

# Mid West Winter Growers 2020

## High Tunnel Soil Nutrition

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Cornell University























**MILLER**  
**WATER-SOLUBLE FERTILIZER**

Miller Chemical & Fertilizer, LLC is a leading company in the development and production of plant crop nutrients with more than 80 years experience in the agricultural and horticultural markets.

Miller Chemical & Fertilizer, LLC's headquarters and manufacturing facilities are located in Harrisburg, Pennsylvania USA, and are currently doing business in more than 96 countries.

Miller Chemical & Fertilizer, LLC's core values are Integrity, Passion, Teamwork and Commitment. Our guiding principals in fostering business relationships are quality products and value for the customer.

Miller Chemical & Fertilizer, LLC possesses a proven track record of providing solutions that provide new and improved agricultural products through innovation and efficiency.

**MAGRICULTURE**

MAGNESIUM SULFATE

**MILLER**  
**MICROFLEX**

COMBINATION FERTILIZER

Great for lawns, square, poe garden, flower beds, and more!

Brilliant

Great for lawns, square, poe garden, flower beds, and more!

Application: Aromatic White Granules  
Ground Crab Shell  
Organic Nitrogen  
N-P-K: 10-10-10  
Transpiration: 1000  
Solubility: 1000  
pH: 7.0-8.0

APPROXIMATE: 1000  
Transpiration: 1000  
Solubility: 1000  
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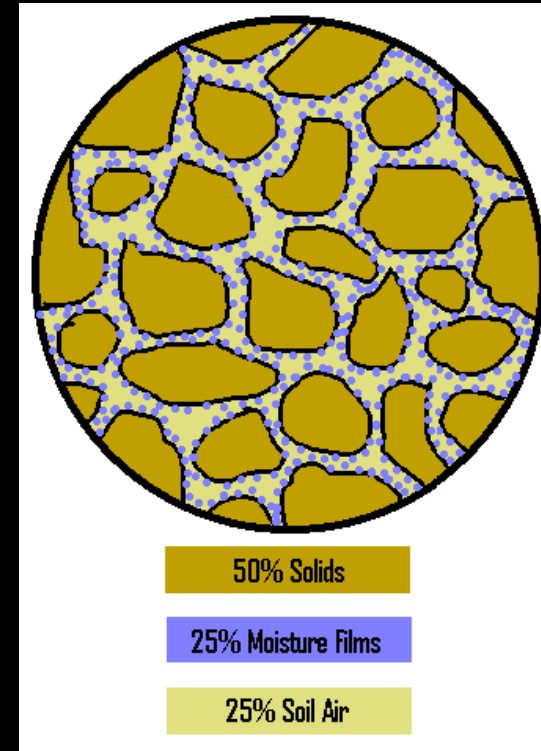
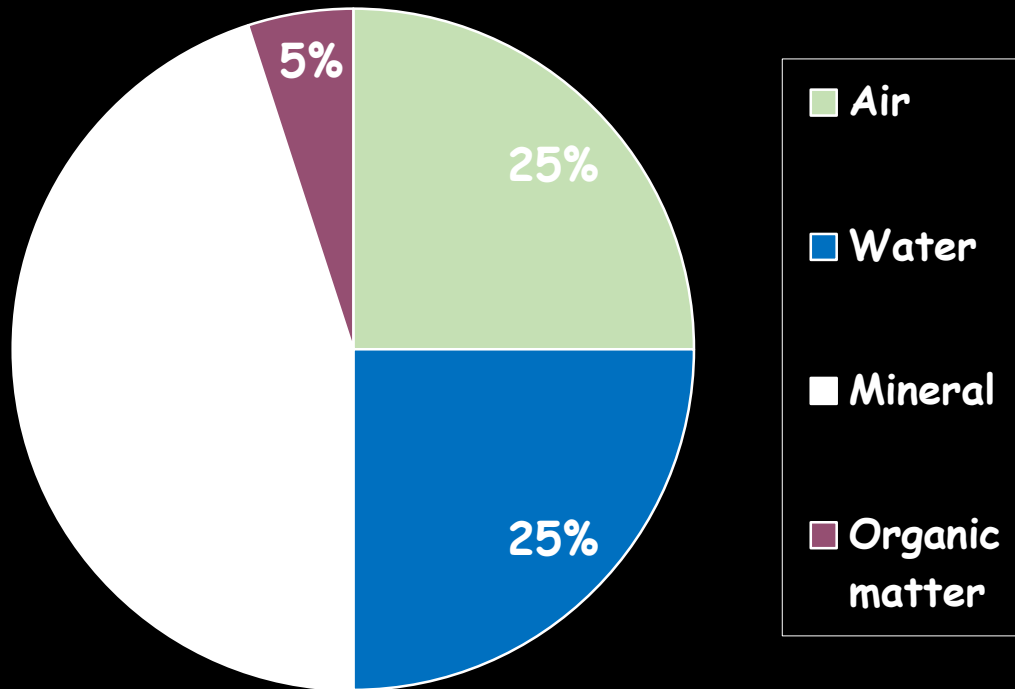
APPROXIMATE: 1000  
Transpiration: 1000  
Solubility: 1000  
pH: 7.0-8.0



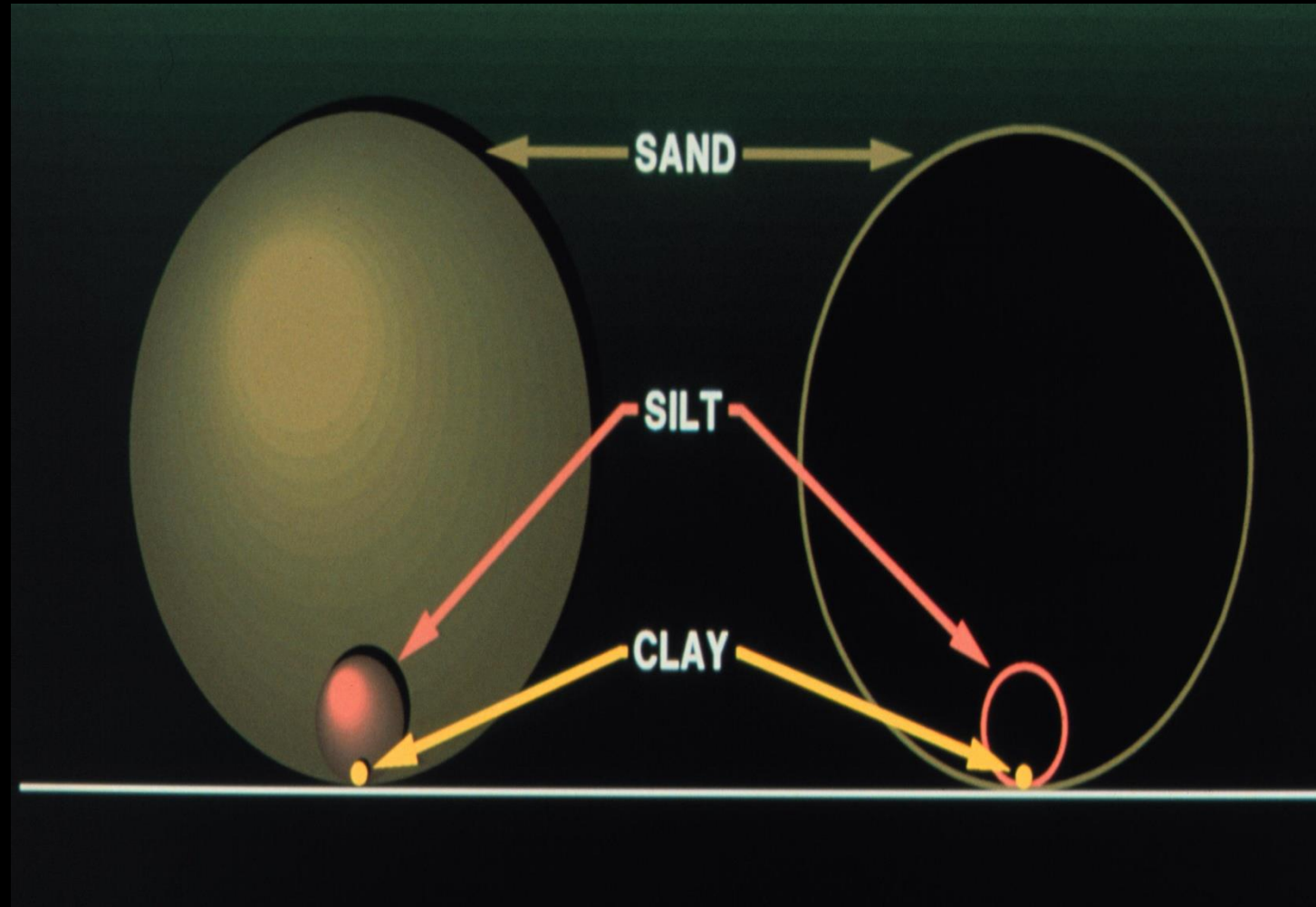




# What is soil?

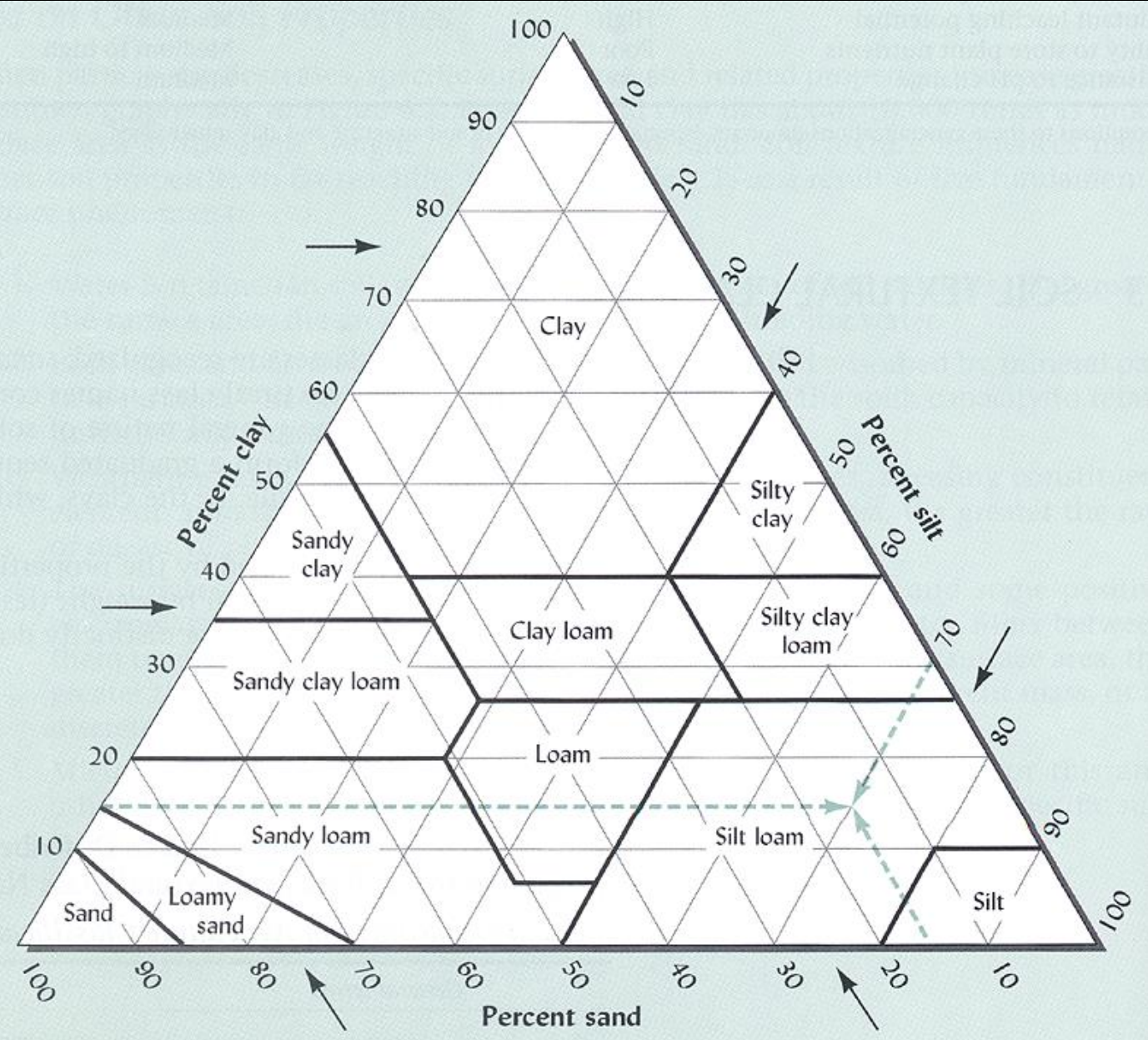


# Basic Units of Soil: Sand, Silt and Clay





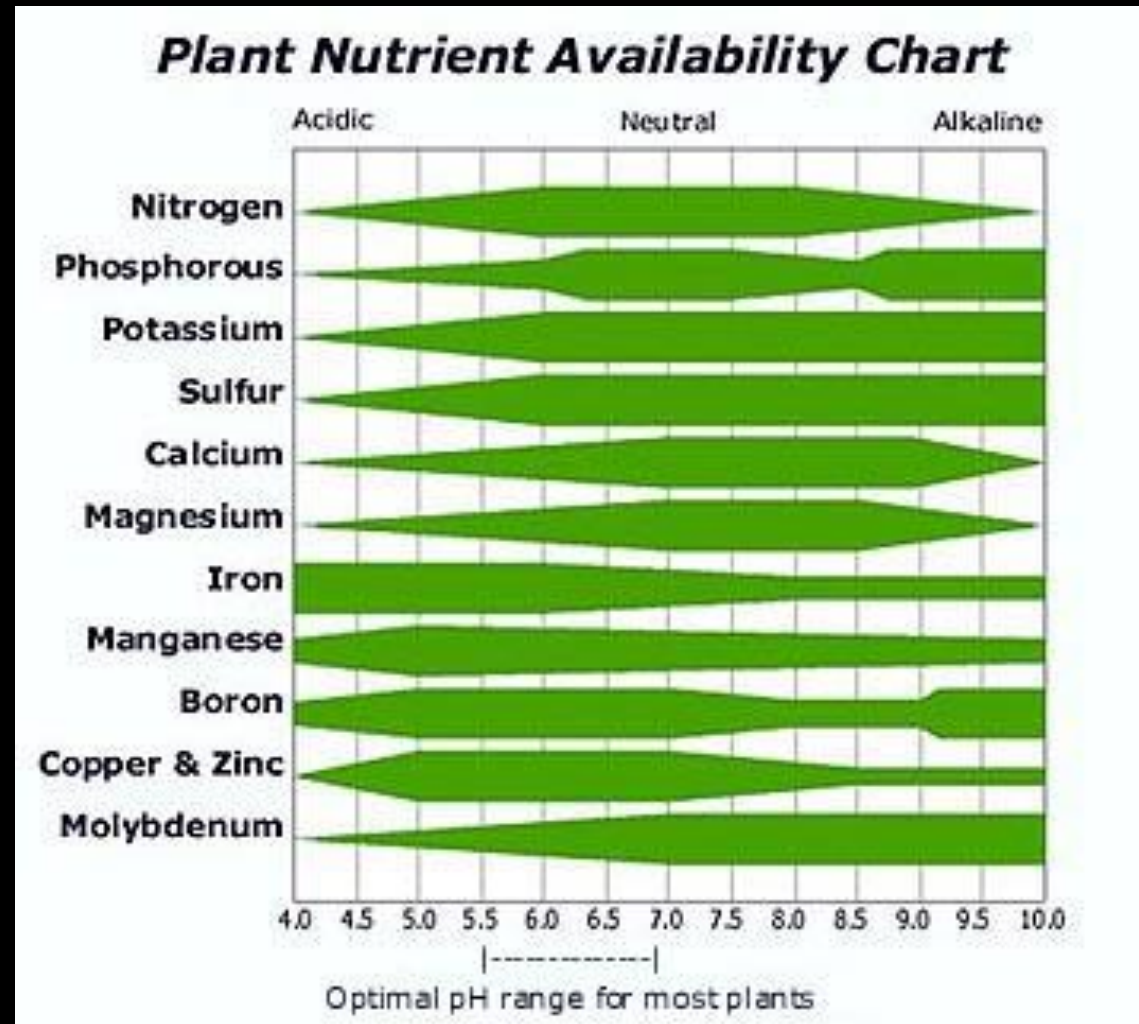
# USDA Soil Triangle



# Soil Chemistry

- All soils contain some levels of basic nutrients
  - Macro-nutrients: N, P, K
  - Secondary nutrients: Calcium, Magnesium, Sulfur
  - Micronutrients: Boron, Copper, Iron, Chloride, Manganese, Molybdenum, and Zinc

# Nutrient availability varies with pH







Soil Test is Essential

Element	lbs/acre*	Very Low	Low	Optimum	High	Very High
Phosphorus (P)	836					
Potassium (K)	3,351					
Calcium (Ca)	8,994					
Magnesium (Mg)	1,509					

Element	Value	Element	Value	Element	Value
Soil pH	7.9	Zinc (Zn), lbs/acre	5	% OM	12.8
Iron (Fe), lbs/acre	3	Aluminum (Al), lbs/acre	12		
Manganese (Mn), lbs/acre	64	Soluble Salts, mmhos/cm	0.4		

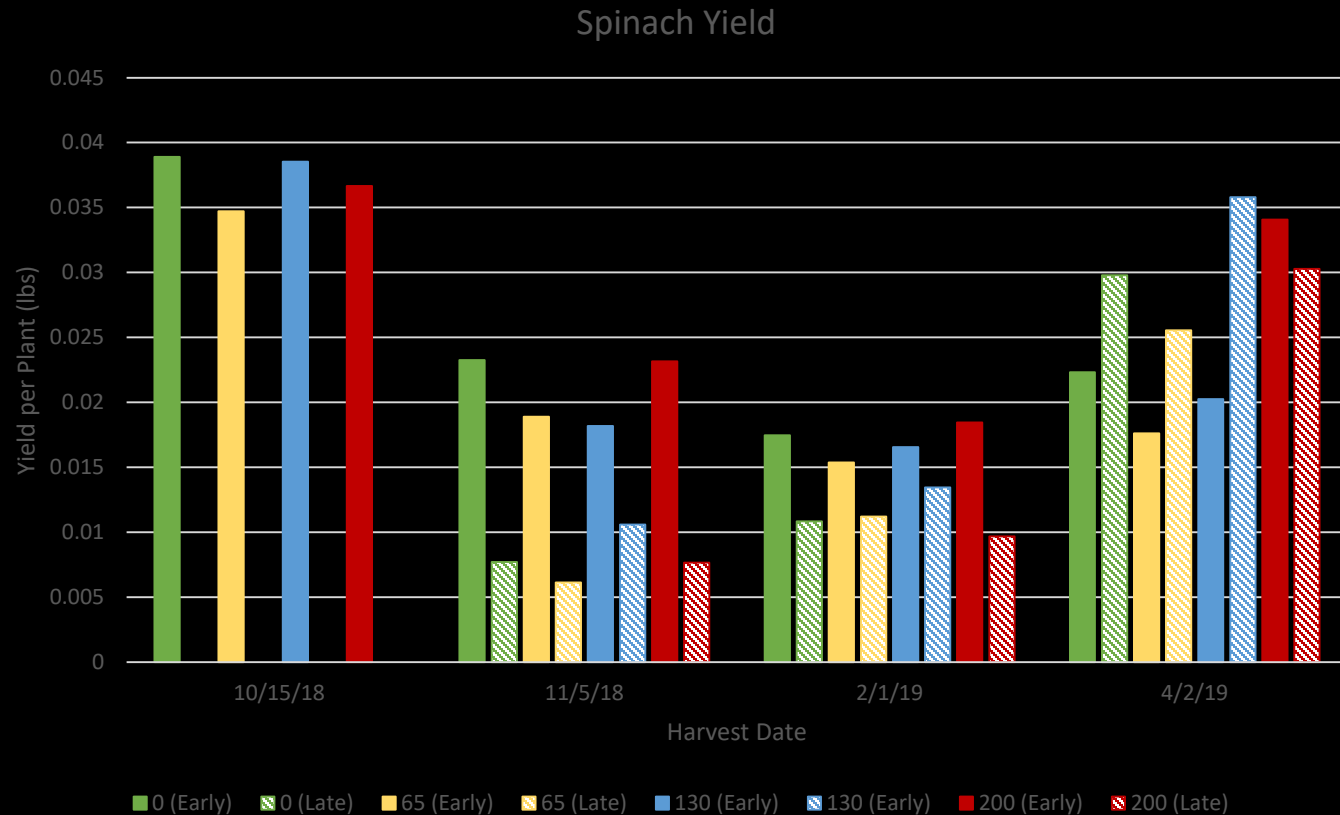






# Winter High Tunnel Research at CCE

## N fertilization does not increase spinach yield



Aug. 27

Sept. 10



- Higher yields from earlier planting
- No significant yield differences across N fertility treatments: 0, 65, 130, and 200 lbs N/ac



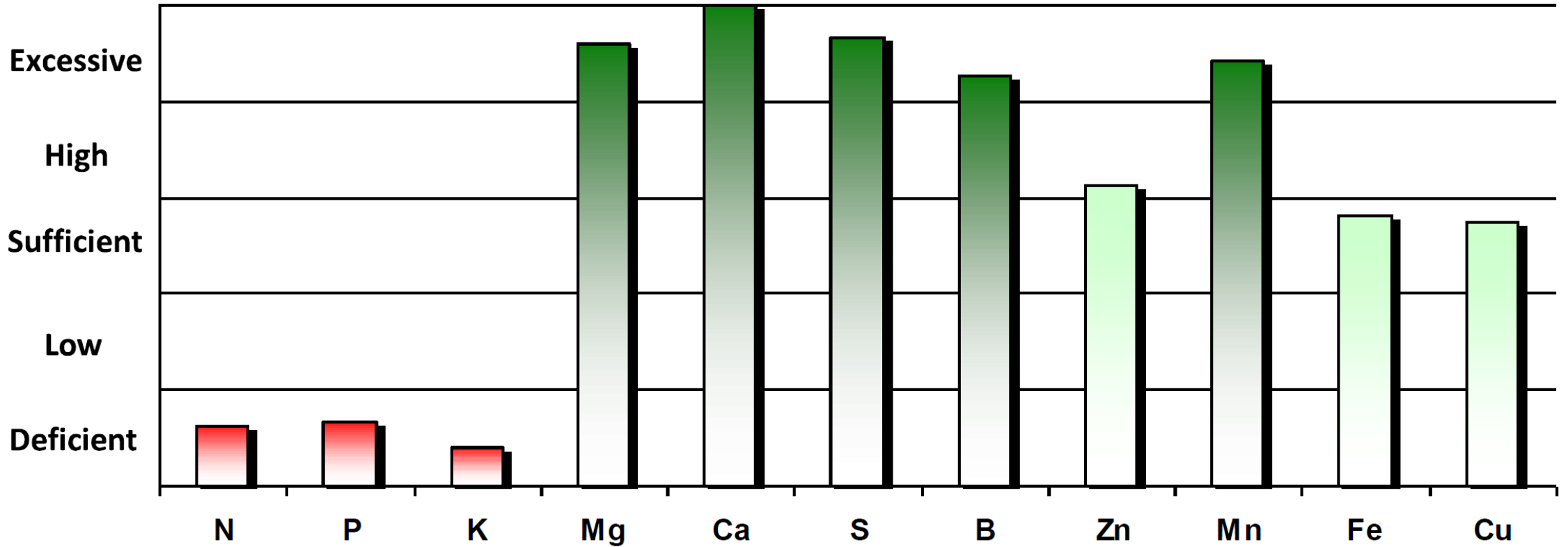


Foliar Test also Essential



Element	N %	P %	K %	Mg %	Ca %	S %	B (ppm)	Zn (ppm)	Mn (ppm)	Fe (ppm)	Cu (ppm)
Result	2.27	0.17	1.08	1.36	7.48	2.42	95	34	282	111	16

## Plant Analysis Ratings



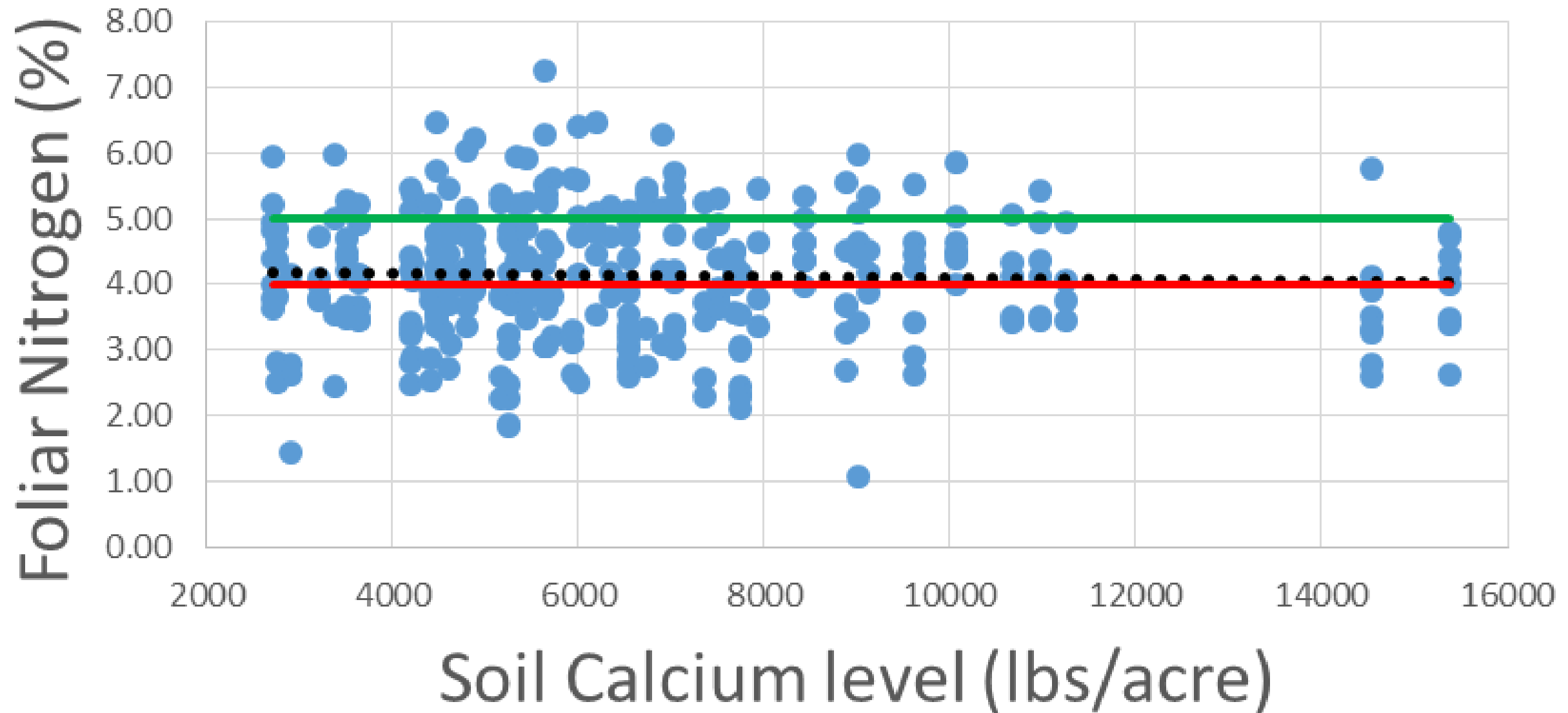
**Table 6.** Recipe for tomatoes in winter according to crop growth stage (units are ppm).

	<b>Weeks 0-6 Higher N, Ca and Mg for vegetative growth</b>	<b>Weeks 6-12 Lower N, higher K for reproductive growth</b>	<b>Week 12+ Maintain balance of vegetative / reproductive growth</b>
Nitrogen (N)	224	189	189
Phosphorus (P)	47	47	39
Potassium (K)	281	351	341
Calcium (Ca)	212	190	170
Magnesium (Mg)	65	60	48
Iron (Fe)	2.00	2.00	2.00
Manganese (Mn)	0.55	0.55	0.55
Zinc (Zn)	0.33	0.33	0.33
Boron (B)	0.28	0.28	0.28
Copper (Cu)	0.05	0.05	0.05
Molybdenum (Mo)	0.05	0.05	0.05

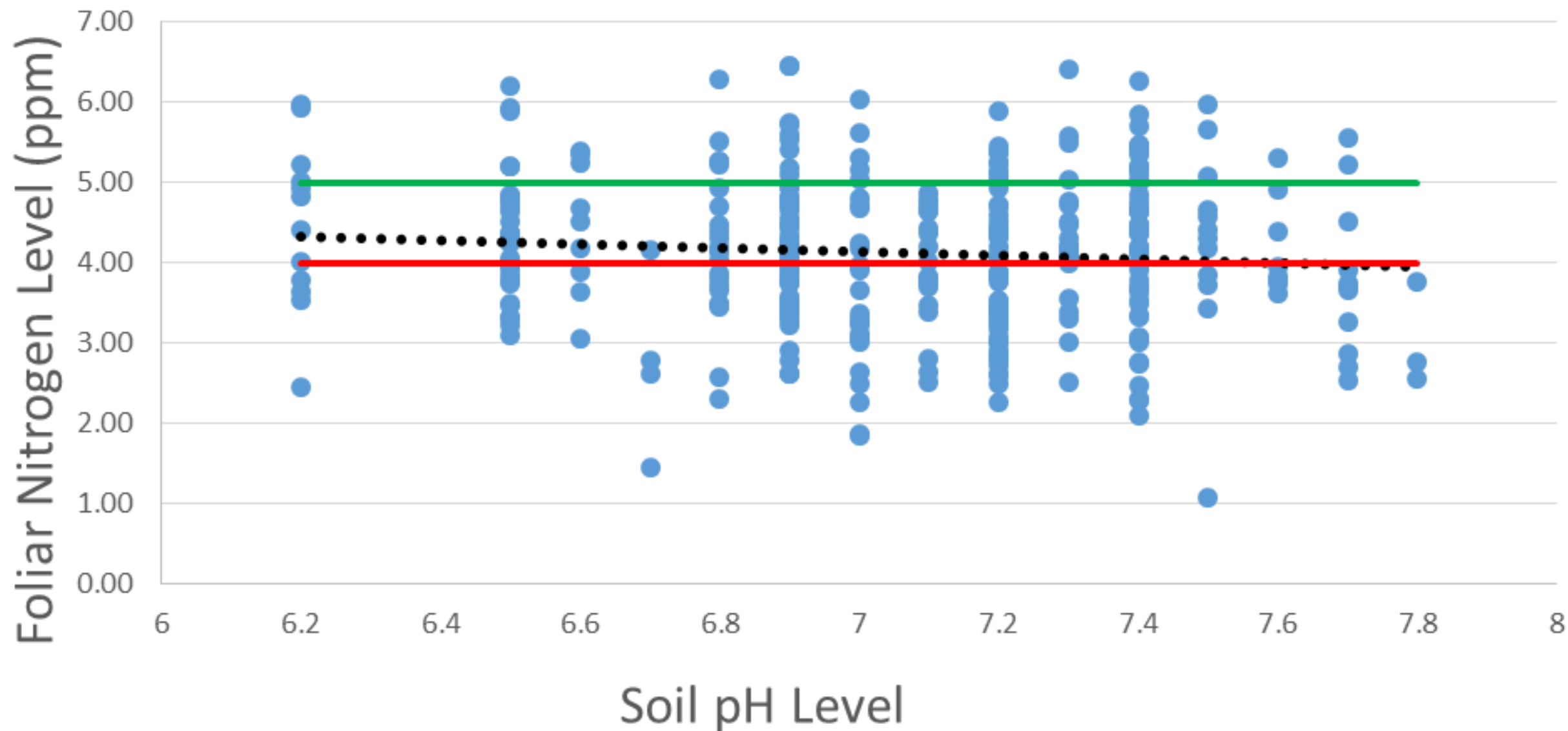
Source: Sunco, Ltd., and University of Arizona, Controlled Environment Agriculture Center, <http://tinyurl.com/ljj785/>



# Soil Calcium Level vs Foliar Nitrogen Level

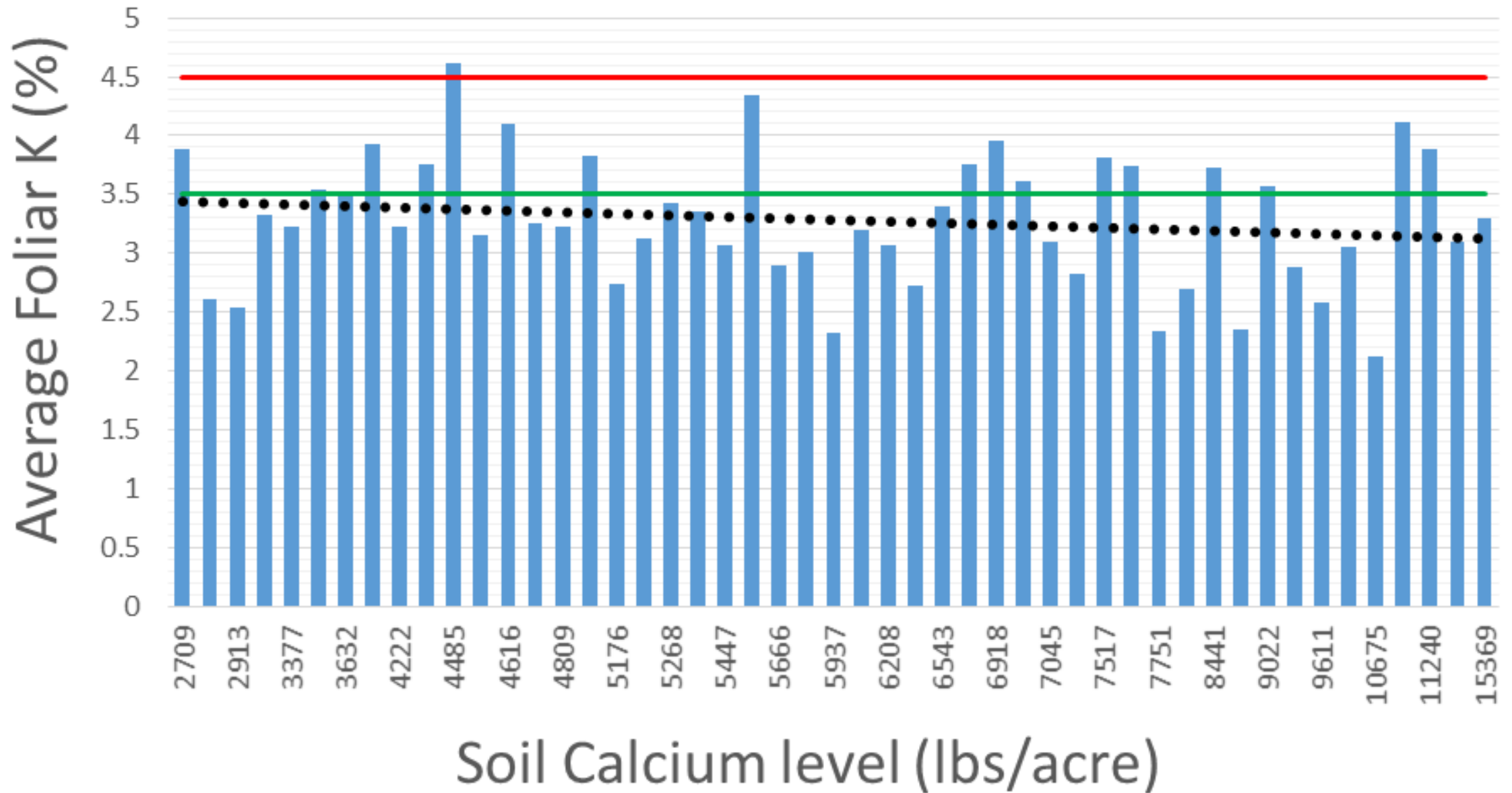


# Soil pH vs Foliar Nitrogen Level

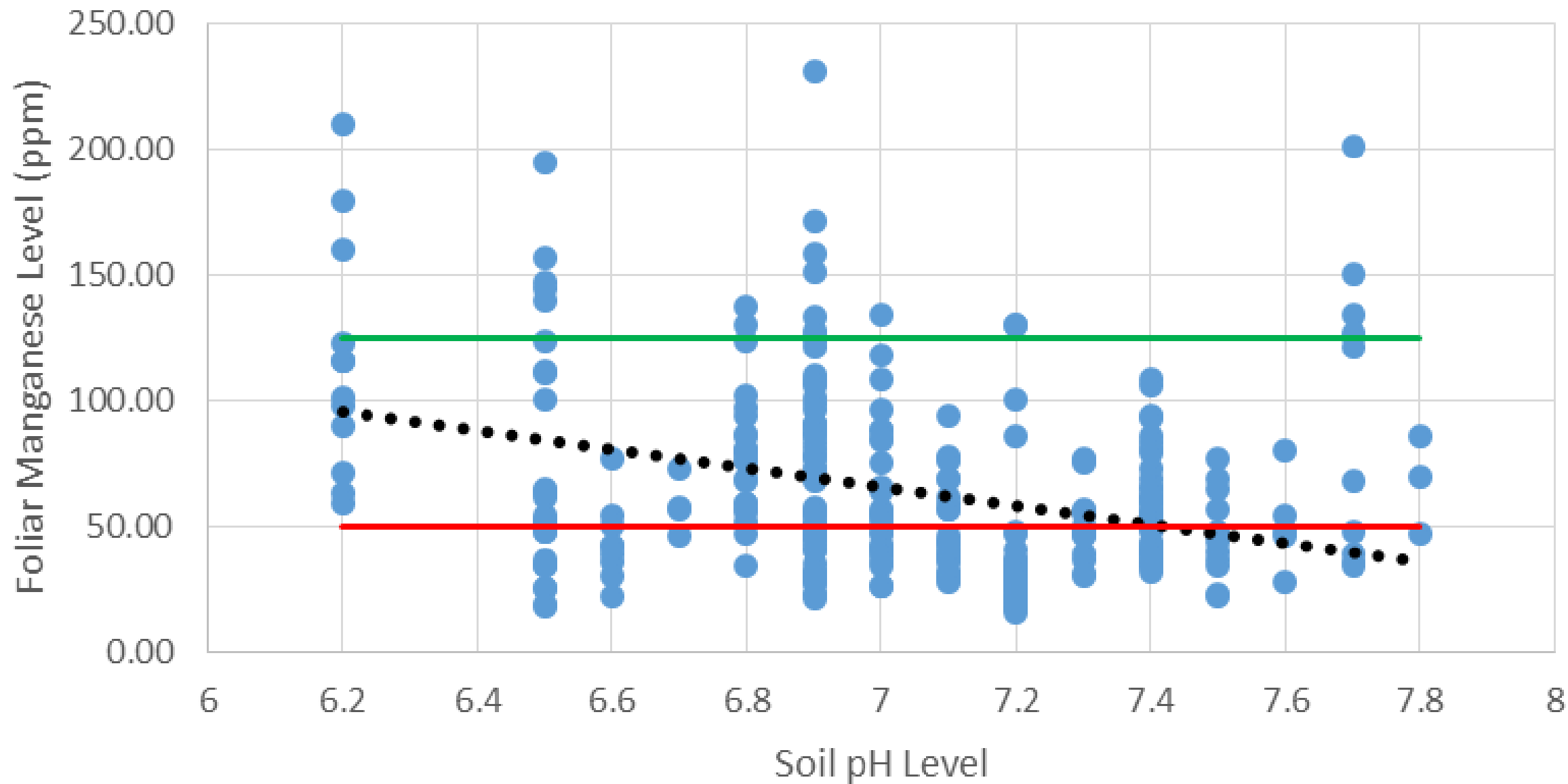




# Soil Calcium Level vs Foliar Potassium Level



# Soil pH vs Foliar Manganese Level





# Approaches to reducing high pH/calcium

- Prevention
  - No to low calcium fertilizers
  - Avoid compost
  - No lime
- Acidification of irrigation water
- Elemental sulfur
- Peat moss
- Plastic removal
- Moveable tunnels

# Irrigation Water

pH

Alkalinity



# Injectors

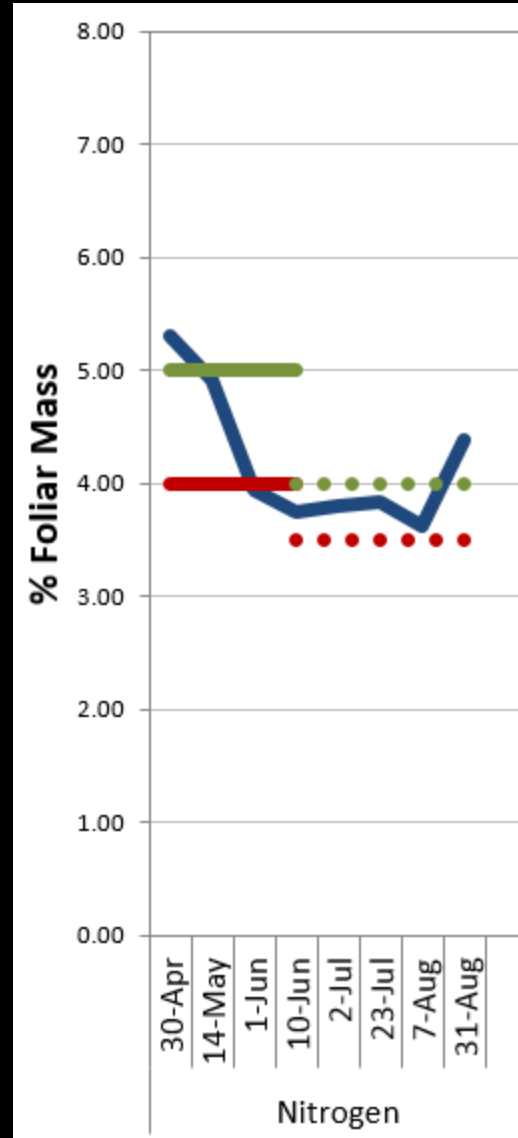






Fertilizer	% Nitrate (NO <sub>3</sub> )	% (NH <sub>4</sub> <sup>b</sup> )	Potential acidity <sup>c</sup> or basicity <sup>d</sup>
Ammonium sulfate	0	100	2200 a
Urea	0	100	1680 a
21-7-7 acid	0	100	1539 a
21-7-7 acid	0	100	1518 a
Diammonium phosphate	0	100	1400 a
Ammonium nitrate	51	49	1220 a
Monoammonium phosphate	0	100	1120 a
18-9-18	47.7	53.3	708 a
20-20-20	27.5	72.5	532 a
21-5-20	62.3	37.7	407 a
20-10-20	59.5	40.5	404 a
20-10-20	60	40	401 a
21-5-20	60	40	390 a
17-5-17	70.6	29.4	106 a
20-0-20	54	46	0
15-0-20	76.7	23.3	38 b
15-5-15	80	20	69 b
15-5-15	78.7	21.3	131 b
15-0-14	82.7	17.3	165 b
15-0-15	86.7	13.3	221 b
15-0-15	80.8	18.8	319 b
Calcium nitrate	100	0	400 b
Potassium nitrate	100	0	520 b
Sodium nitrate	100	0	580 b

# Optimal Nitrogen levels in high tunnel tomatoes:

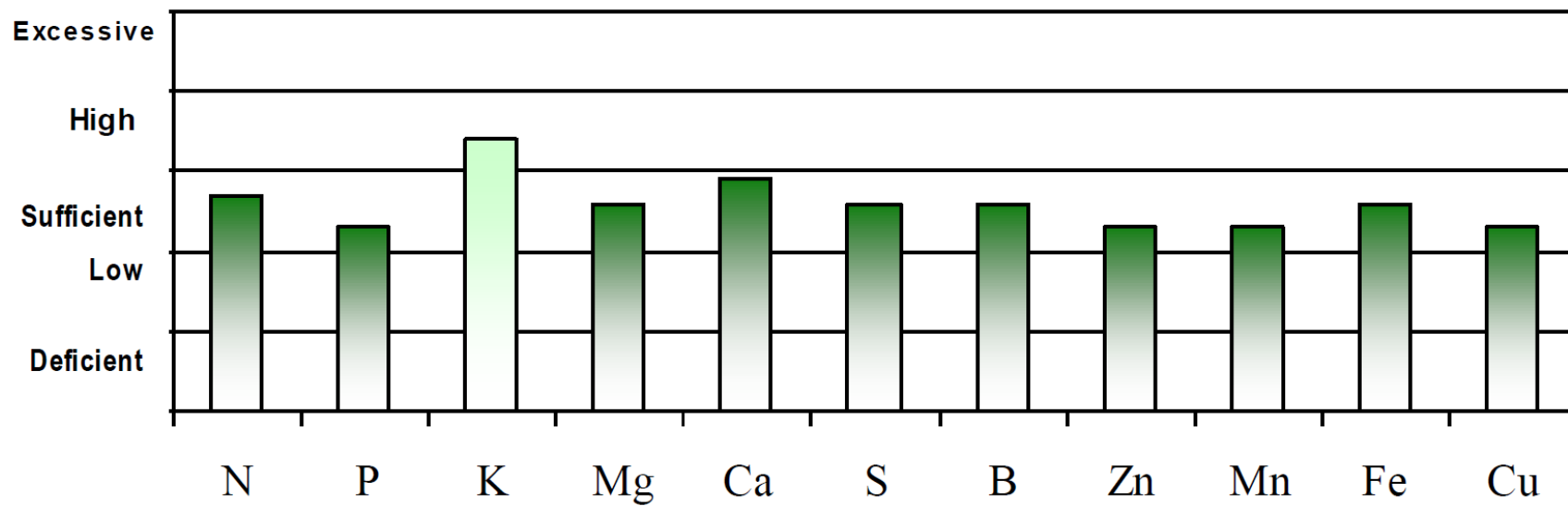


Stage of growth:	% Dry matter
Vegetative:	4% to 5%
Fruiting:	3.5% to 4%



N	P	K	Mg	Ca	S	B	Zn	Mn	Fe	Cu
6 %	0.44 %	6.08 %	0.57 %	2.03 %	0.56 %	39 ppm	55 ppm	72 ppm	154 ppm	9 ppm
<b>NO<sup>3</sup> - N</b>	<b>Na</b>	<b>Al</b>	<b>Mo</b>	<b>Ni</b>	<b>Cl</b>			Actual Ratio	<b>N:S</b>	<b>N:K</b>
ppm	%	ppm	ppm	ppm	%				Sufficient Ratio	10.7
									9.1	1.0

## Plant Rating





























# Pre-Plant Nitrogen Sources

(low phosphorus, calcium, salts & pH)

Name	Analysis	\$ per pound of nitrogen (average)	Release Rate	Things to note
Alfalfa Meal	3-1-2 (varies)	\$20+	Medium-slow	Incorporate well into the root zone.
Blood Meal	12-0-0	~\$15	Very fast	Hot. Can burn roots. Mix with a slow release fertilizer for season on N availability
Composted plant material	Variable, usually around 2-1-1	Variable	Slow	Need to test for nutrient content. Will help increase organic matter and improve tilth. Don't rely on it alone for nitrogen.
Feather meal	13-0-0 (varies)	\$8	Medium	Can be hot – incorporate well to avoid hotspots.
Soybean meal	7-1-2	\$13	Medium	Apply 2 weeks prior to transplant to avoid burning plants.

# In-Season Nitrogen Sources

(low phosphorus, calcium, salts & pH)

Name	Analysis	\$ per pound of nitrogen (average)	Release rate	Drawbacks
Blood meal	12-0-0	~\$15	Very Fast	Hot, can burn roots. Not soluble (can side dress)
Chilean nitrate (Sodium nitrate)	16-0-0	\$3	Very fast	High salts. Currently OMRI approved but likely to become prohibited pending rule changes. Use for no more than 20% of N requirement and check with certifier.
Nature's Source	3-1-1	~\$50	Fast	Soluble. Made from oilseed extracts.
Pure Protein Dry	15-1-1	\$200	Fast	Codfish hydrosolate. Soluble (can be injected)
Verdanta PL-2	2-0-6	?	Fast	New soluble product made of fermented sugar cane. Low salt index. High K.
Ferti-Nitro Plus	13-0-0	\$53	Fast	Soy protein derivative.
Wisgeranic	3-1-1	In development	Fast	Derived from food waste



# Nitrogen sources to consider avoiding

(high phosphorus, calcium, salts & pH)

Name	Analysis	\$ per pound of nitrogen (average)	Release rate	Drawbacks
Composted animal manure	Varies	Varies	Slow	High pH, salts and phosphorus. Can also add excess calcium.
Fish emulsion	2-4-2	Varies	Medium	High salts, phosphorus. N not readily available to plants.
Fish Meal	10-.5-3.5	~\$15	Medium	Salty, lots of micronutrients that can throw things out of balance.
Foliar feeding of any kind	Varies	Varies	Fast	May cause plants to “green up” for a bit but not a good way to provide a crop with sufficient nitrogen.

# AGMINO 14-0-0

[Home](#) / [PRODUCTS](#) / [LIQUID & SOLUBLE FERTILIZER](#) / [AGMINO 14-0-0](#)



Available in 3 sizes: 1 lb. Bag, 5 lb.

Bag, 25 lb. Bag

## DESCRIPTION

TOTAL NITROGEN (N) 14.0%  
14.0% Water Soluble Nitrogen

## GUARANTEED ANALYSIS

## DOWNLOADS

## APPLICATION RATES

*Derived from:*

Soy Protein Hydrolysate

Does not contain animal protein. Non-GMO.



# FISH POWDER 12-1-1

Home / PRODUCTS / LIQUID & SOLUBLE FERTILIZER / FISH POWDER 12-1-1



Available in 4 sizes: 4 oz. Bag, 1 lb.

Bag, 5 lb. Bag, 50 lb. Bag

## DESCRIPTION

TOTAL NITROGEN (N) 12.0%  
10.0% Water Soluble Nitrogen  
2.0% Water Insoluble Nitrogen

AVAILABLE PHOSPHATE (P<sub>2</sub>O<sub>5</sub>) 1.0%

SOLUBLE POTASH (K<sub>2</sub>O) 1.0%

## GUARANTEED ANALYSIS

## APPLICATION RATES

## DOWNLOADS

*Derived from:*

Fish Protein Hydrolysate

# Soluble OMRI Micros

- “Micronutrient deficiency must be documented by soil or tissue testing or other documented and verifiable method as approved by a certifying agent”
- Fish and seaweed products (micro quantities unknown)
  - Caution-the oils in these products can burn foliage
- Other micros available, often as derivatives of sulfates
- Before moving into this approach remember that your micro-nutrient deficiency is most likely caused by compaction, pH or nutrient imbalance and not a soil deficiency.



# LIQUID MICRONUTRIENT

Home / PRODUCTS / LIQUID & SOLUBLE FERTILIZER  
/ LIQUID MICRONUTRIENT



Available in 3 sizes: 1 quart, 1  
gallon, 2.5 gallon

## DESCRIPTION

## GUARANTEED ANALYSIS

## APPLICATION RATES

## DOWNLOADS

TOTAL NITROGEN (N) 2.0%

2.0% Nitrate Nitrogen

SOLUBLE POTASH (K<sub>2</sub>O) 1.0%

BORON (B) 0.1%

0.1% Water Soluble Boron (B)

COPPER (Cu) 0.1%

0.1% Water Soluble Copper (Cu)

IRON (Fe) 2.0%

2.0% Water Soluble Iron (Fe)

MANGANESE (Mn) 2.0%

2.0% Water Soluble Manganese (Mn)

ZINC (Zn) 2.0%

2.0% Water Soluble Zinc (Zn)

*Derived from:*

Sodium Nitrate, Potassium Sulfate, Sodium Borate, Copper Sulfate, Ferrous Sulfate, Manganese Sulfate and Zinc Sulfate.

Listed by the Organic Materials Review Institute for use in organic production.

**Table 1. Salt index and partial salt index of various fertilizer materials (arranged in increasing order of salt index within each category).**

<i>Material and analysis</i>	<i>Salt index</i>	<i>Partial salt index<sup>a</sup></i>
<b>Nitrogen</b>		
Anhydrous ammonia, 82% N	47.1	0.572
Urea, 46% N	74.4	1.618
Ammonium sulfate, 21% N, 24% S	88.3	3.252
Ammonium thiosulfate, 12% N, 26% S	90.4	7.533
Ammonium nitrate, 34% N	104	3.059
<b>Phosphorus</b>		
Superphosphate, 20% P <sub>2</sub> O <sub>5</sub>	7.8	0.39
Triple superphosphate, 45% P <sub>2</sub> O <sub>5</sub>	10.1	0.224
MAP, 10% N, 50% P <sub>2</sub> O <sub>5</sub>	24.3	0.405
MAP, 11% N, 52% P <sub>2</sub> O <sub>5</sub>	26.7	0.405
DAP, 18% N, 46% P <sub>2</sub> O <sub>5</sub>	29.2	0.456
Phosphoric acid, 54% P <sub>2</sub> O <sub>5</sub>		1.613 <sup>b</sup>
Phosphoric acid, 72% P <sub>2</sub> O <sub>5</sub>		1.754 <sup>b</sup>
<b>Potassium</b>		
Monopotassium phosphate, 52.2% P <sub>2</sub> O <sub>5</sub> , 34.6% K <sub>2</sub> O	8.4	0.097
Potassium sulfate, 50% K <sub>2</sub> O, 18% S	42.6	0.852
Potassium thiosulfate, 25% K <sub>2</sub> O, 17% S	68	2.72
Potassium nitrate, 13% N, 44% K <sub>2</sub> O	69.5	1.219
Potassium chloride, 60% K <sub>2</sub> O	116.2	1.936
<b>Common liquid solutions</b>		
2-20-20 <sup>c</sup>	7.2	0.17
3-18-18 <sup>c</sup>	8.5	0.22
6-24-6 <sup>c</sup>	11.5	0.32
6-30-10 <sup>c</sup>	13.8	0.3
9-18-9 <sup>c</sup>	16.7	0.48
Ammonium polyphosphate, 10% N, 34% P <sub>2</sub> O <sub>5</sub> <sup>d</sup>	20	0.455
4-10-10 <sup>e</sup>	27.5	1.18
7-21-7 <sup>e</sup>	27.8	0.79





















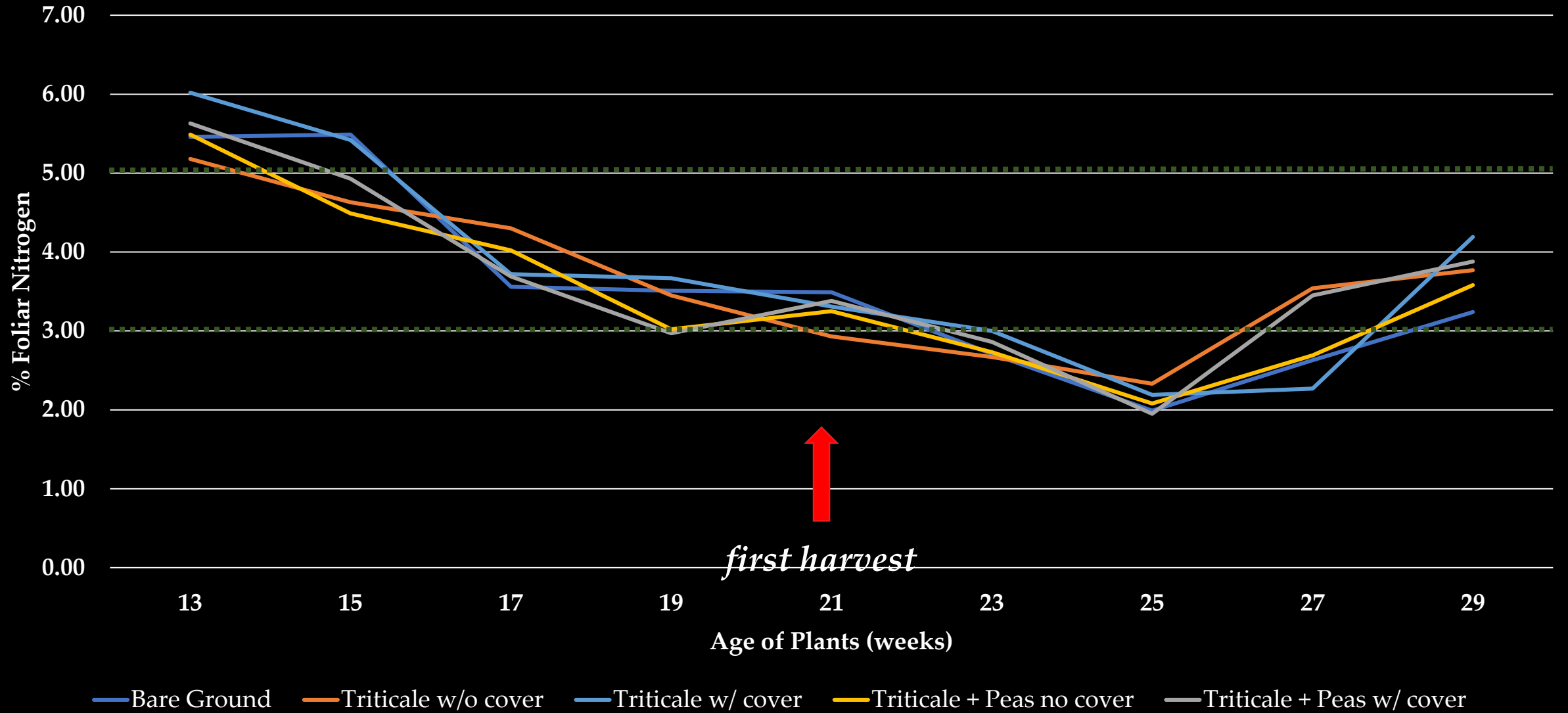


# Nitrogen Fertility Cost-Savings

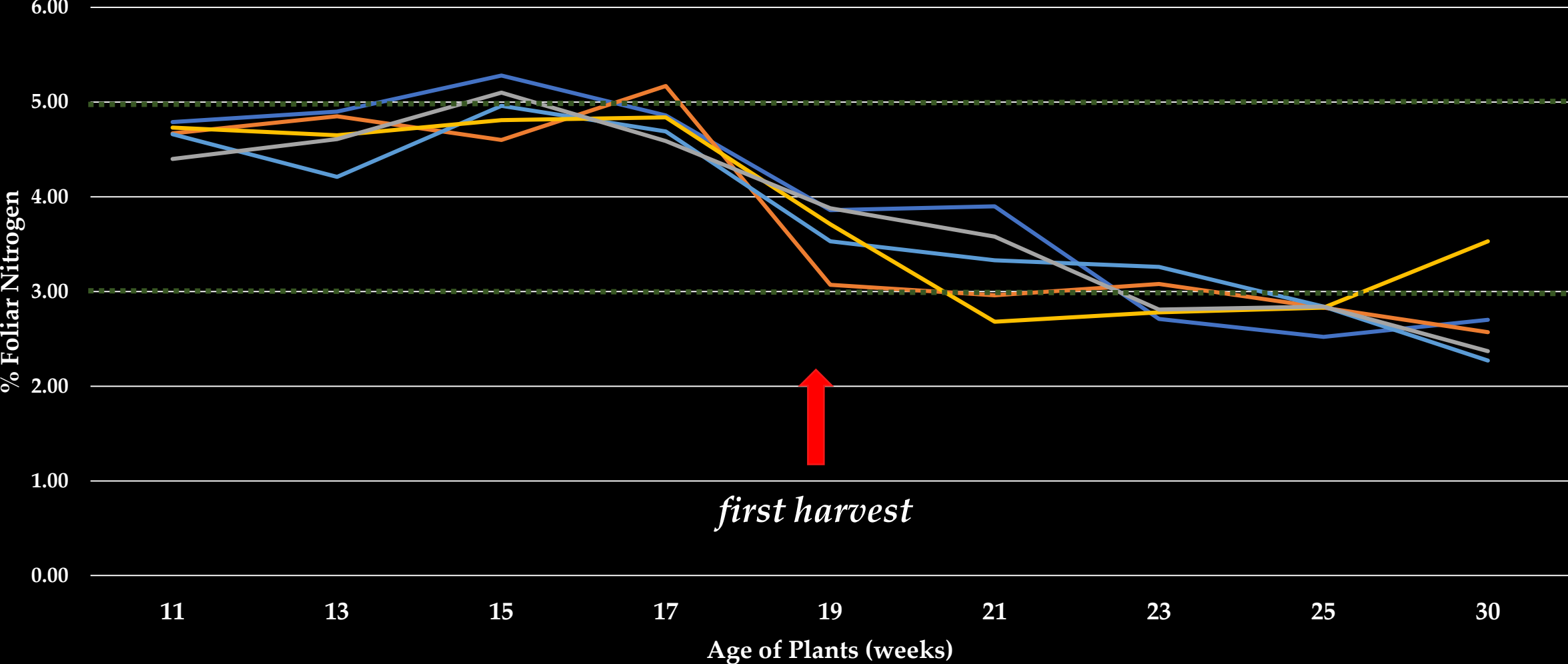
		<i>Organic N</i>			<i>Conventional N</i>		
	lbs. N /Acre from cover crop	Pro-Booster 10-0-0 \$6.40/lb	Feather Meal 13-0-0 \$8.00/lb	Soybean Meal 7-1-2 \$13.00/lb	Urea 46-0-0 \$0.43/lb		Miller's 20-20-20 \$2.14/lb
<b>Tunnel 1</b>							
Triticale, w/ cover	<b>73</b>	\$467	\$584	\$949	\$31		\$156
Triticale, no cover	<b>72</b>	\$461	\$576	\$936	\$31		\$154
Triticale + Peas, w/ cover	<b>40</b>	\$256	\$320	\$520	\$17		\$86
Triticale + Peas, no cover	<b>61</b>	\$390	\$488	\$793	\$26		\$131
<b>Tunnel 3</b>							
Triticale, w/ cover	<b>24</b>	\$152	\$190	\$309	\$10		\$51
Triticale, no cover	<b>19</b>	\$122	\$153	\$248	\$8		\$41
Triticale + Peas, w/ cover	<b>25</b>	\$158	\$197	\$320	\$11		\$53
Triticale + Peas, no cover	<b>27</b>	\$171	\$214	\$347	\$11		\$57



# % Foliar Nitrogen Tomatoes, Tunnel 1



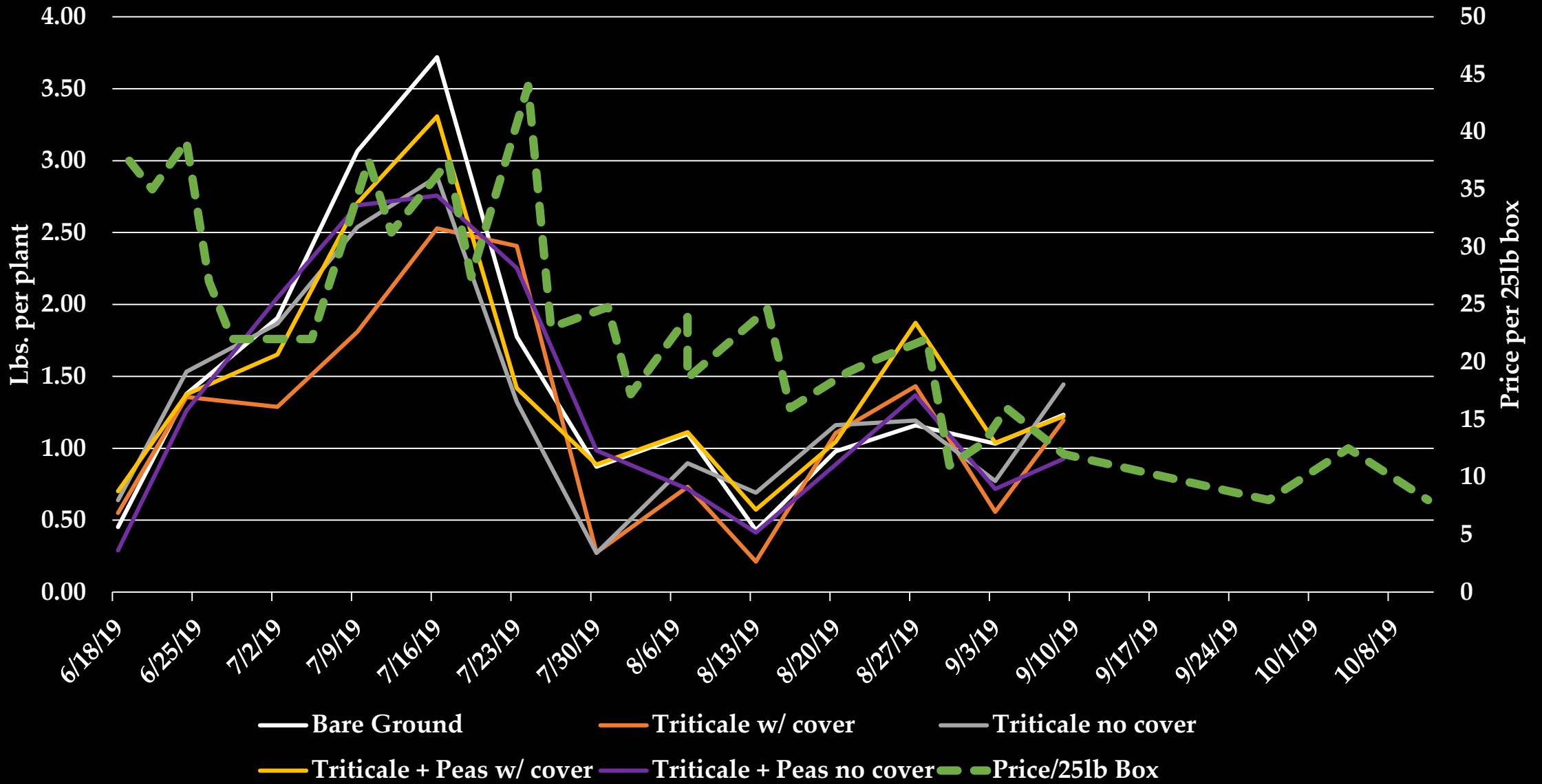
# % Foliar Nitrogen Tomatoes, Tunnel 3



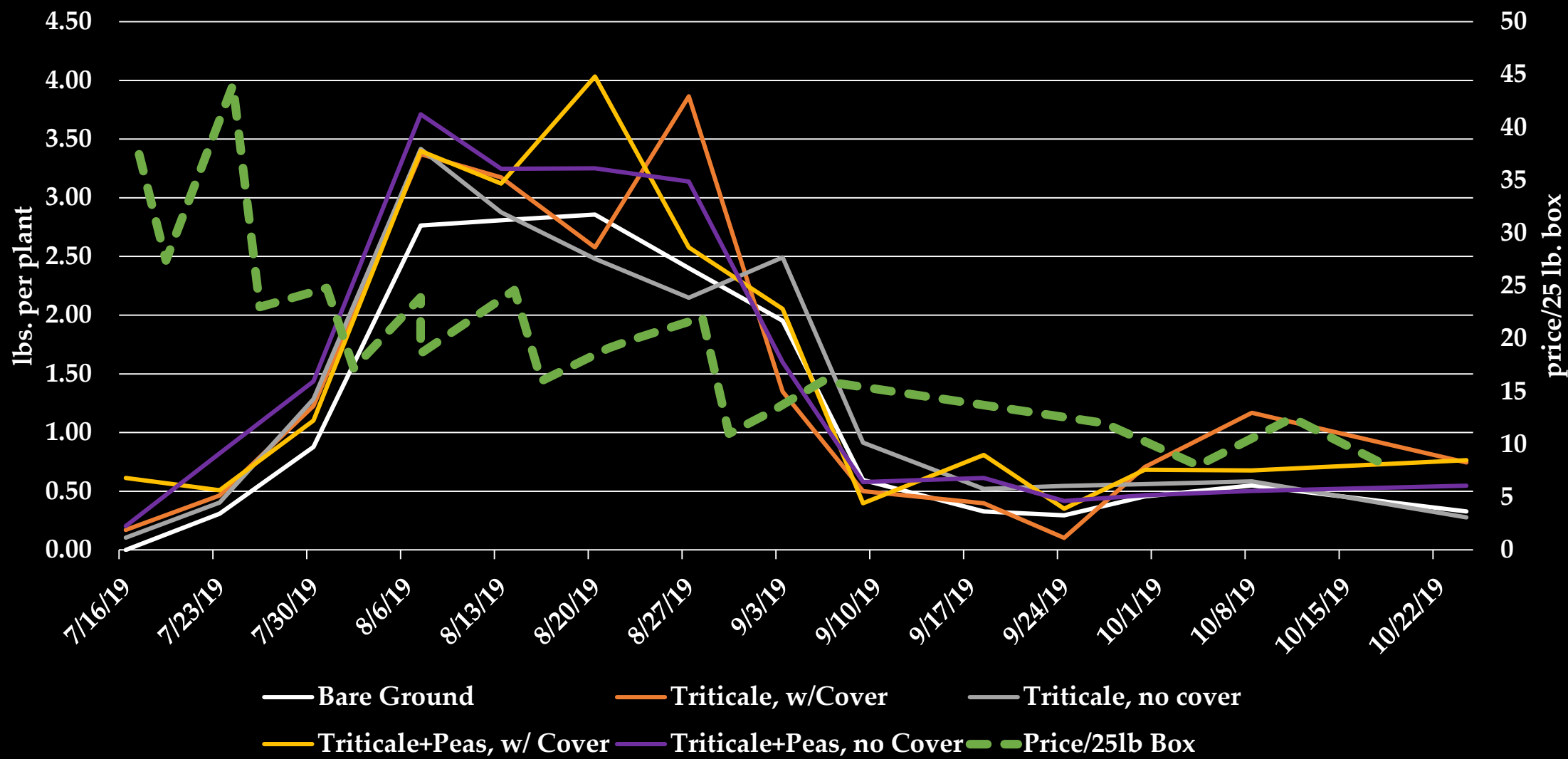
— Bare Ground    — Triticale w/o cover    — Triticale w/ cover    — Triticale + Peas no cover    — Triticale + Peas w/ cover



# Seasonal Prices & Tomato Yields, (early planting)



# Seasonal Prices & Tomato Yields, (late planting)





# Conclusions

- Keep pH and calcium in check:
  - Acidify water
  - Add sulfur to soil in the fall
  - Avoid additional Ca fertilizers
- Soil and foliar test, then add only what you need
- Cover crops can contribute significant quantities of nitrogen
- We are still learning



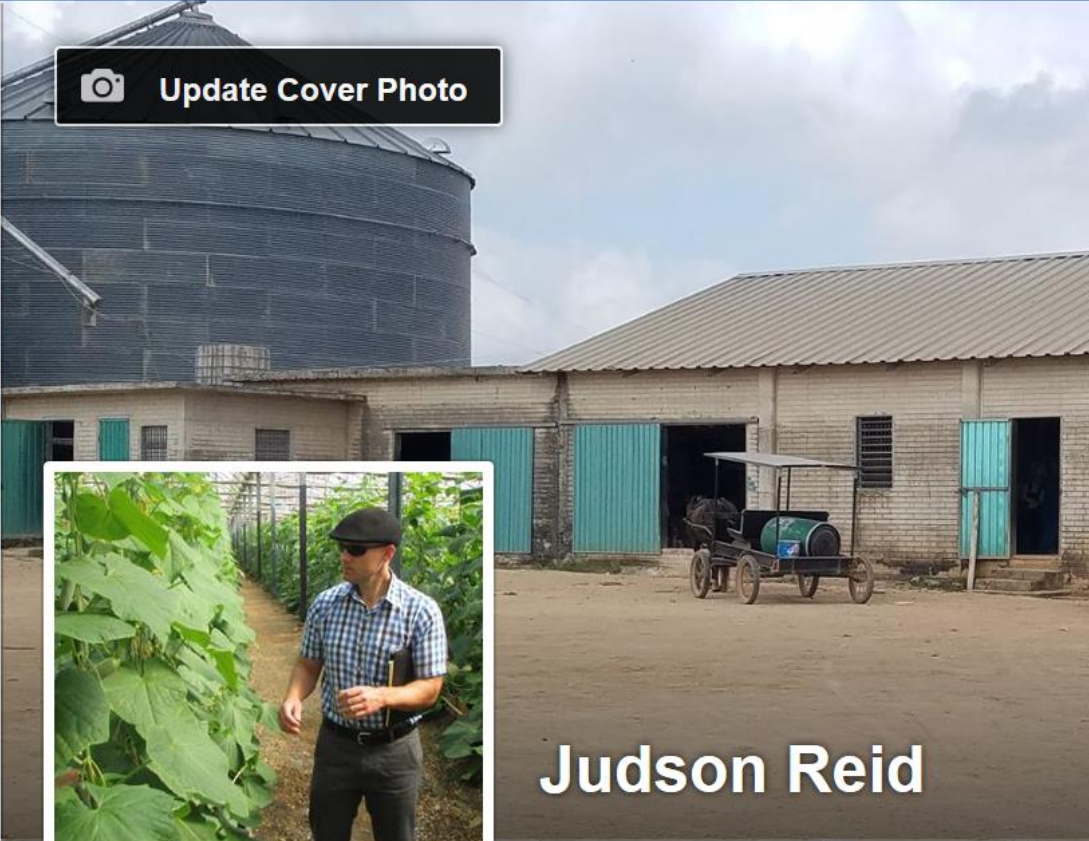




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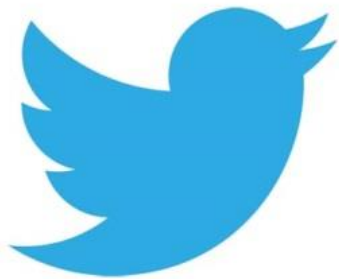
Update Cover Photo



Judson Reid

Timeline ▾

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