# APPENDIX D-18
# CEC Method 9-3.1/9.4.2

**Exchangeable Cation Determination with Total Cation Exchange Capacity**

**Method ASA 9-3.1/9-4.2**

Summary of Method

A soil is extracted with 1 *N* Ammonium Acetate to replace and release exchangeable cations which are then determined by metals analysis. A second extraction with 10% potassium chloride replaces and releases the ammonium ion. Ammonium ion concentration is determined colorimetrically and is equal to the Cation Exchange Capacity (CEC).

Reagents

1. 1*N* Ammonium Acetate - Dilute 1035 ml of glacial acetic acid to 14 liters with water. Add 1200 ml concentration ammonium hydroxide. Dilute to 18 liters with deionized water. Adjust to pH 7.0 with acetic acid or ammonium hydroxide. Smaller volumes may be prepared in the same ratios.

1.1 Ammonium Hydroxide - Concentrated, reagent grade

1.2 Acetic Acid - Glacial, reagent grade

2. 95% Ethanol - reagent grade

3. 10% KCl - Add 100g of potassium chloride to 900 ml water. Adjust to pH 2.5 with hydrochloric acid. Dilute to 1 liter with deionized water.

Procedure

ASA 9-3.1 - Exchangeable Cations - Ammonium Acetate Method

1. Sieve an air-dried soil sample through a 2 mm sieve (9 mesh).

2. Weigh 20 g of soil ( < 2 mm fraction) into an extraction flask. Weigh the soil to 0.0001 g on an analytical balance. Record the weight.

3. Add 50 ml 1*N* ammonium acetate.

4. Shake for 30 minutes and allow to stand at least 6 hours, preferably overnight.

5. Swirl sample. Transfer the entire sample to a Buchner funnel fitted with Whatman #42 filter paper (or equivalent).

6. Filter, then leach the soil with 200 ml of additional ammonium acetate in four increments of 50 ml each.

   Note: Do not allow the soil to dry or crack.

7. Transfer the leachate to a 250 ml volumetric flask and make to volume. Keep the soil in the funnel to determine CEC in step 9.

8. Submit the leachate for metals analysis (Na, K, Ca, Fe, etc.) for exchangeable cations by means of atomic absorption or inductively coupled plasma.

ASA 9.4.2 Cation Exchange Capacity - Potassium Chloride Method

9. Wash the soil with 200 ml of 95% ethanol in four 50 ml increments.

   Note: Do not allow soil to dry or crack.

10. Using a clean suction flask, leach soil with 200 ml of 10% KCl in four 50 ml increments.

11. Transfer the leachate to a 250 ml volumetric flask and make to volume with 10% KCl.

12. Submit the leachate for ammonium analysis using a flow injection analyzer or other autoanalyzer.

13. Report results of CEC and exchangeable cations in centimole per kilogram.

$$\text{Capacity (centimoles/kg)} = \frac{X \text{ mg/L} * 0.25 * 100}{MW * WT}$$

Where X is the liquid concentration of the analyte in mg/L, WT is the weight of soil in grams and MW is the molecular weight.

Or

$$\text{Capacity (centimoles/kg)} = \frac{Y \text{ mg/kg}}{MW * 10}$$

Where Y is the concentration of the analyte in soil in mg/kg.

| Analyte | MW | Factor |
|---|---|---|
| Na | 22.99 | 1 |
| Ca | 40.08 | 2 |
| K | 39.10 | 1 |
| Mg | 24.31 | 2 |
| Al | 26.98 | 3 |
| Ammonia N | 14.01 | 1 |

Note: Some researchers request the capacity in centiequivalents/kg. In that case, multiply by the factor in the table above.

References

"Replacement of Exchangeable Cations, Ammonium Acetate Method" Section 9-3.1 in *Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties*, Second Edition, A. L. Page Editor, American Society of Agronomy, Inc. 1982

"Exchangeable Acidity, Potassium Chloride Method," Section 9-4.2 in *Methods of Soil Analysis, Part 2, Chemical and Microbiological Properties*, Second Edition, A. L. Page Editor, American Society of Agronomy, Inc. 1982