Soil Moisture and Loss-on-Ignition

Introduction

Soil moisture content must be known in order to relate other soil characteristics, like soil acidity, cation exchange capacity and contents of exchangeable ions to the soil dry weight. Likewise, the organic matter content of soils must be known to characterise soils. Organic matter can be roughly determined by measuring weight loss after burning. The majority of "loss-on-ignition" (LOI) will stem from organic carbon oxidizing to CO_2. Results are typically accurate to 1-2% for soils with over 10% organic matter. In high clay soils, water of hydration may be lost during the burn resulting in additional error. If the samples are from saline environments, additional steps must be taken to subtract weight loss due to the oxidation of sulphur to SO_2. The present protocol is modified from Reeuwijk (2002).

Principle

Soil samples (air-dried or fresh) are dried in an oven at 105°C and the moisture content estimated as the weight loss. Thereafter the samples are burnt at 450°C and the organic matter estimated as the weight loss as LOI ("loss-on-ignition").

Protocol

1. Set the muffle furnace temperature to 450°C and leave the porcelain crucibles in it for 8 hours.
2. Remove crucibles from furnace and allow cooling in a glass desiccator.
3. Weigh the crucibles using the mass balance (resolution 0.001 g) (**A** gram)
4. Transfer 5 to 10 g fine soil (< 2mm) into the crucibles and re-weigh crucible and sample (**B** gram). Difference yields the water content
5. Dry crucible with sample in the oven at 105°C until dry (overnight).
6. Remove crucibles from oven and cool in a desiccator and weigh (**C** gram)
7. Place the crucibles in a preheated muffle furnace at 450°C and leave the crucibles in it for 4 hours.
8. Remove crucibles from furnace and allow cooling in a glass desiccators and re-weigh (**D** gram). The difference from the dry state yields the organic content.

Calculations

Moisture content:

$$\text{Moist } (\%) = \frac{B - C}{C - A} \times 100 \qquad [\text{wt } \%]$$

Moisture correction factor:

$$\text{Moisture correction factor (mcf)} = \frac{100 + \text{Moist } \%}{100}$$

Loss-on-ignition:

$$\text{LOI } (\%) = \frac{C - D}{C - A} \times 100 \qquad [\%\text{ of DW}]$$

Ash content:

$$\text{ASH } (\%) = 100 - \text{LOI } (\%) \qquad [\%\text{ of DW}]$$

where: A = weight of porcelain crucible
B = weight of porcelain crucible + fresh soil sample
C = weight of porcelain crucible + sample after drying at 105°C
D = weight of porcelain crucible + sample after burning at 450°C

The moisture correction factor (mcf) is used as a multiplication factor to convert parameters measured on fresh or air-dried samples to a dry weight basis.

Materials and reagents

- Scale (resolution 0.001 g)
- Oven, 105°C
- Muffle furnace
- Porcelain crucibles
- Glass desiccator

Safety

- The Muffle furnace is VERY hot. For safety, you must use asbestos gloves any time the temperature in the furnace exceeds 100°C.

Interpretation of loss on ignition:

The loss-on-ignition (LOI) method is a simple and relatively inexpensive method for determining organic matter and is widely used in soil science. However, the ignition temperature and the heating time influence the results as organic matter may not be completely converted into CO_2 if temperature is too low or if burning time is too short. If temperature is too high or heating too long, inorganic compounds such as carbonates and sulphate may be converted to CO_2 and SO_2. The following tables show the influence of temperature and time on LOI for compost and fresh manure (Matthiessen et al., 2005).

Table 1.
Effect of ignition temperature (averaged over heating times) on ash content of compost and manure (Matthiessen et al., 2005).

Temperature (°C)	Compost ash content (%)	Manure ash content (%)
400	71.3	31.1
450	69.7	28.0
500	68.4	27.6
550	68.1	26.7
600	67.6	26.2
650	67.3	25.9

Table 2.
Effect of heating time (averaged over ignition temperatures) on ash content of compost and manure (Matthiessen et al., 2005).

Temperature (°C)	Compost ash content (%)	Manure ash content (%)
1	70.2	30.0
2	69.2	27.7
8	68.6	27.0
12	68.4	27.1
16	68.0	26.5
40	68.3	26.7
24	68.1	26.7

References:

Matthiesen, MK, Larney, FJ, Selinger, LB, Olson, AF (2005). Influence of Loss-on-Ignition Temperature and Heating time on Ash Content of Compost and Manure. - *Communications in Soil Science and Plant Analysis*, 36: 2561–2573

Reeuwijk, LP van (2002) – Editor. Procedures for Soil Analysis. 6th edition. – Technical Paper/International Soil Reference and Information Centre,Wageningen, The Netherlands.