4.6 Electrical Conductivity and Soluble Salts

4.6.5 1:5 Aqueous Mixture by Volume for Subaqueous Soils ($EC_{1:5vol}$)

4.6.5.1 Electrical Conductivity Meter, Pocket-Type or Hand-held

4.6.5.1.1 Electrical Conductivity

Application

Electrical conductivity (EC) measurements are quick, simple determinations for water-soluble salts in soils. For subaqueous soils, EC must be measured in a fresh, field wet sample (moisture content at sample collection) that has been refrigerated or even frozen because sulfides may oxidize during drying forming, sulfate salts, which increase the EC value. The recommended EC method for subaqueous soils uses a soil:water ratio (volume) of 1:5 ($EC_{1:5vol}$), and EC is measured in the supernatant not the extract (Soil Survey Staff, 2010). A hand-held conductivity meter is commonly used to measure the $EC_{1:5vol}$ for subaqueous soil samples. This method assumes that the salts in subaqueous soils are highly soluble chloride and sulfate salts, in a dissolved state, with no important contributions from minerals, such as gypsum. Soil $EC_{1:5vol}$ is used in the *Keys to Soil Taxonomy* (Soil Survey Staff, 2010) at the great group level to distinguish freshwater subaqueous soils (Frasiwassents and Frasiwassists) from saltwater and brackish water subaqueous soils (Balduff, 2007; Payne, 2007). Salinity values for subaqueous soil interpretations are based on the pore water salinity, as this is what a plant root or aquatic organism sees or endures *in situ*.

Summary of Method

The volume of a fresh moist soil sample or one stored in the refrigerator is measured. The other sample is mixed with 5 parts distilled water. The mixture is briefly stirred and left to equilibrate. $EC_{1:5vol}$ is determined for unfiltered supernatant and reported as dS m^{-1}. *Optionally*, another fresh moist sample is extracted using a vacuum pump. Electrical conductivity is determined for the extract and reported as dS m^{-1}.

Interferences

Electrical conductivity increases at approximately 1.9% per degree centigrade increase in temperature (Rhoades et al., 1999). EC needs to be expressed at a reference temperature for purposes of comparison and accurate salinity interpretations. The commonly used reference temperature is 25 °C. The best way to correct for the temperature effect on conductivity is to maintain the temperature of the sample and cell at 25° ± 0.5 °C while EC is being measured. Alternatively, many EC conductivity meters correct to 25 °C.

Provide airtight storage of KCl calibration solutions. Exposure to air can cause gains and losses of water and dissolved gases. These gains or losses significantly affect EC readings. Store calibration solutions in a dry, dark, and cool room.

Soil samples from salt or brackish water may contain sulfides. If testing cannot be performed for several days, the sulfides may oxidize to form sulfates unless the sample is kept moist and refrigerated, or even frozen. $EC_{1:5vol}$ is not directly comparable to EC determined by saturated paste or any other $EC_{1:5vol}$ measurement. At this time $EC_{1:5vol}$ is used only for subaqueous soils.

Safety

Use protective gloves and eye protection when handling reagents. Avoid contact with eyes and skin. Refer to the Material Safety Data Sheets (MSDS) for information on the chemical makeup, use, storage, emergency procedures, and potential health effects of the hazardous materials associated with this method.

Equipment

1. Beakers, polypropylene, 100-ml
2. Stirring stick
3. Cylinder, polypropylene, 25-mL
4. EC meter, pocket-type or hand-held
5. *Optional Equipment* (if pore water salinity is determined) as follows:

5.1 Vacuum pump, with tubing (HACH, 1992)
5.2 Buchner funnel, 56 mm
5.3 Receiving tube, with 5-mL mark
5.4 Filter flask, 125 mL
5.5 Filter papers
5.6 Spatula

Reagents

1. Distilled water
2. Potassium chloride (KCl), 0.010 *N*. Dry KCl overnight in oven (110°C). Dissolve 0.7456 g of KCl in distilled water and bring to 1-L volume. Conductivity at 25 °C is 1.4 dS m^{-1}. *Alternatively*, KCl calibration solutions that are commercially prepared (e.g., 20-ml calibration solution packets).
3. Material Safety Data Sheets (MSDS)

Procedure

1. Calibrate EC meter using calibration solution.
2. Measure 10 mL of moist sample into a 100-mL beaker. Samples should be refrigerated before testing if collected a day or two prior to testing. They should be frozen if stored longer.
3. Measure 50 mL distilled water (5 times the volume of soil) into a second 100-ml beaker.
4. Pour the 50 mL distilled water into the beaker containing 10 mL of soil and briefly stir for 10 s.
5. Allow the mixture to settle. Coarse textured samples will settle in as little as 15 min. Fine-textured samples and those high in organic matter may require overnight settling and should be refrigerated in these cases.
5. Immerse tip of calibrated hand-held EC meter into mixture, being careful not to stick the electrode into the soil phase of the mixture.
6. Allow readings to stabilize. Read and record $EC_{1:5vol}$ of the unfiltered supernatant.
7. *Optionally*, determine pore water salinity as follows:
   7.1 Fill 100-mL plastic beaker approximately to 50-mL mark with soil.
   7.2 Connect Buchner funnel to receiving tube in beaker using the adapter.
   7.3 Moisten clean filter with water and place paper into Buchner funnel.
   7.4 Transfer moist sample into Buchner funnel. Carefully smooth sample over filter paper with spatula. Sample should cover bottom of Buchner funnel completely to a depth of about 1/2 in (≈1.3 cm). Do not allow sample dry out.
   7.5 Connect vacuum pump to flask and pump to create vacuum in filter flask. Typically, about 10 pumps are sufficient to create vacuum. Pump frequently to maximize infiltration rate.
   7.6 Depending on soil type, drops of extract begin to collect in receiving tube. Obtain enough extract to determine the test. Filtering time can be reduced by increasing the moist sample amount in funnel.
   7.7 Disconnect apparatus and transfer contents in the receiving tube into another beaker. Read and record EC. Dilution of extract may be necessary.

Calculations

None.

Report

Report the $EC_{1:5vol}$ to the nearest 0.1 dS m^{-1} (USDA-NRCS, 2011). Optionally, report EC for pore water to the nearest 0.1 dS m^{-1}.

References

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