WASHINGTON STATE UNIVERSITY
IRRIGATED SOIL MANAGEMENT

Soil Fertility for Vegetable Crops

Joan R. Davenport
WSU-Prosser

WATER | GIS AND MAPPING | NUTRIENTS | TESTING | CHEMISTRY | SOILS | PLANTS







Soil Derived Plant Essential Nutrients

- Macro Nutrients
  - Nitrogen (N)
  - Phosphorus (P)
  - Potassium (K)
  - Sulfur (S)
  - Calcium (Ca)
  - Magnesium (Mg)
- Micro Nutrients
  - Boron (B)
  - Chloride (Cl)
  - Copper (Cu)
  - Iron (Fe)
  - Manganese (Mn)
  - Molybdenum (Mo)
  - Zinc (Zn)

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How to Determine Nutrient Need

- Crop Requirement
- Soil Supply

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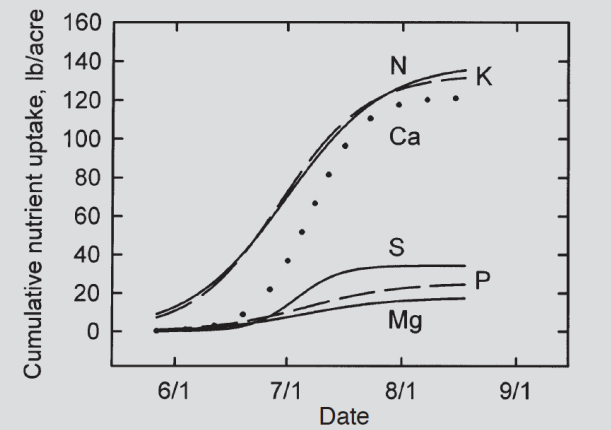
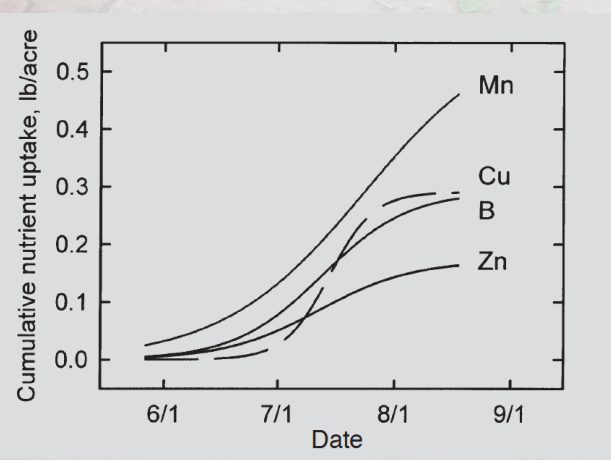
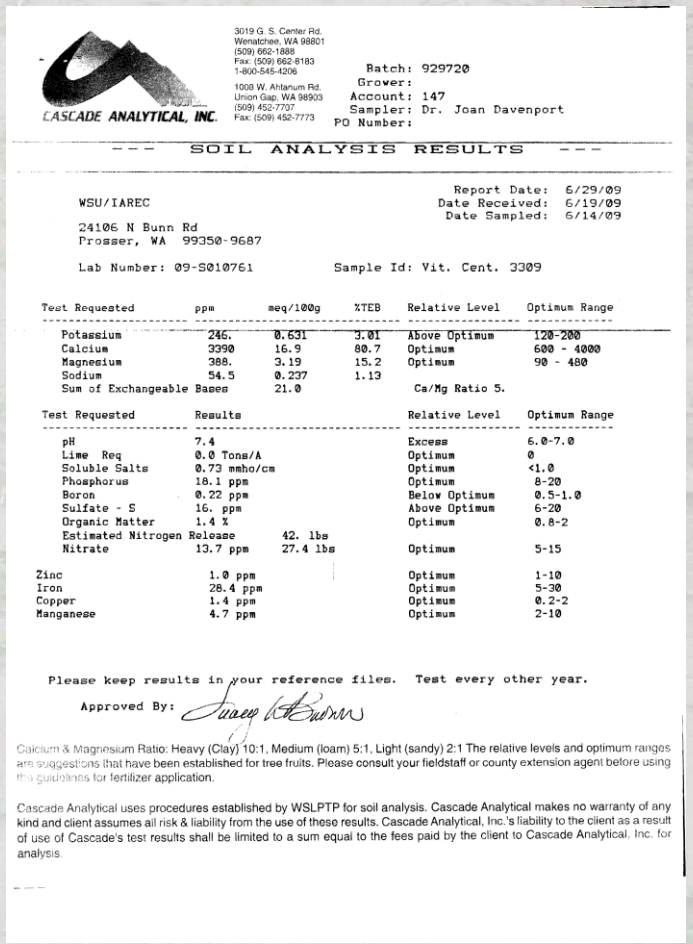




Onions, from PNW 546

- Soil Supply



CASCADE ANALYTICAL, INC.

3019 G. S. Center Rd.
Wenatchee, WA 98801
(509) 662-1888
Fax: (509) 662-8183
1-800-545-4206

1008 W. Ahtanum Rd.
Union Gap, WA 98903
(509) 452-7707
Fax: (509) 452-7773

Batch: 929720
Grower:
Account: 147
Sampler: Dr. Joan Davenport
PO Number:

--- SOIL ANALYSIS RESULTS ---

WSU/IAREC
24106 N Bunn Rd
Prosser, WA 99350-9687

Report Date: 6/29/09
Date Received: 6/19/09
Date Sampled: 6/14/09

Lab Number: 09-S010761 Sample Id: Vit. Cent. 3309

Test Requested	ppm	meq/100g	%TEB	Relative Level	Optimum Range
Potassium	246.	0.631	3.01	Above Optimum	120-200
Calcium	3390	16.9	80.7	Optimum	600 - 4000
Magnesium	388.	3.19	15.2	Optimum	90 - 480
Sodium	54.5	0.237	1.13		
Sum of Exchangeable Bases		21.0		Ca/Mg Ratio 5.	

Test Requested	Results		Relative Level	Optimum Range
pH	7.4		Excess	6.0-7.0
Lime Req	0.0 Tons/A		Optimum	0
Soluble Salts	0.73 mmho/cm		Optimum	<1.0
Phosphorus	18.1 ppm		Optimum	8-20
Boron	0.22 ppm		Below Optimum	0.5-1.0
Sulfate - S	16. ppm		Above Optimum	6-20
Organic Matter	1.4 %		Optimum	0.8-2
Estimated Nitrogen Release		42. lbs		
Nitrate	13.7 ppm	27.4 lbs	Optimum	5-15
Zinc	1.0 ppm		Optimum	1-10
Iron	28.4 ppm		Optimum	5-30
Copper	1.4 ppm		Optimum	0.2-2
Manganese	4.7 ppm		Optimum	2-10

Please keep results in your reference files. Test every other year.

Approved By:

Calcium & Magnesium Ratio: Heavy (Clay) 10:1, Medium (loam) 5:1, Light (sandy) 2:1 The relative levels and optimum ranges are suggestions that have been established for tree fruits. Please consult your fieldstaff or county extension agent before using the guidelines for fertilizer application.

Cascade Analytical uses procedures established by WSLPTP for soil analysis. Cascade Analytical makes no warranty of any kind and client assumes all risk & liability from the use of these results. Cascade Analytical, Inc.'s liability to the client as a result of use of Cascade's test results shall be limited to a sum equal to the fees paid by the client to Cascade Analytical, Inc. for analysis.

Let's look at a soil test report

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Let's look at a soil test report

Soil Test Results

Phosphorus	Olsen	mg/kg	3
Potassium	Olsen	mg/kg	133
Boron	DTPA	mg/kg	0.13
Zinc	DTPA	mg/kg	0.8
Manganese	DTPA	mg/kg	0.8
Copper	DTPA	mg/kg	0.7
Iron	DTPA	mg/kg	7
Calcium	NH4OAc	meq/100g	20.5
Magnesium	NH4OAc	meq/100g	1.7
Sodium	NH4OAc	meq/100g	0.11
Total Bases	NH4OAc	meq/100g	22.6

pH 1:1			8.3	
E.C. 1:1	m.mhos/cm		0.14	
Est Sat Paste E.C.	m.mhos/cm		0.36	
Effervescence			High	
				Lbs/Acre
Ammonium - N		mg/kg	1.2	5
Organic Matter W.B.		%	1.2	ENR: 42

Depth inches	Nitrate-N mg/kg	Nitrate-N lbs/acre	Sulfate-S mg/kg	Moisture Inches
0 -12	6.1	24	5	
Totals	**6.1**	**24**	**5**	

Sum of Tested N: 71 lbs/acre N

Other Tests:

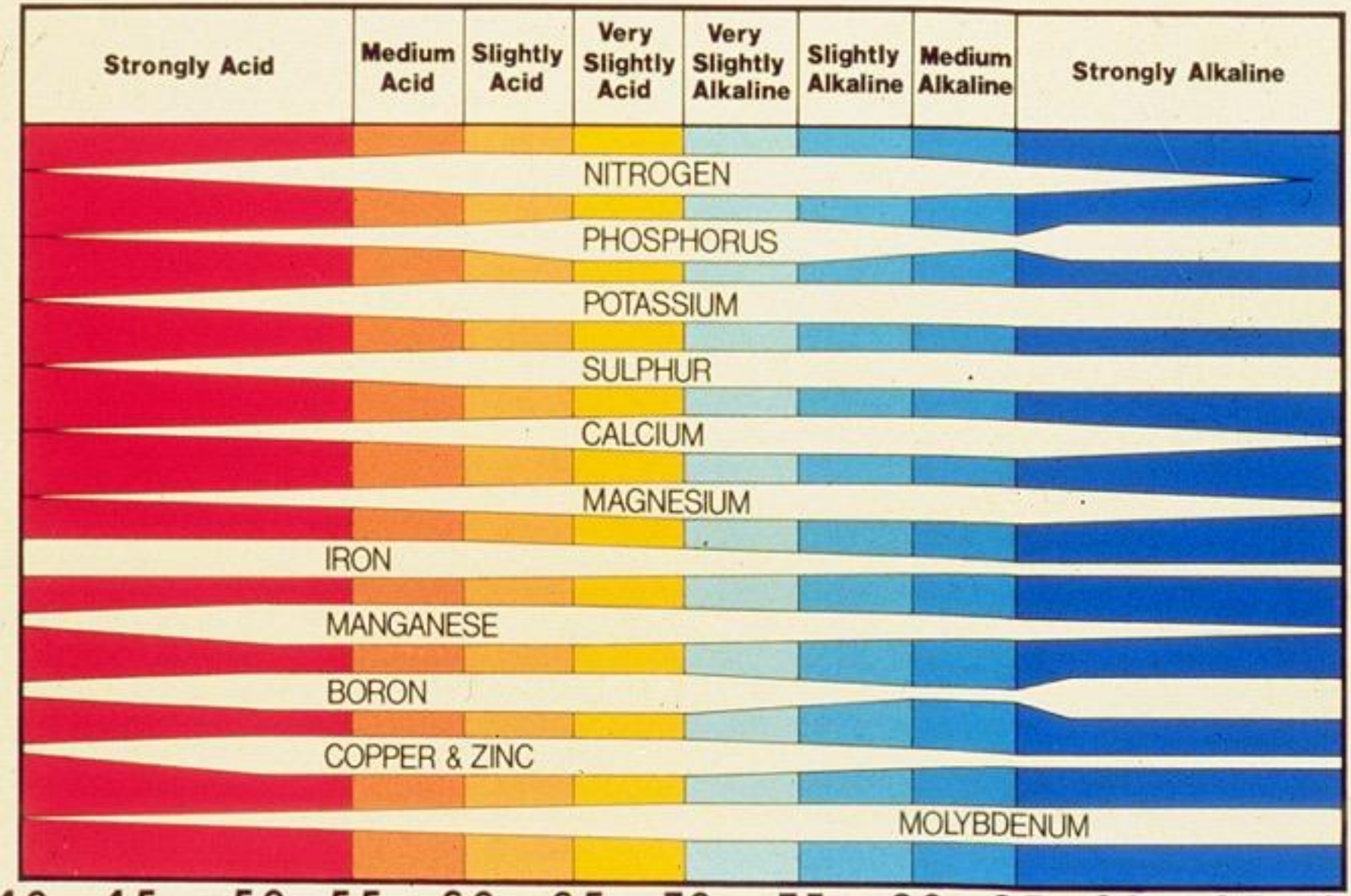
Interpretation Guide

Fertilizer recommendations for

of HOPS after HOPS

			Low	Medium	High	
Nitrogen	71	lbs/acre				140 lbs/acre of Nitrogen
Phosphorus	3	mg/kg				190 lbs/acre of P2O5
Potassium	133	mg/kg				75 lbs/acre of K2O
Sulfur	5	mg/kg				25 lbs/acre of Sulfur
Boron	0.13	mg/kg				2 lbs/acre of Boron
Zinc	0.8	mg/kg				0 lbs/acre of Zinc
Manganese	0.8	mg/kg				0 lbs/acre of Mn

How Soil pH Affects Availability of Plant Nutrients



Nitrogen Management Example - Sweet Corn

- Soil Test NO_3-N
  - 13.7 ppm (mg/kg)
  - 27 lbs/A
- Pivot System
  - preplant (1/2)
  - in season (1/2)

Table 2.—N fertilization rates according to total soil test values.

NO_3-N Soil test (lb/a)	N Application (lb/a)[1] After nonlegume crop[2]	After beans and peas[3]	After productive alfalfa, clover
0	200	160	140
40	160	120	100
80	120	80	60
120	80	40	20
160[4]	40	0	0
200[4]	0	0	0

[1]These application rates are suggested for silt loam, loam, and clay loam soils. For sandy soils, increase the application rates by 40 lb N/a.
[2]When straw is incorporated after September 1, increase the N fertilizer rate by 30–50 lb/a.
[3]After beans and peas and low-producing alfalfa and clover.
[4]For early plantings into cool soil, apply 20–30 lb N/a in a 2-inch x 2-inch band.

Sweet Corn, from FG 62

Not Enough N in Sweet Corn

Healthy

Low N

Phosphorus Management Example - Onion

- Soil Test P - Olsen
  - 3 ppm
- Effervescence
  - High
- A word about Olsen P and pH

Bicarbonate (Olsen) soil test P 0 to 12 inches	Soil lime concentration (%)[a]			
	0	5	10	15
(ppm)	P fertilizer application rate (lb P_2O_5 per acre)[b]			
	Not fumigated before planting			
0	160	200	240	280
5	100	140	180	220
10	40	80	120	160
15	0	20	60	100
20	0	0	0	40
above 25	0	0	0	0
	Fumigated before planting			
0	200	240	280	320
5	140	180	220	260
10	80	120	160	200
15	20	60	100	140
20	0	40	20	80
25	0	0	0	20
above 30	0	0	0	0

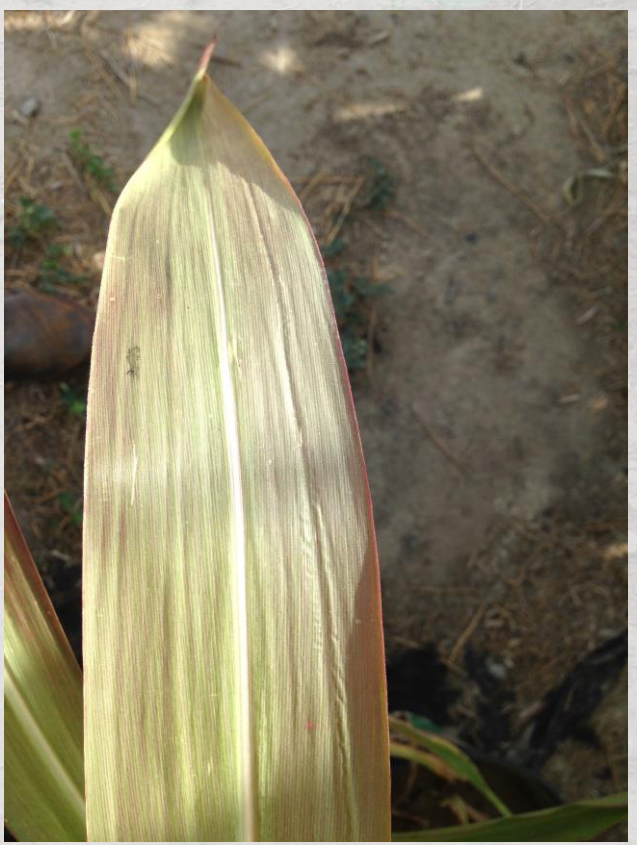
[a]Soil lime concentration as determined by calcium carbonate equivalent test.

[b]To convert from the oxide (P_2O_5) to the elemental form (P) multiply by 0.43.

Onions, from PNW 546

Low P in Sweet Corn - Once soil is warm

Whole Plant



Leaf

Potassium - Soil Test (Olsen) of 133 mg/kg

- Corn
- We would add K

- Onion
- No K needed

Table 4.—K fertilization rates for sweet corn.

If the soil test for K is (ppm)	Apply this amount of potash (K_2O) (lb/a)	(kg/ha)
0–100	120–180	135–200
100–200	60–120	65–135
over 200	0	0

Potassium (K) soil test[a] 0 to 12 inches (ppm)	K fertilizer application rate (lb K per acre)	(lb K_2O per acre)
0	200	240
50	100	120
above 100	0	0

[a]Soil test K as determined by sodium bicarbonate (Olsen) extraction.

Low K in Sweet Corn

Healthy

Low K

Micronutrients

Boron

- Typically low in WA
- Mobile in soil (leach)
- Easy to over apply

- Sample - 0.22 mg/kg

- Typical application of 2 - 3 lbs/A yearly

Zinc

- Typically low in WA
- pH regulated
- Long term tie up

- Sample - 0.7 mg/kg

Zinc

• Onion

Onions are sensitive to zinc deficiency. Deficiencies usually occur on white, high lime subsoils that have been exposed by land leveling or erosion. Soils are considered marginal at 0.8 to 1.0 ppm DTPA extractable Zn. Deficient Zn concentrations in leaf tissue probably are 10 to 20 ppm (dry wt. basis), based on data from other crops. Zinc deficiency can be corrected by soil or foliar Zn applications. There is insufficient data to support specific recommendations.

• Corn

Sweet corn has a relatively high requirement for Zn. An application of Zn is suggested when the Zn soil test value is below 0.8 ppm.

Where Zn is required, either 10 lb/a (10 kg/ha) of Zn should be broadcast and worked into the soil prior to planting, or 3 to 4 lb/a (3 to 4 kg/ha) of Zn should be banded with the fertilizer at planting time. An application of 10 lb Zn/a should supply Zn needs for 2 or 3 years.

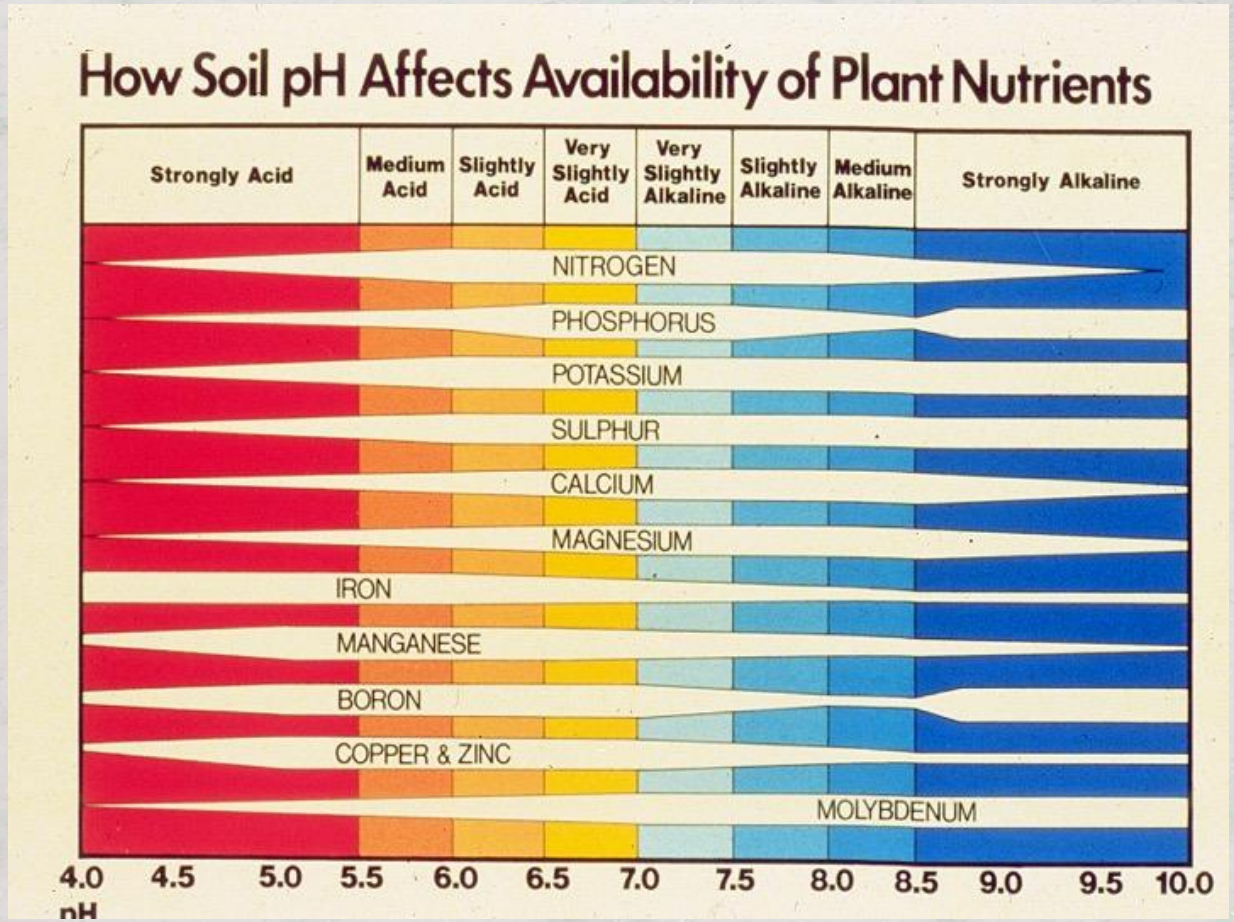
To correct Zn deficiency during the growing season, thoroughly wet plants with a solution containing 1 lb (0.5 kg) Zn in 50 to 100 gal (190–380 liters) of water.

Boron Toxicity

- http://ecoursesonline.iasri.res.in/pluginfile.php/1761/mod_page/content/3/Chapter_15_7.JPG

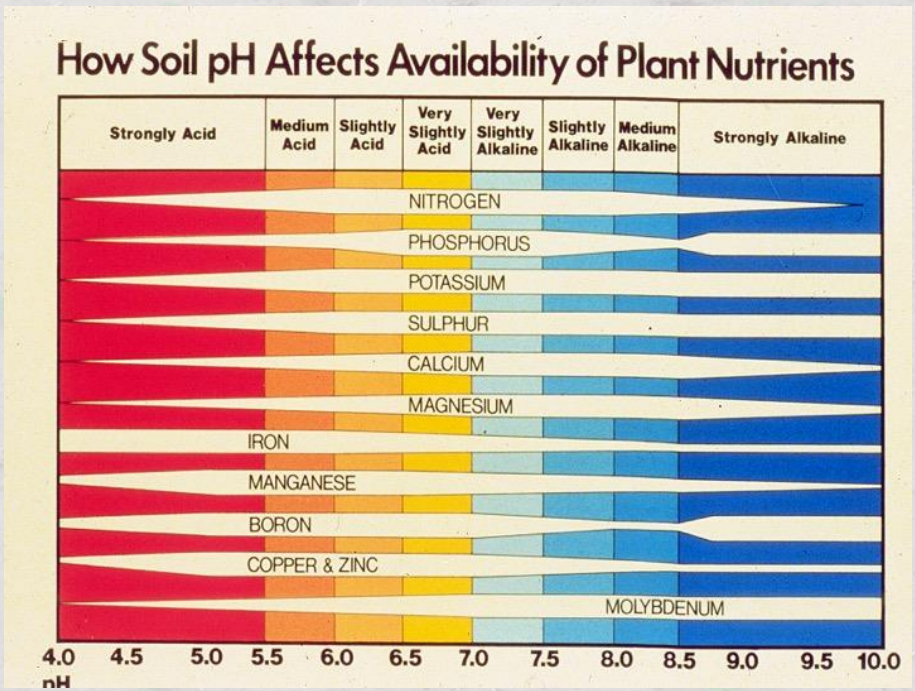
Closing thoughts on soil pH and 'free lime'

- Free lime - measured as effervescence or percent



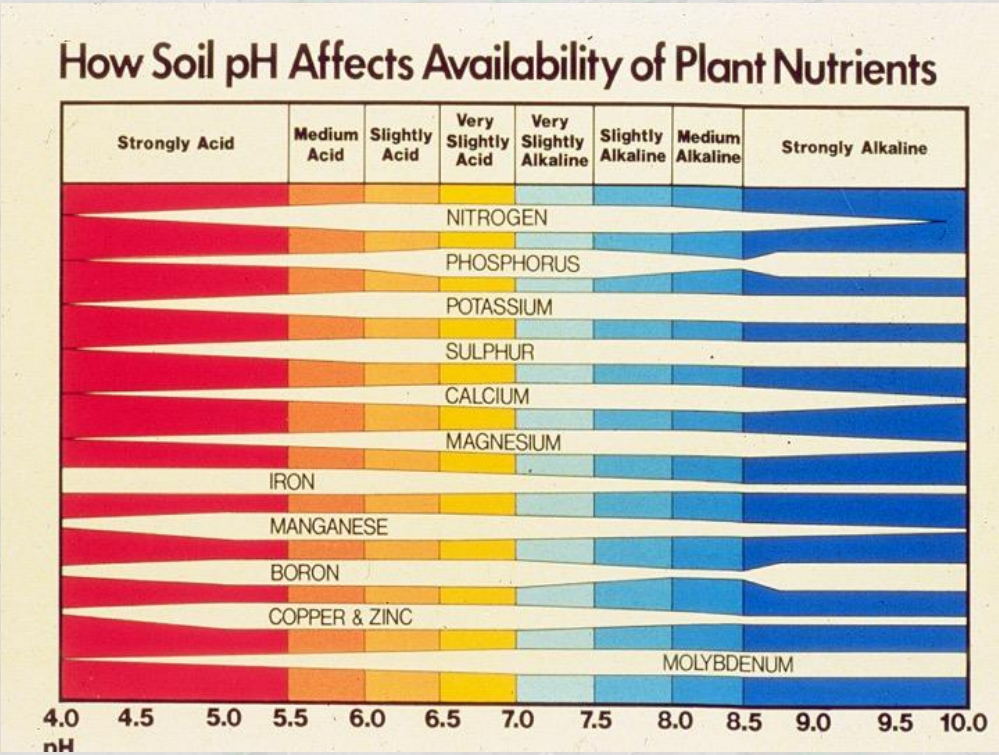
Closing thoughts on soil pH and 'free lime'

- pH high
- Free lime high
- Micronutrients low, iron (Fe) an issue
- Foliar application, usually chelates



Closing thoughts on soil pH and 'free lime'

- Long-term use of N fertilizer lowers pH
- Huge issue in onion
- Lime pre-plant 500 – 1,000 lbs/A



References

- Gardener, E. H., N. S. Mansour, H. J. Mack, T. L. Jackson, and J. Burr. 2000. Sweet Corn Eastern Oregon - East of the Cascades. Oregon State University FG 62.
- Sullivan, D. M., B. D. Brown, C. C. Shock, D. A. Horneck, R. G. Stevens, G. Q. Pelter, and E. B. G. Feibert. 2001. Nutrient Management for Onions in the Pacific Northwest. PNW 546.

Questions?