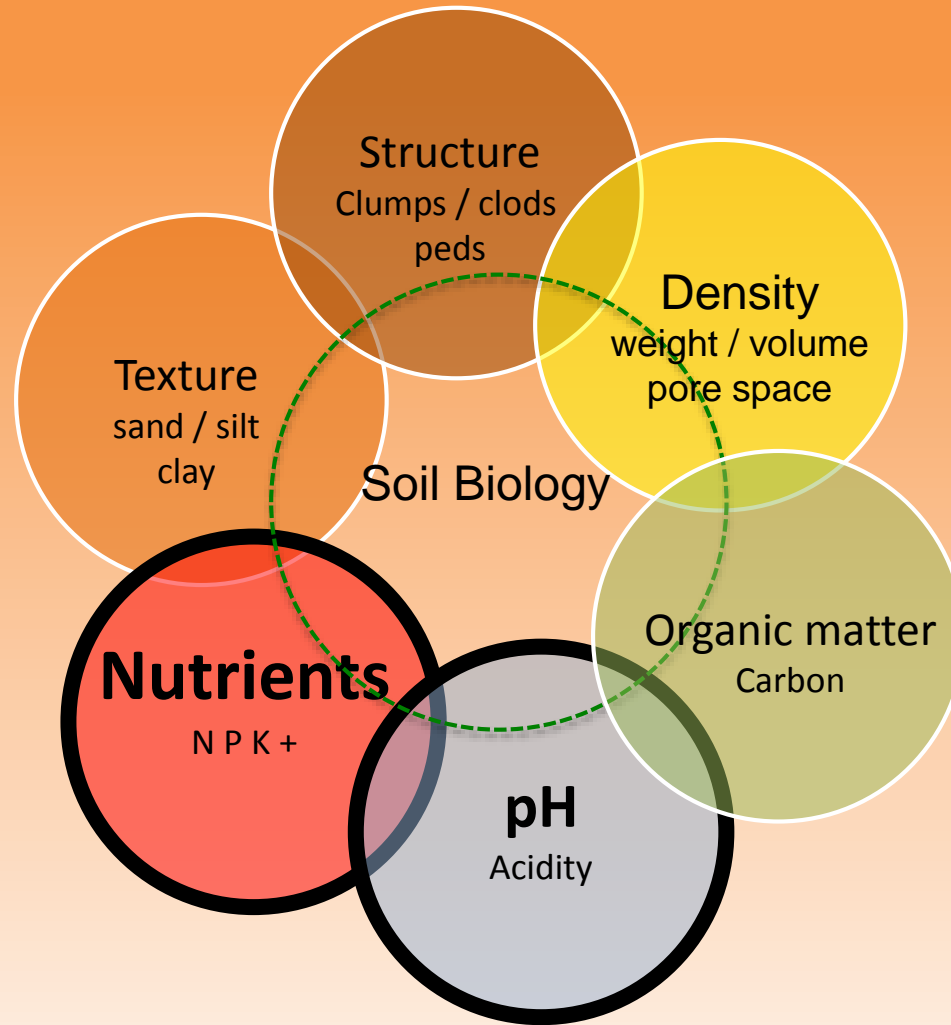


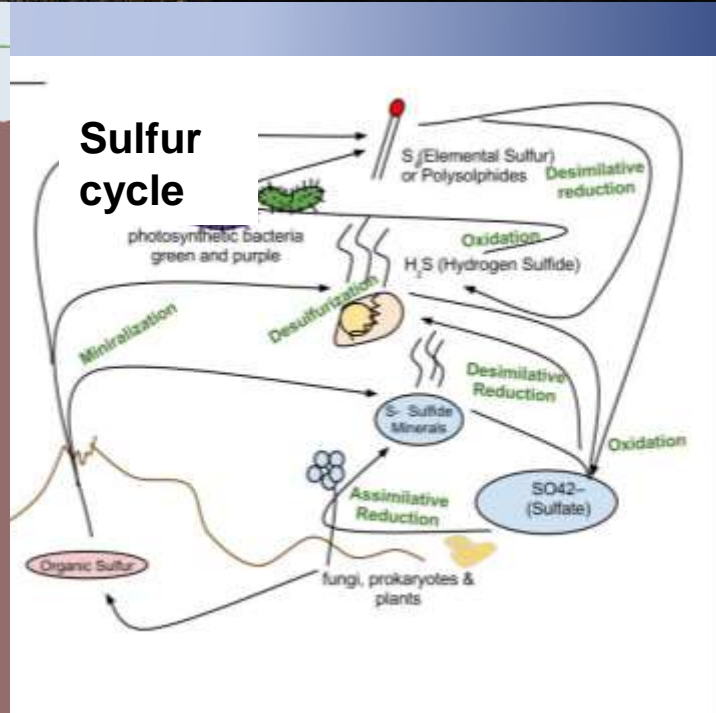
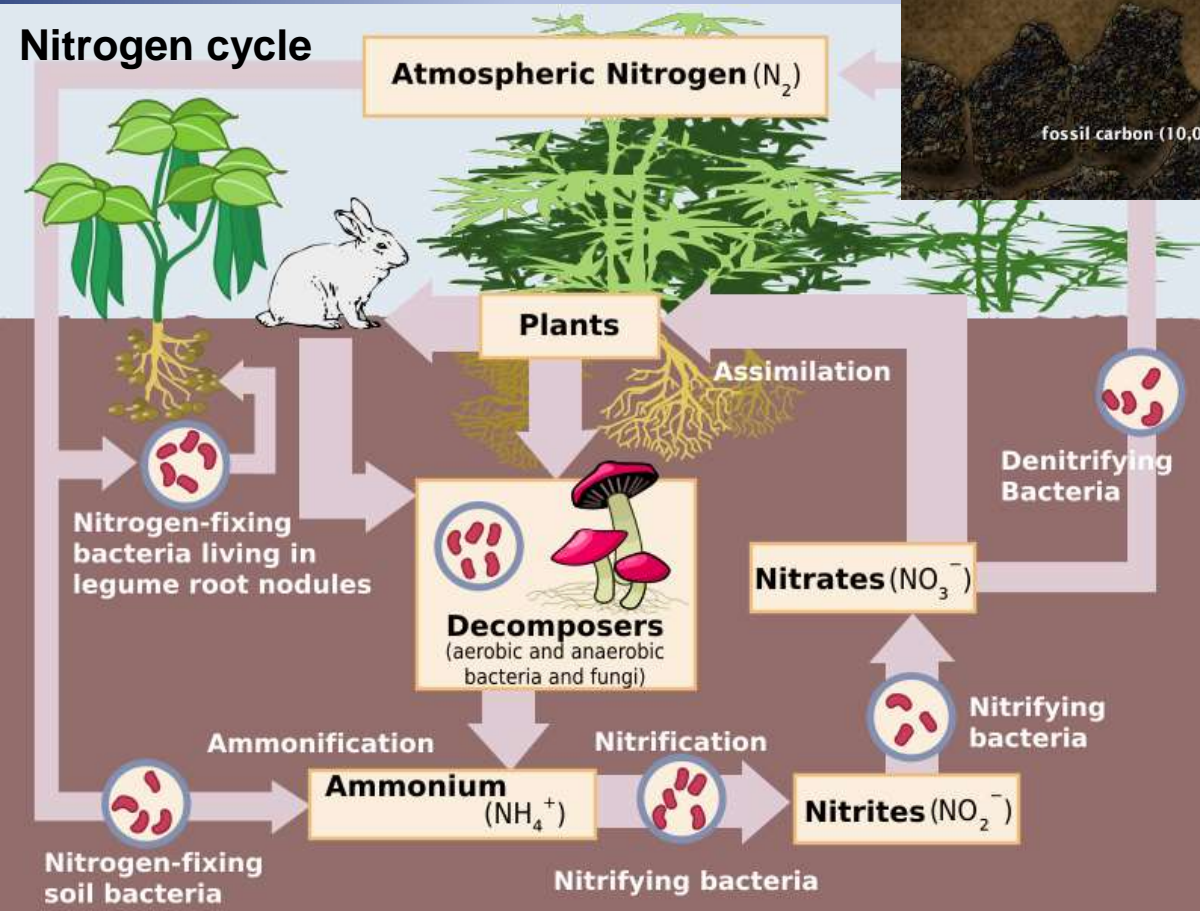
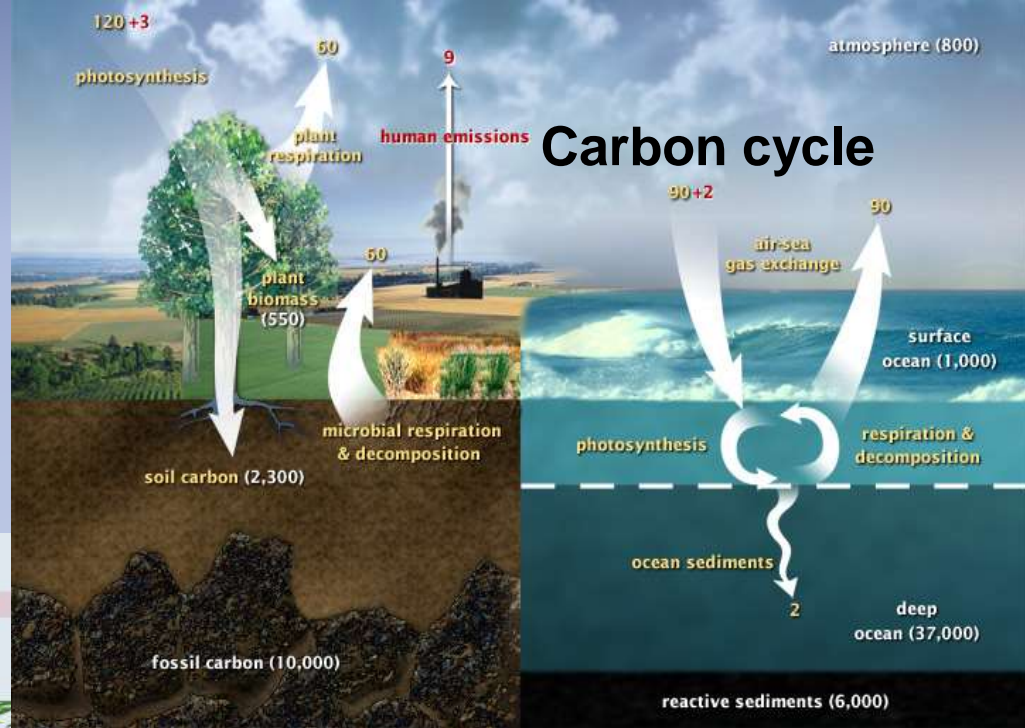
Chemical Properties of Soil



Air and water movement / soil profile

Chemical Properties of Soil

- endless cycles



Justus Von Liebig's Law of the Minimum:
A plant's yield is limited by the most limited nutrient.



Sir Albert Howard's Law of Return:
Plant and animal wastes should be returned to the soil to maintain nutrient and humus levels.



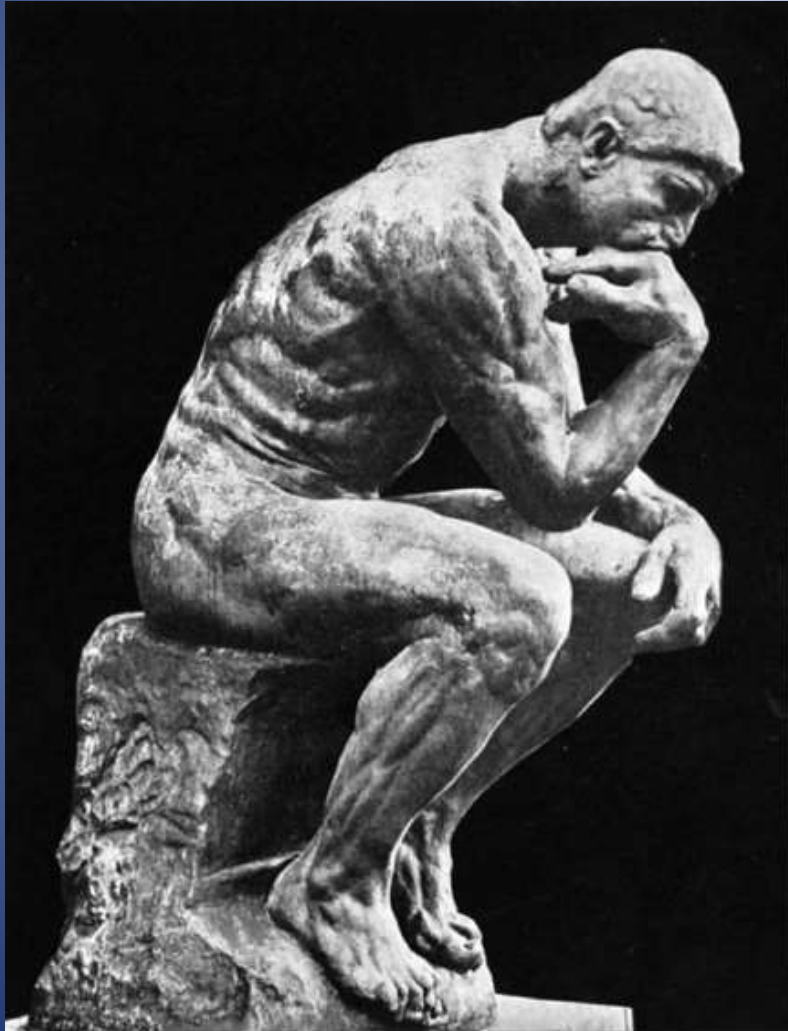
Questions for the Stewards:

What can we do to regain some kind of functional system?

Which cycles can be repaired and which cannot?

If an part of a natural cycle is lost permanently, what can we do to simulate that part?

What's wrong?



What can we do?

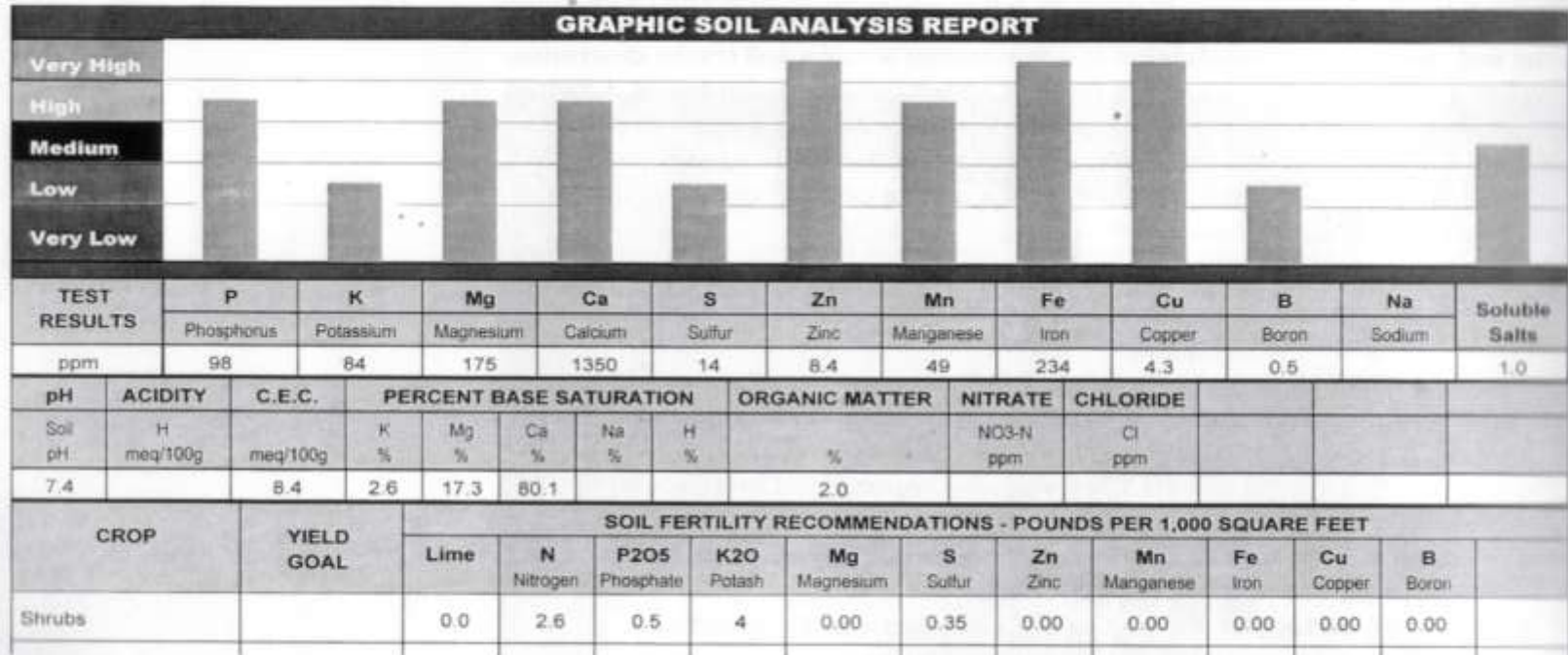
Soil Testing

Sample Number: GP-1

Lab Number: 987

Date Received: 10/20/2005

Date Reported: 10/24/2005



The use of fertilizers should be based on information that can only be obtained by having your soil tested.

Analytical Results	Sample: 'Veggie Garden'	Simply Soil Testing
Customer: Joe Customer 1432 E Jameson St Seattle, WA 98199	Date received: 01/04/14 Report date: 01/07/14 Sample reference #: 00273 Plant code: 01 - Vegetable Garden Tests requested: Basic, OrgM, B, S, Zn, Mn, Cu, Fe	

The report shows the levels of macro-nutrients, phosphorus and potassium (in ppm). Nitrogen levels are not customarily tested.

Customer's description of the location where the soil sample was taken.

The secondary nutrients, calcium, magnesium and sulfur are often deficient in NW soils, and are not included in conventional fertilizer blends.

The plant or crop that the customer has indicated will be planted. The fertilizer and lime recommendations are tailored to the selected plants.

Organic matter improves the texture of garden soil and serves as a reservoir for many nutrients.

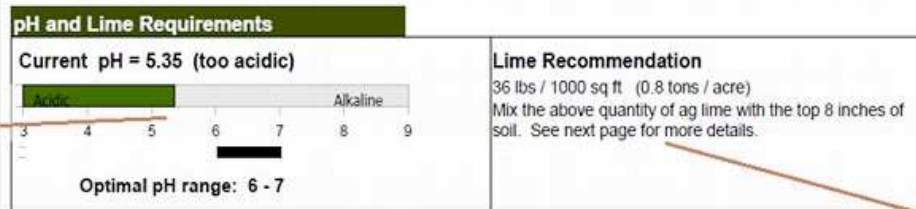
The bar graphs show, at a glance, whether the soil nutrient levels are adequate.

RESULTS		INTERPRETATION				
Nutrient	Level	Low	Medium	High	V High	Result
Phos. (Bray-P1)	52 ppm	[Bar graph showing High level]				High
Potassium (K)	141 ppm	[Bar graph showing Medium level]				Medium
Calcium (Ca)	1057 ppm	[Bar graph showing Medium level]				Medium
Magnesium (Mg)	412 ppm	[Bar graph showing Very High level]				Very High
Boron (B)	0.99 ppm	[Bar graph showing High level]				High
Sulfur (S as SO4)	5.4 ppm	[Bar graph showing Medium level]				Medium
Organic Matter	16.5 %	[Bar graph showing Very High level]				Very High
Soluble Salts	0.1 mS/cm	[Bar graph showing Satisfactory level]				Satisfactory

Micronutrients	Critical Range	Result
Zinc	0.5 - 1.0 ppm	Very High
Manganese	0.7 - 1.4 ppm	Very High
Copper	0.4 - 0.7 ppm	High
Iron	2.5 - 5.0 ppm	Very High

The micro-nutrients are less often deficient. Deficiencies are usually only observed in particular geographical regions.

This graph shows the current soil pH and whether it is within the optimal range for your garden, orchard or lawn.



If the soil pH is below what is recommended for your plants, this section will show the recommended amount of lime to add.

This section shows which nutrients are deficient and how much of each nutrient is needed to achieve recommended levels.

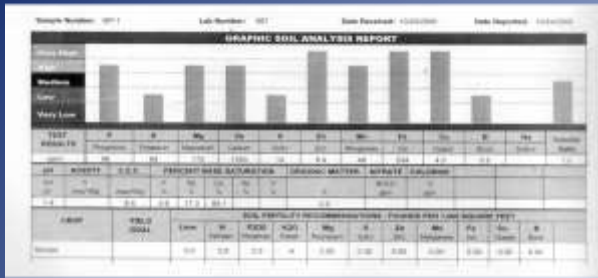
Fertilizer Recommendations			
Nutrient	Weight / 1000 sq ft	Nutrient	Weight / 1000 sq ft
Nitrogen	2.0 lbs (85 lbs/acre)	Boron (B)	none required
P (as phosphate)	none required	Sulfur (S)	8 oz (2.5 lbs as gypsum)
K (as potash)	2.1 lbs	Iron (Fe)	none required
Calcium	24 lbs (60 lbs as CaCO3)	Manganese (Mn)	none required
Magnesium	none required	Copper (Cu)	none required

<http://www.simplysoiltesting.com/Services.html#report>

Recommended addition rates of various conventional or organic fertilizers (your choice) in pounds per 1000 sq ft.

proportion of nutrients, so nitrogen and potassium should be applied individually. Below is a list of some organic fertilizer options, along with the quantity needed:

- Nitrogen: Blood meal - 16 lbs/1000sf, or Milorganite - 33 lbs/1000sf, or Urea - 4.2 lbs/1000sf or Organic manure - 49 lbs/1000sf
- Potassium: Greensand - 30 lbs/1000sf, or Potassium chloride - 3.5 lbs/1000sf or Potassium sulfate - 4.2 lbs/1000sf



Common tests for your soil include:

- Nutrient Content (Fertility)
- Salt Content (Salinity)
- Cation Exchange Capacity
- Soil Texture
- pH
- Organic Matter Content

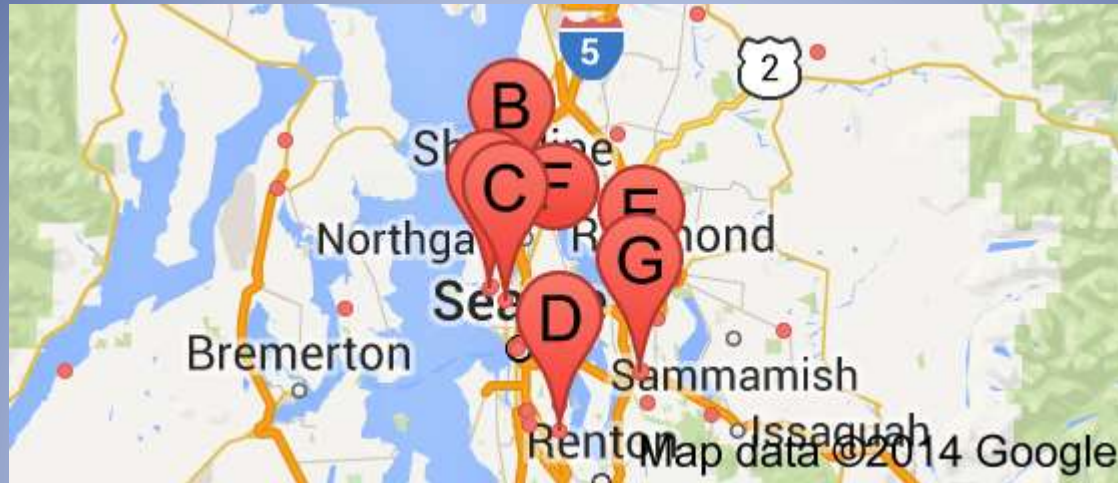


Additional tests available for soils:

- Biological Activity
- Heavy Metals
- Pesticides
- Hydrocarbons
- Irrigation Water Analysis
- Soil Particle Size
- Soilless Mix Analysis
- Water Holding Capacity
- Plant Tissue Analysis

Land use and land history should guide the choice of additional tests

Search Result for “Soil Testing Seattle” by Google



Laboratory websites should contain:

- 1. Tests Offered**
- 2. Soil Sampling Guidelines**
- 3. Sample Soil Report**
- 4. Methods Used**
- 5. Submission Forms**

Soil Testing Resources

Washington State University

<http://puyallup.wsu.edu/soilmgmt/Soils.html>

King County

http://www.kingcd.org/pro_far_soi.htm

King County Conservation District offers free basic soil testing

Grow Smart Grow Safe

<http://www.growsmartgrowsafe.org/SoilAmend.aspx>

Teaming With Nutrients

Jeff Lowenfels



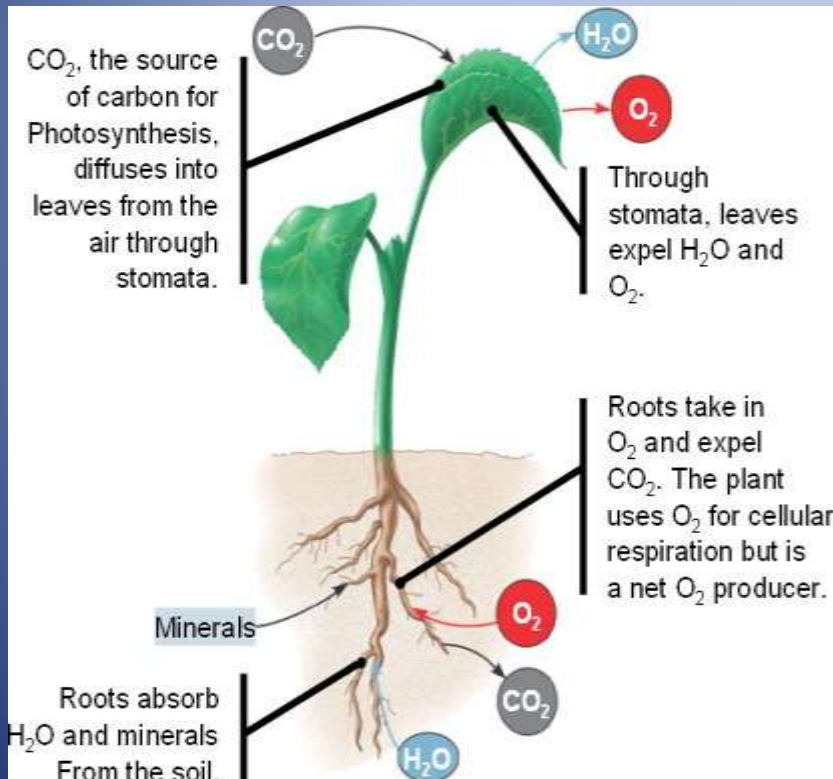
Elements Required by Plants

Base Elements Macronutrients Micronutrients

Oxygen (O)
Hydrogen (H)
Carbon (C)

Nitrogen (N)
Phosphorus (P)
Potassium (K)
Calcium (Ca)
Magnesium (Mg)
Sulfur (S)

Boron (B)
Chlorine (Cl)
Cobalt (Co)
Copper (Cu)
Iron (Fe)
Manganese (Mn)
Molybdenum (Mo)
Zinc (Zn)



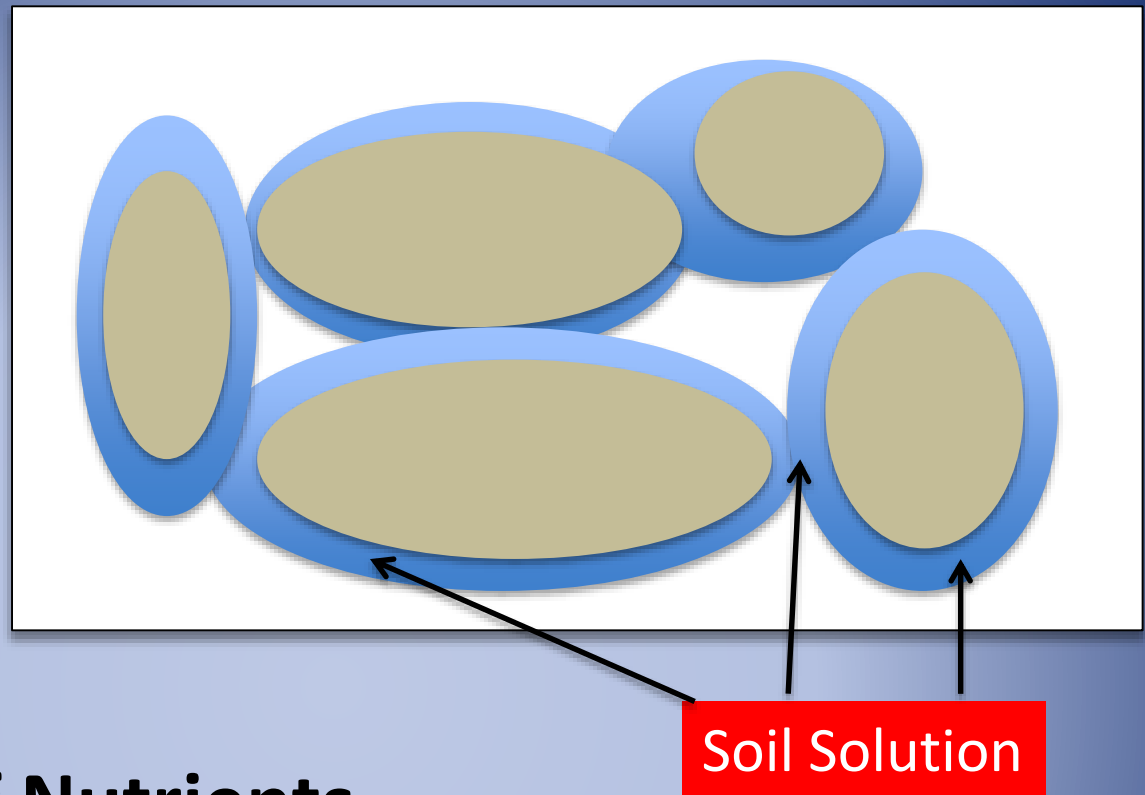
Caution:

Micronutrients are rarely deficient and the range between deficient and toxic can be very small.

**Beware of
Bio-accumulation!**

Source	Heavy Metal									
	As	Cd	Co*	Cr	Cu*	Hg	Mn*	Ni	Pb	Zn*
Natural										
Mineral parent material		X		X	X			X	X	X
Volcanic gasses		X		X	X	X	X	X		X
Precipitation		X			X				X	X
Marine aerosols	X	X			X		X	X		
Forest Fires	X	X			X	X		X	X	X
Anthropogenic										
Fossil fuel combustion	X	X	X		X			X	X	X
Industrial and domestic chimneys					X			X	X	X
Automobiles		X		X		X		X	X	X
Mining and smelting		X	X		X		X	X	X	X
Fertilizers		X		X	X		X	X		X
Pesticides	X				X	X				
Liming materials					X		X			X
Organic manures		X		X	X		X	X	X	X
Sewage Sludge		X		X	X		X	X	X	X

Model of Soil Showing Micropores and Macropores at Field Capacity

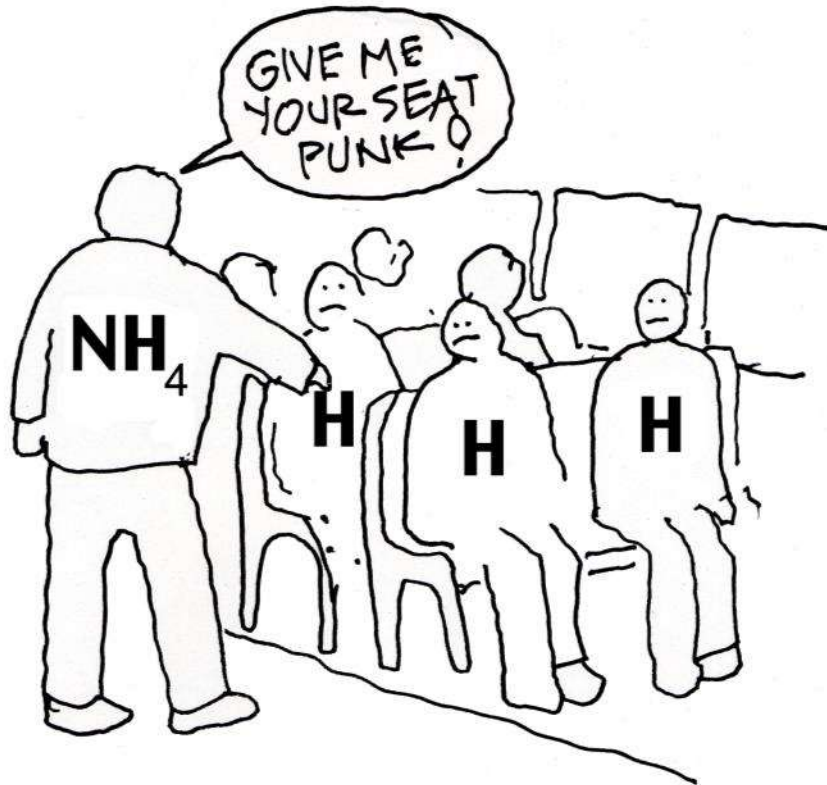


Four States of Nutrients

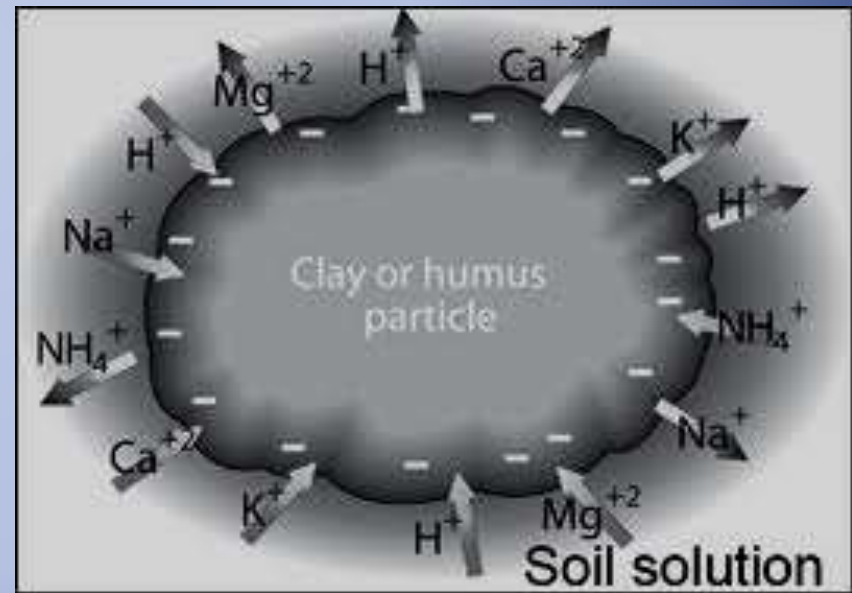
1. Mineral solids (CaCO_3 , CaSO_4 , Mica, Granite, etc.)
2. Parent organics (sugars, proteins, lignins, etc.)
3. Dissolved ions in solution
4. Exchangeable ions adsorbed onto particle surfaces

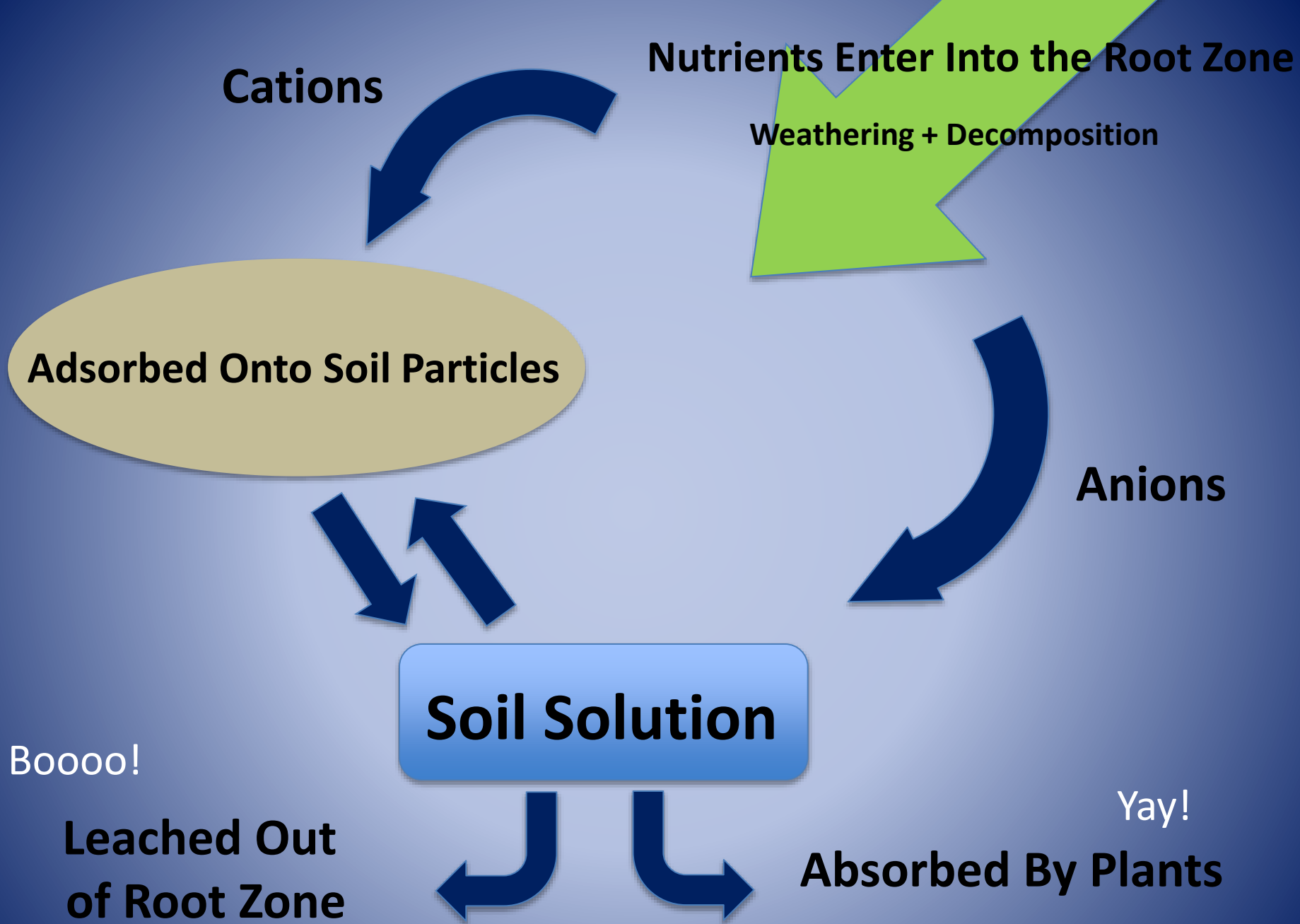
Cation Exchange Capacity (CEC)

The Cation Exchange Capacity is a measure of how many negatively charged sites are available in a particular soil.



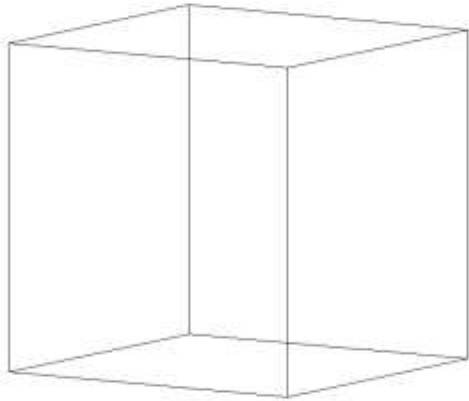
The soil particle is like a bus. The seats are the negative charges. All the seats must always be full with positively charged particles. Hydrogen has a weak charge and Ammonium (NH_4) a stronger charge, so they “exchange” seats if the Ammonium ion wants to sit down.





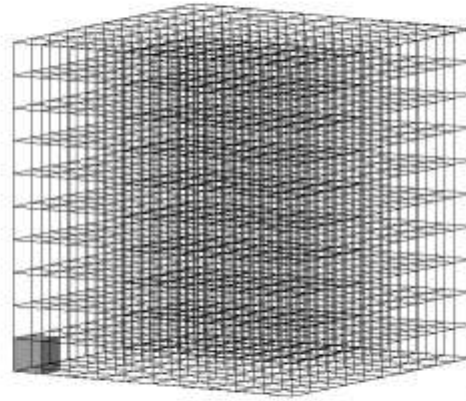
Sand

1 Particle Fine **Sand** .2mm
0.24mm² Surface Area



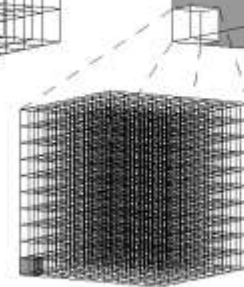
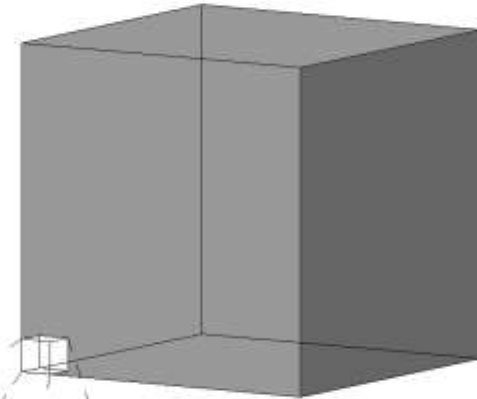
Silt

1,000 Particles **Silt** .02mm
2.4 mm² Surface Area



Clay

1,000,000 Particles **Clay** .002 mm
24 mm² Surface Area



The smaller the particle
the greater the CEC.

Humus/clay colloids have the most!

Relative surface area

Cation Exchange Capacity (CEC) for planting soil mixes (mmol/kg)

Low fertility soil	Less than 5
Medium fertility	5-10
High fertility	10-30

Compost / humus up to 200!

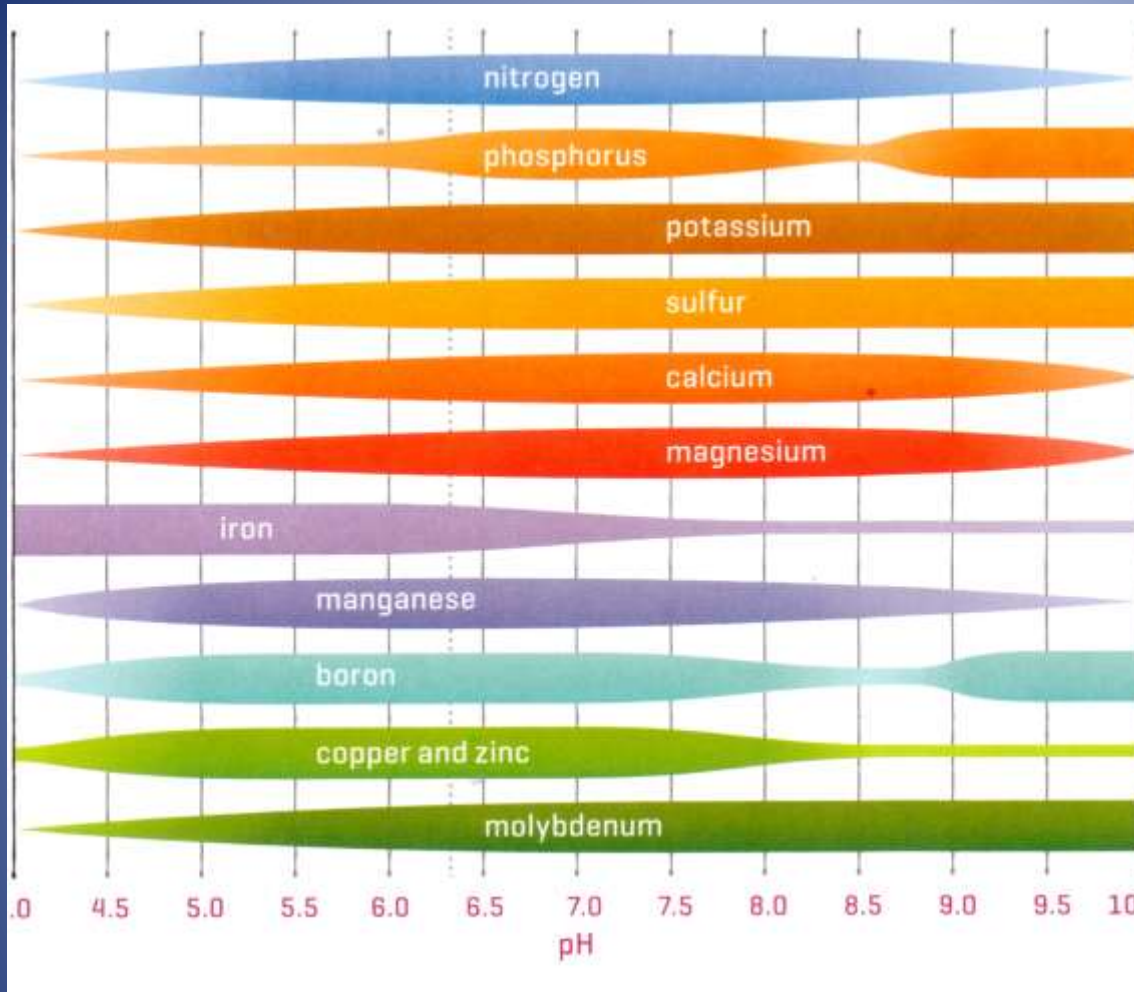
- Fine sand 0.24mm²
- Silt 2.4mm²
- Clay 24mm²

USDA pH Classification

	pH range	
Ultra acid	1.8 - 3.4	Toxic to most plants
Extremely acid	3.5 - 4.4	Restrictive to most plants
Very strong acid	4.5 - 5.0	
Strongly acid	5.1 - 5.5	Acid-tolerant plants
Moderately acid	5.6 - 6.0	
Slightly acid	6.1 - 6.5	Best nutrient availability for most plants
Neutral	6.6 - 7.3	
Slightly alkaline	7.4 - 7.8	Alkaline-tolerant plants
Moderately alkaline	7.9 - 8.4	
Strongly alkaline	8.5 - 9.0	Restrictive to most plants
Very strongly alkaline	9.1 - 11.0	Toxic to most plants

Lower or higher pH decreases availability of different nutrients

Humus (compost) buffers pH towards optimal 6.3 to 6.8



pH influences plant growth indirectly through its effects on the solubility of ions and the activity of microorganisms

Potential Soil/Plant Problems

pH

Common Plant Symptoms

Lack of drainage,
Sodium toxicity

12

11

Marginal leaf burn
Chlorosis, Death

10

Iron, Zinc, Manganese
deficiency

9

8

Interveinal Chlorosis and
Bleaching of new growth

7

Aluminum toxicity, Calcium
and Magnesium deficiency

6

5

Reduced Growth and
Chlorosis in sensitive plants

4

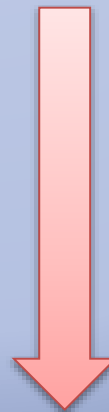
Aluminum toxicity, Calcium
and Magnesium deficiency

3

2

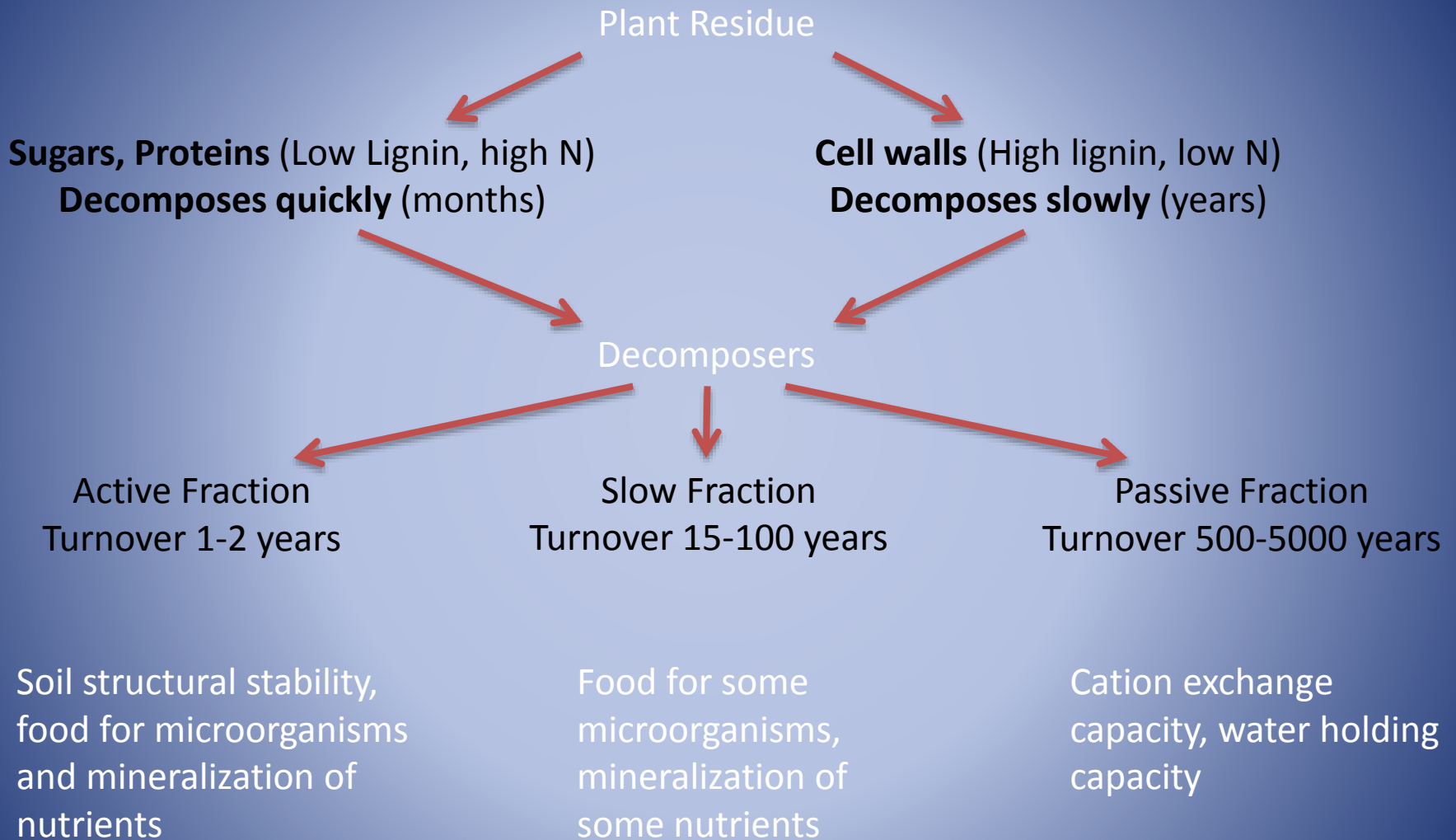
Reduced growth, Chlorosis,
Distorted new growth,
Necrotic areas

1



Decreasing Microbial Activity

What Happens to Organic Soil Ammendments?



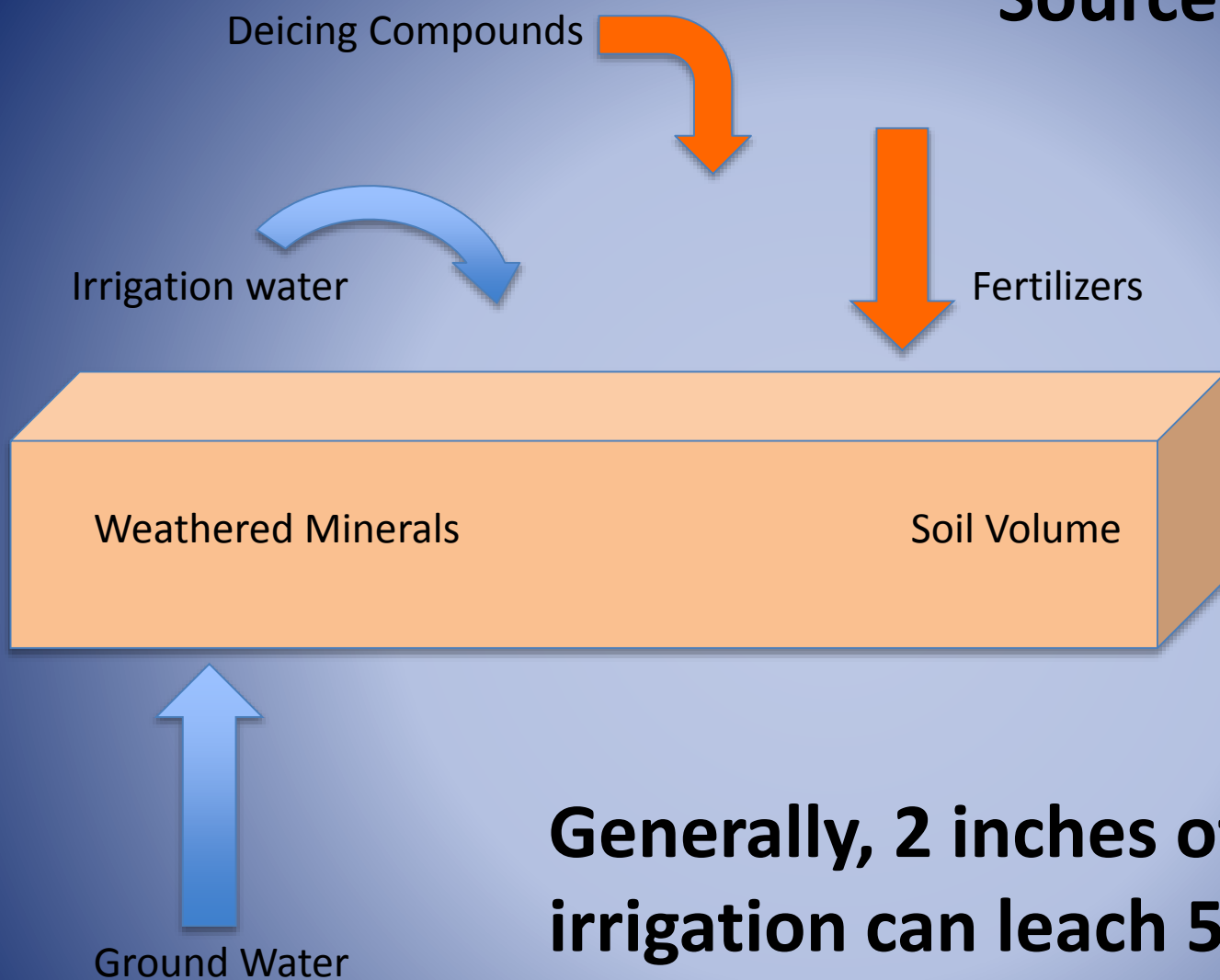


Salt!

Air Salt
vs.
Soil Water Salt



Sources of Salt



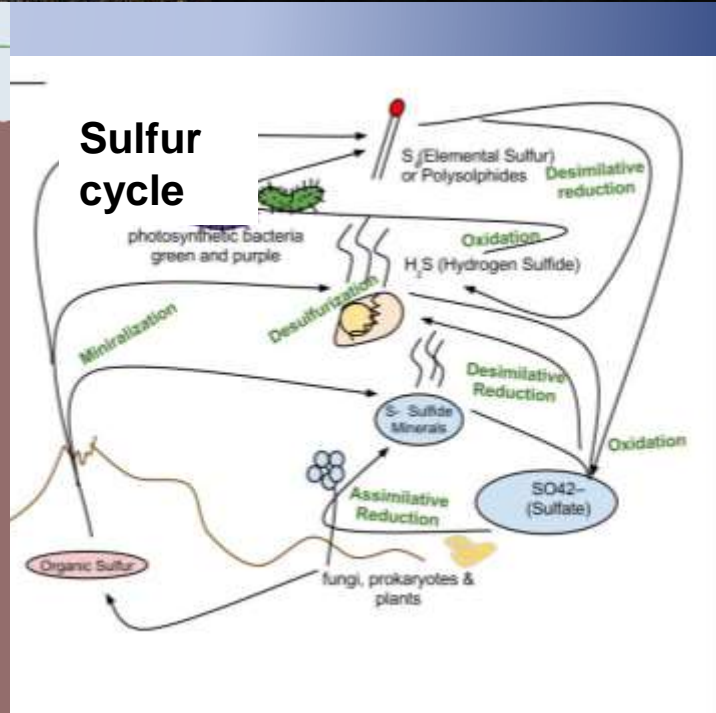
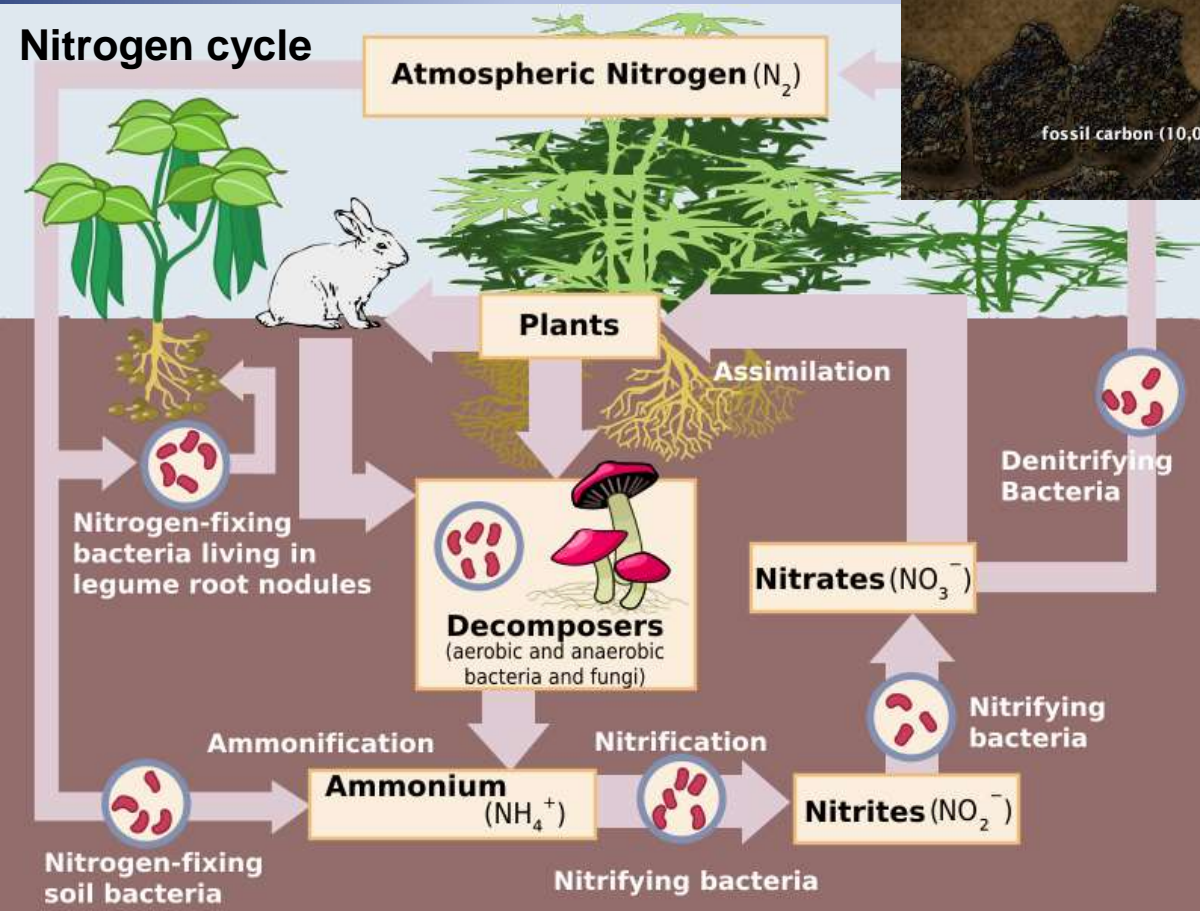
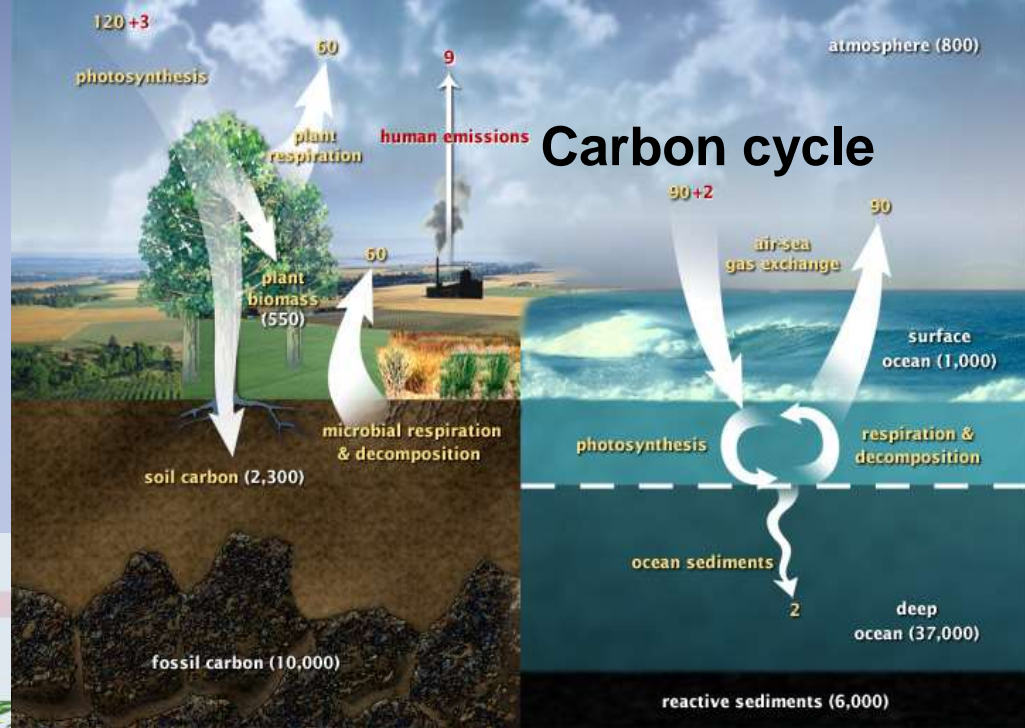
Generally, 2 inches of proper irrigation can leach 50% of salt from the top 4 inches of soil.

Salt Tolerance of Various Shrubs and Trees

Taxa	Low	Medium	High
<i>Ailanthus altissima</i>	X		
<i>Cercis</i> spp.		X	
<i>Citrus</i> spp.	X		
<i>Cupressus</i> spp.	X		
<i>Eucalyptus</i> spp.			X
<i>Ficus</i> spp.		X	
<i>Morus alba</i> , <i>M. nigra</i>	X		
<i>Pinus halapensis</i>			X
<i>P. pinaster</i>			X
<i>P. radiata</i>			X
<i>Rosa</i> spp.	X		

Chemical Properties of Soil

- endless cycles





University of Washington Botanic Gardens

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<http://depts.washington.edu/hortlib/index.shtml>

Try the **Gardening Answers Knowledgebase**, a searchable database of Plant Answer Line question/answer sets and recommended websites.

Call the **Plant Answer Line** at 206-897-5268 (**206-UW-PLANT**) or email hortlib@uw.edu.

