High Tunnel Tomatoes

August 12, 2020

High Tunnel Tomatoes and Soil fertility

Becky Maden

August 12, 2020

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Why grow in a high tunnel

No such thing as a “typical” high tunnel


No such thing as a “typical” crop


But tomatoes are the most common tunnel crop

In-ground growing is highly buffered, due to soil volume

Slide courtesy of Vern Grubinger

usually the soil is amended with a lot of compost, nutrients

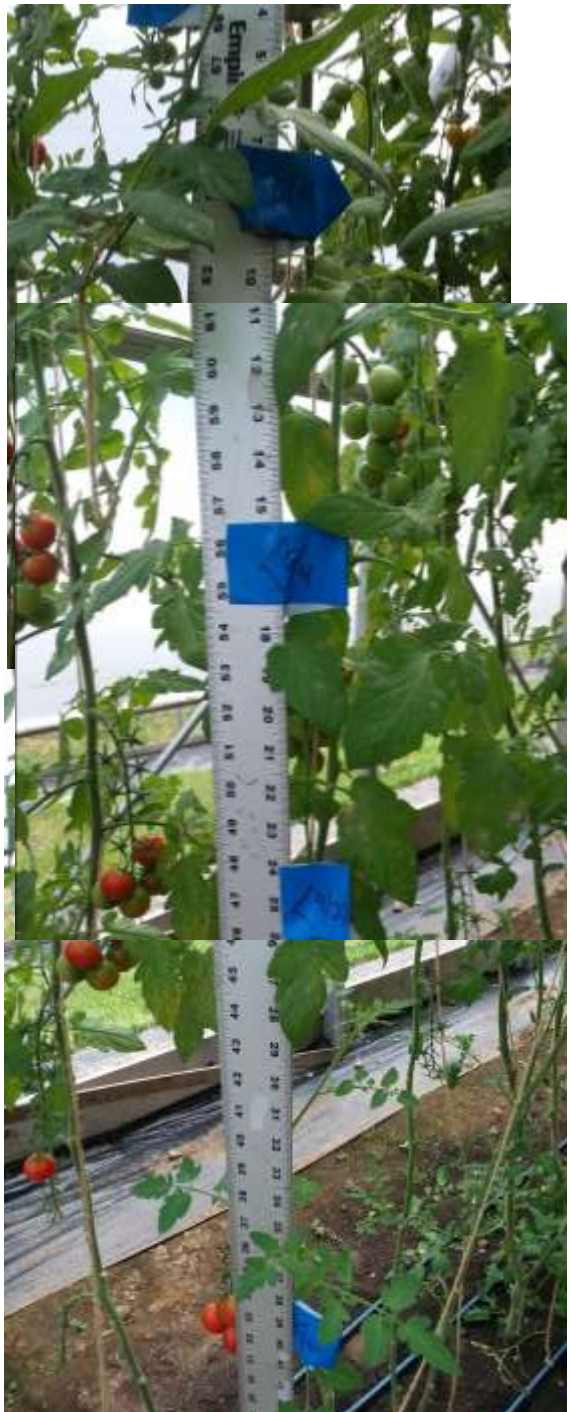
If soil on site is poor quality or compacted, make raised beds

Plan for nutrients based on soil tests AND expected yield

Slide courtesy of Vern Grubinger

Tomatoes: plan ahead for heavy nutrient demand, yields can be much greater than in the field

Weekly Growth– Heavy Nutrient Demand Early in Season



Monthly crop images

May 1st

June

July

August

September

November

Nitrogen applications should be based on yield potential

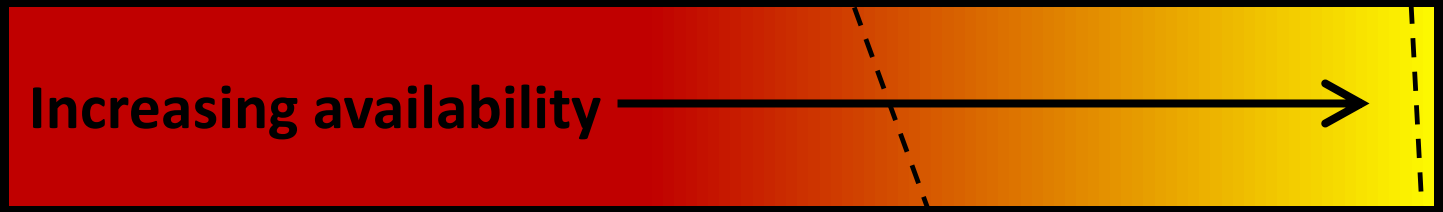
N application rate based on yield goal

	Yield goal lb/acre	=Yield lb/ft²	=Yield lb/stem = lb/4 ft²	Approx. plant height	N need lb/acre @ 90% recovery	N need* lb/1,000 ft²
Low yield	40,000	1	4	8’	100	2.3
Medium yield	80,000	2	8	12’	200	4.6
Good yield	120,000	3	12	16’	300	6.9
High yield	160,000	4	16	20’	400	9.2

* Subtract N credit for each 1% soil organic matter of .25 lb/1,000 ft², up to 1 lb.

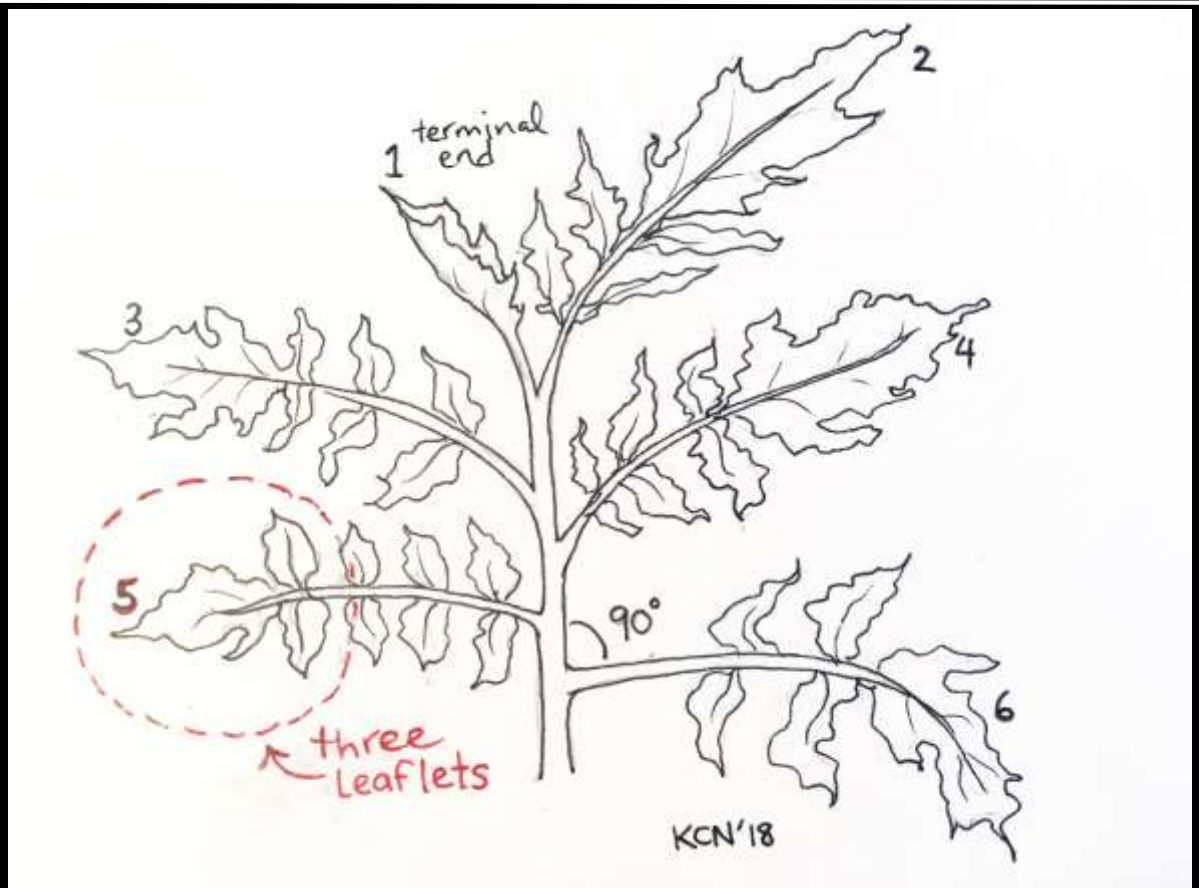
Monitoring Nutrient Levels

Soil



Modified Morgan **Saturated Media**

Leaf



Different tests require different samples

Field soil test*: use modified Morgan's only! Submit 1 cup soil – stick to same time each year.*

SME test: Submit 1 pint of soil that's been warm and moist for 1-2 weeks, a month or so before you'll be ready to plant.

Compost test: Submit 1 quart, warm and moist for 1-2 weeks.

Leaf analysis: take samples from correct place on ~20 plants.

Slide courtesy of Vern Grubinger

Some Testing Options

UMaine:

Long term tunnel test: $30

(SME plus modified Morgan's field test)

Compost: $55

Tissue Test: $27

**Turn around time = 2 weeks*

Dairy One:

Tissue test: $27,

**Quicker turn around time*

PRINT DATE	LAB NO.	SAMPLE IDENTIFICATION	COUNTY	ACRES OR SQ. FT.
03/28/2019	749	TOMMY HOUSE	---	1800 sq. ft

•SOIL TEST REPORT FOR:

BECKY MADEN- SINGING CEDARS
30 BLACK SNAKE LANE
ORWELL VT 05760

MAINE SOIL TESTING SERVICE

UNIVERSITY OF MAINE
5722 DEERING HALL
ORONO,MAINE 04469-5722

• **SOIL TEST SUMMARY & INTERPRETATION**
(see Numerical Results section for more information)

	Level Found	LOW / MEDIUM / OPTIMUM / ABOVE OPTIMUM
Soil pH	7.2	
Organic Matter(%)	8.6	
Major nutrients		
Nitrate-N (ppm)	193	
Phosphorus (lb/A)	389	
Potassium (lb/A)	935	
Calcium (% Sat)	72.7	
Magnesium (% Sat)	18.7	
Sulfur (ppm)	415	
Micronutrients		
Boron (ppm)	2.0	
Copper (ppm)	0.22	
Iron (ppm)	3.9	
Manganese (ppm)	14	
Zinc (ppm)	3.0	

• **RECOMMENDED ADDITIONS FOR** ORGANIC GROWING - Crop Code # 392 (HIGH TUNNEL)

No lime recommended. Soil pH is at or above the optimum level for this crop.

Magnesium level is sufficient to meet crop requirement.
To meet major nutrient requirements, Apply on every 1000 sq. ft.:

No fertilizer necessary, Current nutrient levels are sufficient.

N-P-K recommendations are for heavier feeding crops, such as Tomatoes, Peppers, & Vines.
1/2 the recommended rates should be sufficient for Greens, Cut Flowers, and Fruit crops

MAINE SOIL TESTING SERVICE

High Tunnel Saturated Media Analysis For:

THE UNIVERSITY OF MAINE

BECKY MADEN- SINGING CEDARS FARMSTEAD
30 BLACK SNAKE LANE
ORWELL VT 05760

Analysis date: 03/28/2019 **Job #** 314

Sample Name: TOMMY HOUSE

Crop Grown: Tomato

Comments: 749

Analytical Results

Determination	*Optimum Range*	Level Measured		Relative Level
pH	*6.0 - 7.0*	7.2		HIGH
Soluble Salts	*2.0 - 4.0 mmhos/cm*	3.60	mmhos/cm	OK
Organic Matter	*8 - 12 %*	8.6	%	OPTIMUM
Nitrate-N	*100 - 200 ppm*	210	ppm	HIGH
Ammonium-N	*< 10 ppm*	3.0	ppm	OK
Phosphorus	*1 - 5 ppm*	2.1	ppm	OPTIMUM
Potassium	*150 - 275 ppm*	72	ppm	LOW
Magnesium	*> 60 ppm*	227	ppm	OPTIMUM
Calcium	*> 250 ppm*	512	ppm	OPTIMUM
Aluminum	*< 10 ppm*	0.1	ppm	OK

common organic soil amendments

- **N**: soy, peanut, feather meal; Chilean (sidedress or fertigate)
- **P**: bone meal, bone char
- **K**: potassium sulfate, sul-po-mag
- **Ca**: lime, gypsum
- **Mg**: lime, sul-po-mag, epsom salts
- **Blends**: ProGro, Cheep-Cheep, alfalfa meal etc.
- **Micros**: compost, borax, Azomite, chelates
- **Organic matter**: compost, peat moss

Slide courtesy of Vern Grubinger

Fertigation

Dosatron

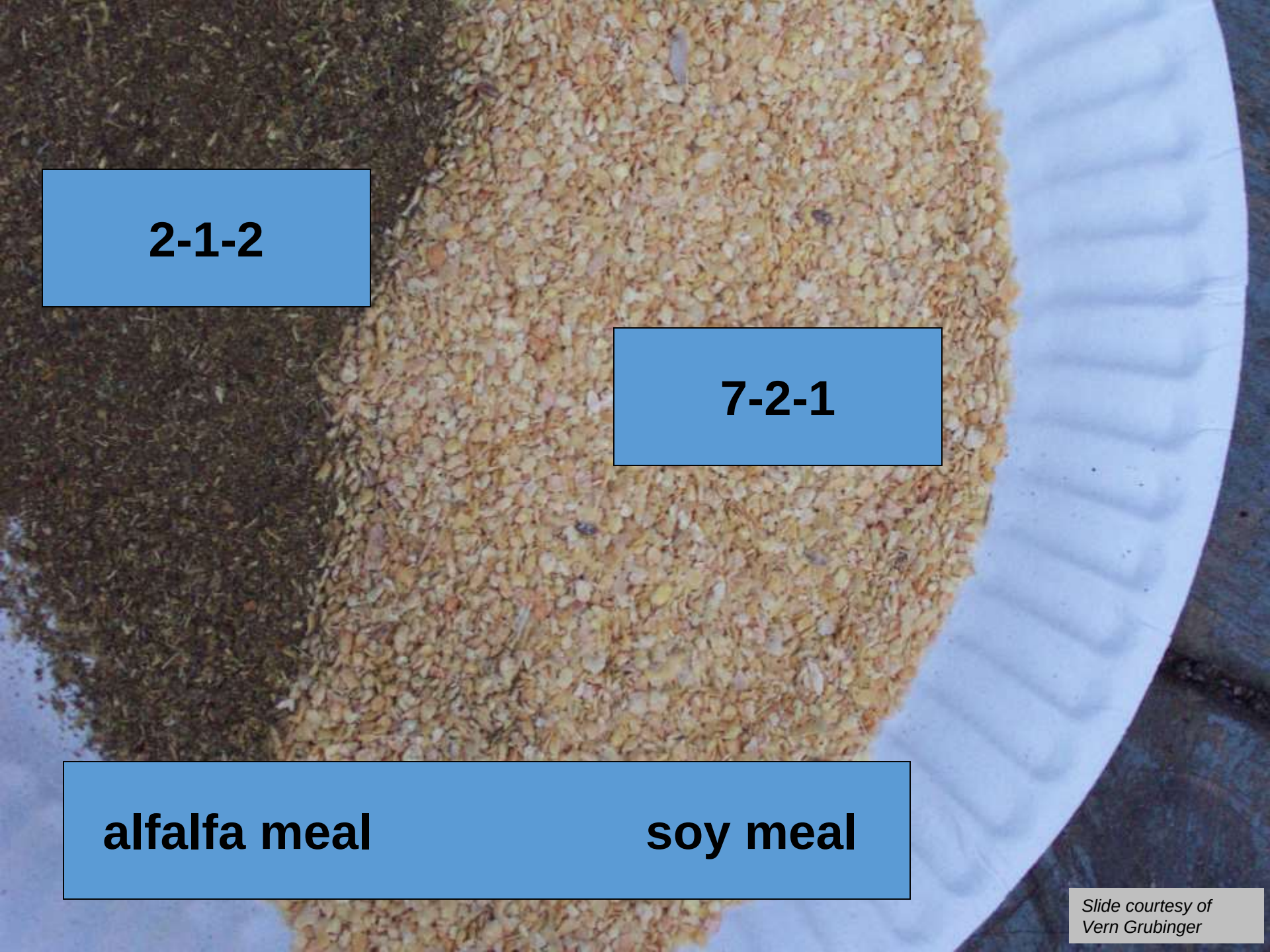
Mazzei Injector

½ to 2/3 of total N and K put on pre plant

4-6 weeks after transplant,

fertigate 1 x/ week

watering can



Slide courtesy of Vern Grubinger

PRO-GRO 5-3-4
A NATURAL/ORGANIC FERTILIZER

This product is blended from the following list of natural ingredients:

BONEMEAL
ROCK PHOSPHATE
COLLOIDAL PHOSPHATE
OYSTER MEAL
KELP MEAL

GREENSAND
LANGBEINITE
VEGETABLE PROTEIN MEALS
MEAT AND BONE MEAL

NATURAL NITRATE OF SODA
LEATHER MEAL
FISH MEAL
BENEFICIAL BACTERIA
HUMATES
TRACE MINERALS

Slide courtesy of Vern Grubinger

Slide courtesy of Vern Grubinger

Slide courtesy of Vern Grubinger

Slide courtesy of Vern Grubinger

For K, potassium sulfate is a better value, unless you also need magnesium

sul-po-mag 0-0-22-11 Mg
(same as langbenite, Kmag)

potassium sulfate 0-0-50 “fines” are more available

Slide courtesy of Vern Grubinger

Epsom Salts for Mg

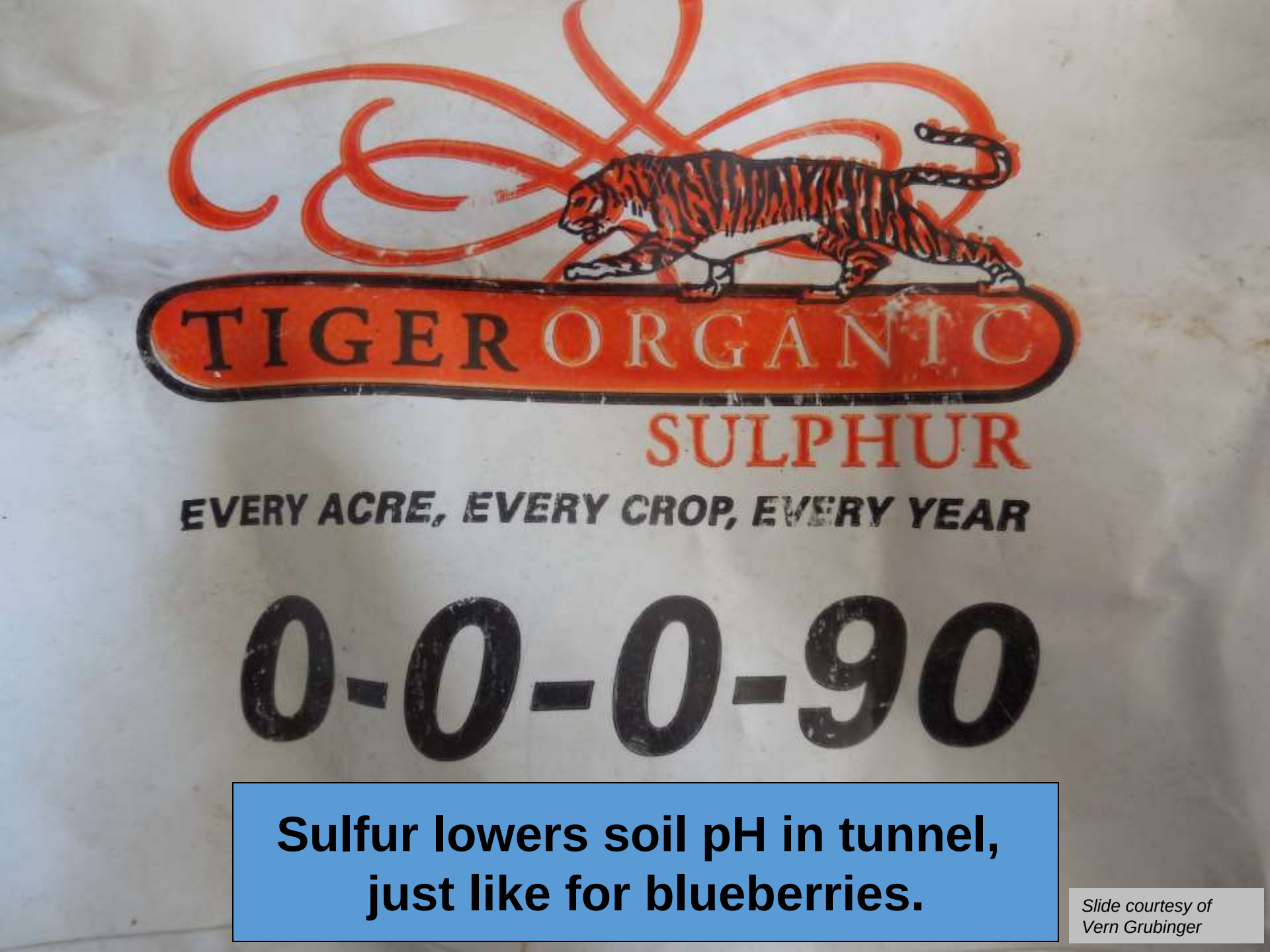
gypsum adds calcium, doesn't change soil pH

Slide courtesy of Vern Grubinger


peat moss
adds organic matter,
not nutrients

3-5 bales compressed peat moss per 1000 sq ft (+ lime if needed)

Slide courtesy of Vern Grubinger



Sulfur lowers soil pH in tunnel, just like for blueberries.

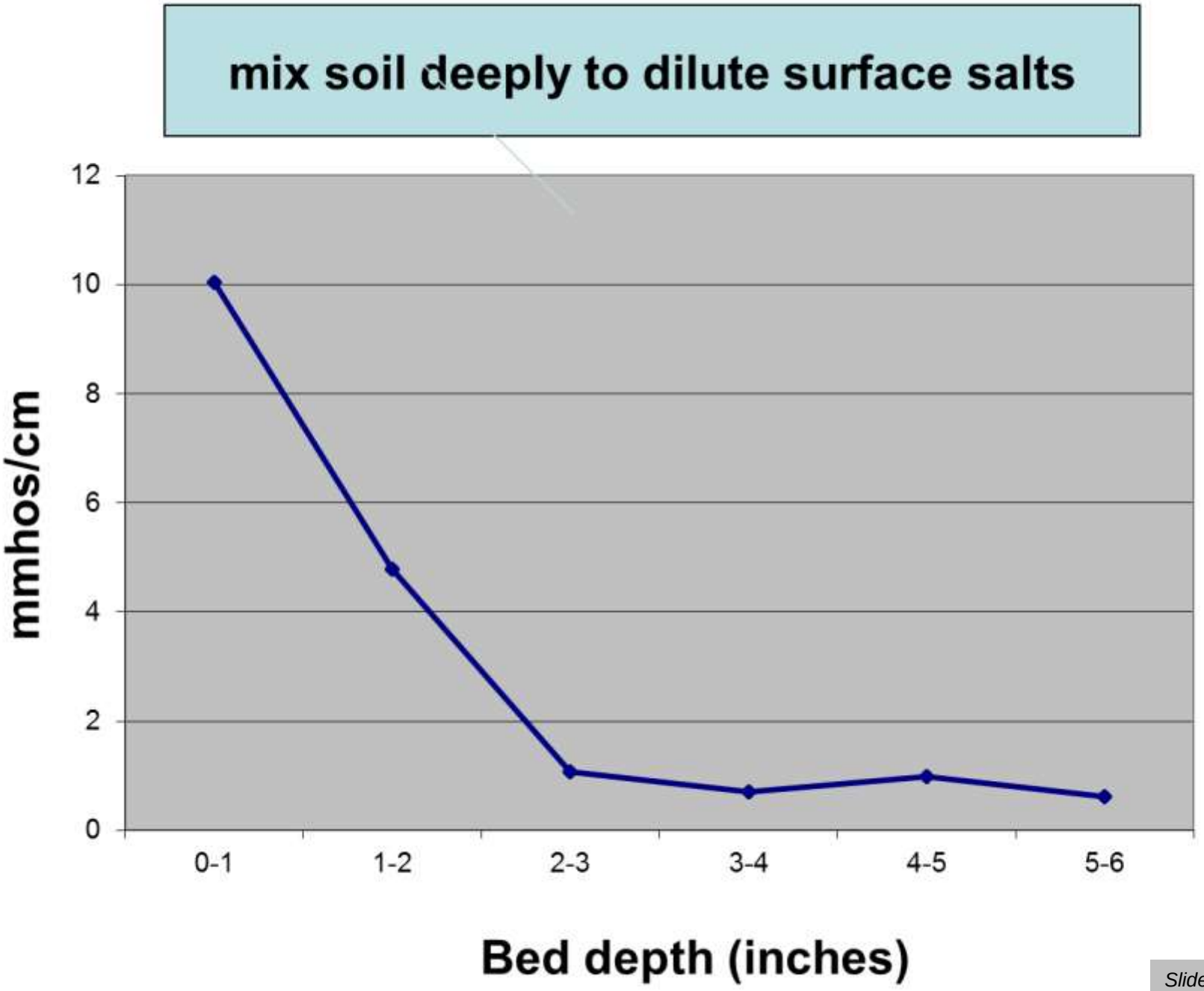
Slide courtesy of Vern Grubinger

spread soil amendments materials evenly!

Slide courtesy of Vern Grubinger

Slide courtesy of Vern Grubinger

Salts can build up in a tunnel, especially near the surface



Slide courtesy of Vern Grubinger

2018 New England Tomato High Tunnel Study

THE UNIVERSITY OF MAINE

UMass Extension

University of New Hampshire Cooperative Extension

UNIVERSITY OF RHODE ISLAND COOPERATIVE EXTENSION

VERMONT VEGETABLE & BERRY GROWERS ASSOC.

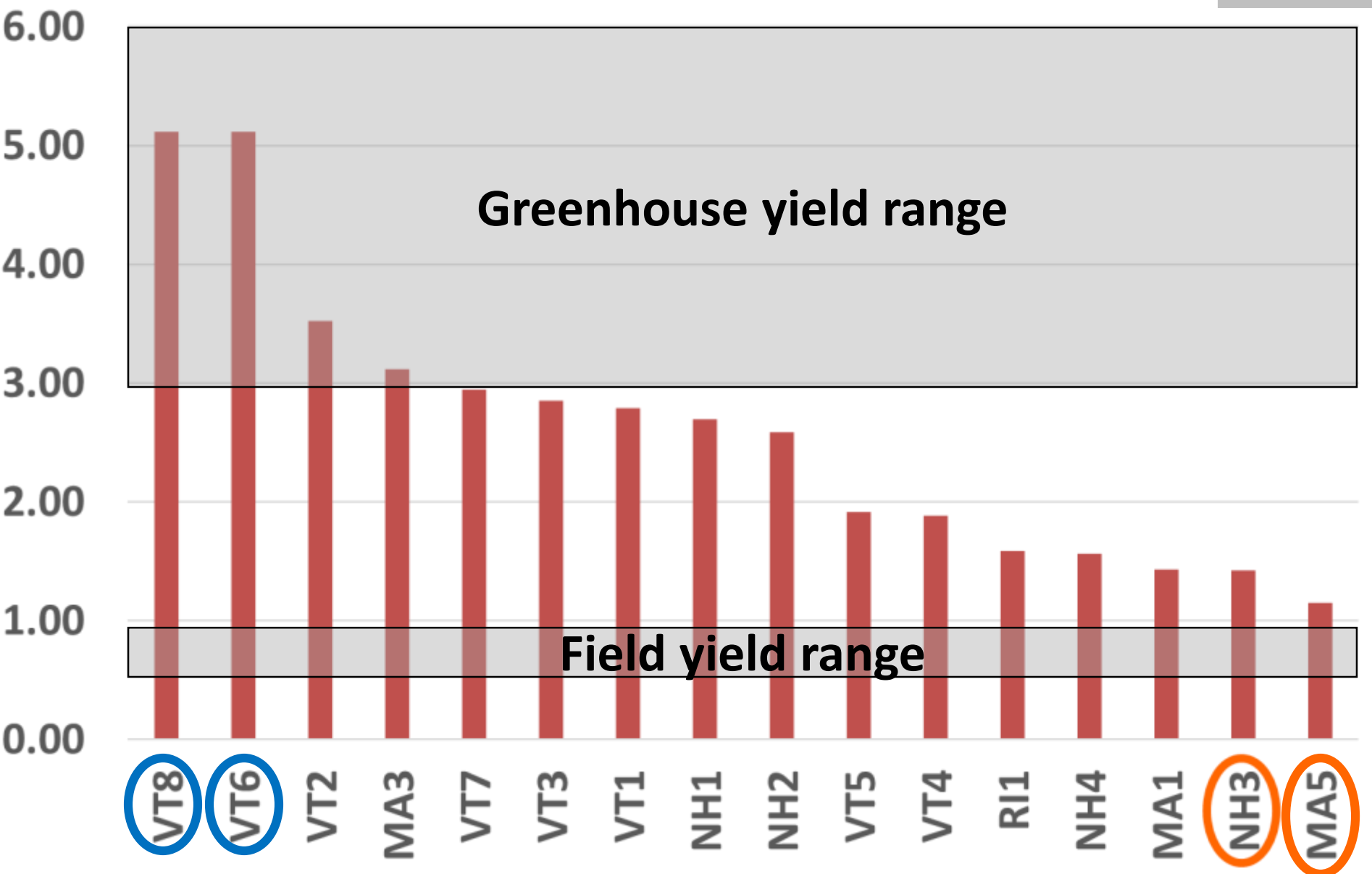
NEW ENGLAND VEGETABLE & BERRY GROWER'S ASSOC.

UNIVERSITY OF VERMONT EXTENSION

Slide courtesy of Vern Grubinger

Yield lbs per ft^2

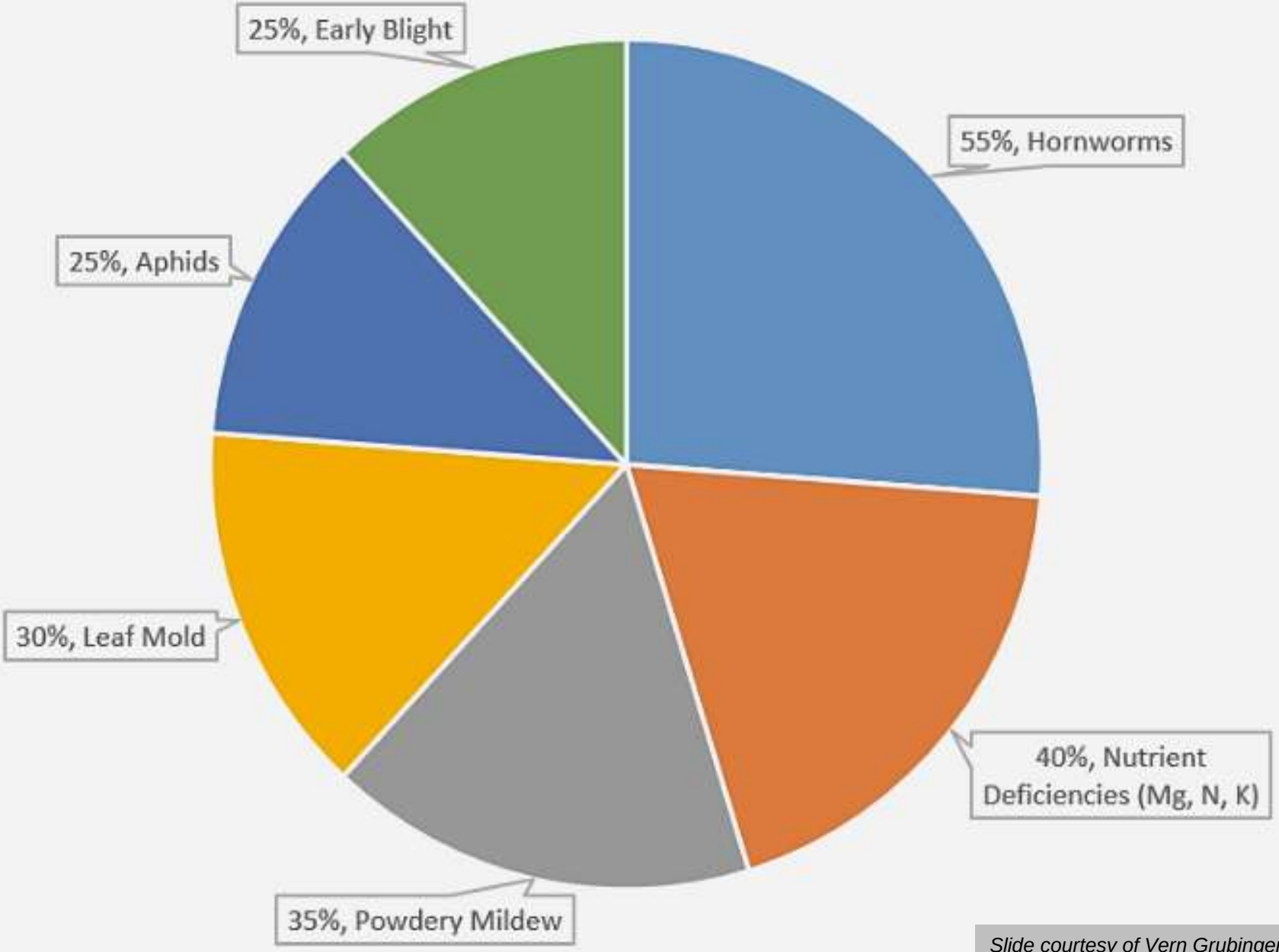
Slide courtesy of Vern Grubinger



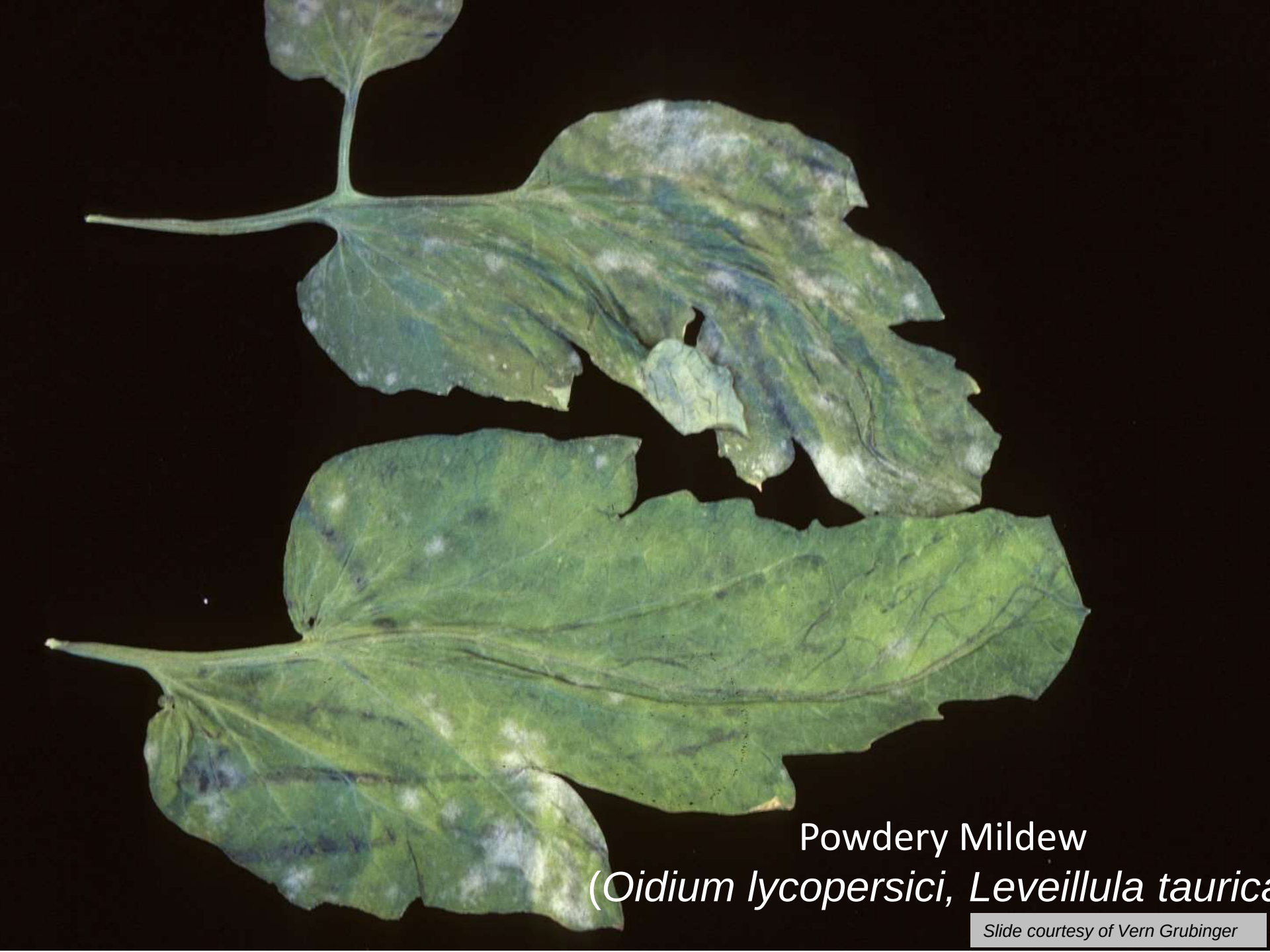
Factors besides nutrients affected yield

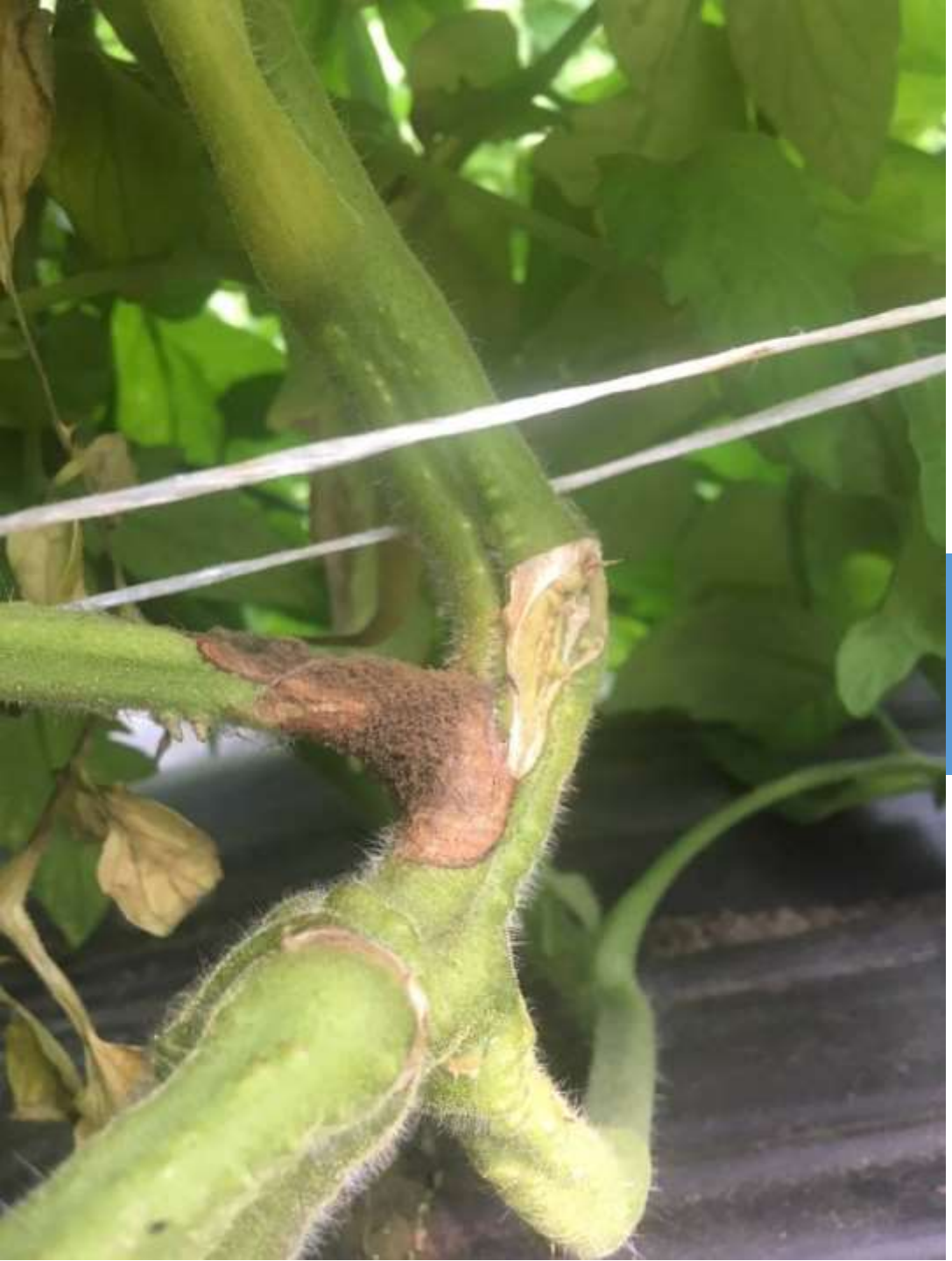
Slide courtesy of Vern Grubinger

Top insects and diseases reported



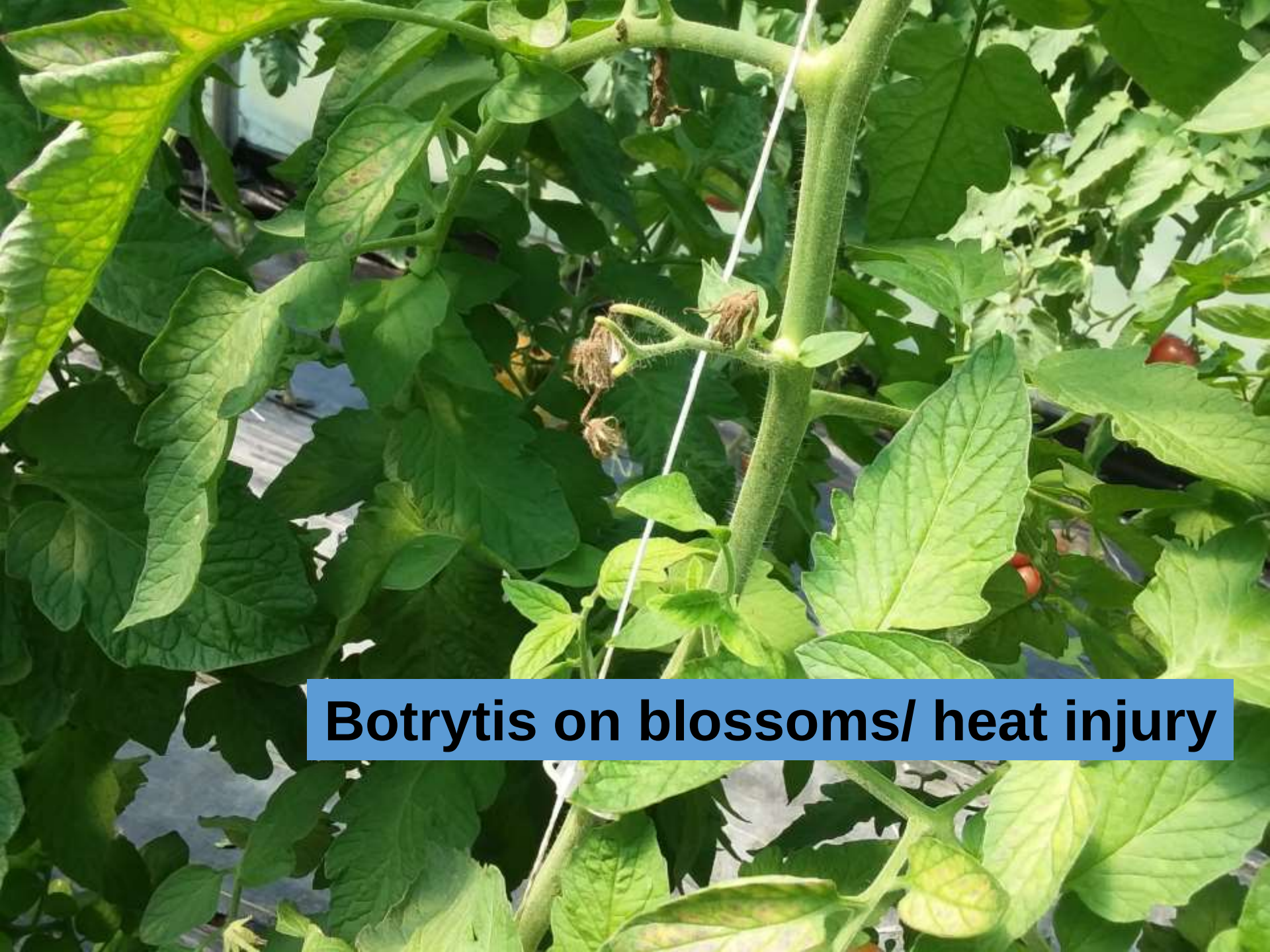
Slide courtesy of Vern Grubinger


Powdery Mildew
(*Oidium lycopersici, Leveillula taurica*
Slide courtesy of Vern Grubinger



Botrytis canker (*Botrytis cinerea*)

Slide courtesy of Vern Grubinger


Botrytis on blossoms/ heat injury

Leaf Mold (*Passalora fulva*)

Slide courtesy of Vern Grubinger

Cracking and heat related injury

Use enough drip lines to moisten the entire rooting area when irrigating

Pruning and lower leaf removal


Maintain good airflow and low humidity

Efficiencies

Recommendations

- **Estimate your target yield – then track yields!**
- **Consider tighter plant spacing, if appropriate**
- **Measure soil compaction, address if needed**
- **Add irrigation lines for uniform soil moisture**
- **Keep up with leaf pruning**
- **Scout for pests often; be prepared to manage them**
- **Adjust soil pH to 6-7, aim for organic matter 6%+?**
- **Monitor available and reserve soil nutrient levels**
- **Provide sufficient N and K needed for high yields**

Slide courtesy of Vern Grubinger

2020-2021 High Tunnel Tomato Project

- 50 Growers In New England and New York participating
- Input production practices
- Follow soil fertility recommendations based on high tunnel soil tests
- Track yields.
- Use tissue analysis combined with soil tests to understand what the plants are utilizing.
- Refined recommendations based on outcomes.

Funding for this project is made possible by the Vermont Specialty Crop Block Grant Program, 02200-SCBGP-15-3.

Thank You!

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Funding for this project is made possible by the Vermont Specialty Crop Block Grant Program.

THE UNIVERSITY OF VERMONT EXTENSION

Part 2: What's Bugging You?

Cheryl Frank Sullivan & Margaret Skinner ~ Univ. of Vermont, Entomology Research Laboratory

High Tunnel Tomato Management
Vegetable and Berry Grower Webinar Series
August 12, 2020

IPM is a Decision Making Process

Scouting
What & where are the problems?

Thresholds
When to intervene?

Damage
Is the VALUE of the plant impacted?

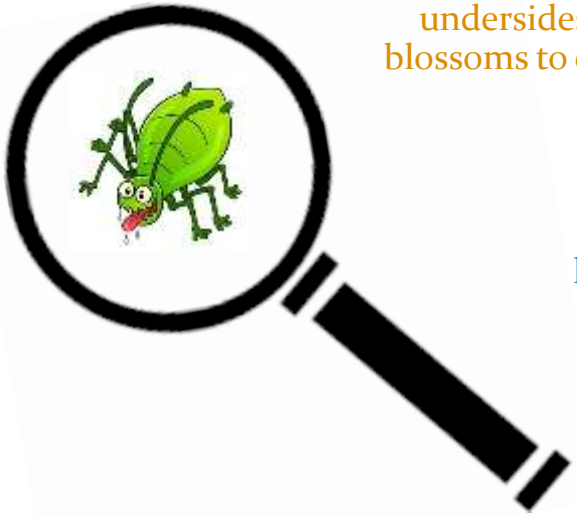
Management
What should I do?
How much will it COST?

Friend or Foe?

If you use natural enemies, some are generalists (attack many) and some are specialists (attack few or one). Don't make an expensive mistake by choosing the wrong thing!

Scouting & monitoring for pests & natural enemies critical for successful management program

Know where & how to look: leaf undersides, growth tips, tap blossoms to dislodge arthropods



How many plants are infested & at what magnitude

Use magnifying apparatus (hand lens) properly or collect samples & send to Univ. Diagnostic Clinic

Know their life cycles – at what stages do pests get attacked/natural enemies attack

Keep track of when management occurred, rates & effectiveness

When in doubt, call a specialist (University Extension or Biocontrol Supplier)

Mighty Terrifying Mites

Broad mite (*Polyphagotarsonemus latus*)

Family: Tarsonemidae

Can only id see microscopically.

Two-spotted spider mite (*Tetranychus urticae*)

Family: Tetranychidae

red overwintering phase

Tomato russet mite (*Aculops lycopersici*)

Family: Eriophyidae

Koppert: Spider mites and other mites: https://www.koppertus.com/challenges/spider-mites-and-other-mites/
Managing Mites and Miticides in High Tunnels (Univ. of Kentucky):
https://kentuckypestnews.wordpress.com/2015/03/17/managing-mites-and-miticides-in-high-tunnels/
Broad Mite Factsheet (IFAS Extension): https://edis.ifas.ufl.edu/pdffiles/IN/IN105300.pdf

Broad Mite~ Damage

Foliar distortion/curling

Russeting/deformity/splitting

Leaf Curling and Stunting in Tomato Plants

Broad Mites in Pepper (UNH Extension): https://extension.unh.edu/blog/broad-mites-pepper
Broad Mites in Fruiting Vegetables (PennState Extension): https://extension.psu.edu/broad-mites-in-fruiting-vegetables
Cornell Vegetable MD Online: Broad Mite Damage http://vegetablemdonline.ppath.cornell.edu/DiagnosticKeys/TomWlt/Broad_Tom.htm

Tomato Russet Mite~ Damage

Russeting/Stem & fruit bronzing

Rust colored ‘powder’ mite build-up

Foliar distortion/curling

Tomato russet mite (Koppert): https://www.koppertus.com/challenges/spider-mites-and-other-mites/tomato-russet-mite/
Russet Skinned Tomatoes? eGro Alert. http://e-gro.org/pdf/2017_629.pdf

Spider Mites ~ Damage

Yellow stippling visible on leaf surfaces

Yellow flecking on fruits

Webbing

Mites ~ Natural Enemies

Stratiolaelaps scimitus
(Hypoaspis miles)

Phytoseiulis persimilis

Predatory Mites

(Specialist – eats only SM – bright red color – fast moving)

(Generalists – eats SM, other small arthropods & pollen – tan/yellow colors – fast moving)

Predatory midge (fly)

Predatory as yellow-brown maggot/larva

mosquito like adult

Feltiella acarisuga

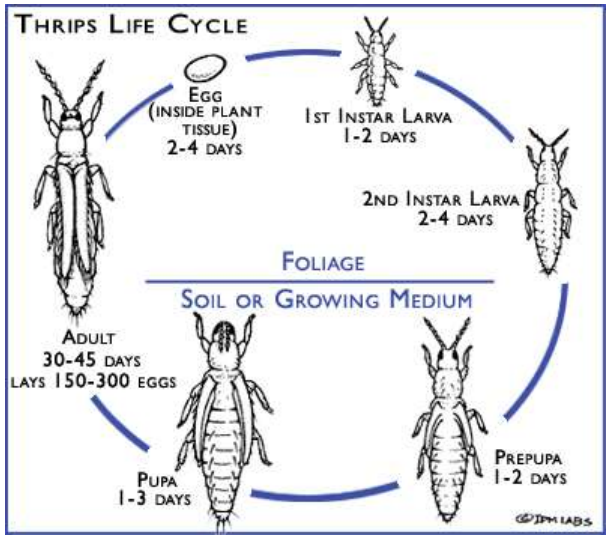
Neoseiulus (Amblyseius) andersoni, californicus, cucumeris & fallacis

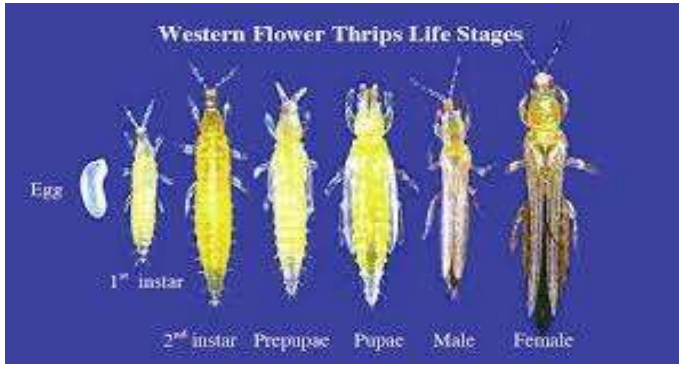
Bush Bean Trap Plants

Great for spider mites when young.

Thrips

Thrips tabaci (Onion) & *Frankliniella* spp. (Flower)





Thrips (Koppert): https://www.koppert.com/challenges/thrips/
Thrips General Management (IPM Labs, Inc.): https://www.ipmlabs.com/plant-pest-management/thrips/general-management/
Thrips (BioBest): https://www.biobestgroup.com/en/biobest/pests-and-diseases/thrips-4975/

Thrips Damage

Silver patches with black dots (frass)

Virus symptoms (TSWV)

Distortion, yellowing & flecking of fruits

Thrips ~ Natural Enemies

Predatory Beetle

Dalotia (Atheta) coriaria
Rove beetle

Soil dwelling, predatory as adults & larvae, consume soil dwelling arthropods like the thrips pupal stage.

Thrips	•			
Biocontrol agents	**Egg**	**Nymph**	**Pupa**	**Adult**
Amblyseius swirskii				
Neoseiulus cucumeris				
Orius insidous				
Hypoaspis spp.				
Dalotia coriaria				

https://www.growliv.com/

Bar width represents biocontrol agents efficiency
Only effective in soil

Marigold
Trap/Guardian Plant

Predatory Mites

Neoseiulus (Amblyseius) cucumeris (top) *& swirskii* (bottom)

Generalists – eats other small arthropods & pollen

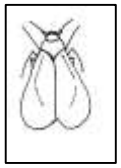
Predatory Bug

Predatory as adults & nymphs, naturally occurring

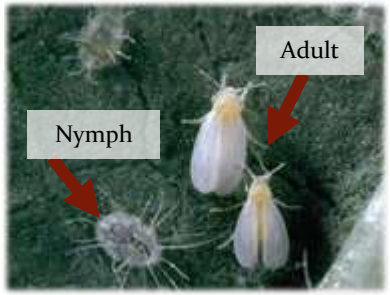
Orius insidiosus
(minute pirate bug/insidious flower bug)

Whiteflies ~ Natural Enemies

The Pests



Adults have flat wing shape



Trialeurodes vaporariorum (Greenhouse)

Nymphs cake shaped & hairy

Encarsia formosa

Prefers GWF - adults black & yellow - parasitized nymphs turn black

Parasitic Wasps (specialists)

Bemisia spp. *(Silverleaf/Sweetpotato)*

Adults have tent wing shape

Nymphs pancake shaped

Prefers SWF - adults lemon yellow - parasitized pupae turn gold

Eretmocerus eremicus

Whiteflies ~ Damage

Leaf curling & yellowing/chlorosis (from feeding or viruses)

Irregular ripening of fruit

Sooty mold on leaves from honeydew excretion

The Aphid Apocalypse

Aulacorthum solani (Foxglove)

Pale green, yellow & shiny color, parallel-slightly divergent tubercles, dark spots at cornicle bases

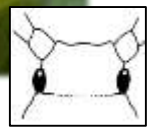
Myzus persicae (Green peach)

Green, pink, orange color, converging inward (W) tubercles, long cornicles with black tips

Pink, green color, parallel-slightly divergent tubercles, slender, pear shaped body, very long cornicles

Aphids can also be winged!

Aphis gossypii (Melon)



Green, yellow color, undeveloped, flat tubercles, short, dark cornicles

Macrosiphum euphorbiae (Potato)

Aphids ~ Damage

Cast skins

Distortion

Honeydew & Sooty mold

Aphids ~ Natural Enemies

Parasitic Wasps
(specialists)

Predatory Green Lacewings

Chrysoperla rufilabris

Aphidius colemani (green peach & melon)
Aphidius ervi (potato & foxglove)

Praon spp.

Mummies

Larvae-pupae develop within aphid 'mummy'

Predatory fly

Predatory as orange maggot/larva

Aphidoletes aphidimyza
(many aphids)

Aphelinus abdominalis
(potato & foxglove)

Hornworms/Caterpillars & Natural Enemies

Tomato
Manduca quinquemaculata
five-spotted hawkmoth

Tobacco
Manduca sexta
Carolina sphinx moth

Cotesia wasp adult (above) pupae on hornworm after larvae feed within (below)

Bacillus thuringiensis (Bt) bacteria

Trichogramma adult – egg parasitoid

http://entnemdept.ufl.edu/creatures/field/hornworm.htm
http://entnemdept.ufl.edu/creatures/field/tobacco_hornworm.htm
https://extension.unh.edu/resource/hornworms-tomatoes-new-hampshire-fact-sheet-o

Parasitic Wasps | National Geographic

Aphids vs Parasitic Wasps:
https://www.youtube.com/watch?v=Bc69LLLEQRk

Caterpillar vs Parasitic Wasp:
https://www.youtube.com/watch?v=vMG-LWyNcAs

HABITAT HARBORS HAPPINESS

Habitat planting of alyssum, marigold and bush bean in high tunnel tomatoes.

HABITAT PLANTINGS provide favorable food (floral resources & attracted pests), sites for reproduction & shelter to beneficial insects. Many natural enemies attack pests in both their adult and immature stages. Some only in their immature stages while the adult stage consumes pollen and nectar. Providing these in high tunnels provides these resources to natural enemies to help them more effectively manage pests.

Parasitic wasp adult

Syrphid fly adult

Beetles (like the well known lady) and bugs predate on small insects in both their adult and immature larval or nymph stages.

Syrphid fly larva predates on pests.

Aphid 'mummy' contains wasp immature stages

Many Syrphid flies and aphid parasitic wasps adults feed on floral resources. They kill pests in their immature stages.

Beneficial Breakdown

Natural enemies observed within habitat plantings

Pesticides

Table 21: Biorational and Selective Insecticides and Miticides - New England Vegetable Management Guide: https://nevegetable.org/table-21-biorational-and-selective-insecticides-and-miticides

Insect Control - New England Vegetable Management Guide: https://nevegetable.org/crops/insect-control-6

Compatibility: Pesticides and natural enemies of pests: Cornell Biocontrol Bytes https://blogs.cornell.edu/biocontrolbytes/2020/05/12/compatibility-pesticides-and-natural-enemies-of-pests/

Pesticide Safety Education Program (UVM): https://www.uvm.edu/extension/psep

Additional Resources

Applied Bio-nomics Ltd. Technical Manual: https://www.appliedbio-nomics.com/technical-manual/

Biocontrol Supplier Partial Listing (UVM): https://www.uvm.edu/~entlab/Greenhouse%20IPM/Links.html#Bio

Cornell High Tunnels Tomatoes: http://blogs.cornell.edu/hightunnels/vegetables/tomatoes/

High Tunnel Pest Management (UVM): https://www.uvm.edu/~entlab/High%20Tunnel%20IPM/HighTunnelIPM.html

High Tunnel Tomato Project (UNH): High tunnel tomato project https://hightunneltomatoproject.wordpress.com/

High Tunnel Tomato Production Manual Download (MU Extension): https://extension2.missouri.edu/m170

New England Tomato Crop Profile: https://ipmdata.ipmcenters.org/documents/cropprofiles/NewEnglandtomatoes.pdf

New England Vegetable Management Guide: https://nevegetable.org/

Pests Commonly Found on Tomato (Virginia Tech): https://www.insectid.ento.vt.edu/insect-id/vegetable-pests/tomato.html

Sustainable Pest Management in Greenhouses and High Tunnels (Cornell): https://www.sare.org/Learning-Center/Fact-Sheets/Sustainable-Pest-Management-in-Greenhouses-and-High-Tunnels

Tomato Pest ID (UCONN): http://ipm.uconn.edu/documents/documents/App-TomatoPestIdentification3.pdf

Vermont Vegetable and Berry Grower Pages (UVM): https://www.uvm.edu/vtvegandberry/

Thank You!

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

2020 Vermont Vegetable and Berry Grower Webinar Series
http://www.uvm.edu/vtvegandberry/Webinars2020.html

3rd High Tunnel Conference to be held December 2020! Details coming soon!

Please me anytime for site visits and to discuss pest management options.

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