



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-L400

Soil Moisture – Gravimetric Method

Standard Operating Procedure

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1. Purpose

This SOP describes the gravimetric determination of soil moisture content. Gravimetric moisture is a fundamental soil property required for expressing analytical results on a dry-weight basis (e.g., microbial biomass carbon, nutrient concentrations) and for characterizing site conditions (Gardner, 1986).

2. Scope

- **Applies to:** All soil samples collected per [SOP-F400 Soil Sampling and Processing](#) that require moisture correction or moisture characterization.
- **Does not apply to:** Volumetric soil moisture measured with in-situ probes (TDR, capacitance sensors); soil water potential measurements.
- **Location:** EA Program laboratory.

3. Definitions

- **Air-dry moisture content:** The moisture content of soil equilibrated with ambient laboratory air (typically 20–40 °C, 30–60% relative humidity); generally a few percent and varies with humidity (Gardner, 1986).
- **Constant mass:** The criterion for complete drying: successive weighings separated by at least 2 hours of additional oven time agree within 0.01 g.
- **Dry-weight correction factor (f):** The ratio of moist soil mass to oven-dry soil mass for the same sample; used to convert results expressed per gram of moist soil to per gram of oven-dry soil: $f = (W_{\text{moist}} - W_{\text{container}})/(W_{\text{dry}} - W_{\text{container}})$.
- **Field-moist soil:** Soil at the moisture content it had when collected from the field; the reference state for biological and enzyme activity measurements (Robertson et al., 1999).
- **Gravimetric moisture content (θ_g):** Mass of water per mass of oven-dry soil: $\theta_g = (M_{\text{wet}} - M_{\text{dry}})/M_{\text{dry}}$; expressed as g g^{-1} or as a percentage (Gardner, 1986).
- **Oven-dry soil:** Soil dried at 105 °C to constant mass; the standard reference state for expressing soil chemical and physical properties (Gardner, 1986).
- **Soil moisture:** The amount of water contained in the pore spaces of soil; may be expressed as gravimetric content (θ_g , g g^{-1}), volumetric content (θ_v , $\text{m}^3 \text{ m}^{-3}$), or as a percentage (Gardner, 1986).
- **Volumetric moisture content (θ_v):** Volume of water per volume of soil: $\theta_v = \theta_g \times \rho_b / \rho_w$ where ρ_b is bulk density and ρ_w is the density of water (1.0 g cm^{-3}).

4. Safety and Hazards

Hazards

- **Thermal:** Drying ovens operate at 105 °C. Use heat-resistant gloves and tongs when removing samples.
- **Physical:** Hot aluminum tins retain heat for several minutes after removal from the oven. Do not handle bare-handed.

4.1. Required PPE

- ☐ Safety glasses
- ☐ Laboratory coat
- ☐ Heat-resistant gloves (when handling hot tins)

5. Equipment and Materials

5.1. Equipment

Item	Notes
Drying oven	Regulated at 105 ± 2 °C; verify with a calibrated thermometer (Gardner, 1986)
Analytical balance	Resolution 0.01 g
Desiccator	With active color-indicating silica gel
Crucible tongs	For safe removal of hot tins

5.2. Consumables

Item	Notes
Aluminum tins or ceramic crucibles	Pre-labeled with permanent marker or engraved
Spatula	For transferring soil to tins

6. Estimated Time

Task	Time Required
Sample preparation and weighing	5–10 minutes per batch
Oven drying	24 hours at 105 °C
Cooling and re-weighing	30–45 minutes per batch (including cooling)
Total per batch	Approximately 25 hours (mostly unattended)

7. Procedure

7.1. Preparation

1. Print copies of the Soil Moisture Datasheet (Appendix A) for recording measurements.
2. Label aluminum tins or ceramic crucibles with a permanent marker or engraving tool.
3. Pre-dry the empty containers at 105 °C for at least 1 hour to remove any residual moisture (Gardner, 1986).
4. Cool the containers in a desiccator to room temperature.
5. Weigh each empty container to the nearest 0.01 g and record as Tin Weight on the datasheet.

7.2. Sample Weighing

1. Using a spatula, transfer approximately 10–20 g of field-moist soil into a pre-weighed container.

2. Record the mass of the container plus moist soil to the nearest 0.01 g as Wet Weight on the datasheet.
3. Avoid compacting the soil; a loose arrangement promotes even drying.

 Tip

Process moisture subsamples at the same time as other subsamples (e.g., for microbial biomass or respiration) to ensure the moisture value accurately reflects the condition of the soil used in those analyses (Robertson et al., 1999).

7.3. Drying

1. Place the uncovered containers in the drying oven set to 105 °C (Gardner, 1986).
2. Dry for a minimum of 24 hours.
3. After 24 hours, remove one or two containers, cool in the desiccator, and re-weigh. If the mass has decreased by more than 0.01 g compared to a check 2 hours earlier, return all samples to the oven for an additional 4 hours and re-check.
4. Drying is complete when the mass is constant (change of less than 0.01 g between successive weighings).

7.4. Cooling and Final Weighing

1. Transfer all containers from the oven to a desiccator.
2. Allow to cool to room temperature (approximately 20–30 minutes).
3. Weigh each container plus dry soil to the nearest 0.01 g and record as Dry Weight on the datasheet.

7.5. Calculations

Gravimetric soil moisture content (%):

$$\theta_g(\%) = \left(\frac{W_{\text{moist}} - W_{\text{dry}}}{W_{\text{dry}} - W_{\text{container}}} \right) \times 100$$

where:

- W_{moist} = mass of container + moist soil (g)
- W_{dry} = mass of container + oven-dried soil (g)
- $W_{\text{container}}$ = mass of empty container (g)

Dry-weight correction factor (for converting field-moist analytical results to a dry-weight basis):

$$f = \frac{W_{\text{moist}} - W_{\text{container}}}{W_{\text{dry}} - W_{\text{container}}}$$

To convert a result expressed per gram of moist soil to per gram of dry soil, multiply by f (Gardner, 1986).

8. Quality Control

- Run analytical duplicates for at least 10% of samples; the coefficient of variation between duplicates should be less than 5% (Robertson et al., 1999).
- Verify oven temperature with a calibrated thermometer at the start of each drying cycle.
- Ensure the desiccator contains active (indicating) desiccant; replace or regenerate when the indicator changes color.
- Re-weigh a subset of samples after an additional 2 hours of drying to confirm mass constancy (Gardner, 1986).

9. Waste Disposal

Waste Type	Disposal Method
Oven-dried soil	Standard trash or return to field site
Aluminum tins	Clean and reuse, or recycle

10. References

- Gardner (1986)
- Robertson et al. (1999)

Gardner, W. H. (1986). Water content. In A. Klute (Ed.), *Methods of soil analysis, part 1: Physical and mineralogical methods* (2nd ed., pp. 493–544). Soil Science Society of America.

Robertson, G. P., Coleman, D. C., Bledsoe, C. S., & Sollins, P. (1999). *Standard soil methods for long-term ecological research*. Oxford University Press.

11. Training Record

Before performing this procedure independently, personnel must:

1. Read this SOP in full
2. Demonstrate safe operation of the drying oven
3. Demonstrate proper use of the analytical balance and desiccator
4. Perform the procedure under supervision with acceptable duplicate precision
5. Be signed off by the PI or lab manager

12. Appendix A: Soil Moisture Datasheet

Print this page and use it to record measurements in the lab.

Project / Soil Location: _____

Sampling Date (YYMMDD): _____

Researcher Name: _____

Oven Temperature (°C): _____

Date of Entry (YYMMDD): _____

Soil ID	Soil Tin #	Tin Weight (g)	Wet Weight (Tin + Wet Soil) (g)	Dry Weight (Tin + Dry Soil) (g)
1				
2				
3				
4				
5				
6				
7				
8				
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