

Soil Salinity

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PLANTS, SOILS & CLIMATE

What is "Soil Health"

- Soil "health" and "quality" often used interchangeably.

"The continued capacity of soil to function as a vital living ecosystem that sustains plants, animals, and humans." (NRCS Soil Health Website)

Things that Diminish Soil Health

- Erosion (physical change)
- Loss of organic matter (biological and chemical changes)
- Adverse soil chemistry conditions
 - Soil salinity and/or sodicity buildup (chemical and physical)
 - Crop protection chemical residues (chemical and biological)
- Soil structure breakdown (physical changes)

Soil structure

- The combination of sand, silt and clay (with organic matter) into secondary particles called *aggregates*



Soil salinity = soluble mineral content in soil

- Salts (dissolved minerals) can inhibit plant growth
- Excess salts cause "chemical drought" - equivalent to induced water stress (some specific ion toxicity with Na and Cl in high concentration, but a special case)
- Visual diagnosis (secondary): salt crusting/salt burn
- Soil test diagnosis (primary):
 - Electrical conductivity (EC) is the surrogate measure of soil salinity (more salt = higher conductivity)
 - EC > 2 deciSiemens/meter is a saline soil for horticultural crops (fruits, veggies, etc.)
 - EC > 4 deciSiemens/meter is saline for ag

Visual Examples – secondary symptom

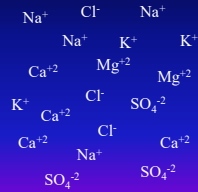


Long before visual symptoms are evident, salts can be reducing plant growth

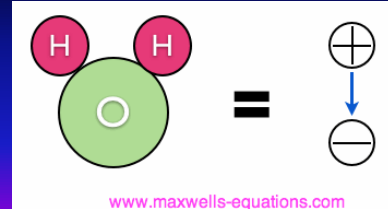
Chemical Drought

Salts:

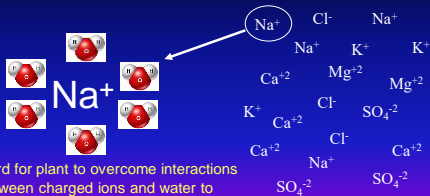
CaSO₄ (gypsum)
Na₂SO₄ (glauber's)
MgSO₄ (epsom)
NaCl (table salt)
KCl (Muriate of Potash)
CaCl₂
MgCl₂



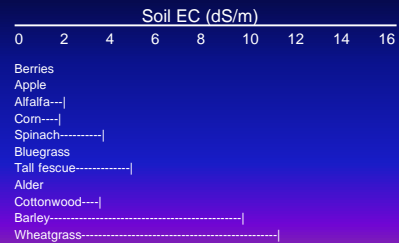
Dipolar Character of Water



Chemical Drought



Salinity and plant adaptation



Sources of salts

- Irrigation waters
 - All water contains some dissolved minerals – solutes left behind after ET removes water (higher evaporative demand than precipitation)
 - Well water in contact with saline deposits and/or leach water from saline soils above
- Over-application of fertilizers and/or manures and composts
 - Fertilizers are mineral salts of the nutrient elements (AmSulfate, MAP, KCl, etc.)
 - Manures and composts contain dissolved minerals and urea
 - Used in excess, residual adds to salinity

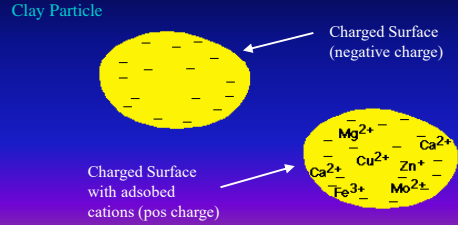
Solutions to salt problems

- Control the source
 - History, water, fertilizer, manure runoff, other?
- Select salt tolerant crops or varieties
 - Salt prone areas
 - Salt prone landscapes
- Clean up the problem
 - Remove salts by leaching with water (cannot sequester or neutralize salts, they must be physically removed)

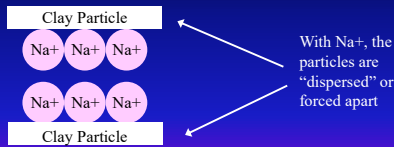
Reclamation: Leaching salts with water

- Ensure that soil has good internal drainage. Water must move through the soil to carry salts out
 - Add organic matter
 - Deep tillage/ripping
- Apply water over 1-2 days
 - 6 inches of water to cut EC by 50%
 - 12 inches of water to cut EC by 80%
 - 24 inches of water to cut EC by 90%
- Only effective if water table below 6 to 8 feet or artificial drainage collection is provided (otherwise capillarity will draw salt back up into the surface soil).

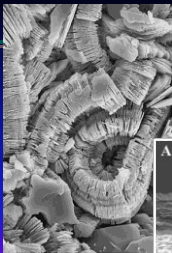
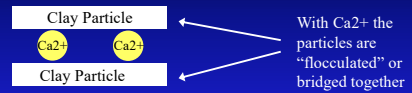
Reclamation: High soil sodium content soil



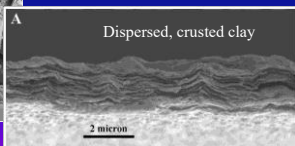
Sodium vs Calcium Adsorption



Sodium vs Calcium Adsorption



Flocculated, aggregated clay

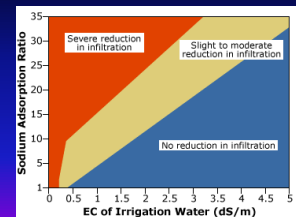


Dispersed, crusted clay

Salinity Classifications

- Saline = > 4 dS/m
- Sodic = $> 15\%$ ESP (or $> SAR$ 13 of soil extract)
- Saline-Sodic = Both conditions apply

Note the interplay \rightarrow



Reclamation: High soil sodium content soil

- Step 1: Provide soil with a flocculent (typically soluble Calcium) and promote aggregation
 - Gypsum addition (Calcium sulfate)
 - In high lime (Calcium Carbonate) soils, acid is added to dissolve lime and free the Ca (temporary effect in alkaline soils due to pH buffering/acid neutralization)
 - Other soluble sources of Ca (Ca-Nitrate, etc.)
 - Organic Matter (promotes soil aggregate formation)

Reclamation: High soil sodium content soil

- Step 2: Allow soil exchange between Na and Ca
 - Sped up by incorporation of Ca source, finer particles, etc.
 - Plenty of soil moisture to allow some diffusion of Ca and Na between the exchange surfaces
- Step 3: Leach with water to remove excess Na and Ca
 - Na needs to be removed to reduce dispersion
 - Excess Ca and Na removed to reduce overall salinity

Further Reading and Learning

USU Extension Publications:

- Solutions to Soil Problems I. High Salinity
- Salinity and Plant Salt Tolerance
- Soil Salinity and Ornamental Plant Selection
- Water Salinity and Crop Yield (newer version in preparation)
- "In the Garden" Series (each crop...in the garden)

QUESTIONS?

