ARIZ 729b
March 31, 2010
(4 Pages)

EXCHANGEABLE SODIUM IN TOPSOIL

(An Arizona Method)

1. SCOPE

(a) This test method is used to compare or qualify topsoil for cultivation of plants insofar as the proportion of exchangeable sodium among the four major cations (Sodium, Potassium, Calcium, and Magnesium) is related to plant welfare. "Exchangeable" is defined by the method itself and is based on the exchange of ammonium ion from the reagent Ammonium Acetate Solution with the four major cations under the conditions given by the method. The four cations are brought into solution by the reagent and their concentrations in solution are determined by Atomic Absorption or Flame Emission Spectrophotometry.

(b) This test method may involve hazardous material, operations, or equipment. This test method does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to consult and establish appropriate safety and health practices and determine the applicability of any regulatory limitations prior to use.

(c) See Appendix A1 of the Materials Testing Manual for information regarding the procedure to be used for rounding numbers to the required degree of accuracy.

2. APPARATUS

(a) Requirements for the frequency of equipment calibration and verification are found in Appendix A3 of the Materials Testing Manual. Apparatus for this test procedure shall consist of the following:

(1) No. 12 sieve.

(2) A balance or scale capable of measuring the maximum weight to be determined and conforming to the requirements of AASHTO M 231, except the readability and sensitivity of any balance or scale utilized shall be at least 0.01 gram.

(3) Plastic vials, 1-1/4 inches in diameter and 4 inches in length, with caps.

(4) Reciprocating shaker capable of 180 cycles per minute, with carrier for holding vials in place.

(5) Sodium-free quantitative filter paper, 11 cm diameter.

(6) Atomic Absorption or Flame Emission Spectrophotometer capable of determining Sodium, Potassium, Calcium, and Magnesium.

3. REAGENTS

(a) Ammonium Acetate Solution, 1 Normal. (Measure 57 mL reagent glacial acetic acid into a 1 liter volumetric flask and dilute to 500 mL with deionized water. Add 69 mL reagent concentrated ammonium hydroxide. Dilute to approximately 950 mL with deionized water and mix. Adjust pH to 7.0 using glacial acetic acid or ammonium hydroxide dropwise as necessary. Dilute to the mark with deionized water.)

(b) Sodium Stock Solution, 1000 mg/liter. (Available as calibrated standard solution from chemical suppliers).

(c) Potassium Stock Solution, 1000 mg/liter. (Available as calibrated standard solution from chemical suppliers).

(d) Calcium Stock Solution, 1000 mg/liter. (Available as calibrated standard solution from chemical suppliers).

(e) Magnesium Stock Solution, 1000 mg/liter. (Available as calibrated standard solution from chemical suppliers).

(f) Hydrochloric Acid Solution, 50%. (Dilute concentrated reagent grade hydrochloric acid 1:1 with deionized water.)

(g) Lanthanum Chloride Reagent Solution, 0.26%. (Weigh 1.30 grams anhydrous reagent grade lanthanum chloride into a 500 mL volumetric flask. Dilute to the mark with deionized water.)

4. PROCEDURE

(a) Weigh 2.00 grams of soil, passing a No. 12 sieve into a plastic vial.

(b) Pipette 40.0 mL Ammonium Acetate Solution into the vial, and cap it.

(c) Place vial into carrier of reciprocating shaker. Shake at 180 cycles per minute for exactly 5 minutes.

(d) Immediately filter into a clean vial. (The folded filter paper can be placed onto the rim of the vial instead of using a funnel.) Cap the vial. This is the Original Extract Solution.

(e) Prepare a diluted solution by transferring a suitable aliquot from the Original Extract Solution to a volumetric flask, adding hydrochloric acid to 1% and lanthanum chloride to 26 mg/liter. (If a 50 mL flask is used, 1.0 mL of Hydrochloric Acid Solution and 0.5 mL of Lanthanum Chloride Reagent Solution is required.) The dilution is made with deionized water. This is the Diluted Extract Solution. The dilution should be sufficient to bring the absorbances of the four elements to values below those of the Standard Solution.

(f) Prepare a solution with concentrations of 1.00 mg/liter of sodium, 2.00 mg/liter of potassium, 5.00 mg/liter of calcium, and 0.50 mg/liter of magnesium. This solution should have 1% strength hydrochloric acid and 26 mg/liter lanthanum chloride. The dilution is made with deionized water. This is the Standard Solution.

(g) Prepare a solution with 1% Hydrochloric Acid and 26 mg/liter Lanthanum Chloride in deionized water. This is the Reagent Blank Solution.

(h) Perform an Atomic Absorption or Flame Emission Spectrophotometric analysis using the Diluted Extract Solution, the Standard Solution, and the Reagent Blank Solution. (The instrumental parameters, given in the table below are recommended for the analysis.) Determine the concentration of each of the four cations in the Original Extract Solution to the nearest 0.1 mg/liter. If the concentration of any element in the Diluted Extract Solution is higher than that in the Standard Solution, a more dilute Diluted Extract Solution should be prepared as in paragraph 4(e).

ELEMENT	WAVELENGTH	FLAME
Sodium	589.2	Air-Acetylene
Potassium	766.5	Air-Acetylene
Calcium	422.7	Air-Acetylene
Magnesium	285.2	Air-Acetylene

5. CALCULATIONS

(a) Calculate the concentration of exchangeable cations in milliequivalents per 100 grams (meq /100 g) of soil using the following formulas:

$$C'_{Na}\ (\text{in meq/100 g}) = (0.087)\ x\ (C_{Na})$$

$$C'_{K}\ (\text{in meq/100 g}) = (0.051)\ x\ (C_{K})$$

$$C'_{Ca}\ (\text{in meq/100 g}) = (0.100)\ x\ (C_{Ca})$$

$$C'_{Mg}\ (\text{in meq/100 g}) = (0.165)\ x\ (C_{Mg})$$

Where: C_{Na}, C_K, C_{Ca}, or C_{Mg} is the concentration of each cation, in mg/liter, respectively in the Original Extract Solution.

(b) Compute the total Cation Exchange Capacity (CEC) of the soil, which is the sum of the four exchangeable cation concentrations, as follows:

$$CEC\ (\text{in meq/100 g}) = C'_{Na} + C'_{K} + C'_{Ca} + C'_{Mg}$$

(c) Compute the Exchangeable Sodium Percentage (ESP), which is the exchangeable sodium proportion of the total Cation Exchange Capacity, as follows:

$$ESP = \frac{C'_{Na}}{CEC}\ x\ 100$$

(d) Compute the Exchangeable Sodium (ES) in the soil, in parts per million, using the following formula:

$$ES\ (\text{in ppm}) = (20)\ x\ (C_{Na})$$

6. REPORT

(a) Report Exchangeable Sodium Percentage (ESP) to the nearest 0.1 percent.

(b) Report Exchangeable Sodium (ES) to the nearest 1.0 ppm.