UNIVERSITY OF ILLINOIS EXTENSION

GROWING A NEW GENERATION OF ILLINOIS FRUIT AND VEGETABLE FARMERS

SOIL TESTING

Shelby Henning, Jeff Kindhart
and Mike Krueger
March 2015

new ILLINOIS fruit & vegetable FARMERS

Do I need to test my soil?

- YES
- The basis for proper nutrient management (and optimal yields) it to conduct soil tests.

ACME SOIL TESTING KIT

- Easy to use!
- Just add dirt and water!
- Highly accurate!

This isn't what we're talking about! Soil testing is sound science and should be carried out by a qualified laboratory

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Find a certified lab near you

- Illinois Soil Testing Association
  - http://www.soiltesting.org/labcertification.html

A point to consider: Not all labs offer the same tests.

LAB	pH water	pH salt	K M3	K AA	P Bray	P M3 Spec	P M3 ICP
A&L Great Lakes Laboratories, Inc.	X	X	X	X	X		X
AgSource Cooperative Services	X			X	X		
Charter Soil Service	X		X			X	
GMS Laboratories, Inc.	X		X				X
Ingram Soil Testing	X		X				X
Key Agricultural Services	X		X			X	
KSI Laboratory	X		X			X	
Midwest Laboratories	X			X	X		
MSE, Inc.	X			X	X		X
Rock River Laboratory, Inc.	X		X		X		X
SGS Alvey Laboratory, Inc. - Belleville	X		X				X
SGS Mowers Soil Testing Plus	X		X				X
Soiltech, Inc.	X			X	X		
Solum, Inc.	X		X		X		X
Southern Illinois Ag Solutions, Inc.	X		X			X	
Spectrum Analytic	X		X	X	X		X
United Soils, Inc.	X		X			X	
Waters Agricultural Laboratories	X		X		X		X

http://www.soiltesting.org/5certifiedlabs.html

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Not all labs cater to the small grower or provide interpretations

University of Illinois Extension

Soil Testing Labs

This list is provided for your reference. Call for current fees and services. Request an interpretation of the soil test results. Often labs will provide sample bags prior to you taking a soil sample, if you request sampling information.

H = accepts home samples

I = provides interpretations for home samples

C = accepts agricultural samples

M = test for heavy metals (lead, arsenic)

A&L Great Lakes Laboratories, Inc.
(H I C)
3505 Conestoga Drive
Fort Wayne, IN 46808-4413
Phone: (260) 483-4759
Fax: (260) 483-5274
http://www.algreatlakes.com/
Email: Lab@algreatlakes.com

AgriEnergy Resources
(H I C)
21417 1950 E Street
Princeton, IL 61356
Phone: (815) 872-1190
Fax: (815) 872-1928
http://www.agrienergy.net/
Email: gcampbell@agrienergy.net

ASM Inc.
(H I C)
2106 County Road 1000 East
P.O. Box 3655
Champaign, IL 61826
Phone: (217) 356-5756
Fax: (217) 356-8609

Brookside Laboratories, Inc.
(H C)
308 S Main St.
New Knoxville, OH 45871
Phone: 419-753-2448
Fax: 419-753-2949
http://www.blinc.com/

http://urbanext.illinois.edu/soiltest/

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Test	Rating[a]
Water pH	100
Salt pH	30
Buffer pH	30
Exchangeable H	10
Phosphorus	85
Potassium	60
Boron: alfalfa	60
Boron: corn and soybeans	10
Iron: pH > 7.5	30
Iron: pH < 7.5	10
Organic matter	75
Calcium	40
Magnesium	40
Cation-exchange capacity	60
Sulfur	40
Zinc	45
Manganese: pH > 7.5	40
Manganese: pH < 7.5	10
Copper: organic soils	20
Copper: mineral soils	5

[a]On a scale of 0 to 100, 100 indicates a very reliable, useful, and cost-effective test, and 0 indicates a test of little value.

A point to consider: Not all tests are 100% accurate.

Lab accreditation helps! – Use a certified lab!

https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf

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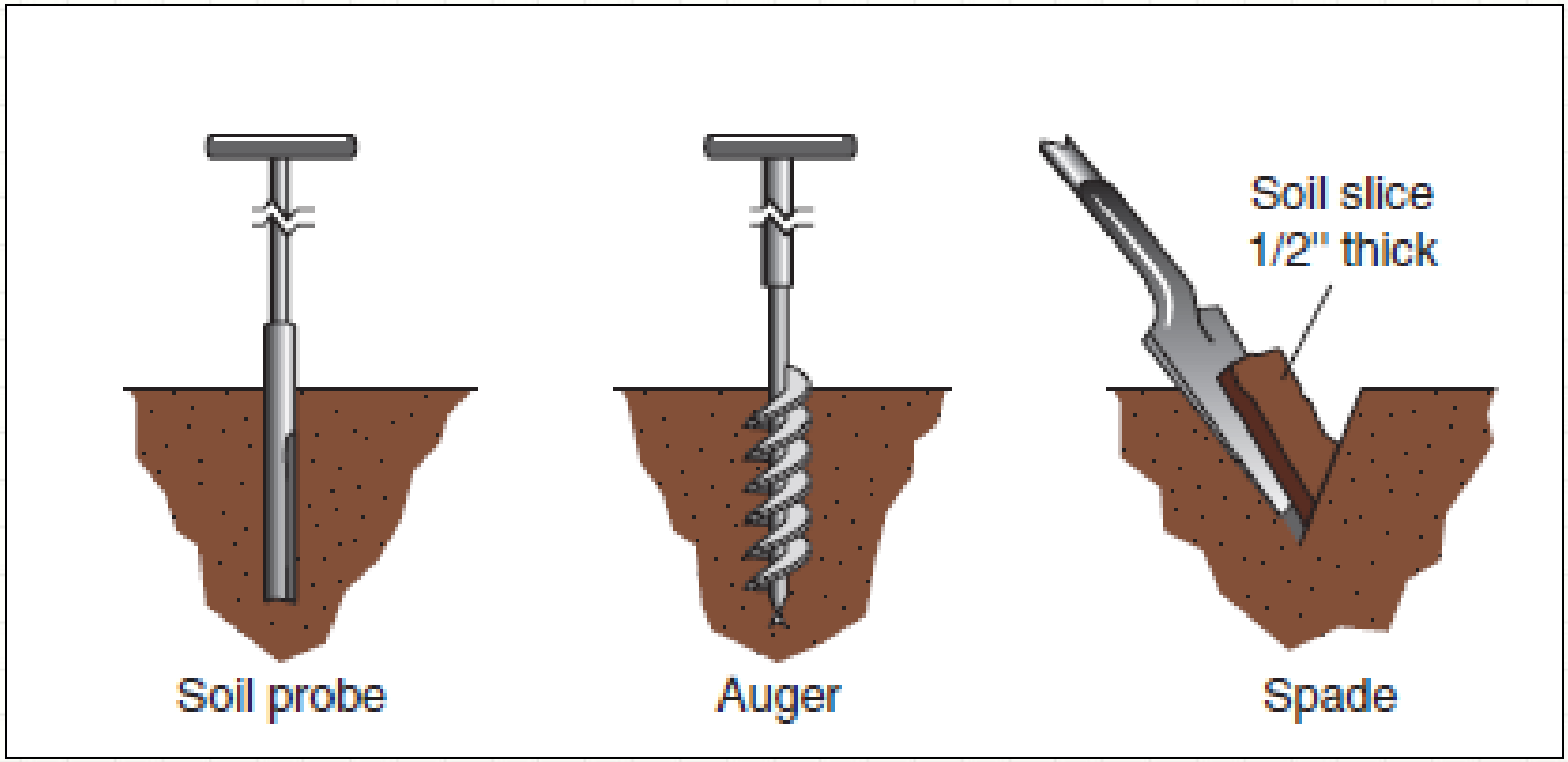
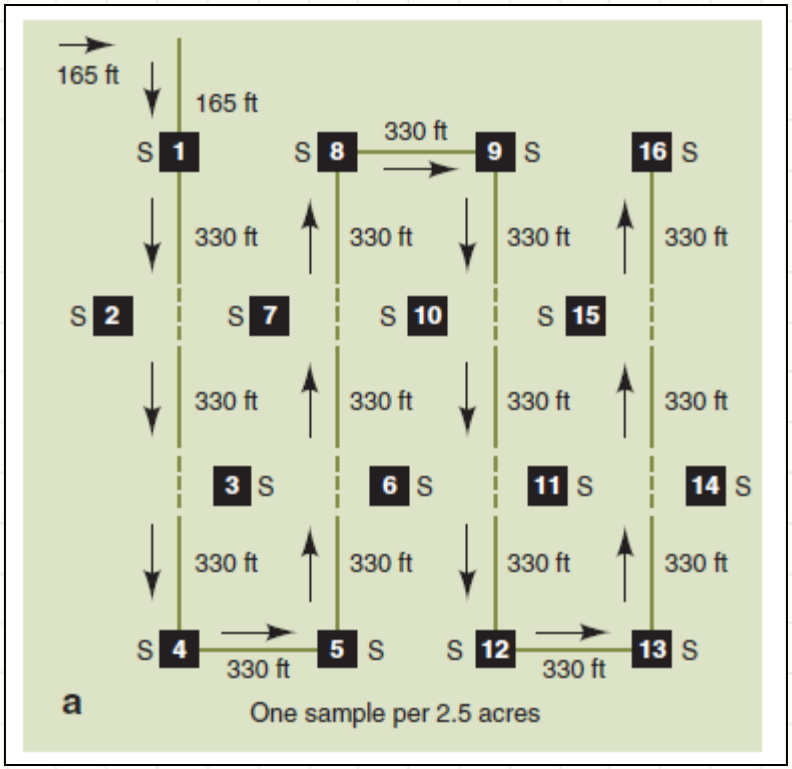
How do I take a soil sample?

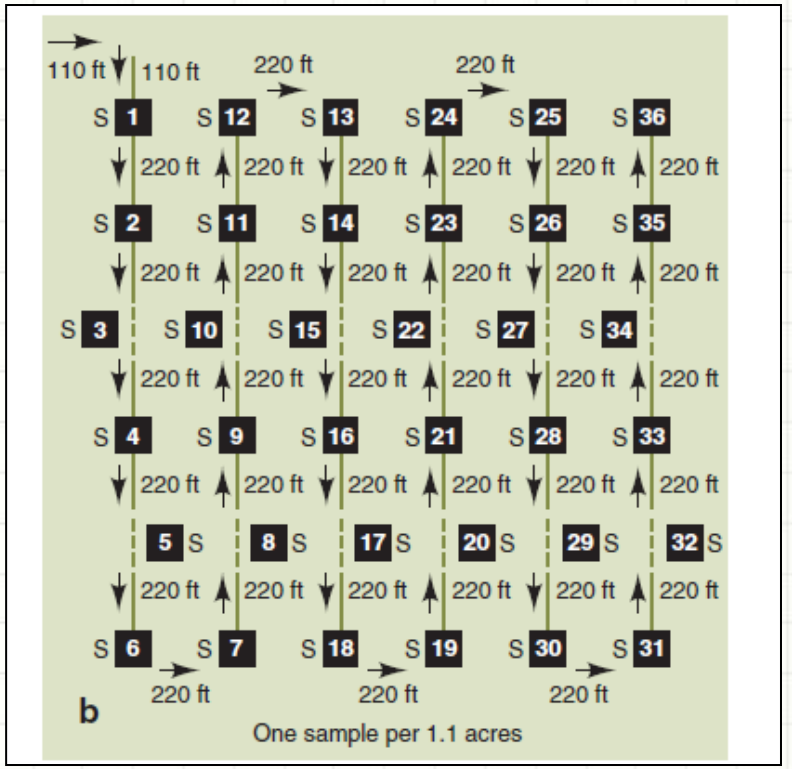
How to take samples with a soil probe, an auger, and a soil spade



https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf

Taking a field representative sample





How to collect soil samples from a 40-acre field. Each sample (diagram a) should consist of five soil cores, 1 inch in diameter, collected to a 7-inch depth from within a 10-foot radius around each point. Higher frequency sampling (diagram b) is suggested for those who can use computerized spreading techniques on fields suspected of having large variations in test values over short distances.

https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf

http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=IL

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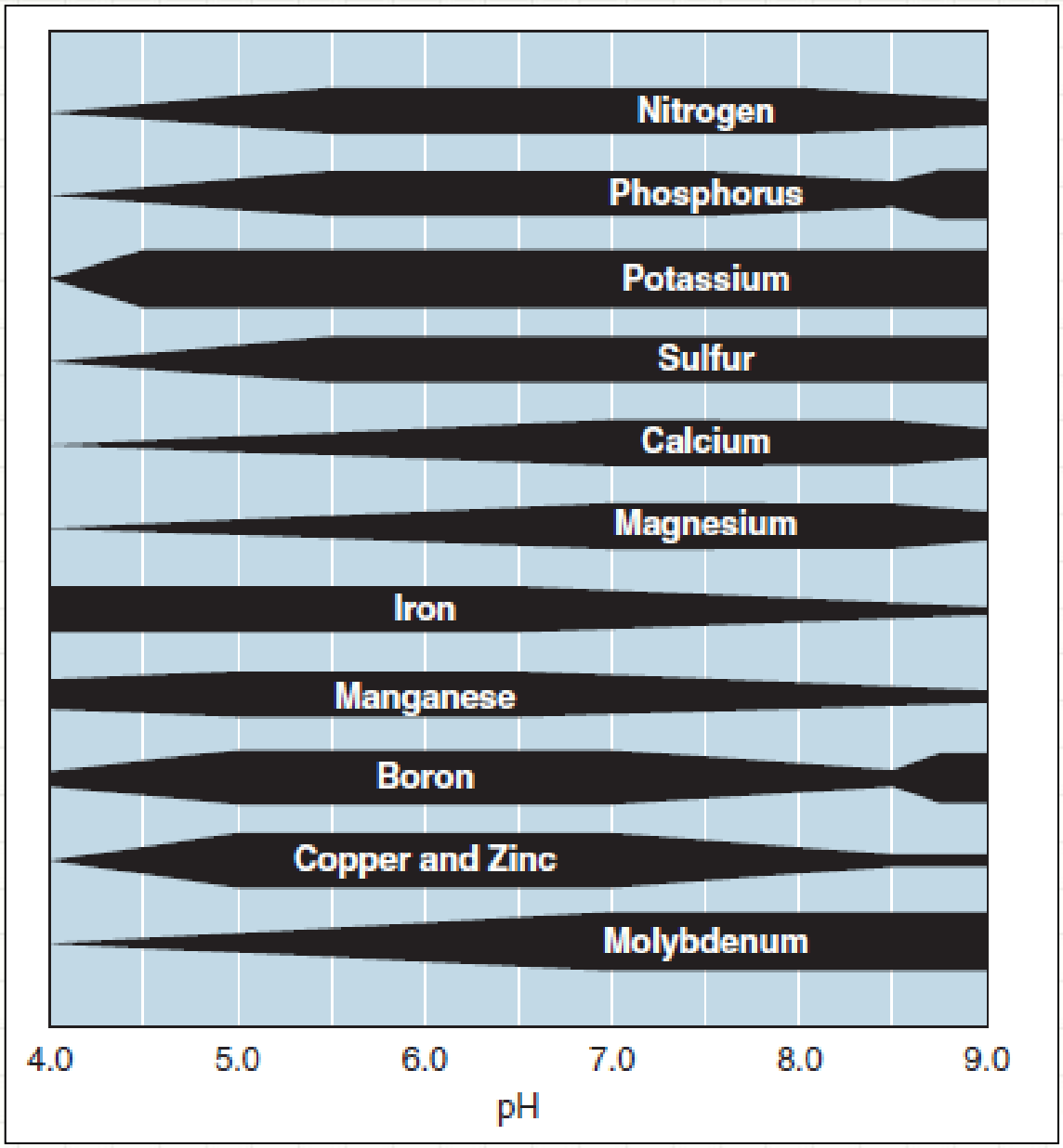

Nutrient availability is controlled by soil pH

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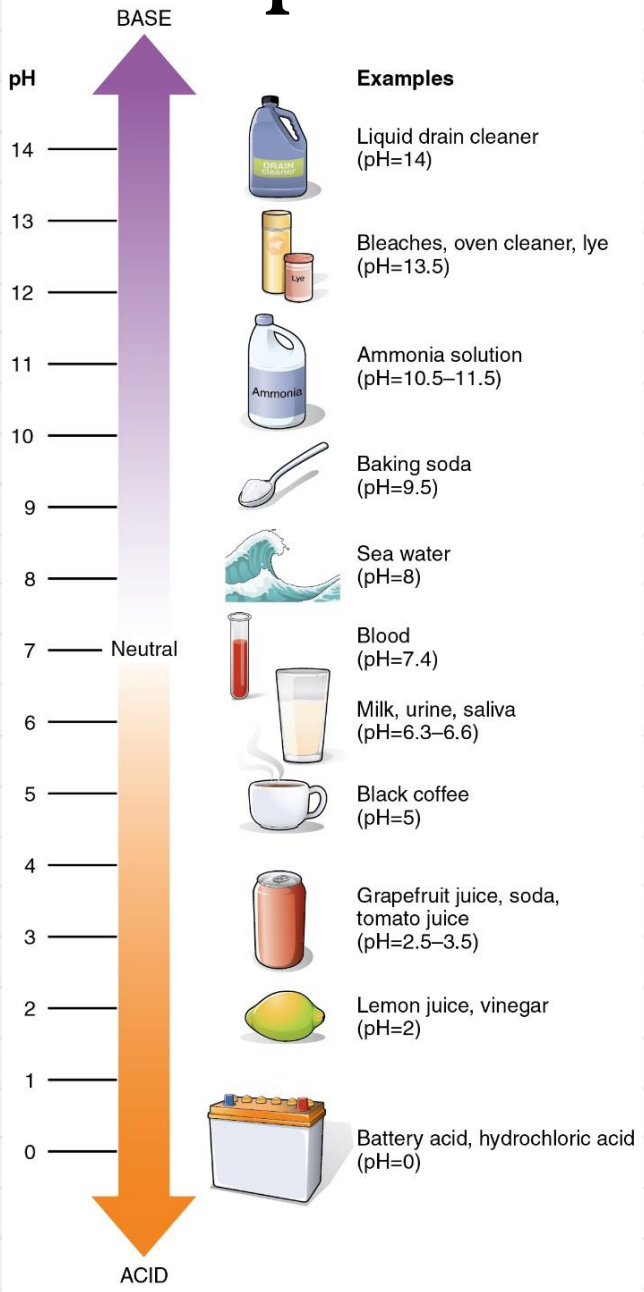
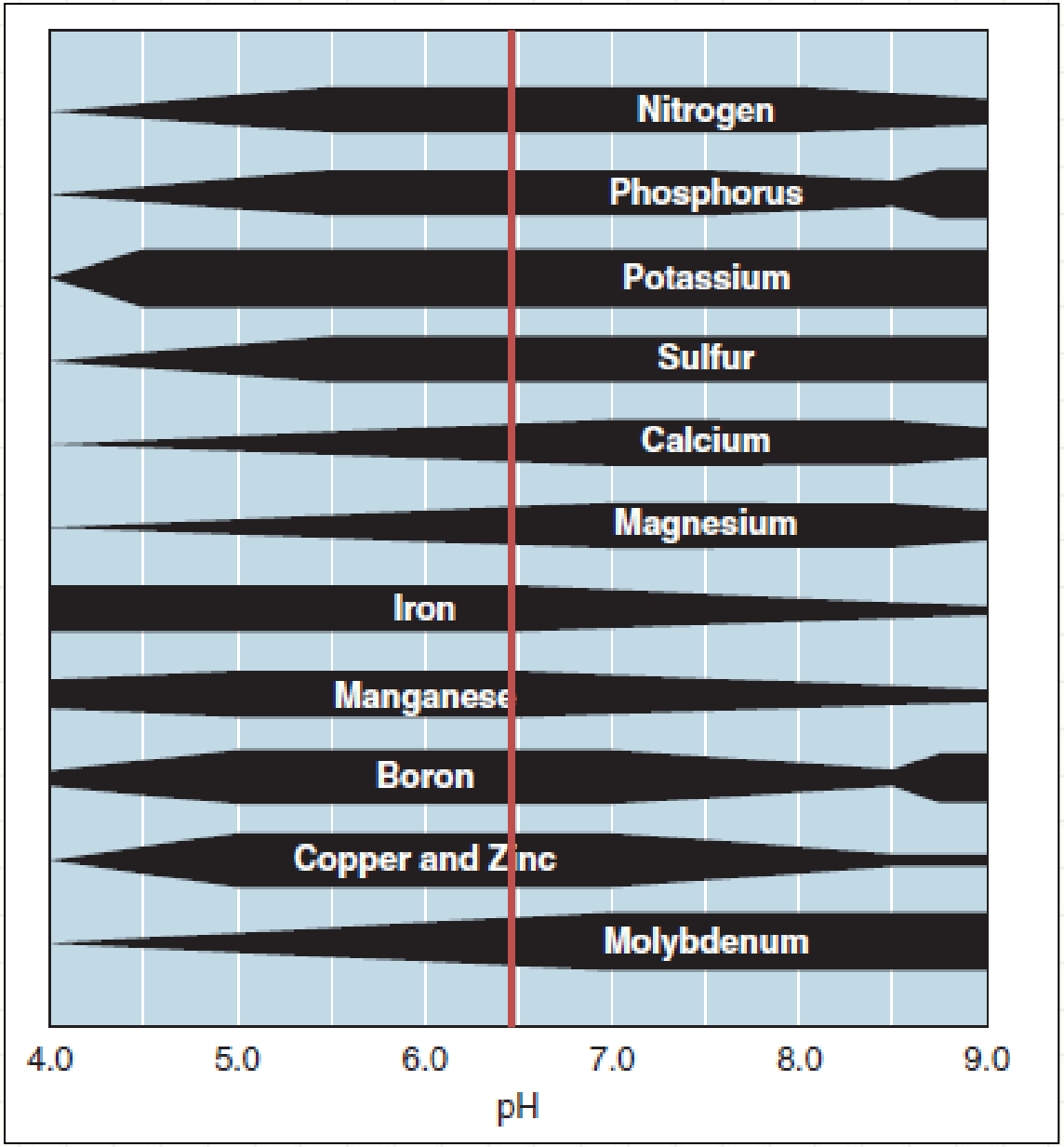
How pH measurements are made



- This is the first test you should do
- Remember soil pH controls availability
  - Reactive dyes
    - Fairly low-tech, simple
  - pH paper
    - Cheap, simple
  - pH meter
    - Good meters aren't cheap
    - 1:1 paste is made,
      measured after short time

What is optimal?



- A pH of 6-6.5 is generally considered ideal

https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf

Soil pH	Soil group[a]			
	A	B	C	D
Elemental sulfur (lb/A) needed to reach pH 5.0				
6.4	2,700	2,100	1,400	700
6.2	2,400	1,800	1,200	600
6.0	2,150	1,625	1,075	550
5.8	1,925	1,450	950	475
5.6	1,700	1,275	850	425
5.4	1,225	925	625	300
5.2	775	575	375	200
Elemental sulfur (lb/A) needed to reach pH 4.5				
6.4	4,000	3,000	2,000	1,000
6.2	3,800	2,800	1,900	950
6.0	3,525	2,650	1,775	925
5.8	3,300	2,475	1,650	825
5.6	3,075	2,300	1,525	775
5.4	2,600	1,950	1,300	650
5.2	2,150	1,625	1,075	550
5.0	1,375	1,050	700	350

[a]Soil A: Dark-colored silty clays and silty clay loams (CEC > 24). Soil B: Light- and medium-colored silty clays and silty clay loams; dark-colored silt and clay loams (CEC 15–24). Soil C: Light- and medium-colored silt and clay loams; dark- and medium-colored loams; dark-colored sandy loams (CEC 8–15). Soil D: Light-colored loams; light- and medium-colored sandy loams; sands (CEC < 8).

What if my pH is too high?

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Some things to remember

- Granular sulfur is the cheapest and most readily available acidifying agent (there are many)
  - But being granular takes longer to carry out the desired soil acidification
- Don't apply more than 2 lbs. sulfur/100 ft^2 per application at one time.
- Wait at least 3 months to make another application
- RETEST!

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What do I do is my soil is too acidic?

Soil type[a]	Soil pH value																				
	4.5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.4	6.5	7.0
Tons of typical limestone[b] to apply to grain farming systems																						
A	8.0	8.0	8.0	8.0	8.0	8.0	7.8	7.0	6.3	5.5	4.8	4.0	3.3	2.5	1.8	1.0	Optional					
B	8.0	8.0	7.5	7.0	6.5	6.0	5.5	5.0	4.5	4.0	3.5	3.0	2.5	2.0	1.5	1.0	Optional					
C	6.6	6.3	5.9	5.5	5.1	4.8	4.4	4.0	3.6	3.3	2.9	2.5	2.1	1.8	1.4	1.0	Optional					
D	4.0	3.8	3.6	3.4	3.2	3.0	2.8	2.6	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0	Optional					
E	4.0	3.6	3.2	2.8	2.4	2.0																
Tons of typical limestone[b] to apply to forage farming systems (alfalfa, clover, lespedeza)																						
A	11.0	11.0	11.0	11.0	11.0	11.0	11.0	10.3	9.6	8.9	8.1	7.4	6.7	6.0	5.3	4.6	3.9	3.1	2.4	1.7	1.0	Optional
B	11.0	11.0	11.0	10.4	9.9	9.3	8.8	8.2	7.7	7.1	6.6	6.0	5.4	4.9	4.3	3.8	3.2	2.7	2.1	1.6	1.0	Optional
C	10.0	9.6	9.1	8.7	8.2	7.8	7.3	6.9	6.4	6.0	5.5	5.1	4.6	4.2	3.7	3.3	2.8	2.4	1.9	1.5	1.0	Optional
D	6.0	5.8	5.5	5.3	5.0	4.8	4.5	4.3	4.0	3.8	3.5	3.3	3.0	2.8	2.5	2.3	2.0	1.8	1.5	1.3	1.0	Optional
E	6.0	5.4	4.9	4.3	3.8	3.2	2.7	2.1	1.6	1.0												

Note: If plowing is less than 9 in., reduce the amount; if it is more than 9 in., increase it. A chisel plow, disk, or field cultivator rather than a mold-board plow may not mix limestone deeper than 4 to 5 in.; for no-till or pasture systems, use the equivalent of a 3-in. tillage depth (one-third of the amount suggested).

[a]Soil A: Dark-colored silty clays and silty clay loams (CEC > 24). Soil B: Light- and medium-colored silty clays and silty clay loams; dark-colored silt and clay loams (CEC 15–24). Soil C: Light- and medium-colored silt and clay loams; dark- and medium-colored loams; dark-colored sandy loams (CEC 8–15). Soil D: Light-colored loams; light- and medium-colored sandy loams; sands (CEC < 8). Soil E: Muck and peat. Soil color is usually related to organic matter.Light-colored soils <2.5% organic matter; medium-colored soils 2.5–4.5% organic matter; dark-colored soils >4.5% organic matter.

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Not all lime is created equal

Particle sizes	Efficiency factor	
	1 yr after application	4 yr after application
Greater than 8-mesh	5	15
8- to 30-mesh	20	45
30- to 60-mesh	50	100
Passing 60-mesh	100	100

8 mesh = 0.093 inch diameter
60 mesh = 0.0098 inch diameter

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Last thought on pH adjustment

- If you send your sample to a reputable lab, they will often generate a report and tell you how much, and what, to use as an amendment.

Soil Testing Report

Dealer: Precision Partners (#103062)
Client: Kevin Hahn
Farm: Plots
Field: Plots
October 08, 2012

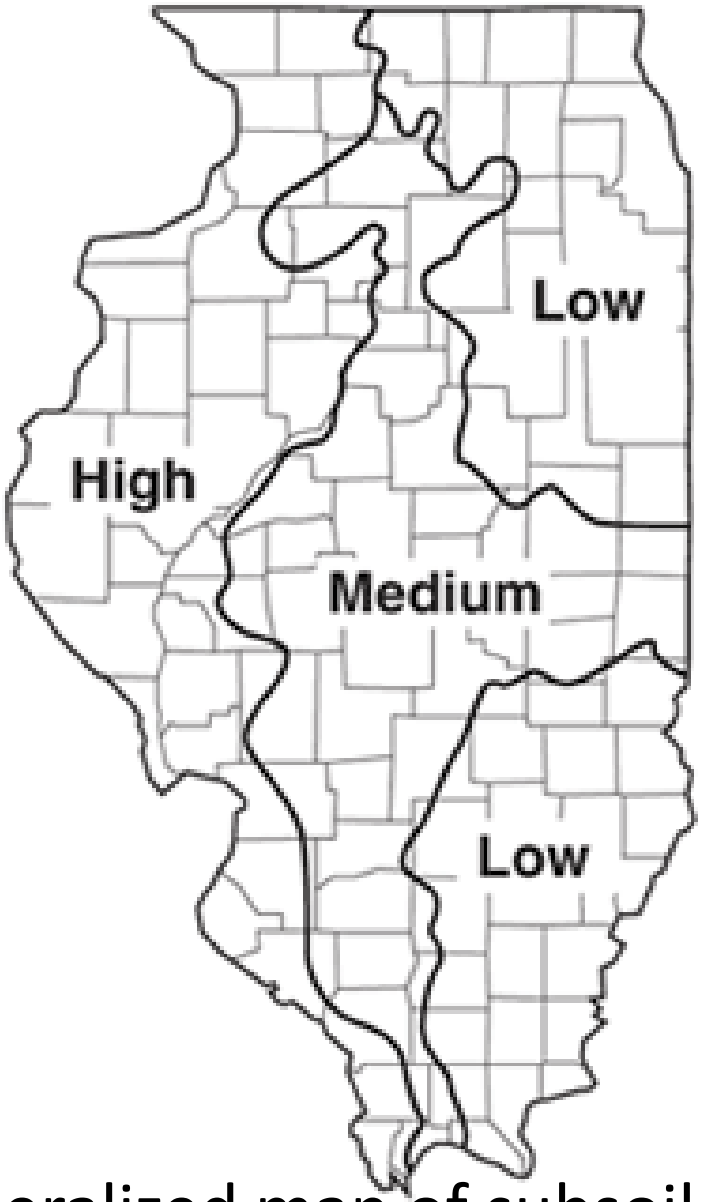
Work order #12530
File #: 284.1
No of samples: 4

Accuracy in Soil Testing
GMS Laboratories, Inc.
23877 E. North Rd. PO Box 61
Cropsey, IL 61731
Ph: (309) 377-2851 Fax: (309) 377-2017

Sample #	Lab #	pH water	pH Buffer	OM cc LOI %	NRx® ISNT ppm	P #/a	K #/a	Ca #/a	Mg #/a	CEC meq/100g	Base Saturation %K	%Ca	%Mg	%H	S ppm	Zn ppm	Mn ppm	Fe ppm	Cu ppm	B ppm	Na ppm
West plot		6.2	6.8	3.5	0.0	69	203	3402	290	11.8	2.2	72.2	10.3	15.3	39	1.8	187	163	1.3	2.4	26
Center plot		6.3	6.9	3.0	0.0	58	149	2696	268	9.0	2.1	75.3	12.5	10.1	34	1.4	126	176	1.1	1.6	20
Top plot		5.9	6.5	3.5	0.0	80	244	3185	341	14.7	2.1	54.2	9.7	34.0	36	1.1	59	151	0.8	1.8	20
Crk. bottom		6.9	7.0	3.5	0.0	92	258	4881	664	15.3	2.2	79.8	18.1	0.0	50	3.1	117	187	1.6	2.4	20
Averages		6.3	6.8	3.4	0.0	75	214	3542	391	12.7	2.2	70.4	12.7	14.8	40	1.9	122	169	1.2	2.0	22

*OM cc: OM reported using Color Card

*OM LOI: OM reported using LOI



Soil phosphorous

Generalized map of subsoil phosphorous supplying power in Illinois

https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf

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P-testing: accepted methodologies

- Bray-Kurtz P1 (1945) extraction method
  - Dilute acid 0.025 M HCl; 0.03 M NH_4F)
  - Used for low to neutral pH soils
- Olson extraction method (1954)
  - 0.5 M $NaHCO_3$
  - Used only for high pH soils typical of Western states
- Mehlich 2 extraction method (1984)
  - 0.2 N CH_3COOH; 0.25 N NH_4NO_3; 0.015 NH_4F; 0.013 N HNO_3; 0.001 M EDTA
  - Robust
- P content of extract determined by flame photometry, inductively coupled plasma emission spectroscopy (ICP), colorimetrically, etc.
- The type of test can change recommendations

P fertilization guidelines

- Guidelines based on:
  - Soil test value
  - Type of crop
  - Estimates of crop removal
- Midwest growers guide recommendations
  - Crops cultivated on mineral soils will benefit if from added P if test is less than 35-40 ppm (Bray)
  - Mineral soils > 80 ppm, no additional P is recommended

How much P to add?

- Applying P_2O_5 fertilizer at 90-100 pounds per acre will increase the soil P test level by about 10 pounds per acre.

Further P fertilization guidelines

FERTILIZER: *Tomatoes*

The following fertilizer rates are to be used only as guidelines. Research at the University of Kentucky and at the University of Tennessee indicates that there is no yield increase from using more than 60 lb/A K_2O or 60 lb/A of P_2O_5 when soil test P and K levels are high.

Soil Test Results (lb/A)		Fertilizer Needed (lb/A)
Phosphorus		**Phosphate (P_2O_5)**
Low	<31	181-240
Medium	31-60	61-180
High	61-80	1-60
Very High	>80	0

Supplemental applications: On bare ground plantings, apply an additional 30 lb of nitrogen/A as a sidedressing when the first fruits are golf-ball size. A second sidedress application of 30 lb N may also be desirable two or three weeks later, depending on the crop's growing condition. For plasticulture with drip on medium-textured soils, apply all recommended phosphorus and potassium requirements prior to laying plastic mulch. See "Fertigation" table for N application rates.

http://www2.ca.uky.edu/agc/pubs/id/id36/id36.pdf

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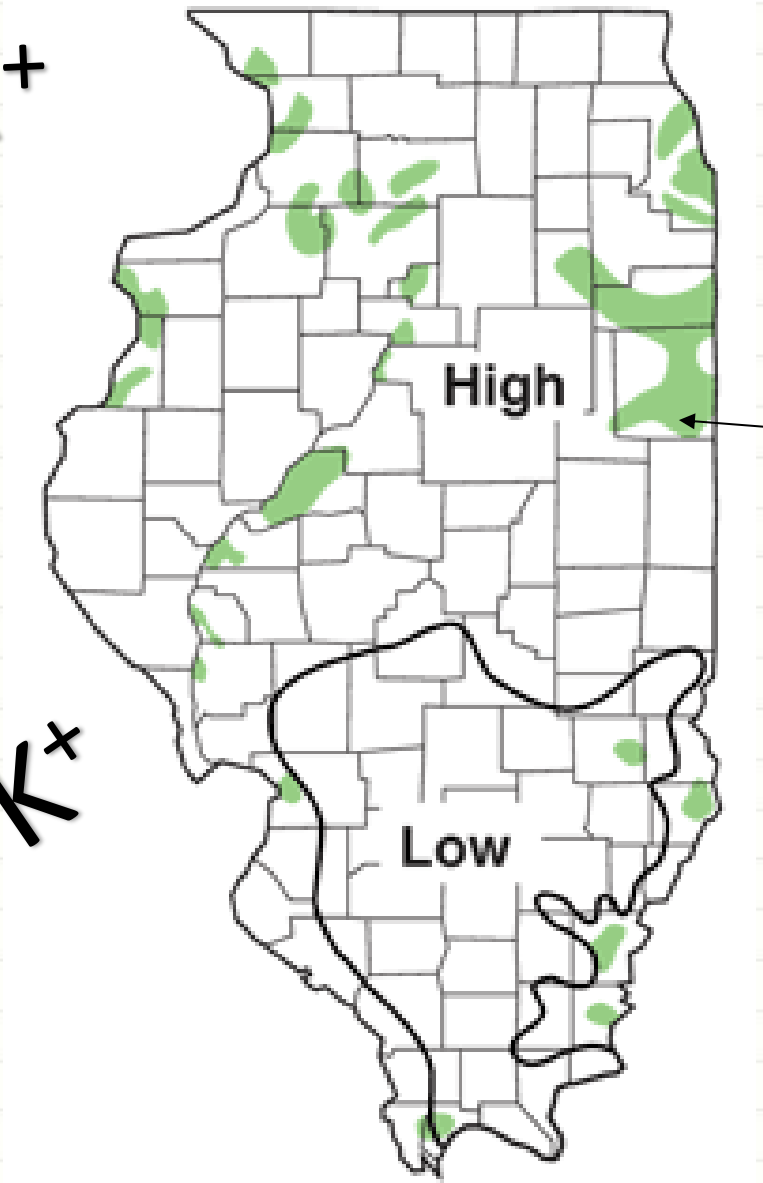
Soil Potassium



Green shaded areas of sandy soils with very low CEC test values

CEC corresponds with K-supplying power of soil

https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf

K-testing

- Extraction with Mehlich 3, $NH_4C_2H_3O_2$
- Amount of K in extract measured by ICP, flame photometer

K fertilization guidelines

- K recommendations are based on:
  - The soil test value
  - Soil CEC
  - Crop
  - Estimates of removal

K fertilization guidelines

- Midwest growers guide recommendations:
- Vegetables usually benefit from K fertilization is soil test is:
  - Less than 85 ppm K on a soil with a low CEC (~4)
  - Less than 115 ppm K on a soil with medium CEC (~16)
- Maximum K recommendation is 300 lbs K_2O/A/Yr.
- K fertilizer not recommended if test is:
  - Greater than 135ppm K on a soil with low CEC
  - Greater than 165 ppm K on a soil with medium CEC

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Potassium fertilization guidelines

FERTILIZER: *Tomatoes*

The following fertilizer rates are to be used only as guidelines. Research at the University of Kentucky and at the University of Tennessee indicates that there is no yield increase from using more than 60 lb/A K_2O or 60 lb/A of P_2O_5 when soil test P and K levels are high.

Potassium		Potash (K_2O)
Low	<201	121-250
Medium	201-300	61-120
High	301-450	1-60
Very High	>450	0

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Soil N testing

- Standard tests aren't available to predict how much N a vegetable crop needs
- Fertilizer N requirement affected by:
  - Experience (on farm trials can help optimize)
  - Soil type ("bad soils" need more N fertilizer)
  - Cropping history
  - Organic matter amendments
  - Crop culture system

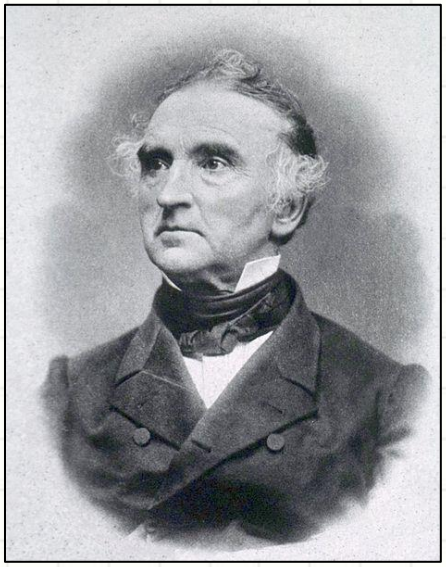
Soil N testing

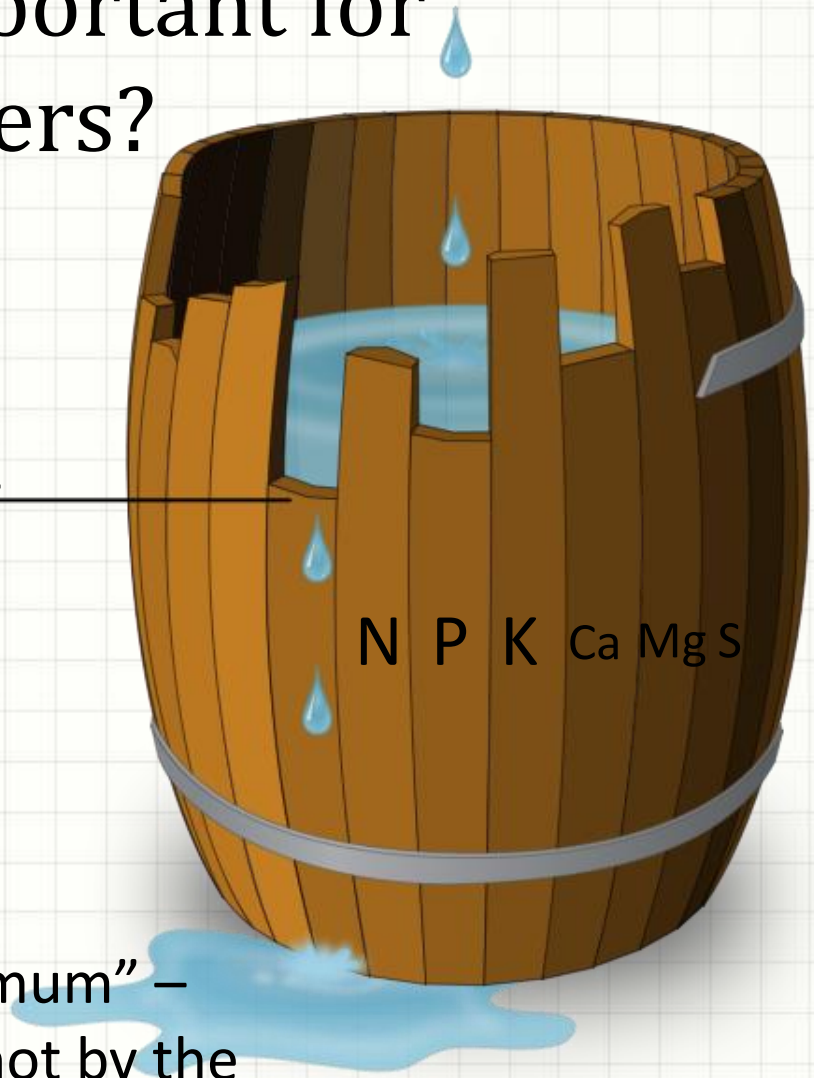
- No perfect N test (yet)
- Soil NO_3^--N prior pre-plant or prior to sidedressing
- ISNT
  - Still needs research and development to determine usefulness to specialty growers
- Soil incubations followed by N analysis

N fertilization guidelines

- Vary between crops
- Affected by plant population

Why is soil testing important for specialty crop producers?





Justus von Liebig's "law of the minimum" –

"Plant growth is controlled not by the total amount of resources available, but by the scarcest resource"

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Problems more commonly found in specialty crops

- Phosphorus scores too high
- Advising on foliar feeding
- Nutrients out of balance?
- “Disease” associated with fertility

Other differences

- Fertilizer materials used
- Timing of application
- Method of application
- Fertilizer input expenses are normally not that significant in the overall cost of production
- Excess fertilizer may result in problems beyond the simple waste of money

Tools in addition to soil testing utilized by Illinois specialty crop producers

- Visual inspection
- Downloaded feeding schedules
- Tissue analysis
- Petiole sap testing

Petiole sap testing

- Relatively simple, used with N and K
- Immediate results
- Useful for making timely adjustments in fertilizer application rates when using fertigation.
- An on-farm crop management tool and are meant to supplement, not replace, standard soil testing and nutrient management

A NO_3^--N testing kit

Procedures for Sap Testing

To collect a sample for sap testing:

- Obtain a representative sample.
- Sample at a consistent time of day — sampling time may affect N results.
- Sample the uppermost, recently matured leaves.
- Remove the petiole or "leafstalk."
- Collect about 25-30 petioles per sample.
- Avoid damaged, diseased leaves.
- Collect separate samples for different:
    - Varieties, planting dates, and areas with deficiency symptoms.
    - Cultural practices, soil types, and irrigation sections.

Procedures for Sap Testing

After collecting a sample for sap testing, follow these handling guidelines:

- Do not allow petioles to lose moisture after picking.
- Strip leaf blades from petioles soon after picking.
- Place samples in closed plastic bags and store them in a cooler on ice.
- Do not store expressed sap for long periods (unless frozen).
- You can store petioles for 1 or 2 hours at moderate temperatures, somewhat longer on ice.

Procedures for Sap Testing

To analyze and interpret sap test results:

- Calibrate the meter every day before use.
- Warm petioles to room temperature before pressing and analyzing them.
- Cut petioles into ¼-inch pieces with a clean knife on a clean cutting board and mix the pieces well.
- Squeeze sap from a subsample of petiole pieces onto the electrode with a garlic press.
- Compare results with previous tests — are levels increasing, decreasing, or staying about the same?
- Adjust fertigation or side-dress fertilizer rates based on sap-test results.

Cardy meters for nitrate-N and K petiole sap testing are available in the United States through two sources: Spectrum Technologies (www.specmeters.com) and Gempler's (www.gemplers.com).

Sap nitrate-N and K recommendations are available in:

> *Plant Petiole Sap Testing: Guide for Vegetable Crops* (University of Florida Cooperative Extension Service Circular 1144, edis.ifas.ufl.edu/cv004).

Specialized plant sap press

Inexpensive garlic press

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Table 1: Guidelines for Plant Leaf Petiole Fresh Sap Nitrate-N and K Testing[1]

Crop	Crop Developmental Stage	Fresh Petiole Sap Concentration (ppm)	
		NO_3-N	K
Broccoli and Collard	Six-leaf stage	800-1,000	NR
	One week prior to first harvest	500-800	
	First harvest	300-500	
Cantaloupe	First blossom	1,000-1,200	NR
	Fruit 2 inches long	800-1,000	
	First harvest	700-800	
Cucumber	First blossom	800-1,000	NR
	Fruit 3 inches long	600-800	
	First harvest	400-600	
Eggplant	First fruit 2 inches long	1,200-1,600	4,500-5,000
	First harvest	1,000-1,200	4,000-4,500
	Mid-harvest	800-1,000	3,500-4,000
Pepper	First flower buds	1,400-1,600	3,200-3,500
	First open flowers	1,400-1,600	3,000-3,200
	Fruit half-grown	1,200-1,400	3,000-3,200
	First harvest	800-1,000	2,400-3,000
	Second harvest	500-800	2,000-2,400

[1]NR=no recommendation.

Source: George Hochmuth, *Plant Petiole Sap Testing*, University of Florida Cooperative Extension Service Circular 1144, 1994.

Detailed list also available on page 14 of the Midwest Vegetable Production Guide for Commercial Growers
http://mwveguide.org/

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Fertigation

"The application of fertilizers, soil amendments, or other water-soluble products through an irrigation system"

Fertigation

- If you do not have properly functioning check valves and interlocks, the injected chemicals could backflow into the water source.
- EPA and many state regulations specify that each system must contain a reduced pressure zone backflow prevention system
- Most regulations require a power interlock between the irrigation pump and the chemical injector unit, a low pressure shut down switch and a check valve on the chemical injection hose.
- For specific requirements, check with the appropriate local or state agency.

Fertigation recommendations

- For N fertilization only
- Based on 150 lb actual N/A with 50 lb N/A applied preplant and the remaining N divided into equal amounts to be fertigated on a weekly basis
- Fertigation can begin 10-14 d after transplant assuming 50 lb/A was applied preplant

Total N required	Actual N/week (lb/A)	Ammonium nitrate (lb/A/wk)	Ammonium nitrate (lb per 1000 plants/wk)	Calcium nitrate (lb/A/wk)	Calcium nitrate (lb/1000 plants/wk)_
75 lb/A	7 lb 8 oz	22 lb 6 oz	5 lb 5 oz	48 lb 6 oz	11 lb 8 oz
100 lb/A	10 lb	30 lb	7 lb	64 lb 8 oz	11 lb 6 oz

FERTIGATION: *Staked Tomatoes*[1]

Moderate Rate	
Actual N/week:	7 lb 8 oz/A
Ammonium Nitrate	22 lb 6 oz/A 5 lb 5 oz/1,000 plants
Calcium Nitrate	48 lb 6 oz/A 11 lb 8 oz/1,000 plants
High Rate	
Actual N/week:	10 lb/A
Ammonium Nitrate	30 lb/A 7 lb/1,000 plants
Calcium Nitrate	64 lb 8 oz/A 15 lb 6 oz/1,000 plants

AT-RISK SITES

Moderate Rate	
Actual N/week:	7 lb 8 oz/A
Potassium Nitrate	57 lb 11 oz/A 13 lb 12 oz/1,000 plants
Potassium Nitrate: K provided	25 lb 6 oz/A 6 lb 1 oz/1,000 plants
High Rate	
Actual N/week:	10 lb/A
Potassium Nitrate	76 lb 15 oz/A 18 lb 5 oz/1,000 plants
Potassium Nitrate: K provided	33 lb 14 oz/A 8 lb 1 oz/1,000 plants

Total amount/season:	125 lb/A (moderate rate) 150 lb/A (high rate)
Preplant amount:	50 lb/A
Fertigated amount:	75 lb/A (moderate rate) 100 lb/A (high rate)
Growing season:	10 weeks

Fertigation can begin 10 to 14 days after transplanting.

The doses for 1,000 plants are based on a plant population of 4,200 plants/A (i.e., rows on 6 foot centers in 5-row blocks and plants 18 inches apart).

For harvest seasons extending beyond 10 weeks from transplanting, a maintenance dose of 1 to 1.5 lb N (3 to 4.5 lb ammonium nitrate, or 11.5 lb potassium nitrate for "at risk" sites) per week is adequate.

IMPORTANT: If a UK soil test indicates your site is "at risk" for ripening disorders (Hartz ratio), you should alternate the fertigations listed above with those listed at left.

Potassium nitrate supplies both nitrogen and potassium and can be used as a substitute for ammonium or calcium nitrate.

[1] *All recommendations assume starter fertilizer was used.*

http://www2.ca.uky.edu/agc/pubs/id/id36/id36.pdf

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Fertigation

- Most growers use ammonium, calcium, or potassium nitrate, usually dissolved in water prior to fertigating.
- Many fertilizers are easily soluble together, care must be taken not to mix fertilizers that may precipitate when together.
- This can lead to clogs at emitters, resulting in inadequate irrigation.
- Often, high-phosphorous fertilizers can precipitate when mixed with sufficient concentrations of calcium.

Final thoughts on soil testing

- On-farm tests can assist in optimizing a fertility program
- Know who are your extension agents and get to know them
- Remember that quality soil testing labs often give liming and fertilization recommendations
- Repeat soil testing every 3-4 years

Additional resources

- http://www2.ca.uky.edu/agc/pubs/id/id36/id36.pdf
- http://mwveguide.org/
- https://extension.cropsci.illinois.edu/handbook/pdfs/chapter08.pdf
- http://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=IL
- http://www.extension.umn.edu/agriculture/nutrient-management/nitrogen/nitrogen-application-with-irrigation-water-chemigation/

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