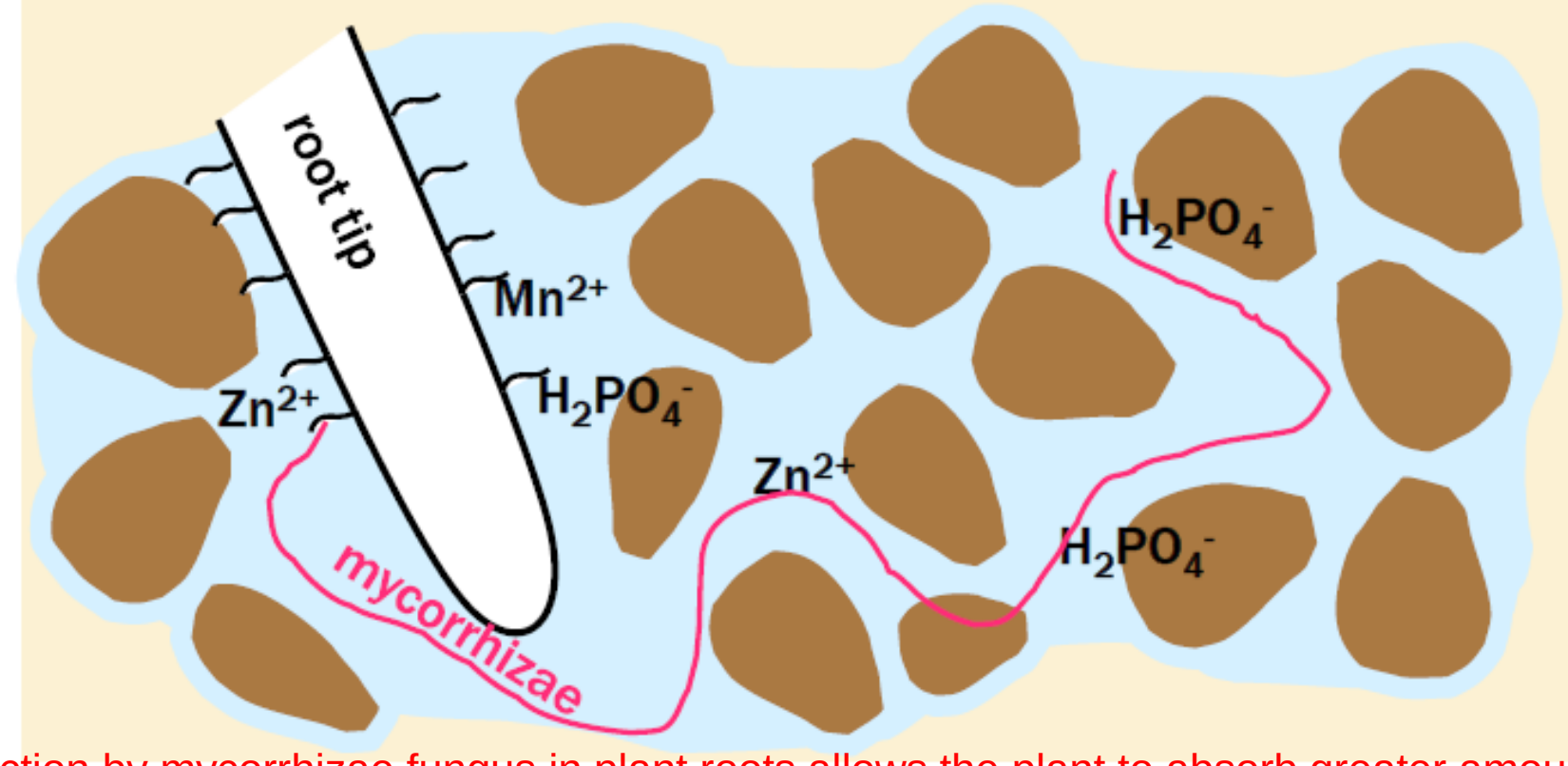
Vegetable Fertility

There are 3 ways that nutrients move to a plant's roots to be absorbed

Root interception – roots obtain nutrients by physically contacting nutrients in soil solution or on soil surfaces;

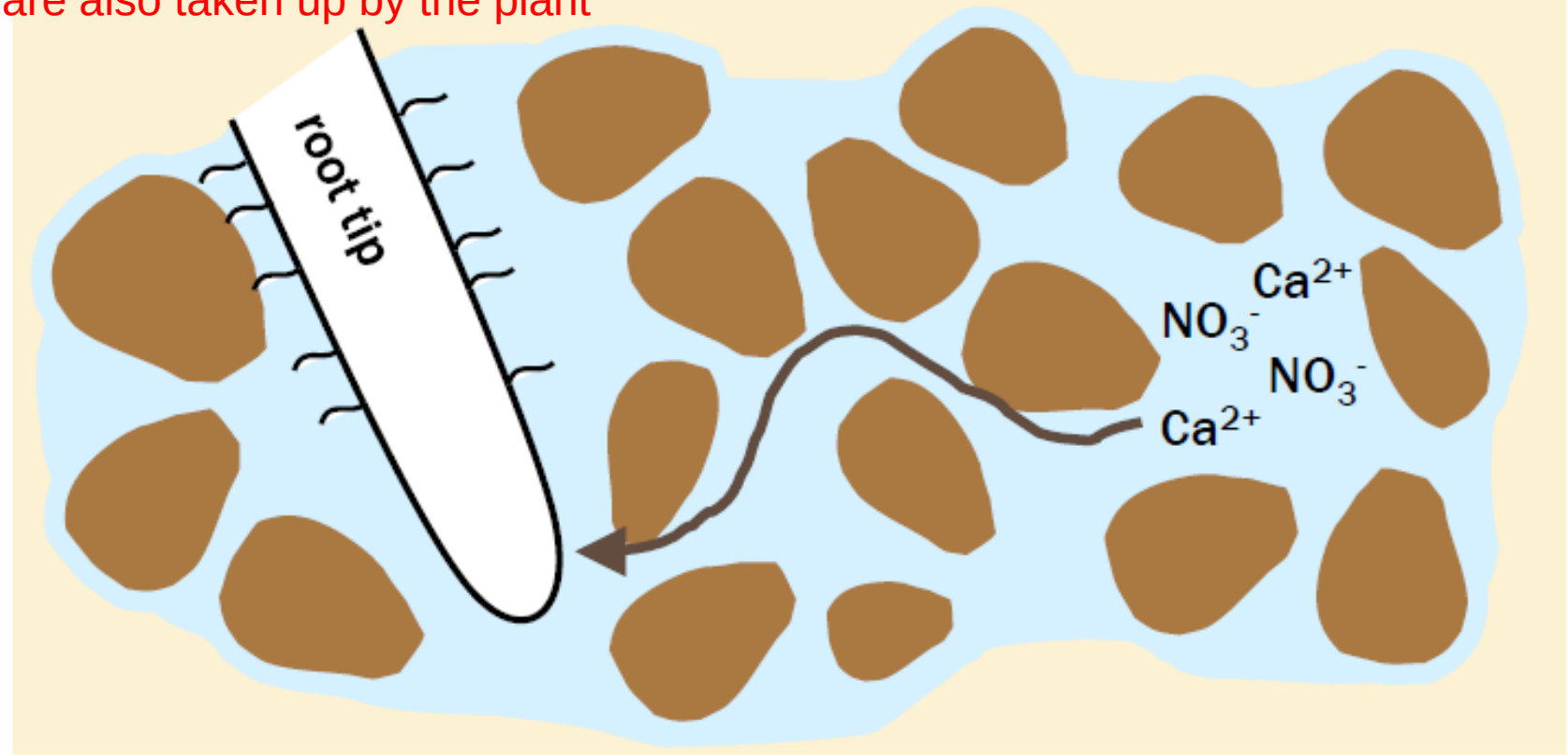
- roots contact ~1% of soil volume;
- mycorrhizal infection of root increase root-soil contact



Infection by mycorrhizae fungus in plant roots allows the plant to absorb greater amounts of some nutrients, especially phosphate. In return the plant gives the fungus carbohydrates

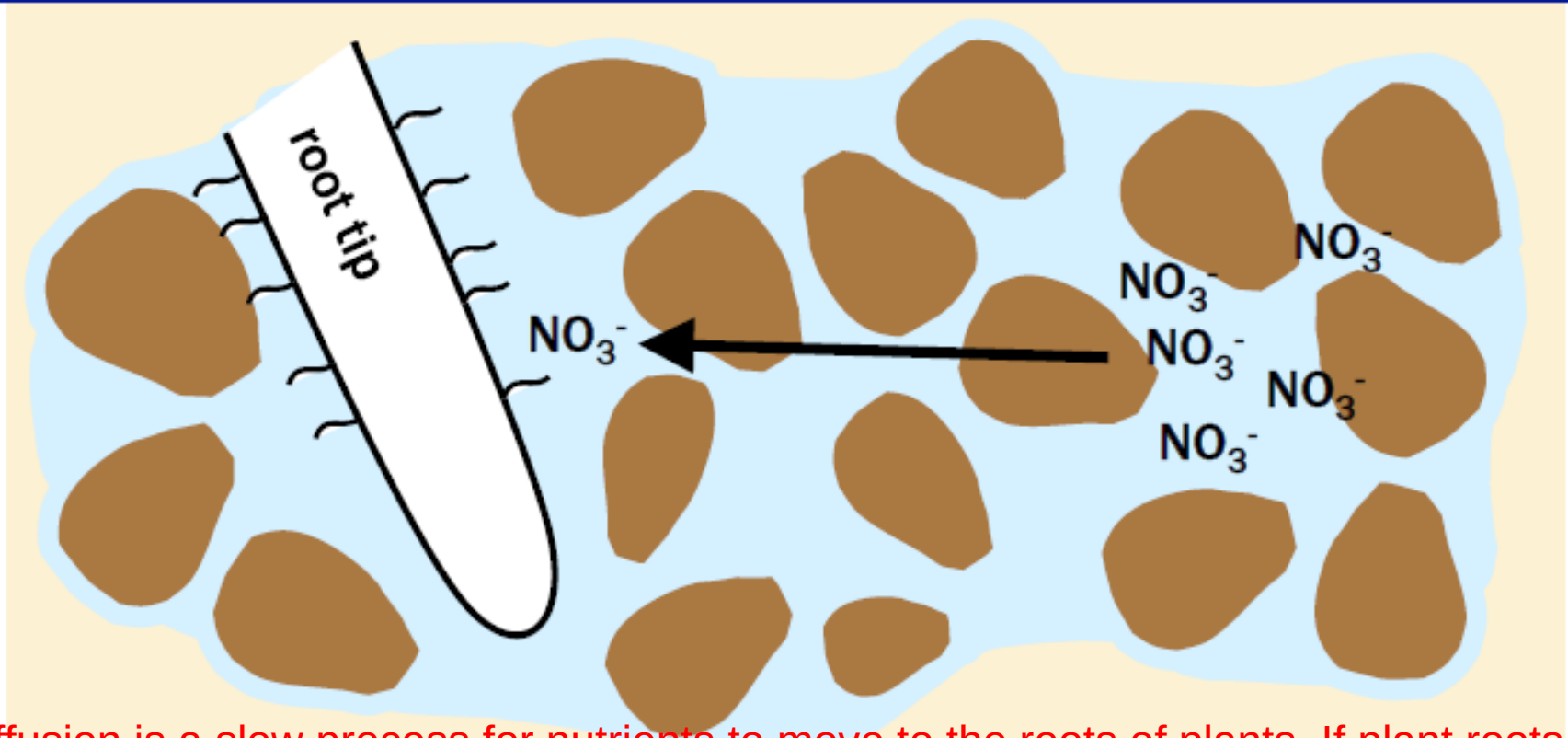
Mass flow – dissolved nutrients move to the root in soil water that is flowing towards the roots

Mass flow is the way most nutrients move to the plant's roots. As water is taken up by the plant the nutrients dissolved in the water come along for the ride and are also taken up by the plant



Diffusion – nutrients move from higher concentration in the bulk soil solution to lower concentration at the root;

-In the time it takes NO_3^- to diffuse 1 cm, K^+ diffuses 0.3 cm, and $H_2PO_4^-$ diffuses 0.05 cm



Diffusion is a slow process for nutrients to move to the roots of plants. If plant roots are not actively growing and 'searching' new soil areas for nutrients they can temporarily

PRINCIPAL WAYS IN WHICH IONS MOVE FROM SOIL TO THE ROOTS OF CORN

Nutrient	Amount of Nutrient Required for 150 bu/a of Corn (lb/a)	Amount of nutrient supplied by		
		Root Interception	Mass Flow	Diffusion
N	170	1	99	0
P	35	3	6	94
K	175	2	20	78
Ca	35	171	429	0
Mg	40	38	250	0
S	20	5	95	0

Barber, Soil Bionutrient Availability, (1984). Diffusion estimated be difference between total nutrient need and nutrient supply by root interception & mass flow.

This data is from corn roots, but the principle is the same for any plant roots. Most of our nutrient are moved via mass flow, except for…….

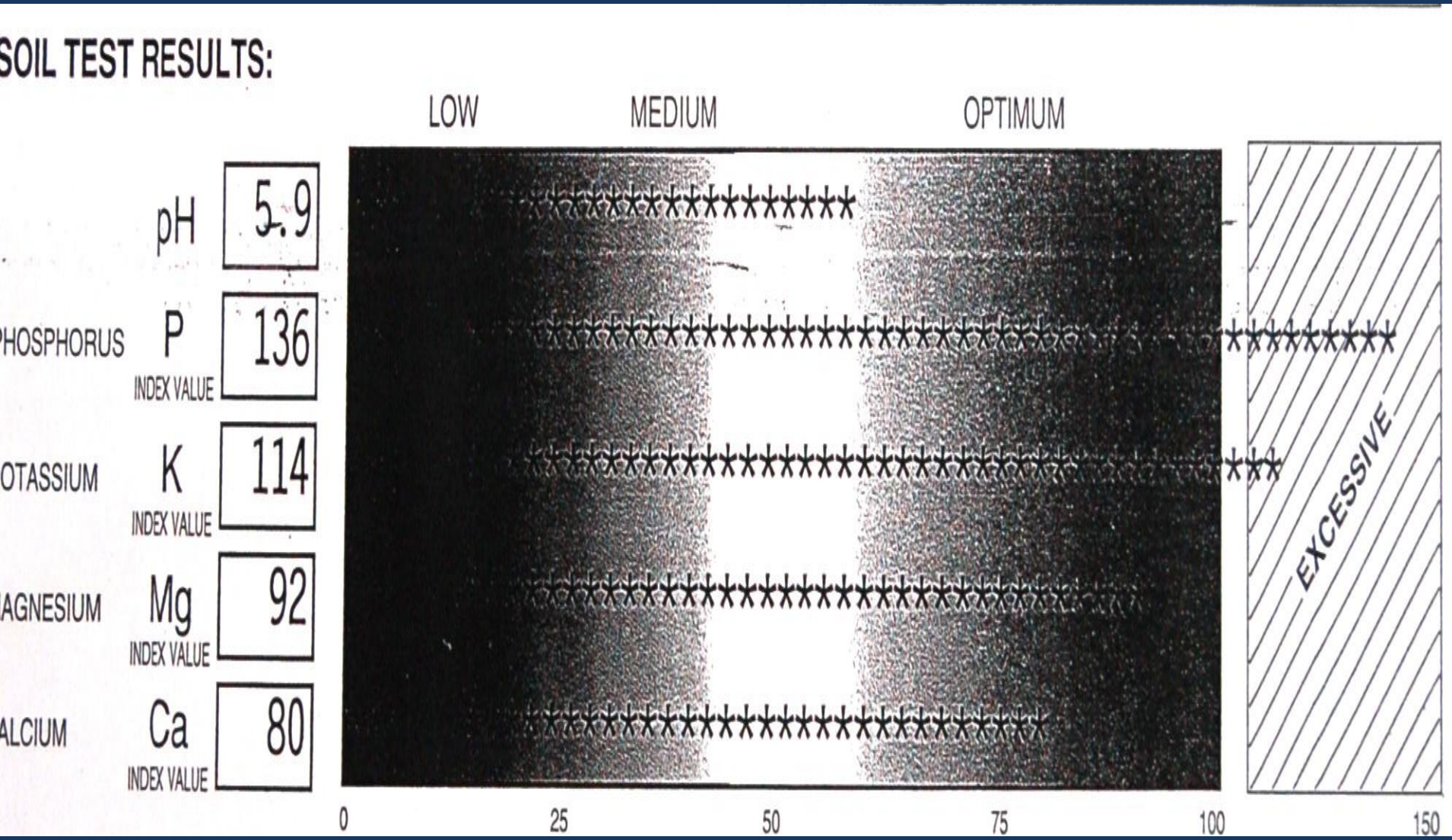
PRINCIPAL WAYS IN WHICH IONS MOVE FROM SOIL TO THE ROOTS OF CORN

Nutrient	Amount of Nutrient Required for 150 bu/a of Corn (lb/a)	Amount of nutrient supplied by		
		Root Interception	Mass Flow	Diffusion
N	170	1	99	0
P	35	3	6	94
K	175	2	20	78
Ca	35	171	429	0
Mg	40	38	250	0
S	20	5	95	0

Barber, Soil Bionutrient Availability, (1984). Diffusion estimated be difference between total nutrient need and nutrient supply by root interception & mass flow.

Phosphorous and Potassium are the only two macro nutrients that move by diffusion

What doe this mean for growers? Below is part of the results from a soil test that shows P and K are in the excessive range for this field going into tomatoes



Report Number: R09222-5003
Account Number: 27680

A&L EASTERN LABORATORIES, INC.

7621 Whitepine Road • Richmond, Virginia 23237 • (804) 743-9401
Fax No. (804) 271-6446

PLANT ANALYSIS

Submitted By: MIKE NEWELL
Copy To:
Sample ID: TOM-HT
Plant Type: TOMATO (FIELD)
Variety:

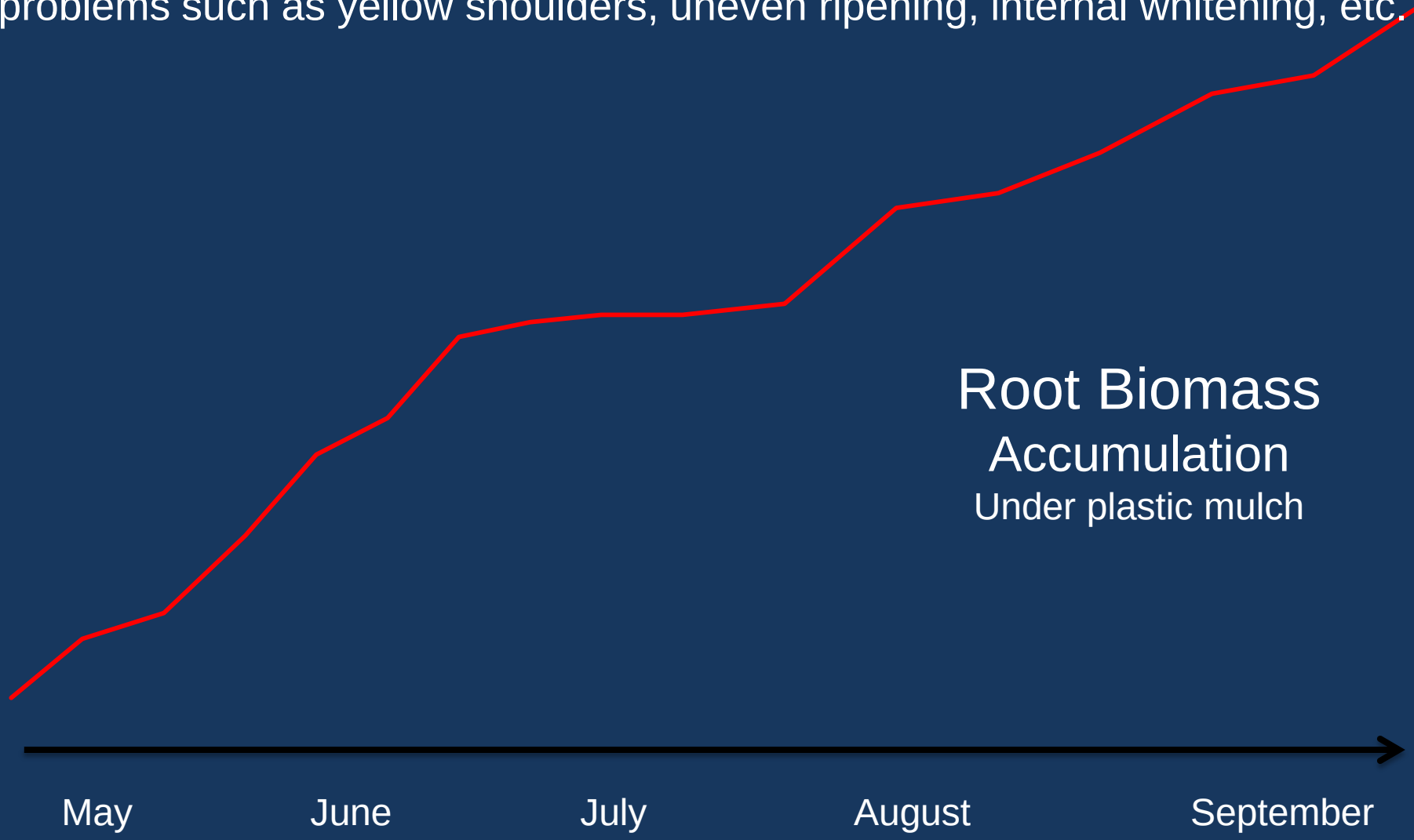
To: WYE RESEARCH/FIELD CROPS
POB 169
QUEENSTOWN, MD 21658

For: JERRY BRUST

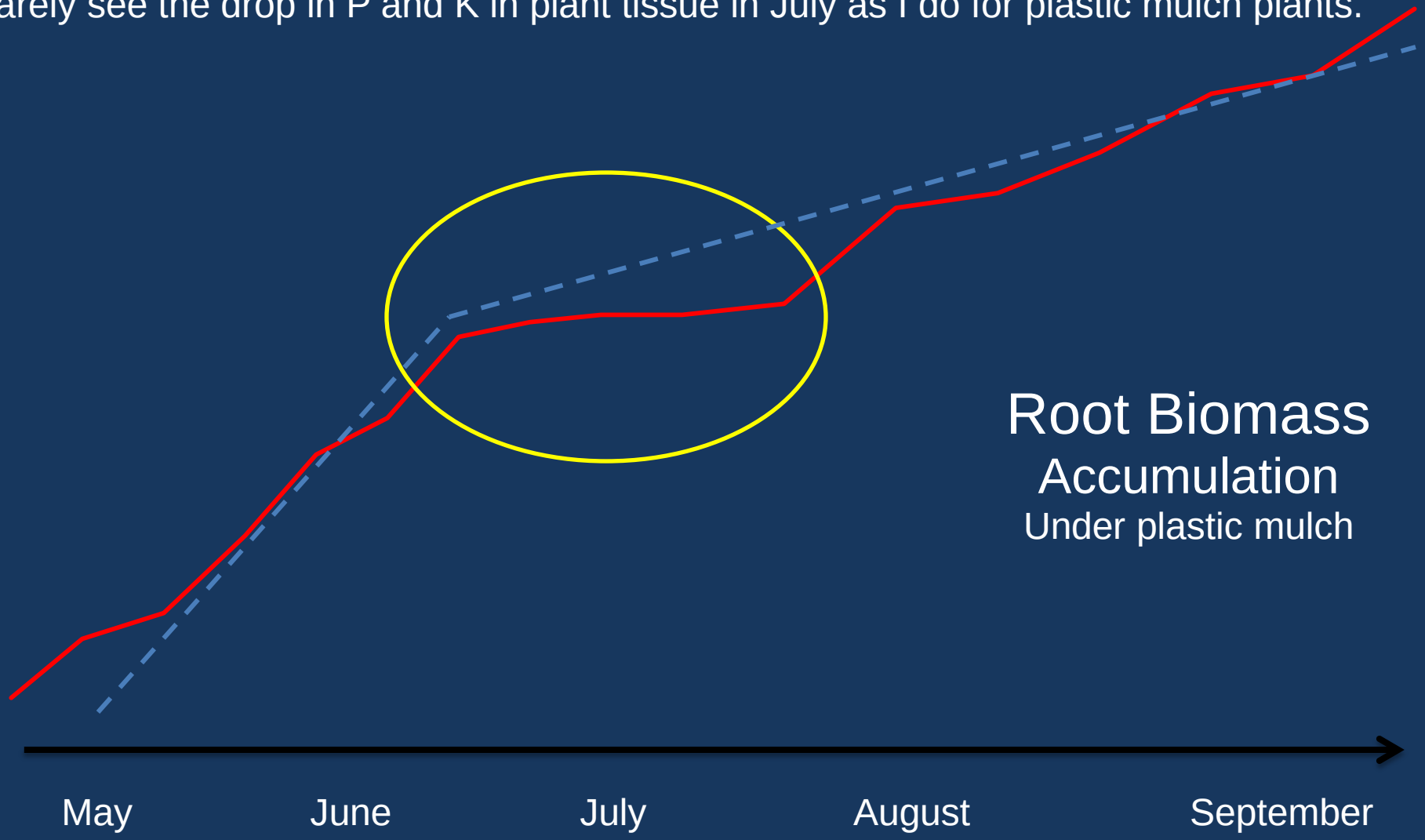
Date Sampled	Lab Number	Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Nitrate Nitrogen (ppm)	Molyb-denum (ppm)
	222017	4.04	0.69	0.22	2.19	0.77	4.57	0.11	88	25	103	104	14	21		
Normal Range		4.00 6.00	0.40 1.20	0.25 0.75	2.90 5.00	0.40 0.60	2.50 4.00	0.01 0.03	25 60	20 50	40 250	40 200	8 20	1 300		

Above are the results of a tissue test taken in July from the tomatoes from the same field the soil tests were taken from. They show there are only 2 nutrients that are deficient—P and K, Why? Tomato plant roots in July tend to not be growing to a great extent and are not contacting a great deal of new soil. So……

The plant quickly depletes the soil the roots are confined to of P and K and while P and K diffuse slowly towards the roots there is a temporary deficiency of these nutrients in the plant. Low K can especially cause fruit ripening problems such as yellow shoulders, uneven ripening, internal whitening, etc.



Under black plastic mulch there is a slow down of root biomass accumulation in July because of very high temperatures on the black plastic and roots. I do not see this great of a slow-down in biomass accumulation in a no-till field (blue line). Consequently I rarely see the drop in P and K in plant tissue in July as I do for plastic mulch plants.



Average tomato leaf tissue analysis needed at the time of fruit production

%

N	P	K	Mg	S	Ca
4-6	0.5-1	3.5-5.5	0.5-1	0.5-1	2-4

ppm

Mn	Fe	Zn	Na	B
50-200	60-250	25-120	100-400	25-75

Important Ratios of nutrients needed in leaf tissue

N:K ~ 1

K:Mg ~ 4-7

K:Ca ~ 2-3

N:S ~ 6-8

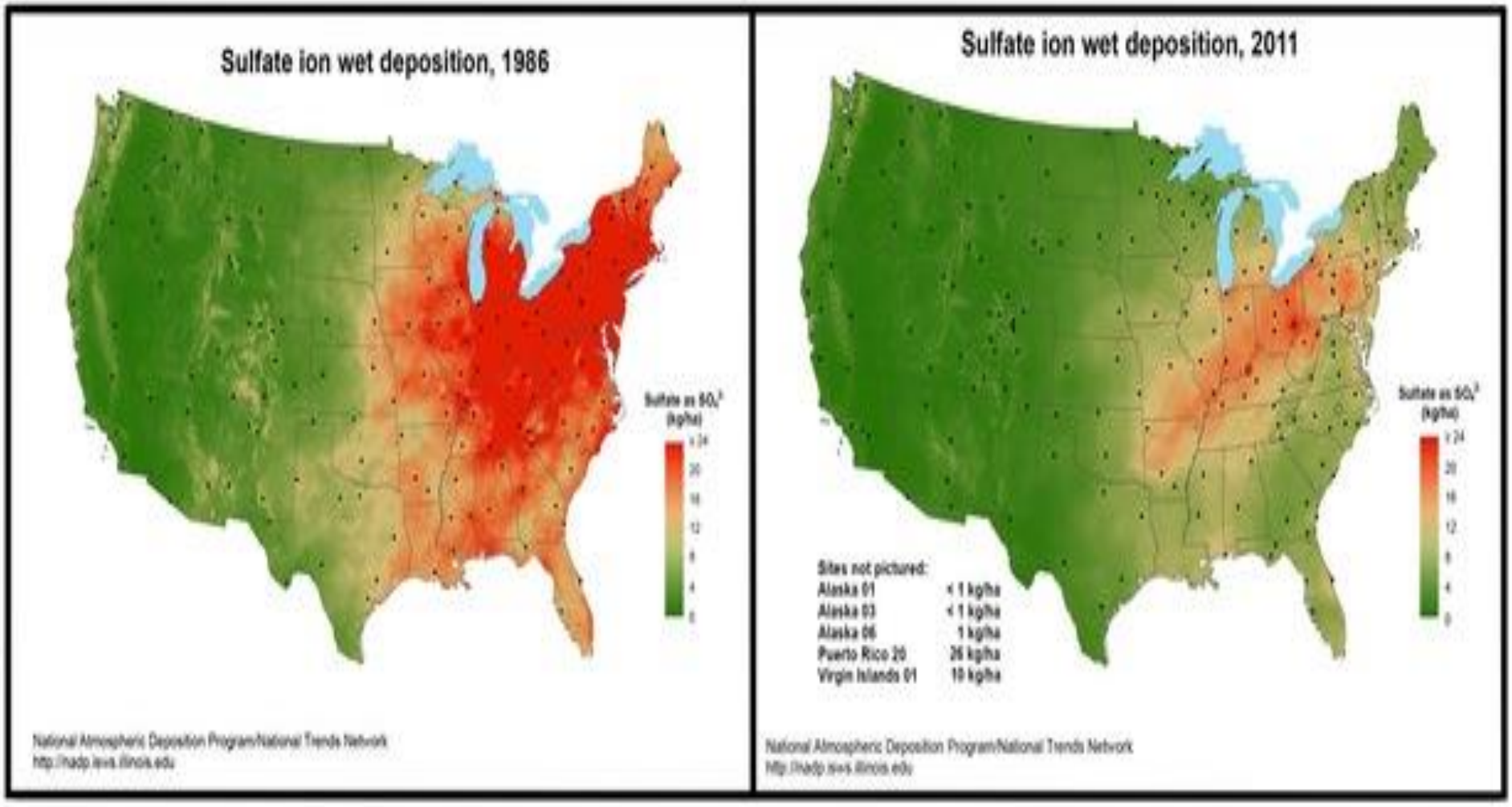
P:S ~ 1

Ca:Mg ~ 3-6

It is ‘easy’ to get the ratios out of whack if a grower is not careful. Some growers add too much nitrogen to plants that are fruiting and when K levels drop this causes a much too high a ratio of 3 or 4 for N:K that should be around 1. By adding too much dolomitic lime you can screw-up the K:Mg ratio, causing poor fruit quality. And finally some growers add too much Ca to their soils causing a very low ratio between K and Ca. As long as soil tests show Ca levels are good or even adequate that is enough calcium for a good crop of tomatoes. Good irrigation practices are the most important factor in eliminating blossom end rot problems.

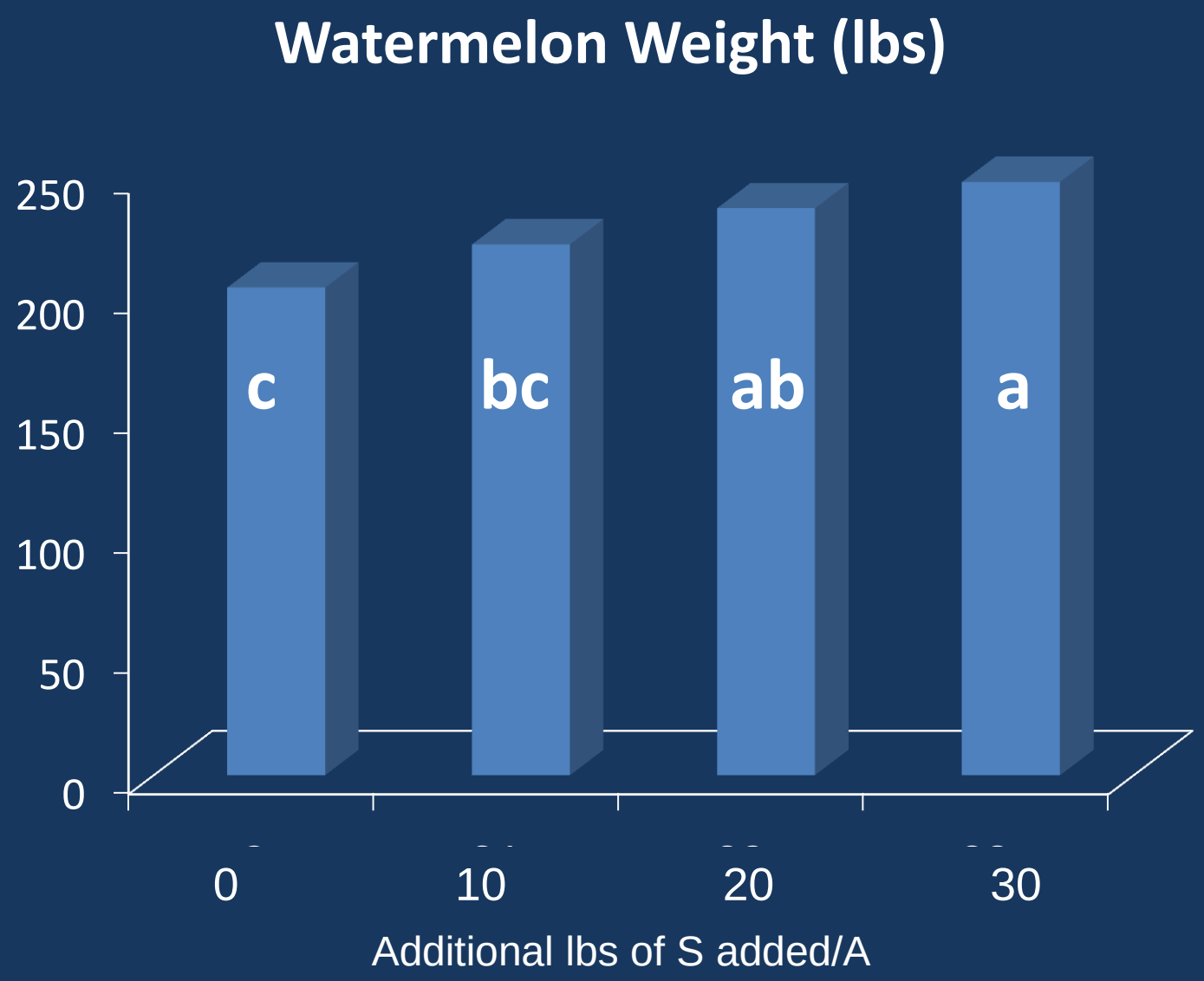
The map shows sulfur (S) deposition in the form of acid rain in our environment over the last 30 years. As you can see we have made great strides in reducing acid rain—which is a good thing. But growers need to be aware of this that we are NOT getting our free influx of S like we used to do.

The maps show reduced levels of sulfate sulfur deposited in rainwater for 1986 vs 2011.




To test whether or not watermelons were getting enough S a trial was conducted

The field was brought up to recommended S levels (~20 lbs/A) determined by soil tests and then an additional 10, 20 and 30 lbs of S were added. As you can see the addition of 20 or 30 additional pounds/A of sulfur increased yields significantly. ^{o}Brix readings were slightly greater in the higher S additions, but not significantly so.



Applying nutrients through the drip

“Fertigation grade" and "Greenhouse grade" standards. (The latter is more demanding in terms of purity, solubility, and reduced insoluble matter rates.)
The products included in these groups are highly soluble, low in insoluble ingredients, practically free of deleterious ingredients, such as chloride, sodium, heavy metals, and perchlorates.

Micronutrients

STEM – soluble trace element mix

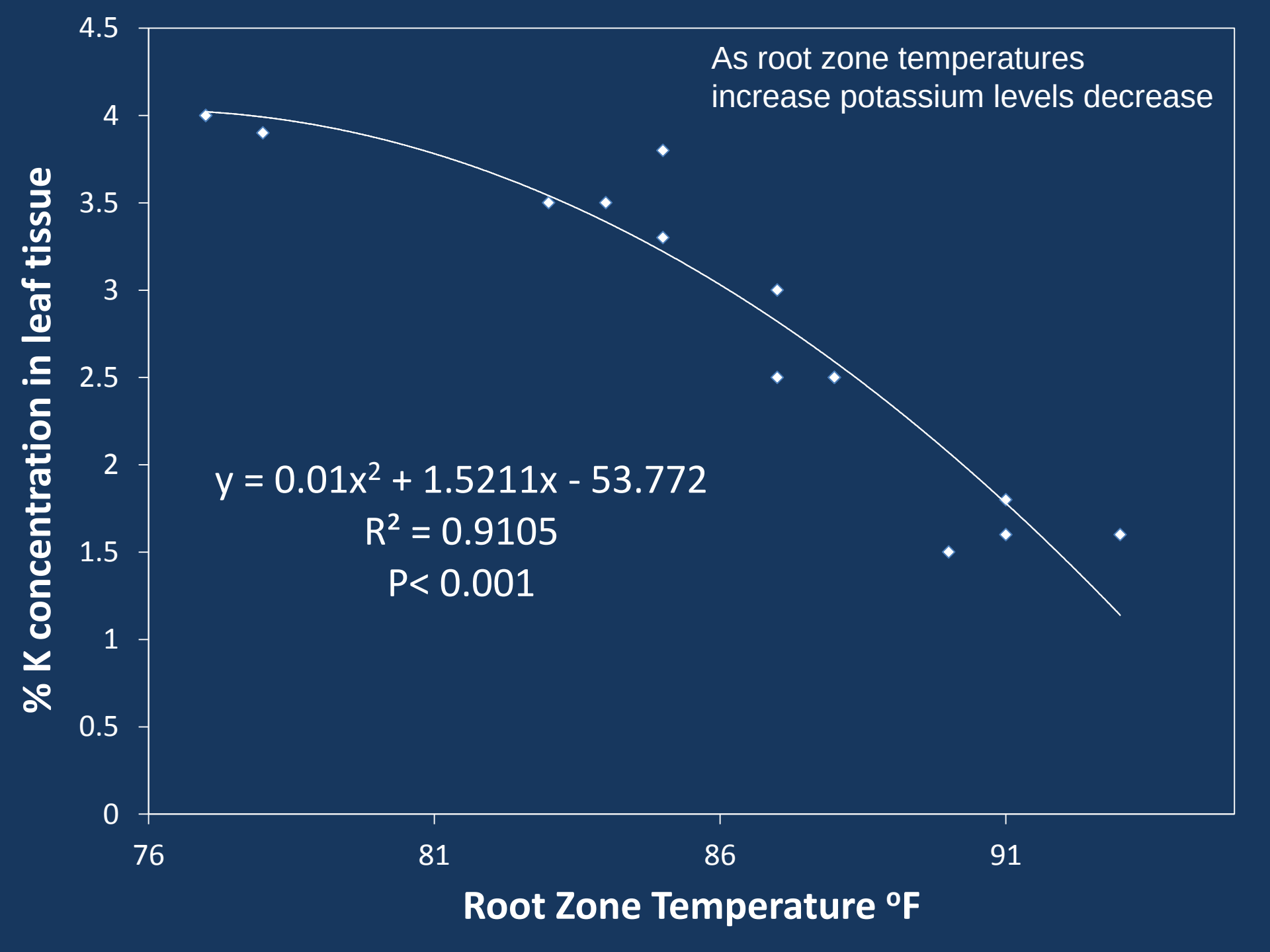
Chelated micronutrients are more soluble and penetrate into the leaf more quickly

Boron can be a little low in tomatoes at times and can be applied at planting to soil as borax, or to foliage as solubor.

Some studies show that applying micronutrients improves fruit quality

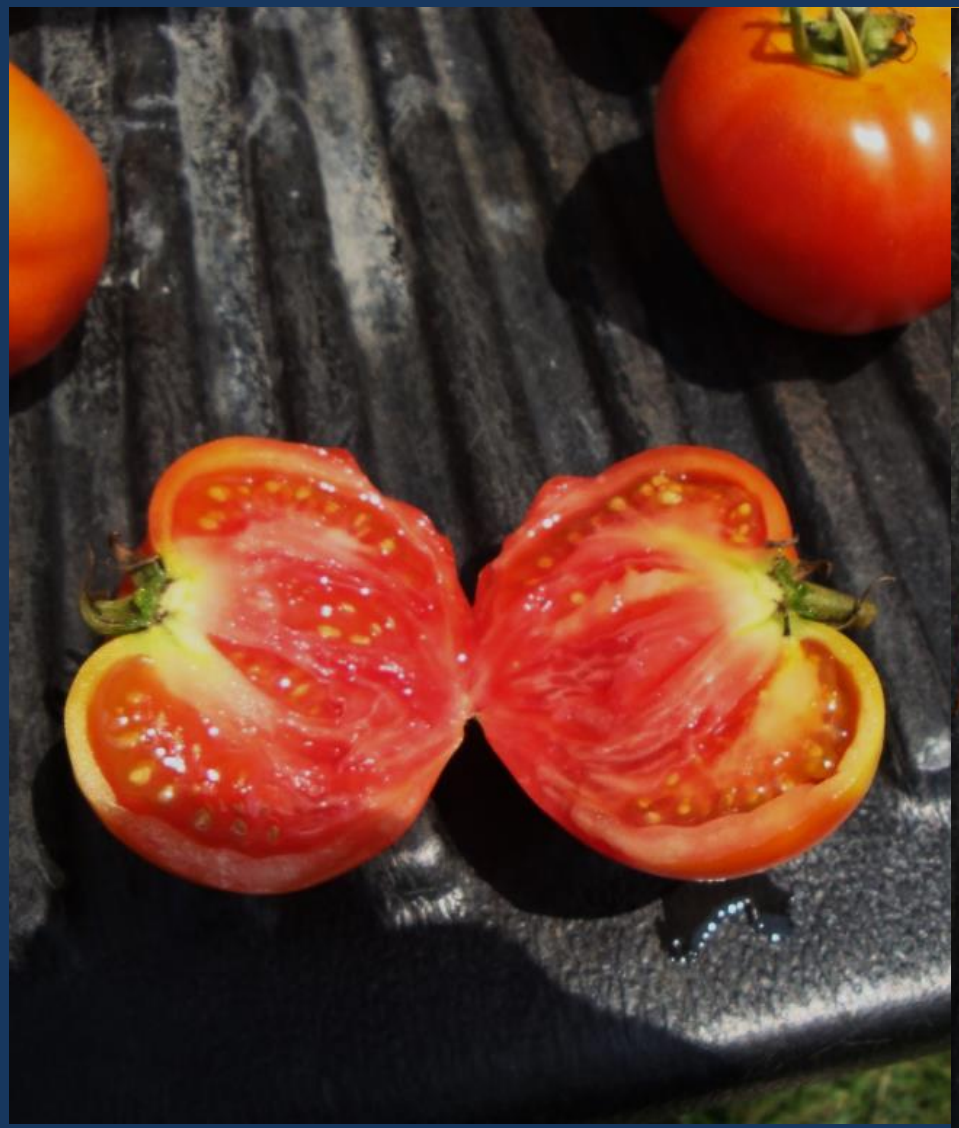
Tomatoes and Potassium

again


As root zone temperatures increase potassium levels decrease
y = 0.01x² + 1.5211x - 53.772
R² = 0.9105
P< 0.001
% K concentration in leaf tissue
Root Zone Temperature ºF
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
76
81
86
91

Tomatoes on the left were from plots that had extra K added to them through the drip during the season. the tomatoes on the right side did not have any additional K added through the drip tape.

Cut open tomato on left had extra K added through the drip during the season. The cut open tomato on the right did not have extra K. Both tomatoes looked nice and red before being cut open. Low levels of K can cause this ‘internal whitening’ even when the outside of the tomato is red.

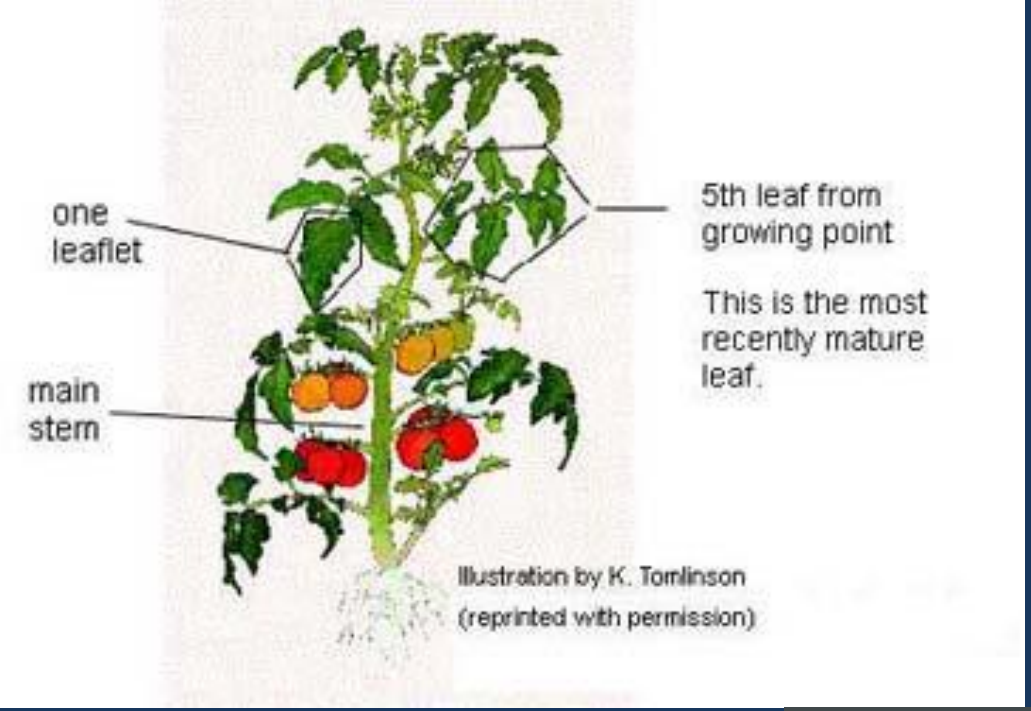


Soil tests are important, but tissue tests are even more so—they tell you what is going on NOW inside your plant

The best time to collect samples is between mid-morning and mid-afternoon.

Nitrate nitrogen varies with time of day and prevailing conditions but generally not enough to alter interpretation.

Keep samples dry and free of soil and other contaminants that can alter results



Sample first fully mature leaf, which is the 4th or 5th leaf from top

Place ~15-20 leaves in a paper envelope and send in another paper envelope.
No Plastic

Before flowering use a: 20-20-20 or 10-10-10

At flowering use a : 10-15-30 or 5-10-30
If soil tests show excessive levels of P: 10-0-25

You will lose 80% of the potassium in the
0-6 inch level of soil by the end of the season

Tissue test at first flower and “every 2-6 weeks”

EC for tomatoes should be 0-3 dS/m

Tomatoes can tolerate an EC reading up to
6-8 dS/m, but will suffer somewhat

Biostimulents

In the late 1960s, Dr. T.L. Senn at Clemson University found that high levels of natural plant hormones in seaweed, called cytokinin, stimulated plants, providing a growth stimulator effect.

Stimplex, Greenstim, many others

Biostimulents and crop responses: a review
2014

Percentage of watermelon (*Crimson Sweet*) plants killed by fusarium root rot disease in seaweed and non-seaweed treatments at CMREC in 2008

	Date		
Treatment	July 7	July 14	July 21
No seaweed	20.6 a	27.3 a	30.2 a
Stimplex	5.4 b	7.6 b	10.1 b

Means within a column with different letters are significantly different at the $P \leq 0.05$ level

Stimplex is a biostimulent I have worked with for many years and it usually, but not always produces significantly better crops (depending on what I am looking at) compared to the same crop that I did not use it on.

Watermelon Yields (weight (lbs) and numbers of fruit) in Stimplex Treated and Control Plots

Treatment	Pounds of Watermelon [1]	
	LESREC	CMREC
100 lbs	201.4 a	263.8 a
150 lbs	257.1 b	304.2 b
100+ Stimplex	259.7 b	297.3 ab
150+ Stimplex	316.3 c	345.9 c

[1]Means with different letters within a column are significantly different from one another at the P< 0.05 level, orthogonal contrasts

Soil disease and nutritional additive study

- *Phytophthora* and *Fusarium* both found in field
- Field out of cucurbit production for 3 years
- Corn-soybean-corn rotation
- Grew *Gladiator* pumpkins with and without silicon and Stimplex additives
- Calcium magnesium silicate slag used- 3,000lbs/A
- Products called AgrowSil™ or Excellerator™

Severity of fusarium wilt problem in this field

Soil disease study-loss of plants

Silicon	Stimplex	% dead plants	
		August	Sept
-	-	18.3a	24.6a
+	-	15.6ab	19.2ab
-	+	9.5b	13.6b
+	+	4.2c	6.1c

Means within a column with different letters are significantly different at the P≤ 0.05 level

By adding silicon at a high rate and Stimplex I was able to significantly reduce the severity of fusarium wilt in this field compared to either alone or using neither.

Soil disease study-Yields

Silicon	Stimplex	Pumpkin Yield
-	-	265.8 a
+	-	291.6 ab
-	+	357.7 b
+	+	485.4 c

Means with different letters are significantly different at the P≤ 0.05 level

Not surprisingly yields were much greater in areas with lower levels of plants being killed by fusarium wilt. Stimplex by itself reduced fusarium wilt problems and significantly increased yields, but when combined with silicon synergistically increased yields.

Questions

UNIVERSITY OF MARYLAND EXTENSION
Solutions in your community

jbrust@umd.edu

http://extension.umd.edu/mdvegetables