**SOIL 4234 Laboratory #8**

**Saline and Sodic Soils (20 points)**

Student

Lab

TA

**Objectives**

1. Understand and interpret laboratory derived EC, SAR, and ESP values.
2. Identify procedures and strategies for reclaiming saline and/or sodic soils.

**Introduction**

**SALINE SOILS**

Major characteristic: contain high enough concentrations of soluble salts to interfere with plant growth and development.

Chemistry: Ions in soluble salts are weakly bound and strongly attracted to water.

Accumulation of soluble salts in soil decreases water availability to plants. Common salts present: NaCl, Na2SO4, Na2CO3, NaHCO3, MgSO4, CaSO4, CaCO3.

Properties:

* remain moist longer
* occupy poorly drained areas
* have a white surface layer of salt after drying
* occur in semi-arid, temperate regions with rainfall adequate to support chemical weathering, but not sufficient to leach the soluble salts out of the root zone.

Measurement of soluble salts content: Ions derived from the soluble salts present in the soil allow electricity to pass through (the more ions the greater the EC).

Thus: Soluble salt content is measured by

* saturation of soil sample with water
* extract the water and the dissolved salts
* measure the ability to conduct electricity.

Salinity: accumulation of free salts to such an extent that it leads to degradation of soils and vegetation. Sodium Absorption Ratio (SAR): SAR of 13 from a saturated soil extract is comparable to 15% of the adsorption sites being occupied by Na+.

Saline soil: EC>4000 micromhos/cm (µmhos/cm) also written as 4 mmhos/cm or 4 dS/m, SAR<13 (The U.S. Salinity Laboratory).

Soils classified saline: extract of saturated paste has an EC≥4,000 micromhos/cm (µmhos/cm).

At this EC value, soil contains approximately 2600ppm soluble salts.

\*\*\*Note\*\*\*:

1 micromhos/cm (µmhos/cm) = 1 microsiemen/cm (µS/cm)

Both mhos and siemens are a measure of electrical conductance. Siemens per meter (S/m) is the SI unit of conductivity. Conventionally, conductance is reported as decisiemens per meter (dS/m) which can be calculated as (µS/cm)/1000.

Reclamation:

* leaching of soluble salts out of the soil by using good quality irrigation water
* create good drainage (both surface and internal)
* incorporation of organic matter
* avoid deep tillage
* plant salt tolerant species (bermudagrass, barley).

**SODIC SOILS**

Major characteristic: contain abnormally high levels of exchangeable sodium (Na+).

Chemistry: Na+ is absorbed on cation exchange sites of clay and humus. Na+ attracts water; large shell of water around Na+ prevents it from neutralizing the negative charges of clay and humus. Absorbtion of large quantities of Na+ cause clay particles to repel each other (disperse). Clay and humus particles form a suspension, when dispersed.

Sodicity: a measure of exchangeable Na+ in relation to other exchangeable cations; expressed as the Exchangeable Sodium Percentage. ESP is calculated as the proportion of the cation exchange capacity occupied by the sodium ions and is expressed as a percentage. Sodicity index: 0-5 = non-sodic, 5-15 = sodic, >15 = strongly sodic. Sodic soil: SAR >13; EC>4000 micromhos/cm (µmhos/cm) (The U.S. Salinity Laboratory)

Soils classified sodic: contain more than 15% of exchangeable Na+.

Properties:

* have poor internal drainage
* moist/wet surface soil and dry subsoil
* weak structural stability

Effect on plant growth:

* toxicity to sodium-sensitive plants
* nutrient deficiencies or imbalances
* high pH
* low nutrient/water availability due to poor soil physical quality

Reclamation:

* same as reclamation of saline soils discussed above, plus:
* addition of calcium-based soil amendments (gypsum, calcium chloride)

**SALINE and SODIC SOILS**

Soils can be naturally saline and/or sodic due to:

* high salt concentration in the parent material
* marine deposits
* inadequate drainage

Agricultural practices:

* dryland: deforestation/loss of native vegetation causes water table to raise (dissolved salts are carried from the bedrock to the soil surface)
* irrigation: excessive irrigation, bad irrigation water quality (due to salts present in irrigation water + evaporation)

“Double Trouble”:

* contain high enough concentrations of soluble salts to interfere with plant growth and development
* contain abnormally high levels of exchangeable sodium (Na+)

Reclamation:

* takes several years
* requires 2 or more pore volumes of good quality irrigation water.

**1mmhos/cm = 1mS/cm  
1S=10dS=1000mS=1,000,000µS**

**Laboratory Procedures:**

**Electrical Conductivity (EC) of a Saturated Paste**

1. Weigh out approximately 200 g of soil into glass jar.

2. Slowly added deionized water to the soil, mixing the soil:water slurry as you add the water.

3. Add water until the sample appears saturated. The sample should glisten and not collapse in on itself as you move the stir-rod across the sample. If water pools in the soil:water slurry then you have added too much water. To correct this, add a small amount of soil back to the sample and re-mix.

4. Place a piece of Whatman #42 filter paper on the Buchner funnel. Wet the filter paper with deionized water and turn the vacuum on. This will set your filter paper on the funnel.

5. Discard the filtrate from the flask and reconnect the funnel to the flask.

6. Carefully add the soil slurry to the funnel as the vacuum is on. Try to avoid pouring the soil near the edges of the funnel.

7. Collect the filtrate until adequate sample has been collected. If any soil is in the filtrate, the sample will need to be re-filtered.

8. Measure and record on your data sheet the electrical conductivity using the EC meter.

**Determination of exchangeable sodium percentage (ESP)**

1. Place 2.0 g of the air-dried soil provided into a 250 ml Erlenmeyer flasks (record weight to the nearest 0.01 g).

2. Add 20 ml of ammonium acetate (NH4OAc) extracting solution to each flask and shake.

3. Decant the liquid portion through a Whatman #42 filter, saving the filtrate in a clean

250 ml beaker. **Be careful not to get too much soil onto your filter paper as this**

**will greatly slow the rate of filtration (**refilter if extracts not clear). 4

4. Concentrations of K, Ca, Mg, and extractable acidity will be given to you. You will be given an absorbance standard curve and an absorbance value for your soil sample for analysis of Na and asked to determine the concentration of Na on the soil exchange site.

**Equations needed for determination of exchangeable sodium percentage and sodium adsorption ratio.**

1. μg cation/ kg of soil



1. 

3)

4)

**Data Sheet (10 points)**

Electrical Conductivity

Wt. of sample (g) \_\_\_\_\_\_200\_\_\_\_

Electrical Conductivity (micromhos/cm) \_\_\_\_713\_\_\_\_\_\_

Exchangeable Na

Wt. of sample (g) 2.01

Absorbance of Na from AA/ICP (abs.) 0.0244

Concentration of Na extract from standard curve (μg/ml) \_\_\_\_\_\_\_\_\_\_

Exchangeable Na (cmoles(c) /kg of soil) \_\_\_\_\_\_\_\_\_\_

Exchangeable K (cmoles(c) /kg of soil) 0.0327

Exchangeable Ca (cmoles(c) /kg of soil) 0.0500

Exchangeable Mg (cmoles(c) /kg of soil) 0.0704

Exchangeable Basic cations: (cmoles(c) /kg soil) \_\_\_\_\_\_\_\_\_\_

Exchangeable Acidity (cmoles(c) /kg of soil) 0.0101

Cation Exchange Capacity (cmoles(c) /kg of soil) \_\_\_\_\_\_\_\_\_\_

Exchangeable Sodium Percentage (percent) \_\_\_\_\_\_\_\_\_\_

**SHOW CALCULATIONS TO RECEIVE FULL CREDIT!REPORT** (20 pts total)

**Data** (10 pts)

Please include Page 6 with all raw data and calculations.

***Show all calculations to receive full credit!***

**Questions**

1. (3 point) Based upon your electrical conductivity and calculated exchangeable sodium percentage, would your soil classify as a saline soil, sodic soil, or saline/sodic soil?

(Use Fig. 1 from PS-2226 fact sheet).

2. (3 point) Assume the texture used in our experiment is a medium textured soil. Based upon your calculated exchangeable sodium percentage values, how many tons per acre of gypsum would you add to remediate the soil?

(Use Table 1 from PS-2226 fact sheet).

3. (3 points) Describe the naturally occurring landscape (topography) and surface drainage conditions that may lead to the formation of a saline seep.

4. (1 point) Suppose I have the following AA test results from a saturated soil paste extract. Using equation #4 from page 10, what is the sodium adsorption ratio of the sample and would you suspect there to be any agronomic production problems? Show Work!!!

|  |  |
| --- | --- |
| Element | Conc. (meq/L) |
| Na+ | 90 |
| Ca+2 | 155 |
| Mg+2 | 70 |