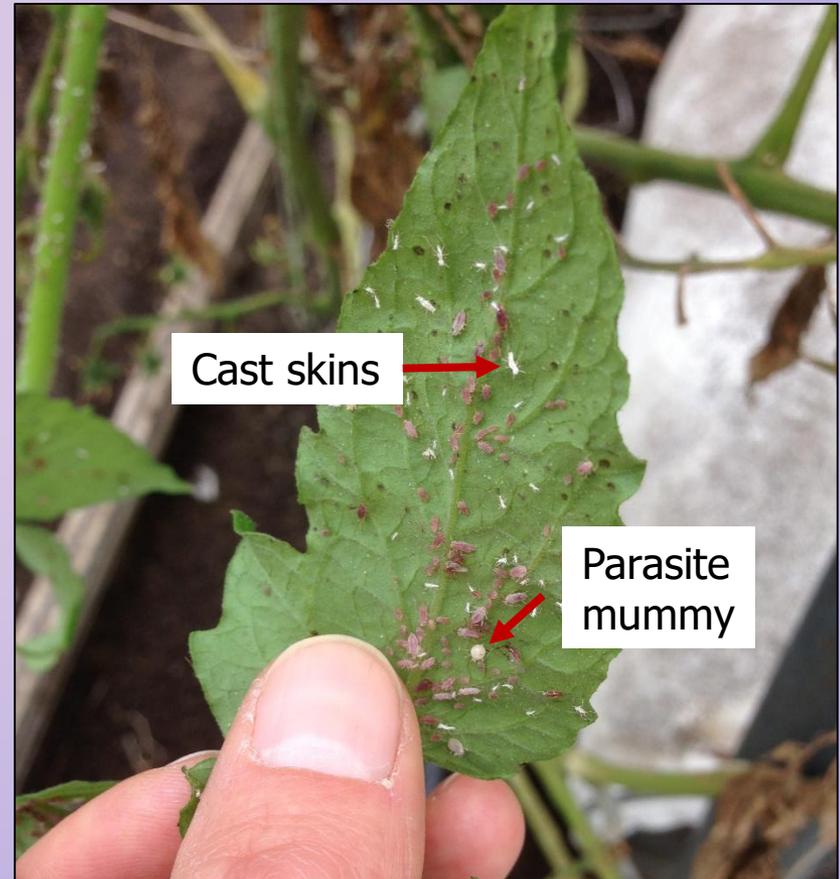
Check lower And upper leaves



Honey dew



Leaf Distortion



Cast skins

Parasite mummy

Aphid Id (usual suspects)

★ Potato, *Macrosiphum euphorbiae*
This one can decimate your tomatoes



Foxglove, *Aulacorthum solani*



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



Melon, *Aphis gossypii*



Aphid Natural Enemies

Wasp Parasitoids

Several wasp species are commercially available:

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

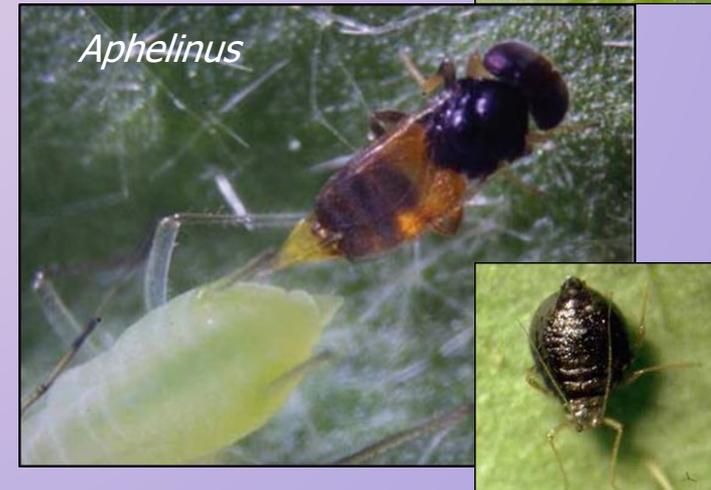
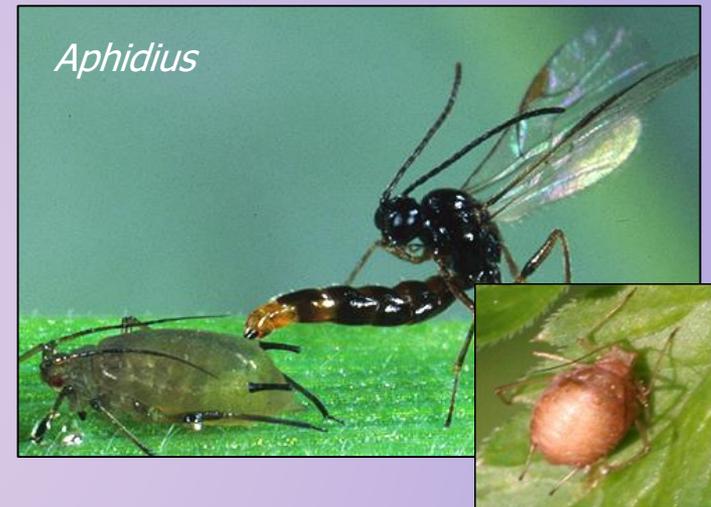
Many other naturally occurring spp.

Adults lay eggs inside aphids

Larvae-pupae feed on guts of the aphid and then pupate, turning aphid into brown or black 'mummies'

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

Subject to hyper-parasitism (parasite of the parasite)



Aphid Natural Enemies

Not All Wasps Are Created Equal

Parasitoid	Green Peach	Melon	Foxglove	Potato
<i>Aphidius colemani</i>	X	X		
<i>Aphidius ervi</i>			X	X
<i>Aphidius matricariae</i>	X			
<i>Aphelinus abdominalis</i>			X	X

That's why it's important to ID your aphids.

When in doubt, send specimens to your diagnostic lab
& talk to your bio supplier



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)

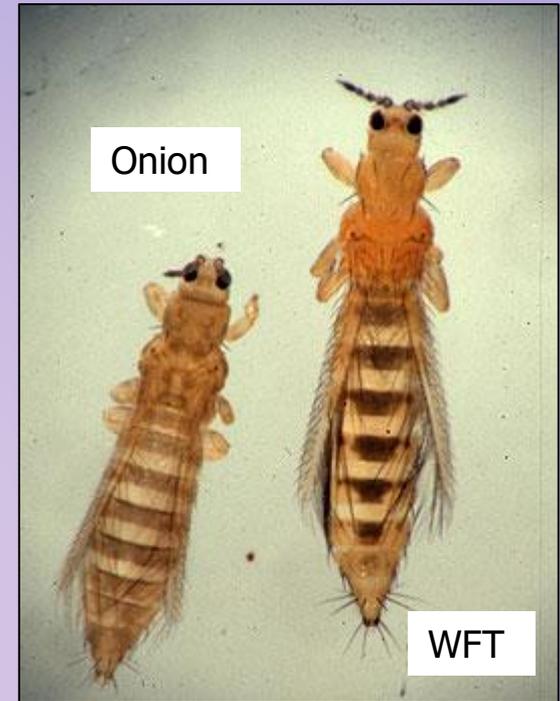
Above spp. pupate in soil

- Hard to manage with contact insecticides (limited contact)

Wide host range

- Cucumbers, Eggplant, Tomatoes

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



Older & younger larvae

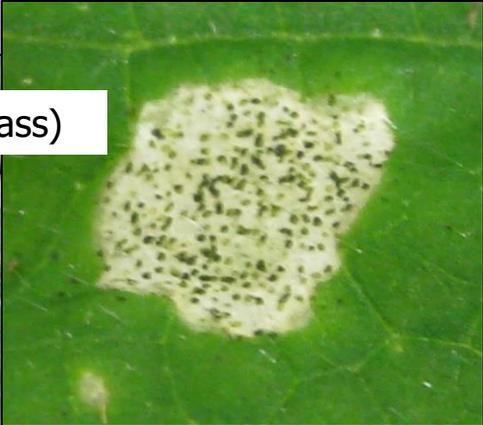
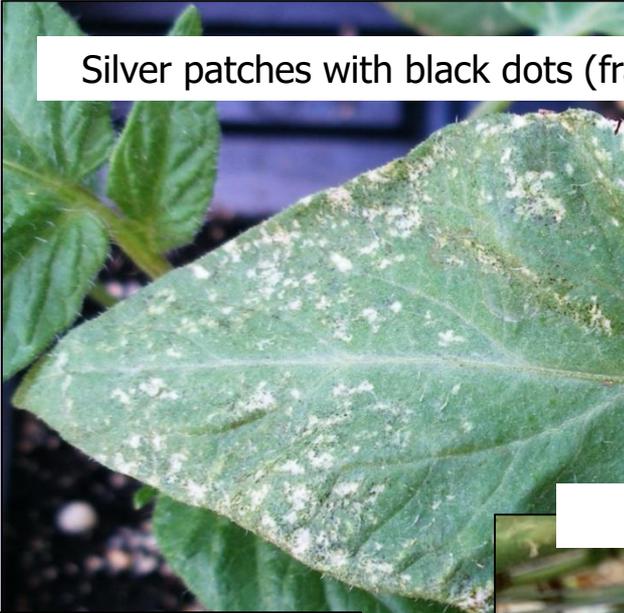
Thrips Damage

Western flower thrips damage on tomatoes

Stippling on onions from onion thrips



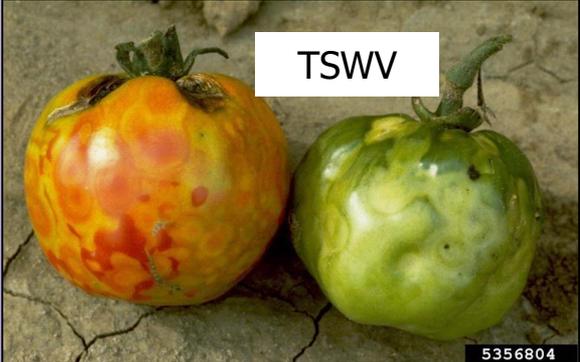
Silver patches with black dots (frass)



Yellow flecking on fruits



TSWV



Managing Thrips

Natural Enemies & Trap Plants



Amblyseius (=Neoseiulus) cucumeris

- Generalist, beige predatory mite
- Can survive on pollen & other pests

Marigold Trap Plants (Hero Yellow)

- Lure thrips out of crop, release predatory mites on marigolds
- Dispose of infested marigolds
- Cheap, easy to produce, flower prolifically



Monitor thrips adults with sticky cards

**Rapid reproductive rate,
Start biocontrol program early**

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

Found on the underside of leaves

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

Thrive under Hot & Dry conditions

Overwinter inside tunnels near side walls & in structural crevices

Overwintering mites are reddish, NOT green

If you see mite webbing, you know it's a SERIOUS infestation.



Spider Mite Damage

Yellow stippling visible on leaf surfaces



Webbing



Yellow flecking on fruits



Managing Spider Mites

Natural Enemies, Trap Plants & Cultural Control

Bush bean trap plant (Provider)



Stratiolaelaps (Hypoaspis) scimitus

- Generalist predatory mite (soil dweller)
- Release around tunnel perimeter early to target overwintering mites) & other soil dwelling pests

Tip: A soft water spray can reduce mite populations, but watch out for powdery mildew.

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 flower nectar

Overwinters as pupa (warm regions) or in tunnels where soil does not freeze (results in June adults).

Also migrate in from southern regions in July, 1-2 generations/year



Tomato



Tobacco

Hornworms

Pupa



Damage

Defoliation



Egg



Frass (poop)



Fruit scarring



Managing Hornworms

Scouting

- Check upper part of plants for feeding damage by tobacco hornworm, lower leaves for tomato hornworm
- Light traps (probably not)
- Scout every 1-2 wk during feeding period



Tip: If you find these, protect them so the wasps hatch.

Management

- Till soil to destroy pupae early in the season
- Hand pick eggs and larvae on foliage
- Remove crop residue after harvest
- Keep the weeds down
- Grow habitat plants for beneficials
- Apply *Bacillus thuringiensis* (Bt) var. *Kurstaki*



Cutworms

Many species (surface, climbing, army, subterranean, winter)

Most are night feeding caterpillars (curl up when disturbed)

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

- Black cutworm (*Agrotis ipsilon*)

Later season, some feed on foliage & fruit making holes or consuming the entire leaf

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

Adults (nocturnal) feed on nectar

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

Overwinter as pupae or larvae

Can have multiple generations/year

Variegated cutworms



Cutworms and Armyworms

Black



Variegated



Winter



Cutworm Damage

Foliar feeding



Wide host range: tomato, beans, beets, cole crops, lettuce, small fruit, flowers, field grasses, weeds

Ad



Severed stem

External surface & neat holes on fruit



Scouting and Managing Cutworms

Scouting:

- Look for damage
- Check in the soil around damaged plants for larvae (they go deeper in drier soil)
- Many larvae are nocturnal, so scout plants in the late afternoon or early mornings
- Collect larvae and get them identified



Management:

- ✓ Minimize weeds, adults lay eggs there in the spring
- ✓ Remove weeds around outside of high tunnel
- ✓ Protect stems of seedlings
- ✓ Lay down cardboard or boards and hand-pick larvae hiding underneath
- ✓ Promote a broad array of predators and parasites (beetles, parasitic wasps and flies, toads, etc.)
- ✓ Spray with *Bacillus thuringiensis* (Bt) var *kurstaki* (not too effective though)
- ✓ Apply parasitic nematodes if soil is damp and warm enough (above 45 deg. F), apply at sunset
- ✓ Cultivate the soil in the fall after harvest or in spring before planting

Thank You!

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