Soil Water Holding Capacity

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Introduction

Soil water holding capacity (WHC) under most circumstances is well related to field water capacity, i.e. field capacity (θ_{fc}). Field capacity is the fraction of soil moisture held in the soil after excess water has drained away (i.e. all gravity drained water, typically 2-3 days) and the rate of downward water movement has stopped. Water holding capacity is 100 % of the field capacity, meaning the maximum amount of water typically held by a soil under field conditions (usually between 25 and 50 % water, soils rich in organic matter can be more).

In essence, WHC is a quick and useful measure to assess a soil's ability to retain water. This functional definition of the state of soil saturation was developed as a means of relating soil water availability to plants in agricultural settings and as such can be important in explaining changes in primary productivity and soil biological activity. In addition, many biogeochemical assays require soils to be incubated at a particular WHC value where specific soil conditions are met (e.g. nutrient or O_2 availability). The lower limit of "plant available water" has been termed the *permanent wilting point*, the point at which the plant can no longer effectively extract water from the soil. Measurement of the permanent wilting point requires more specialized equipment and is described elsewhere (see Dane and Topp, 1996).

Equipment needed

Vacuum filter funnels (with open bottoms)
Whatman No. 1, 42, or GF/A filters (55 mm)
Mason jars or large pan to contain water
Coarse balance (0.01 g)
Saran wrap cut into 4x4 inch squares
Small rubber bands
Kimwipes or paper towels
Squirt bottle filled with DI or RO water
Oven (105°C)

Procedure

1. Place filter in funnel and record the dry filter funnel + filter weight along with the funnel ID #. This will be tared before adding soil to the funnel.
2. Place ~20 g of dry sieved soil into soil filter funnel and record weight. This will be your ***dry soil + funnel weight***.
3. Setup three funnels without soil as your blanks (the filters will adsorb a small amount of water that should be accounted for later). Make sure all the filters are the same type.
4. Place soil filter funnels into the tops of the mason jars.
5. Add DI water to the funnels to submerge the soil by about 1 cm. When adding water make sure to squirt the water on the side of the funnel slowly to disturb the soil as little as possible.
6. Allow the water to infiltrate and **drain until it is just above the soil surface**, then quickly repeat step 5.

Note: It is important **not** to let the water infiltrate all the way past the soil surface because this will entrap air in the soil pores, preventing the soil from draining properly and will likely result in inaccurate WHC values.

7. Repeat the wetting process a total of 2 times. After the third time saturate the soil and cover funnels with Saran wrap to prevent evaporation. The Saran wrap should have 2-3 small holes poked in it to prevent a vacuum from forming which will prevent proper drainage.
8. Let soils drain for 48-72hr or until the soil surface no longer glistens.
9. Record filter funnel + filter + moist soil weight. This will be your ***wet soil + funnel weight***.

Note: Make sure to remove excess water from the bottom of the filter funnels or the lip inside the funnel as this water does not relate to soil water holding capacity (be consistent).

Calculations

Calculate field water capacity nearly the same as gravimetric water content using the equation below (make sure to subtract your tare weights):

$$\text{Field water capacity } \theta_{fc} (\%) \approx 100\% \text{ WHC} = \frac{\text{wet soil (g) - dry soil (g)}}{\textbf{dry} \text{ soil (g)}} *100$$

Note: the one difference here is you must subtract the average water weight of the wet filter blank samples from the wet weights.

Example:

Site ID	Plot#	Habitat	FILTER	Funnel ID	Funnel wt (g)	Dry soil wt (g)	wet wt (24hr) (g)
LDP	5	AMDE	GF/A	1	60.92	79.98	90.95
BLANK			GF/A	2	60.42	60.42	62.44
BLANK			GF/A	3	60.48	60.48	62.48
BLANK			GF/A	4	60.36	60.36	62.40

Average blank wt. = ((62.44-60.42) + (62.48-60.48) + (62.40-60.36)) / 3
= 2.02 g

θ_{fc} (%) = (((90.95-2.02-60.92) - (79.98-60.92)) / (79.98-60.92)) *100
= 46.96 %
or
= 0.4696 g water/g dry soil

*Therefore the maximum amount of water held by the soil (i.e. WHC at 100%) is 0.4696 g water/g dry soil.

*If you are adjusting your soils for incubations to 60 % WHC you would multiply your field capacity of 0.4696 by 0.6 which equals 0.2818 g water/ g dry soil.

References

Dane, J. H., Topp, C., Campbell, G. S., Horton, R., Jury, W. A., Nielsen, D. R., ... & Topp, G. C. (2002). Pg. 721-738. Part 4-Physical methods. *Methods of Soil Analysis*.