TEXAS A&M AGRILIFE EXTENSION

Soil Nutrient Management

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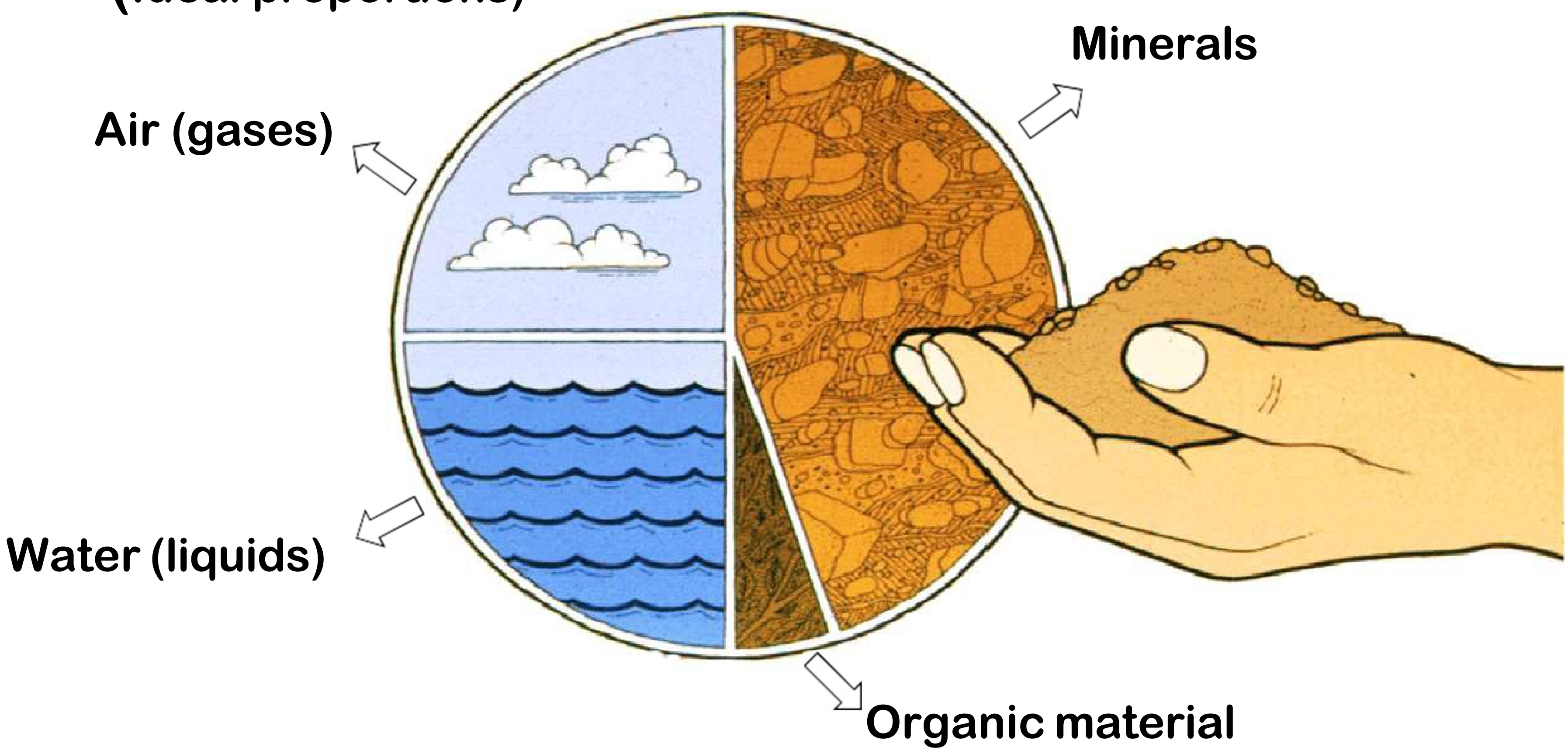
“Daddy, which is this — soil or dirt?”

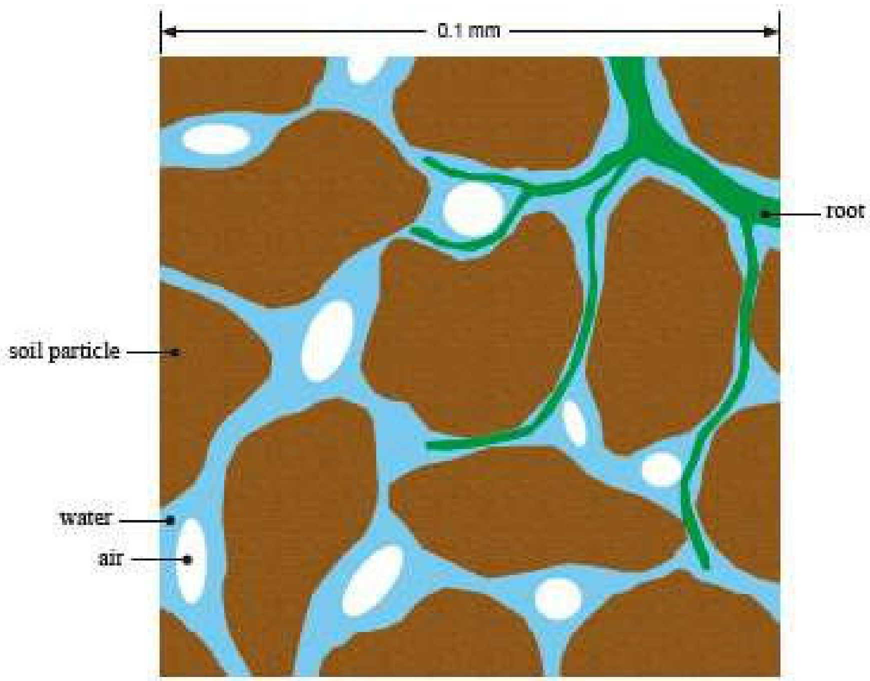
Four Principal Components of Soil

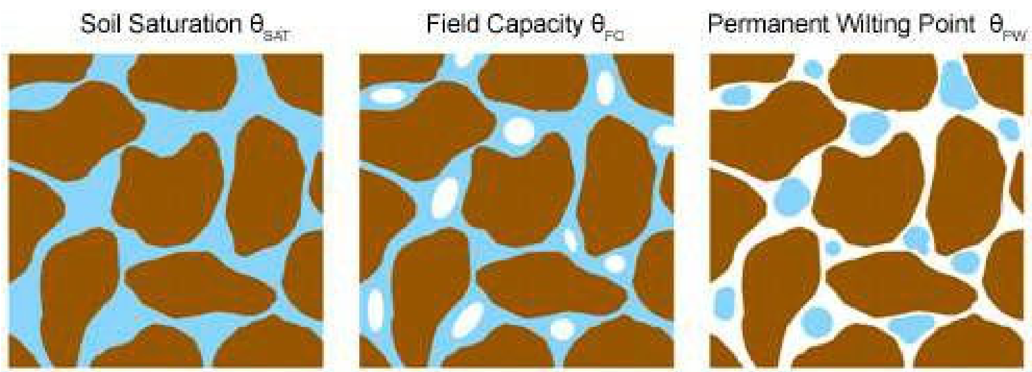
(Ideal proportions)



Putting it all together

Soil components create a 'structure'



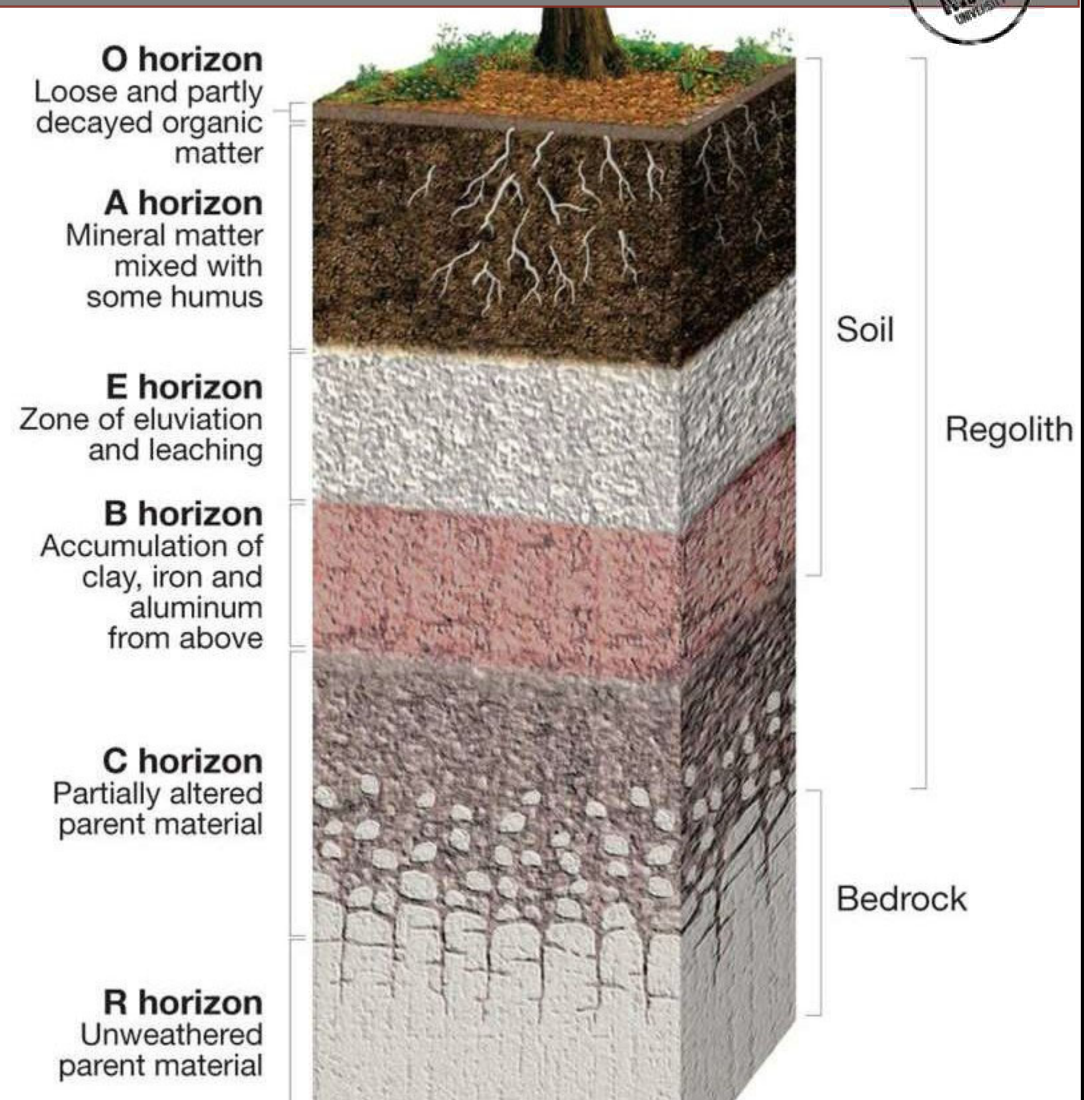


Source: http://www.stevenswater.com/articles/irrigationscheduling.aspx

Soil Horizons

A. - Topsoil.

Mineral layer with organic matter & loss of Fe, Al, Clay. Often darkest layer with most roots.



B. - Subsoil

Accumulation of Clay, Fe, Al, $CaCO_3$
Loss of $CaCO_3$

C. - Soft Bedrock

Some alteration of parent material and weakened consolidation

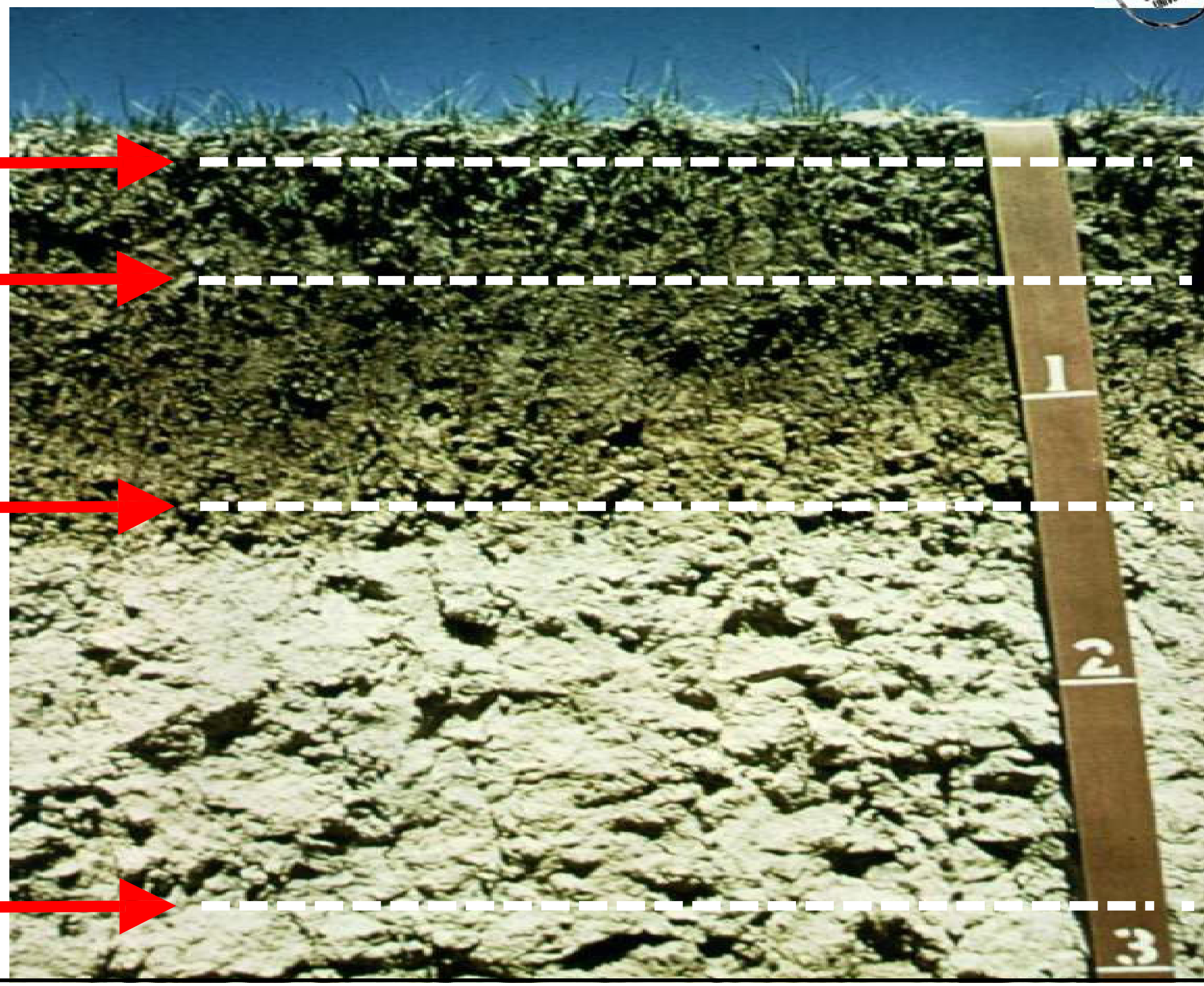
Soil Horizons

O

A

B

C

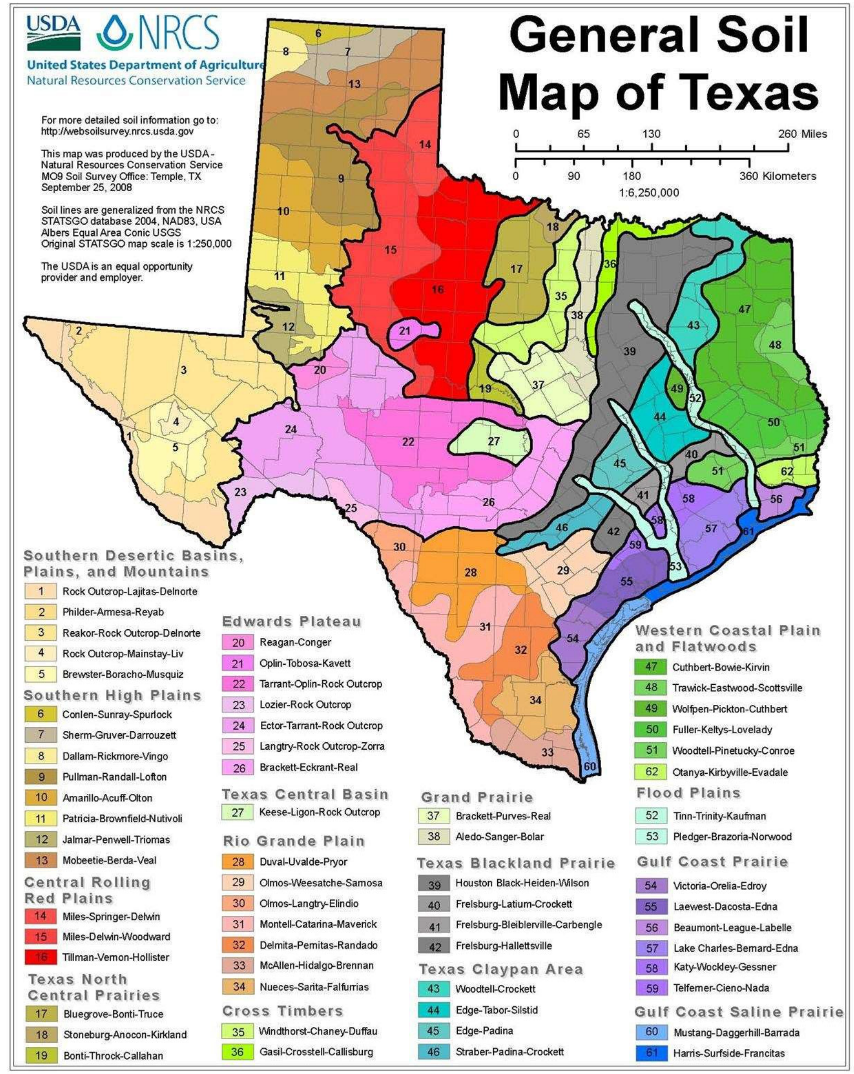


Variation in Soils

- Geology
- Climate
- Vegetation

Soils in Texas vary by:

- **Type**
  - ✓ Physical properties
  - ✓ Structure
  - ✓ Chemical properties
  - ✓ Management history
- **Productivity**
- **Fertility**



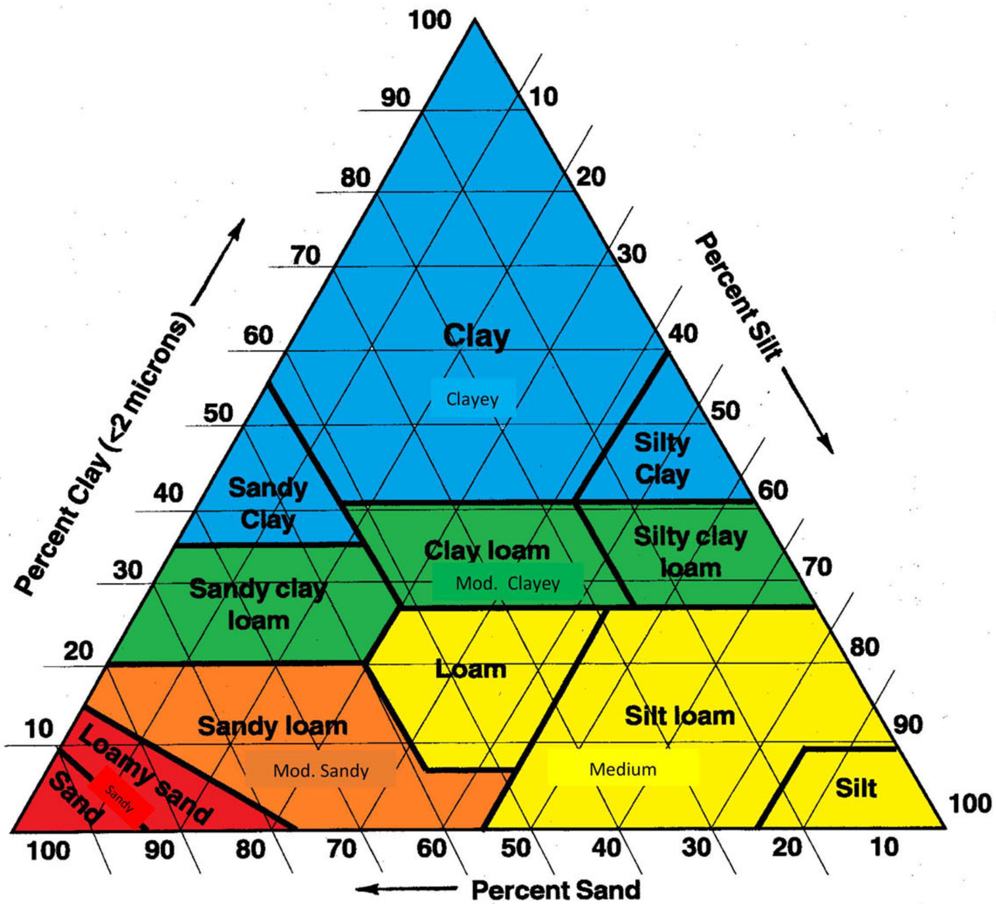
Soil Texture

SAND	Very Coarse	2.0 – 1.0 mm
	Coarse	1.0 – 0.5 mm
	Medium	0.5 – 0.25 mm
	Fine	0.25 – 0.1 mm
	Very Fine	0.1 – 0.05 mm
SILT		.05 - .002 mm
CLAY		< .002 mm

Diameter of Individual Particles

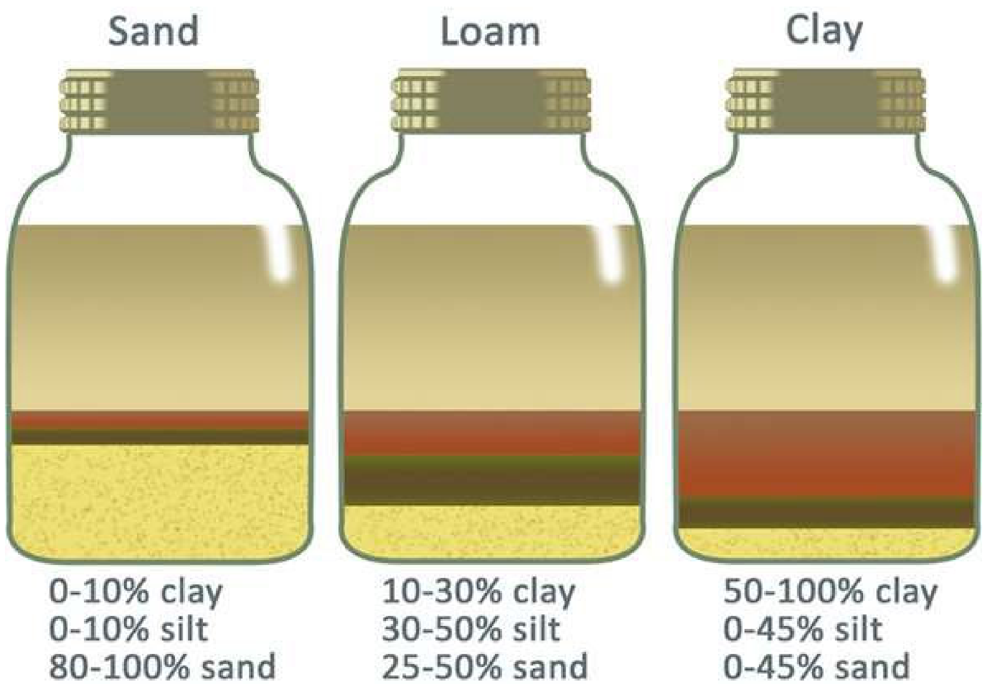
Soil Textural Triangle

Not every soil particle is the same size



There is a 'distribution' of particle sizes

Soil Texture by the 'jar' test.



Air
Water
Nutrients
Roots

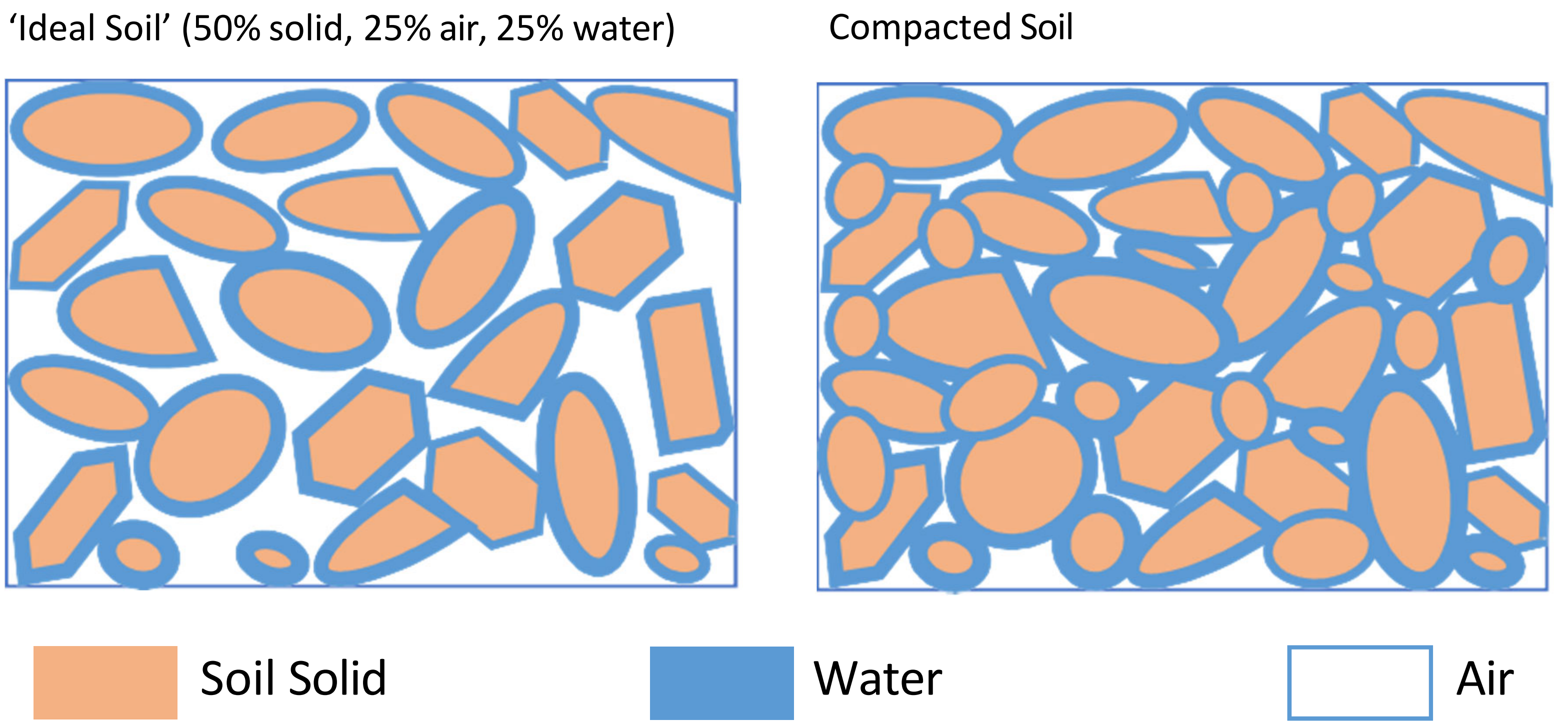
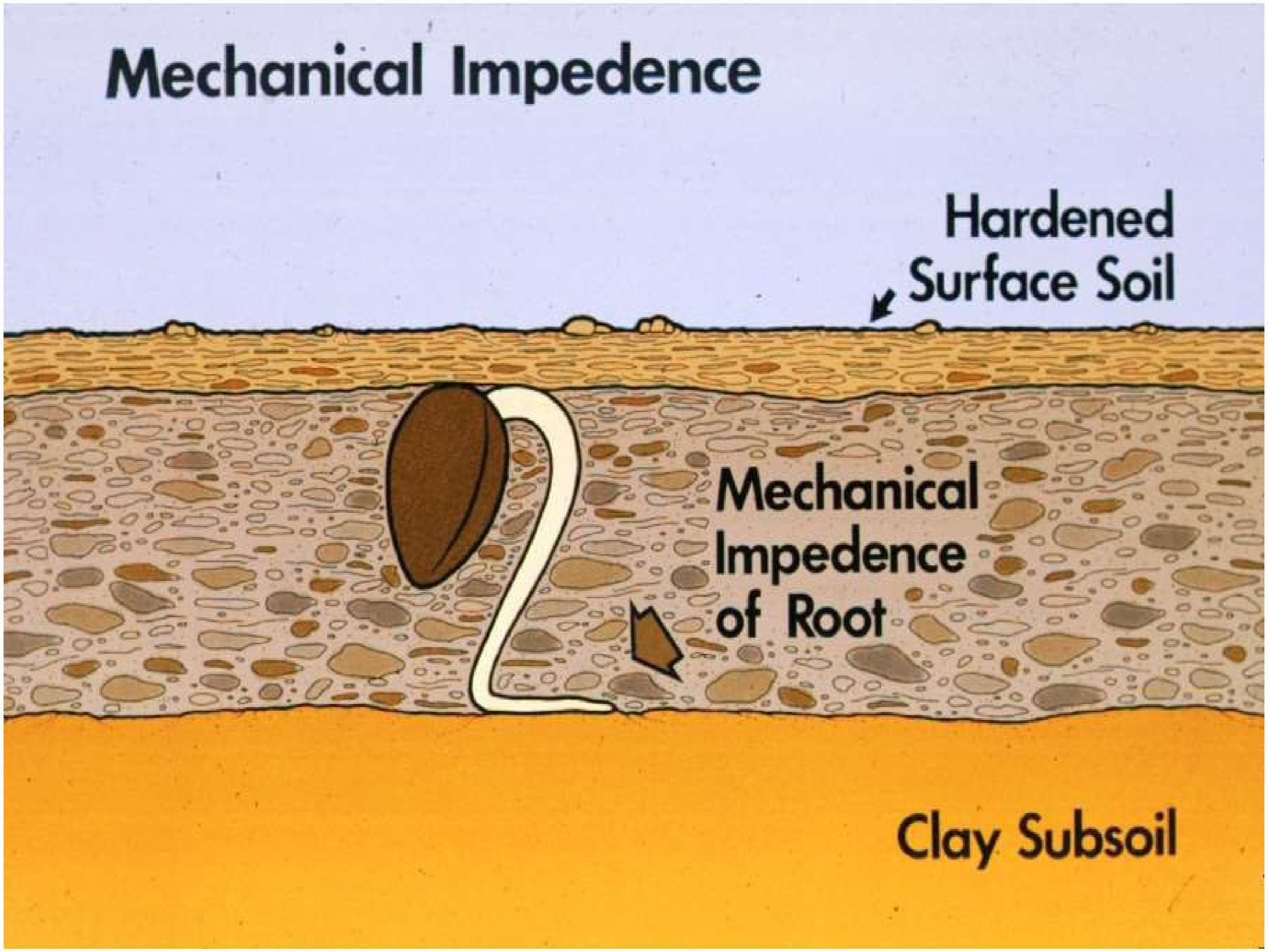
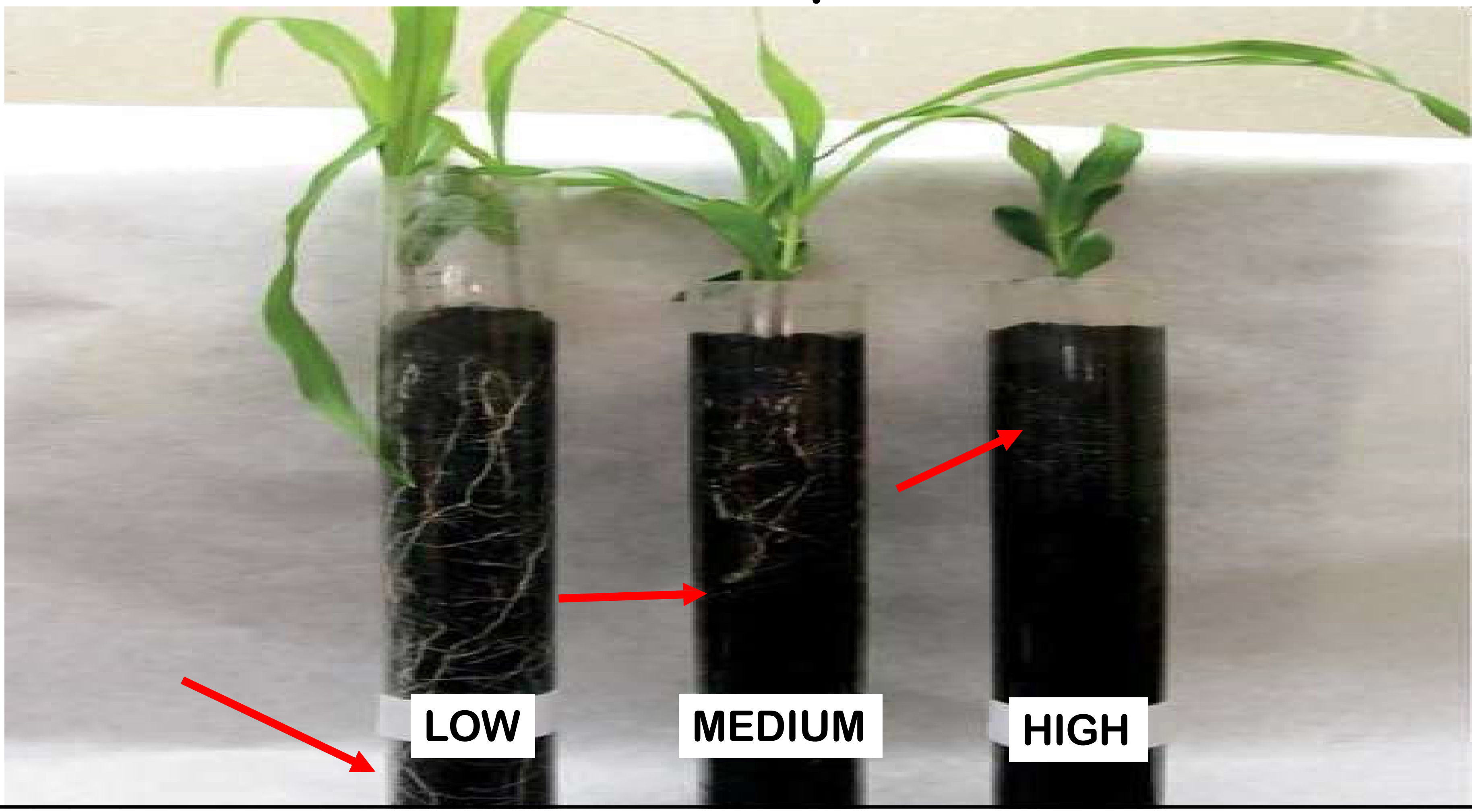


Figure 1. Soil compaction causes a reduction in available space for soil air and water, and limits pathways for crop roots.

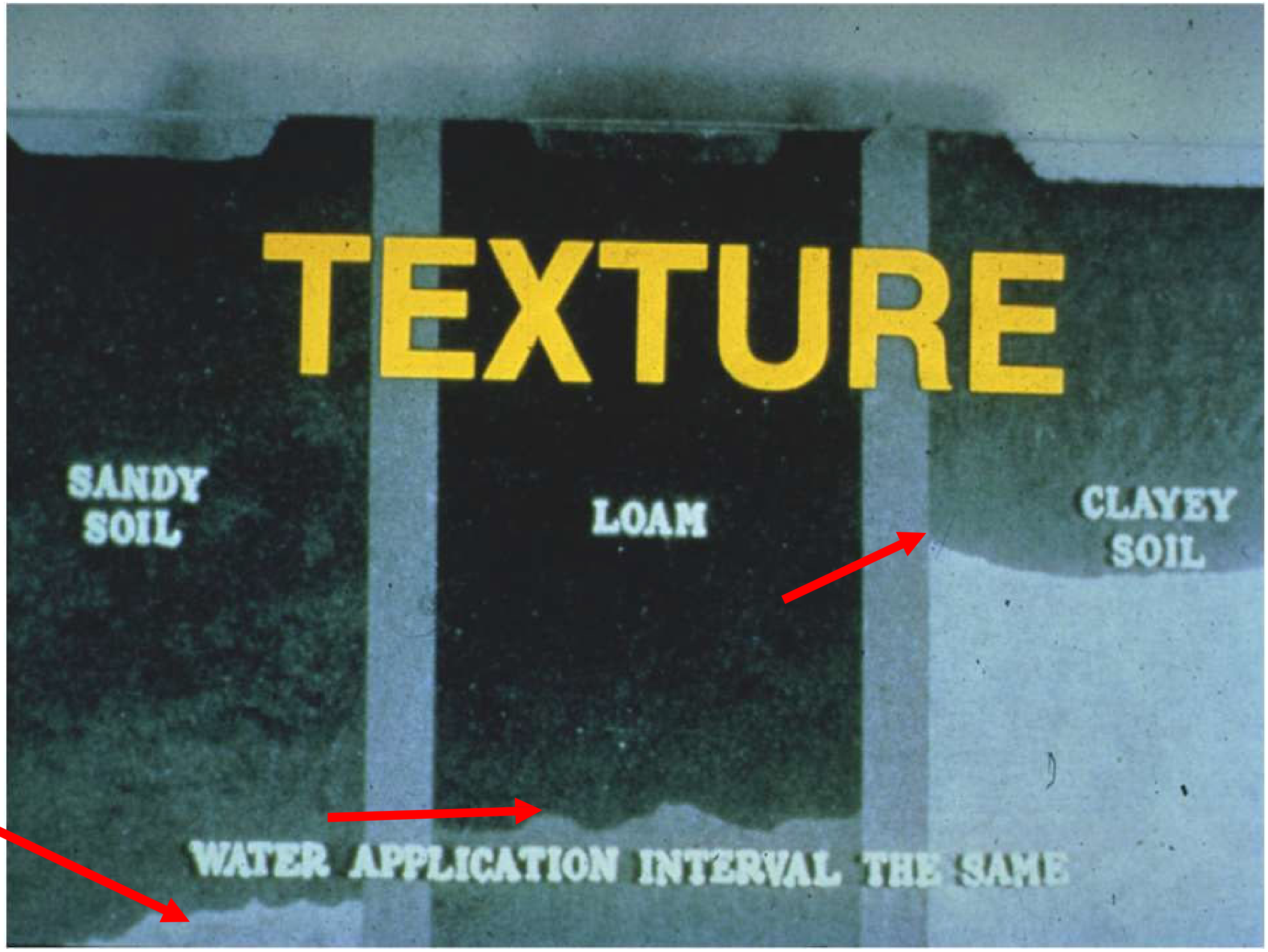

Mechanical Impedence
Hardened Surface Soil
Mechanical Impedence of Root
Clay Subsoil

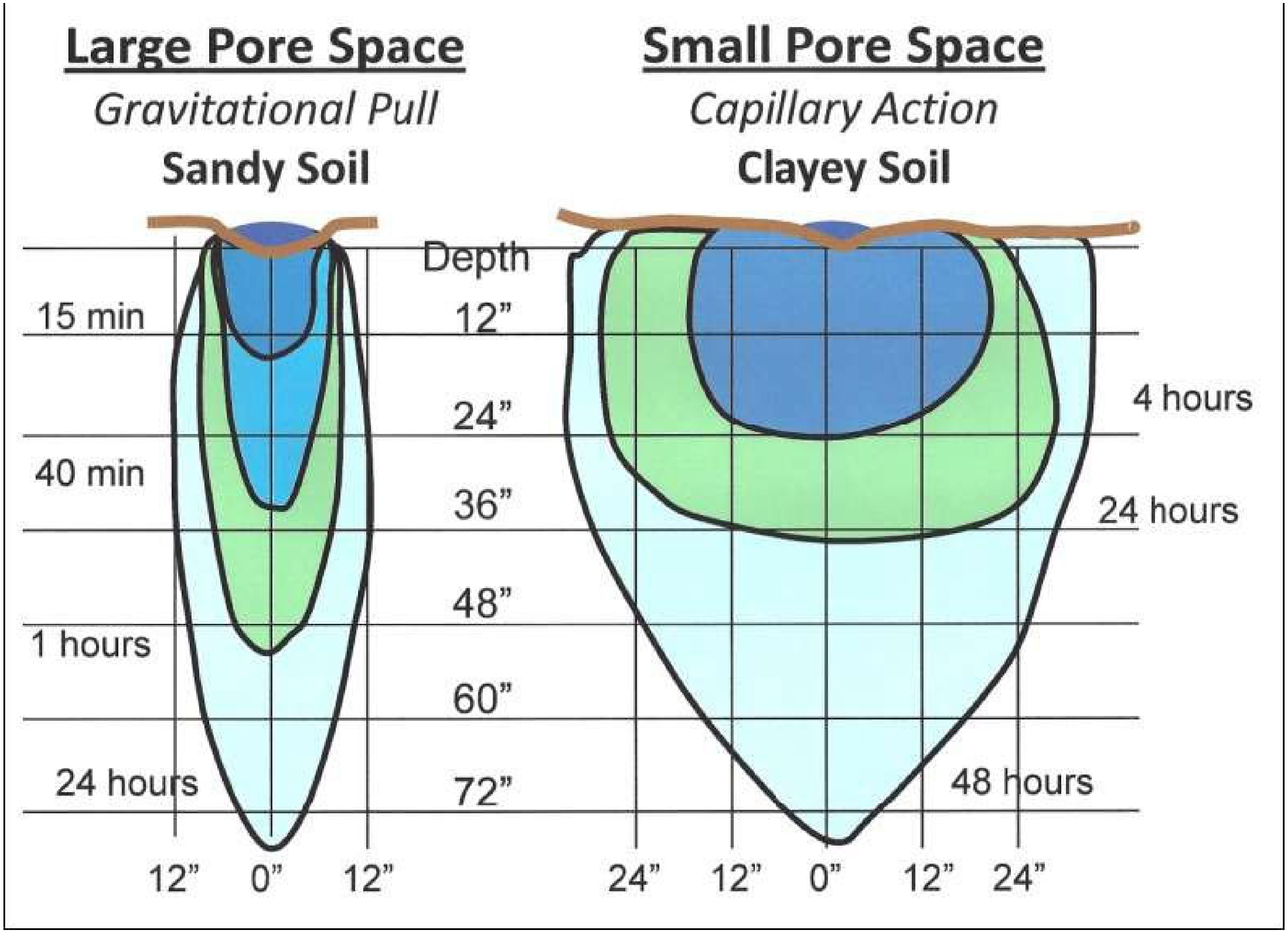
Subsoil Compaction

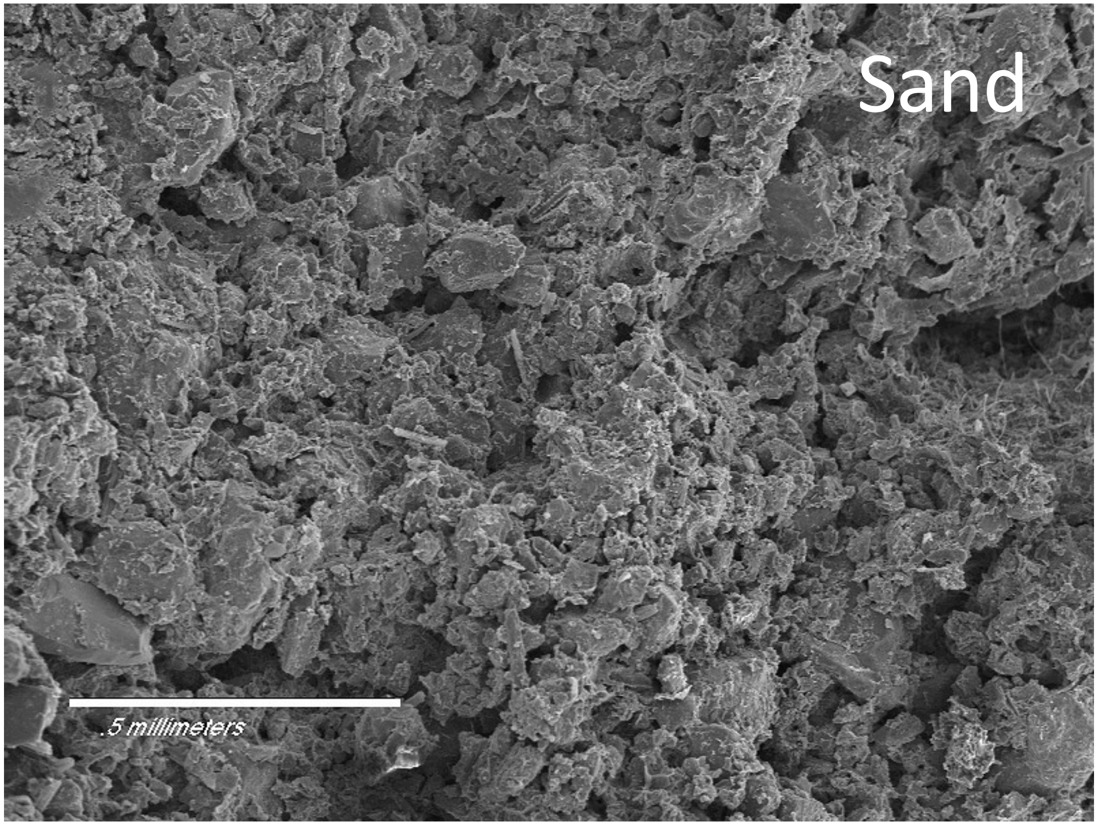


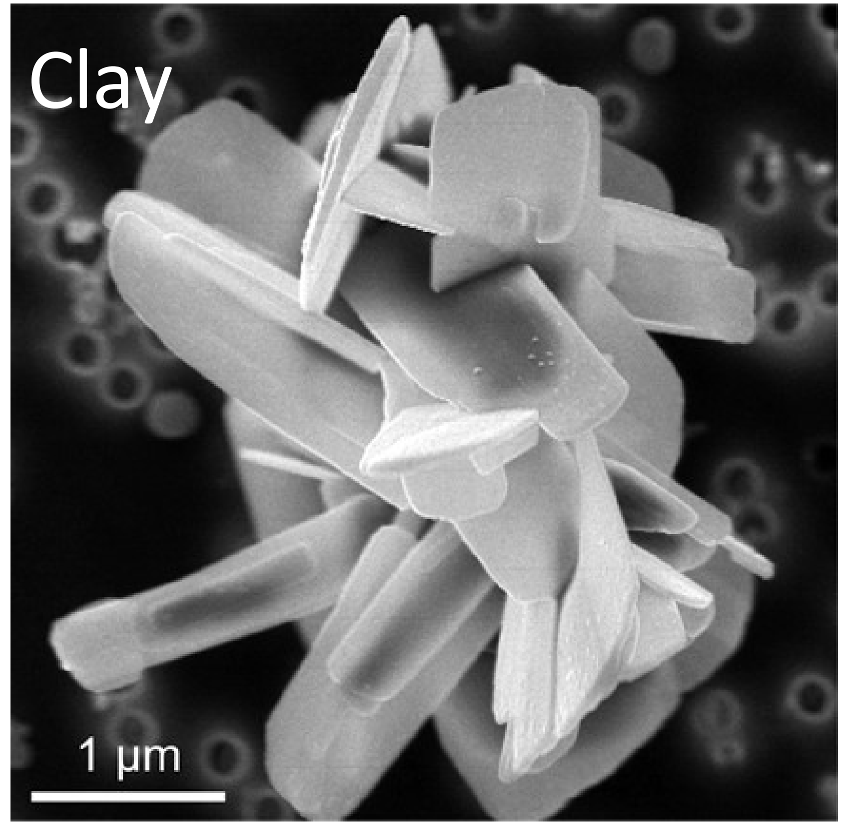
Subsoil Compaction


Permeability


TEXTURE
SANDY SOIL
LOAM
CLAYEY SOIL
WATER APPLICATION INTERVAL THE SAME


Large Pore Space
Gravitational Pull
Sandy Soil
Small Pore Space
Capillary Action
Clayey Soil
Depth
12”
24”
36”
48”
60”
72”
15 min
40 min
1 hours
24 hours
4 hours
24 hours
48 hours
12”
0”
12”
24”
12”
0”
12”
24”





http://www.geol.lsu.edu/Faculty/Ferrell/class/ClarkCreek/sediments_img1.html

Center for Microscopy – University of Basil

Water Holding Capacity & Texture

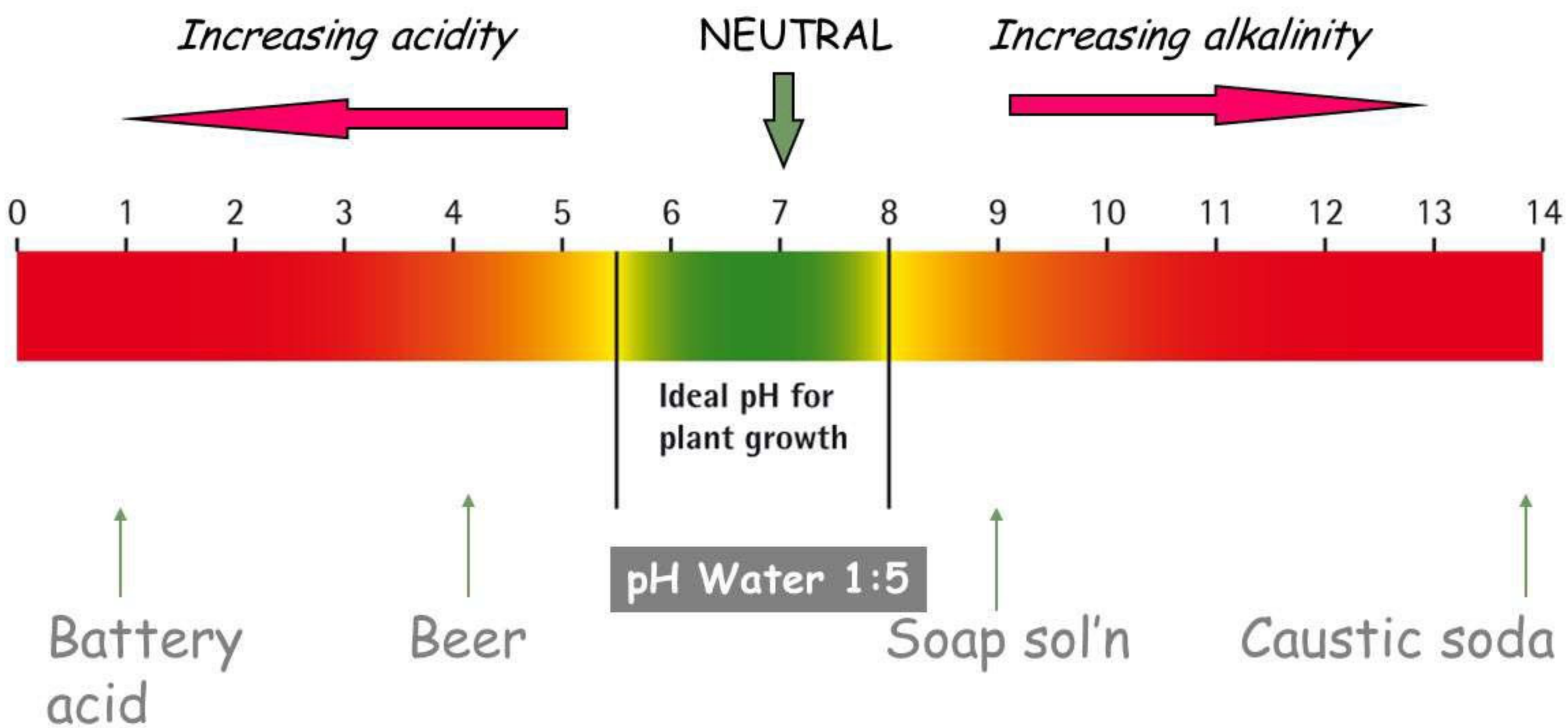
Soil Texture	Permeability	Water Retention
Sand	High	Low
Loam	Medium	Medium
Silt	Low	High
Clay	Low	High

Soil Structure

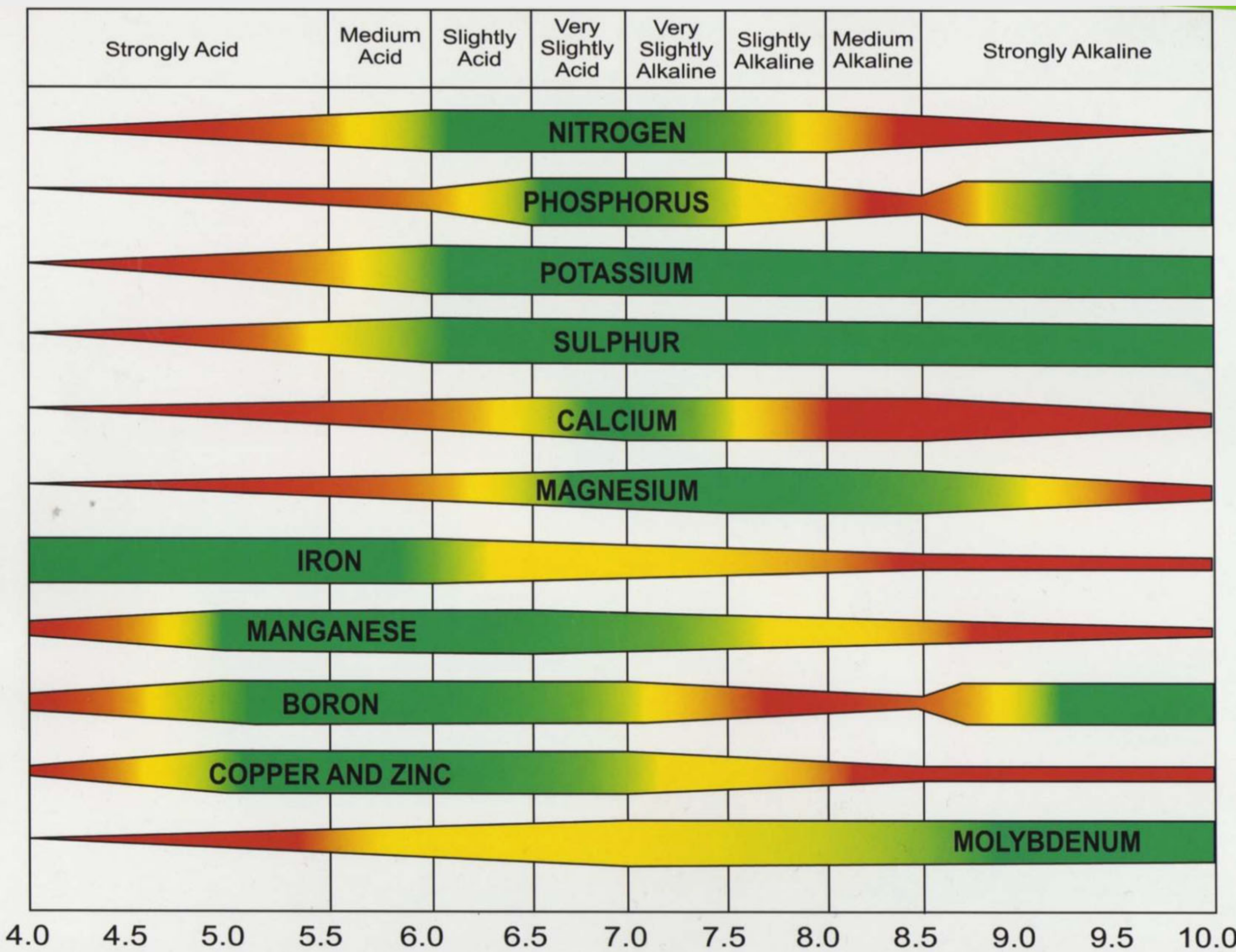
- Granular
- Improve by adding organic matter
- Prevent/correct compaction - hardpans, traffic pans

Soil pH – what is it?

- measure of the acidity or alkalinity of a soil
- concentration of hydrogen ions (H+) in the soil solution

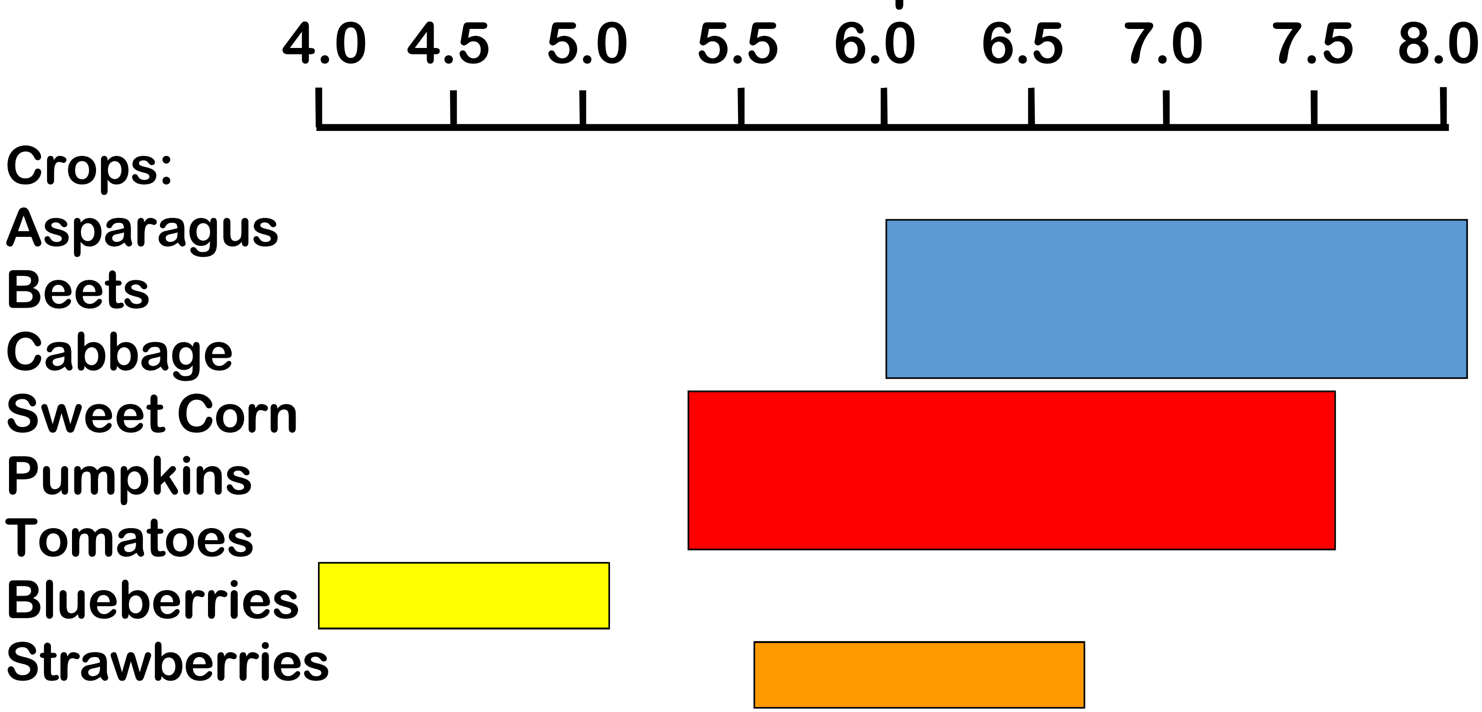


Soil pH affects plant nutrient availability



Preferred pH Ranges of Various Plants

Optimum pH Range for Vegetable Crops



Law of the Minimum

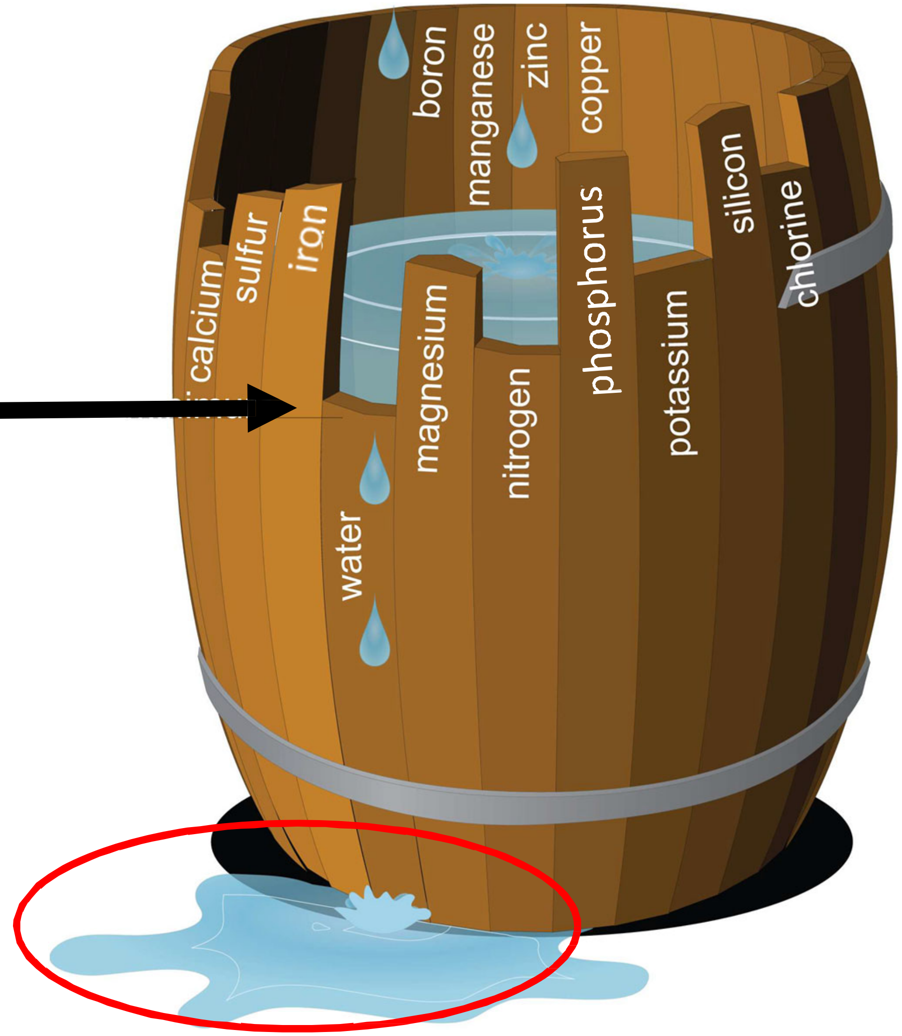
Justus von Liebig 1803-1873

Growth is controlled
not by the [illegible]
amount of nutrients
available, but by
the [illegible]
(most limiting)
single nutrient

Liebig's Barrel

Level of most

limiting factor



- **Productivity shortfall**
- **Lost opportunity**
- **Money**

Primary Nutrients

Nitrogen

Phosphorus

Potassium

Excess Nitrogen

- Reduced root growth.
- Excess water use.
- Reduced cold tolerance
- Thatch accumulation.
- Disease and insect susceptibility.
- Reduced vegetable yield

Phosphorus
Characteristics and Functions

Available Forms

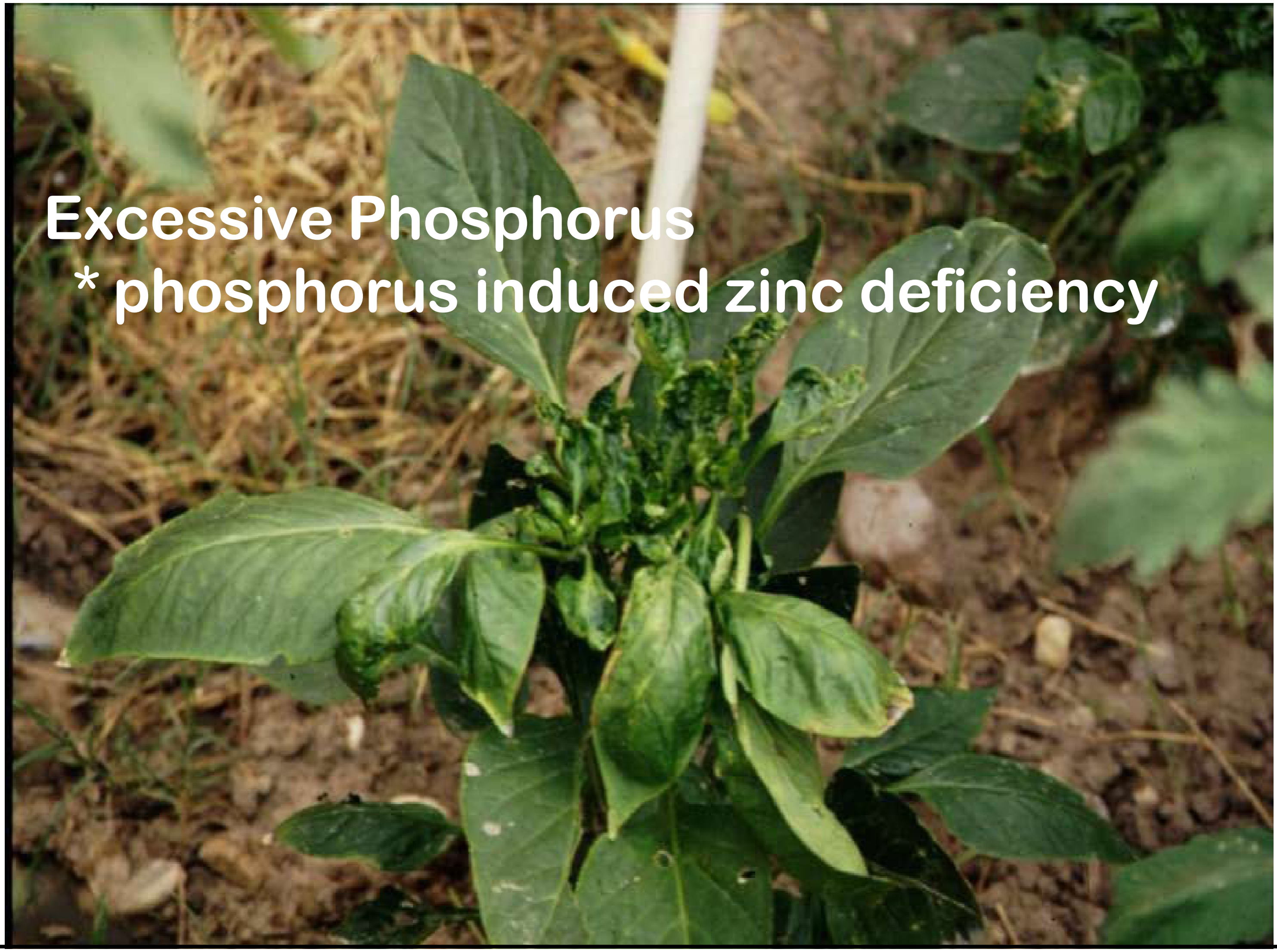
Primary orthophosphate ($H_2PO_4^-$)
Secondary orthophosphate (HPO_4^{2-})

Movement in Soil:

Very immobile; Will not leach or volatilize
Tends to accumulate/build up in soils.

Functions in Plant: ENERGY STORAGE (ATP/ADP)

Stimulates early growth & root formation
Hastens maturity and promotes seed, vegetable, and floral production


Excessive Phosphorus
* phosphorus induced zinc deficiency

Potassium
Characteristics and Functions

Available Forms: Potassium ion (K^+)

Movement in Soil: Does not leach/volatilize

Functions in Plant:
Increases water use efficiency
Increases disease resistance
Improves cold hardiness

Secondary Plant Nutrients

Calcium (Ca) Cell elongation & stability

Magnesium (Mg) Chlorophyll & enzymes

Sulfur (S) Proteins & enzymes

Essential Micronutrients

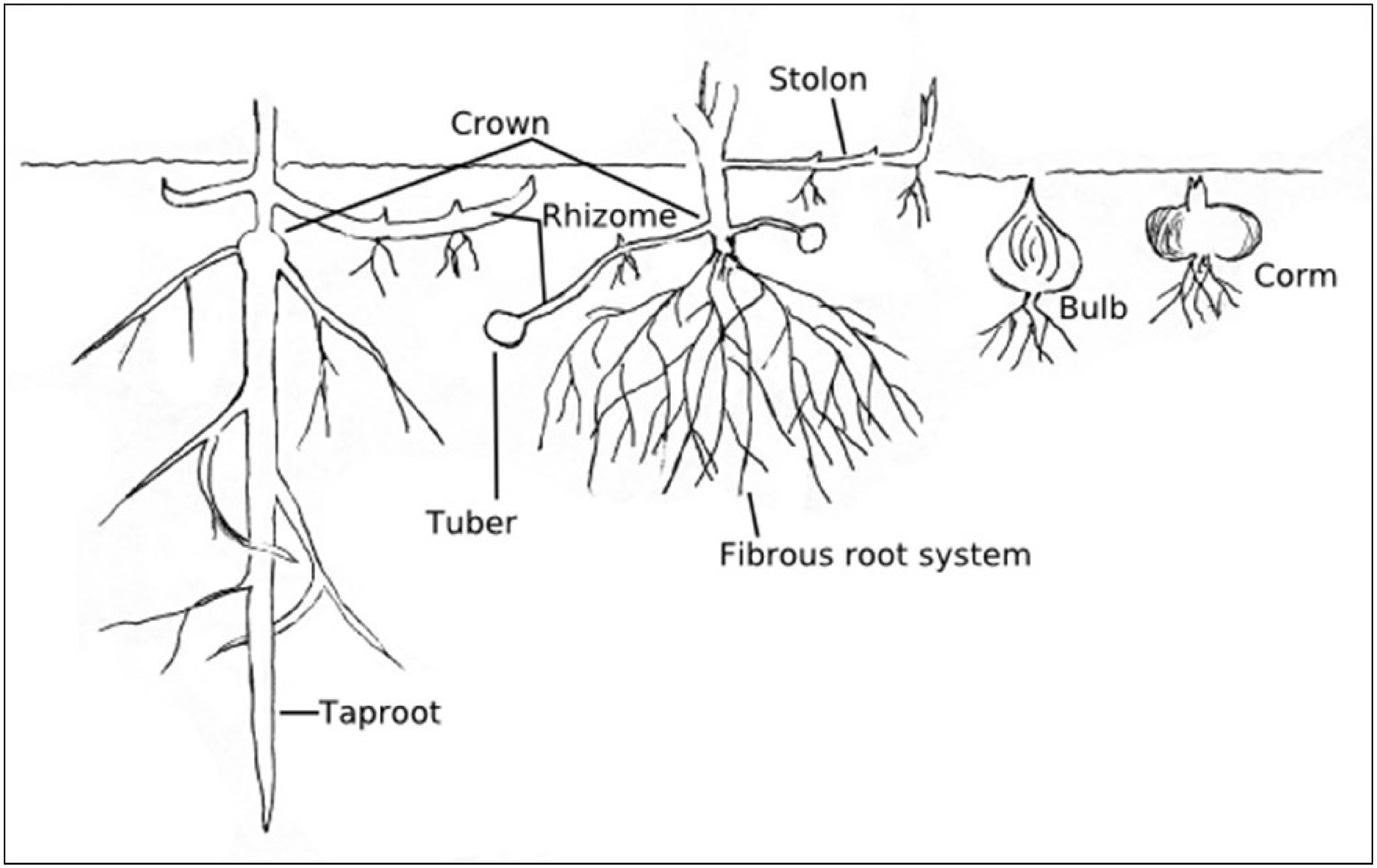
Zn	Fe	Cu	Mn	B	Cl	Mo

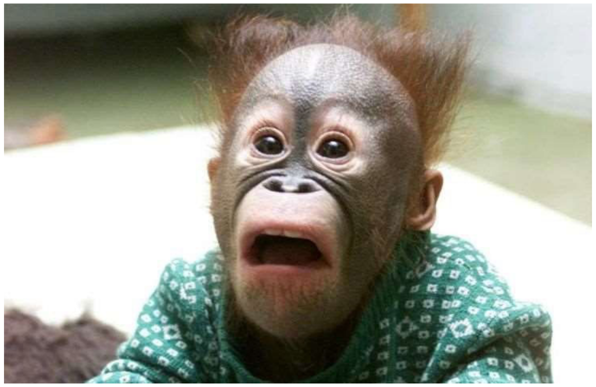
- Needed in very small amounts
- Most micronutrients come from decomposition of O.M.
- Increase in soil pH decreases micronutrient availability (Except Mo and Cl)

Iron Chlorosis

Manganese deficiency
Interveinal chlorosis

Plant uptake of nutrients in soil





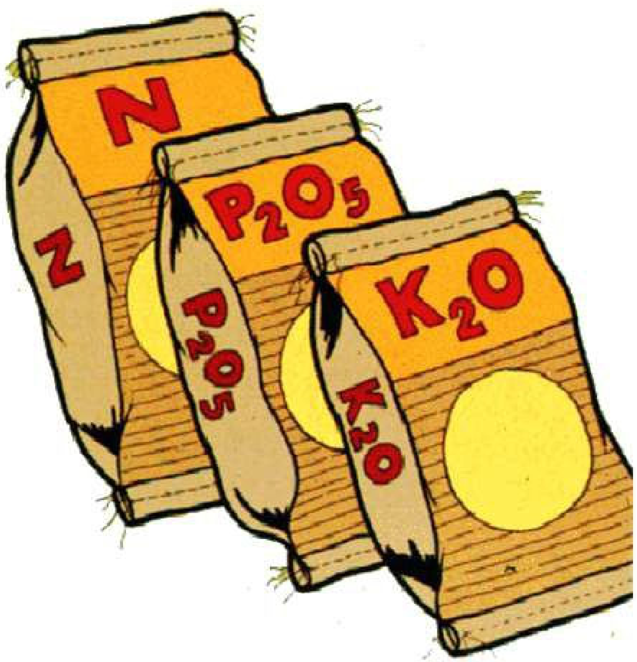
The Best and Proper Fertilizer to Use is the One Based on a Soil Test!

There is no standard fertilizer product, nutrient ratio or rate of application for yards, gardens, etc.

- Each crop, location and year can and often will be different.

Fertilizers Must Always Be Used Properly

Types of Fertilizers



Single Nutrient

"Simple Fertilizers"

Multinutrient

"Mixed Fertilizers or Complexes"

Fertilizer Analysis

- 15-5-10
  - State Law – commercial fertilizers must have a label identifying the materials guaranteed analysis (grade)
  - Guaranteed Analysis – minimum weight (%) of each nutrient contained in the fertilizer

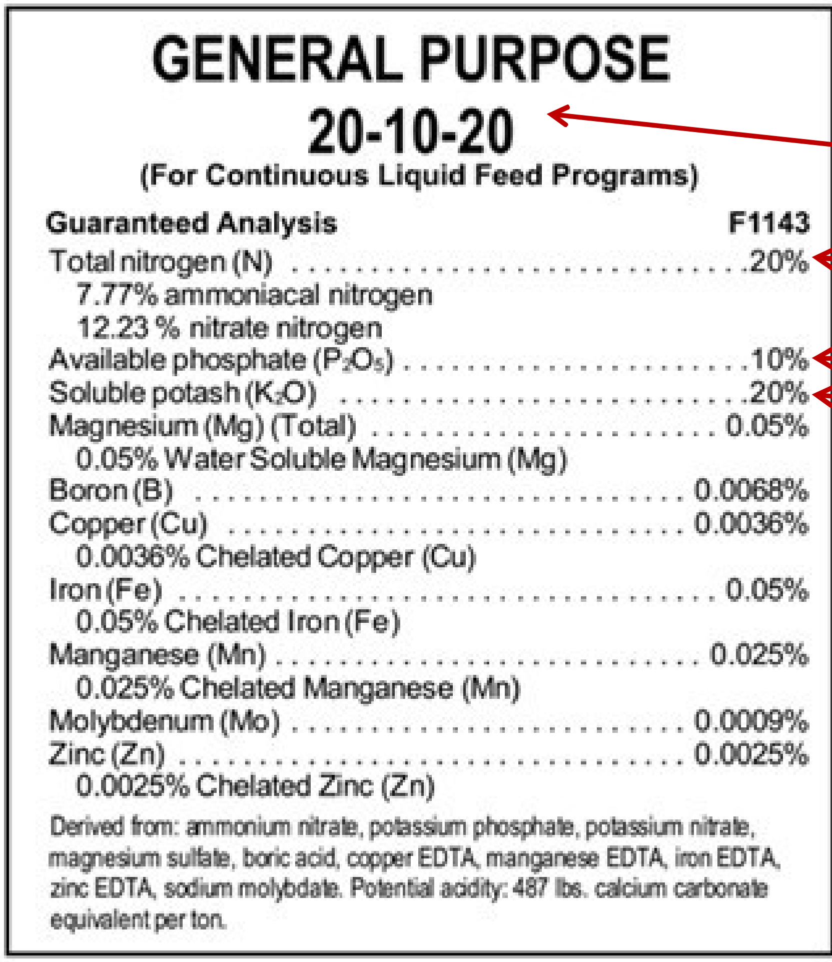
Fertilizer Grade

15 - 5 - 10

% Nitrogen (N) | % Phosphate (P_2O_5) | % Potash (K_20)

Ratio 3 : 1 : 2

The Fertilizer Label



GENERAL PURPOSE
20-10-20
(For Continuous Liquid Feed Programs)

Guaranteed Analysis F1143

Total nitrogen (N) 20%
7.77% ammoniacal nitrogen
12.23 % nitrate nitrogen
Available phosphate (P_2O_5) 10%
Soluble potash (K_2O) 20%
Magnesium (Mg) (Total) 0.05%
0.05% Water Soluble Magnesium (Mg)
Boron (B) 0.0068%
Copper (Cu) 0.0036%
0.0036% Chelated Copper (Cu)
Iron (Fe) 0.05%
0.05% Chelated Iron (Fe)
Manganese (Mn) 0.025%
0.025% Chelated Manganese (Mn)
Molybdenum (Mo) 0.0009%
Zinc (Zn) 0.0025%
0.0025% Chelated Zinc (Zn)

Derived from: ammonium nitrate, potassium phosphate, potassium nitrate, magnesium sulfate, boric acid, copper EDTA, manganese EDTA, iron EDTA, zinc EDTA, sodium molybdate. Potential acidity: 487 lbs. calcium carbonate equivalent per ton.

Fertilizer Grade

Total Nitrogen

Phosphate

Potash

Sources of nutrients

Taking Soil Samples

Soil tests are only as accurate as the samples on which they are based.

Samples must be representative of the area to be cropped.

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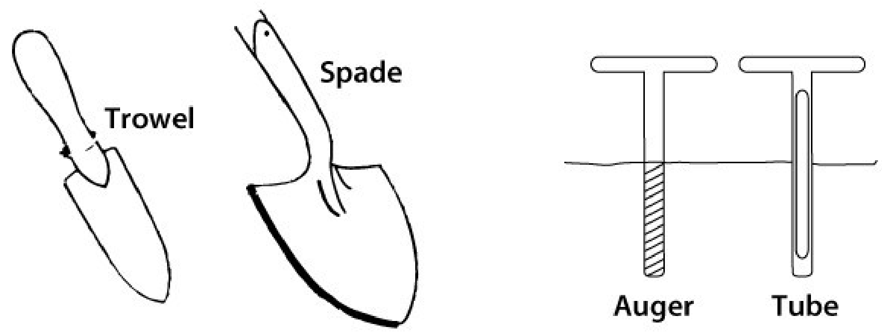
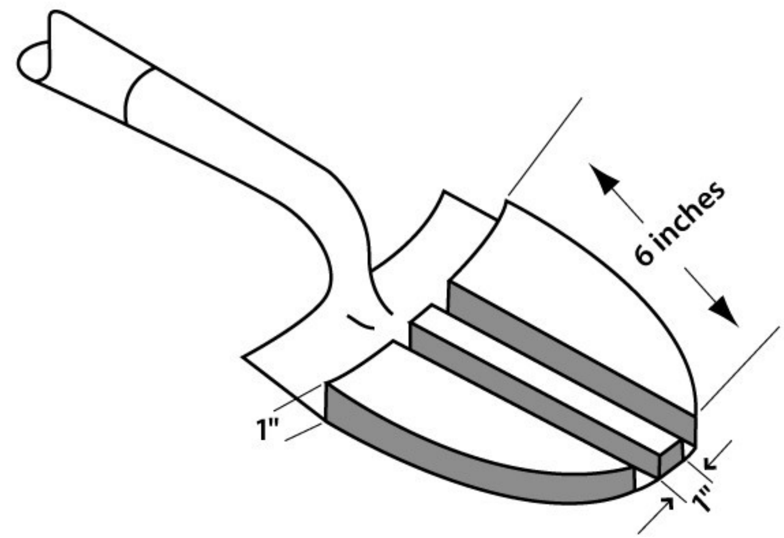
Soil Testing & Taking Soil Samples





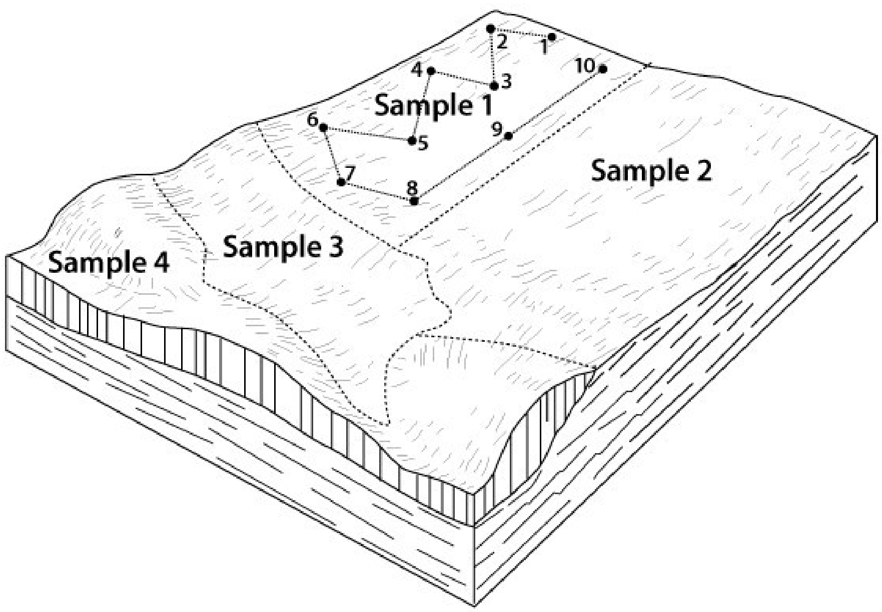
- 6 " composite sample = normal recommendation (4" for sod; 12-24" for pH, salinity, residual nutrients)
- Routine test = Soil pH, salinity, nitrates, macro nutrients.
- Micronutrient test = Zn, Fe, Mn, & Cu
- Other tests: Boron, detailed salinity, lime requirement, texture, & organic matter

Taking Good Soil Samples

Take 10-20 cores for each management area (yard, garden, flower beds).

Place cores in clean plastic bucket, and mix thoroughly.

Put 2 pints in bag and mail immediately to laboratory.



Crop Grown: LANDSCAPE (LAWN , TREES , SHRUBS , OR GROUND COVER)

Analysis	Results	CL*	Units	VLow Low Mod High VHigh Excess.	Fertilizer Recommended
pH	8.9	(6.2)	-	Strongly Alkaline	
Conductivity	138	(-)	mho/cm	None	
Nitrate-N	7	(-)	ppm		0.8 lbs N/1000sqft
Phosphorus	10	(50)	ppm		3.1 lbs P2O5/1000sqft
Potassium	34	(175)	ppm		3.2 lbs K20/1000sqft
Calcium	1,809	(180)	ppm		0 lbs Ca/1000sqft
Magnesium	298	(50)	ppm		0 lbs Mg/1000sgft
Sulfur	21	(13)	ppm		0 lbs S/1000sqft
Sodium	181	(-)	ppm		
Iron	4.82	(4.25)	ppm		
Zinc	0.81	(0.27)	ppm		
Manganese	1.66	(1.00)	ppm		
Copper	2.05	(0.16)	ppm		
Boron					
Limestone Requirement					0.00 lbs/1000sqft

*CL=Critical level is the point which no additional nutrient and/or limestone are recommended.

Nueces County **Area Represented: 40 sqft**

Laboratory Number: 364717
Customer Sample ID: NC-161
Crop Grown: GARDEN

Analysis	Results	CL*	Units	ExLow VLow Low Mod High VHigh Excess.	Fertilizer Recommended
pH	7.4	(6.5)	-	Slightly Alkaline	
Conductivity	570	(-)	umho/cm	Slight	
Nitrate-N	17	(-)	ppm		0.6 lbs N/1000sqft
Phosphorus	1,109	(50)	ppm		0 lbs P2O5/1000sqft
Potassium	748	(175)	ppm		0 lbs K20/1000sqft
Calcium	7,105	(180)	ppm		0 lbs Ca/1000sqft
Magnesium	524	(50)	ppm		0 lbs Mg/1000sqft
Sulfur	537	(13)	ppm		0 lbs S/1000sqft
Sodium	353	(-)	ppm		
Iron					
Zinc					
Manganese					
Copper					
Boron					
Limestone Requirement					0.00 lbs/1000sqft

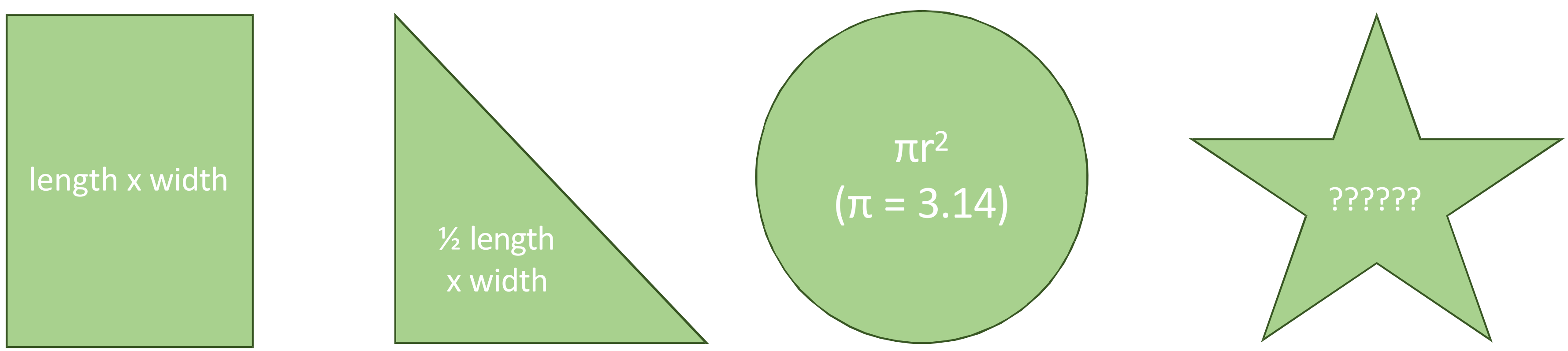
*CL=Critical level is the point which no additional nutrient (excluding nitrate-N, sodium and conductivity) is recommended.

Nitrogen: Apply an additional 1 lb N/1000 sqft every 4-6 weeks, as needed, to maintain vegetative growth.

Phosphorus: Phosphorus is highly elevated, avoid phosphorus containing fertilizers and organics for the next 5 years, retest annually.

Calculating Fertilizer Needs

- The laboratory recommends the amount of nutrient need per acre or per 1000 sqft, not the amount of fertilizer needed.
- You may not have 1000 sq ft.. What shape is your lawn or garden area?



Calculating Fertilizer Rates

STR

N	0.6 lb
P	0.0 lb
K	0.0 lb

- Possible Fertilizer: 46-0-0
- 5 lb bag has 2.3 lbs N
- need 2.3 lbs urea for 1000 sq ft

Nueces County
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Crop Grown: GARDEN

Area Represented: 40 sqft

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Potassium	748	(175)	ppm		0 lbs K20/1000sqft
Calcium	7,105	(180)	ppm		0 lbs Ca/1000sqft
Magnesium	524	(50)	ppm		0 lbs Mg/1000sqft
Sulfur	537	(13)	ppm		0 lbs S/1000sqft
Sodium	353	(-)	ppm		
Iron					
Zinc					
Manganese					
Copper					
Boron					
Limestone Requirement					0.00 lbs/1000sqft

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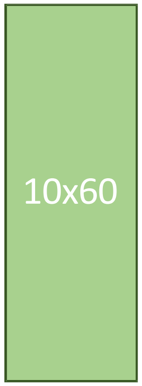
Phosphorus: Phosphorus is highly elevated, avoid phosphorus containing fertilizers and organics for the next 5 years, retest annually.

$$\frac{0.6 \text{ lbs N}}{1000 \text{ sq ft}} \times \frac{\text{lb fertilizer}}{0.46 \text{ lbs N}} = \frac{2.3 \text{ lbs fertilizer}}{1000 \text{ sq ft}}$$

Calculating Fertilizer Rates

Soil Test Fertilizer Recommendation

Your area (ex: 60' x 10' = 600 sq ft) / 1000 x your recommendation (ex: 0.6 lb N / 1000 sq ft



$$\frac{600 \text{ sq ft}}{1000 \text{ sq ft}} \times 0.6 \text{ lbs N} = 0.36 \text{ lbs N}$$

soiltesting.tamu.edu/webpages/calculator.html

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Texas A&M System

Soil, Water and Forage Testing Laboratory
Department of Soil and Crop Sciences

Fertilizer Calculators

The fertilizer calculators provide the user the ability to enter a soil testing recommendation for nitrogen (N), phosphate (P2O5) and potash (K2O) and enter one or more fertilizer grades to determ
1) Is the selected fertilizer appropriate for the soil test determined nutrient needs?
2) Do additional fertilizer or nutrient sources need to be added to meet soil test determined nutrient needs?
3) What application rates of N, P2O5 and K2O are being applied?
4) What application rate of fertilizer(s) is required to meet the soil test determined nutrient needs?

These fertilizer grade, commonly referred to as the fertilizer analysis, is represented by the three numbers with dashes between the numbers, commonly located on the front of a fertilizer bag. A product (as a percentage), followed by the available phosphate (also as a percentage), and finally the third number represents available potash (also as a percentage). In some cases, additional additional nutrients with greater specificity.

- Urban Fertilizer Calculator - Basic edition, Single Fertilizer Entry

The urban calculator allows for quick evaluation of a retail bagged fertilizer and its fulfilling the soil test recommendations for your lawn, garden or other small area.

- Urban Fertilizer Calculator - Commonly Available Fertilizer List and Single Fertilizer Entry

This calculator includes a user selectable list of commonly available fertilizers found in home and garden centers in addition to the functions of the calculator above.

- Agricultural Fertilizer Calculator

The agricultural fertilizer calculator allows for the input of up to three different dry fertilizers and calculates the indivudal rates of application and total combined fertilizer rate.

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Soil, Water and Forage Testing Laboratory

Agricultural Fertilizer Management Calculator-version 1.2

Enter selections, recommendations and pricing in the red boxes.

Soil Test Recommended Nutrient rates lbs/acre

Nitrogen	100	lbs N/acre
Phosphorus	25	lbs P_2O_5/acre
Potassium	175	lbs K_2O/acre

(Does your soil test recommendations suggest split applications of potassium?)

Your First Fertilizer Selection

This is the grade of fertilizer you might have historically used or available at your local ag retailer. Please use the red drop-down boxes to select each number of the fertilizer grade.

"Nitrogen" N		"Phosphate" P2O5		"Potash" K2O	Price per ton
16	-	6	-	12	700.00

Apply this amount of selected fertilizer:

625 lbs fertilizer/acre

Nitrogen applied	100 lbs N/acre
Phosphate applied	37.5 lbs P2O5/acre
Potash applied	75 lbs K2O/acre

How this fertilizer supplies your soil test needs:

Nitrogen needs fulfilled

PHOSPHATE OVER APPLIED BY 12.5 LBS/ACRE.

AN ADDITIONAL 100 LBS K2O/ACRE REQUIRED.

Your Second Fertilizer Selection-applied in addition to first fertilizer selection

"Nitrogen" N		"Phosphate" P2O5		"Potash" K2O	Price per ton
0	-	0	-	60	950.00

Apply this amount of selected fertilizer:

166.7 lbs fertilizer/acre

Nitrogen applied	0 lbs N/acre
Phosphate applied	0 lbs P2O5/acre

Your Second Fertilizer Selection-applied in addition to first fertilizer selection

"Nitrogen" N		"Phosphate" P2O5		"Potash" K2O	Price per ton
0	-	0	-	60	950.00

Apply this amount of selected fertilizer:

166.7 lbs fertilizer/acre

Nitrogen applied	0 lbs N/acre
Phosphate applied	0 lbs P2O5/acre
Potash applied	100 lbs K2O/acre

How this fertilizer supplies your soil test needs:

Nitrogen needs fulfilled

PHOSPHATE OVER APPLIED BY 12.5 LBS/ACRE.

Potash needs fulfilled

Your Third Fertilizer Selection-applied in addition to first two selections

"Nitrogen" N		"Phosphate" P2O5		"Potash" K2O	Price per ton
0	-	0	-	0	0.00

Nitrogen applied	0 lbs N/acre
Phosphate applied	0 lbs P2O5/acre
Potash applied	0 lbs K2O/acre

How this fertilizer supplies your soil test needs:

Nitrogen needs fulfilled

PHOSPHATE OVER APPLIED BY 12.5 LBS/ACRE.

Potash needs fulfilled

Summary of Calculations

Fertilizers selected	Rate (lbs/acre)	Cost ($/acre)
16 - 6 - 12	625	$218.75
0 - 0 - 60	166.7	$79.18
Total weight and cost of fertilizer applied	791.7 lbs/acre	$297.93

Nitrogen requirements have been met.
Fertilizer selection has resulted the calculation of an over application of phosphate.
Potash requirements have been met.

Update Reset Print

Done

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Soil, Water and Forage Testing Laboratory
Urban Fertilizer Management Calculator-Edition 1.1

Enter the results from your soil test report in the red boxes below.

	Soil Test Values ppm	Recommend Nutrient Rates lbs/1000 sqft	
Nitrogen	0	1	lbs N/1000 sqft
Phosphorus	0	1	lbs P_2O_5/1000 sqft
Potassium	0	0	lbs K_2O/1000 sqft
Recommended fertilizer ratio		1 - 1 - 0	

Your Fertilizer Selection

This is the grade of fertilizer you might have historically used, observed at a local garden center, or home center. Please select either select your fertilizer under the Commonly Available Fertilizer drop-down menu or enter the individual nitrogen, phosphate and potash values using the three drop-down boxes.

Commonly Available Fertilizers

10 - 8 - 8

Select a fertilizer from this list or enter an unlisted fertilizer grade using the drop-down boxes below.

This fertilizer's ratio **1.3 - 1 - 1**

If you selected a fertilizer above, insure the three drop-down boxes below display "None".

"Nitrogen" N	"Phosphate" P2O5	"Potash" K2O
13	27	0

*Note: if your soil test provides a nitrogen recommendation, please first select a fertilizer to fulfill the N requirements.

Apply this amount of selected fertilizer to met your nitrogen needs:

10 lbs fertilizer/1000 sqft

Nitrogen applied	1 lbs N/1000 sqft
Phosphate applied	0.8 lbs P2O5/1000 sqft
Potash applied	0.8 lbs K2O/1000 sqft

How this fertilizer supplies your soil test nutrient recommendations:

Nitrogen adequately supplied
P2O5adequately supplied
Potash is over applied by 0.8 lbs K2O/1000 sqft

Carefully evaluate your fertilizer selection, it appears not to match soil testing recommendations.


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