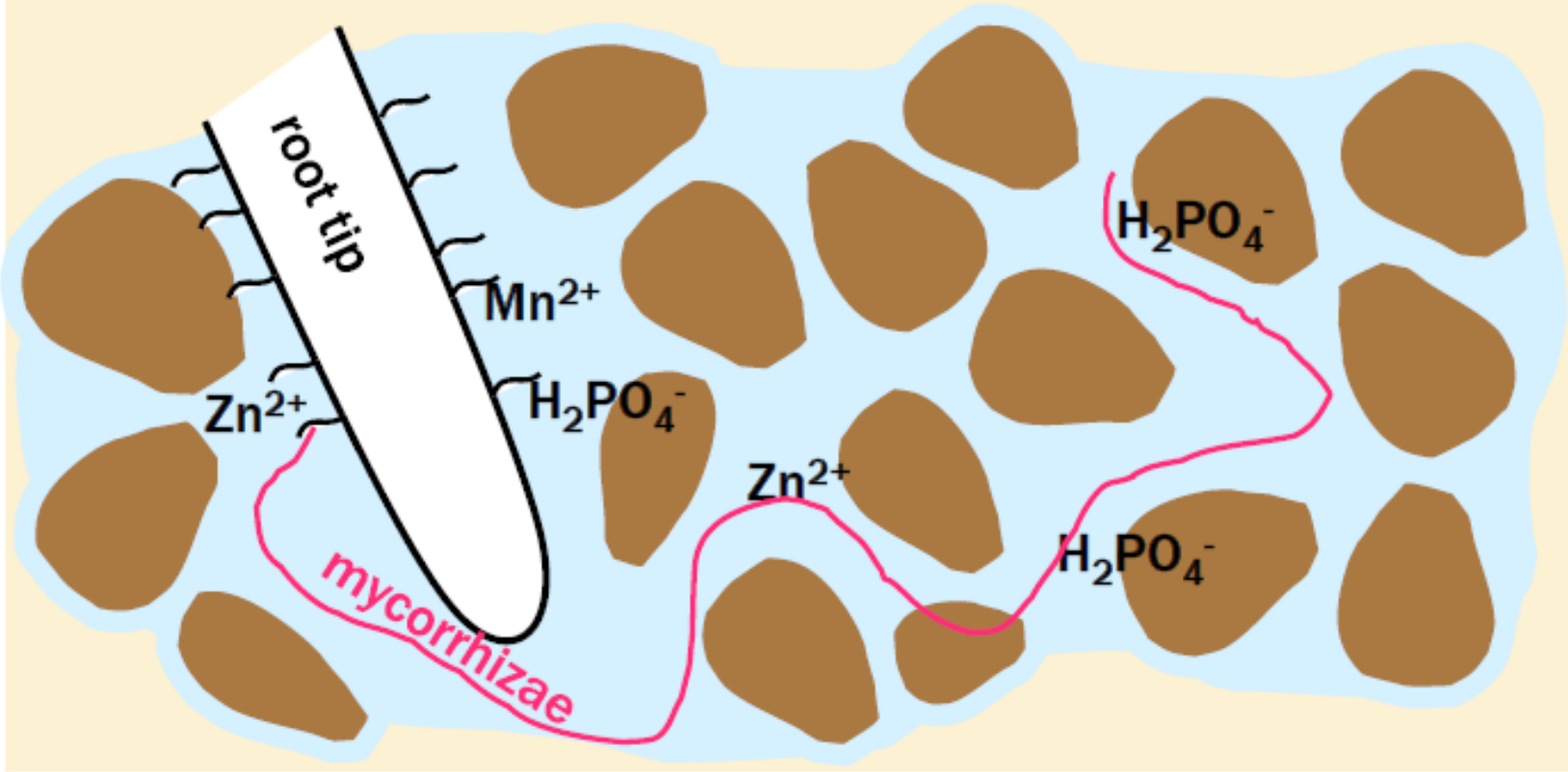
Nutrient Problems and Their Management in Tomatoes

pH best at 6.0-6.5 for best quality tomato fruit, if greater than 6.5 could have problems taking up potassium

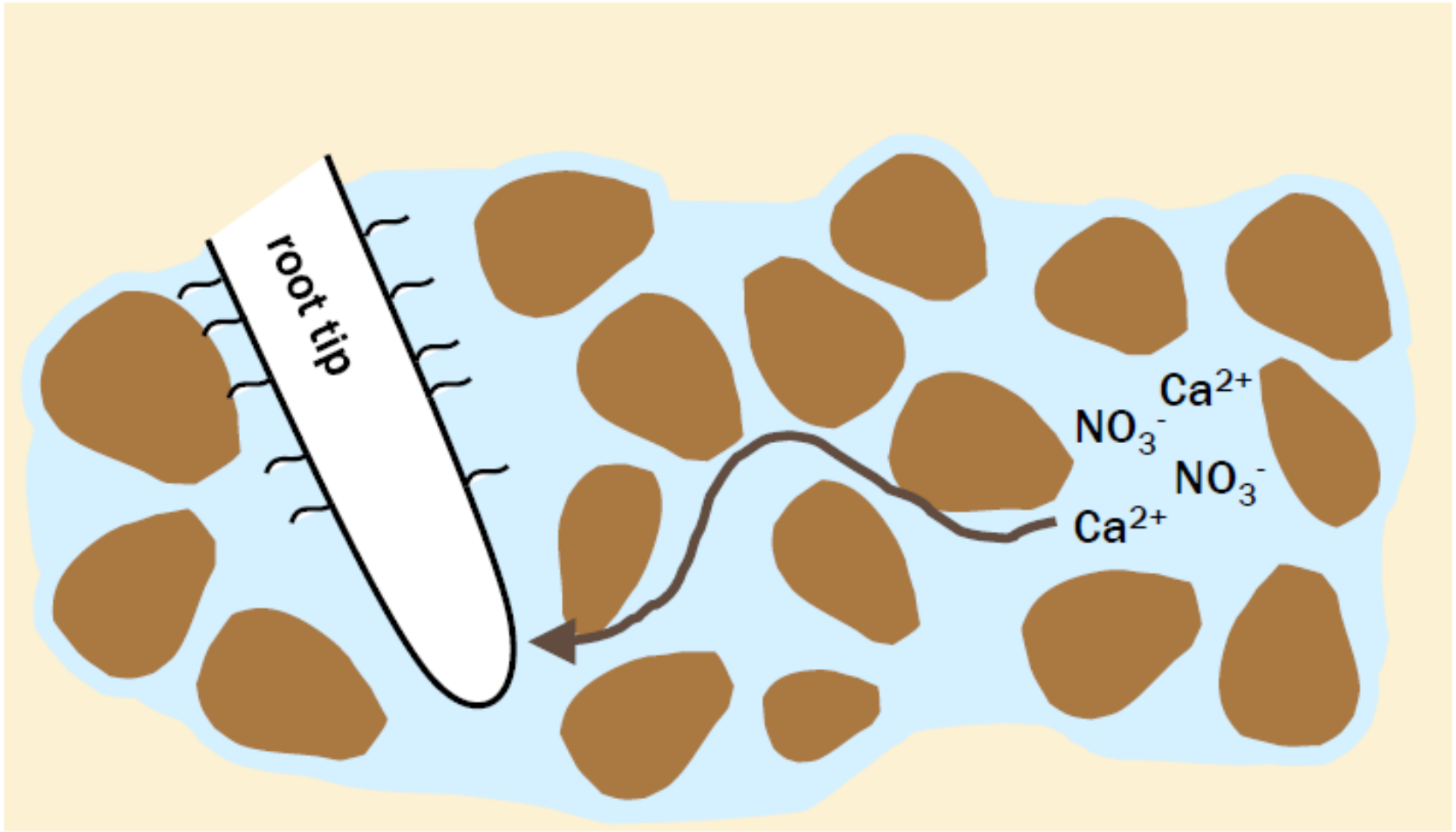
If using dolomitic limestone, be sure Mg levels do not become too great

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

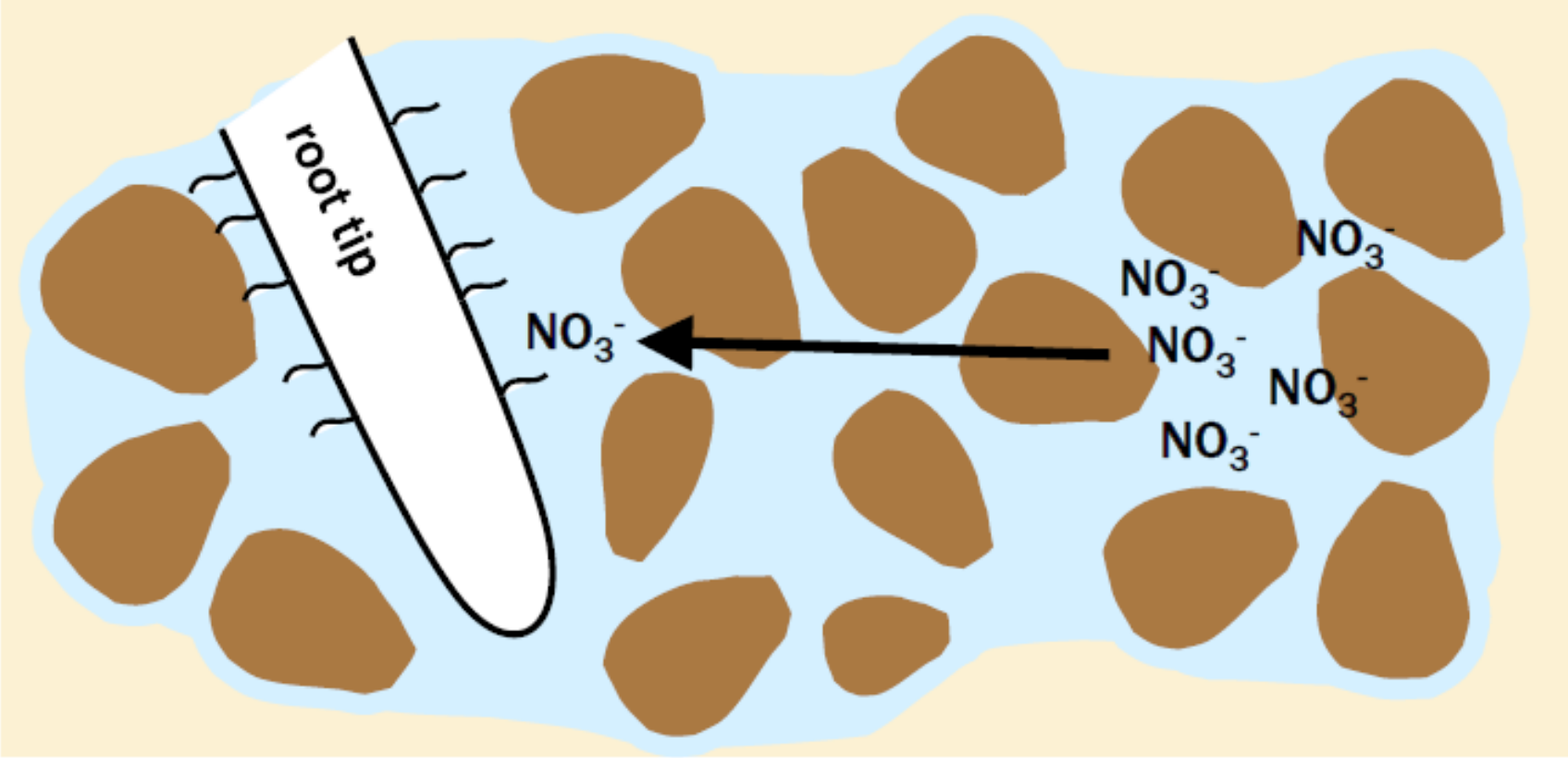


Mass flow – dissolved nutrients move to the root in soil water that is flowing towards the roots



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



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)	Percentage (%) 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.

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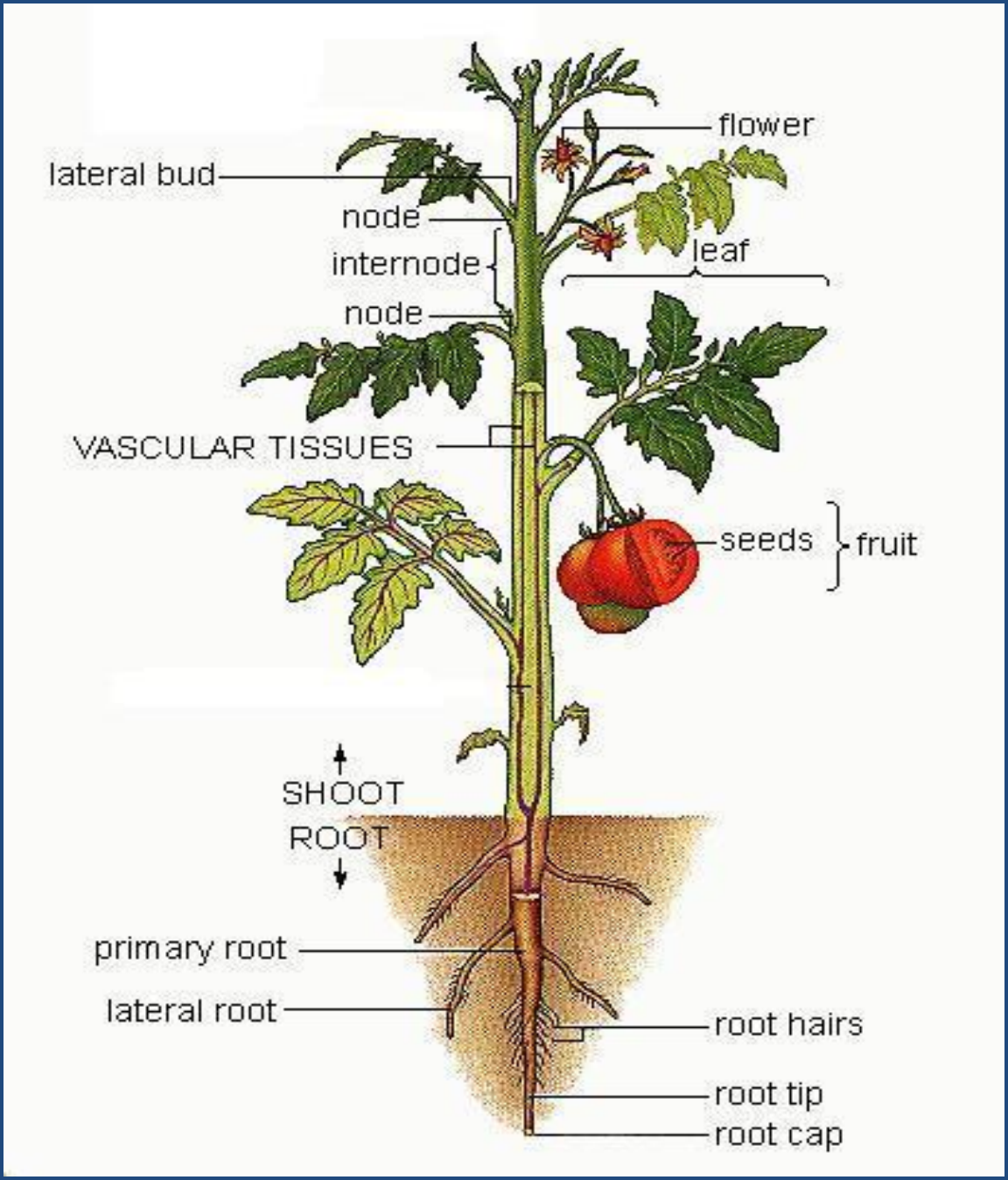
Blossom end rot



Calcium moves into and up through the plant in the water stream. Anything that disrupts the stream as the tomato is sizing will cause a slight decrease in the Ca levels in the tomato fruit causing blossom end rot



From the time the tomato fruit is fertilized until it is the size of a quarter, it will need an uninterrupted flow of calcium (water) to that fruit if blossom end rot is not to develop. Poor watering techniques cause most blossom end rot problems, NOT a lack of calcium in the soil.

Different symptoms of blossom end rot

Best management guidelines

A steady supply of water through the plant is one of the best management practices to stop blossom end rot

Soils need to have a % base saturation of Ca of 55-70%

Soil (2,000-4,500 ppm) and tissue (2-5%) tests should show a moderate to high level of Ca

Other common fruit ripening problems of tomato have been appearing more frequently in the last 4-5 years throughout Maryland and states north of us

Yellow shoulders

Uneven Ripening

Blotchy Ripening

Different levels of yellow shoulders

Research over the last 4 years took place in the field and in high tunnels throughout Maryland

Soil and tissue samples were taken from several high tunnels and fields with fruit ripening problems scattered across the state

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

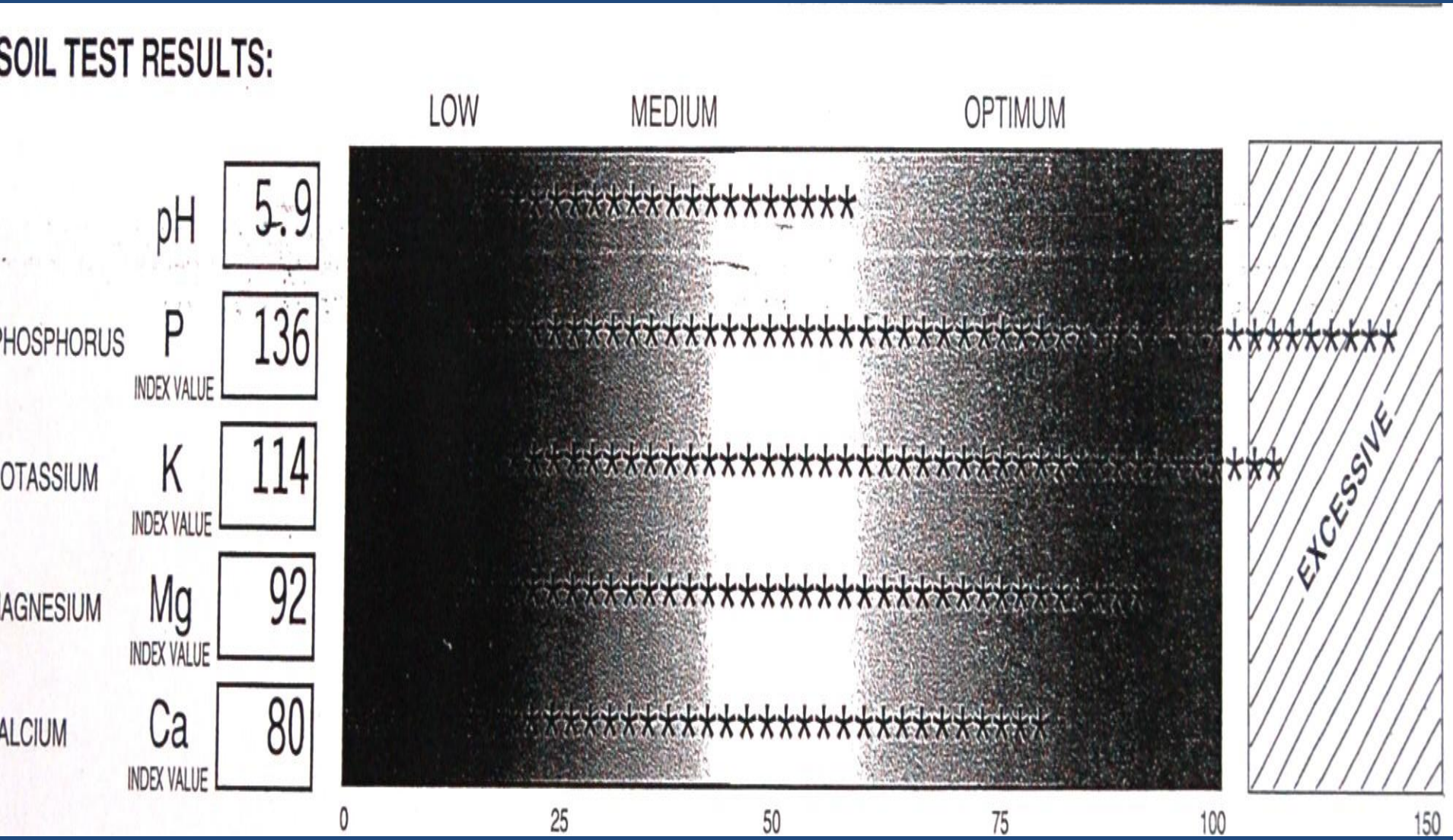
PLANT ANALYSIS

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

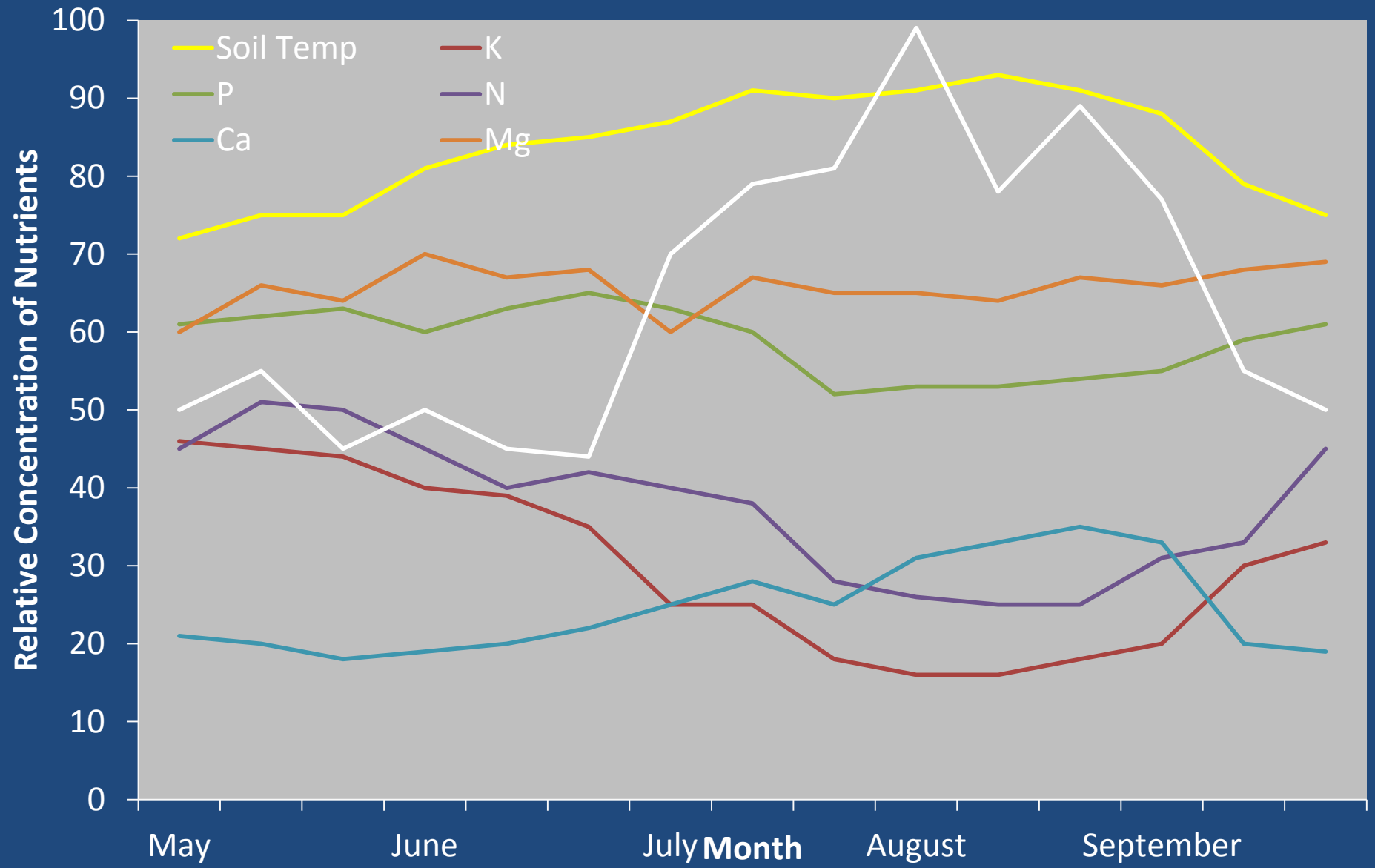
To: WYE RESEARCH/FIELD CROPS
POB 169
QUEENSTOWN, MD 21658

For: JERRY BRUST

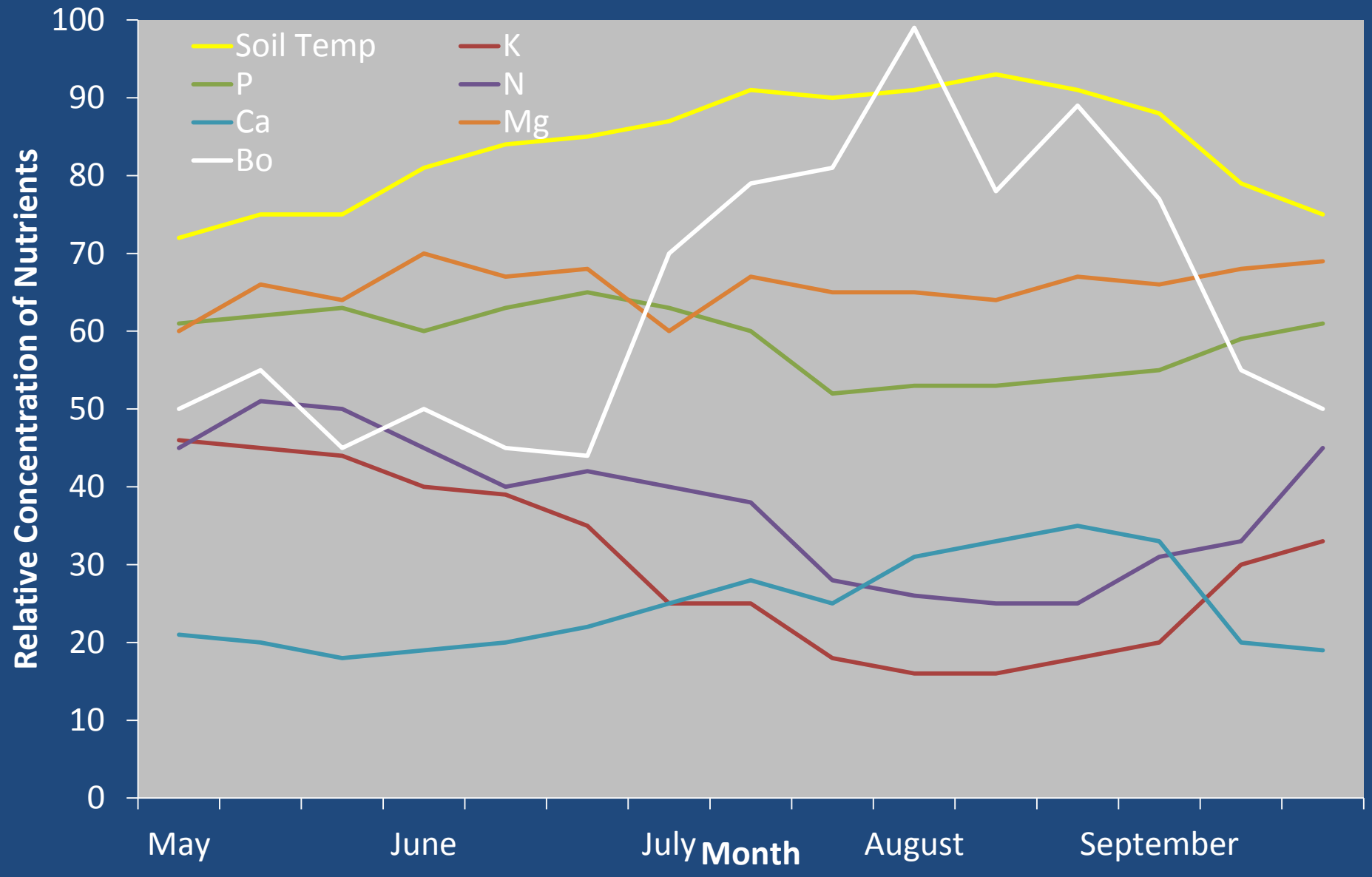
Date Sampled	Lab Number	Nitrogen (%)	Sulfur (%)	Phosphorus (%)	Potassium (%)	Magnesium (%)	Calcium (%)	Sodium (%)	Boron (ppm)	Zinc (ppm)	Manganese (ppm)	Iron (ppm)	Copper (ppm)	Aluminum (ppm)	Nitrate Nitrogen (ppm)	Molyb-denum (ppm)
	222017	4.04	0.69	0.22	2.19	0.77	4.57	0.11	88	25	103	104	14	21		
Normal 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		


SOIL TEST RESULTS:
LOW
MEDIUM
OPTIMUM
pH
5.9
PHOSPHORUS
P
INDEX VALUE
136
POTASSIUM
K
INDEX VALUE
114
MAGNESIUM
Mg
INDEX VALUE
92
CALCIUM
Ca
INDEX VALUE
80
EXCESSIVE
0
25
50
75
100
150

Soil analyses showed that potassium (K) was at excessive levels in the soil at the time of fruit ripening problems, but tissue tests consistently showed a drop in K and to a lesser extent Nitrogen throughout the growing season.



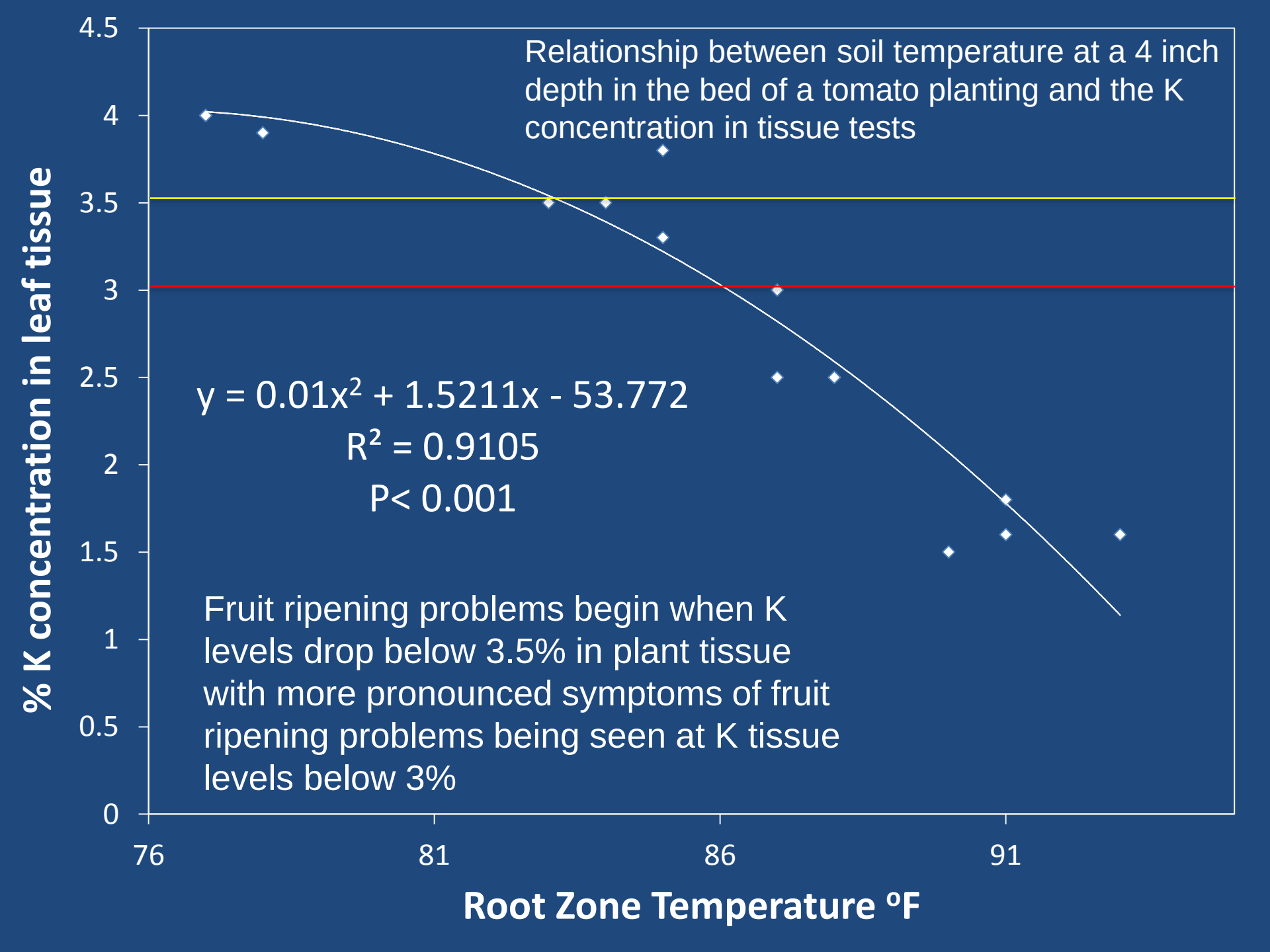
Relationship between soil temperature and nutrient concentration in leaf tissue of tomato, as soil temperatures increased, K levels dropped

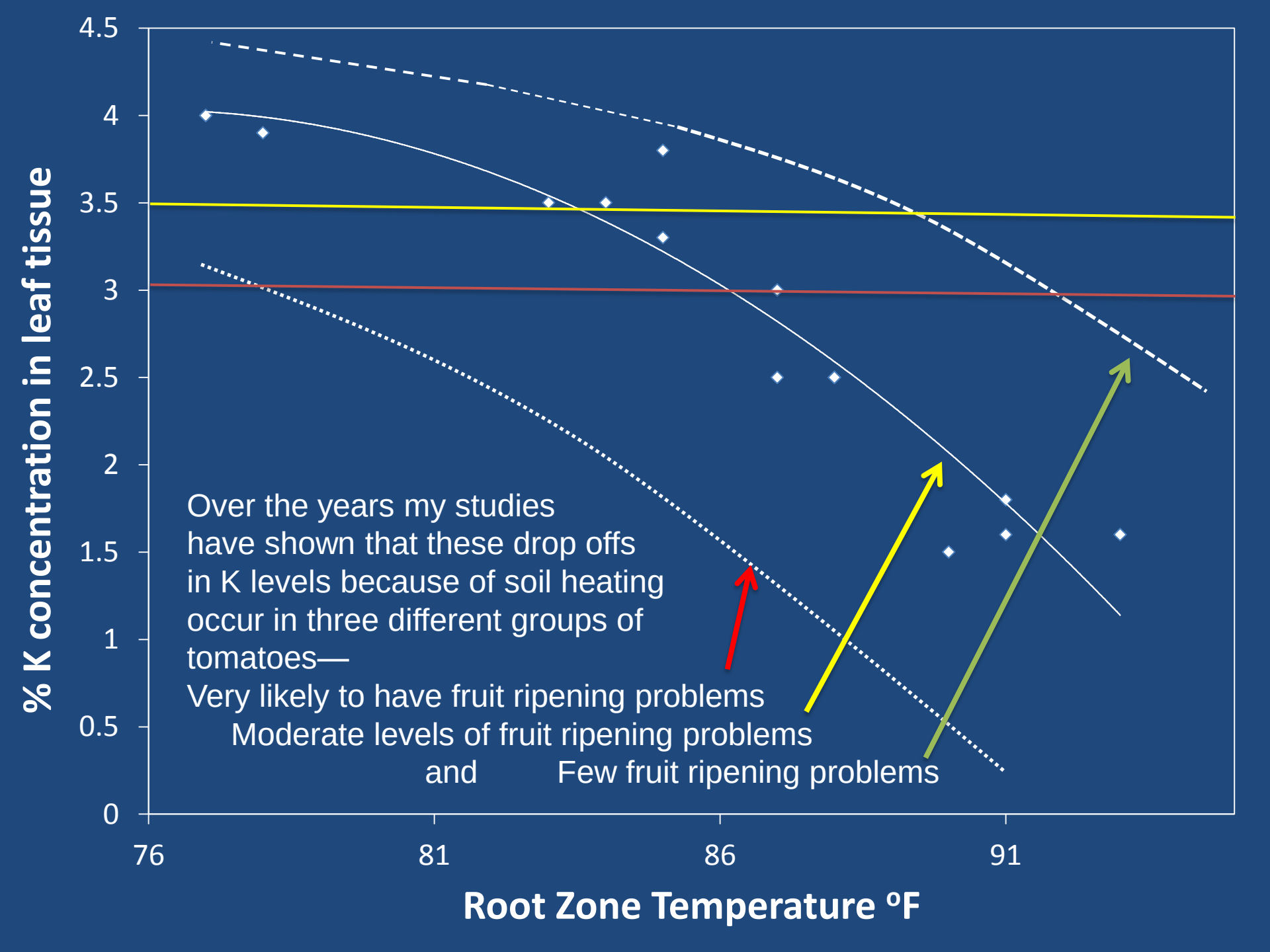


What could cause a reduction in K+ in the plant when there was plenty in the soil?

• Inadequate moisture or a poor tomato root system and slow K+ movement in the soil resulted in a plant that could not take up the proper amount of K+

• Plants with roots that are concentrated in the top 6-8 inches of soil with an average plant canopy can expose black plastic to the sun and raise soil temperatures to the point where K+ uptake is reduced enough to cause ripening problems.


Relationship between soil temperature at a 4 inch depth in the bed of a tomato planting and the K concentration in tissue tests
y = 0.01x² + 1.5211x - 53.772
R² = 0.9105
P< 0.001
Fruit ripening problems begin when K levels drop below 3.5% in plant tissue with more pronounced symptoms of fruit ripening problems being seen at K tissue levels below 3%
% K concentration in leaf tissue
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
76
81
86
91
Root Zone Temperature ºF


% K concentration in leaf tissue
4.5
4
3.5
3
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2
1.5
1
0.5
0
76
81
86
91
Root Zone Temperature ºF
Over the years my studies
have shown that these drop offs
in K levels because of soil heating
occur in three different groups of
tomatoes—
Very likely to have fruit ripening problems
Moderate levels of fruit ripening problems
and
Few fruit ripening problems

Potassium trials

Potassium Treatments

Foliar Sprays:

1. K (Greenstim 2-8-14)
2. K (Nutri-K 7-6-16)
3. K (xltret319)
4. Ca (Nutri-Cal 8% Ca)

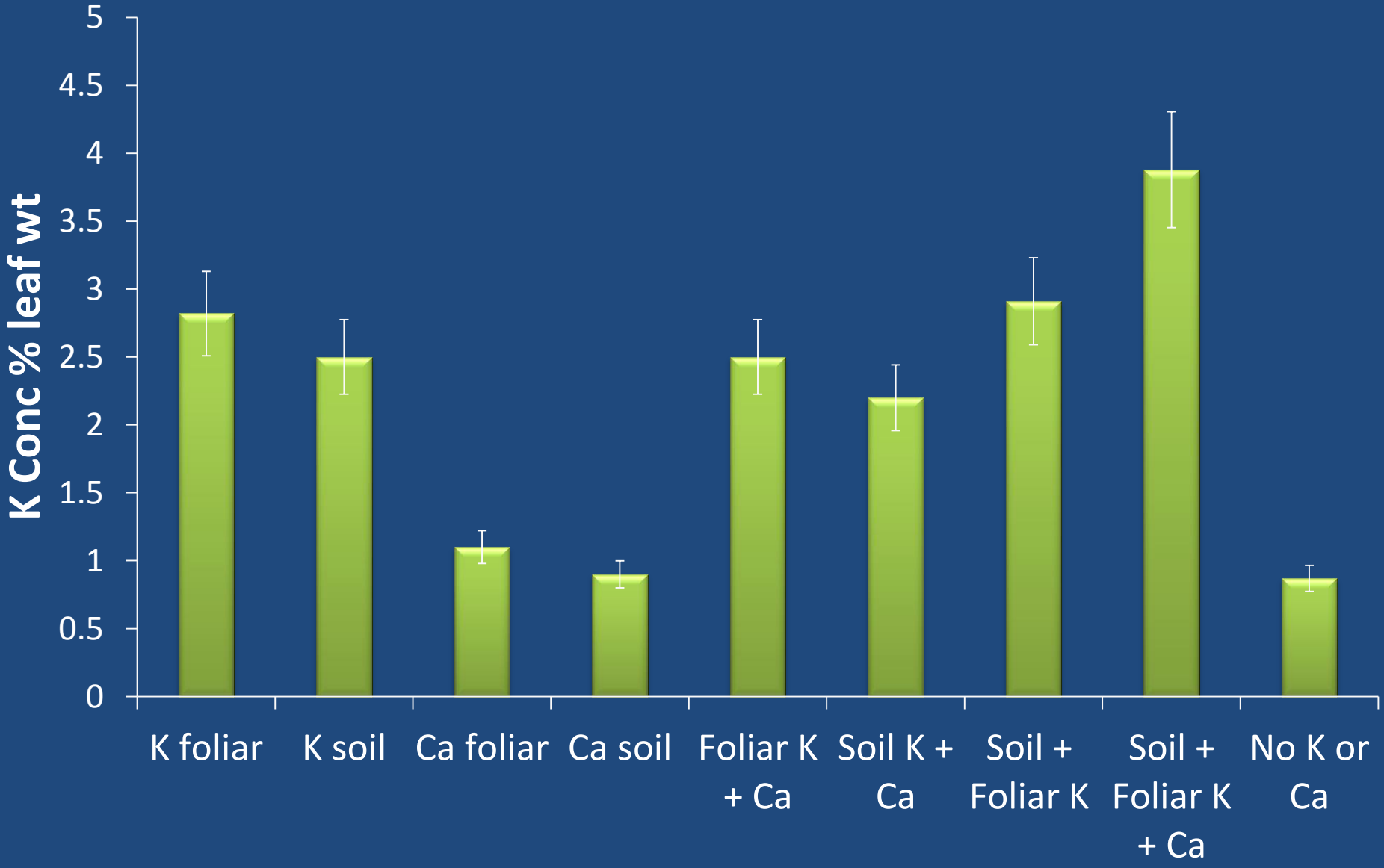
Soil Applications:

5. K (K 500lbs)
6. Ca (Ca-nitrate)

K-Soil and Foliar combos:

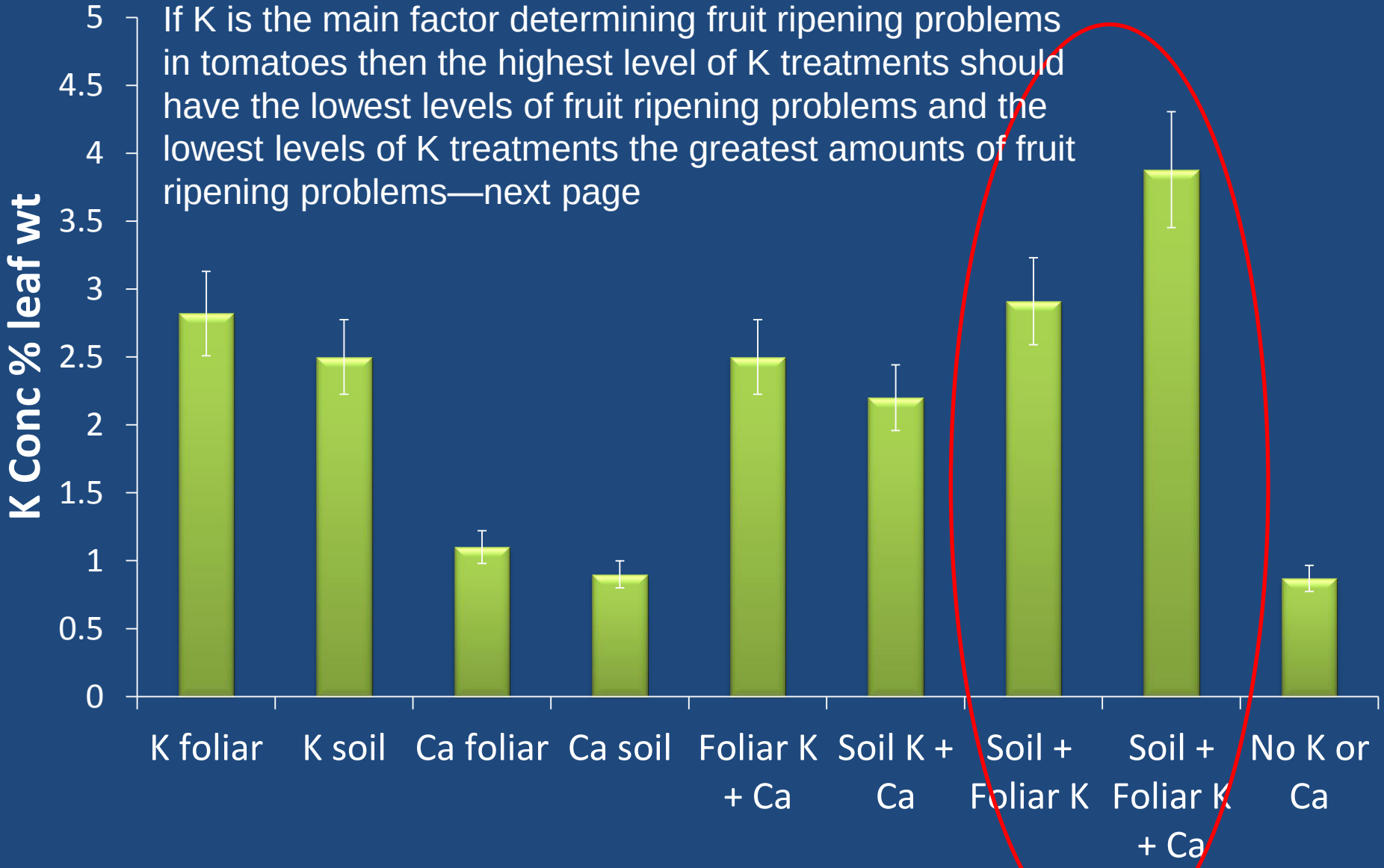
7. Foliar K+ foliar Ca
8. Soil K+ foliar Ca
9. Soil K + foliar K
10. Soil K + foliar K & Ca
11. No extra K or Ca

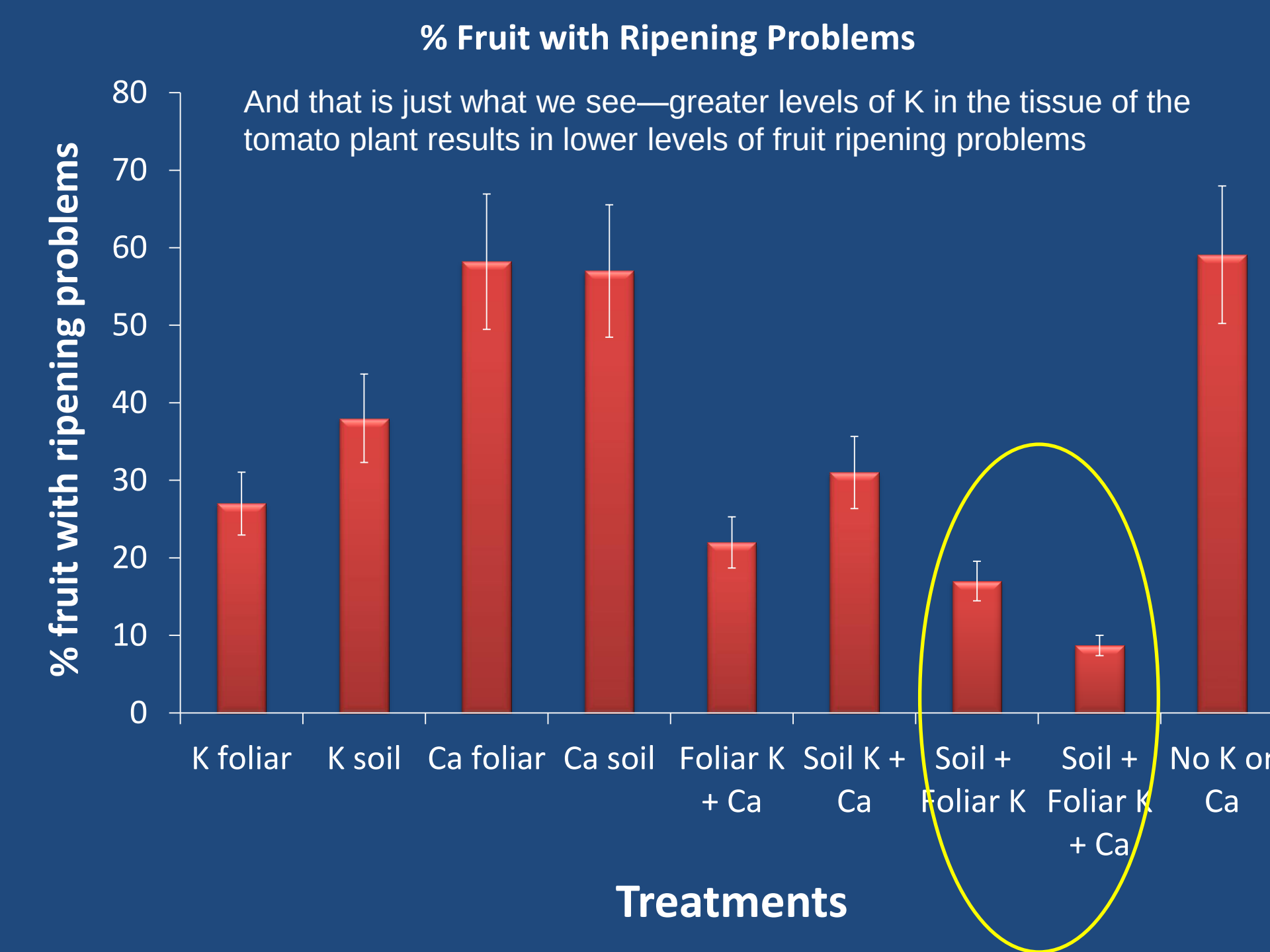
Treatment effect on leaf tissue K+ in tomato



Treatment effect on leaf tissue K+ in tomato

If K is the main factor determining fruit ripening problems in tomatoes then the highest level of K treatments should have the lowest levels of fruit ripening problems and the lowest levels of K treatments the greatest amounts of fruit ripening problems—next page




% Fruit with Ripening Problems
And that is just what we see—greater levels of K in the tissue of the tomato plant results in lower levels of fruit ripening problems
% fruit with ripening problems
80
70
60
50
40
30
20
10
0
K foliar
K soil
Ca foliar
Ca soil
Foliar K + Ca
Soil K + Ca
Soil + Foliar K
Soil + Foliar K + Ca
No K or Ca
Treatments

Extra K added

No K added

K added

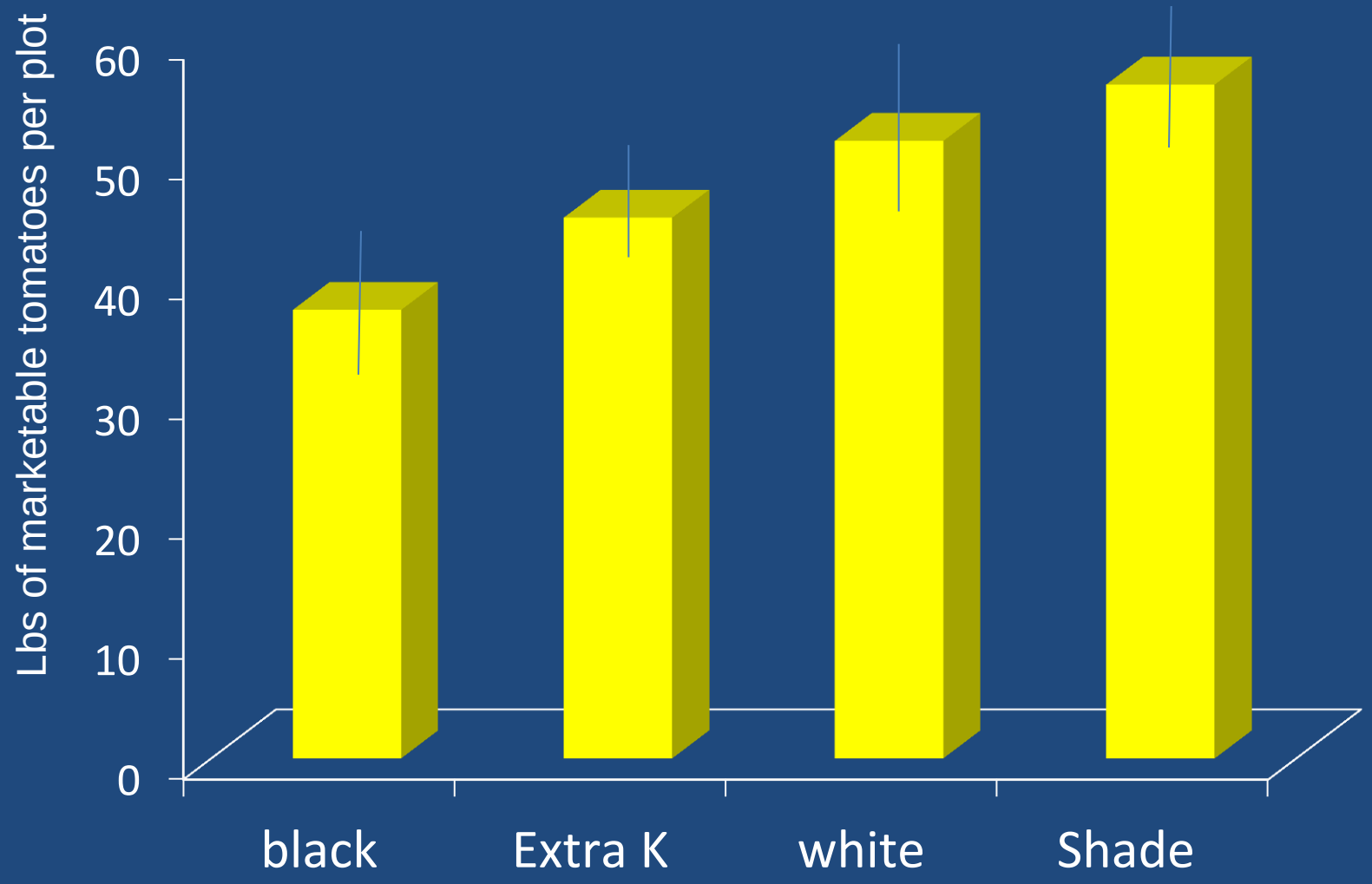
No K added

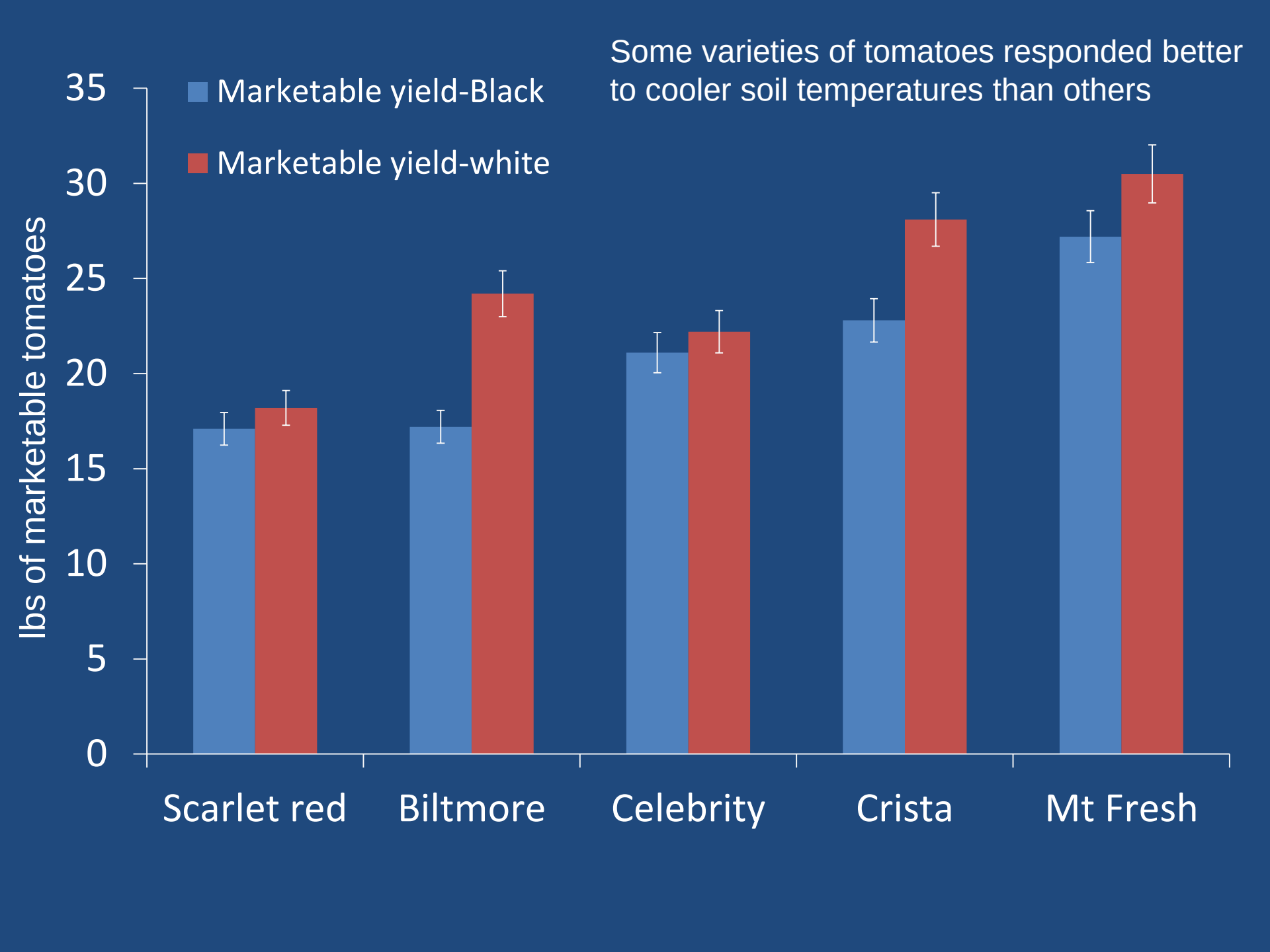
If soil root zone temperature is so important couldn’t we reduce the soil temperature, which should increase the K concentration in the plant and reduce fruit ripening problems?

What if we used 30% shade cloth on the tomatoes?

Tomatoes grown on different mulches, with extra K and under shade

Growing tomatoes on white vs black plastic mulch increased K levels in the plant by 25-30% and decreased fruit loss due to ripening problems, increasing net yield. White mulch did better at increasing K levels than adding extra amounts (300 lbs) of K to the soil.




Some varieties of tomatoes responded better to cooler soil temperatures than others
Marketable yield-Black
Marketable yield-white
lbs of marketable tomatoes
35
30
25
20
15
10
5
0
Scarlet red
Biltmore
Celebrity
Crista
Mt Fresh

Extra K through the drip and grown on white plastic mulch

Control-black plastic mulch no extra K

Tomato fruit ripening problems in high tunnels and in the field in 2009

High Tunnel problems

Tomato fruit was reported to look very good when ripe, but….

When sliced open the fruit commonly had internal whitening problems

Soil and tissue samples were taken from several high tunnels and fields with fruit ripening problems scattered across the state

As before the soil levels of K were high or excessive in most cases, but tissue levels were below 3% in all cases

What could cause a reduction in K+ in the plant when there was plenty in the soil?

The best explanation for this was the early season weather we had in April, May and June.

From 1 April to 30 June, 2009 we had 23.6 inches of rain at the BWI Airport, which was 9.64 inches above average.

The airport recorded only 7 "clear" days in the 91 days since April 1. Another 33 were rated "partly to mostly cloudy," while 51 were "cloudy."

The fruit ripening problem was due to low potassium levels in the plant at the time of fruit expansion, but instead of it being due to high root zone heat it was due to the plant being too ‘weak’ because of the lack of sunshine to take up enough K at the proper time.

So, same cause as we have seen in previous studies—a lack of K in the plant, but the symptoms were quite different. Why the fruit symptoms were different from low K levels due to high root zone temperatures vs. low K levels due to plants too weak to take up enough K is not known at this time. Both problems are a type of fruit ripening problem with the same cause, but a different symptom.

Plant Nutrient Recommendations for tomatoes

Average 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	1.5-4

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 ~ 6-8

K:Ca ~ 2-3

N:S ~ 6-8

P:S ~ 1

Ca:Mg ~ 3-6

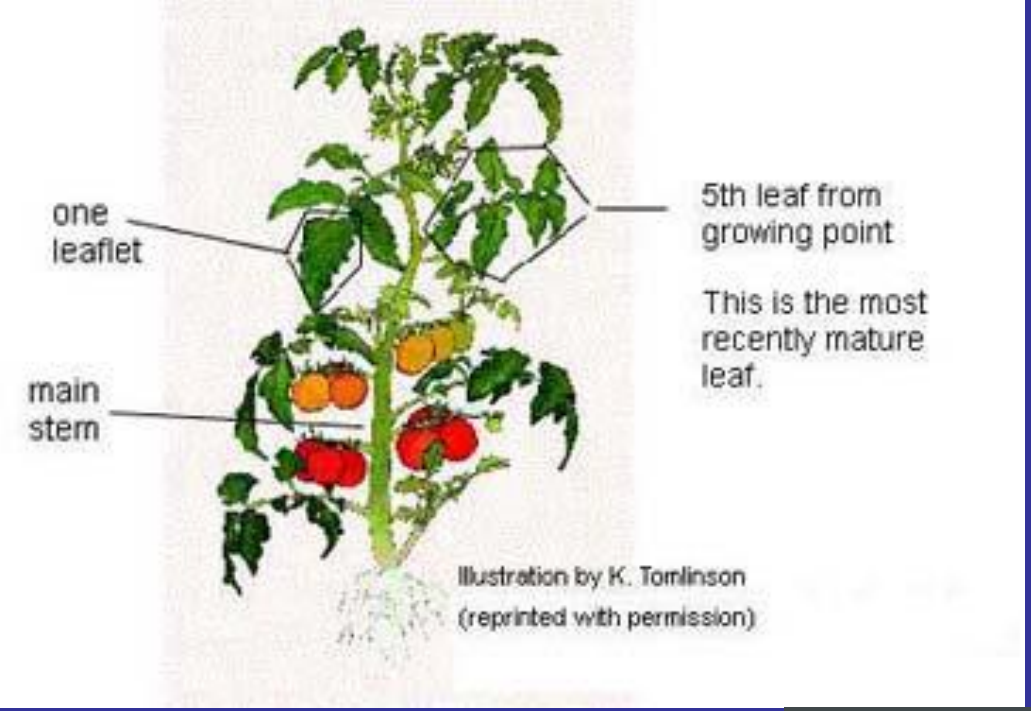
Ca:B ~ 2.2 ppm

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 : 9-15-30 or 5-10-27

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 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

General Management Practices

- Select a variety that has little fruit ripening problems
- Take first tissue samples at first flower
- Use white plastic mulch for plantings that are to be harvested in late July through August
- Drip feed plants during the season with potassium

Questions

UNIVERSITY OF MARYLAND EXTENSION

Solutions in your community

jbrust@umd.edu

http://mdvegetables.umd.edu/