

Soil Water Holding Capacity Demo Kit User Guide

For more detailed instructions please visit: soilhealth.cals.cornell.edu/resources

Materials list

- 1 sponge with large pores (coarse textured)
- 1 sponge with small pores (fine textured)
- 1 large beaker (approx. 4L); 2 small beakers (if available)
- 1 tray for capturing water
- Access to water source



Demonstration

Soils are a lot like sponges in the way they hold and release water through a range of saturation.

- The amount of pore space and relative quantity and variety of pore sizes - large to very small - govern important processes of water and air movement in both soils and sponges.
- If soil contains mostly large pores, like a coarse sand, it loses water quickly through gravitational drainage.
- If soil contains mostly small pores, like a fine clay, water infiltration, aeration and root growth will be limited.

Wetting

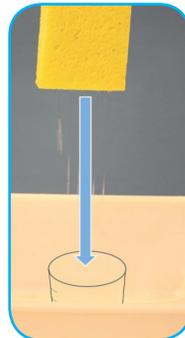
The large-pore sponge behaves like a **COARSE SAND** or well aggregated soil.

- Squeeze sponge in large beaker underwater to expel air.
- Air in pores will be replaced by water.



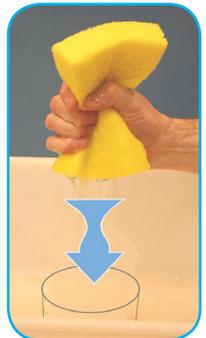
Gravity

- Remove sponge from large beaker. Hold longest side of the sponge vertically above a small beaker.
- Sponge quickly loses water then stops - WHY? Larger pores cannot retain water against the pull of gravity.
- **Field Capacity:** When saturated soil ceases to drain freely from gravity after wetting.
NOTE: Water in beaker is 'lost' to free drainage. Ideal conditions.



Storage

- Hold sponge above beaker and squeeze to expel water.
- **WHERE DOES IT COME FROM?** Hand squeeze is like plant ability to extract water from smaller pores beyond field capacity to permanent wilting point.
- **Permanent Wilting Point (PWP):** Lowest end of plant available water after free drainage.



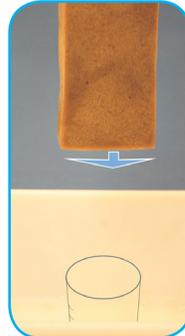
Part I - Demonstration

The small-pore sponge behaves like a **FINE CLAY** or compacted soil.

- Squeeze in large beaker underwater to expel air and fill pores with water.



- Hold longest side of the sponge above 2nd small beaker.
- Little water leaves the sponge - WHY? Few large pores. The very small pores are not emptied by gravity.
- **Water-logged:** There is an excess of pores too small to be drained by gravity. Stressed conditions.



- Squeeze sponge vigorously.
- **WHERE DOES WATER COME FROM?** Significant water remains stored in small pores after drainage from gravity and hard squeeze (PWP). Abundance of remaining water is unavailable to plants.

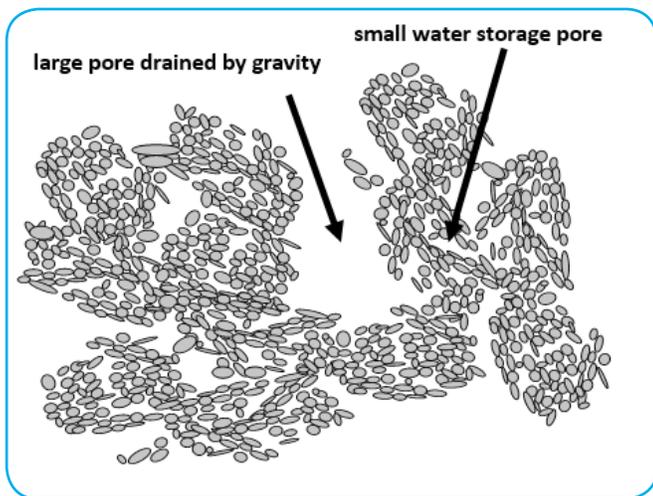


Part II - Example

For Discussion

- The expelled water between field capacity and permanent wilting point represents the Available Water Capacity (storage for plant use). Plants must expend considerable energy to empty the smallest pores.
- Coarse sands tend to have less stored water available to plants than fine clays due to rapidly draining larger pores. Rapidly draining water through sands can result in the loss of pesticides and nitrates to groundwater.
- Extended near-saturation conditions in fine loams and clay can result in gaseous N loss through denitrification.
- An ideal soil would have a balance between excessive drainage and excessive water storage (like a silt loam).

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Soil particles and pore space

- Soil typically contains ~ 50% solid particles and 50% pore space. OM makes up portion of solids.
- Soil particles are defined by size - sand, silt and clay.
- Textural class, an inherent characteristic, is defined by relative amounts of sand, silt and clay.
- Spaces between particles, or pores, are just as important as sizes of particles.
- Pore size is affected by amount of varying particle sizes and the amount of aggregation.
- Pores can fill with air, water, organic matter and biota.

Soil Water Holding Capacity Key Points:

- Soils behave like sponges where the water holding capacity depends largely on amount of pore space and quantity of variously sized pores.
- Soil aggregates contain a range of particle and pore sizes. Large pores can exchange water and air rapidly while smaller pores store water between rain events.
- Well-aggregated soils improve good water infiltration - which increases plant water availability and reduces runoff.
- Crumb-like aggregates containing sand and clay sized particles are common in good topsoil.
- The soil's physical condition affects its ability to function and produce crops.
- **Although a soil's inherent texture cannot be changed, it can be improved through short and long-term management strategies** involving organic amendments (green and brown manures) and tillage.
- More details can be found in *Building Soils for Better Crops 3rd Edition* (sare.org).

In the short term:

Coarse textured soils can be improved with large additions of stable organic materials including

- » compost
- » biochar
- » and mulches.

These amendments can store large amounts of water (and nutrients) and minimize evaporation. Reduced and no-tillage planting systems are also a good short term option.

Fine textured soils can be improved by applying fresh organic material to promote activity of soil biota. Plant debris and microbial breakdown products promote binding of clay particles into stable conduits for air and water. Integrate cover crop rotations and use focused tillage to encourage root proliferation.

In the long term:

Building organic matter and aggregation will increase porosity which, in turn, will improve water intake and storage. Sandy soils retain more plant available water and can store more plant nutrients.

The development of larger, stable pores in clay soils increases the intake and movement of air and water to plant roots. Over time, this is accomplished by reducing tillage, long-term cover cropping, mulching, rotating annual crops with diverse perennials, and keeping actively growing roots in the system to build and maintain these soil pores.

Building greater water storage can be more challenging in coarse textured soils than in finer ones that inherently store more water.

4/29/16

