Improving Nutrient Management in High Tunnels

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NEVFC

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High tunnels /hoophouses /greenhouses have proliferated on vegetable farms in the Northeast

Most production is "in the ground"



High tunnels extend the season and protect crops from increasingly severe weather



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Annual Precipitation 1941-2013 BTV

11.11



Source: https://www.uvm.edu/femc/products/long_term_update/2017/vermont/climate

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a stand with

Soil fertility is important, but a whole-tunnel approach is needed



Many different tunnel systems ...so guidance varies



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Many different production contexts, too



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

The ground is typically amended with lots of compost and nutrients so it is somewhere between a field soil and a potting soil



Tunnel tomatoes have heavy nutrient demands--

Yields can be much greater than in the field



Nutrients affect quality not just yield

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Nutrient deficiencies also occur in mature plants

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Tunnel soil looks good and feels good, but what is in it?

Soil tests can help you understand what is going on.

Soil testing provides data about nutrient content, pH, salt level



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'Field' soil test alone for established tunnel soil is not so helpful: nutrients are usually **'off the chart'** but that is for field yields. Also does not include soluble salts, nitrate-N, ammonium-N

Best option is Saturated Media Extract (water soluble nutrients) + field soil test



Soil tests: Measure reserve and available nutrients

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Increasing availability

Modified Morgan

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Saturated Media

and the second second

Leaf tissue tests tell you what the plant actually took up



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	PRINT DATE	LAB NO.	SAMPLE IDENTIFICATION	COUNTY	ACRES OR SO. FT.			
	THE DATE		Status Island I for ION	0000.11	THE OT OX. II.			
	•SOIL TEST REPORT FOR: MAINE SOIL TESTING SERVICE							
	LINIVERSITY OF MAINE BERKING							
				5722 DE	FRING HALL			
	5/22 DEEKING HALL							
	OKONO, MAINE 04469-5722							
	• SOIL TEST SUMMARY & INTERPRETATION (see Numerical Results section for more information)							
	Level LOW MEDIUM OPTIMUM OPTIMUM							
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	Nitrate-N	(ppm) 37	7 XXXXXXXXXXXX					
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	Magnesium	n (% Sat) 15.1	1 XXXXXXXXXXXXXXXXXXXXXXXXXXXX	*****	****			
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	Iron	(ppm) 5.1	3 XXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXX	~~~~~			
	Zinc	(ppm) 7.0	5 XXXXXXXXXXXXXXXXXXXXXXXXXXXXX	XXXXXXXXXXXXXXXXX	xxxxxxxxxxxxxx			
	RECOMMENT	DED ADDIT	IONS FOR ORGANIC GE	OWING - Crop Code	# 392 (HIGH TUNNEL)			
	To raise	soil pH to	6.5, apply 30 pounds of lin	ne per 1000 sq. f	t.			
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	COL Magnesium	lowol ic						
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MAINE MAINE SOIL TESTING SERVICE High Tunnel Saturated Media Analysis For: Analysis date: 03/20/2020 Job # 379 Sample Name: HHT Crop Grown: Tomato Comments: 1027 Analytical Results Optimum Range Level Measured Relative Level Determination 6.0 - 7.0 6.1 pH OPTIMUM 2.0 - 4.0 mmhos/cm Soluble Salts 2.44 mmhos/cm OK 8 - 12 % Organic Matter 7.9 % LOW 100 - 200 ppm Nitrate-N 31.7 ppm LOW Saturated Ammonium-N < 10 ppm 0.5 ppm OF media Phosphorus 1 - 5 ppm 0.3 ppm LO 150 - 275 ppm (soluble Potassium 8 ppm LO nutrients) > 60 ppm Magnesium 107 ppm OPTI > 250 ppm OPTIMUM Calcium 444 ppm < 10 ppm OK Aluminum 0.2 ppm Boron 0.05 - 0.50 ppm 0.62 ppm HIGH 0.01 - 0.5 ppm OPTIMUM Copper 0.013 ppm Iron 0.3 - 5.0 ppm 0.04 ppm LOW 0.1 - 3.0 ppm 0.24 ppm Manganese OPTIMUM Sodium < 100 ppm 163 ppm HIGH 25 - 100 ppm Sulfur 491 ppm HIGH 0.3 - 3.0 ppm Zinc 0.08 ppm LOW

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Note: Results are expressed as concentration in saturated media water extract, measuring the short-term intensity of nutrient availability in your soil. .

Use soil test results to plan ahead for nutrient demands...



But also consider your production goals and context

Factors include planting date, grafting, tomato type and variety, tunnel style, markets, heat, etc.



2018 New England High Tunnel Tomato Survey

Landscape 'scan' of 20 farms in New England

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Nitrogen applications should be based on yield potential

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N application rate based on yield goal						
	Yield goal lb/acre	=Yield lb/ft ²	=Yield lb/stem = lb/4 ft ²	Approx. plant height	N need Ib/acre @ 90% recovery	N need* lb/1,000 ft ²
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 ft ² , up to 1 lb.						

2020-2021 High Tunnel Tomato Research

Applied newly revised recommendations & tracked outcomes

Developed "intake" form to document practices and inform recommendations

Farms reported yield and quality

51 farms participated

5 farms closely studied with monthly soil and tissue samples



What did we learn?



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High tunnel tomatoes yield 14 times more marketable fruit than field tomatoes

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Average yield in this study's tunnels (n=51) = 71 tons/ acre Average yield in Vermont field = 5 tons/ acre*



<u>*NASS, 2017</u>.



Irrigation is important! Marketable tomato yield increases w/ up to 4 lines of drip

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Number drip lines per row tomatoes



Heat 🛱 Unheated 🚔 Ground heat 🚔 Air heat Air heat helps Pounds marketable tomatoes per sq ft but does it pay off? 6 4 2 -0 Unheated Ground heat Air heat

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Sulfur lowers soil pH in tunnel.

Takes time to change pH

(rate ~apx, 15 lbs/ 1000 sq feet)



Basic high tunnel soil amending

Follow soil test recommendation rates

Amend full rates of P, Mg, Ca, and other nutrients but only **2/3 N and K up** front

Sidedress remaining N and K 3 to 4 weeks after planting and/or begin fertigating weekly 4-6 weeks after planting



Spread "front loaded" soil amendments evenly!

Many tunnels have lower yields in areas by sidewalls due to lower fertility, colder soil, other...?



Common organic soil amendments

N: soy, peanut, feather meal; Chilean (sidedress), "meat" meals (e.g. Naturesafe 13-0-0)

P: bone meal, bone char

K: potassium sulfate, sul-po-mag, greensand

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, leaves, carbon, etc.

Slide courtesy of Vern Grubinger



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If pH and nutrients are high, consider materials besides compost to add organic matter

Peat moss (3-4 bales compressed per 1000 sq feet) works well, but not sustainably sourced

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Shredded cover crops, grass clippings, coir, shredded straw leaves, other organic materials?



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If soil test calls for phosphorus, compost is a good long term source, but for immediate availability, bone char is an organic option



Service State

Epsom Salts for Mg

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Gypsum adds calcium, doesn't change soil pH



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



Leaf tissue analysis measure what the plants took up

Begin 1 month after transplant, sample monthly.



'Reading the plants' is a good idea, but it's not precise, and by the time you see a symptom it's harder to recover

Understanding Tissue Samples

UMaine Lab	Sample results	Optimal Range
Nitrogen (%)	1.54	3.5-5
Potassium (%)	0.96	3.5-4.5
Phosphorus (%)	0.206	0.3-0.65
Calcium (ppm)	2.7	1-3
Magnesium (ppm)	0.218	.35-1
Manganese (ppm)	42	25-200
Iron (ppm)	119.4	50-300
Copper (ppm)	5.42	5-35
Boron (ppm)	45	30-75
Zinc (ppm)	85.8	18-80

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Nutrient	Conc. in leaves (%)				
Nuthent	Before fruiting	During fruiting			
Ν	4.0-5.0	3.5-4.0			
Ρ	0.5-0.8	0.4-0.6			
К	3.5-4.5	2.8-4.0			
Ca	0.9-1.8	1.0-2.0			
Mg	0.5-0.8	0.4-1.0			
S	0.4-0.8	0.4-0.8			

More N and K during vegetative growth; less when fruiting

*Source: https://www.haifa-group.com/

ALC: N

*

Tissue tests help guide fertigation; plants respond quickly.

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Both soil nitrate and potassium quickly respond to soluble applications of N (left) and K (right)

Simple organic fertigation

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0.25 lb/ 1000 sq feet N and K = 1.5 lbs sodium nitrate and 0.5 lbs

potassium sulfate fines dissolved





So what does a "good" crop look like???





May



July



 August
 September
 November

 Marketable Yield = 6.76 lb per sq ft (294,000 lb / acre)













Marketable Yield = 1.3 lb per sq ft (56,602 lb/acre)

What about leafy greens, winter growing?

A lot less nutrients are needed, but data are lacking. Soil testing before planting still makes sense



How important is cover cropping to tunnel soil fertility? *There are pros and cons.*





Other factors that affect yield

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Cultural practices



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A Caller

Maintain good airflow and low humidity

Pruning and lower leaf removal

Recommendations:

- Set yield goal (3-5 lbs/ft²).
- Transplant at higher density 3-5ft² per leader.
- Soil test for available AND reserve soil nutrients.
- Provide sufficient available N for biomass production through the entire growing season
- Make sure adequate K is available, especially as fruits form.





More recommendations:

- Front-load slow-release amendments.
- Take tissue samples one month after transplanting.

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- Be prepared to fertigate N and K.
- Have at least 2 drip lines per plant row; sandier soils 4 lines.
- Track performance.

Efficiencies—pruning and clipping







Efficiencies—harvest carts





Efficiencies—radiant heat system





Ventilation—ridg e vent



Ventilation—gabl e end vent

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Ventilation—Vert ical Air Flow Fans



Ventilation: socket roll ups



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Thank you! Rebecca.maden@uvm.edu

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THE UNIVERSITY OF VERMONT EXTENSION

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