Practical work n°4 :

Carbonates and Bicarbonates in Soil

1. Introduction

Carbonates (CO_3^{2-}) and bicarbonates (HCO_3^-) are important components of soil. Their concentrations influence soil pH, alkalinity, nutrient availability, and salinity. The determination of these ions is therefore useful for assessing soil chemical properties and evaluating soil quality.

2. Objective

Determination of carbonate and bicarbonate concentrations.

3. Principle

When the pH of the saturated paste is higher than 8.4, carbonate ions are likely to be present.

By titrating the sample with an acid solution to pH 8.4, carbonate ions are converted into bicarbonate :

$$CO_3^{2-} + H^+ \rightarrow HCO_3^-$$

The amount of acid required for this titration corresponds to the amount of carbonate initially present.

If the titration is continued, HCO_3^- reacts with the acid to form :

$$HCO_3^- + H^+ \rightarrow H_2O + CO_2$$

Carbonates and bicarbonates are determined on the same aliquot.

In saturated extracts of saline soils, the amounts of carbonates and bicarbonates present generally do not require dilution. Therefore, an undiluted aliquot is used.

4. Materials and Reagents

-Soil sample

-20 mL graduated pipette

-Pipette filler

-Burette (50 mL)

-Erlenmeyer flasks

-Beakers

-Dropper or Pasteur pipette

-Distilled water

-**Phenolphthalein (1%)** : dissolve 1 g of phenolphthalein in 100 mL of ethanol.

-**Methyl orange (0.01%)** : dissolve 0.01 g of methyl orange in 100 mL of distilled water.

-**Sulfuric acid (H_2SO_4), 0.05 N**

5. Experimental Procedure

-Pipette 20 mL of the soil solution into a suitable flask or beaker.

-Add 3 drops of phenolphthalein.

-If a pink coloration appears, carbonates are present.

-Titrate with 0.05 N sulfuric acid until the pink coloration disappears.

-If no coloration appears after adding phenolphthalein, bicarbonates are present.

-Add 3–4 drops of methyl orange.

-Continue the titration with sulfuric acid until the color changes from yellow to orange.

5. Calculations

- Bicarbonates **(**HCO_3) meq/L = (x×0.05×1000) / y

Where:

x = volume of H_2SO_4 used for the titration (mL)

y = volume of the soil solution or water sample (mL), here 20 mL

- Carbonates (CO3) meq/L = (2×x×0.05×1000) / y

Where:

x = volume of H_2SO_4 used for the titration (mL)

y = volume of the soil solution or water sample (mL), here 20 mL

6. Interpretation Standards

Table 1: Interpretation standards for irrigation water established by FAO (1996)

Water parameter	Symbol	Unit	Maximum permissible value
Carbonates	CO_3^{2-}	mg/L	3
Bicarbonates	HCO_3^-	mg/L	610
Chlorides	Cl^-	mg/L	1065
Sulfates	SO_4^{2-}	mg/L	960