

Plain Talk About Soil Chemistry

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Plant nutrients must be
dissolved in water.

Dissolve-ability impacts
availability.

- ◆ Some nutrients easily dissolve in water.
- ◆ Some nutrients take years to dissolve.
- ◆ Application timing can be your ally – or your enemy.

Ammonia and ammonium
fertilizers acidify soil.

Like diamonds, clay soils are
forever.

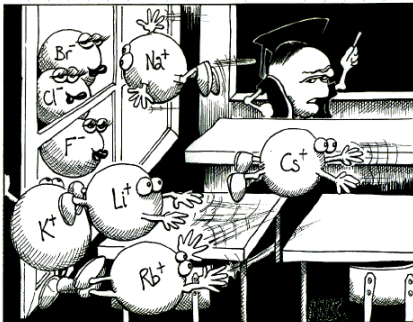
Pop Quiz:

What is the charge on soils?

Soils have a negative charge.

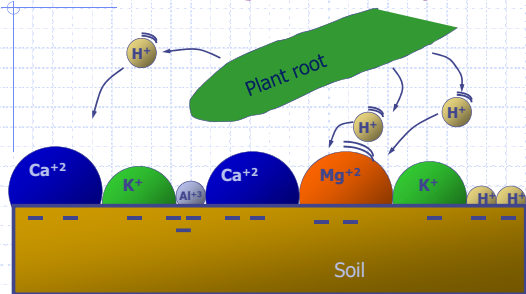
Attraction is everything in soil fertility management.

- ◆ Nutrient management is like teenagers in love.
- ◆ Timing determines nutrient use.
- ◆ Cations = + charge
- ◆ Anions = - charge
- ◆ Cation Exchange Capacity



"Perhaps one of you gentlemen would mind telling me just what it is outside the window that you find so attractive...?"

Cation Exchange is a Swap Meet.



Lime – 2 chemical forms

- ◆ Agricultural lime – Calcium Carbonate
- ◆ Dolomitic lime – Calcium Magnesium Carbonate
- ◆ Quick or slaked lime - Calcium Oxide or Hydroxide
- ◆ *It's the carbonate that changes pH, not the calcium or the magnesium!*
- ◆ Gypsum – Calcium Sulfate – provides calcium but does not change pH.

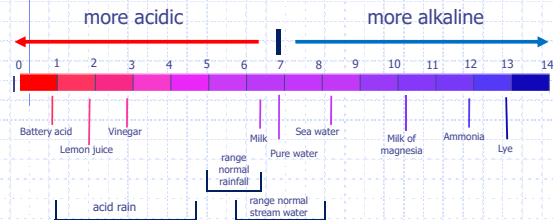
Roots are fussy shoppers.

- ◆ Roots recognize only specific nutrient forms.
- ◆ Nitrogen is the only nutrient plants can recognize in each of two forms.

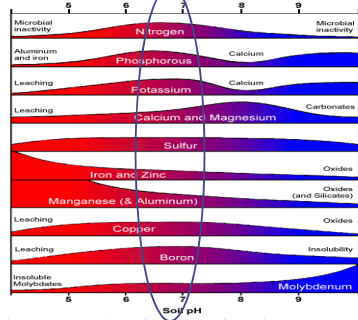
Right soil pH unlocks nutrient availability.

- ◆ pH controls nutrient form and dissolve-ability.
- ◆ Growers can impact soil pH.

pH: A measure of acidity or alkalinity



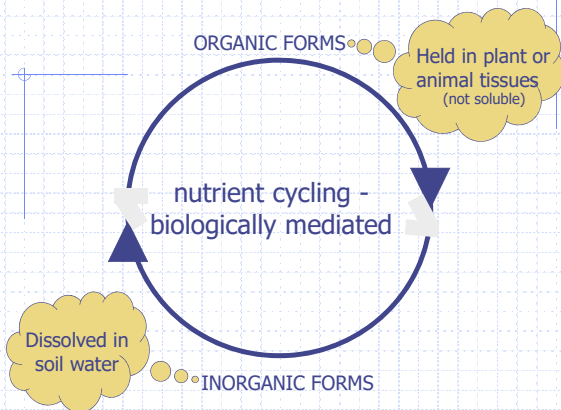
Soil pH & Nutrient Availability



Home soil test kits are OK . . . maybe

- ◆ The results ain't necessarily so
- ◆ You don't need to be a rocket scientist to recognize a problem

nutrient cycling - biologically mediated



Summing it all up:

- ◆ Nutrients must be dissolved in water.
- ◆ Dissolve-ability impacts availability.
- ◆ Roots are fussy shoppers.
- ◆ Soil has a negative charge.
- ◆ NH_3 and NH_4^+ acidify soil.
- ◆ Soil pH controls nutrient form.
- ◆ Home soil test kits.

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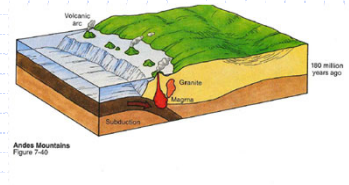


Image credit: Foundations of Physical Geography by H. Bradshaw and R. Weaver, 1995, Wm. C. Brown Publishers

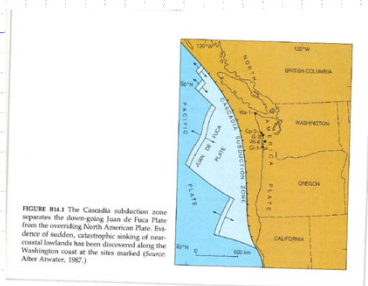
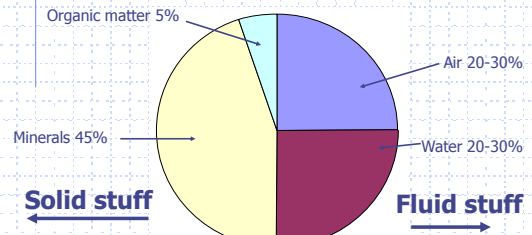


Image Credit: The Dynamic Earth by B.J. Skinner and S.C. Porter, 1988, John Wiley and Sons.

Plain Talk About Soils

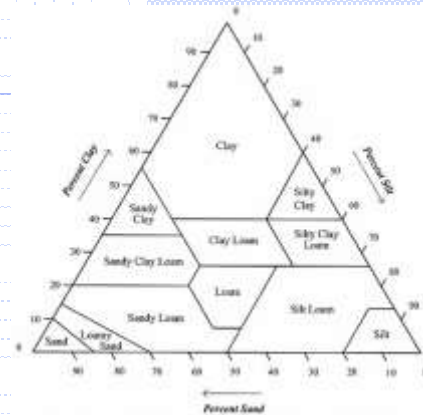
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Soil includes minerals, organic matter, air and water.



Soil texture is the percentage of sand, silt and clay.

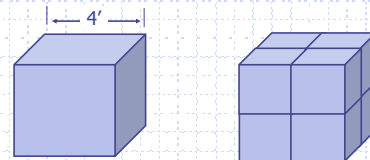
Soil texture cannot be changed. ☹



What's a gram of soil, anyway?

	Particles per gram	Surface Area
Medium Sand	6 thousand	7 in ²
Silt	6 million	70 in ²
Clay	90 billion	1.2 million in ²

Same volume, different surface area.

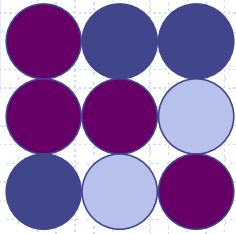


Do the math and prove it to yourself!

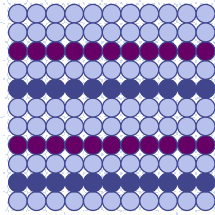
$$\begin{aligned}\text{Surface area} &= 4 \times 4 \times 6 \\ &= 96 \text{ sf}\end{aligned}$$

$$\begin{aligned}\text{Surface area} &= 2 \times 2 \times 6 \times 8 \\ &= 192 \text{ sf}\end{aligned}$$

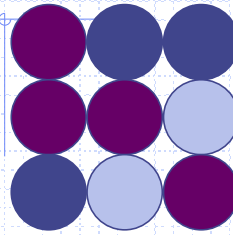
Soil minerals exist as sand, silt and clay particles.



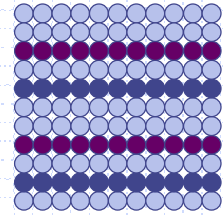
Sand particles are big.



Clay particles are small.

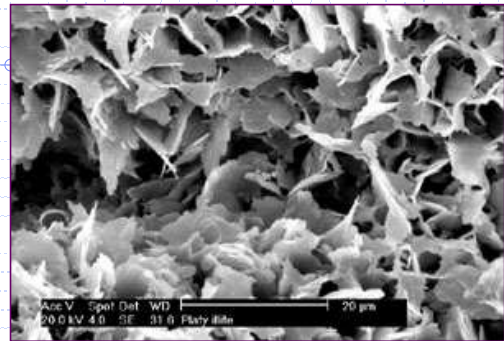


Sand: big particles, big pores.



Clay: little particles, little pores.

- ◆ If a grain of sand were the size of a basketball, then a piece of silt would be the size of a marble and a particle of clay would be a pinpoint.
- ◆ Clay particles are so small, less than one 12,500th of an inch, that electron microscopes must be used to see them.
- ◆ Clay particles are shaped like plates or flakes, and they are "surface active."



Micrograph courtesy Mineralogical Society; http://www.minersoc.org/pages/gallery/claypil/illite/hems24_4.jpg

Soil Structure

- ◆ Changes with depth
- ◆ Promotes drainage
- ◆ Quick to destroy, slow to rebuild



Soil Structure

- ◆ Role of biology in building structure



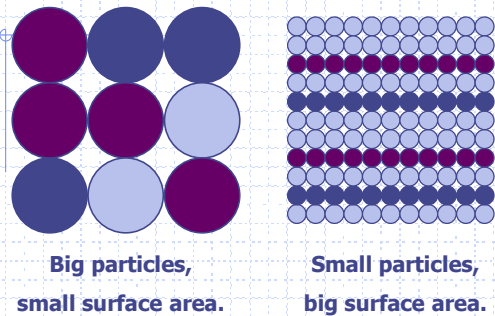
Enhancing Soil Structure

- ◆ Tillage and timing
- ◆ Influence of organic matter
- ◆ Influence of Ca, Mg, K, Na

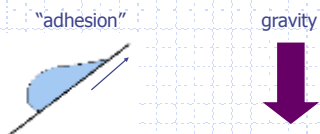
Soil Pore Size Controls Water Movement in Soils

Pore size determines how soils retain and release water.

- ◆ Wet soils are under the control of micropores.
- ◆ Dryer soils are under the control of macropores.

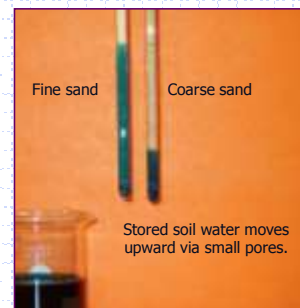


Fact #5: Two major forces control water movement through soil.



Soil texture dictates which is in control.

Adhesive Force in Action

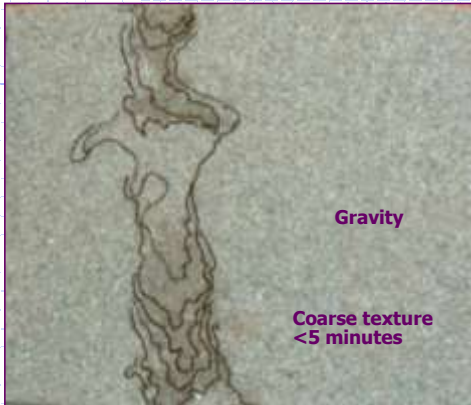




Size of soil
pores
controls
uphill flow.

Little pores
let water
climb higher.

Gravity in Action



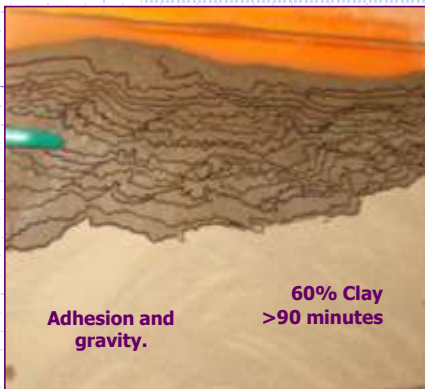
Gravity

Coarse texture
<5 minutes



Adhesion
and gravity

Fine texture
20 minutes



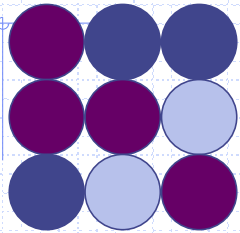
Adhesion and
gravity.

60% Clay
>90 minutes



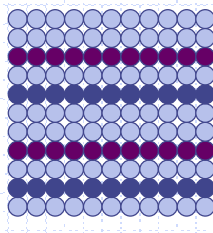
Fine texture
over coarse
texture
7 minutes
2 minutes

Gravity in control



Big particles, big pores,
little uphill flow.

Adhesion in control

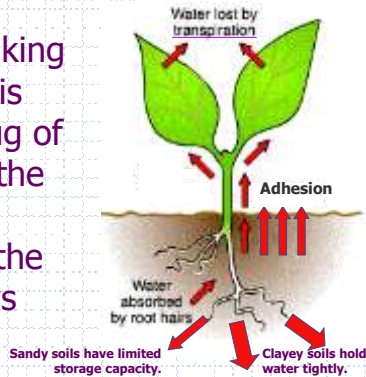


Little particles, little
pores, big uphill flow.

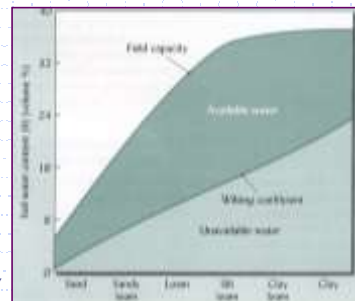
As soil dries out, it holds on to water more tightly; plants have to pull harder to get the water.

Image used with permission from the BBC's Schools Website

A plant taking up water is playing tug of war with the soil. In a drought, the soil always wins.



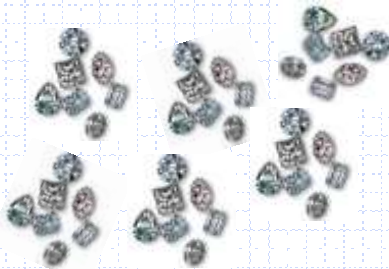
Stored water available to plants varies with soil texture.



GRAVITY

ADHESION

Like diamonds, soil texture is forever. ☹️



Organic matter acts like a magnet.

- ◆ Organic matter absorbs and stores water.
- ◆ Organic matter stores plant nutrients.
- ◆ Organic matter reduces erodibility.
- ◆ Organic matter acts like a blanket to slow surface water loss.
- ◆ Organic matter does not change soil texture!



Review:

- ◆ Soil texture
- ◆ Soil structure
- ◆ Pore size
- ◆ Forces acting on soil water

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