Soils and Soil Physical Properties

A. What is soil? (pg 1, text)

a) Definitions
Different concepts = Different definitions
• Plant growth
• Engineering
• Pedological (soil is a distinct entity)

b) What are the functions of soil?
i. Support growth of higher plants
ii. Primary factor controlling fate of water in hydrologic system
iii. Nature’s recycling system
iv. Habitat for organisms
v. Engineering medium

B. Soil Formation

1. Soil-forming factors
a) Parent material: E.g., rock, alluvium
b) Climate: Temperature, moisture, seasonal distribution
c) Living organisms: Plants, animals, microorganisms
d) Topography: Sloped or flat
e) Time: How long the soil has been forming?

2. Soil profiles and soil development
a) Soil horizons (see diagram- text pg 2) A,B,C
Western soils: (arid = less developed, sandier, more Ca, K, P etc.) Makes organic farming a little easier.
3. What is in soil?

a) 40–50% mineral
   i. Gravel, cobbles, stones, boulders
   ii. Sand (0.05–2.00 mm)
   iii. Silt (0.002–0.05 mm)
   iv. Clay (< 0.002 mm)

b) 0–10% biological
   i. Flora and fauna
   ii. Live and dead (organic matter)
   iii. Macroscopic and microscopic

c) ~50% pore space
   i. Air
   ii. Water

Almost everything you need to know about soil can be learned with Lego!

1. Sort your legos into 3 sizes.

   If the 3 sizes represent clay, sand and silt, which is which?

   Arrange the clay, sand and silt into random piles.

   Which pile has the biggest air spaces (pores)?
   Which pile has the most pore spaces for the same volume?
C. Soil Properties

1. Soil Texture
   a) Mineral particles are divided into 3 categories: sand silt clay.

   Mineral surfaces have important chemical and physical properties.
   *Surface area increases greatly as particle size decreases. So particles with
   the greatest surface area for a given volume are most important.

   LEGOS: Remove legos from the two biggest sized piles to make 3
   approximately equal size piles. Which pile has the most surface area?

   b) Texture triangle (text, pg 4) 12 categories
   *Physical properties of soils are determined mostly by texture: nutrient holding, water holding, compactibility, manageability

   Cabrillo farm soil: Soil test spring 2009 = 52% sand, 20% silt, 27% clay
   Soil test fall 2009 = 52% 28% 20%

   LEGOS: mix your legos up into one random pile. Using the texture triangle,
   estimate what type of ‘soil’ you have.

Compaction experiment

   LEGOS: Take a few pieces of each size lego and connect them directly on top of each other. Now, pull them apart. Which was the hardest?
   So, which particle size is most susceptible to compaction? Which size, when compacted is going to be hardest to Un-compact?

Nutrient and water retention experiment

   Divide the legos up into 3 equal sized piles by removing Legos from the two biggest sizes. If you had to paint each piece, which pile would use the most paint?

   So, which particle size holds the most water and nutrients?
2. Soil Structure

a) **What is it?**
   i. Arrangement of soil particles into aggregates (groups of particles)
   ii. Primary types (see text: figure 1.3). Go for granular!
   iii. Formed by physical forces and binding agents (organic matter)
   iv. Physically formed aggregates: weak. O.m formed = stable
   vi. Aggregated soil is ideal for plant growth: just the right porosity for air and water and roots

b) **What causes structure?**
   i. Biological factors/organic matter. Why is om so effective?
   ii. Clay (type and amount)
   iii. Calcium (positive) and sodium (negative)
   iv. Climate (wet/dry, freeze/thaw)

**LEGOS:** Get the green ‘organic matter’ legos. Use them to form aggregates with the ‘clay’, ‘silt’ and ‘sand’. Which aggregates are the most stable? Which prevent the most compaction? Are you making pores? What are these pores like compared to the ones you made without ‘organic matter’? Which type of pores would a plant root prefer?

3. Soil water

Sandy, low organic matter = well drained, low field capacity
Sandy, high organic matter = well drained, moderate field capacity
Clay, low organic matter = poorly drained, high field capacity.
Clay, high organic matter = moderately well drained, high field capacity

4. Soil temperature

- Biological activity: Soil temperature influences plant growth and microbial activity, and therefore organic matter decomposition and nitrogen availability are dependent on it.
- Conventional fertilizers can side step the temperature effects, organic fertilizers need to be managed properly or plants will be insufficiently nourished.
- Organic matter accumulation: Lower temperature, greater organic matter accumulation

iii. Weathering of parent materials: Fluctuating temperatures help break down mineral grains; warmer temperatures increase chemical weathering
5. Soil microorganisms

Bacteria, fungi, actinomycetes

Decomposition of organic materials, release of nutrients, fixation of nitrogen from the atmosphere.

Nitrogen fixation and rhizobia

Compost