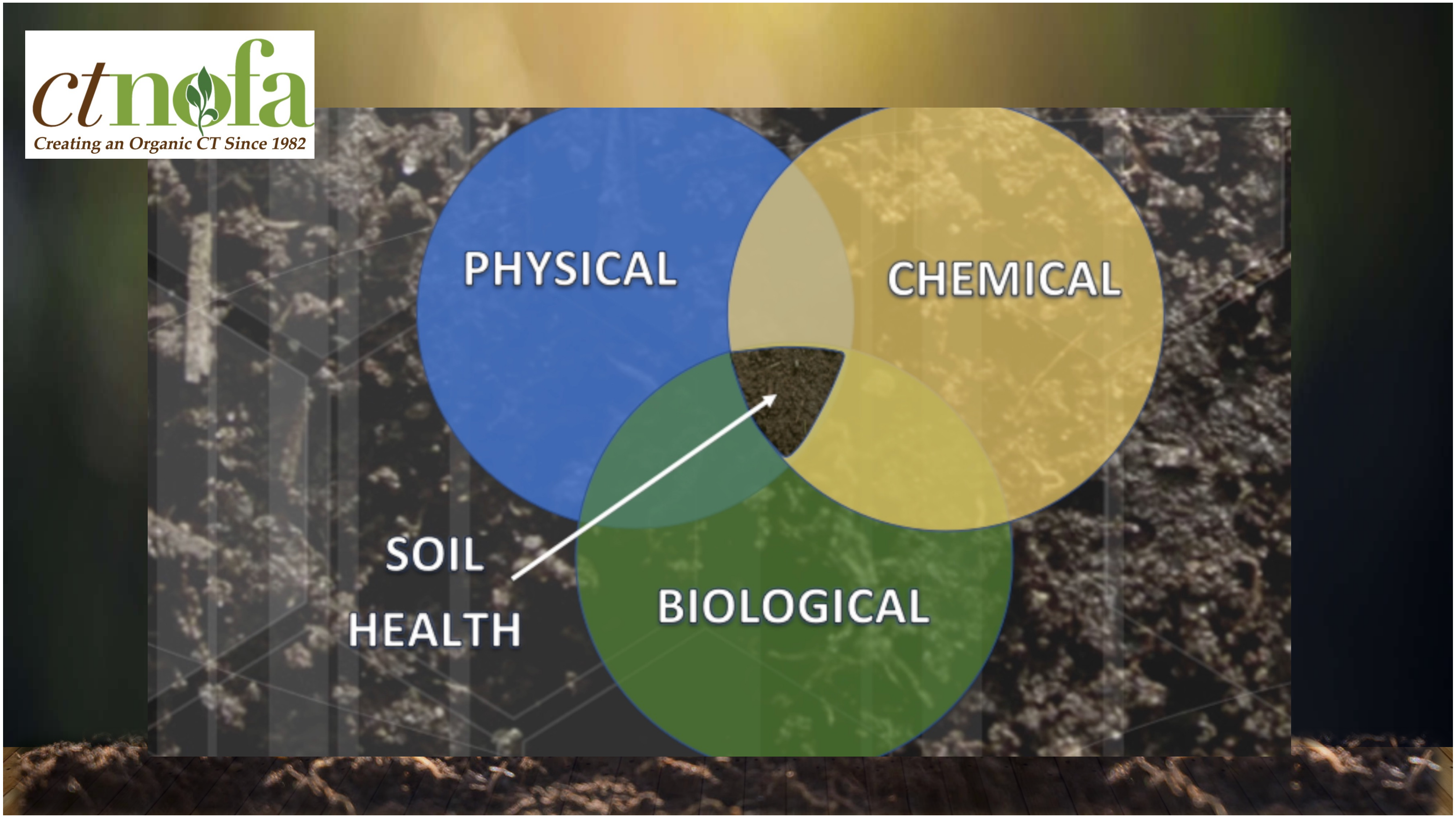
Creating an Organic CT Since 1982

Soil Health - 3 Ways
Physical – Chemical - Biological


ctnofa
Creating an Organic CT Since 1982


ctnofa
Creating an Organic CT Since 1982
PHYSICAL
CHEMICAL
BIOLOGICAL
SOIL
HEALTH


ctnofa
Creating an Organic CT Since 1982
Week 2
Chemical Properties of Soil

but first…Asian Jumping Worms

aka "crazy worm" or "snake worms", these invasive earthworms from East Asia are rapidly spreading across North America.

Unlike common European earthworms that burrow deep and aerate soil, jumping worms live in the top few inches of soil and leaf litter.

Environmental Impact:

- Nutrient depletion: consume leaf litter, stripping nutrients faster than plants can absorb them
- Soil Erosion: Their grainy castings are easily washed away by rain, leading to erosion and exposed roots
- Biodiversity Loss: by destroying the forest's protective leaf layer, the eliminate habitat for other species

Management and Control

- **Mustard Test**: to check for infestation, mix 1/3 cup ground yellow mustard seed with 1 gallon water and pour over soil to drive worms to surface for collection
- **Solarization**: Cocoons and adults die with temps exceed 104 Degrees for several days. Collect worms and store in plastic ziplock bag in the sun
- **Stop the Spread**: Avoid sharing plants in garden soil; instead use bare-root stock

Week 2
Chemical Properties of Soil

Chemical properties of soil

- **Essential elements**
- pH
- Cation Exchange Capacity
- Basic soil testing methods of chemical analysis
- Nutrient cycling
- Nutrient balancing

Essential Plant Nutrients

- Plants absorb at least 90 different elements
  - Only a few are needed for growth and reproduction

- Essential means:
  - A lack of the element stops a plant from completing growth or reproduction
  - The element is directly involved in plant nutrition
  - A shortage of the element can be corrected only by supplying that element *

17 Essential Plant Nutrients

- 3 Non-mineral elements account for 95% of all plant needs
    - Carbon (C), oxygen (O), and hydrogen (H)
    - Available from air and water

- The other 14 are obtained from soil

  - 6 are macronutrients (used in large amounts by plants):
    - Primary macronutrients
      - Nitrogen (N), phosphorous (P), potassium (K)
    - Secondary macronutrients
      - Calcium (Ca), magnesium (Mg), sulfur (S)

  - 8 are micronutrients or trace elements (used in small amounts by plants):
    - Boron, copper, chlorine, iron, manganese, molybdenum, nickel, zinc

17 Essential Plant Nutrients

ESSENTIAL ELEMENTS	% DEFICIENT	% SUFFICIENT OR NORMAL	% EXCESSIVE OR TOXIC
Major Elements			
Nitrogen (N)	<2.50	2.50 - 4.50	>6.00
Phosphorus (P)	<0.15	0.20 - 0.75	>1.00
Potassium (K)	<1.00	1.50 - 5.50	>6.00
Calcium (Ca)	<0.50	1.00 - 4.00	>5.00
Magnesium (Mg)	<0.20	0.25 - 1.00	>1.50
Sulfur(S)	<0.20	0.25 - 1.00	>3.00
Micronutrients	ppm	ppm	ppm
Boron (B)	5 - 30	10 - 200	50 - 200
Chlorine (Cl)	<100	100 - 500	500 - 1,000
Copper (Cu)	2 - 5	5 - 30	20 - 100
Iron (Fe)	<50	100 - 500	>500
Manganese (Mn)	15 - 25	20 - 300	300 - 500
Molybdenum (Mo)	0.03 - 0.15	0.1 - 2.0	>100
Zinc(Zn)	10 - 20	27 - 100	100 - 400

MICRONUTRIENTS / TRACE ELEMENTS

Of the elements known to be essential for plant growth, 8 are required in such small quantities that they are called micronutrients or trace elements

- They are not less important than macronutrients
- Micronutrient deficiencies can be severe
  - Stunted growth, low yields, plant death
- Small applications of micronutrients may produce dramatic results

MICRONUTRIENT / TRACE ELEMENT FORMS

- Except for boron and chlorine, trace elements are metals
- Generally stored in soil differently from macronutrients
  - Some are stored in slightly soluble compounds involved in a cation exchange
  - Many combine with organic molecules to form chelates (a metal atom surrounded by a large organic molecule)

TABLE 15.8 Forms of Micronutrients Dominant in the Soil Solution

Micronutrient	*Dominant soil solution forms*
Iron	Fe^{2+}, $Fe(OH)_2^{+}$, $Fe(OH)^{2+}$, Fe^{3+}
Manganese	Mn^{2+}
Zinc	Zn^{2+}, $Zn(OH)^{+}$
Copper	Cu^{2+}, $Cu(OH)^{+}$
Molybdenum	MoO_4^{2-}, $HMoO_4^{-}$
Boron	H_3BO_3
Cobalt	Co^{2+}
Chlorine	Cl^{-}
Nickel	Ni^{2+}, Ni^{3+}

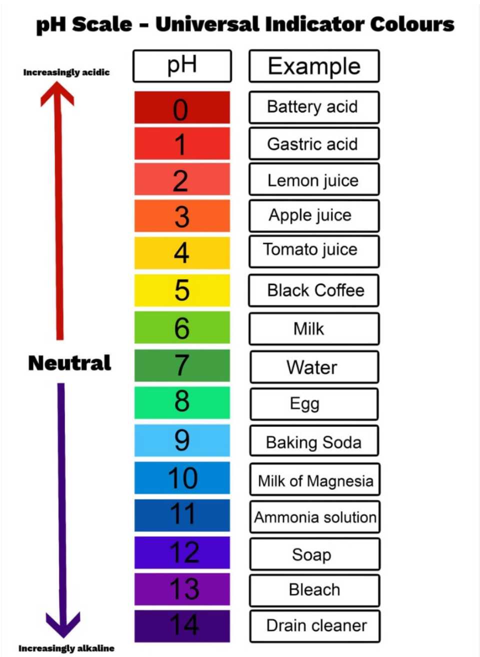
From data in Lindsay (1972).

Chemical properties of soil

- Essential elements
- **pH**
- Cation Exchange Capacity
- Basic soil testing methods of chemical analysis
- Nutrient cycling
- Nutrient balancing

What is Soil pH?

- Also referred to as soil reaction
- Describes how acid or alkaline a soil is
- Strongly affects plant growth
- Measured by the pH scale
  - pH 0 = most acidic
  - pH 7 = neutral
  - pH 14 = most basic

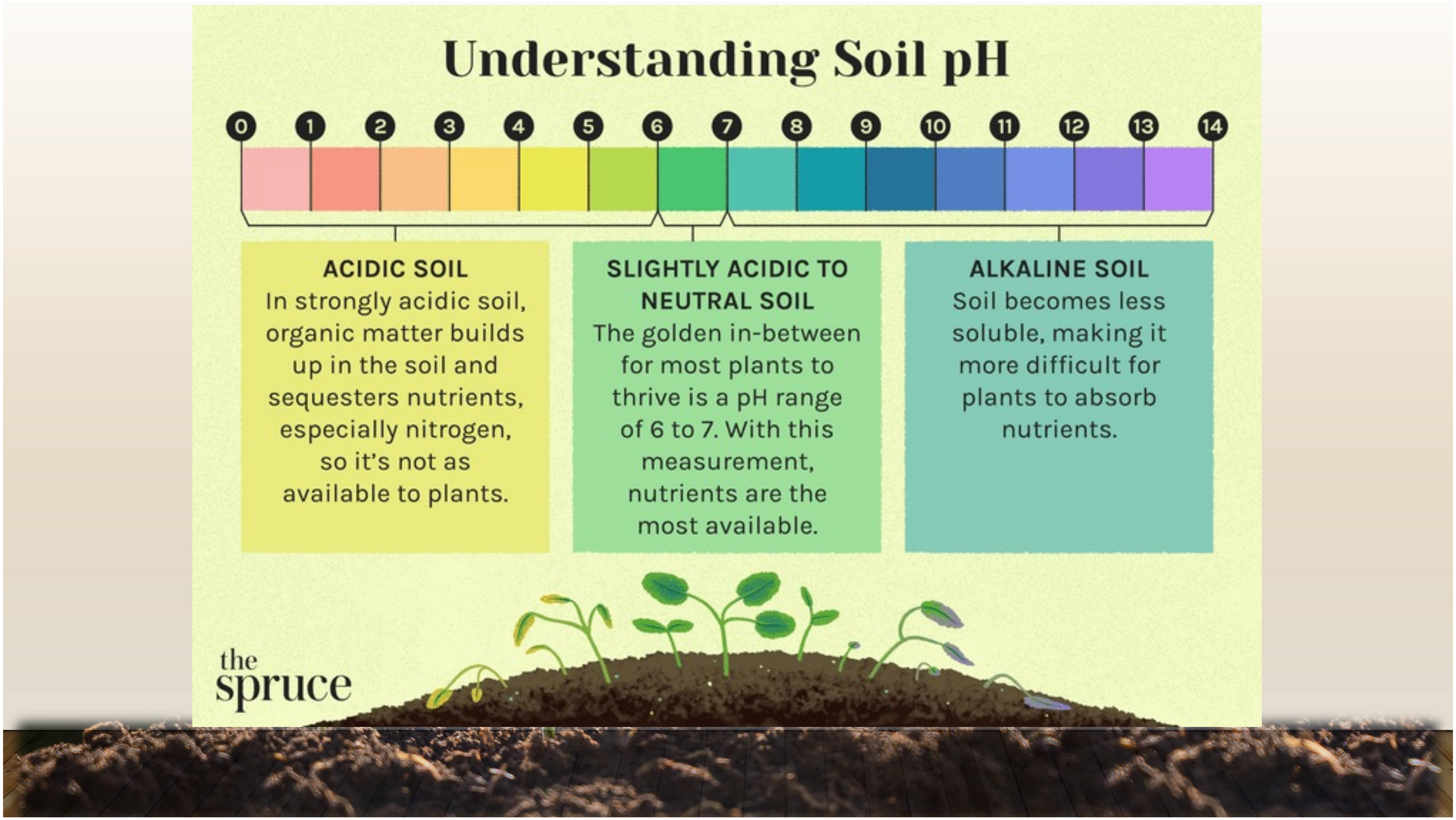


What is Soil pH?

pH

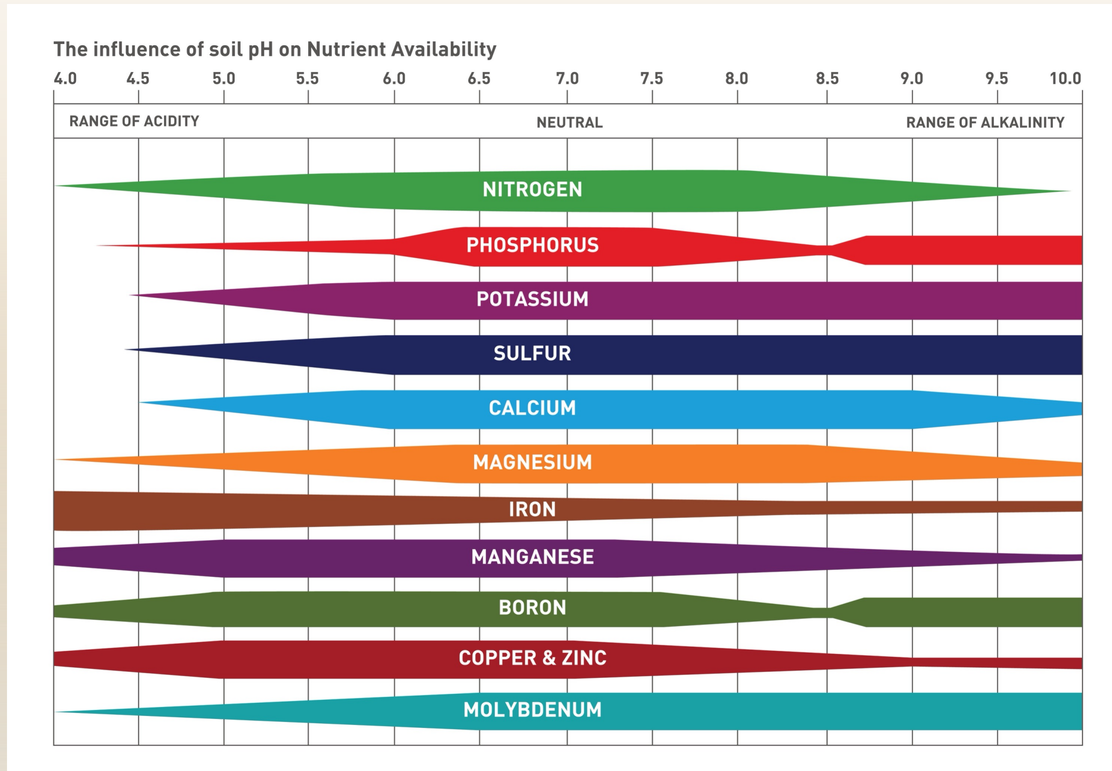
Ideal range: 6.2-6.8 for most crops
Controls nutrient availability - too acidic or alkaline locks things up

Think of it as a dial that opens or closes the nutrient pantry


Understanding Soil pH
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
ACIDIC SOIL
In strongly acidic soil, organic matter builds up in the soil and sequesters nutrients, especially nitrogen, so it's not as available to plants.
SLIGHTLY ACIDIC TO NEUTRAL SOIL
The golden in-between for most plants to thrive is a pH range of 6 to 7. With this measurement, nutrients are the most available.
ALKALINE SOIL
Soil becomes less soluble, making it more difficult for plants to absorb nutrients.
the spruce

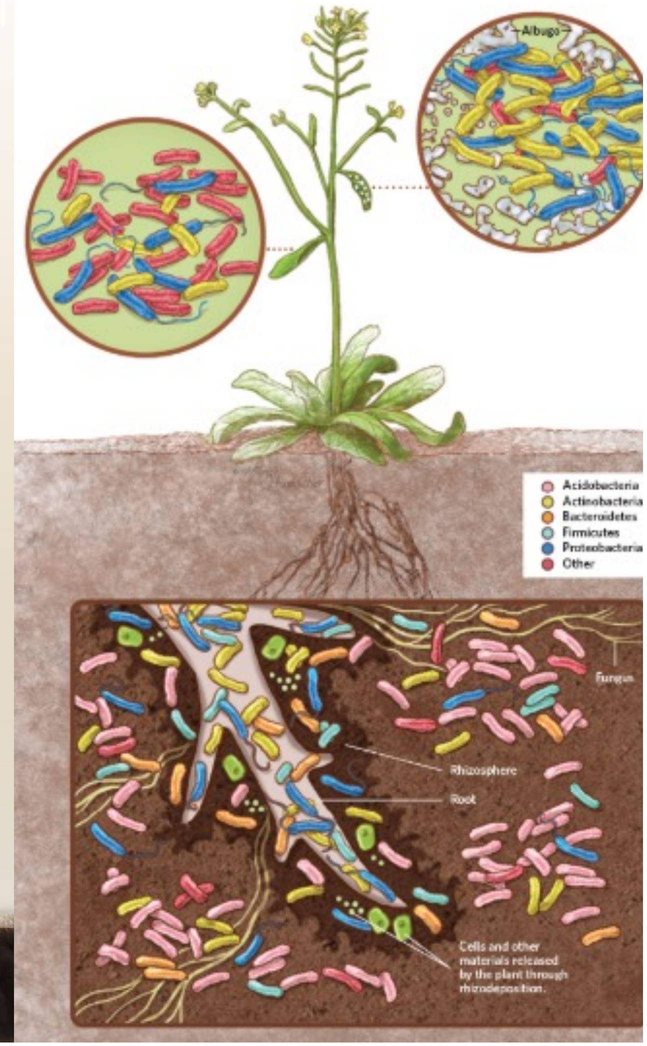
CORE PARAMETERS FOR PH

- 6.2-6.8 = best nutrient availability
- Nutrient lock-up → deficiency symptoms
- Optimal pH is linked to biological energy
- pH reflects bio activity → microbial respiration
- Inputs (lime, salts, fertilizers) can shock microbes
- Soil pH is not static

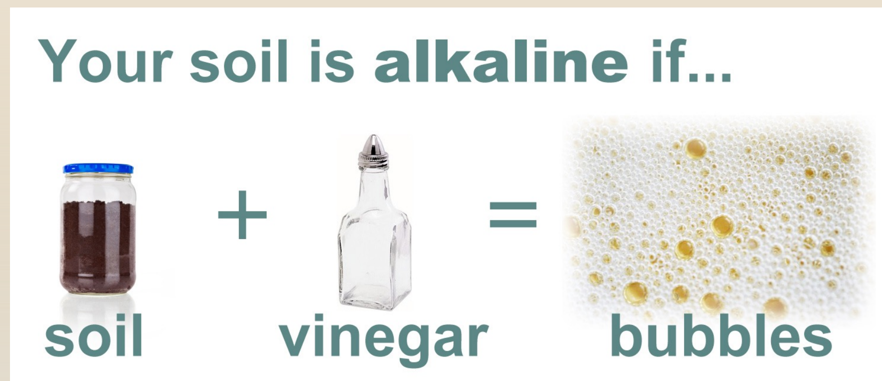


Microbes and pH

- Fungi release organic acids (oxalic, citric)
- Bacteria release alkalizing compounds (ammonia, carbonates)
- Balance of fungal vs bacterial dominance shapes soil pH



At Home test for Soil pH



pH and Parent Materials

- When first formed, soils tend to share the pH of parent materials
- Acidic parent materials, common in New England, Great Lakes, Appalachian states, include:

Shale

Sandstone

Granite

- Alkaline parent materials, common in the Great Plains, include:

Limestone

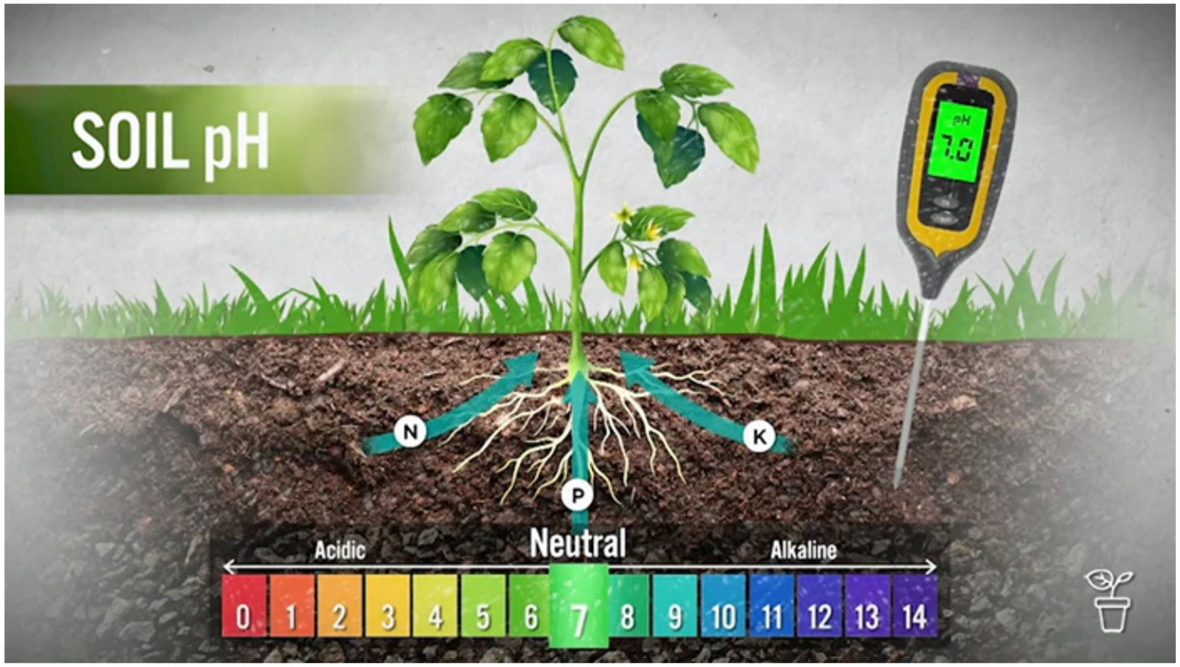
Effect of pH on Nutrient Availability

- Soil elements change their forms through reactions
  - Reactions are controlled by pH
- Ex: phosphorous
  - At low pH, gets tied up with aluminum and iron
  - At high pH, gets tied up with calcium
  - Most available to plants between pH of 6.0 and 7.0
- Nutrients may be present in soil, but may be tied up due to acidity or alkalinity

Conditions affecting level and availability of plant nutrients

- **Soil pH**

pH slightly acid to neutral nutrients are more available



INCORPORATING LIME IN NEW PLANTINGS

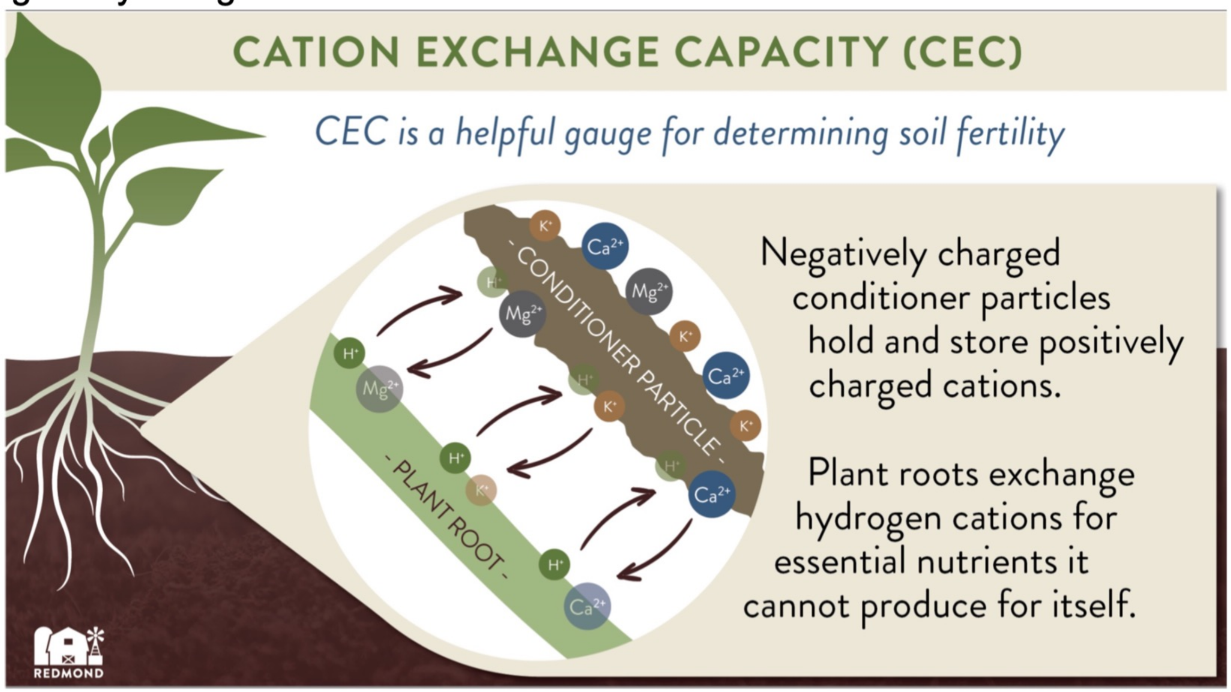
- For rapid reaction, lime must be mixed thoroughly with soil
- Best results with dry soil
- Roto-tilling or harrowing provide good mixing
- A plow turns the soil, it does not provide mixing action

Chemical properties of soil

- Essential elements
- pH
- **Cation Exchange Capacity**
- Basic soil testing methods of chemical analysis
- Nutrient cycling
- Nutrient balancing

CATION EXCHANGE CAPACITY

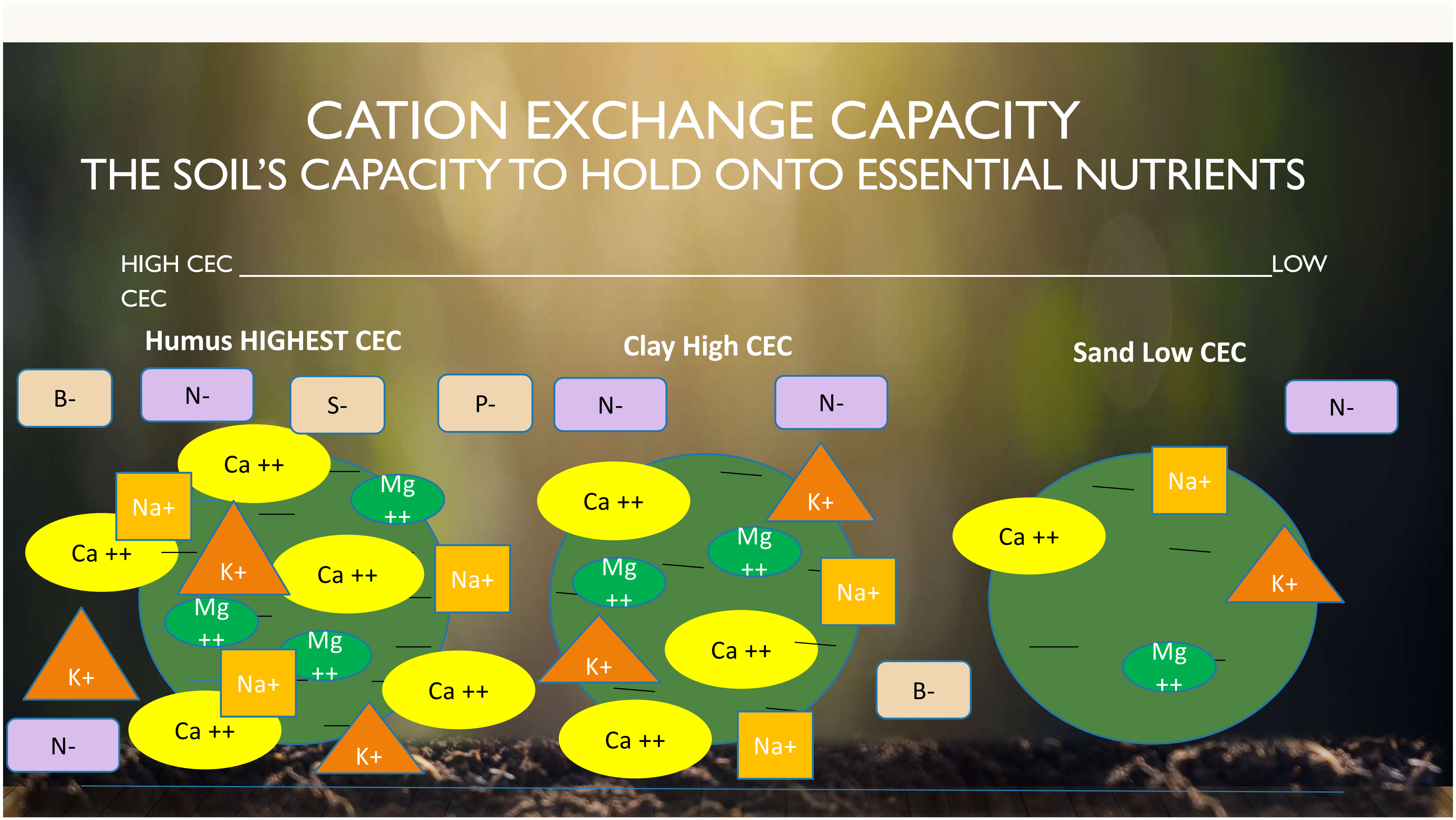
Cation exchange capacity (CEC) is a measurement of soil's ability to hold positively charged ions (cations) by using electrical attraction. When soil can hold onto essential nutrients and minerals, they are more available to plant roots that need them for survival. Cations can be held and stored in the soil by negatively charged colloids:



CATION EXCHANGE CAPACITY

Ideal range:
Sandy: 5-10 meq/100g
Loam: 10-20 meq/100g
Clay/OM: 20-40+ meq/100g

Measures how many nutrients the soil can hold. *The pantry size - small vs. big storage.*


CATION EXCHANGE CAPACITY
THE SOIL'S CAPACITY TO HOLD ONTO ESSENTIAL NUTRIENTS
HIGH CEC
LOW CEC
Humus HIGHEST CEC
Clay High CEC
Sand Low CEC
B-
N-
S-
P-
N-
N-
N-
Ca ++
Mg ++
Na+
Ca ++
K+
Ca ++
Na+
Mg ++
Mg ++
K+
Na+
Ca ++
Ca ++
N-
K+
Ca ++
K+
Mg ++
Mg ++
Na+
K+
Ca ++
Ca ++
Na+
B-
Na+
Ca ++
K+
Mg ++

CATION EXCHANGE CAPACITY

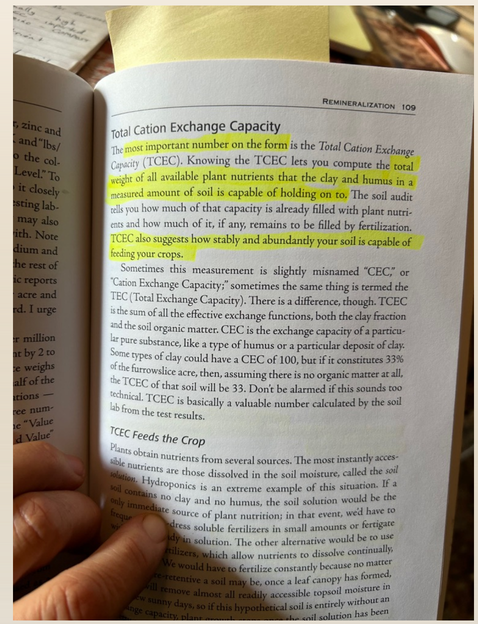
https://www.youtube.com/watch?v=HmEyymGXOfI

THE INTELLIGENT GARDENER BY STEVE SOLOMON

"Total Cation Exchange Capacity

The most important number on the form is the Total Exchange Capacity (TCEC). Knowing the TCEC lets you compute the total weight of all available plant nutrients that the clay and humus in a measured amount of soil is capable of holding on to.

TCEC also suggests how stably and abundantly your soil is capable of feeding your crops."



REMINERALIZATION 109

Total Cation Exchange Capacity

The most important number on the form is the *Total Cation Exchange Capacity* (TCEC). Knowing the TCEC lets you compute the total weight of all available plant nutrients that the clay and humus in a measured amount of soil is capable of holding on to. The soil audit tells you how much of that capacity is already filled with plant nutrients and how much of it, if any, remains to be filled by fertilization. TCEC also suggests how stably and abundantly your soil is capable of feeding your crops.

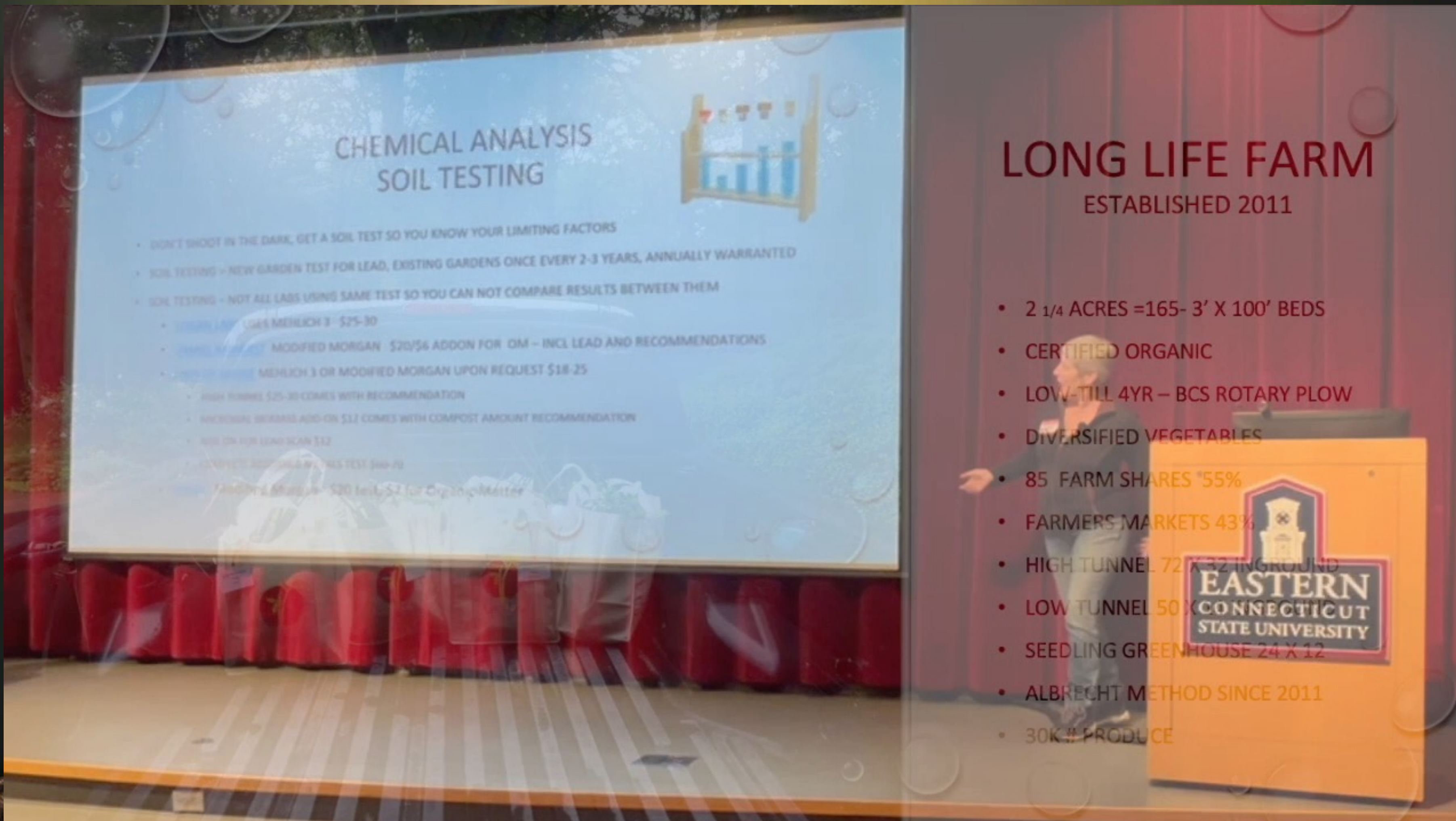
Sometimes this measurement is slightly misnamed "CEC," or "Cation Exchange Capacity;" sometimes the same thing is termed the TEC (Total Exchange Capacity). There is a difference, though. TCEC is the sum of all the effective exchange functions, both the clay fraction and the soil organic matter. CEC is the exchange capacity of a particular pure substance, like a type of humus or a particular deposit of clay. Some types of clay could have a CEC of 100, but if it constitutes 33% of the furrowslice acre, then, assuming there is no organic matter at all, the TCEC of that soil will be 33. Don't be alarmed if this sounds too technical. TCEC is basically a valuable number calculated by the soil lab from the test results.

TCEC Feeds the Crop

Plants obtain nutrients from several sources. The most instantly accessible nutrients are those dissolved in the soil moisture, called the *soil solution*. Hydroponics is an extreme example of this situation. If a soil contains no clay and no humus, the soil solution would be the only immediate source of plant nutrition; in that event, we'd have to freque[illegible] [illegible]-dress soluble fertilizers in small amounts or fertigate wi[illegible] [illegible]dy in solution. The other alternative would be to use [illegible]rtilizers, which allow nutrients to dissolve continually. We would have to fertilize constantly because no matter [illegible]re-retentive a soil may be, once a leaf canopy has formed, [illegible]ill remove almost all readily accessible topsoil moisture in [illegible]w sunny days, so if this hypothetical soil is entirely without an [illegible]nge capacity, plant [illegible] the soil solution has been

Chemical properties of soil

- Essential elements
- pH
- Cation Exchange Capacity
- **Basic soil testing methods of chemical analysis**
- Nutrient cycling
- Nutrient balancing



LONG LIFE FARM

ESTABLISHED 2011

- 2 1/4 ACRES =165- 3' X 100' BEDS
- CERTIFIED ORGANIC
- LOW-TILL 4YR – BCS ROTARY PLOW
- DIVERSIFIED VEGETABLES
- 85 FARM SHARES ˚55%
- FARMERS MARKETS 43%
- HIGH TUNNEL 72 X 32 INGROUND
- LOW TUNNEL 50 X
- SEEDLING GREENHOUSE 24 X 12
- ALBRECHT METHOD SINCE 2011
- 30K # PRODUCE

Compass Public Charter School, RI

Plan BEFORE soil test

note: Row Crops planned for West of Barn

Sample Soil Test:

Community Garden at Housatonic College

Soil Test Report

Prepared For:
Monique Bosch
8 Grumman Avenue
Wilton, CT 06897

moniqueb@optonline.net
203-858-8829

Sample Information:
Sample ID: Garden Plot 5A

Order Number: 53354
Lab Number: S210318-202
Area Sampled:
Received: 3/18/2021
Reported: 3/29/2021

Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	7.3	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	70.2	4-14
Potassium (K)	201	100-160
Calcium (Ca)	2954	1000-1500
Magnesium (Mg)	520	50-120
Sulfur (S)	23.1	>10
Micronutrients *		
Boron (B)	0.5	0.1-0.5
Manganese (Mn)	8.2	1.1-6.3
Zinc (Zn)	1.8	1.0-7.6
Copper (Cu)	0.2	0.3-0.6
Iron (Fe)	4.2	2.7-9.4
Aluminum (Al)	13	<75
Lead (Pb)	0.6	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	19.5	
Exch. Acidity, meq/100g	0.0	
Base Saturation, %		
Calcium Base Saturation	76	50-80
Magnesium Base Saturation	22	10-30
Potassium Base Saturation	3	2.0-7.0
Scoop Density, g/cc	0.84	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

Soil Test Interpretation

Nutrient	Very Low	Low	Optimum	Above Optimum
Phosphorus (P):				
Potassium (K):				
Calcium (Ca):				
Magnesium (Mg):				

Phosphorus is excessive.

Sample Soil Test:

Untreated future site for Production Garden at Simon's Rock

Soil Test Report

Prepared For:

Monique Bosch
Bard College at Simon's Rock
84 Alford Road
Great Barrington, MA 01230

mbosch@simons-rock.edu
203-858-8829

Sample Information:
Sample ID: Orchard

Order Number: 63317
Lab Number: S221121-104
Area Sampled: 0.25 acres
Received: 11/21/2022
Reported: 11/29/2022

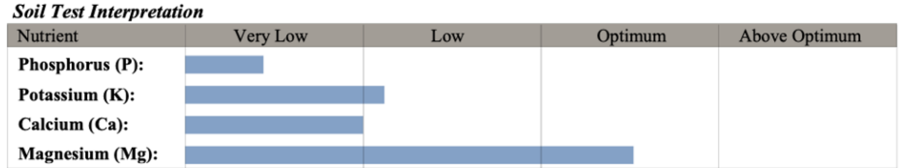
Results

Analysis	*Value Found*	*Optimum Range*
Soil pH (1:1, H2O)	5.6	
Modified Morgan extractable, ppm		
Macronutrients		
Phosphorus (P)	0.9	4-14
Potassium (K)	56	100-160
Calcium (Ca)	500	1000-1500
Magnesium (Mg)	87	50-120
Sulfur (S)	7.8	>10
Micronutrients *		
Boron (B)	0.0	0.1-0.5
Manganese (Mn)	9.4	1.1-6.3
Zinc (Zn)	1.0	1.0-7.6
Copper (Cu)	0.1	0.3-0.6
Iron (Fe)	6.2	2.7-9.4
Aluminum (Al)	85	<75
Lead (Pb)	1.0	<22

Analysis	*Value Found*	*Optimum Range*
Cation Exch. Capacity, meq/100g	10.6	
Exch. Acidity, meq/100g	7.3	
Base Saturation, %		
Calcium Base Saturation	24	50-80
Magnesium Base Saturation	7	10-30
Potassium Base Saturation	1	2.0-7.0
Scoop Density, g/cc	0.94	
Optional tests		
Soil Organic Matter (LOI), %	4.6	

* *Micronutrient deficiencies rarely occur in New England soils; therefore, an Optimum Range has never been defined. Values provided represent the normal range found in soils and are for reference only.*

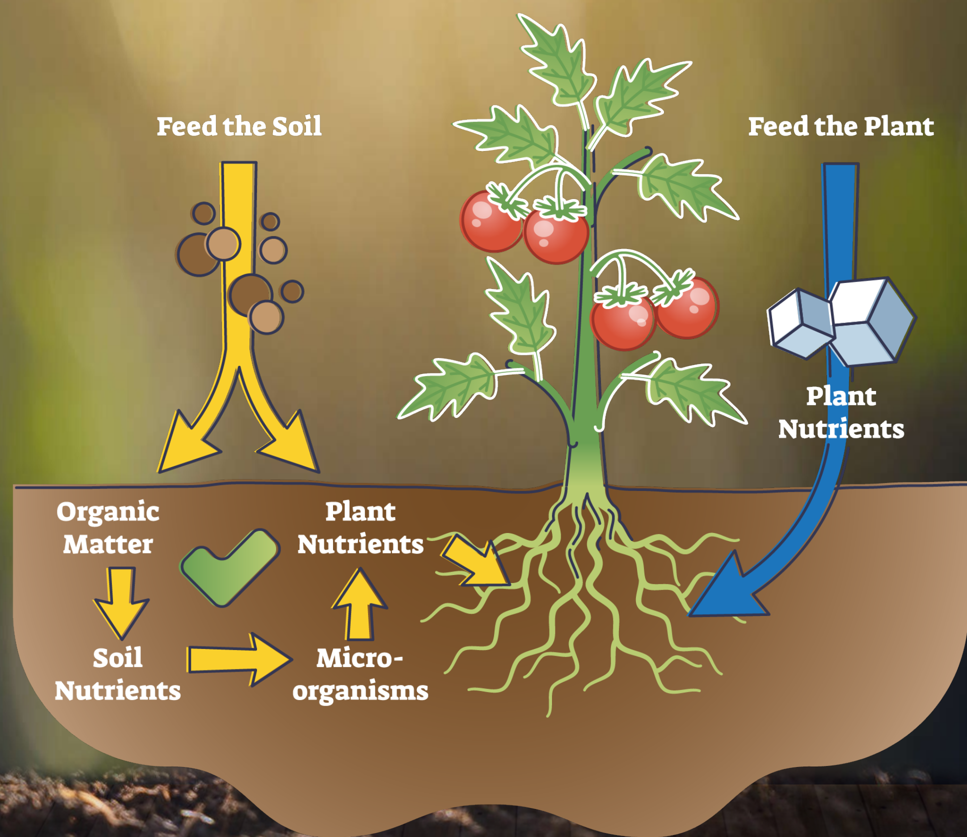
Soil Test Interpretation



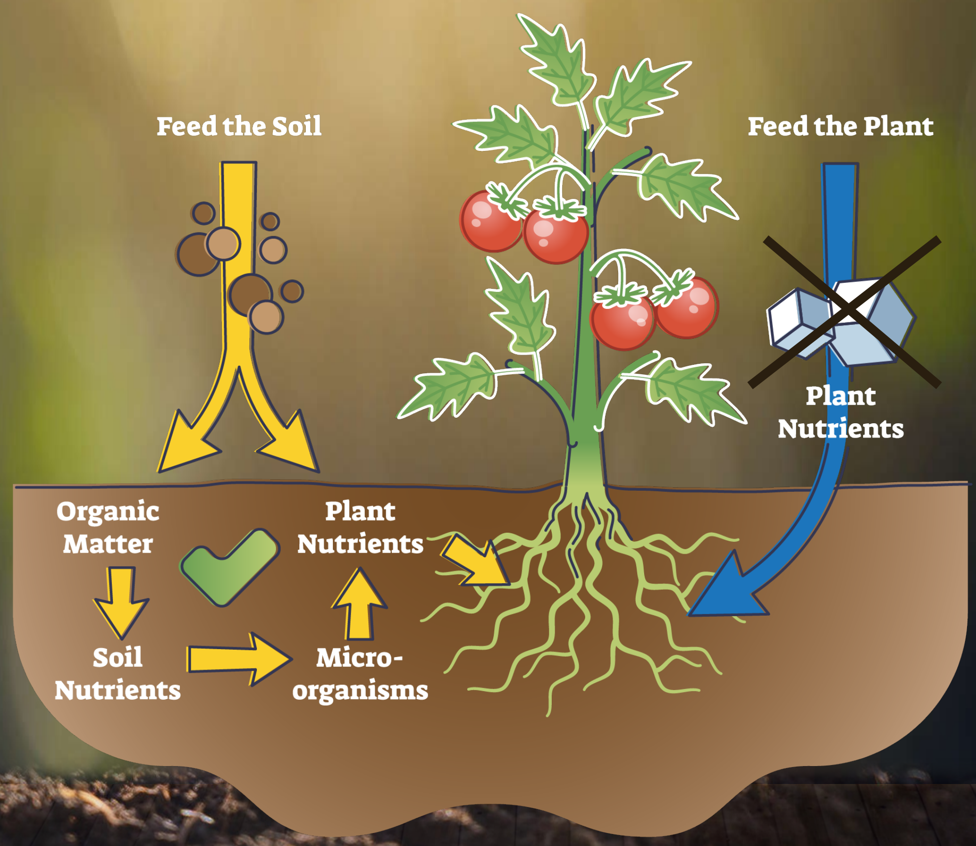
Chemical properties of soil

- Essential elements
- pH
- Cation Exchange Capacity
- Basic soil testing methods of chemical analysis
- **Nutrient cycling**
- Nutrient balancing

"A nutrient cycle is defined as the cyclic pathway by which nutrients pass-through, in order to be recycled and reutilized. The pathway comprises cells, organisms, community and ecosystem."



“A nutrient cycle is defined as the cyclic pathway by which nutrients pass-through, in order to be recycled and reutilized. The pathway comprises cells, organisms, community and ecosystem.”



"A nutrient cycle is defined as the cyclic pathway by which nutrients pass-through, in order to be recycled and reutilized. The pathway comprises cells, organisms, community and ecosystem."

Nutrients consumed by plants and animals are returned to the environment after death and decomposition and the cycle continues.

ecofriendlyhomestead.com

roles in the nutrient cycle

plants

uptake nutrients | release nutrients when decomposing

animals

eat plants | release nutrients in manure + decomposition

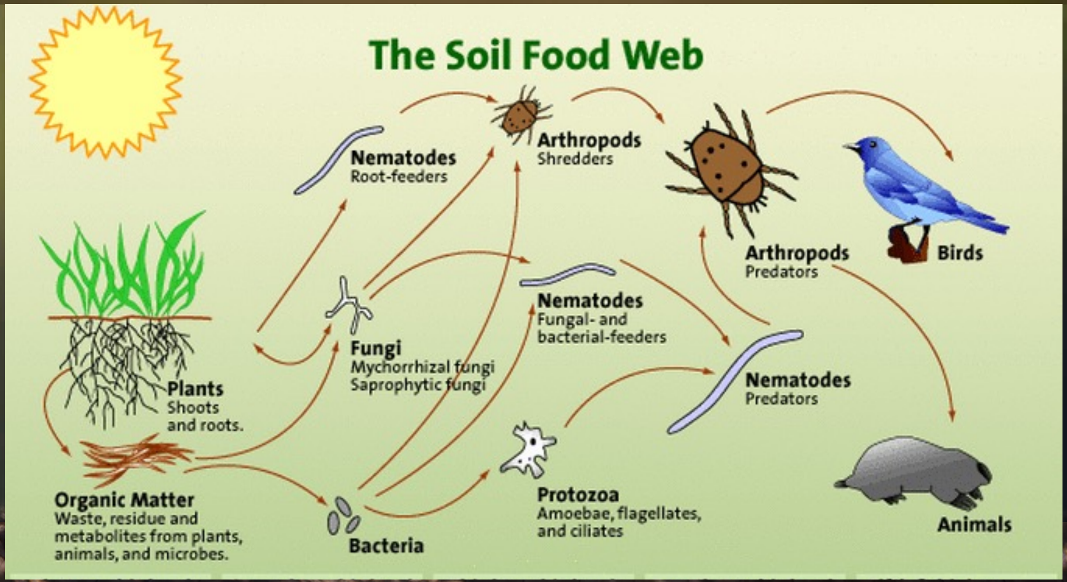
microbes

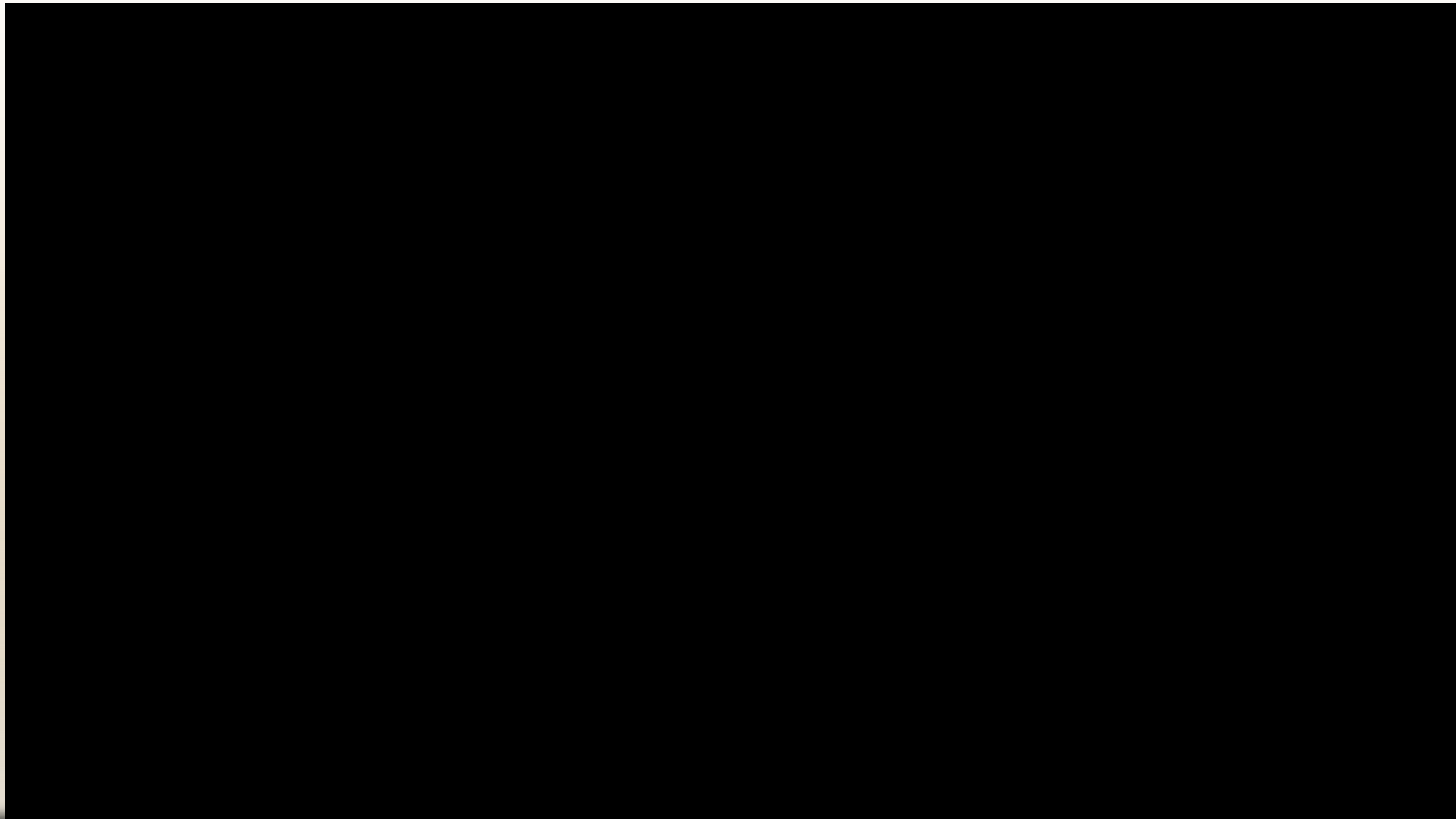
deliver nutrients | initiate decomposition

“A nutrient cycle is defined as the cyclic pathway by which nutrients pass-through, in order to be recycled and reutilized. The pathway comprises cells, organisms, community and ecosystem.”

Nutrients consumed by plants and animals are returned to the environment after death and decomposition and the cycle continues.

Soil microbes play an important role in nutrient recycling. They decompose organic matter to release nutrients. They are also important to trap and transform nutrients into the soil, which can be taken up by plant roots.



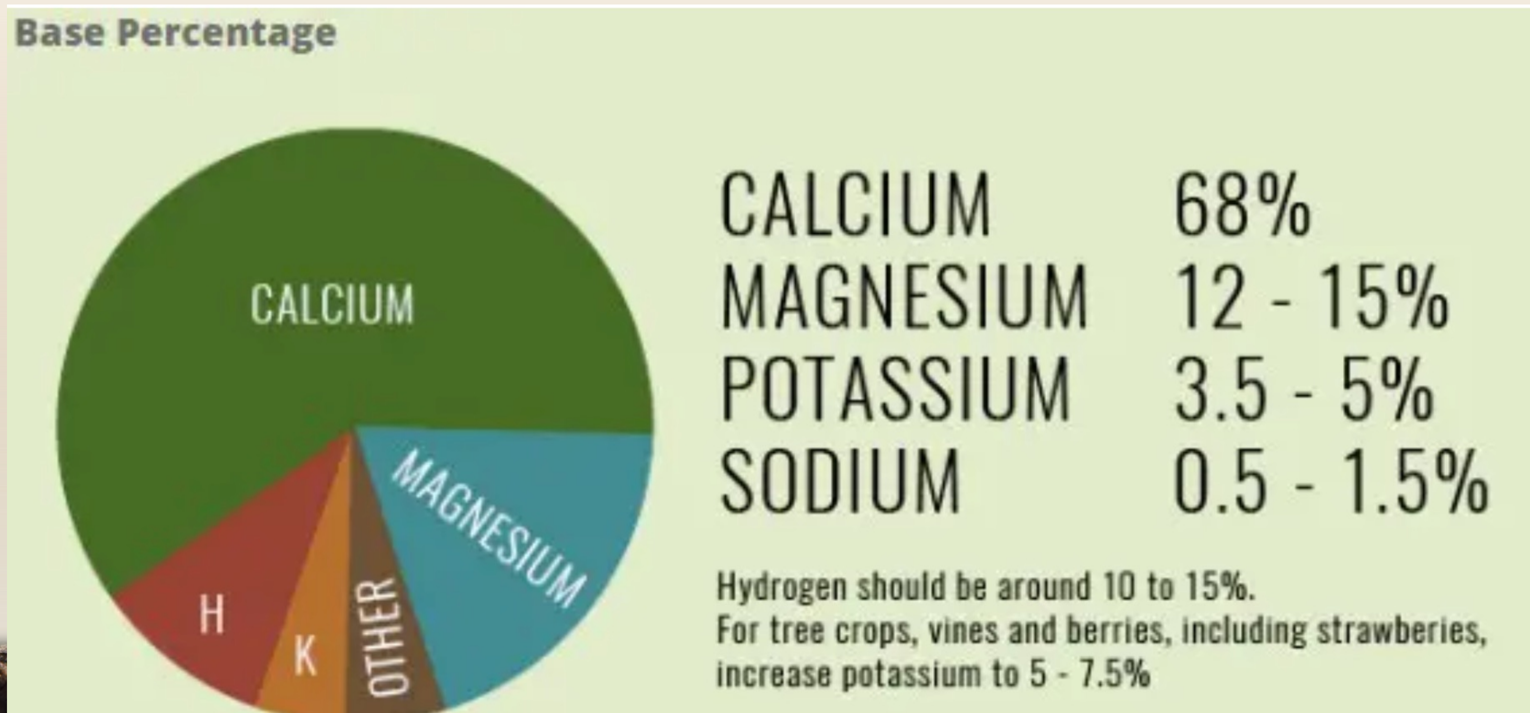


The Nutrient Cycle

Chemical properties of soil

- Essential elements
- pH
- Cation Exchange Capacity
- Basic soil testing methods of chemical analysis
- Nutrient cycling
- **Nutrient balancing**

BALANCED BASE SATURATION



BALANCED BASE SATURATION

Soil Report

Job Name **Monique Bosch** Date 5/21/2025

Company Monique Bosch Submitted By

Sample Location			Lathrop				
Sample ID			Control				
Lab Number			60				
Sample Depth in inches			6				
Total Exchange Capacity (M. E.)			6.03				
pH of Soil Sample			6.7				
Organic Matter, Percent			8.77				
ANIONS	**SULFUR:**	p.p.m.	13				
	Mehlich III Phosphorous:	ppm	98				
EXCHANGEABLE CATIONS	**CALCIUM:** ppm	Desired Value	819				
		Value Found	755				
		Deficit	-64				
	MAGNESIUM: ppm	Desired Value	100				
		Value Found	182				
		Deficit					
	POTASSIUM: ppm	Desired Value	100				
		Value Found	48				
		Deficit	-52				
	SODIUM:	ppm	14				
BASE SATURATION %	Calcium (60 to 70%)		62.63				
	Magnesium (10 to 20%)		25.09				
	Potassium (2 to 5%)		2.04				
	Sodium (.5 to 3%)		1.01				
	Other Bases (Variable)		4.70				
	Exchangable Hydrogen (10 to 15%)		4.50				
TRACE ELEMENTS	Boron (p.p.m.)		0.35				
	Iron (p.p.m.)		50				
	Manganese (p.p.m.)		8				
	Copper (p.p.m.)		0.91				
	Zinc (p.p.m.)		1.75				
	Aluminum (p.p.m.)		1200				
OTHER	Cobalt ppm		< 0.02				
	Molybdenum ppm		0.41				
	Ammonium (p.p.m.)		1.3				
	Nitrate (p.p.m.)		14.1				
	Selenium ppm		0.3				
	Silicon ppm		6.6				
	Estimated Nitrogen Release #N/Acre		119				
	EC mmhos/cm		0.07				

Logan Labs, LLC

BALANCED BASE SATURATION

Soil Report

Job Name **Monique Bosch** Date 5/21/2025

Company Monique Bosch Submitted By

Sample Location			Lathrop				
Sample ID			Control				
Lab Number			60				
Sample Depth in inches			6				
Total Exchange Capacity (M. E.)			6.03				
pH of Soil Sample			6.7				
Organic Matter, Percent			8.77				
ANIONS	**SULFUR:**	p.p.m.	13				
ANIONS	**Mehlich III Phosphorous:**	ppm	98				
EXCHANGEABLE CATIONS	**CALCIUM:** ppm	Desired Value	819				
		Value Found	755				
		Deficit	-64				
EXCHANGEABLE CATIONS	**MAGNESIUM:** ppm	Desired Value	100				
		Value Found	182				
		Deficit					
EXCHANGEABLE CATIONS	**POTASSIUM:** ppm	Desired Value	100				
		Value Found	48				
		Deficit	-52				
	SODIUM:	ppm	14				
BASE SATURATION %	Calcium (60 to 70%)		62.63				
BASE SATURATION %	Magnesium (10 to 20%)		25.09				
BASE SATURATION %	Potassium (2 to 5%)		2.04				
BASE SATURATION %	Sodium (.5 to 3%)		1.01				
BASE SATURATION %	Other Bases (Variable)		4.70				
BASE SATURATION %	Exchangable Hydrogen (10 to 15%)		4.50				
TRACE ELEMENTS	Boron (p.p.m.)		0.35				
TRACE ELEMENTS	Iron (p.p.m.)		50				
TRACE ELEMENTS	Manganese (p.p.m.)		8				
TRACE ELEMENTS	Copper (p.p.m.)		0.91				
TRACE ELEMENTS	Zinc (p.p.m.)		1.75				
TRACE ELEMENTS	Aluminum (p.p.m.)		1200				
OTHER	Cobalt ppm		< 0.02				
OTHER	Molybdenum ppm		0.41				
OTHER	Ammonium (p.p.m.)		1.3				
OTHER	Nitrate (p.p.m.)		14.1				
OTHER	Selenium ppm		0.3				
OTHER	Silicon ppm		6.6				
OTHER	Estimated Nitrogen Release #N/Acre		119				
OTHER	EC mmhos/cm		0.07				

Logan Labs, LLC

BALANCED BASE SATURATION

Soil Report

Job Name **Monique Bosch** Date 5/21/2025

Company Monique Bosch Submitted By

	Sample Location		Lathrop
	Sample ID		Control
	Lab Number		60
	Sample Depth in inches		6
	Total Exchange Capacity (M. E.)		6.03
	pH of Soil Sample		6.7
	Organic Matter, Percent		8.77
ANIONS	**SULFUR:**	p.p.m.	13
	Mehlich III Phosphorous:	ppm	98
EXCHANGEABLE CATIONS	**CALCIUM:** ppm	Desired Value	819
		Value Found	755
		Deficit	-64
	MAGNESIUM: ppm	Desired Value	100
		Value Found	182
		Deficit	
	POTASSIUM: ppm	Desired Value	100
		Value Found	48
		Deficit	-52
	SODIUM:	ppm	14
BASE SATURATION %	Calcium (60 to 70%)		62.63
	Magnesium (10 to 20%)		25.09
	Potassium (2 to 5%)		2.04
	Sodium (.5 to 3%)		1.01
	Other Bases (Variable)		4.70
	Exchangable Hydrogen (10 to 15%)		4.50
TRACE ELEMENTS	Boron (p.p.m.)		0.35
	Iron (p.p.m.)		50
	Manganese (p.p.m.)		8
	Copper (p.p.m.)		0.91
	Zinc (p.p.m.)		1.75
	Aluminum (p.p.m.)		1200
OTHER	Cobalt ppm		< 0.02
	Molybdenum ppm		0.41
	Ammonium (p.p.m.)		1.3
	Nitrate (p.p.m.)		14.1
	Selenium ppm		0.3
	Silicon ppm		6.6
	Estimated Nitrogen Release #N/Acre		119
	EC mmhos/cm		0.07

Logan Labs, LLC

BASE SATURATION %		
	Calcium (60 to 70%)	62.63
	Magnesium (10 to 20%)	25.09
	Potassium (2 to 5%)	2.04
	Sodium (.5 to 3%)	1.01
	Other Bases (Variable)	4.70
	Exchangable Hydrogen (10 to 15%)	4.50

Antagonisms in Reports

If this is High...	Check These Nutrients	What Happens & Why it Matters
Ca (>75% base ast)	Mg, K, B	Suppresses Mg/K uptake B->poor flowering/fruit
Mg (>25% base sat)	Ca, K	Soil gets tight; Ca & K suppressed
K (>7% base sat)	Mg, Ca	Blocks Mg uptake-> bitter pit, grass tetany; weak Ca balance
Na (>3-4% base sat)	Ca, Mg, K	Displaces Ca/Mg; poor structure & drainage
P (>300 lbs/ac)	Zn, Fe, Mn, Cu	Locks up trace metals, stunted roots, chlorosis disease issues

If this is High...	Check These Nutrients	What Happens & Why it Matters
Fe (>150 ppm)	Mn, Zn	Suppresses Mn; imbalance leads to yellow leaves
Mn (very high, low pH)	Fe	Suppresses Fe; can cause chlorossi
Zn (>10ppm)	Fe, Cu	Antagonizes Fe & Cu uptake
Cu (>5ppm)	Zn, Fe	Suppresses Zn/Fe balance
N (nitrate >50ppm)	K, Cu	Suppresses K/Cu uptake; weakens disease resistance
S (>50ppm)	N	Excess S leaches N; upsets N:S balance

LOGAN LABS DESIRED BASE SATURATION

- CALCIUM – 60-68% (CA+MG ADD UP TO 80)
- MAGNESIUM 12-20% (IF MG IS 12, CA SHOULD BE 68; IF MG IS 20, CA SHOULD BE 60)
- POTASSIUM 3-6%
- SODIUM 0.5-3%
- HYDROGEN 10-15%
- IF THE BASE SATURATION IS BALANCED, THE SOIL PH WILL NATURALLY LAND AT 6.3-6.4
- THIS IDEAL SOIL BALANCE IS FROM DR ALBRECHT'S SCIENCE FOR THE IDEAL SOIL FOR PLANT, ANIMAL AND HUMANE HEALTH

CEC goal 12
OM 5% minimum
8 -12% ideal

Base Saturation of Exchange sites

Soil Report

Job Name: **Laura Davis**
Company: Long Life Farm
Date: 8/27/2020
Submitted By:

			1 GH	1 Pond	4 East	4A East	3 Winter
	Sample Location		1 GH	1 Pond	4 East	4A East	3 Winter
	Sample ID		Pond				
	Lab Number		101	102	103	104	105
	Sample Depth in inches		6	6	6	6	6
	Total Exchange Capacity (M. E.)		5.48	6.70	6.89	6.60	9.71
	pH of Soil Sample		6.3	6.8	6.8	6.5	6.2
	Organic Matter, Percent		6.60	7.41	5.41	5.66	7.64
ANIONS	SULFUR:	p.p.m.	45	32	30	22	22
ANIONS	Mehlich III Phosphorous:	ppm	85	79	159	220	172
EXCHANGEABLE CATIONS	CALCIUM: ppm	Desired Value	744	910	936	896	1320
		Value Found	734	997	982	908	1318
		Deficit	-10				-2
	MAGNESIUM: ppm	Desired Value	100	100	100	100	139
		Value Found	74	101	118	102	137
		Deficit	-26				-2
	POTASSIUM: ppm	Desired Value	100	104	107	102	151
		Value Found	56	89	114	110	77
		Deficit	-44	-14			-74
			8 lb	14 lb			10 lb
	SODIUM:	ppm	44	30	41	25	25
BASE SATURATION %	Calcium (60 to 70%)		66.95	74.45	71.31	68.88	67.88
	Magnesium (10 to 20%)		11.26	12.57	14.28	12.82	11.76
	Potassium (2 to 5%)		2.62	3.43	4.23	4.26	2.03
	Sodium (.5 to 3%)		3.52	1.92	2.60	1.65	1.12
	Other Bases (Variable)		5.10	4.60	4.60	4.90	5.20
	Exchangeable Hydrogen (10 to 15%)		10.50	3.00	3.00	7.50	12.00
TRACE ELEMENTS	Boron (p.p.m.)		2 lb 0.56	2 lb 0.52	18 lb 0.65	0.58	0.67
	Iron (p.p.m.)		153	134	137	147	273
	Manganese (p.p.m.)		2 lb 11	9 10	70 lb -7	9	2 lb 7
	Copper (p.p.m.)		2.7	2.04	2.83	2.17	3.76
	Zinc (p.p.m.)		8.76	5.14	6.99	4.29	10.78
	Aluminum (p.p.m.)		1864	1806	2045	1968	1612
OTHER							
			25 lb	75 lb	300 lb		

Logan Labs, LLC

Slide from Laura Davis

THE INTELLIGENT GARDENER BY STEVE SOLOMON

- WONDERFUL BOOK THAT FOCUSES ON BACK YARD GARDENERS
- A GOOD HOW-TO REMINERALIZE YOUR SOIL TO INSURE YOU ARE FEEDING YOUR FAMILY HEALTHY FOOD TO MAKE THEM THRIVE

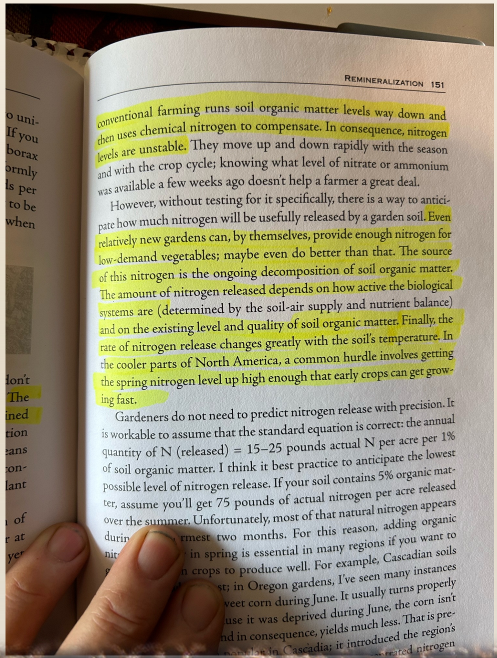
Steve Solomon explains how the home gardener can use the results of an inexpensive soil test to create their own indiviusally tailored soil prescription.

Slides from Laura Davis

THE INTELLIGENT GARDENER BY STEVE SOLOMON

"Even relatively new gardens can, by themselves, provide enough nitrogen for low demand vegetables; maybe even do better than that. The source of this nitrogen is the ongoing decomposition of soil organic matter.

The amount of nitrogen released depends on how active the biological systems are…



REMINERALIZATION 151

conventional farming runs soil organic matter levels way down and then uses chemical nitrogen to compensate. In consequence, nitrogen levels are unstable. They move up and down rapidly with the season and with the crop cycle; knowing what level of nitrate or ammonium was available a few weeks ago doesn't help a farmer a great deal.

However, without testing for it specifically, there is a way to anticipate how much nitrogen will be usefully released by a garden soil. Even relatively new gardens can, by themselves, provide enough nitrogen for low-demand vegetables; maybe even do better than that. The source of this nitrogen is the ongoing decomposition of soil organic matter. The amount of nitrogen released depends on how active the biological systems are (determined by the soil-air supply and nutrient balance) and on the existing level and quality of soil organic matter. Finally, the rate of nitrogen release changes greatly with the soil's temperature. In the cooler parts of North America, a common hurdle involves getting the spring nitrogen level up high enough that early crops can get growing fast.

Gardeners do not need to predict nitrogen release with precision. It is workable to assume that the standard equation is correct: the annual quantity of N (released) = 15–25 pounds actual N per acre per 1% of soil organic matter. I think it best practice to anticipate the lowest possible level of nitrogen release. If your soil contains 5% organic matter, assume you'll get 75 pounds of actual nitrogen per acre released over the summer. Unfortunately, most of that natural nitrogen appears durin[illegible] rmest two months. For this reason, adding organic nit[illegible] in spring is essential in many regions if you want to [illegible] n crops to produce well. For example, Cascadian soils [illegible] st; in Oregon gardens, I've seen many instances [illegible] veet corn during June. It usually turns properly [illegible] use it was deprived during June, the corn isn't [illegible] nd in consequence, yields much less. That is pre- [illegible] Cascadia; it introduced the region's [illegible] nitrogen

From Numbers to Management

✅ 3 Steps to Reading a Soil Report

1 Check the Basics

- pH (6.2–6.8)
- Organic Matter (3–5%+)
- CEC (know your pantry size)
- Base Saturations (Ca 60–70%, Mg 10–20%, K 3–5%, Na <2%)

2 Scan for Antagonisms

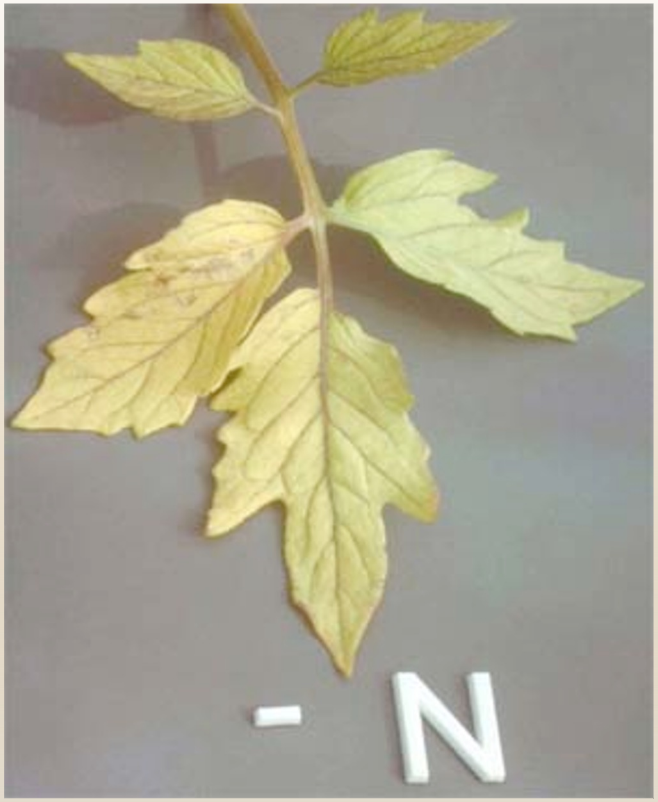
- Look for nutrients that are too high and pushing others down.

3 Look at Ratios

- Ca:Mg (5–7:1), Ca:K (10–15:1), Fe:Mn (~2:1), N:S (~10:1).
- Balanced siblings = harmony at the soil's dinner table.

NITROGEN DEFICIENCY

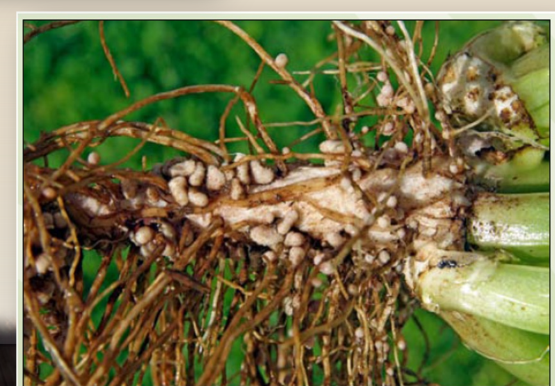
- Due to leaching
- Develop chlorosis
  - Yellowing of foliage
  - First (low) leaves
- Growth may be stunted
- Stems thin and spindly



Tomato Plant with Nitrogen Deficiency

RENEWABLE SOURCES OF NITROGEN

- Compost
- Manure
- Alfalfa meal
- Blood meal
- Nitrogen-fixing legumes



PHOSPHORUS DEFICIENCY

- Supply of P is low in most soils due to low solubility
- Common in acidic or alkaline soils and in soils with high Al
- Symptoms:
  - Interrupted or delayed flowering and fruit set
  - Stunted roots
  - Purplish cast on stems and leaves

Renewable Source:

- Manure
- Liquid seaweed to deficient soils

POTASSIUM DEFICIENCY

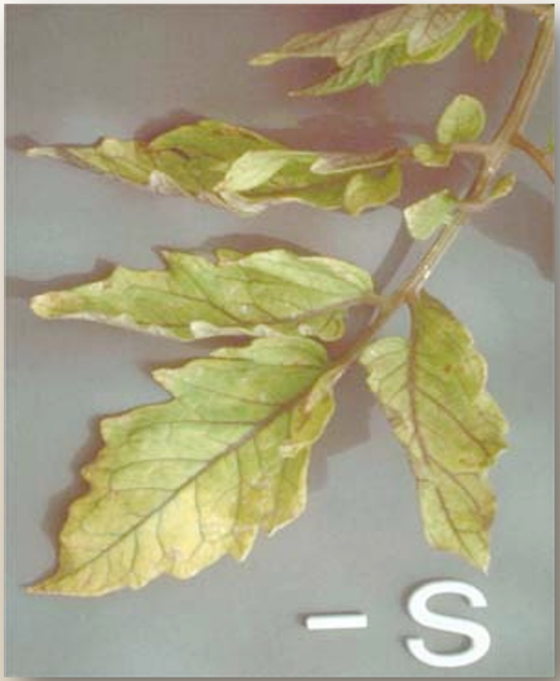
- Easily leach from acidic soils or soils with low CEC
- In soils with excess Ca or Mg
- Symptoms:
  - Stunting,
  - Irregular yellow leaf splotches (older leaves)
  - Scorched-looking lead margins

Renewable Source:

- Compost for fertile soils
- Kelp meal or composted wood ash (for acidic soils only) in deficient soils

SULFER DEFICIENCY

- Clean air standards have reduced sulfur dioxide (SO_2) emissions from burning of coal and oil
- Sulfur is relatively immobile in the plant, so chlorosis develops first on the youngest leaves
- Plants will be spindly and small



Renewable Source:

- Compost provides the missing organic matter

CALCIUM DEFICIENCY

- Most likely to occur on acid, irrigated sands, or where excessive K levels inhibit Ca uptake
- Drought
- Symptoms:
  - Deformity of new (upper) leaves
  - Curling
  - Yellowing of leaf edges
  - Stubby brown roots
  - Hardening of stems
  - Blossom-end rot and tip burn

Sources:

- Kelp meal
- Bone meal
- Wood ash (acidic soils only)
- Limestone to acidic soils
- Gypsum to alkaline soils

MAGNESIUM DEFICIENCY

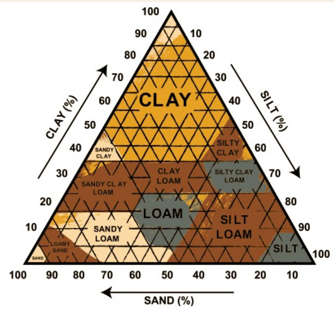
- Acidic sandy soils
- Excess K or Ca
- Symptoms:
  - Yellowing of older leaves
  - Thin, curling foliage
  - Brown spotting on leaf stalks

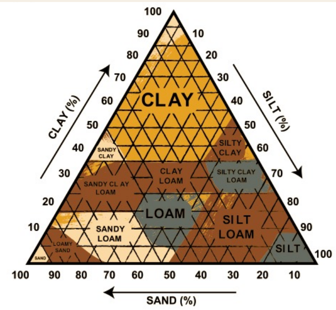
Sources:

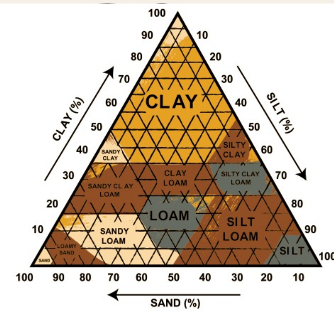
- Coffee grounds
- Composted leaves
- Manure
- Dolomitic limestone to acidic soils
- Epsom salts to alkaline soils

CONDITIONS AFFECTING LEVEL AND AVAILABILITY OF PLANT NUTRIENTS

- **Soil texture**







🏖️ Sandy Soil (CEC <10)

- Small pantry → nutrients leach easily.
- Needs frequent feeding and organic matter additions.
- Strategy: Build OM, cover crops, compost teas.

🌾 Loam Soil (CEC 10–20)

- Medium pantry → flexible nutrient balance.
- Holds nutrients fairly well, but responsive to management.
- Strategy: Maintain OM, balanced amendments.

🏺 Clay/Organic Soil (CEC 20–40+)

- Big pantry → stores lots of nutrients, but many are “locked up.”
- Can be sticky or compact without biology.
- Strategy: Use biology (fungi, acids) to unlock nutrients.

CONDITIONS AFFECTING LEVEL AND AVAILABILITY OF PLANT NUTRIENTS

- **Organic matter**

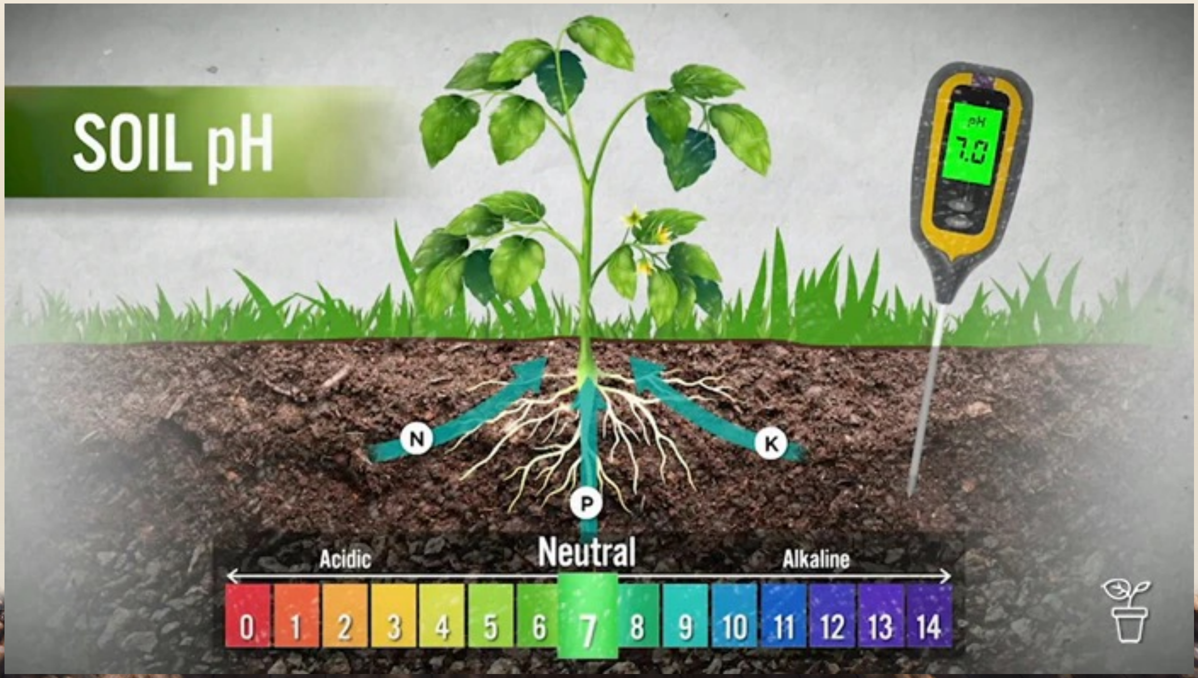
a high CEC; release of the nutrients due to decomposition; effect on water-holding capacity; physical condition, and infiltration

Soil & Soil Components	CEC value (meq/100g)
Soil Texture	
Pure Sand	1-5
Fine Sandy Loam	5-10
Loam	5-15
Clay Loam	15-30
Organic Rich Soils	50-100
Pure Organic Matter	200-400
Clay Type	
Kaolinite	3-15
Illite	15-40
Montmorillonite	80-100

CONDITIONS AFFECTING LEVEL AND AVAILABILITY OF PLANT NUTRIENTS

- **Soil pH**

pH slightly acid to neutral nutrients are more available



Cover Crops: any crop used to cover and protect the surface of the soil and prevent erosion.

Green Manures: anything grown specifically to feed the soil; anything chopped up and turned into soil.
Green manures have 2 main benefits:

- **When incorporated at the succulent stage (pre flowering)** the crop *decomposes quickly and acts primarily as a fertilizer* for the "follow crop, in our area usually a summer or fall crop.
- **When incorporated at a more mature stage (half to full bloom)** with a higher carbon content*, it adds to the organic matter content* of the soil. In this instance nutrients are stored in the reservoir of humus and released slowly over a number of years.

Benefits of Green Manures/Cover Crops:

- **Improve the physical properties** of a soil, particu-larly the enhancement of aggregation and development of a "crumb-like" structure.
- **Increase soil's organic matter content**, which feeds soil microbes and stores nutrients in a non-leachable form and releases them slowly over time.
- **Protect the soil surface and prevent erosion**.
- **Improve water infiltration and retention** as well as drainage.
- Provide a "**feedstock**" for soil organisms.
- **Break up hard pans** and reduce compaction via the "bio-drill" effect of the deep tap roots of legumes, mustard, chicory, daikon radish, etc., and—in the top foot of soil—via the fibrous roots of annual grasses.
- **Cycle nutrients.**
- **Provide habitat and food** (in the form of pollen and nectar) for beneficial insects, i.e., provision the "3 P's": pollinators, predators, and parasitoids
- **Offer a rest or "fallow" period** for soil, with little or no disturbance for 5–7 months (fall through spring). This allows for an increase in earthworm populations, among other benefits.
- **Reduce or eliminate the need for purchased fertilizer.**
- **Increase nitrogen levels in the soil.** Through the use of legume species (vetches, bell beans, clovers, etc.) atmospheric nitrogen can be "fixed" and left in the soil to fertilize subsequent crops (see sidebar, below).

For the Gardener, Orin Martin