Soil is the Key
(Chapter 3)

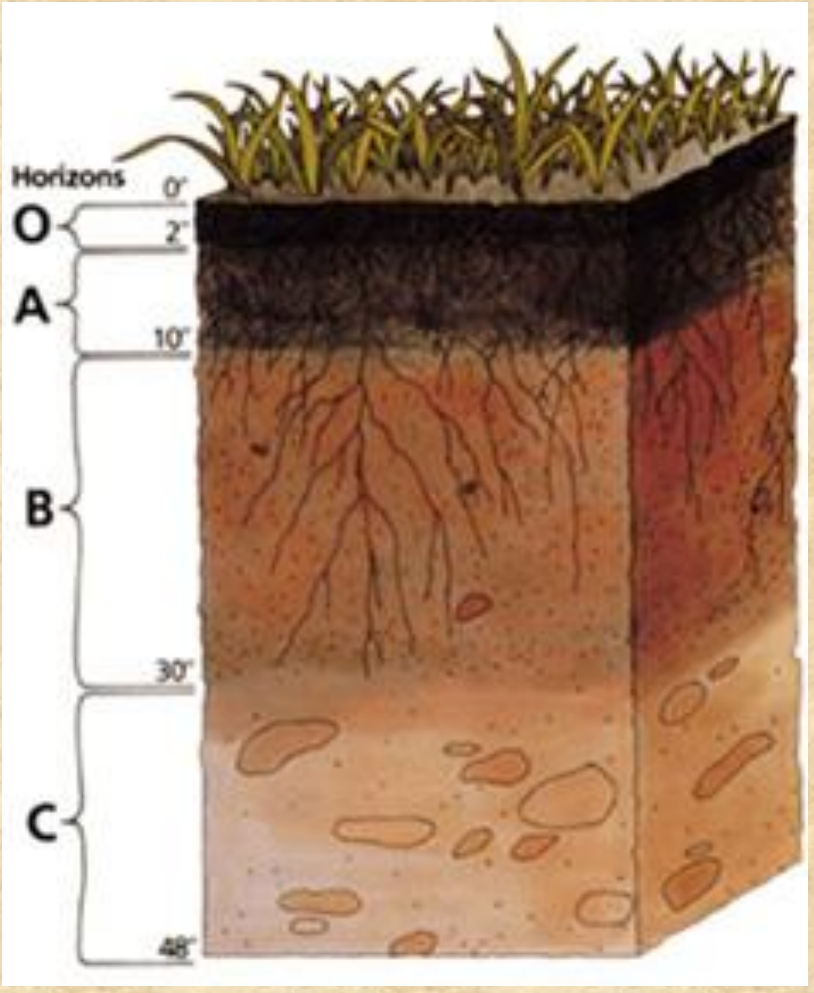
Soils 101

- Soil profile
- Soil sources, texture, chemistry, physical properties
- Soil Amendments
- Identifying your soil
- Soil Testing
- Fertilizers

Soil Profile

- Vertical distribution
  - ➢A = topsoil
  - ➢B = subsoil

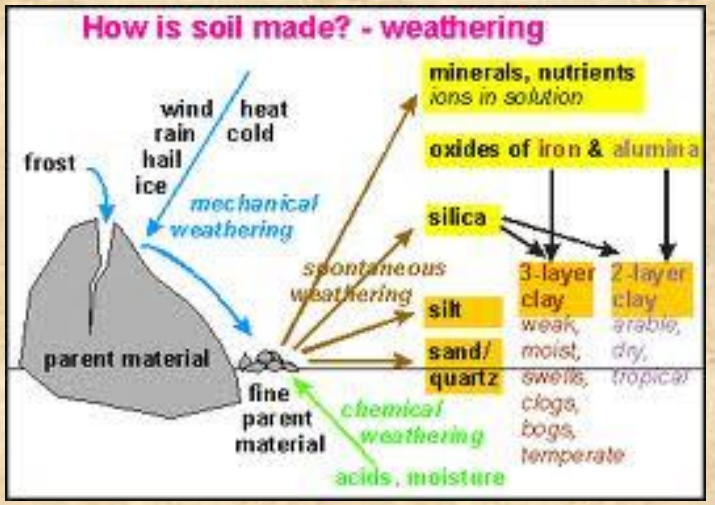
  (accumulates iron & clay)
  - ➢C = rock



Makes a difference following disturbance or construction

Soil Formation

- Created by disintegrating rocks & organic matter
- Components are minerals, organic matter, air & water
- Influenced by “parent material”
  - “weathered from metamorphic & sedimentary rock”
  - “weathered from ultrabasic & serpentinitic rock”



Soil Texture

- Particles are divided by size:

Sand > Silt > Clay

- Use flowchart for analyzing texture: “feel method”

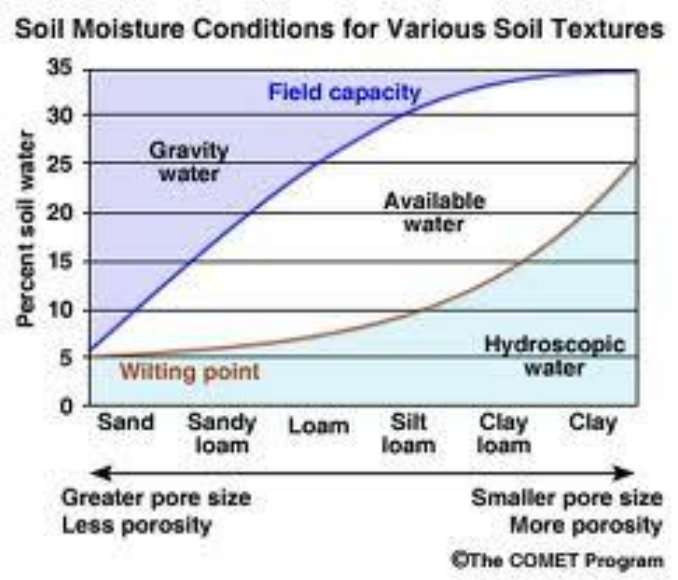
Texture is Important

- Sand
  - Warms faster in spring, drains better, good aeration
  - Low water-holding & nutrient storage
- Clay
  - Surface area million times that of coarse sand
  - Negatively charged particles that attract positive particles that are essential elements to plant
  - Has high exchange rate that makes elements available to plants
  - Has high water holding capacity, but holds water tightly
- Mix of textures = loam

Soil Porosity

- Spaces between solids
- Provides space for roots
- Convey air, water, dissolved minerals
  - Roots & soil organisms need oxygen
  - In waterlogged soils, the pores fill up with H_20
  - In compacted soils, pores are gone
    - Don't work soil when wet
    - Avoid heavy machinery
    - Add organics

Soil Water Availability



- Soil has a chemical & physical attraction to water
- Plants “pull” water away from soil
- Clay has greater water holding capacity, but holds water tighter

Organic Matter

- Decomposing OM (available to plants)
- Living Matter: Worms, bacteria, fungi, algae, etc
  - Churn soil, improve soil structure (usually)
  - Mychorrhizae
    - Association between plant roots & soil fungi
      - Roots provide carbon to fungi
      - Fungi promote better absorption of phosphorus by roots

Soil Fertility & Plant Nutrition

- Plants need 14 elements from soil
  - Primary: nitrogen (N), phosphorus(P), potassium(K)
  - Secondary: Calcium, magnesium, sulfur
  - Micro: boron, chlorine, copper, iron, manganese, molybdenum, nickel, zinc
- Most commonly needed is **Nitrogen**
- Other deficiencies are phosphorus, potassium, zinc and iron
- In excess (toxic) are boron, chlorine & sodium

Soil pH

- pH: measure of acidity or alkalinity of soil
- Ranges from 1(acid) to 14 (alkaline), 7 is neutral
- Most crops grow in a range from 5.5 to 7.5
  - Nutrients are in a form that plant roots can absorb
  - Influences toxicity

Soil Amendments

- Used to improve physical properties
  - Increase water holding capacity, decrease compaction, adjust pH, add microorganisms, decrease toxicity
  - Not necessarily the same as fertilizer
- Mixed into soil (not mulch)

Add Organic Matter!!!!

- Multiple benefits! Increases water holding, provides nutrition, lowers pH…….
- Add 2” per year, can’t add too much over long haul since it decays
- BUT – may have short term consequences and may not improve soil fertility immediately, depending on C:N ratio

Carbon:Nitrogen Ratio

- Material with high C:N ratio (sawdust, straw, leaves AKA “browns”) compete with plants for nitrogen. Browns as mulch – OK.
- Material with C:N ratio less than 20:1 (grass clippings, rotted manures) have enough nitrogen to decompose. But release N quickly.
- Best source – mix like compost

Example C:N Ratios

Grass clippings	19:1
Rotted manure	20:1
Vegetable trimmings	25:1
Oak leaves	26:1
Leaves	varies from 35:1 to 85:1
Peat moss	58:1
Corn stalks	60:1
Straw	80:1
Pine needles	60:1 to 110:1
Farm manure	90:1
Sawdust weathered 3 yrs	142:1
Newspaper	170:1
Douglas fir bark	491:1
Sawdust weathered 2 mnths	625:1

Organic Soil Amendments

- Compost – yes!
  - Contains organics, microorganisms, some nutrients
  - Doesn't add salts
- For clay soils that need structural improvement – add fibrous organics like straw or wood chips
- Worm castings (poop) – good source of water soluble nutrients, enzymes & beneficial microorganisms

Other Soil Amendments

- Manures
  - Contain more salts than plant compost
  - Sometimes contain pathogens
  - Often contain weed seeds (i.e. horse)
    - Need to compost at high temperature (135°F)
    - Use for non-food crops?
  - Vary greatly in nutrient content
    - Steer manure good for organics, not good for nutrients
  - Can be “hot” (poultry)
    - Can harm plants due to high ammonia levels
    - Use aged or composted manure

Other Soil Amendments

- Lower pH for acid-loving crops
  - Organic matter lowers pH slightly over time
  - Add sulfur to lower pH if soil is basic due to calcium salts
  - If the pH is high due to sodium salts, then you need to flush with water
- Increase pH if needed (not typical in CA)
  - Add lime (calcium carbonate) or dolomite (Ca-Mg carbonate) in fall

Other Soil Amendments

- Wood ashes make soil more basic (increase pH) and more “salty”
- Adding clay to sand makes cement (and vice versa) – make sure to add organics also
- Vermiculite (heat-expanded silica)
  - Increases pore space
  - High water holding capacity

Amending Serpentine Soils

- Are high in Magnesium, but low in Calcium
- High in heavy metals like Nickel
- Low in nutrients
- Issues with natural asbestos
- Consider raised beds for gardens

Identifying your Soil

- http://websoilsurvey.nrcs.usda.gov/

- Soil Survey of Trinity County, California, Weaverville Area
  - Includes Hayfork, Douglas City, Lewiston, Junction City (not northern Trinity)

- Call Natural Resources Conservation Service in Weaverville (623-3991)

Soil Testing

- DIY test kits for rough values (pH, N, P, K)
  - Use fresh reagents
- Send soil samples to lab for N, P, K or micronutrients
  - See list of soil labs
  - lab readings for tests for zinc, manganese, iron, copper and boron in addition to organic matter, estimated nitrogen release & nitrate nitrogen, phosphorus (weak bray & sodium bicarbonate P), extractable cations (potassium, magnesium, calcium, sodium), hydrogen, sulfate sulfur, pH & cation exchange capacity and percent cation saturation and excess lime.
  - Need information on interpreting results
- Composite of ~10 samples
  - https://www.youtube.com/watch?v=U1C_AAEf3lE
  - Use stainless, wooden or hard plastic trowel
  - Dry & mix

Soil Test Report

A & L WESTERN AGRICULTURAL LABORATORIES

1311 WOODLAND AVE #1 • MODESTO, CALIFORNIA 95351 • (209) 529-4080 • FAX (209) 529-4736

REPORT NUMBER: 00-336-047

CLIENT NO: 9999-D

SEND TO: A & L WESTERN AGRICULTURAL LABS
1311 WOODLAND AVE.
MODESTO, CA 95351-

SUBMITTED BY:

GROWER: EXAMPLE REPORT

DATE OF REPORT: 04/30/04

SOIL ANALYSIS REPORT

SAMPLE ID	LAB NUMBER	Organic Matter		Phosphorus		Potassium	Magnesium	Calcium	Sodium	pH		Hydrogen	Cation Exchange Capacity	PERCENT CATION SATURATION (COMPUTED)				
		*	**	P1 (Weak Bray) ****	$NaHCO_3$-P (Olsen Method) ****	K *****	Mg ***	Ca ***	Na ***	Soil	Buffer	H	C.E.C.	K	Mg	Ca	H	Na
		% Rating	ENR lbs/A	ppm	ppm	ppm	ppm	ppm	ppm	pH	Index	meq/100g	meq/100g	%	%	%	%	%
130-1	55931	4.0H	110	23M	14**	110L	460M	992VL	104L	4.7	6.2	9.7	19.1	1.5	19.8	25.9	50.5	2.4
130-2	55932	1.5L	60	27H	6**	41VL	569M	1154VL	185M	4.6	5.9	13.3	24.7	0.4	19.0	23.3	54.0	3.3
12-1	55933	3.5M	100	12L	11**	64L	471VH	841VL	87L	5.2	6.5	4.5	13.1	1.2	29.5	31.9	34.5	2.9
12-2	55934	2.8M	86	8VL	9**	29L	553VH	665VL	89M	5.3	6.6	3.7	12.1	0.6	37.7	27.5	31.0	3.2

** NaHCO3-P unreliable at this soil pH

SAMPLE NUMBER	Nitrogen NO_3-N	Sulfur SO_4-S	Zinc Zn	Manganese Mn	Iron Fe	Copper Cu	Boron B	Excess Lime	Soluble Salts	Chloride Cl		PARTICLE SIZE ANALYSIS			
	ppm	ppm	ppm	ppm	ppm	ppm	ppm	Rating	mmhos/cm	ppm		SAND %	SILT %	CLAY %	SOIL TEXTURE
130-1	5L	5L	0.3VL	3M	53VH	0.2VL	0.1VL	L	0.3L			44	25	31	CLAY LOAM
130-2	3VL	41VH	0.1VL	1VL	14M	0.2VL	0.1VL	L	0.6L			60	16	25	SANDY CLAY LOAM
12-1	2VL	5L	0.1VL	2L	50VH	0.1VL	0.3VL	L	0.2VL			42	36	23	LOAM
12-2	2VL	4L	0.1VL	1VL	53VH	0.1VL	0.2VL	L	0.1VL			40	35	25	LOAM

* CODE TO RATING: VERY LOW (VL), LOW (L), MEDIUM (M), HIGH (H), AND VERY HIGH (VH).
** ENR - ESTIMATED NITROGEN RELEASE
*** MULTIPLY THE RESULTS IN ppm BY 2 TO CONVERT TO LBS. PER ACRE OF THE ELEMENTAL FORM
**** MULTIPLY THE RESULTS IN ppm BY 4.6 TO CONVERT TO LBS. PER ACRE P_2O_5
***** MULTIPLY THE RESULTS IN ppm BY 2.4 TO CONVERT TO LBS. PER ACRE K_2O
MOST SOILS WEIGH TWO (2) MILLION POUNDS (DRY WEIGHT) FOR AN ACRE OF SOIL 6-2/3 INCHES DEEP

This report applies only to the sample(s) tested. Samples are retained a maximum of thirty days after testing.

Mike Buttress, CPAg
A & L WESTERN LABORATORIES, INC.

Fertilizers

- “Complete” contains N, P, K (vs incomplete)
- Percentage stated on bag, i.e. 8-2-6
- Inorganic source
  - Usually fast-acting, cheaper, leachable
  - Can be slow-release (coated)
- Organic source
  - Manures, bone meal, cottonseed, fish emulsion, bat guano, blood meal, etc
  - More expensive/lb nutrients, but have other benefits
- All the same to the plant, as a nutrient!

Fertilizer application

- To soil surface, subsurface, foliage & water
- Use soil test, plant need, or symptoms of nutrient deficiency to determine rate of fertilizer application
- Broadcast vs
  Banding vs
  Sidedressing

Questions?