Western Laboratories

Hop Nutrient Needs for Maximum Production & Quality

2016 Research

May 18th, 2018

For more information please visit us at:
www.vimeo.com/westernlaboratories

JOHN P. TABERNA
OWNER & SOIL SCIENTIST

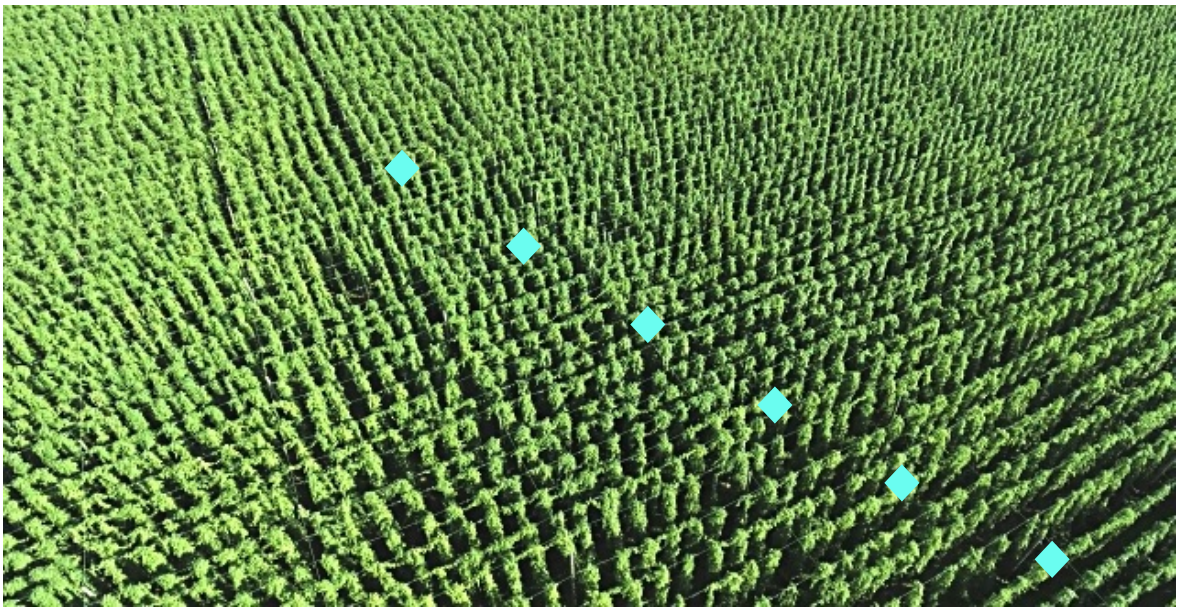
Hop producers that participated in our research:

- 4-B Farms
- Champoux Farms, Inc.
- Cornerstone Ranches, LLC.
- Elk Mountain Farms
- Gooding Farms, Inc.
- Goschie Farms
- Obendorf Hop Inc.
- Schroeder Hops
- Weilmunster Farms

Service companies & crop advisors that participated:

- CPS (Parma, Idaho): Bo Isham & Jeff Watkins
- Greenstar (Bonners Ferry, Idaho): John Figgins & Justin Figgins
- Valley Ag (Greenleaf, Idaho): Phil Shewmaker
- Wilco Farmers (Mt. Angel, Oregon): Cody Duerst & Jared Heuberger
- D&M Chemical (Moxie, Washington): Dee Gargus & Mathias Gargus

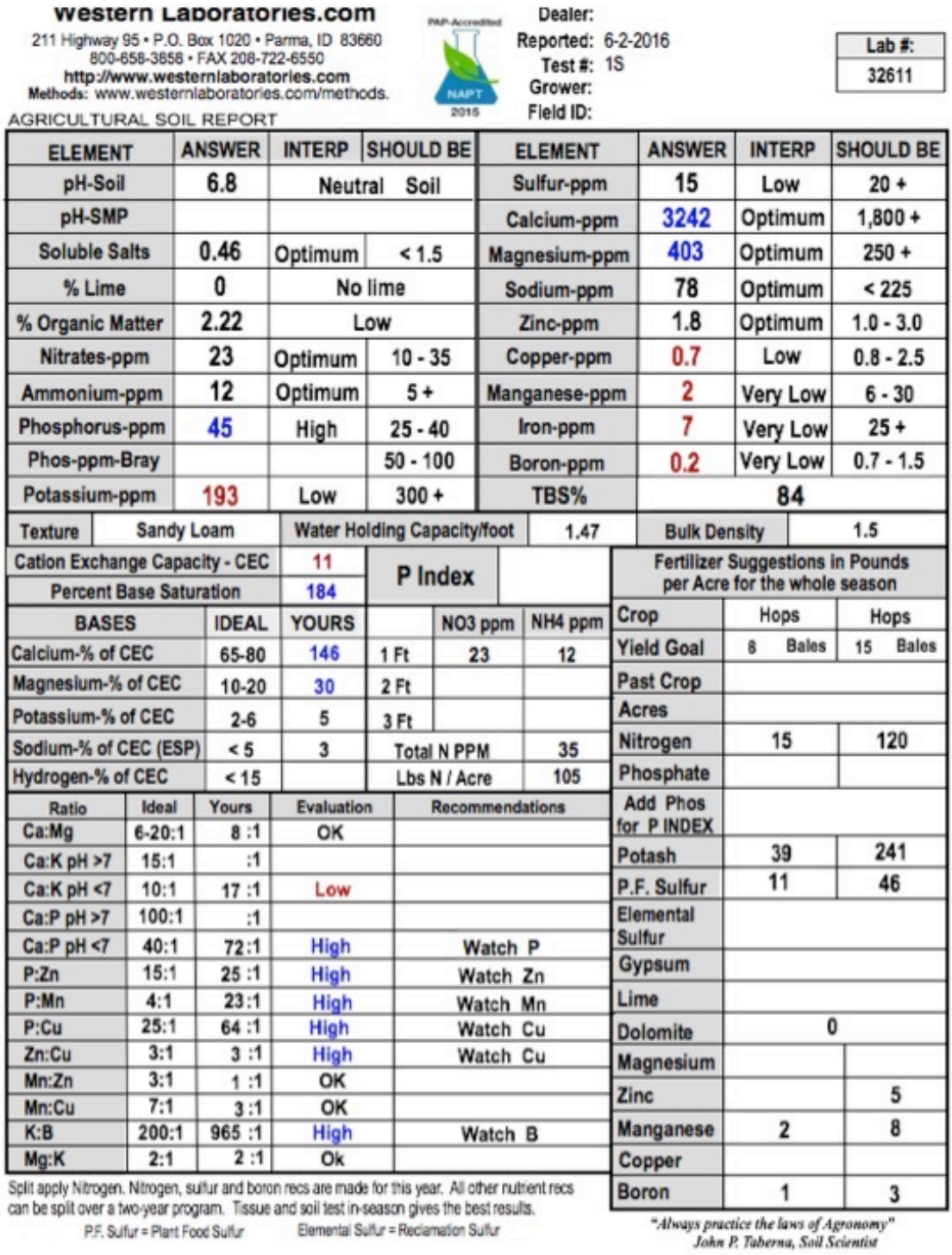
The research started when John Figgins of Greenstar Fertilizer called me to speak on Hop Nutrition for the Elk Mountain Hop Farm staff in Bonner's Ferry, Idaho in March of 2016. 10 minutes into my talk Ed Atkins of Elk Mountain asked if I thought their fertilizer program was wrong. I answered, "Yes!" and three hours later we came up with a plan. I told them Western Laboratories would finance the program and now here are the results from our study in 2016. These are the areas where 25 blocks were tested weekly. The Pacific Northwest produces 90 percent of all hops in the United States.



6 poles were flagged at a 45 degree angle. We tried to select the South West corner as a starting point.

Hop varieties used in our research:

- Cascade
- Centennial
- Chinook
- Citra
- Galena
- Zeus
- Mosiac
- Simco
- El Dorado
- Crystal
- Willamette



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PAP-Accredited NAPT 2015

Dealer:
Reported: 6-2-2016
Test #: 1S
Grower:
Field ID:

Lab #: 32611

AGRICULTURAL SOIL REPORT

ELEMENT	ANSWER	INTERP	SHOULD BE
pH-Soil	6.8	Neutral Soil	
pH-SMP			
Soluble Salts	0.46	Optimum	< 1.5
% Lime	0	No lime	
% Organic Matter	2.22	Low	
Nitrates-ppm	23	Optimum	10 - 35
Ammonium-ppm	12	Optimum	5 +
Phosphorus-ppm	45	High	25 - 40
Phos-ppm-Bray			50 - 100
Potassium-ppm	193	Low	300 +

ELEMENT	ANSWER	INTERP	SHOULD BE
Sulfur-ppm	15	Low	20 +
Calcium-ppm	3242	Optimum	1,800 +
Magnesium-ppm	403	Optimum	250 +
Sodium-ppm	78	Optimum	< 225
Zinc-ppm	1.8	Optimum	1.0 - 3.0
Copper-ppm	0.7	Low	0.8 - 2.5
Manganese-ppm	2	Very Low	6 - 30
Iron-ppm	7	Very Low	25 +
Boron-ppm	0.2	Very Low	0.7 - 1.5
TBS%	84		

Texture	Sandy Loam	Water Holding Capacity/foot	1.47	Bulk Density	1.5

Cation Exchange Capacity - CEC	11
Percent Base Saturation	184

P Index

BASES	IDEAL	YOURS
Calcium-% of CEC	65-80	146
Magnesium-% of CEC	10-20	30
Potassium-% of CEC	2-6	5
Sodium-% of CEC (ESP)	< 5	3
Hydrogen-% of CEC	< 15	

	NO3 ppm	NH4 ppm
1 Ft	23	12
2 Ft		
3 Ft		
Total N PPM		35
Lbs N / Acre		105

Ratio	Ideal	Yours	Evaluation	Recommendations
Ca:Mg	6-20:1	8 :1	OK	
Ca:K pH >7	15:1	:1		
Ca:K pH <7	10:1	17 :1	Low	
Ca:P pH >7	100:1	:1		
Ca:P pH <7	40:1	72:1	High	Watch P
P:Zn	15:1	25 :1	High	Watch Zn
P:Mn	4:1	23:1	High	Watch Mn
P:Cu	25:1	64 :1	High	Watch Cu
Zn:Cu	3:1	3 :1	High	Watch Cu
Mn:Zn	3:1	1 :1	OK	
Mn:Cu	7:1	3 :1	OK	
K:B	200:1	965 :1	High	Watch B
Mg:K	2:1	2 :1	Ok	

Split apply Nitrogen. Nitrogen, sulfur and boron recs are made for this year. All other nutrient recs can be split over a two-year program. Tissue and soil test in-season gives the best results.

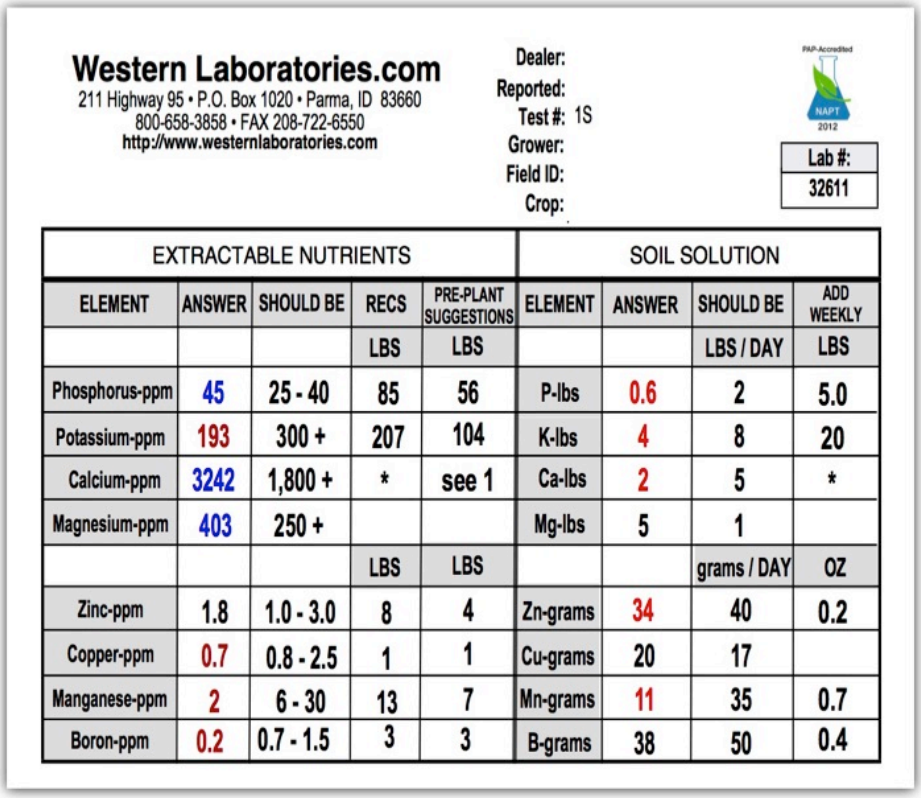
P.F. Sulfur = Plant Food Sulfur Elemental Sulfur = Reclamation Sulfur

Fertilizer Suggestions in Pounds per Acre for the whole season

Crop	Hops	Hops
Yield Goal	8 Bales	15 Bales
Past Crop		
Acres		
Nitrogen	15	120
Phosphate		
Add Phos for P INDEX		
Potash	39	241
P.F. Sulfur	11	46
Elemental Sulfur		
Gypsum		
Lime		
Dolomite	0	
Magnesium		
Zinc		5
Manganese	2	8
Copper		
Boron	1	3

"Always practice the laws of Agronomy"
John P. Taberna, Soil Scientist

Each field was tested as a test #1. A test #1 is a Complete soil test, using Western Universities extraction methods and fertilizer recommendations for 8 and 15 bale yield goals.



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Dealer:
Reported:
Test #: 1S
Grower:
Field ID:
Crop:

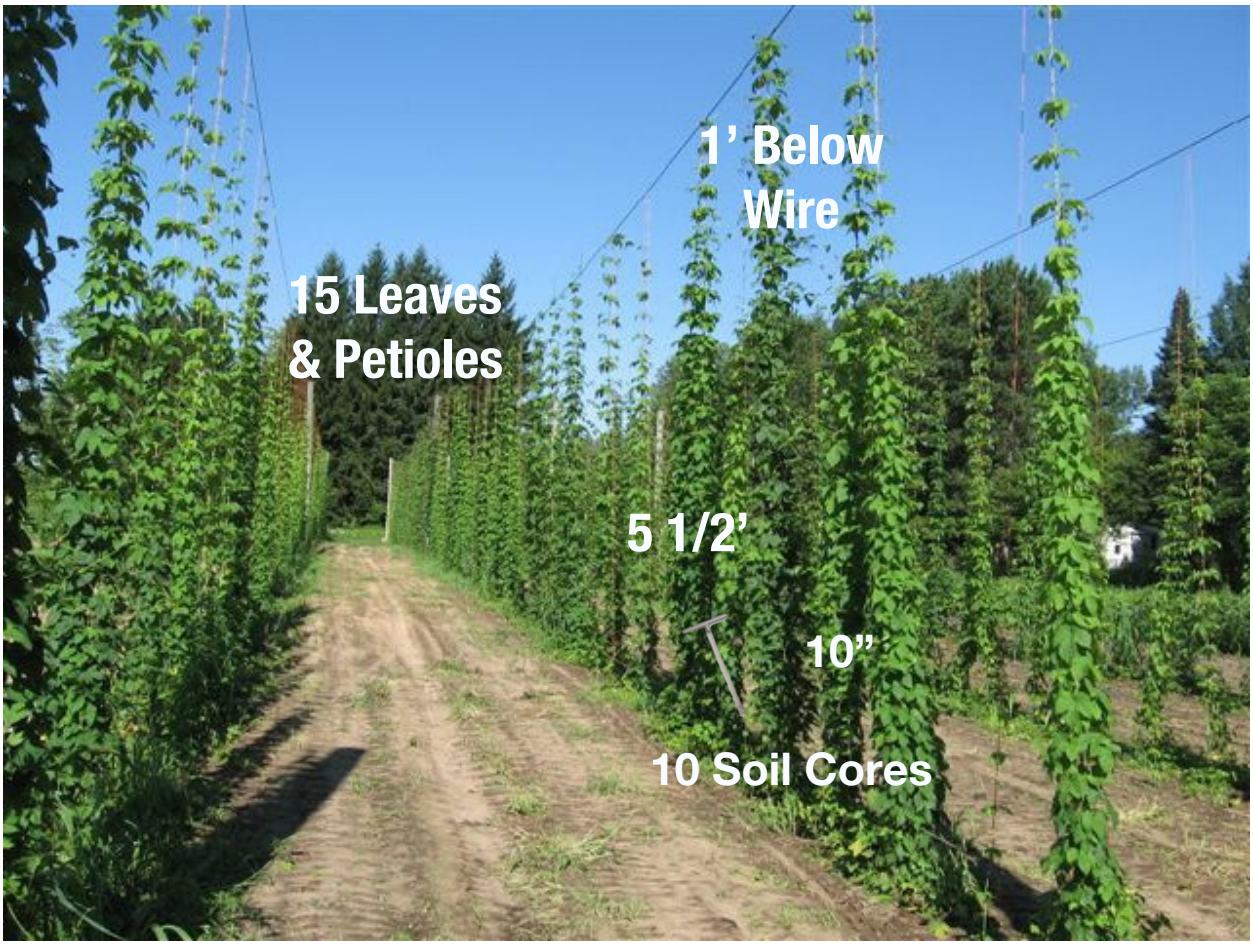
Lab #: 32611

EXTRACTABLE NUTRIENTS					SOIL SOLUTION			
ELEMENT	ANSWER	SHOULD BE	RECS	PRE-PLANT SUGGESTIONS	ELEMENT	ANSWER	SHOULD BE	ADD WEEKLY
			LBS	LBS			LBS / DAY	LBS
Phosphorus-ppm	45	25 - 40	85	56	P-lbs	0.6	2	5.0
Potassium-ppm	193	300 +	207	104	K-lbs	4	8	20
Calcium-ppm	3242	1,800 +	*	see 1	Ca-lbs	2	5	*
Magnesium-ppm	403	250 +			Mg-lbs	5	1	
			LBS	LBS			grams / DAY	OZ
Zinc-ppm	1.8	1.0 - 3.0	8	4	Zn-grams	34	40	0.2
Copper-ppm	0.7	0.8 - 2.5	1	1	Cu-grams	20	17	
Manganese-ppm	2	6 - 30	13	7	Mn-grams	11	35	0.7
Boron-ppm	0.2	0.7 - 1.5	3	3	B-grams	38	50	0.4

This is our test #1S portion of our soil test. On the left is the extractable nutrients from the soil report. On the right is the soil solution test. These numbers must be in the soil solution at all times to obtain maximum growth and yields. I began working on soil solution testing in 1969. In 1992, Harry Kreeft, our plant pathologist/nematologist and I began testing soil solution again and after many trials introduced our improved soil solution test in 2003. It has proven to be important for obtaining maximum yields and quality on several crops.

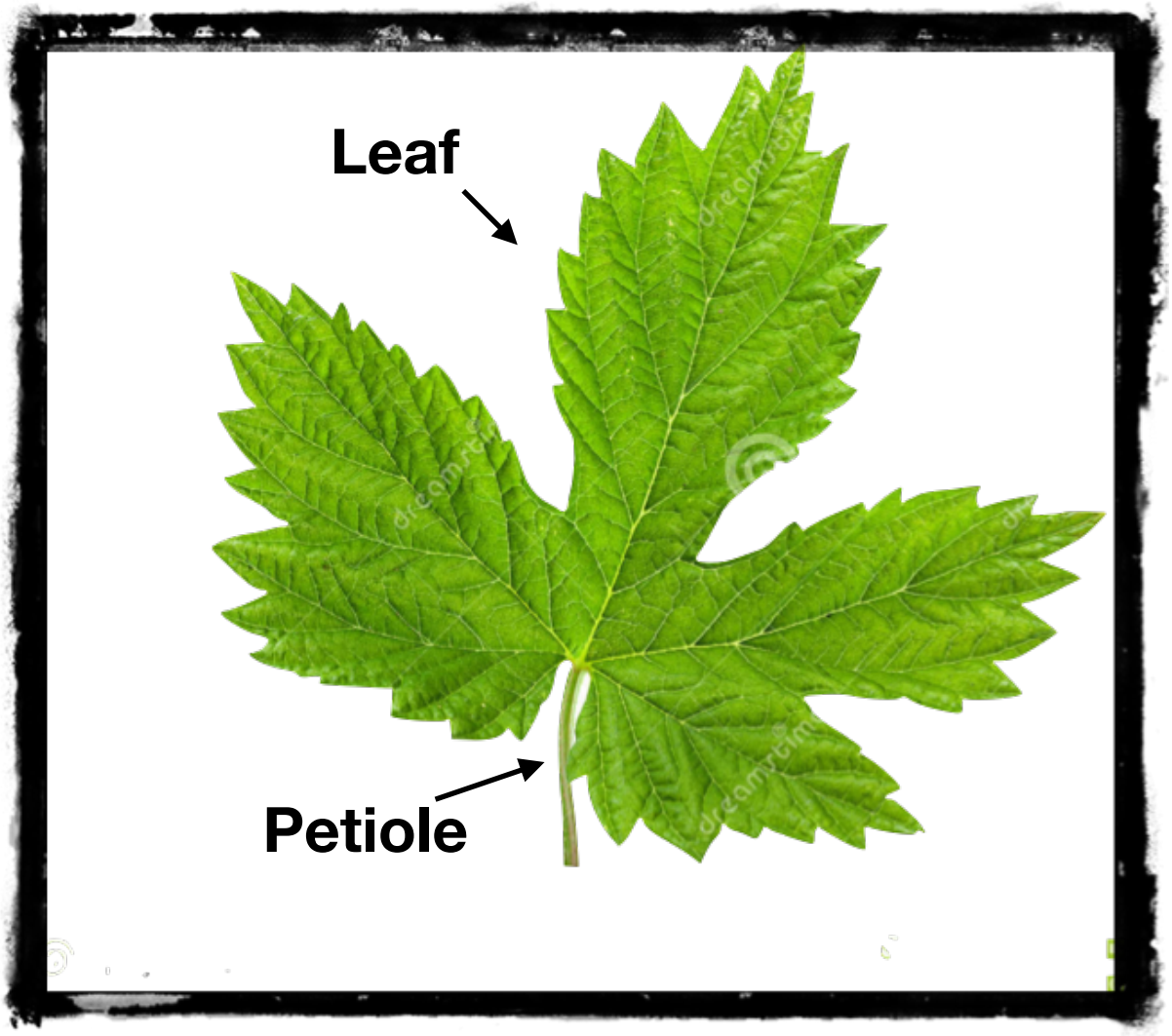
Our Soil Solution test emulates the exudates that plant roots release to stimulate bacteria and fungi to release nutrients from the extractable nutrients in to the soil solution. These are the nutrients that are available for plant assimilation. Once the nutrients are assimilated by the root, a zone of depletion is created around the roots that must be replenished by diffusion and mass flow to maintain maximum daily growth and yields.

Area we tested



Once the bine was 8 foot tall, soil and tissue samples were collected weekly. This is when the plant becomes independent of the nutrient reserves from last years fertilizer program.
When the leaves were 3/4" expanded, samples were taken at 5 1/2 feet for tissue analysis and soil samples were taken 10 inches deep for soil solution testing. 15 leaf plus petiole were taken for complete analysis. Also, 15 leaves and 45 petioles were collected for separate analysis.
Once the bines reached the wire, the same procedure was used. The samples were collected 1 foot below the wire. At the 1st of each month, 12 entire lines were collected for dry matter and nutrient analysis. On August 1st the first cones were collected weekly for complete analysis until September 1st.

Plant parts tested



We tested the leaf plus the petiole on hops.

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Dealer:
Grower:
Variety: Hops
Field id:

SV No: 50501.2

SECRET VAULT 2016

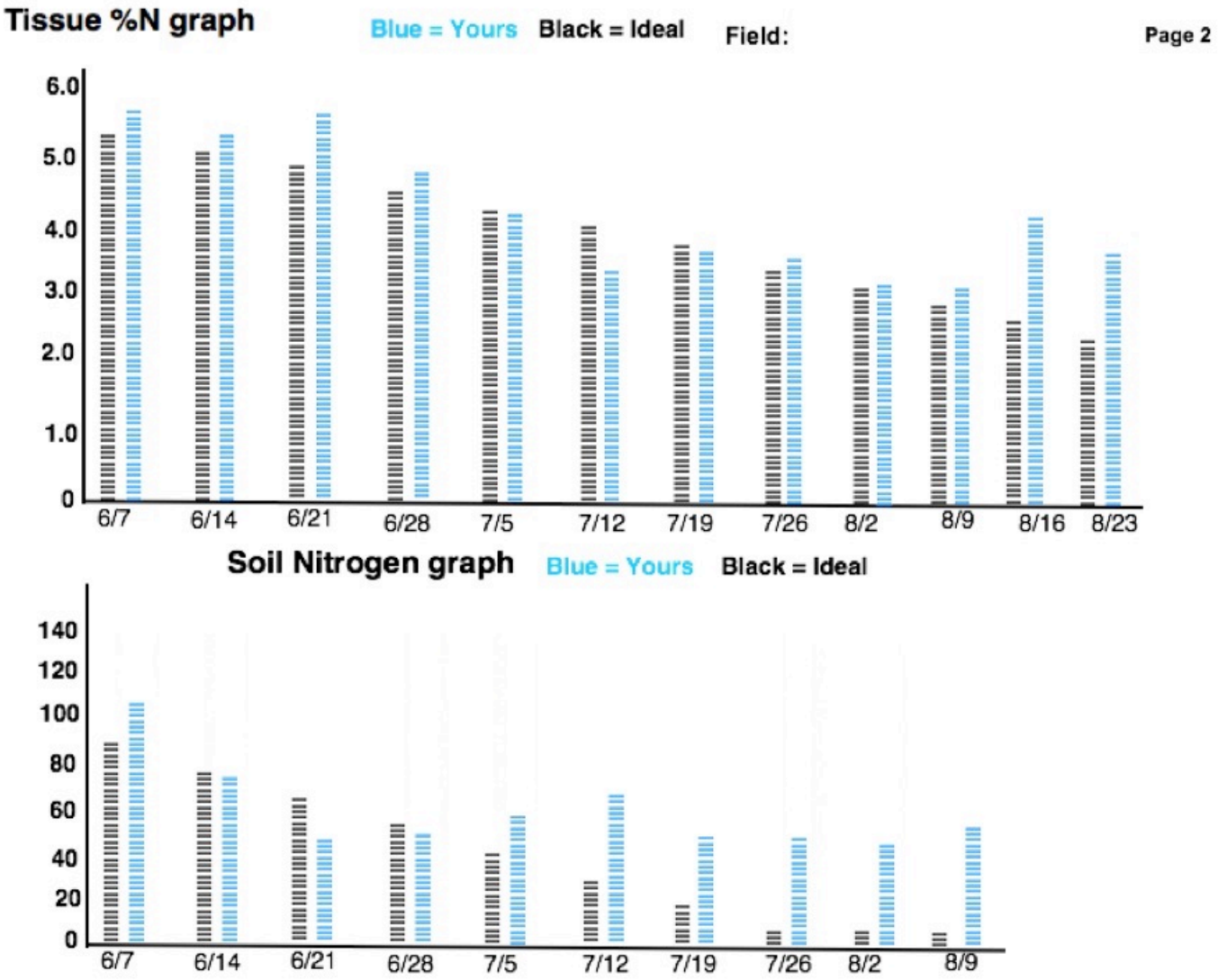
WEEK			Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
LABORATORY NO			398	714	1159	1940	2834	3920	5017	6117	7191	8066
DATE			6/7	6/14	6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9
		IDEAL	YOURS	YOURS	YOURS	YOURS	YOURS	YOURS	YOURS	YOURS	YOURS	YOURS
PLANT	% Nitrogen	> 4.0	5.7	5.4	5.6	4.8	4.2	3.4	3.7	3.6	3.3	3.2
SOIL SOL'N	Nitrogen-lbs	> 4.0	15	12	6	7	8	10	8	8	6	8
PLANT	% Phosphorus	>0.40	0.53	0.47	0.45	0.52	0.38	0.29	0.32	0.4	0.36	0.25
SOILSOL'N	Phosphorus-lbs	>0.85	1.00	1.50	1.80	1.70	1.20	1.60	1.00	1.50	2.00	2.40
PLANT	% Potassium	> 4.0	2.5	2.1	2.0	2.5	2.6	3.9	2.1	2.4	1.5	1.3
SOIL SOL'N	Potassium-lbs	> 5.0	5.4	4.3	6.5	4.5	4.8	5.3	4.4	6.2	7.6	8.1
PLANT	% Sulfur	>0.25	0.34	0.42	0.34	0.4	0.36	0.29	0.3	0.6	0.33	0.22
SOIL SOL'N	Sulfur-lbs	> 2.0	24.8	17.6	2.4	3.5	5.0	6.8	9.4	6.2	4.3	5.5
PLANT	% Calcium	> 2.5	1.1	1.3	2.7	3.3	3.8	2.3	2.6	2.1	1.2	1.7
SOIL SOL'N	Calcium-lbs	> 3.0	14.6	9.2	7.9	9.9	8.6	10.4	10.5	5.7	7.2	7.0
PLANT	% Magnesium	> 0.4	0.35	0.48	0.38	0.45	0.56	0.81	0.54	0.51	0.74	0.64
SOIL SOL'N	Magnesium-lbs	> 2.0	15.8	9.3	8.4	9.2	10.9	15.7	13.5	9.0	8.5	10.0
PLANT	ppm Zinc	> 60	32	30	29	32	42	37	50	69	80	100
SOIL SOL'N	Zinc-grams	> 60	94	40	27	39	54	55	90	84	75	72
PLANT	ppm Manganese	> 85	64	84	122	101	101	63	75	82	110	92
SOIL SOL'N	Manganese-grams	> 25	27	30	30	18	27	18	9	12	15	12
PLANT	ppm Copper	> 10	5	7	10	10	14	7	7	10	13	8
SOIL SOL'N	Copper-grams	> 17	12	12	3	6	9	12	12	18	27	24
PLANT	ppm Boron	> 55	33	46	58	63	52	60	50	30	45	50
SOIL SOL'N	Boron-grams	> 60	110	192	171	135	327	156	405	126	87	102

This is a Secret Vault report for 2016. It contains both tissue and soil solution tests taken over a 10 week period. This report is from 1 field of the 20 fields that were collected 10 times with both tissue and soil solution throughout the summer. The leaf plus petiole analysis is on top and the soil solution numbers are below the leaf analysis. No communications between me and the grower occurred because the information gathering year to get crop curves establish how to get 15 bales on Cascades. I did the same program with 11 Atlantic Giant Pumpkin growers in the US and Canada when the worlds record was 1,060 pounds in 1999. Today, it is over 2,600 pounds and we will have a 3,000 pounder very soon. 2018 all growers on Secret Vault will receive a “Love Letter” making nutrient suggestions for maximum productions. I walked 40 fields weekly in 2017 and see why maximum yields are not being obtained. I will discuss some ideas towards the end of this presentation.

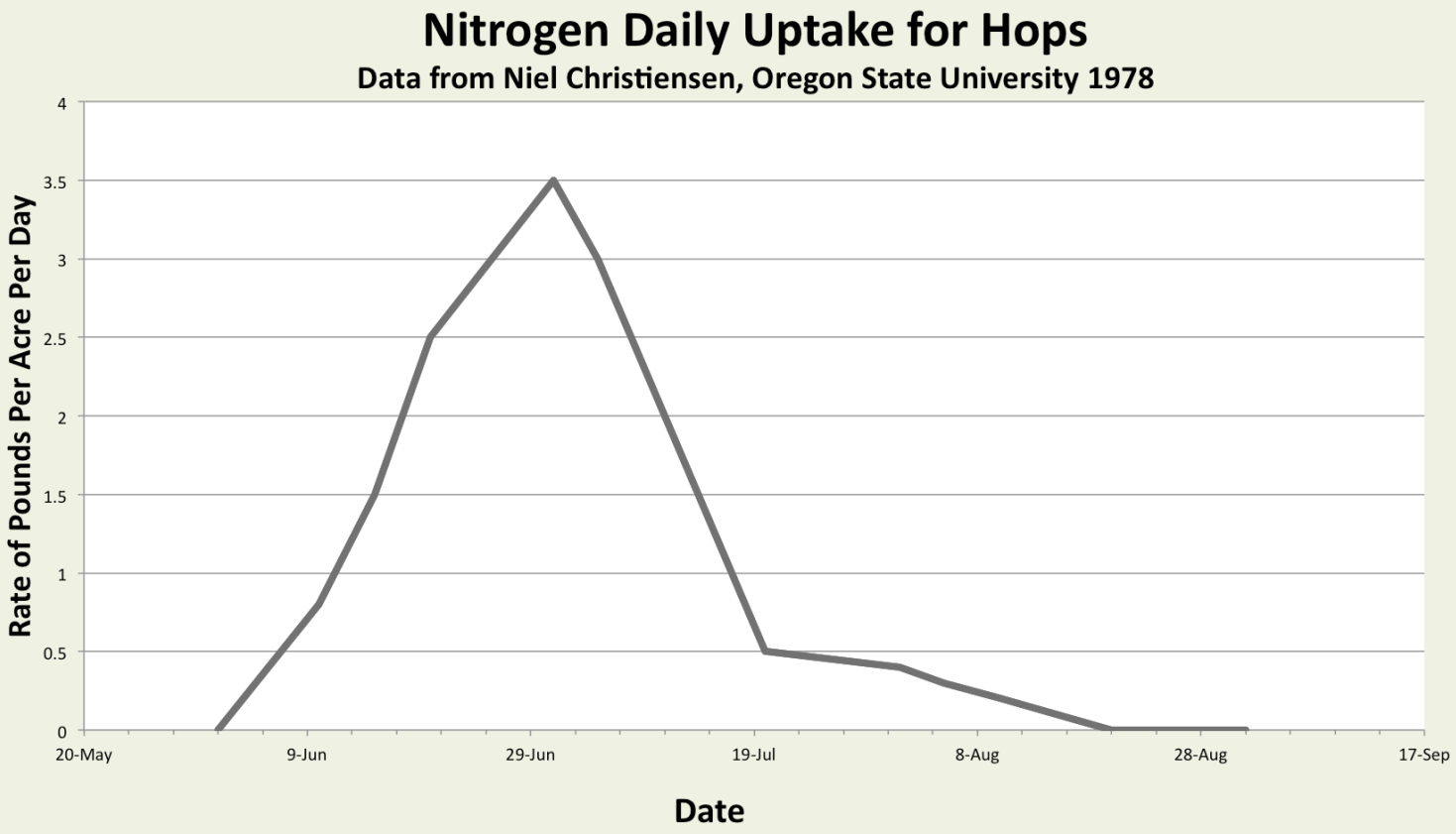
SOIL TEST REPORT	NITROGEN IN POUNDS PER ACRE FOOT									
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10
LABORATORY NUMBER	398	714	1159	1940	2834	3920	5017	6117	7191	8066
DATE	6/7	6/14	6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9
Nitrates - lbs	104	75	37	45	53	66	51	50	39	48
Ammonium - lbs	1	4	5	4	4	3	2	3	3	3
Total Nitrogen - lbs	105	79	42	49	57	69	53	53	42	51

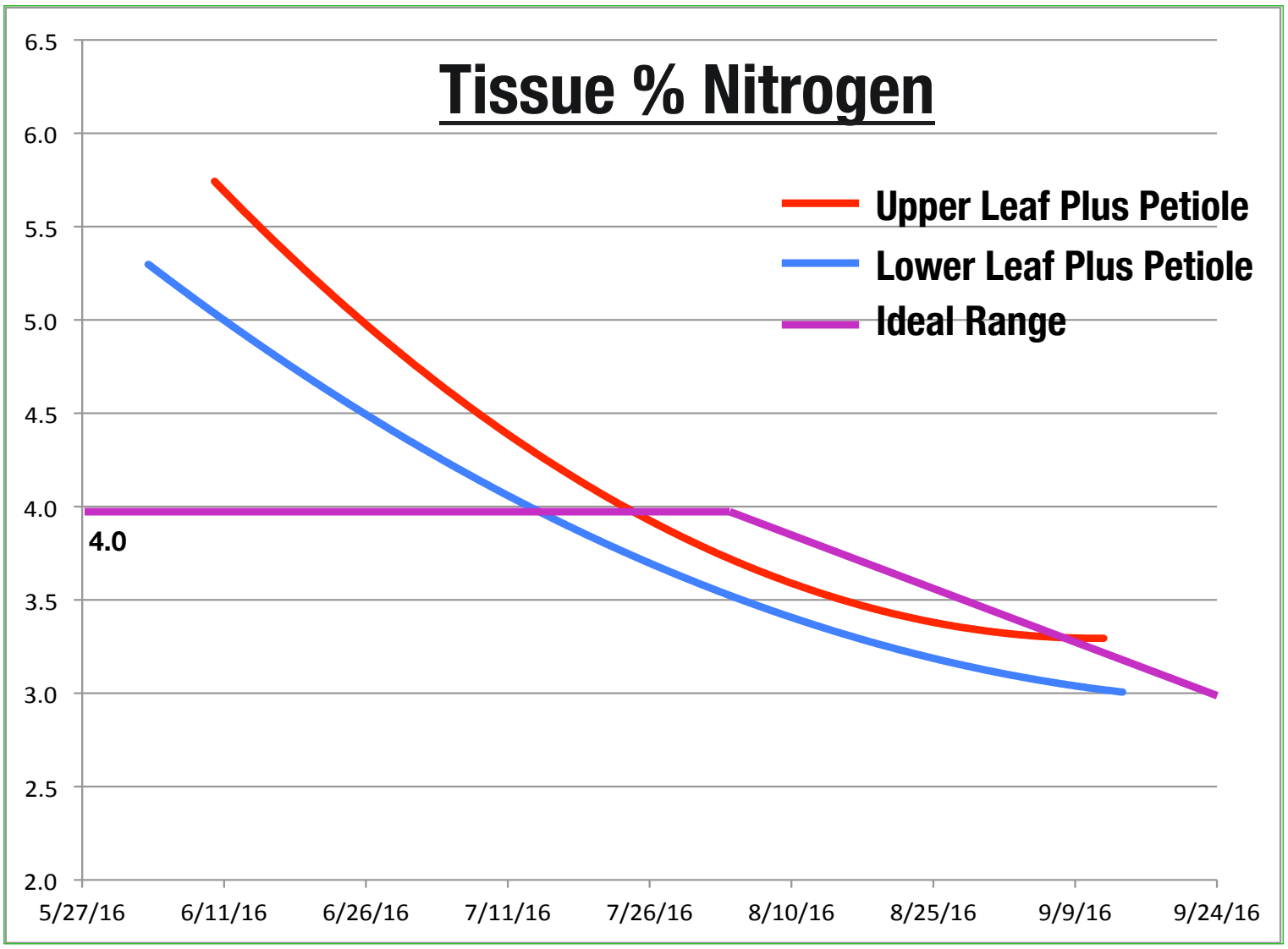
	FERTILIZER RECOMMENDATIONS IN POUNDS ACTUAL PER ACRE											
WEEK	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	Week 12
LAB NO	398	714	1159	1940	2834	3920	5017	6117	7191	8066	8717	9171
DATE	6/7	6/14	6/21	6/28	7/5	7/12	7/19	7/26	8/2	8/9	8/16	8/23
ELEMENT	INJECT	INJECT	INJECT	INJECT	INJECT	INJECT	INJECT	INJECT	INJECT	INJECT	INJECT	INJECT
Nitrogen											20	
Phosphate					10	10	10	10	10	10	10	10
Potash	10	14	10	13	11	10	13	10	10	10	40	10
Sulfur										5		5
Calcium												
Magnesium	2		2									
Zinc	0.25	0.50	0.50	0.50	0.50	0.50	0.25					
Manganese	0.25	0.25		0.25		0.50	0.50	0.50		0.50		
Copper	0.50	0.50	0.50	0.50	0.25	0.50	0.50	0.25		0.25		0.25
Boron	.2	0.20			0.20		0.20	0.20	0.20	.2		

This report contains the measured pounds of Nitrogen in the soil and the computer generated recommendations. It would take a lot of time to explain these last 2 pages… because there is too much to share.

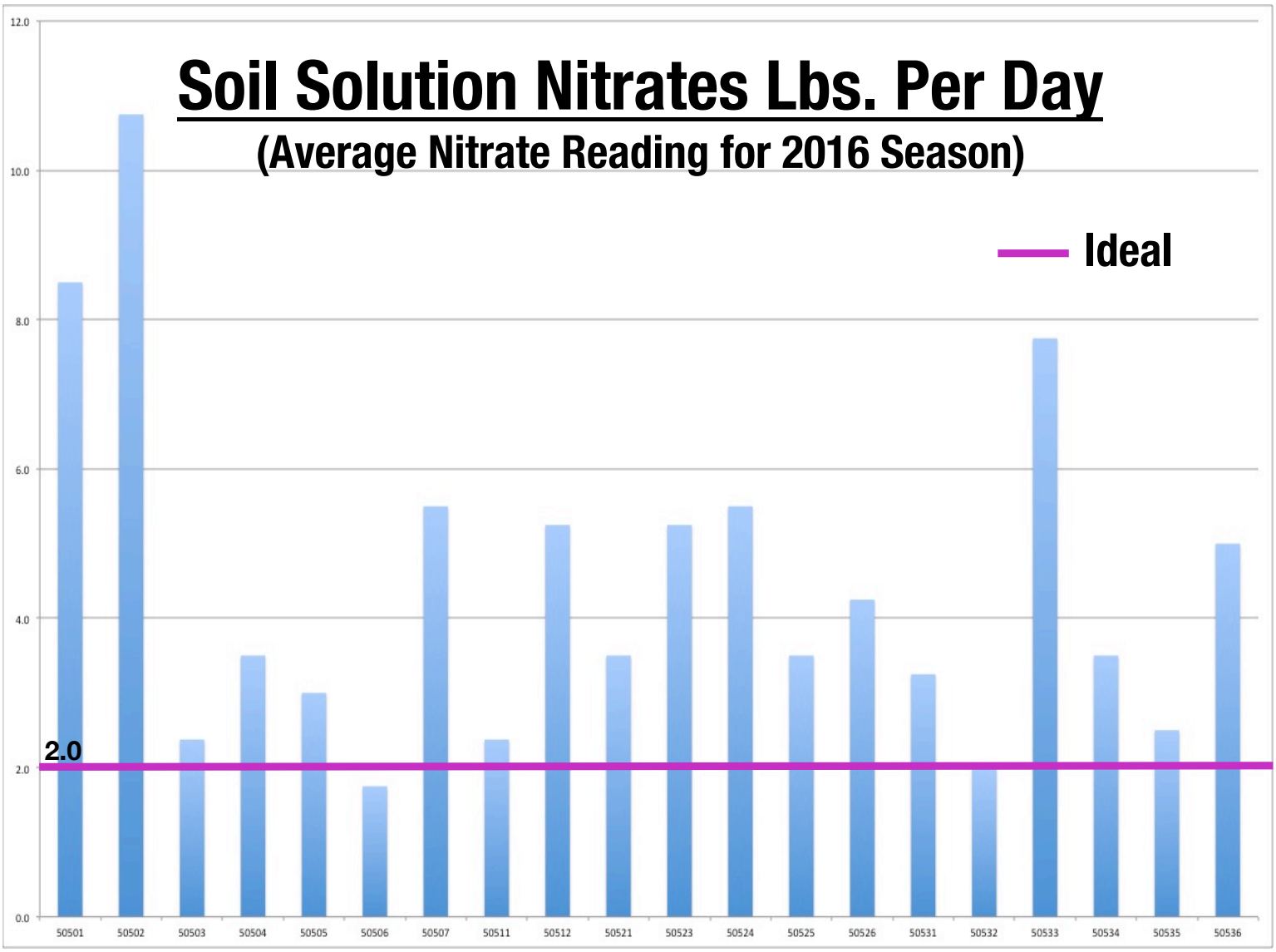


The top graph black line is the ideal sufficiency range for petiole collected at 5 1/2 feet. The bottom graph black lines are the ideal pounds of Nitrogen that should be in the soil through out the growing season. All fields were over fertilized with Nitrogen.

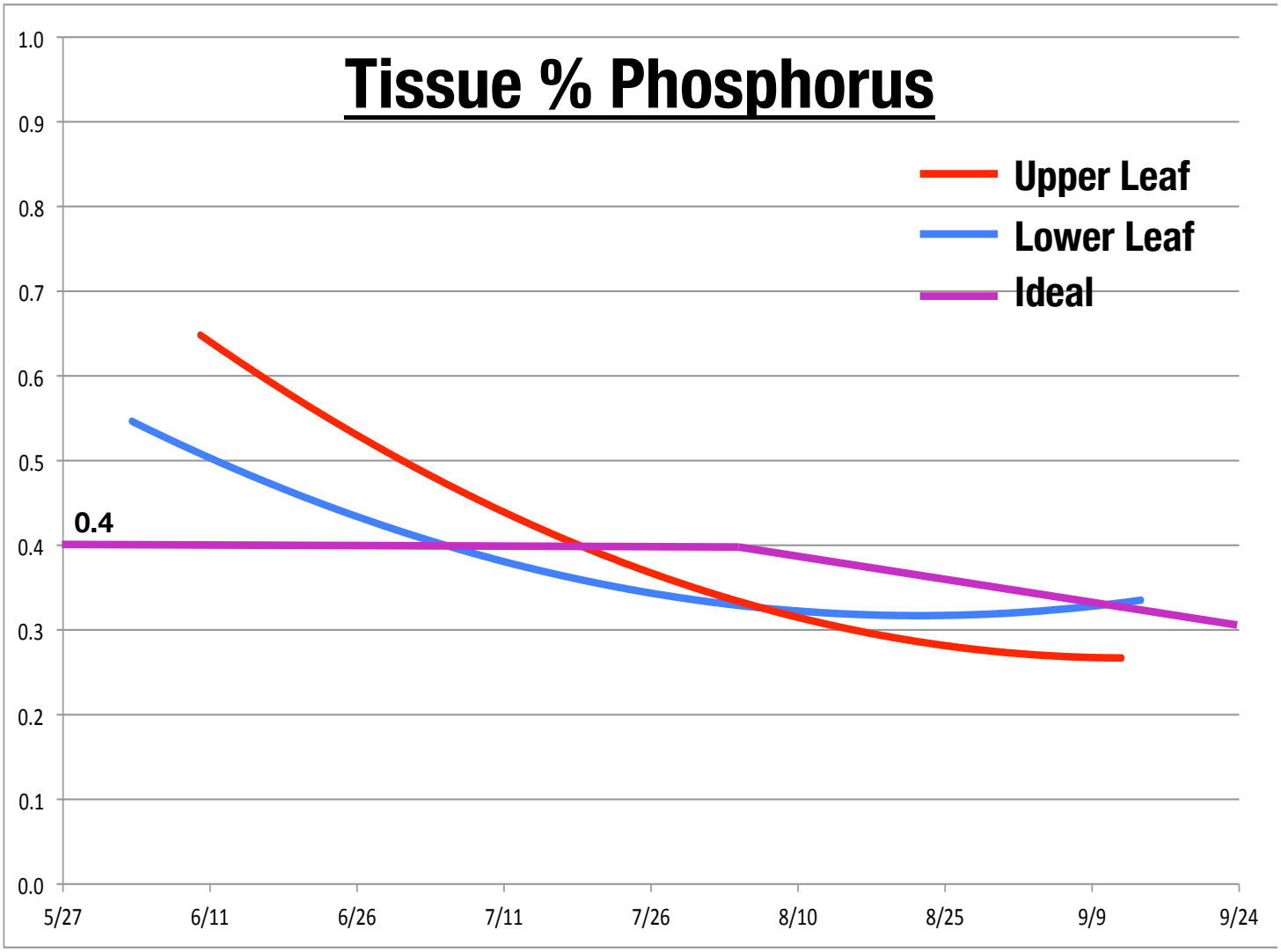

Nitrogen Daily Uptake for Hops
Data from Niel Christiensen, Oregon State University 1978
Rate of Pounds Per Acre Per Day
4
3.5
3
2.5
2
1.5
1
0.5
0
20-May
9-Jun
29-Jun
19-Jul
8-Aug
28-Aug
17-Sep
Date



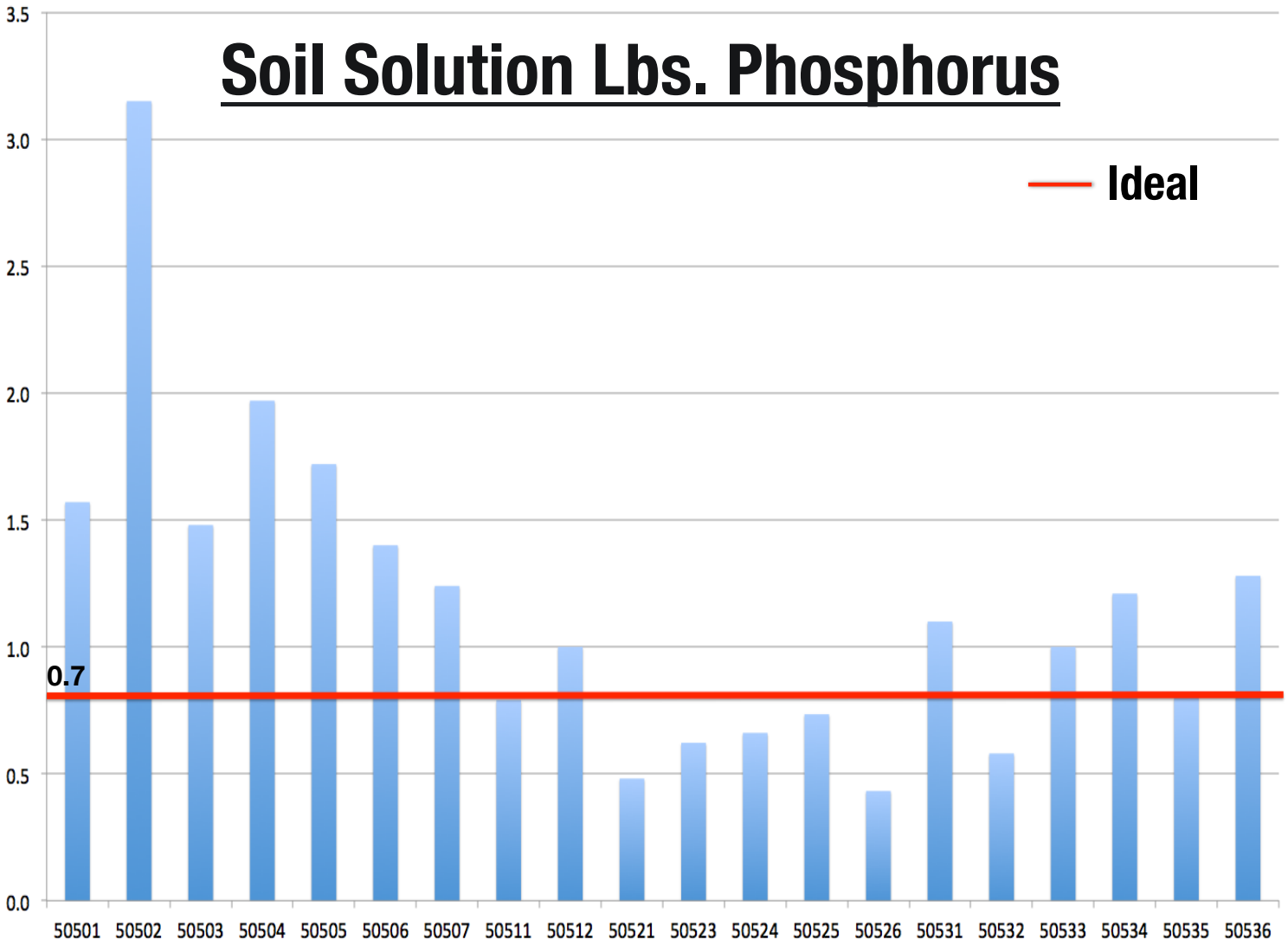
This is the average % Nitrogen on the leaves plus petiole on 25 fields. The blue line is the average Nitrogen collected at 5 1/2 feet from the soil and the red line is the average Nitrogen taken 1 foot below the wire. It appears that around August 1st, regardless of how much Nitrogen is in the soil, the plants physiological brain knows it's time to translocate Nitrogen into the cones and into the roots. Nitrogen is a growth element and may antagonize cone size, alpha acid formation and transport on nutrients into the roots for next springs flush.



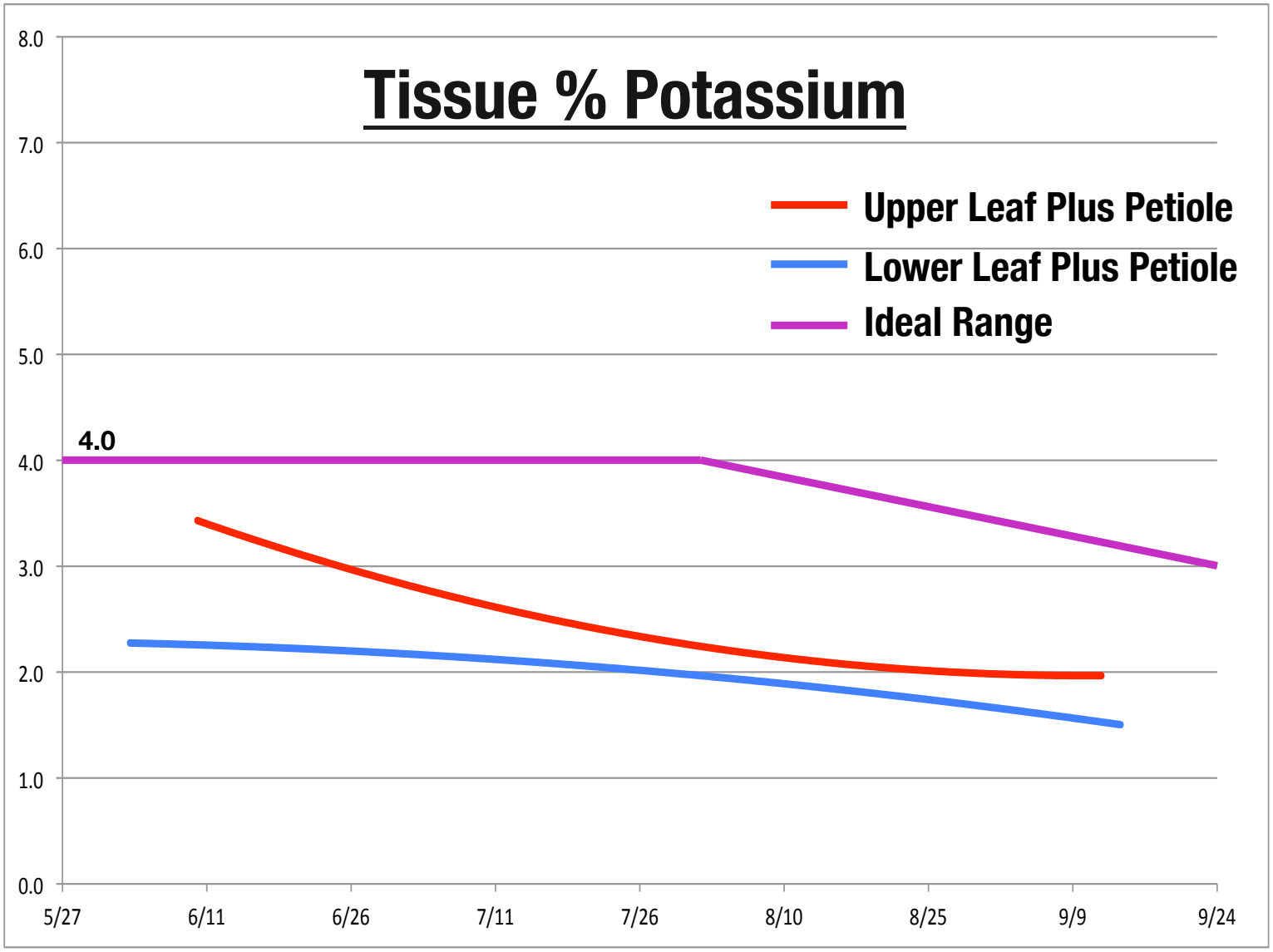
The ideal daily Nitrogen levels would start around 4 pounds per day the 1st of June and be less than 2 pounds per day the 1st of August.



Phosphorus seems to have a typically smooth pattern. All nutrients except Calcium and Magnesium tend to decrease with plant age. Some of the nutrients may recover toward the end of the growing season. This is because the bine growth has diminished.

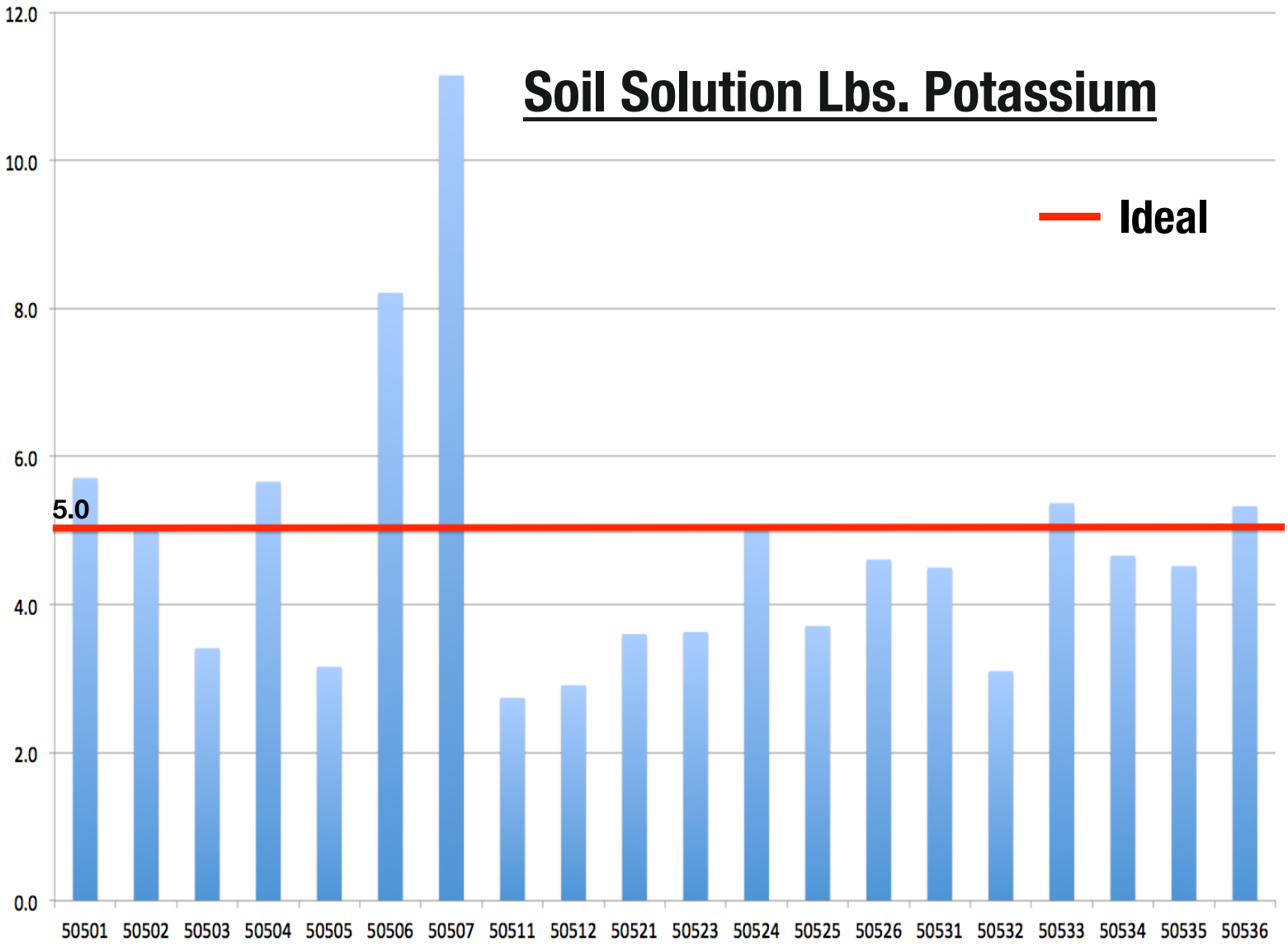


Western Laboratories established that soil solution Phosphorus must be above .85 pounds per day to obtain the maximum production and cone size (amount of Phosphorus the plant can obtain on a daily basis).

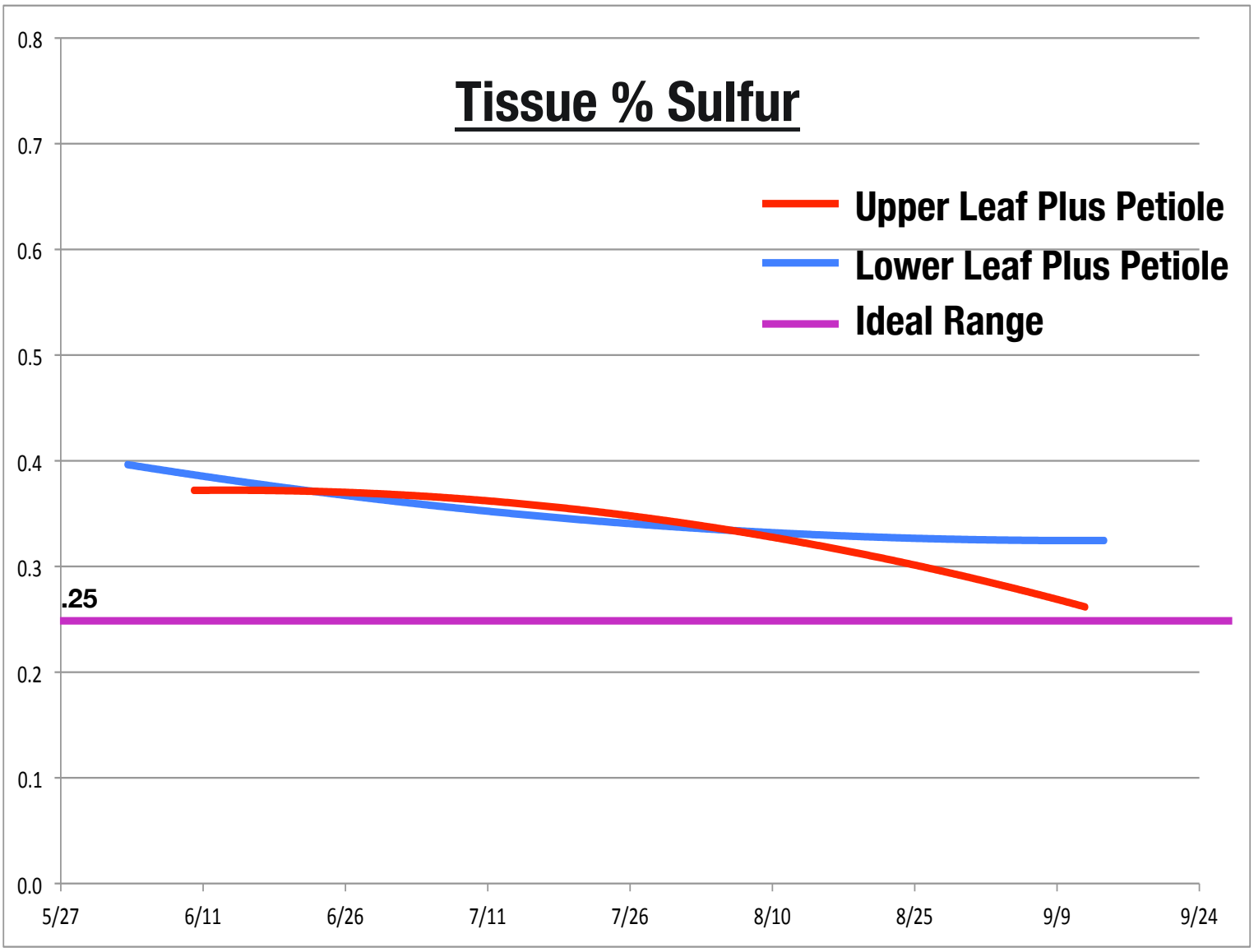


Many fields had high levels in Potassium and all fields tested below the level needed for maximum yields. Potassium is 30% mined by the bine, so it appears this nutrient recovery is related to irrigation methods.

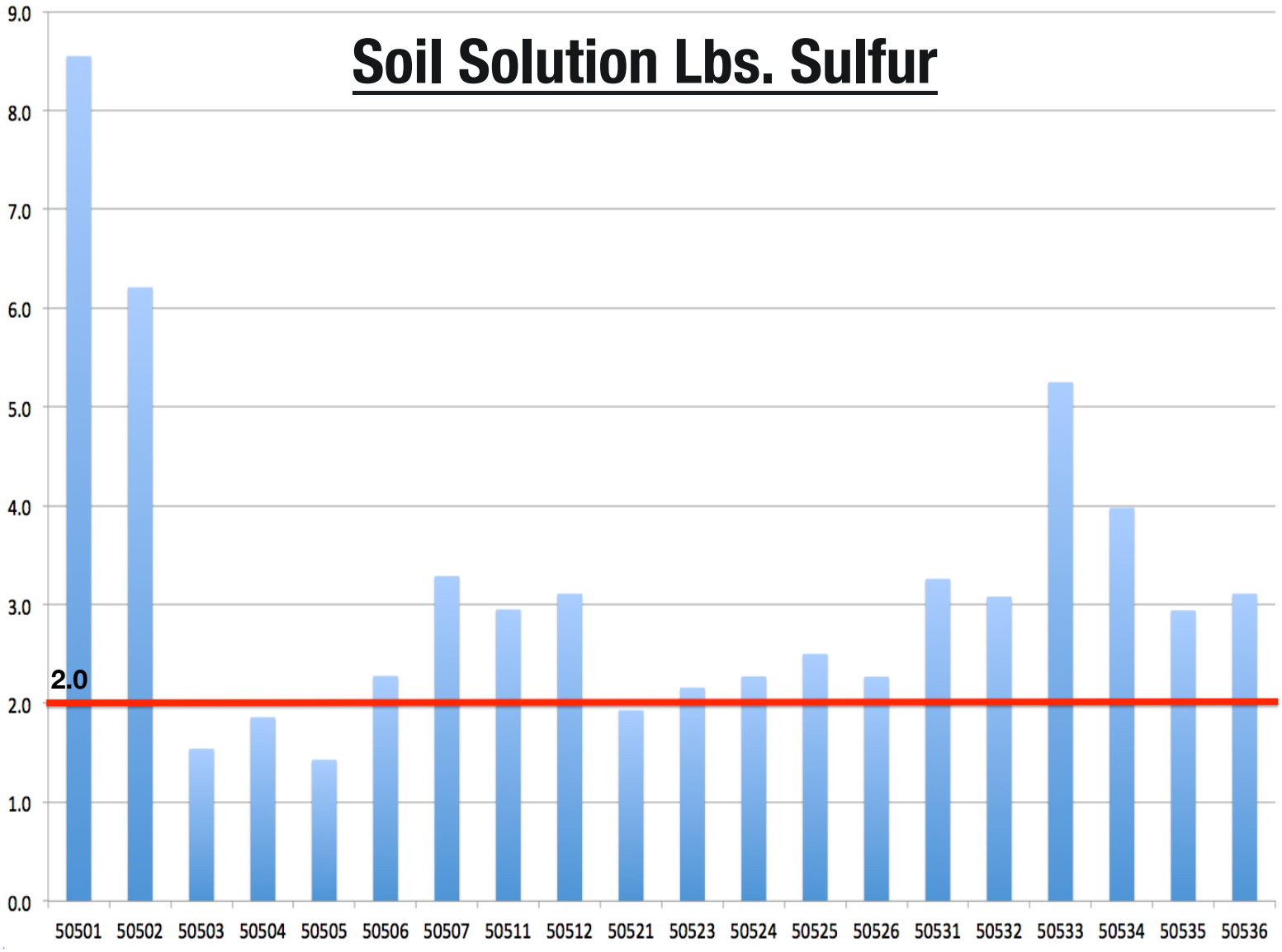
To maintain a 15 bale Cascade Variety yield your irrigation is going to have to be completely changed. I will discuss this on slide 56.



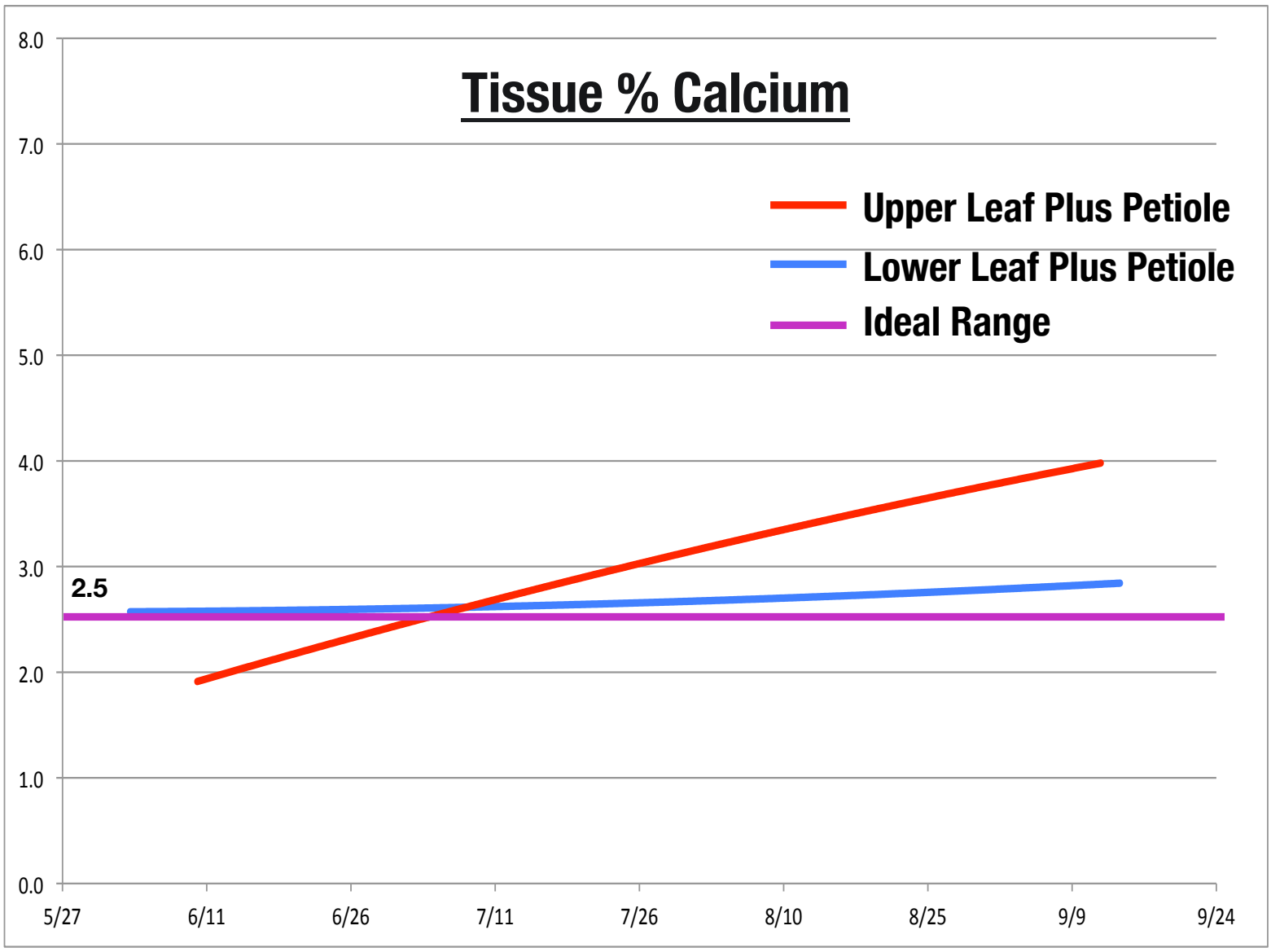
I established that 5 pounds needed to be in the soil solution at all times throughout the summer. Dr. Don Horneck at Oregon State University established numbers that had to be in potatoes and onions to bulk and bulb at 1000 pounds per acre per day. This work was done by using his work. I have established soil solution curves from his work and hundreds of fields are now on Secret Vault because of his work. Don passed away 3 years ago, we all miss him. He would be helping me increase hop yields and quality if he were here.



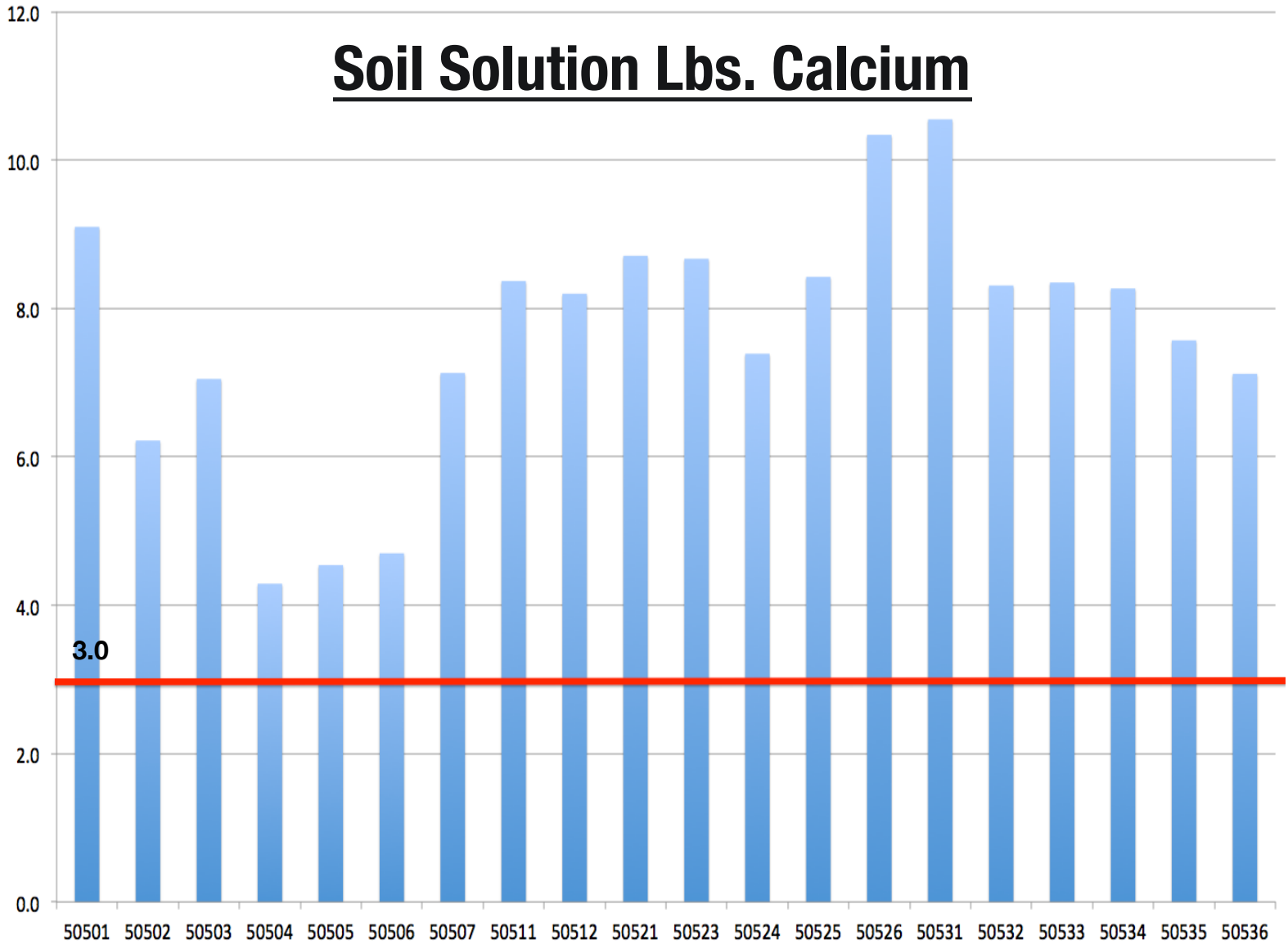
Sulfur is very mobile and uptake is similar to Nitrate uptake. It appears adequate Sulfur is being applied to the soil and leaves with foliar sprays.



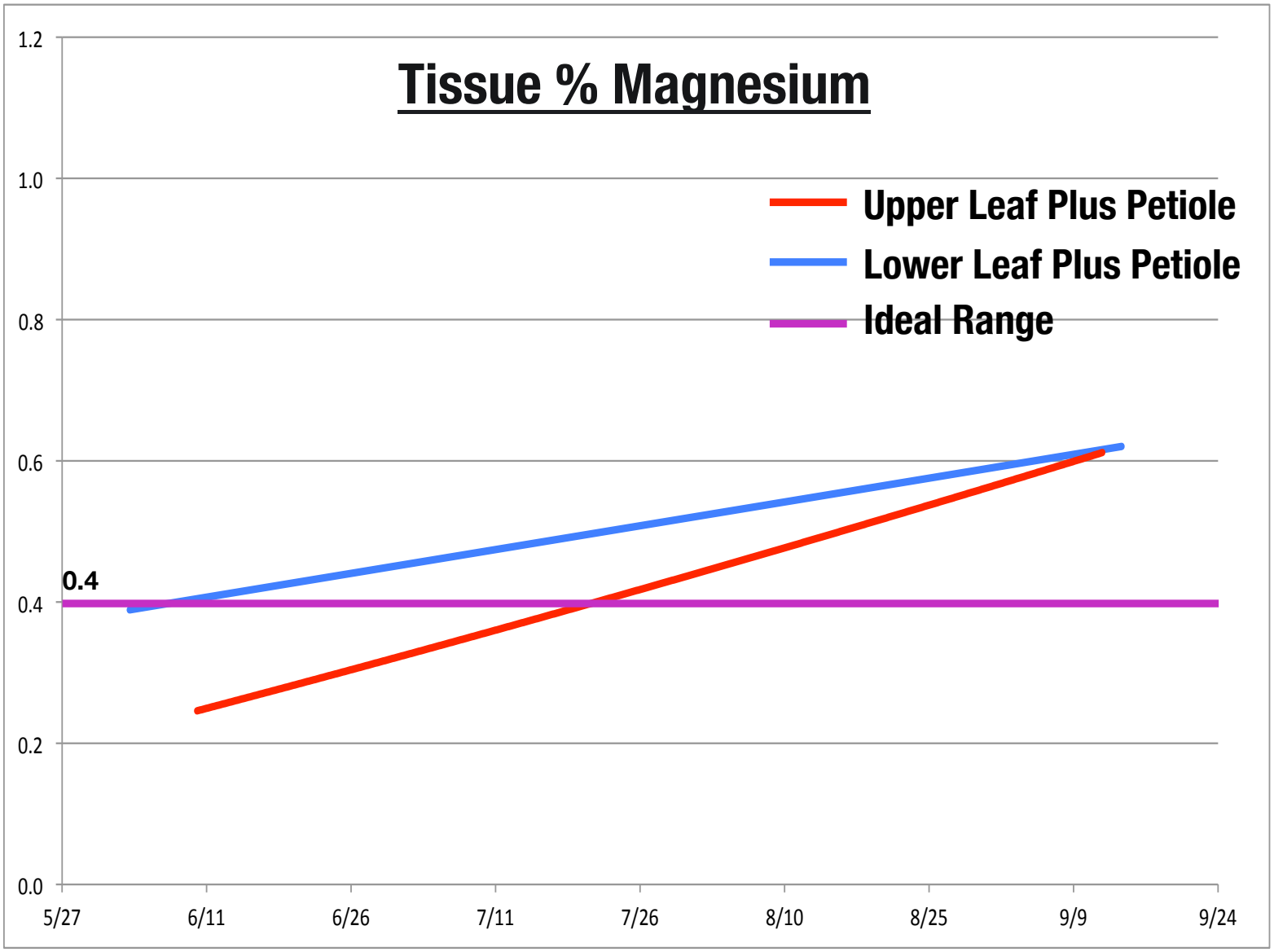
Most fields had adequate supplies of Sulfur.



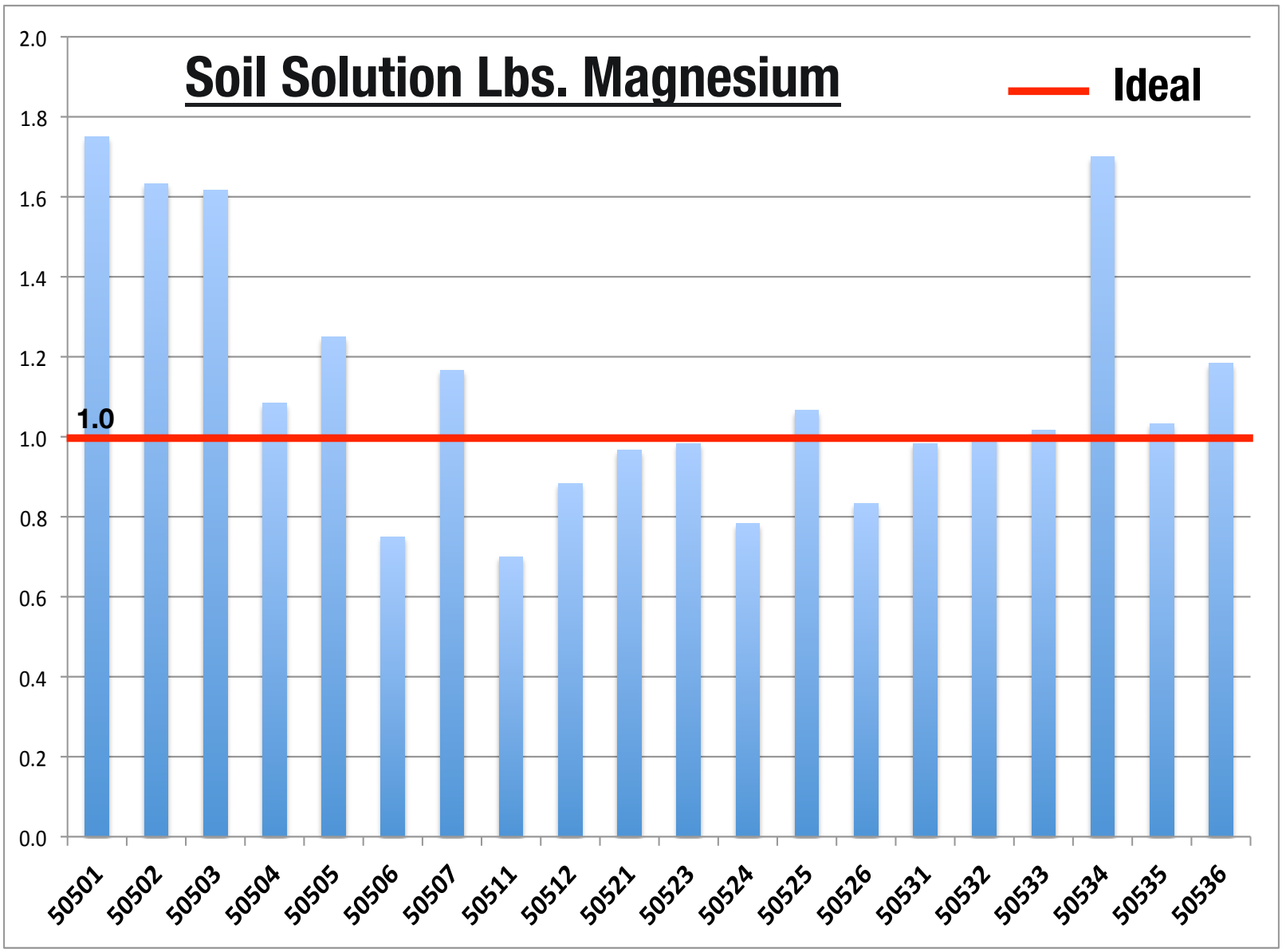
It's not uncommon for Calcium to increase with plant age. This is because Calcium precipitates in the cell wall and the plasma membrane. Calcium is very non mobile within the plant and if there is a calcium deficiency, foliar feeing may be the only alternative you have as long as your soil levels are adequate.



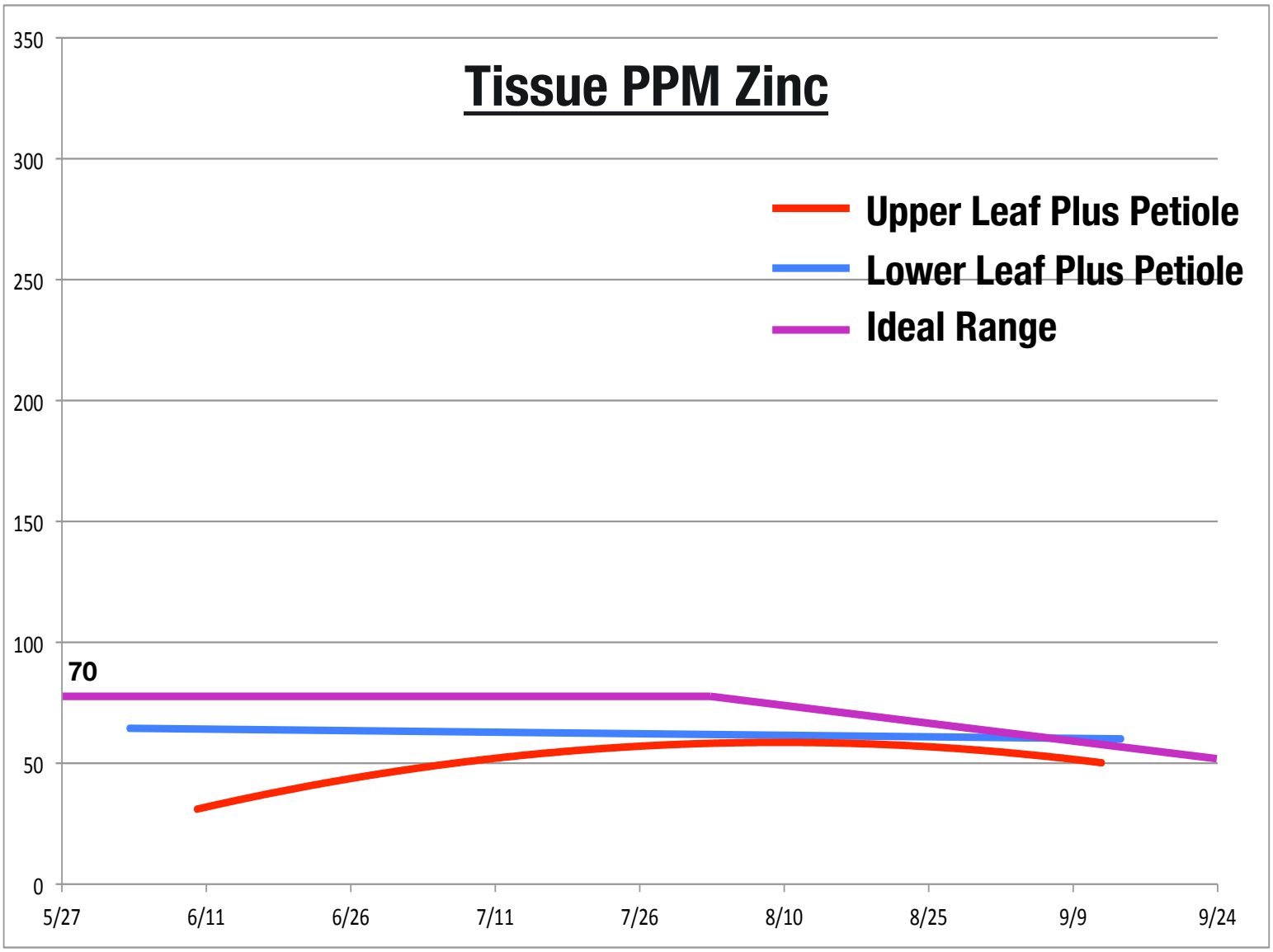
All fields had adequate Calcium supplies in the soil solution.



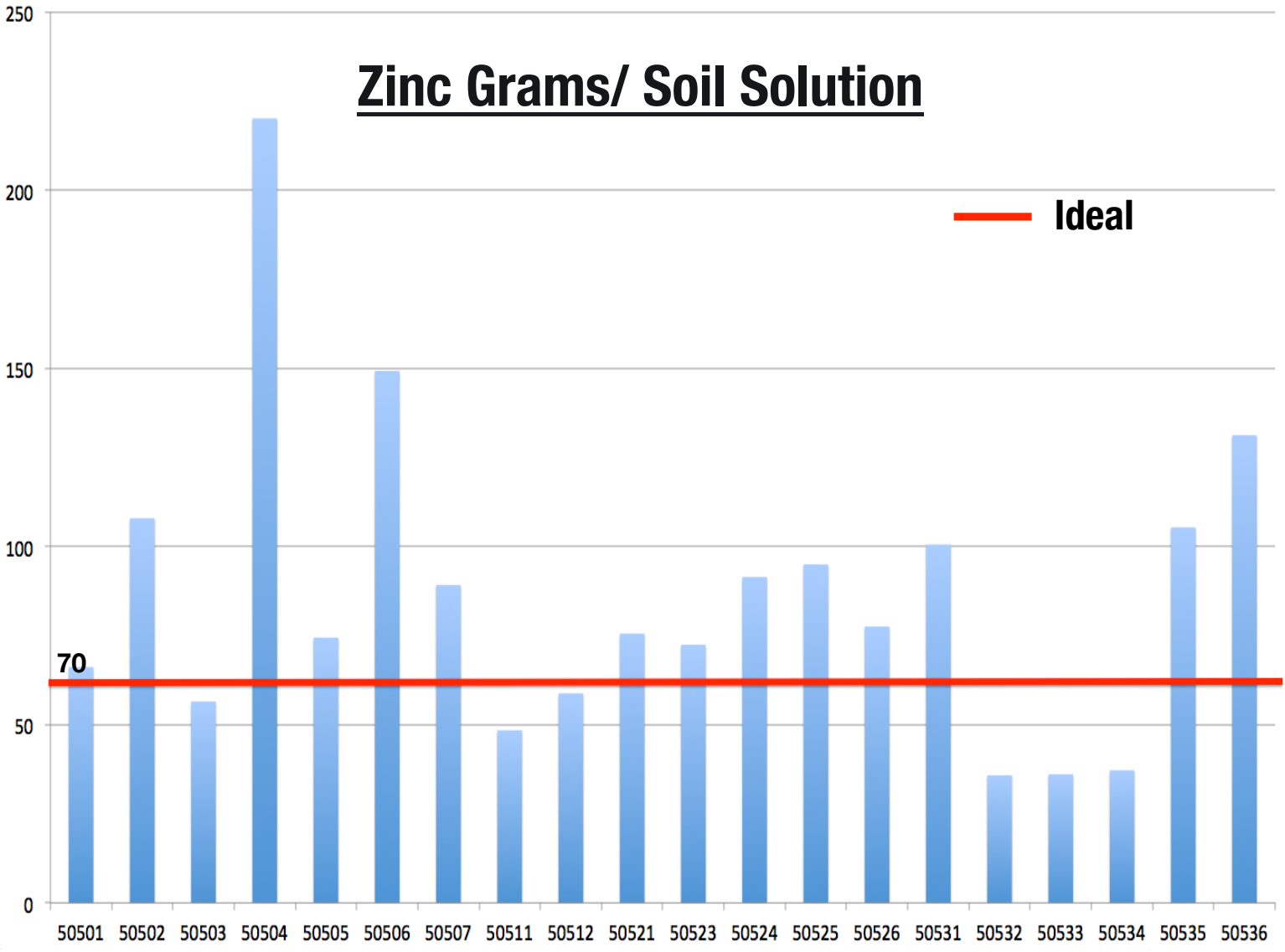
As a rule, Magnesium increases with plant age.



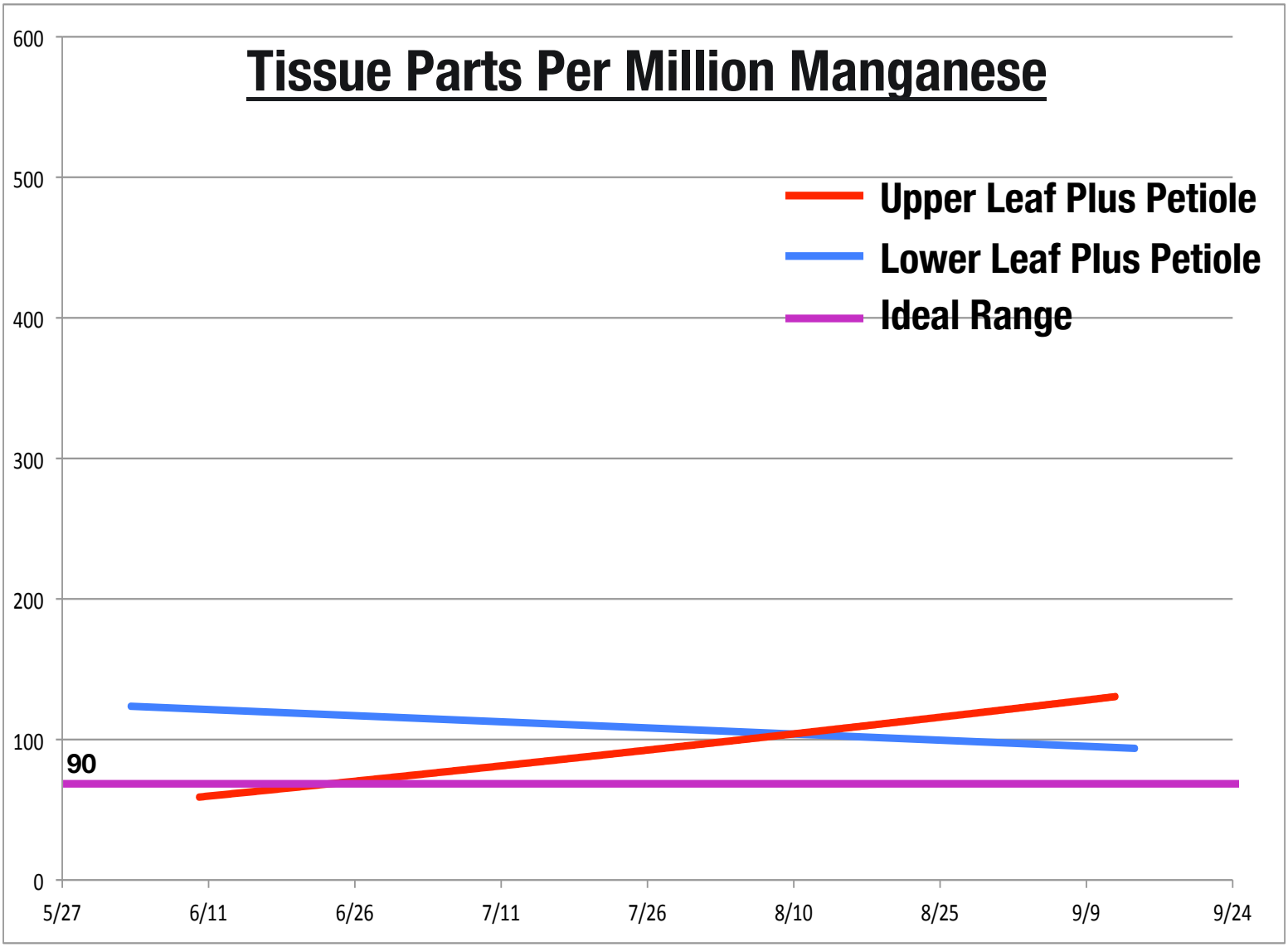
Most fields were adequate for Magnesium on a daily basis.



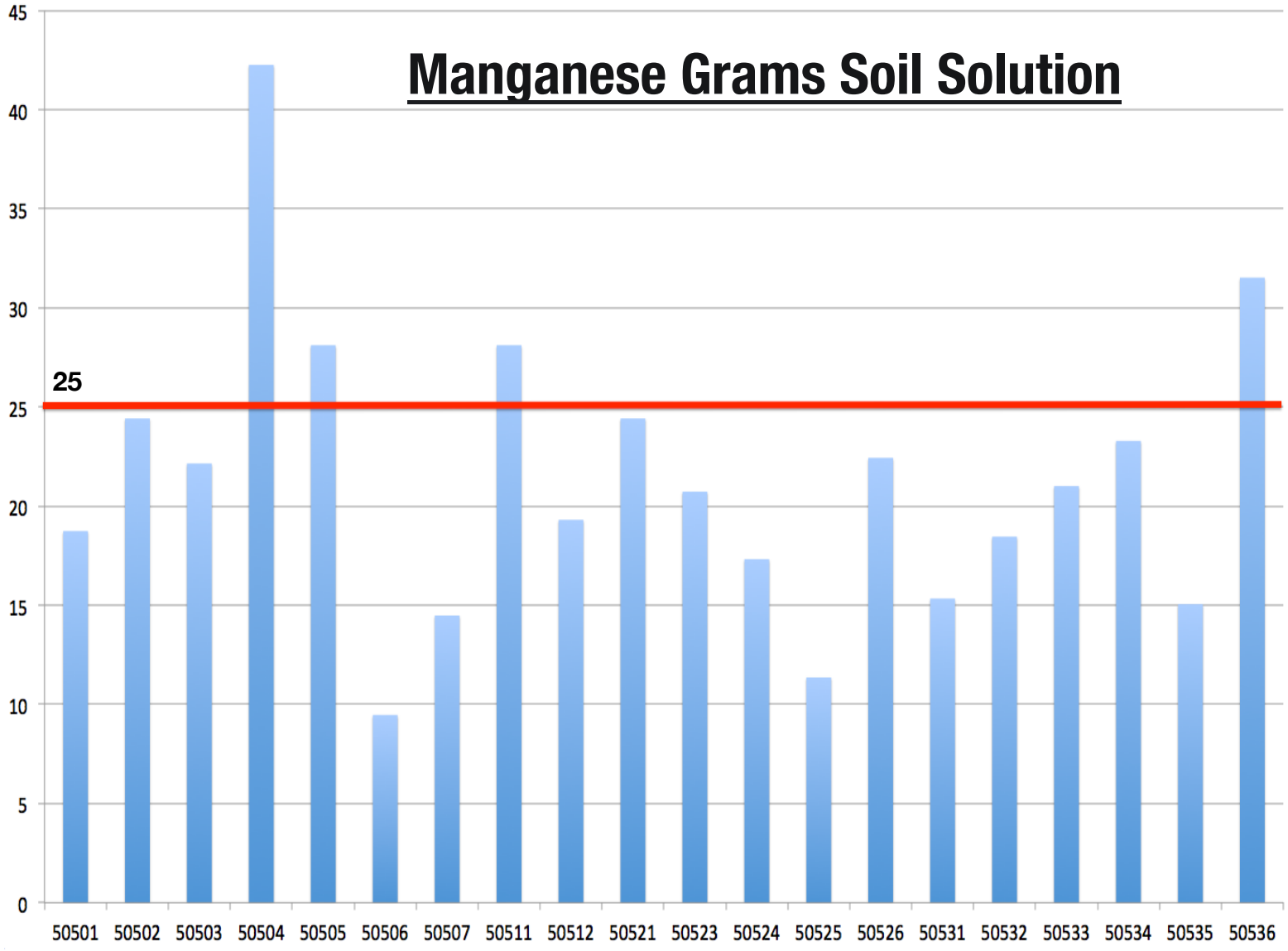
It appears more Zinc needs to be applied foliar.
Consider sulfates, citrate or amino acid chelates.



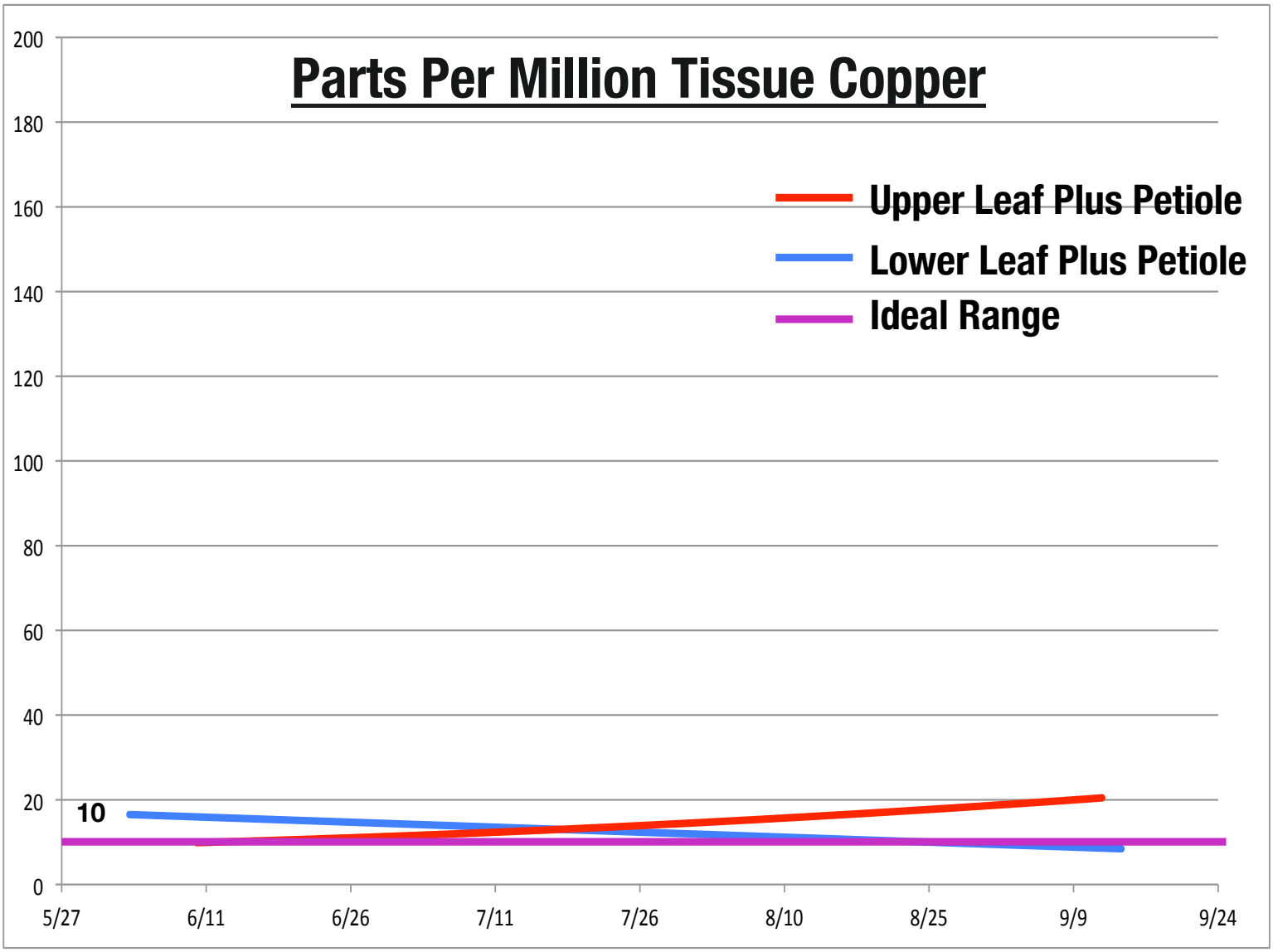
Some fields would benefit from Zinc Sulfates and Zinc EDTA chelates.



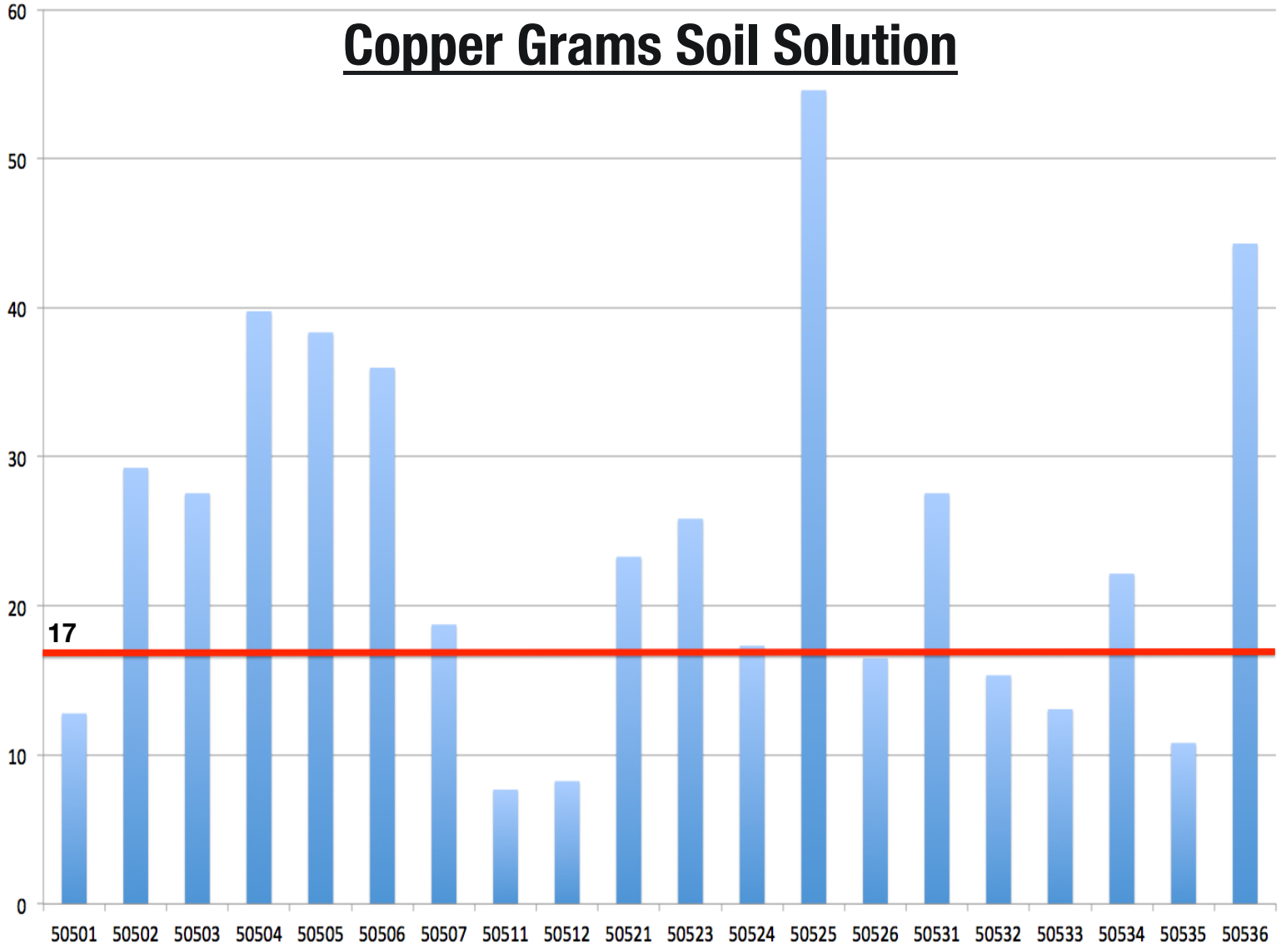
Tissue Manganese levels hung in there.



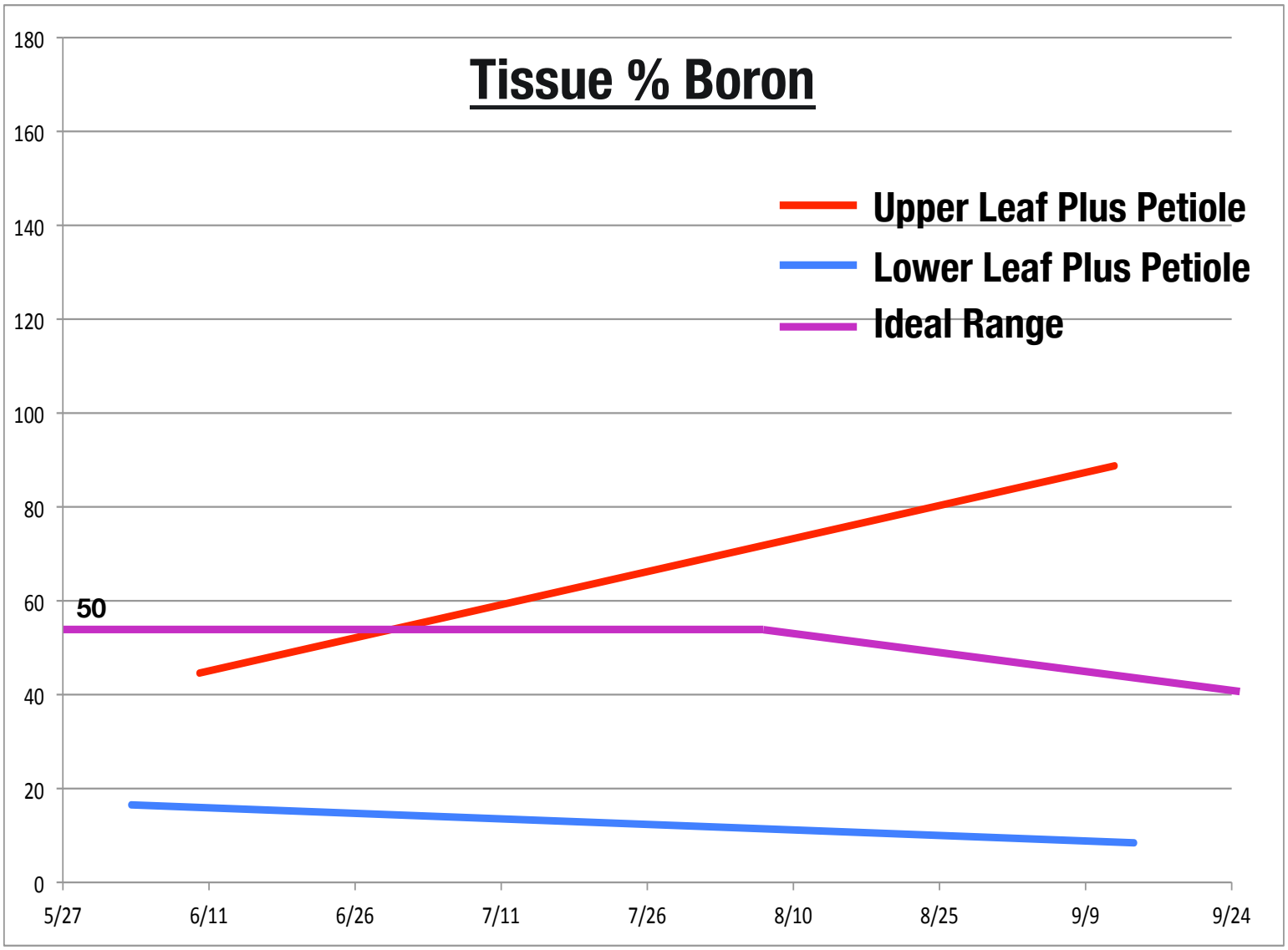
Manganese, Potassium and Boron appear to be the elements most lacking in this 2016 hop trial. These fields would benefit from sulfated and chelated Manganese.



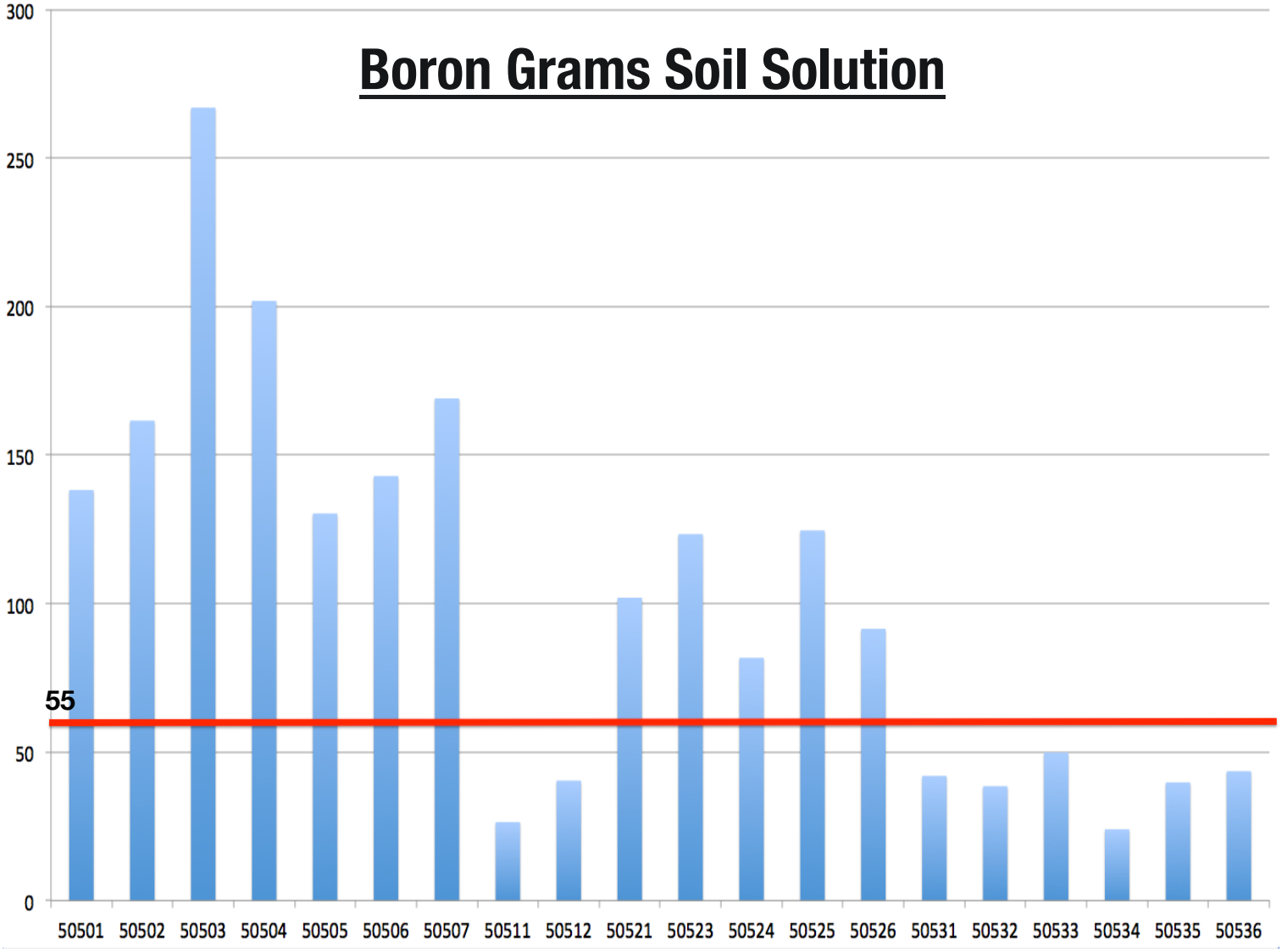
Copper could benefit from foliar sprays.



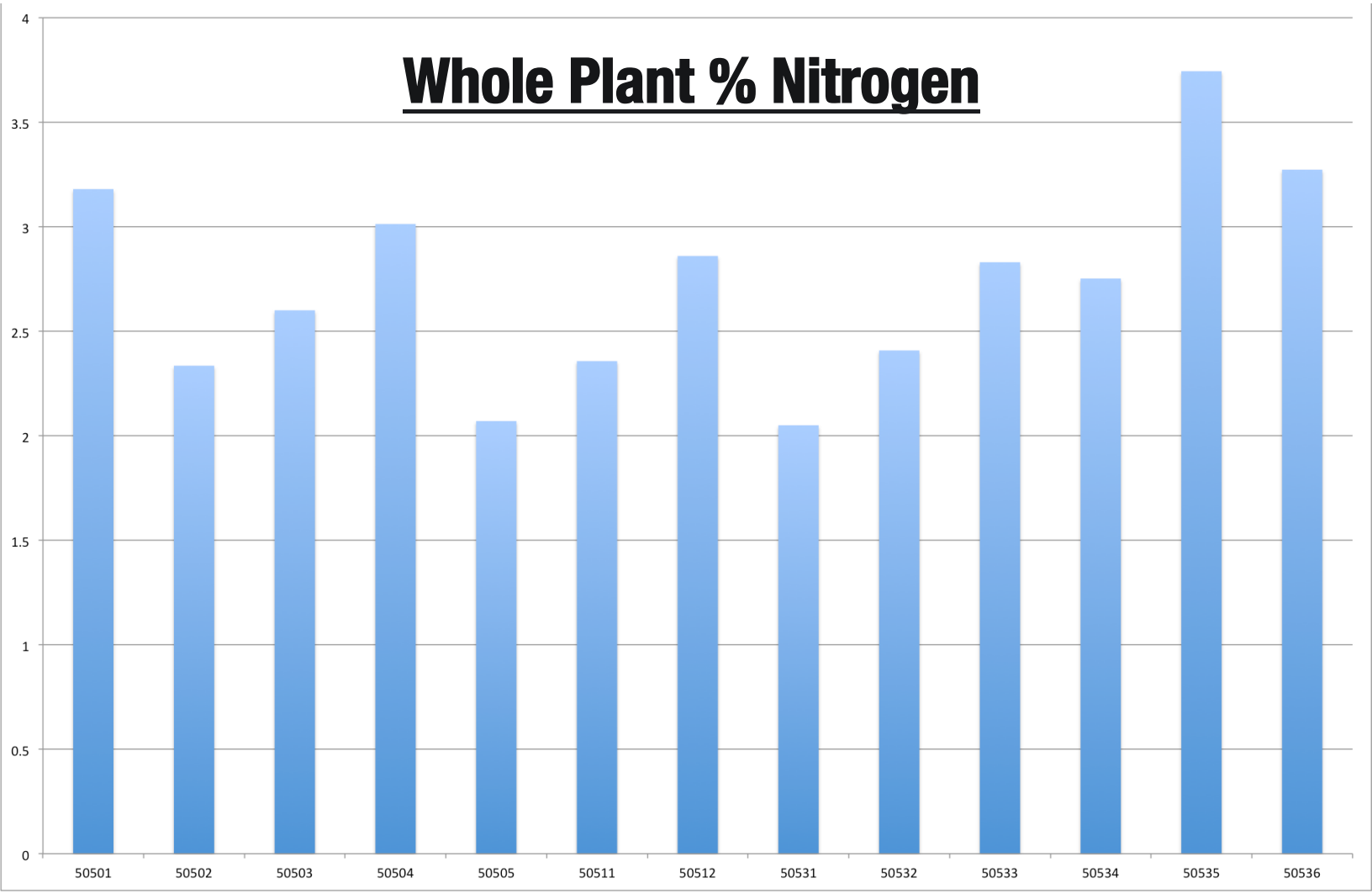
It appears adequate copper is in the soil and the roots aren't assimilating it.



It appears Boron and Potassium are the most limiting nutrients for maximum yields. More Boron needs to be added to your foliar program.

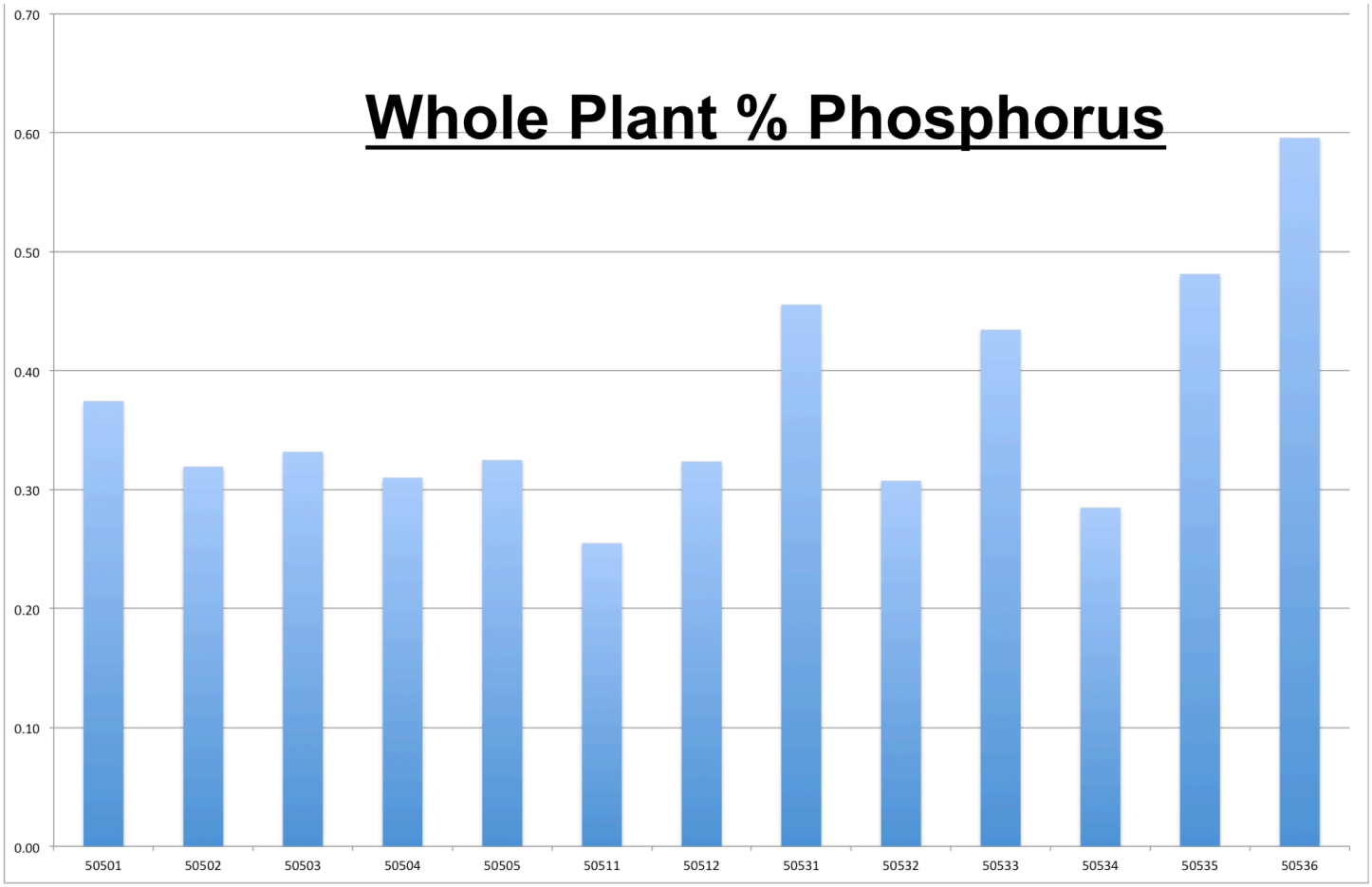


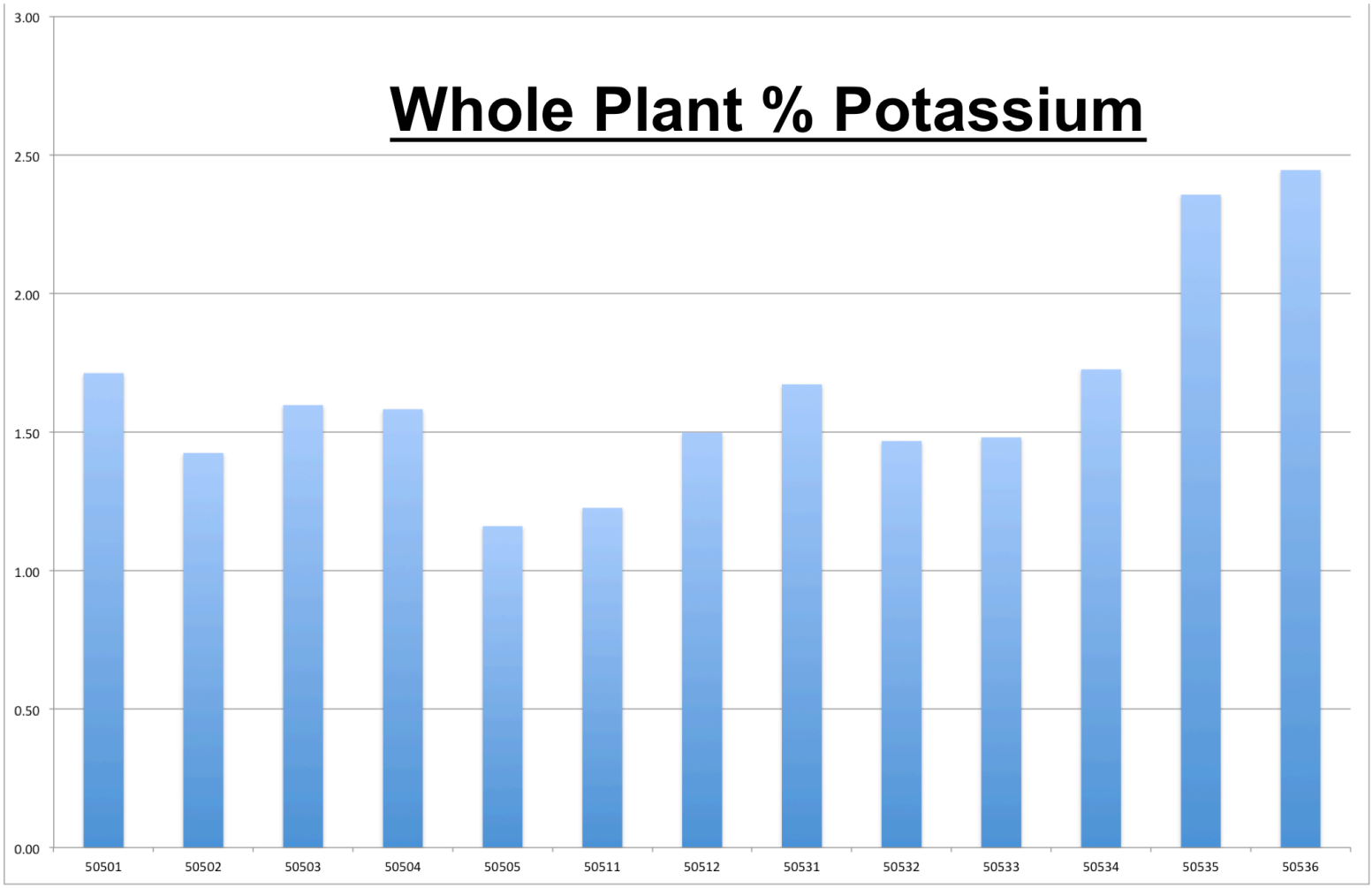
Some fields were low in Boron and all fields didn't assimilate enough Boron to meet daily requirements.

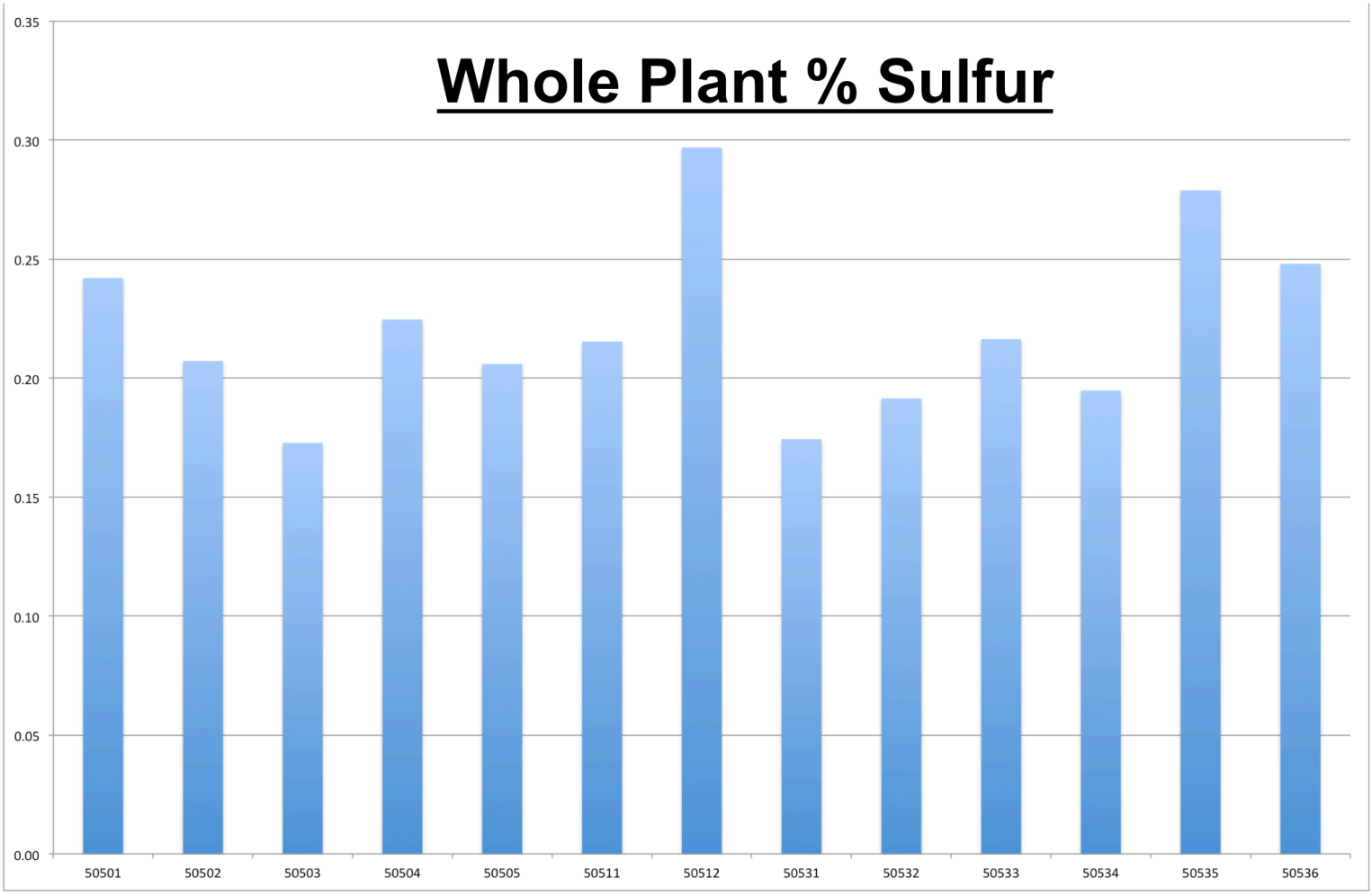


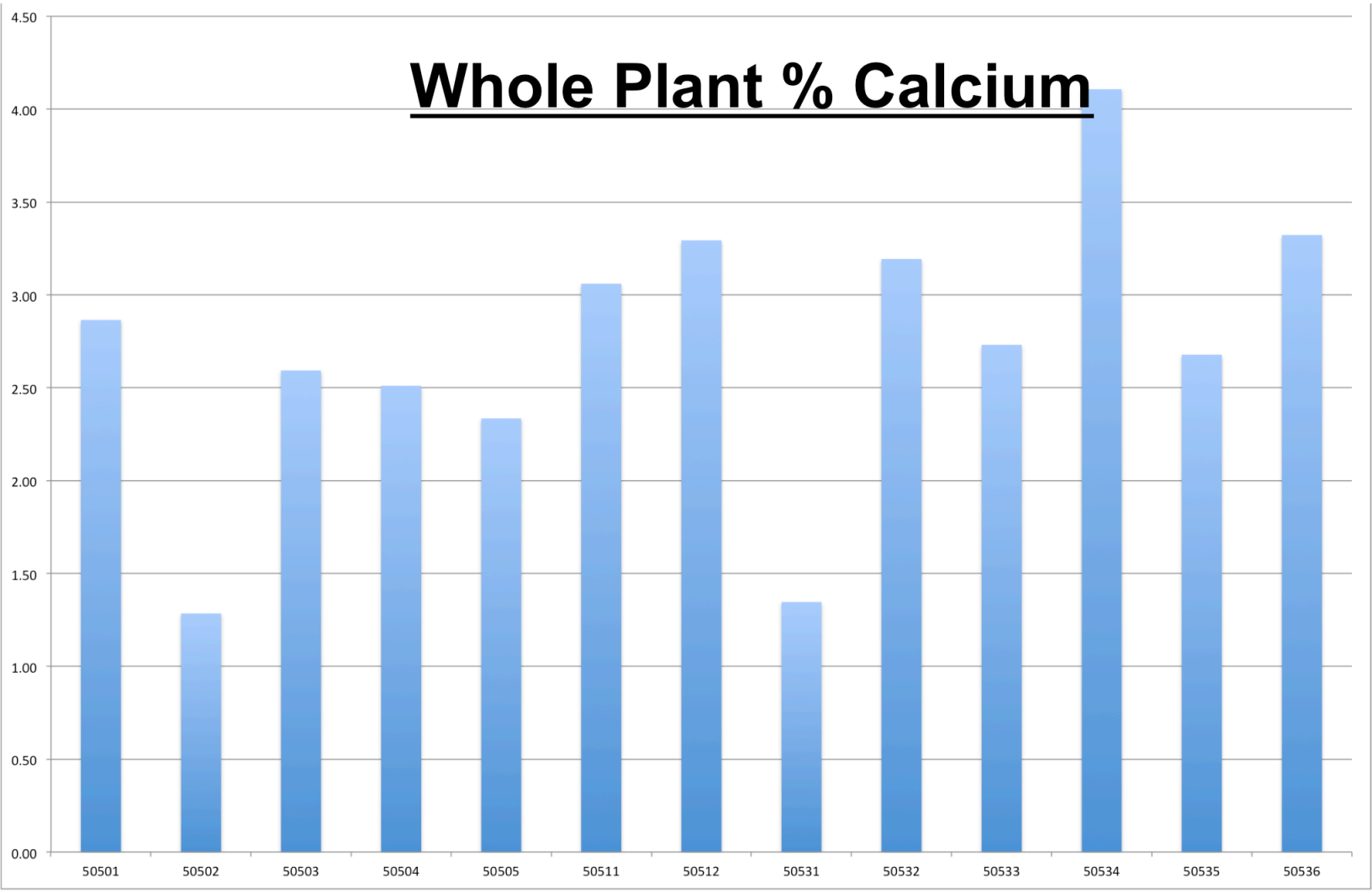
13 fields were tested for nutrient levels in the bines. Entire plants minus the cones were tested. These fields were collected on June 1st, July 1st, August 1st and September 1st. The following whole plant slides are the results from September 1st testing.

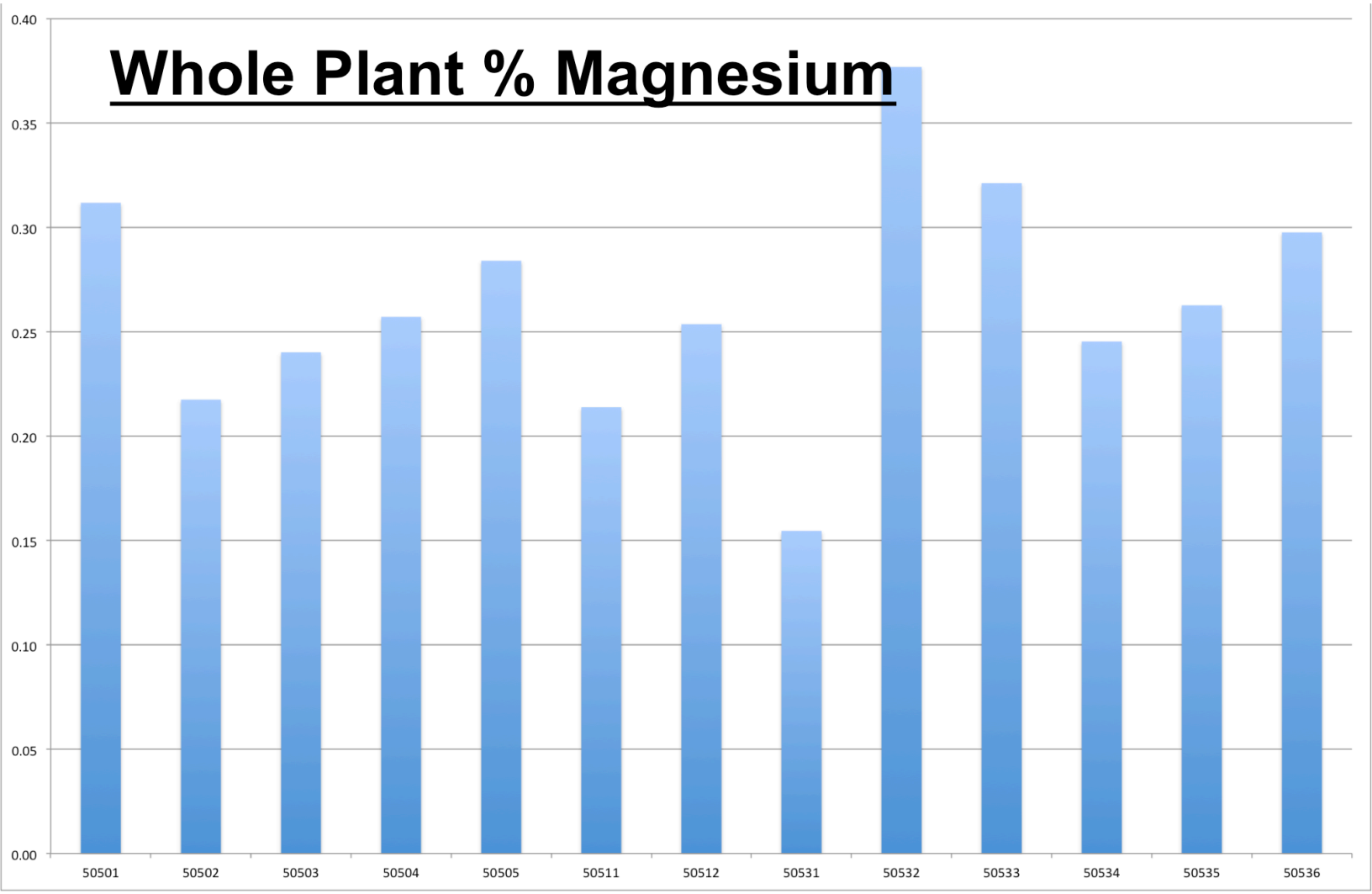
Total bines analysis per acre can be found on slide 54.

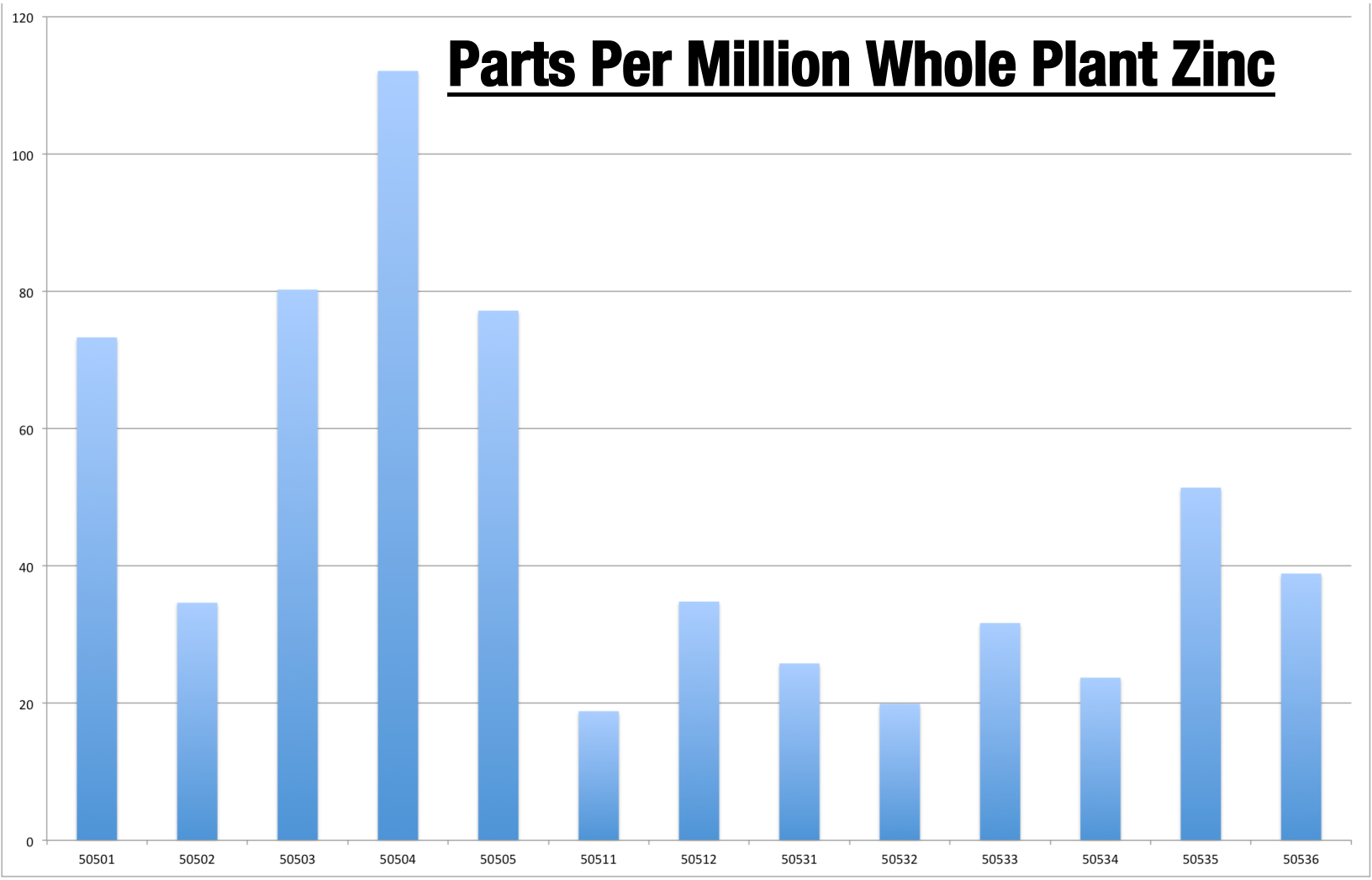

Whole Plant % Phosphorus
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

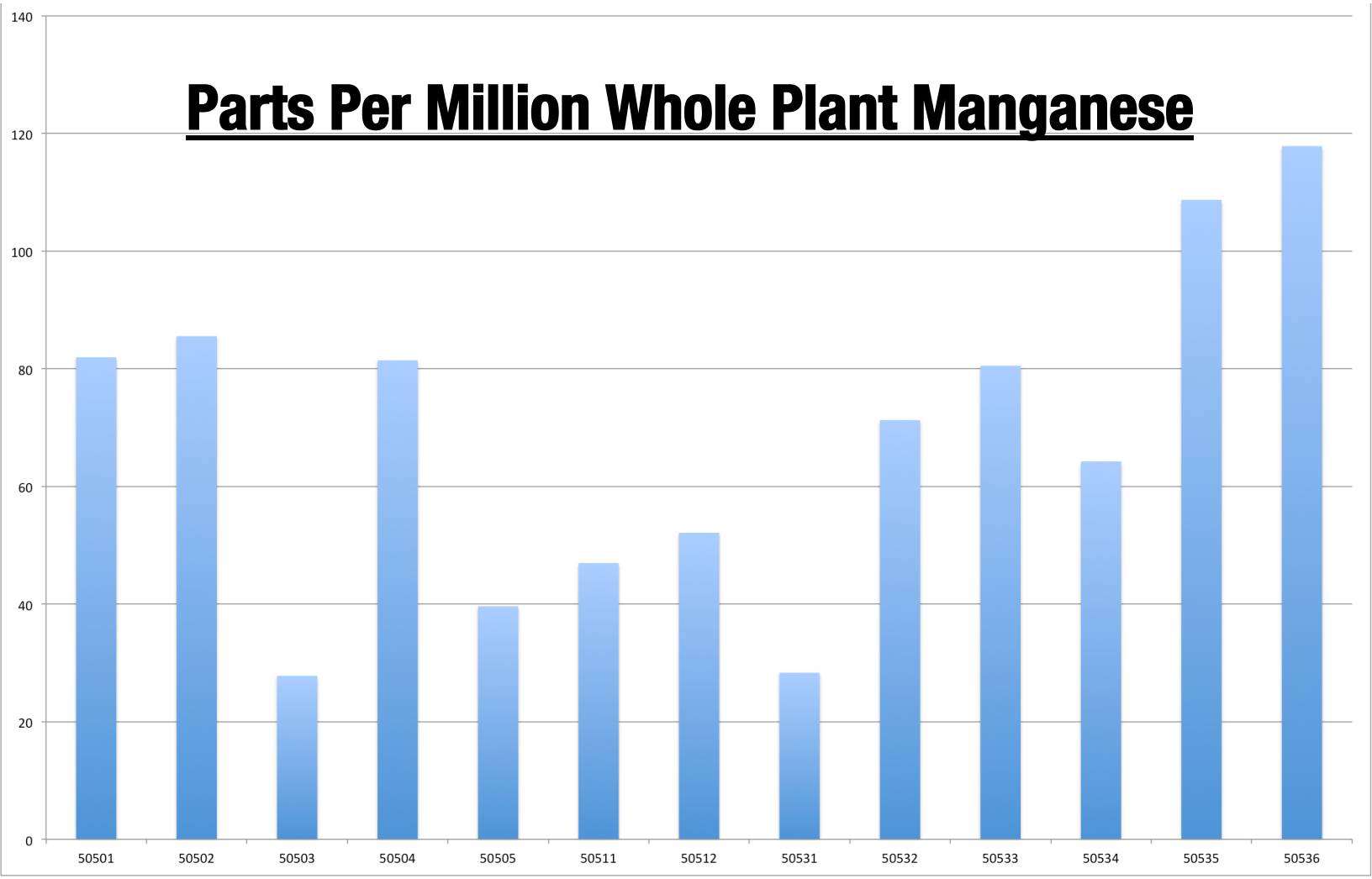

Whole Plant % Potassium
3.00
2.50
2.00
1.50
1.00
0.50
0.00
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

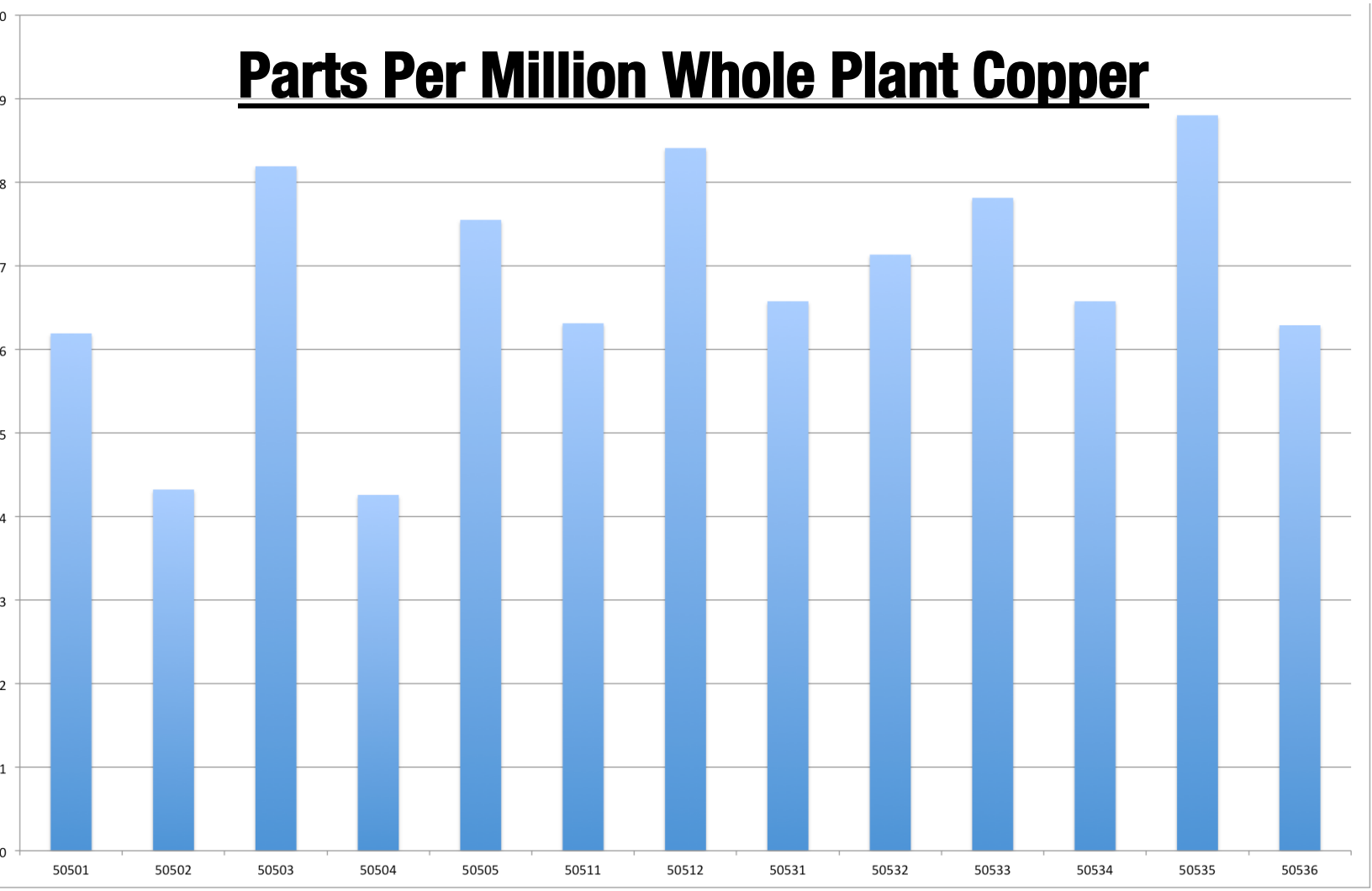

Whole Plant % Sulfur
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

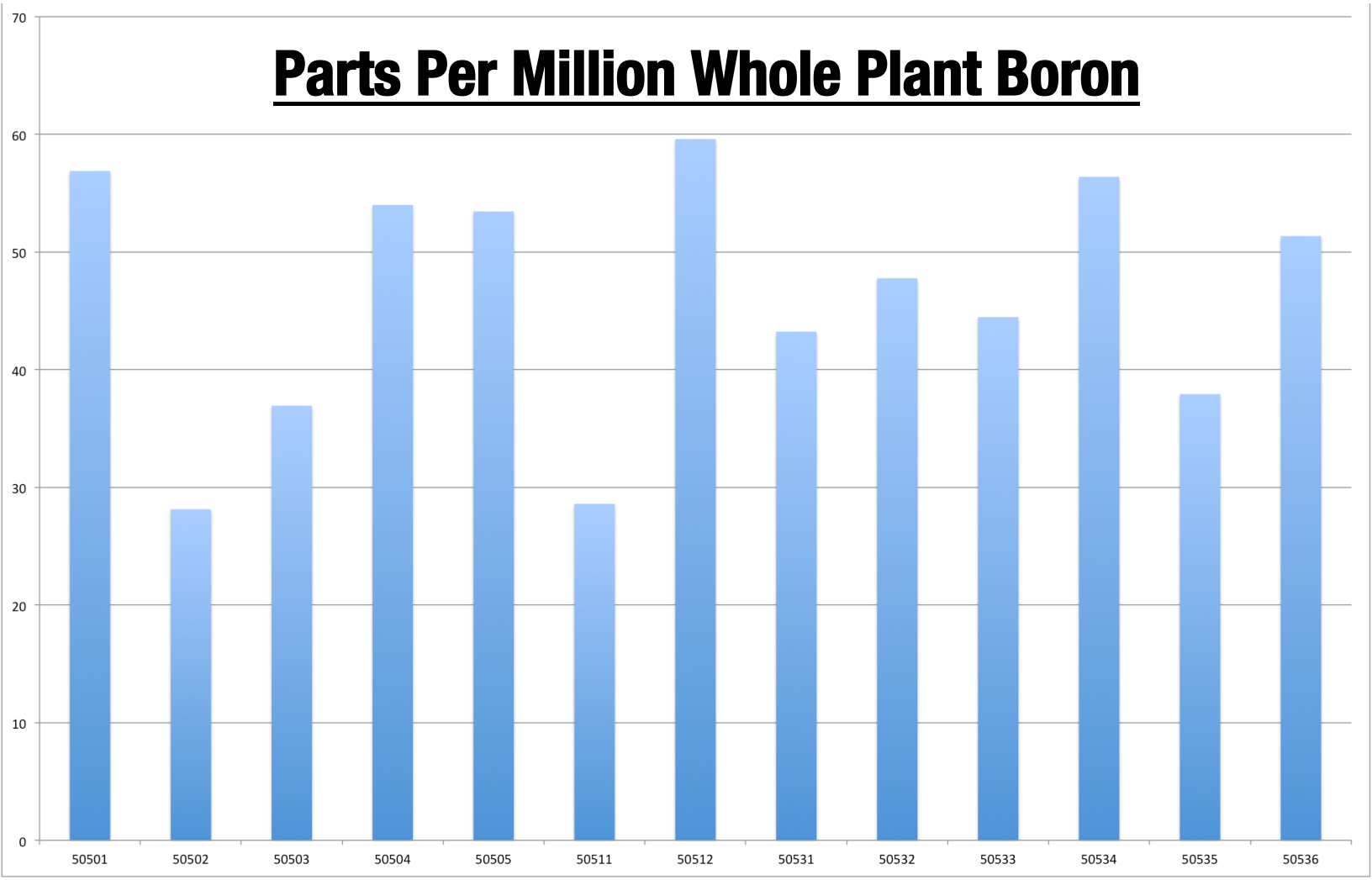

Whole Plant % Calcium
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

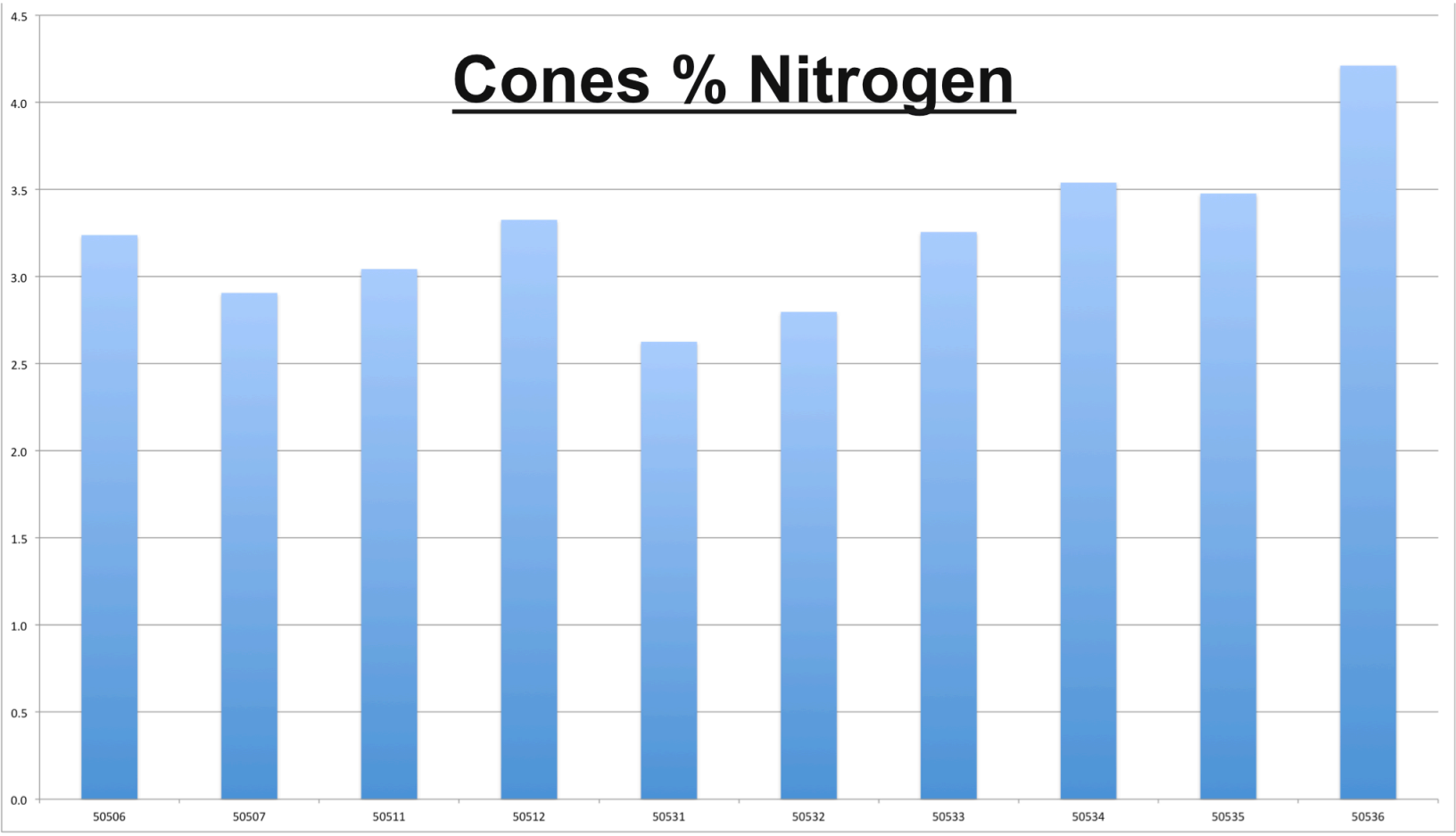

Whole Plant % Magnesium
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536


Parts Per Million Whole Plant Zinc
120
100
80
60
40
20
0
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

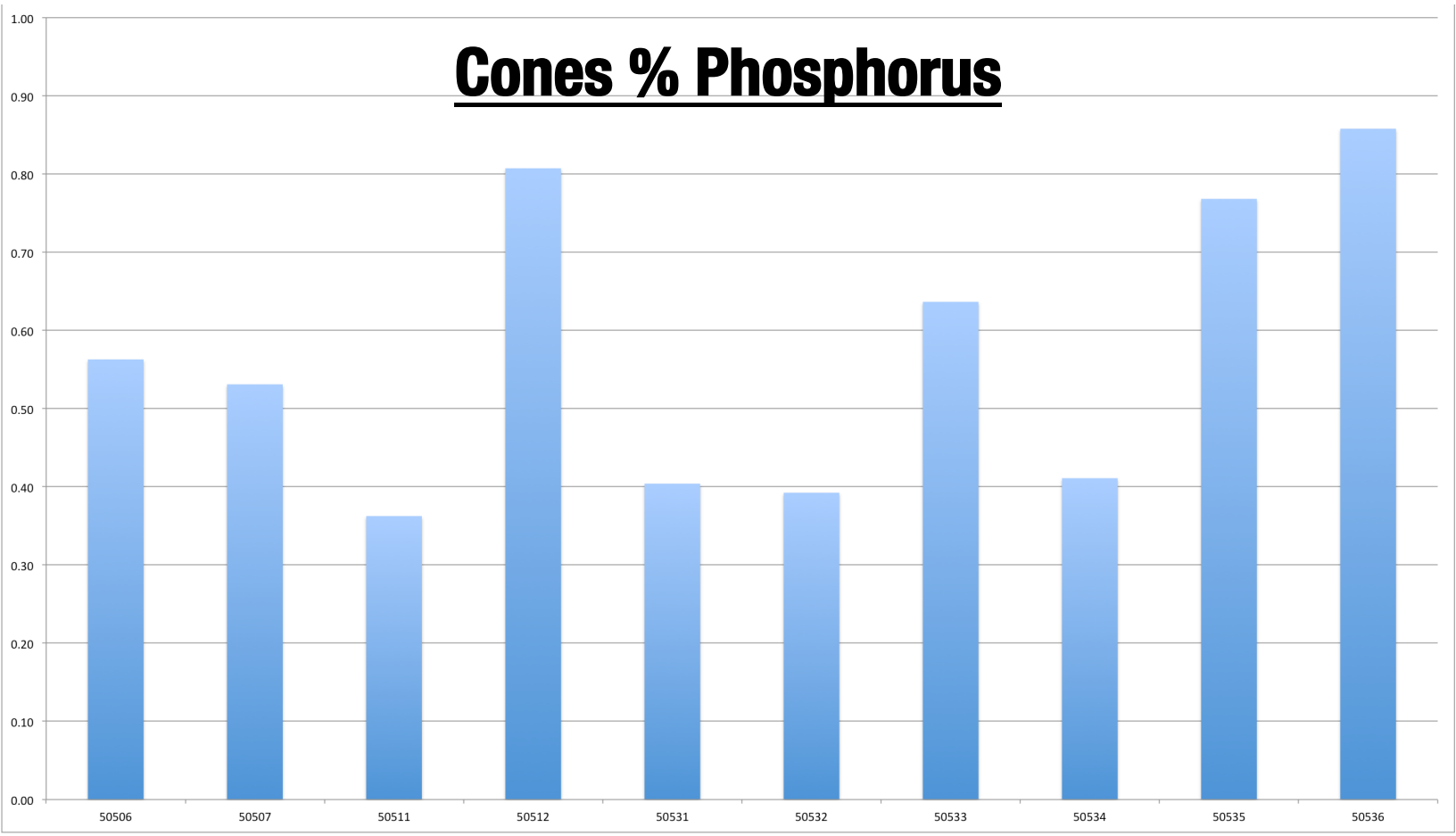

Parts Per Million Whole Plant Manganese
140
120
100
80
60
40
20
0
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

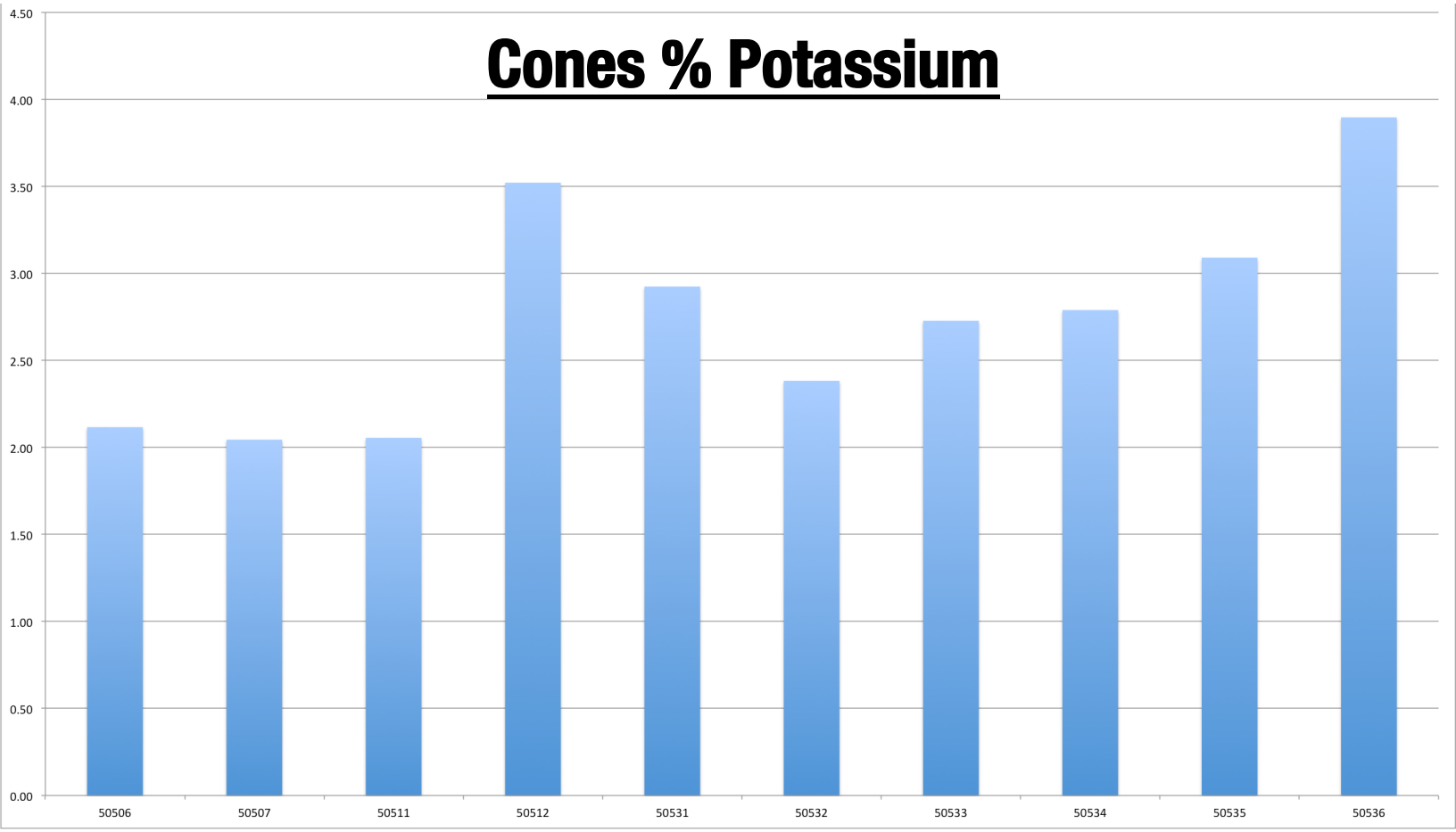

Parts Per Million Whole Plant Copper
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

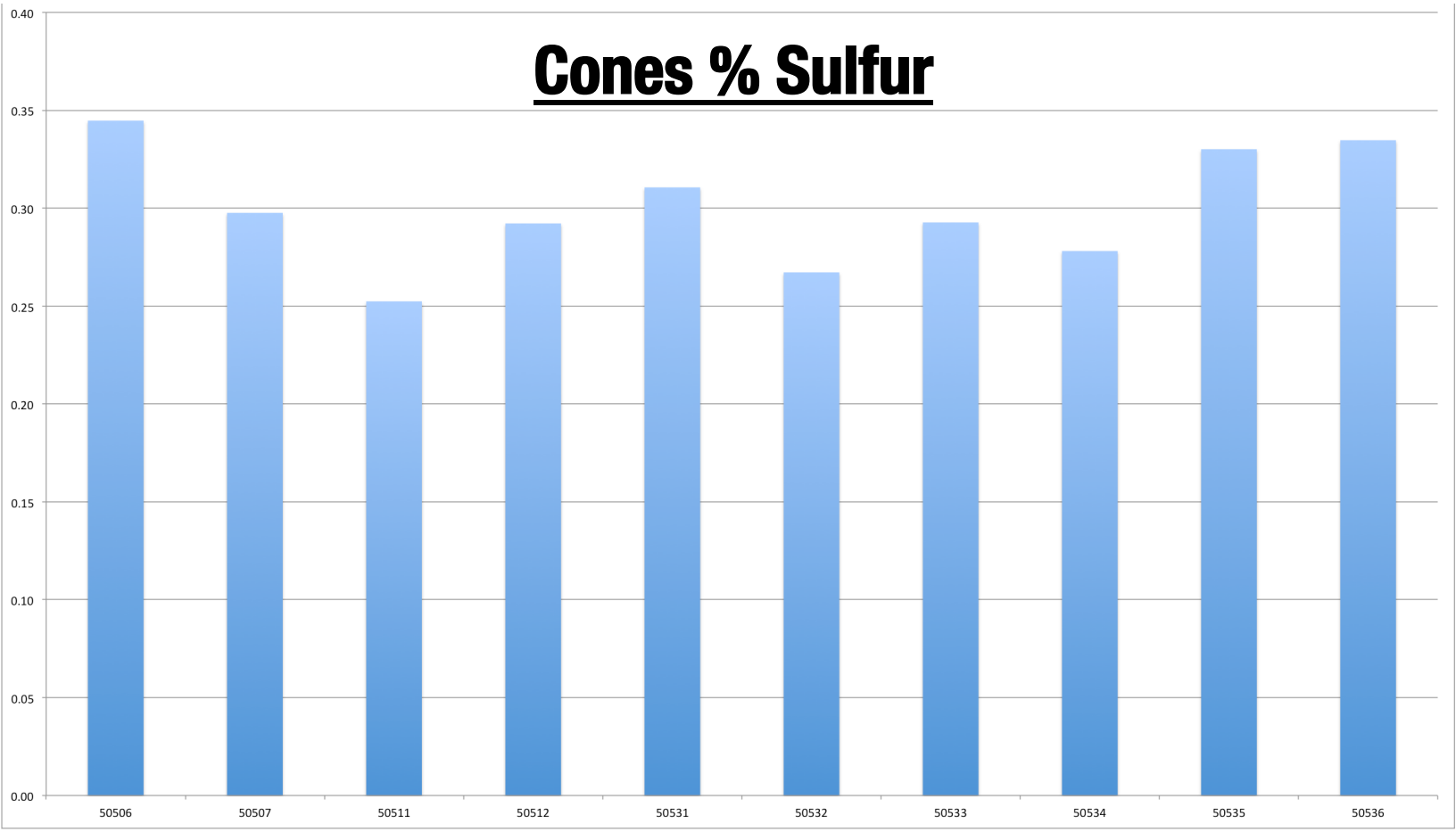

Parts Per Million Whole Plant Boron
70
60
50
40
30
20
10
0
50501
50502
50503
50504
50505
50511
50512
50531
50532
50533
50534
50535
50536

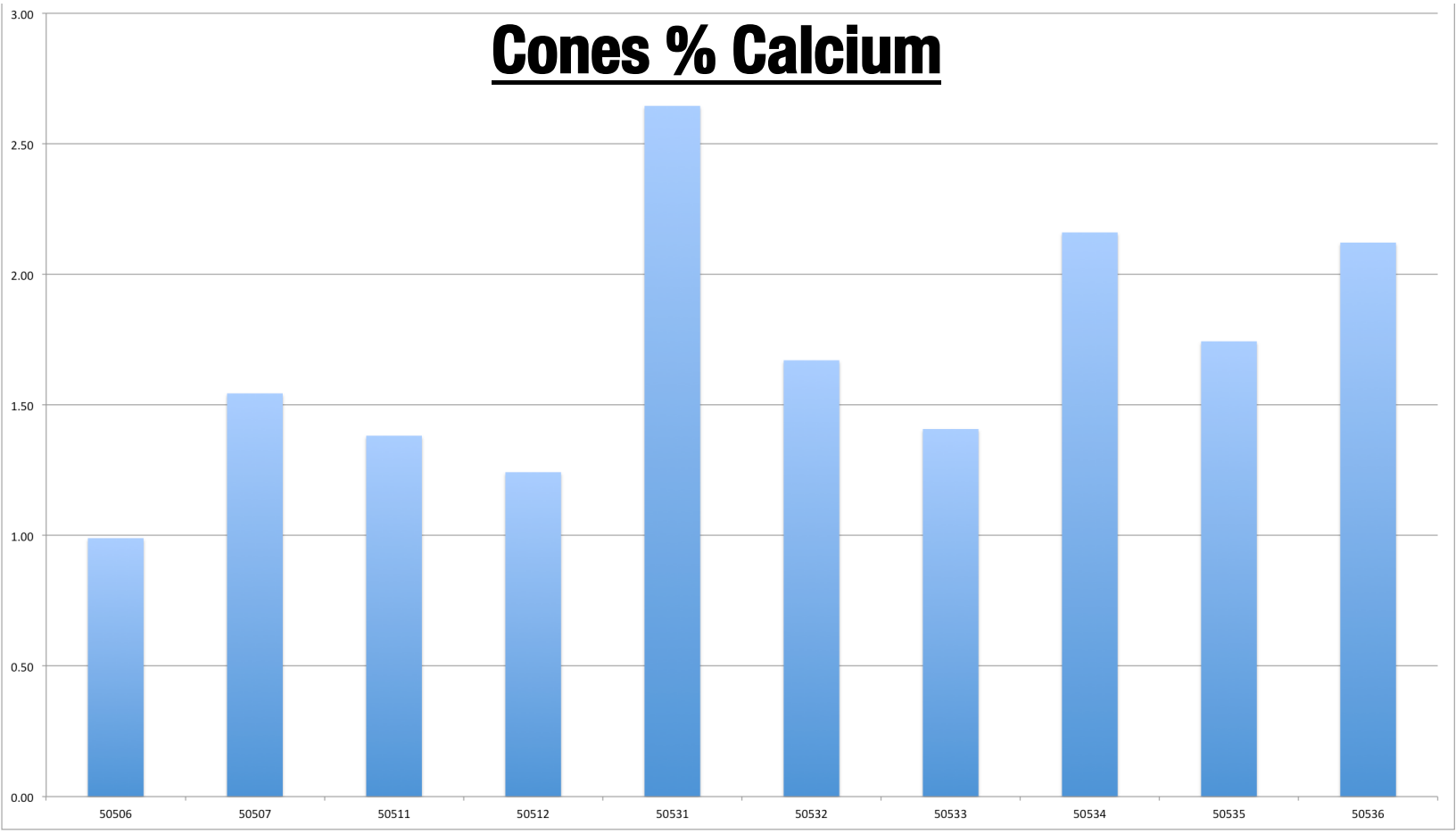


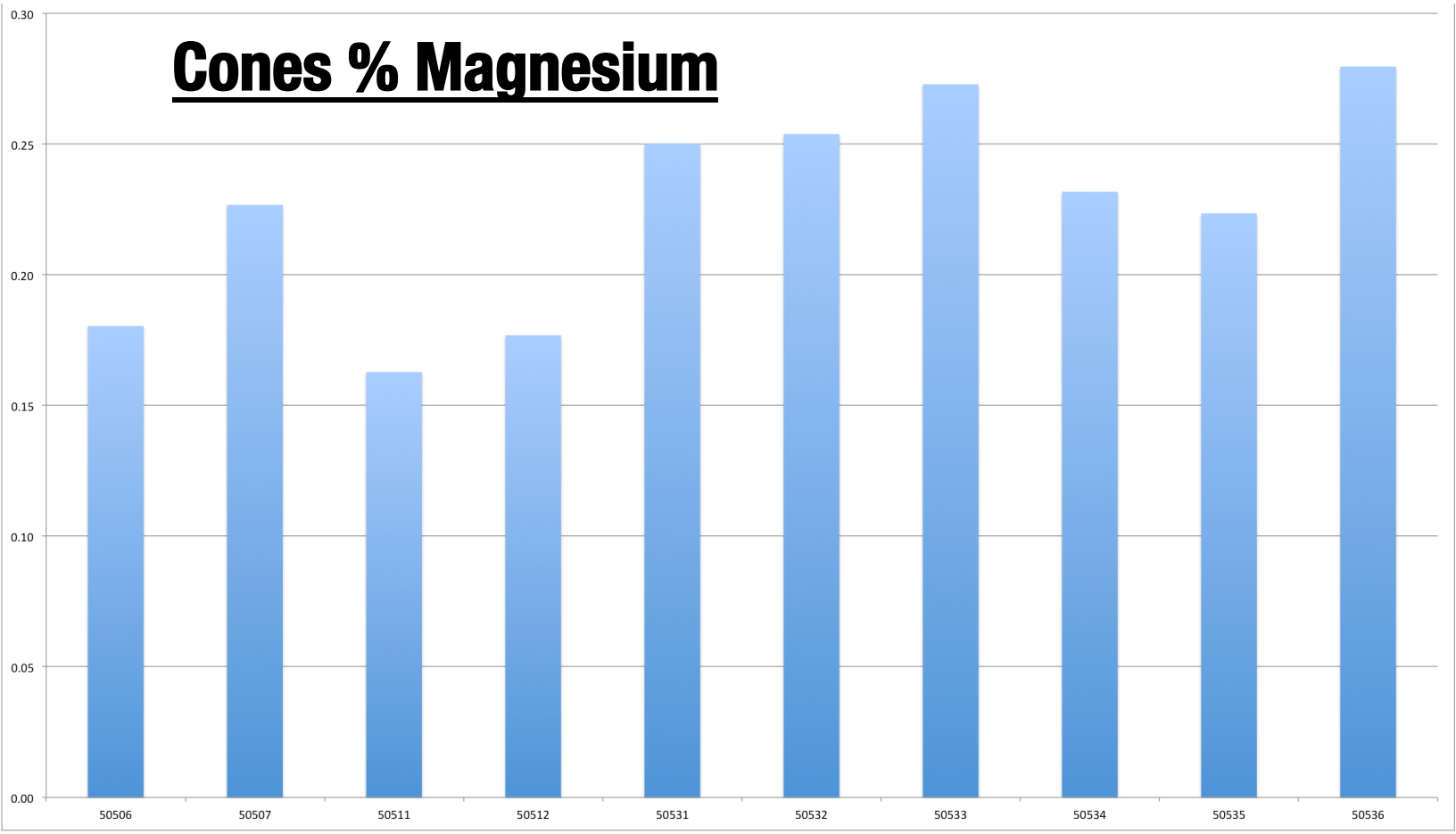
Cones were tested on 10 fields weekly from August 1st to September 1st. The following results are from September 1st. Since the bale weighs 200 pounds, % means pounds per 100 pounds. Multiply the number by 2 to get the pounds of nutrients per bale. For example: the average % reading was 3%. So 3 x 2 = 6, meaning there is 6 pounds of Nitrogen per bale of hops. Parts per million / 10,000 = %, times 2 would = pounds of micronutrients per bale.


Cones % Phosphorus
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536

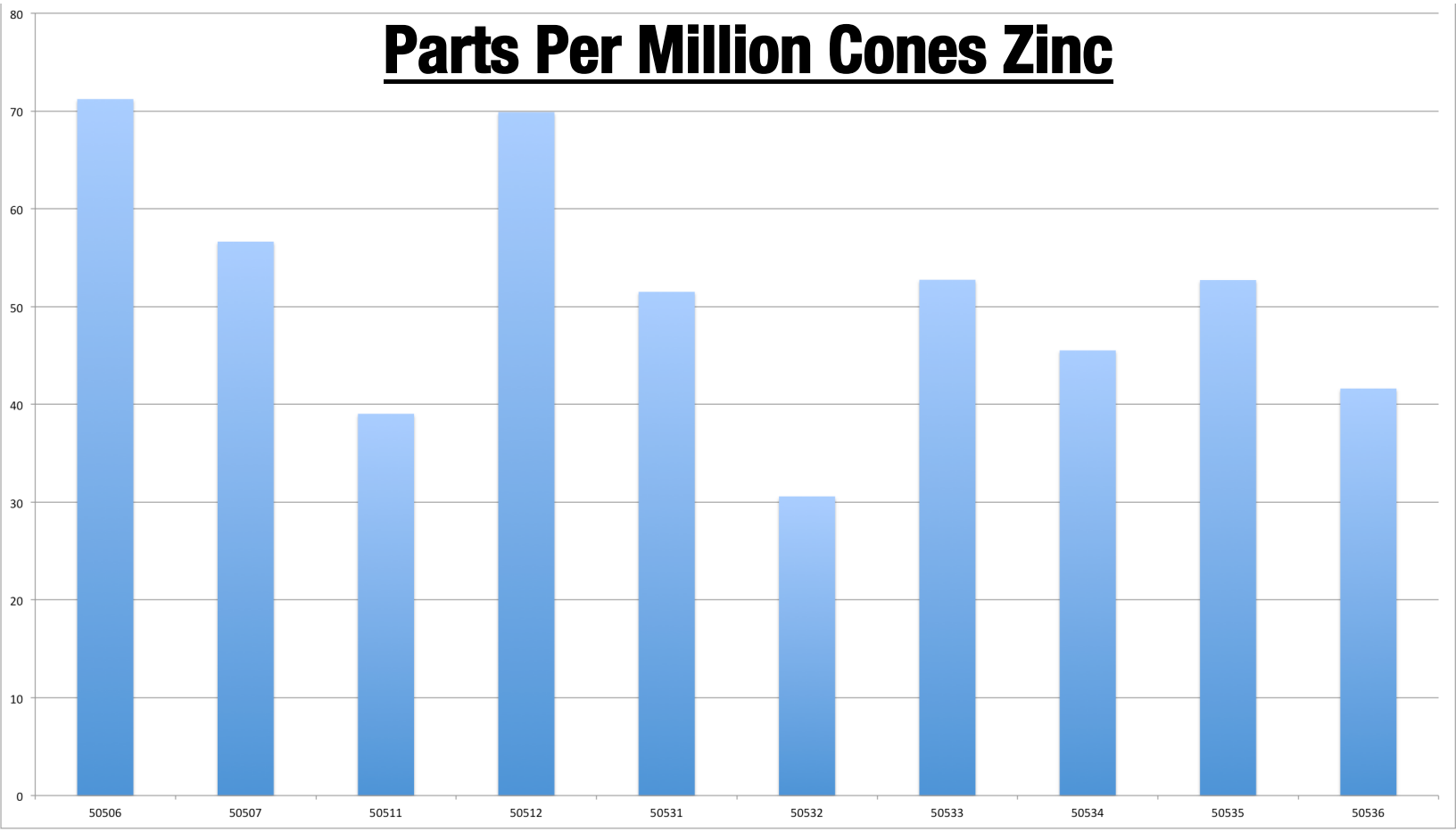

Cones % Potassium
4.50
4.00
3.50
3.00
2.50
2.00
1.50
1.00
0.50
0.00
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536

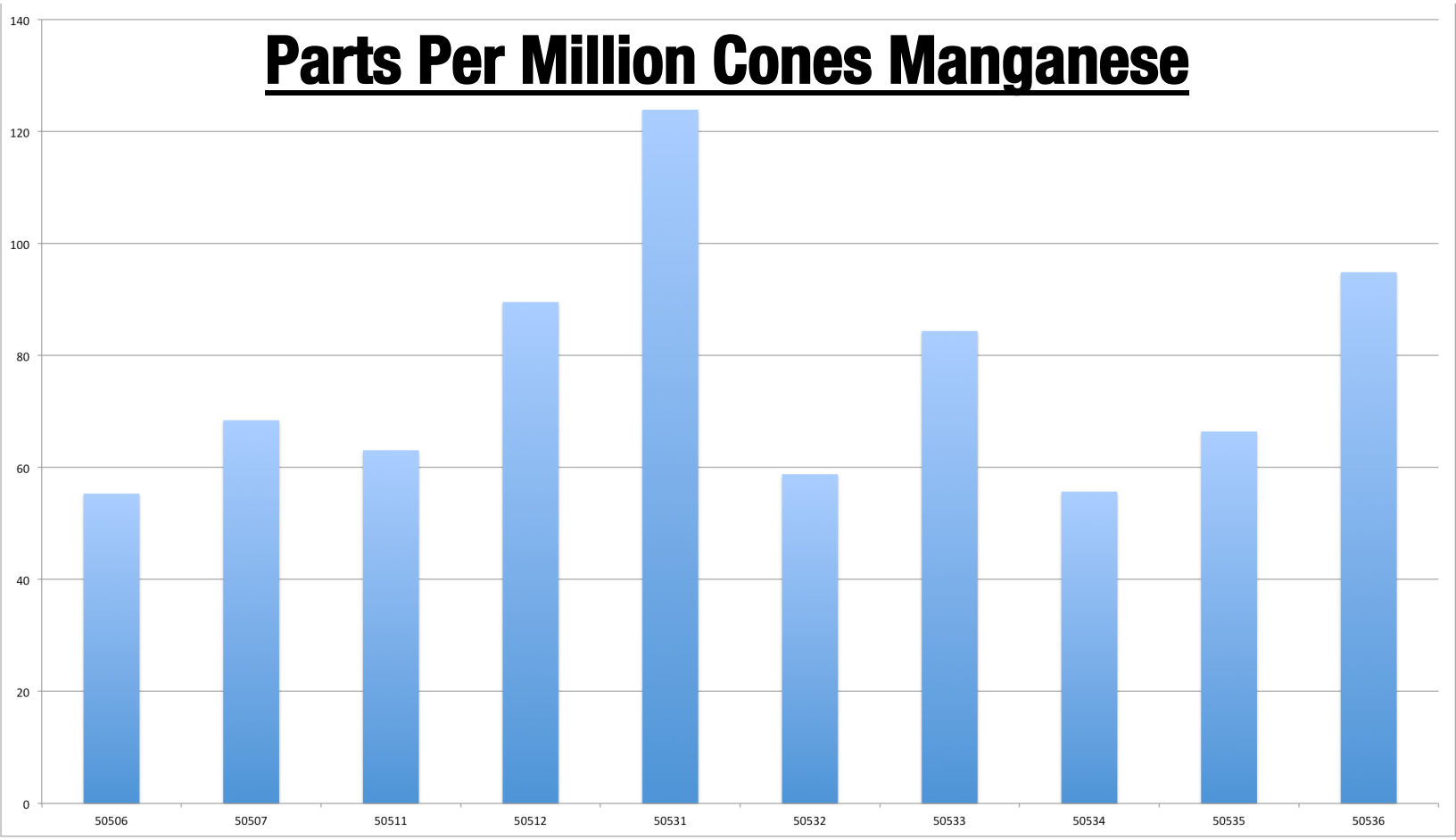

Cones % Sulfur
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536

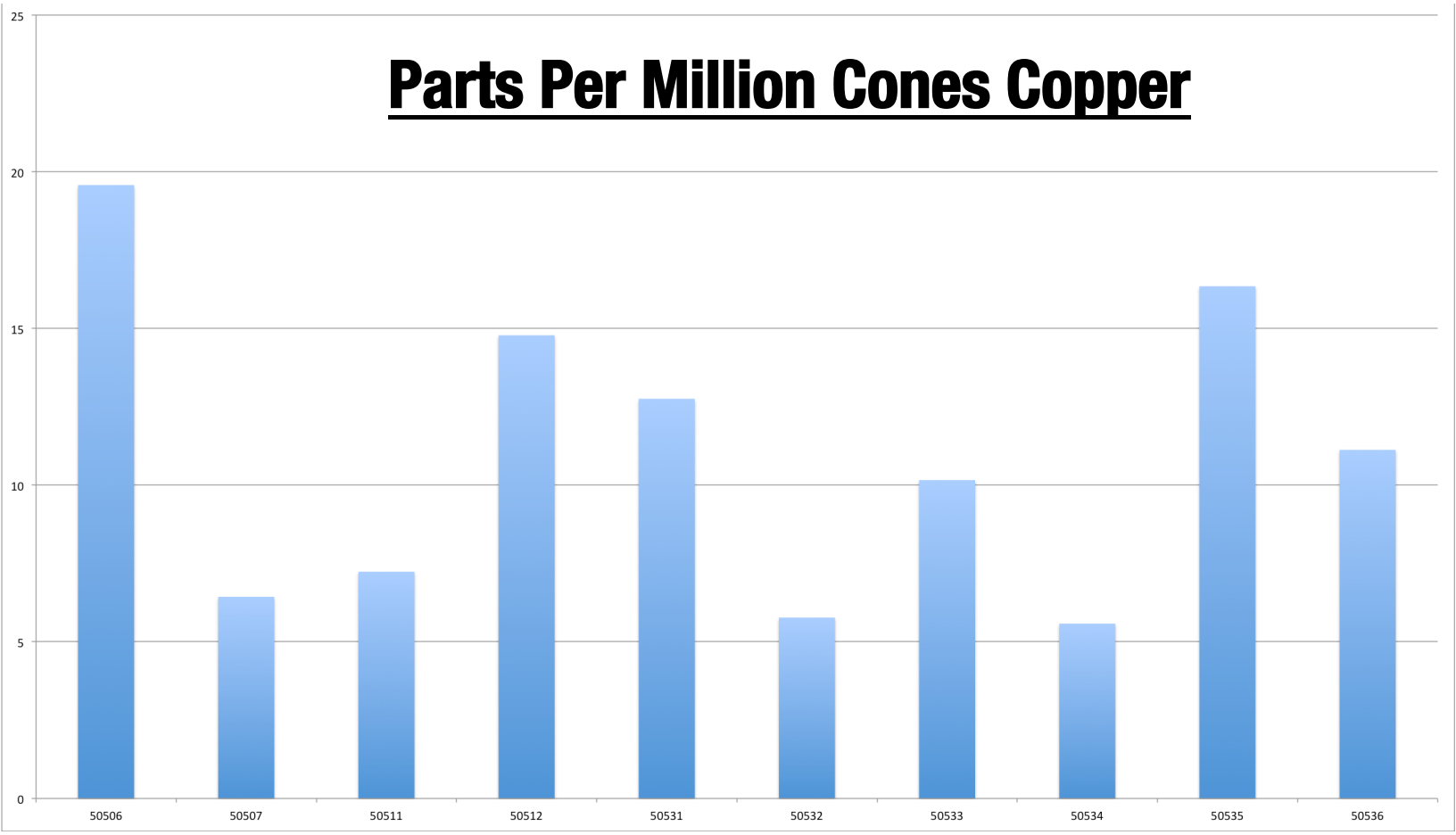

Cones % Calcium
3.00
2.50
2.00
1.50
1.00
0.50
0.00
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536

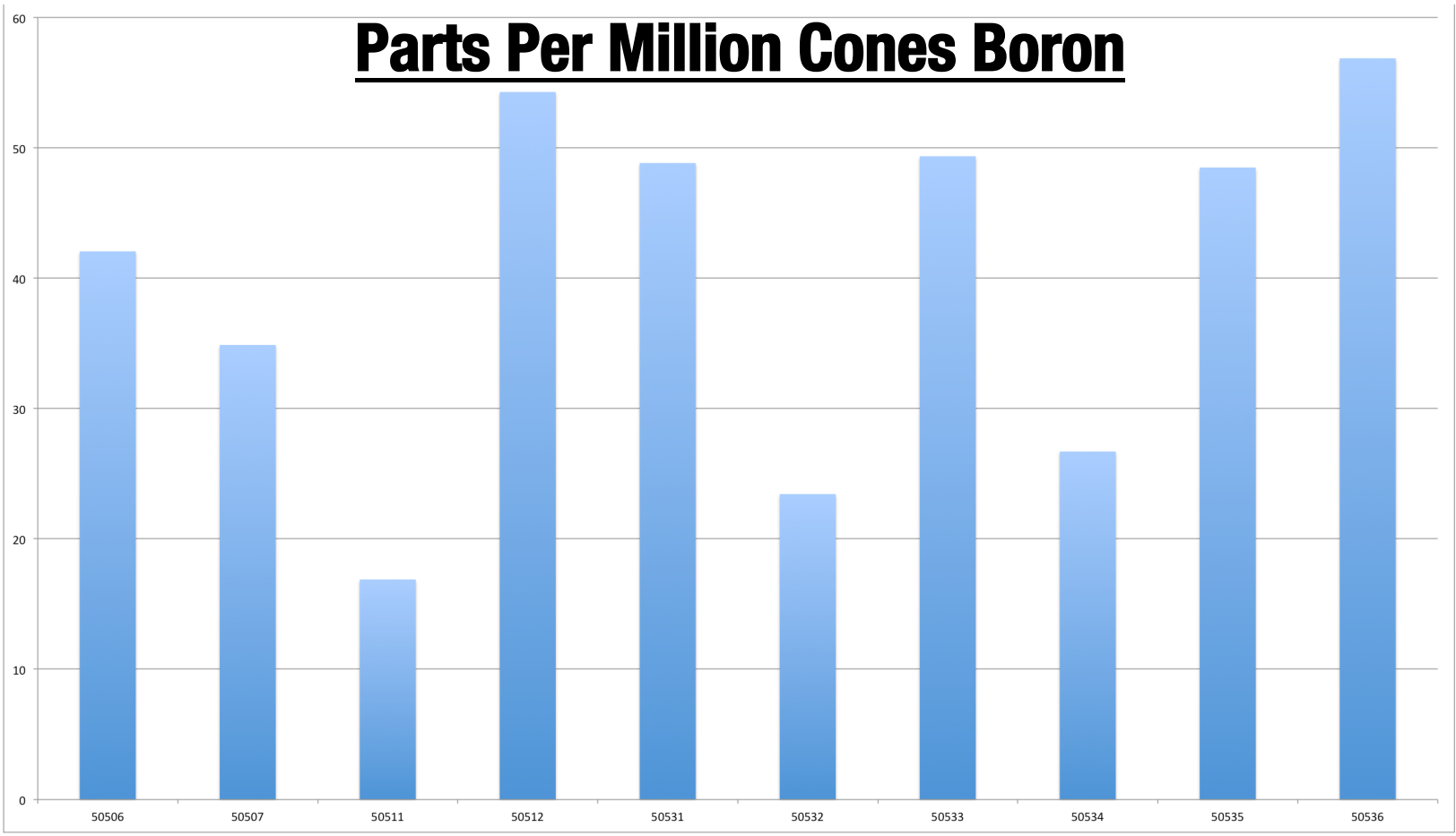

Cones % Magnesium
0.30
0.25
0.20
0.15
0.10
0.05
0.00
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536

Parts Per Million Cones Zinc



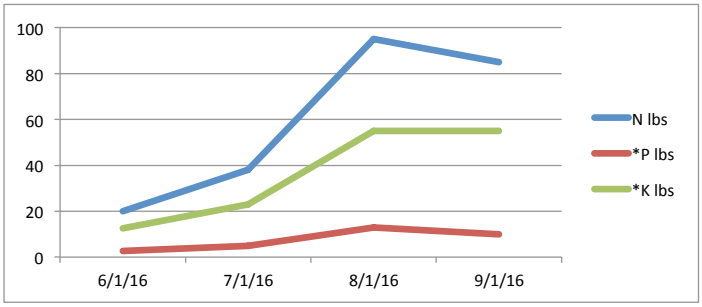

Parts Per Million Cones Manganese
140
120
100
80
60
40
20
0
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536

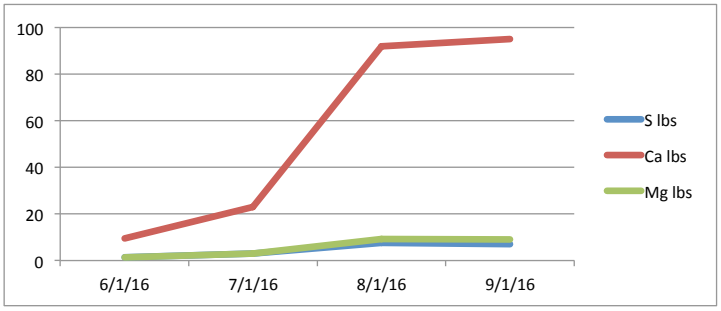

Parts Per Million Cones Copper
25
20
15
10
5
0
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536


Parts Per Million Cones Boron
60
50
40
30
20
10
0
50506
50507
50511
50512
50531
50532
50533
50534
50535
50536

Total Bine Analysis Per Acre

Time	Pounds*	N lbs	*P lbs	*K lbs	S lbs	Ca lbs	Mg lbs	Mn gram	Zn gram	Cu gram	B gram
6/1/16	400*	20	2.6	12.5	1.4	9.5	1.3	13	9	2.3	8
7/1/16	1800*	38	5	23	3	23	3	27	22	4	20
8/1/16	3400*	95	13	55	7.5	92	9.2	100	60	12	100
9/1/16	3300*	85	10	55	7	95	9	115	43	10	70

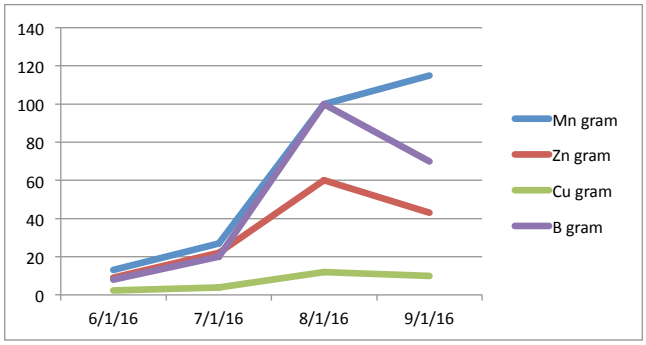




*Bine Weight 100% Dry Per Acre

*P x 2.3 = Pounds P205

*K x 1.2 = Pounds K20



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This is the average bine analysis (dry matter) on 12 fields. The bines were cut at the base and at the top and everything was salvaged. The bines were rapidly washed in the field with local water and returned to Idaho that evening. The sample was weighed for moisture and dried. Note the loss in bine weight from August 1st toSeptember 1st that explains the energy is going to the roots and to the cone and sacrificing some of the bine weight.

Nutrients Removed by Bines Sept 1st, 2016 Minus Cones on Bines Dry Matter Weight of 3400 Pounds

	POUNDS						GRAMS			
	N	P*	K*	S	Ca	Mg	Zn	Mn	Cu	B
1 Bale	6	1.1	6	0.4	2.5	0.4	5	7	1.7	4
Bine	85	10	55	7	95	9	43	115	10	70
5 Bales	30	6	30	2	13	2	25	35	10	20
Total	115	16	85	9	108	11	68	150	20	90
10 Bales	60	11	60	4	25	4	50	70	20	40
Total	145	21	115	11	120	13	93	185	30	110
15 Bales	96	17	96	7	38	7	75	105	30	60
Total	181	27	151	14	133	16	118	220	40	130
20 Bales	120	22	120	9	50	9	100	140	40	80
Total	205	32	175	16	145	18	143	255	50	150
25 Bales	150	28	150	11	63	11	125	175	50	100
Total	235	38	205	18	158	20	168	290	60	170

N,P, K, S, Ca, & Mg in POUNDS

Mn, Zn Cu & B IN POUNDS

N=NITROGEN	Mg=MAGNESIUM
P=PHOSPHORUS	Mn=MANGANESE
K=POTASSIUM	Zn=ZINC
S=SULFUR	Cu=COPPER
Ca=CALCIUM	B=BORON

* Px2.3 = Pounds P205/Bale

*Px1.2 = Pounds K20/Bale

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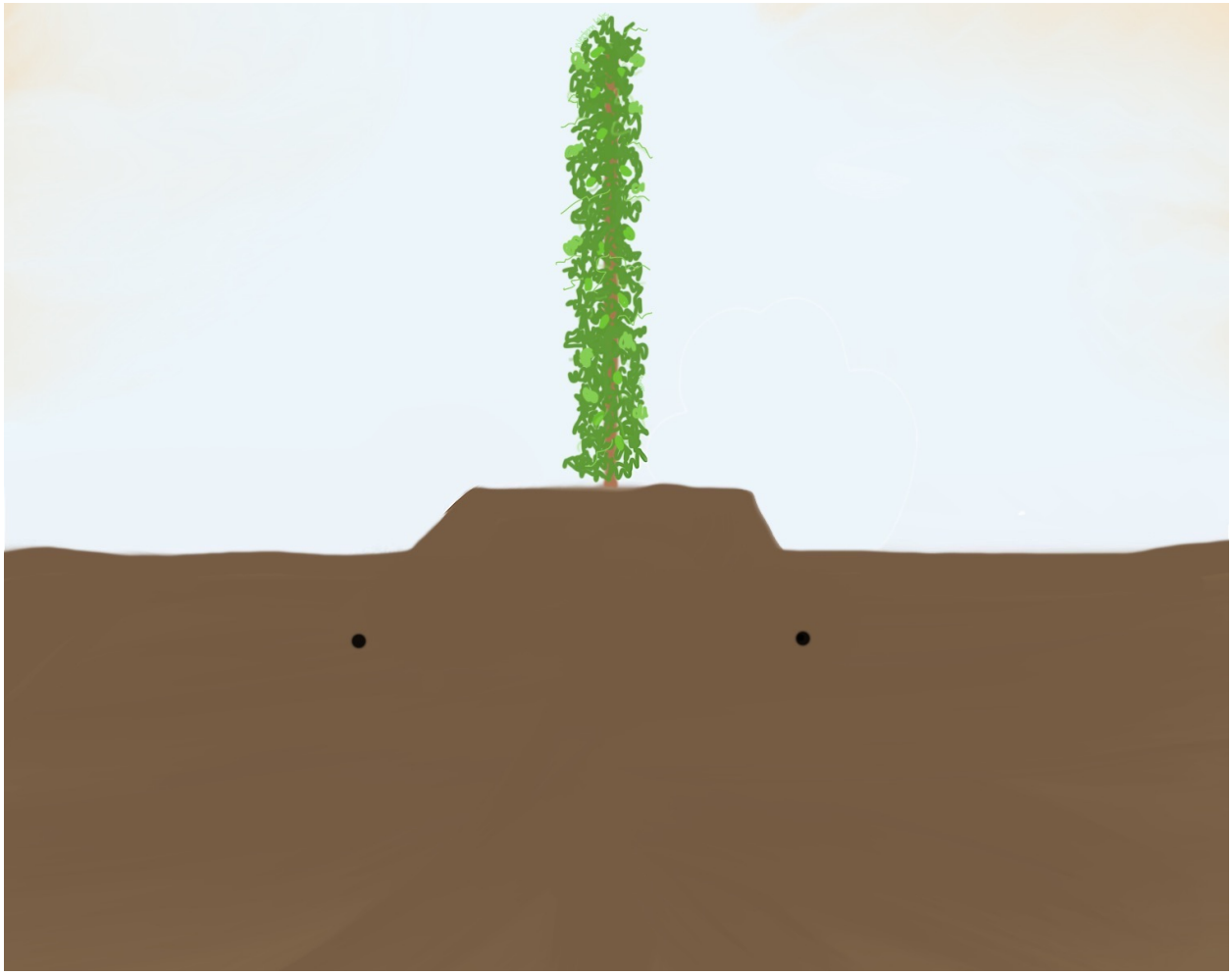

70% of production is water management. The biggest problem I see in hop production is just that. When applying one line above the ground, the only mode of water entry is percolation. Unless you're on very coarse sand the infiltration rate decreases weekly. With typical loam, silt loam and clay loams, the infiltration rate diminishes each week. Unless you are purge irrigating, there will be standing water. The standing water will grow algae and will be a cesspool for mildew diseases on the lower leaves of the bines,

The other problem is nutrient transport downward through percolation. Again, this only occurs on sandy soils. By placing two lines one foot deep inside the tractor tires, you can feed nutrients and in some cases increase your yields by at least 50% with the same basic fertilizer you are using now. By having two lines, you are now feeding approximately a 10 foot range below ground. With purge irrigation, you get capillarity which means surface tension of soil particles attract water to migrate further out.

The hair roots must be in the presence of oxygen to metabolize. A lot of you growers are trying to grow hops in "toilet syndrome". I can almost guarantee that by going to subsurface irrigation, you should see a 2-5 bale per acre increase in 2-3 years (remember next years yield is dominated by last years practices). Your mildew program will drastically improve with the products you're already using. The biggest problem with this program is moles, bowles and gophers. You must have a good pest control program and there must be products that discourage winter water source.

Secret Vault is the ultimate monitoring program! It is designed for hop growers that want to know their tissue nutrient supply rate and the levels in the soil solution.

SV Hops 1 1S Complete Soil Test Plus Soil Solution $90.00 10 Complete Tissue Tests $400.00 10 Complete Soil Solutions $435.00	$875.00
SV Hops 2 10 Complete Tissue Tests $400.00 10 Complete Soil Solutions $435.00	$835.00
We accept all major credit cards, and personal checks.	

Monitoring Hops

1. *Place six flags for collecting samples on a 45-degree angle.*
2. *Soil Samples are collected between plants 10" deep with the 1st inch discarded.*
3. *Collect 12-15 leaves and petiole as 5 ½' high within the flagged area.*
4. *Quickly wash the plant samples and place in a paper bag.*

Western Laboratories

211 HWY. 95
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