The Soil That Holds the Most Water Is Not Necessarily the Soil That Gives the Most

— clay holds **1.230756** times what loam holds but gives **0.477674** of its available water, keeping **0.724971** of what it holds even at wilting point — the separator is whether the water counted is all the water in the soil or the water inside the suction window — [Paper 753]

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— From thinking to syncing. —

Abstract

A soil that holds water well is readily taken for a good soil. Yet not all the water a soil holds can be used by plants.Water held and water available are counted for three soils at two suctions.No new theorem or law is claimed. First, available water lies inside a window of suction——from pF 1.7 to 4.2, a suction ratio of 316.227766 (Section 2). **Second, the window is also a window of capillary radius——only water in pores from 29.623795 μm to 0.093679 μm is available** (Section 2). **Third, clay holds more——at field capacity clay 0.372008, loam 0.302259: 1.230756 times** (Section 3). **Fourth, and this is the core. Yet clay gives less available water——available water is 0.102313 for clay and 0.214190 for loam: 0.477674 times** (Section 3). **Fifth, clay does not release most of what it holds——0.724971 of its field-capacity water remains at wilting point** (Section 3). **Sixth, the separator is whether the water counted is all the water in the soil or the water inside the suction window——"high water retention" does not mean a good soil until one says whether water outside the window is counted** (Section 4). **Keywords**: soil water retention, matric suction, pF, plant-available water, capillary radius, retention curve.

Scope of this paper (scope note): **No new theorem or law is claimed——retention curves, the van Genuchten equation, taking the water between field capacity and permanent wilting point as available, and representative values by soil type are all known (van Genuchten 1980, Carsel and Parrish 1988).Values are representative——the parameters for the three soils are representative, not measurements of real fields.The window's ends are conventions——pF 1.7 and pF 4.2 are widely used conventional values that move with crop and soil.Water movement is not treated——how fast water reaches roots, permeability and evaporation are not treated; only equilibrium content is considered.Salts and roots are not treated——osmotic pressure from salts, root distribution and temperature are not included.Capillary radii are a guide——they are read as perfectly wetted round tubes; real pore shapes are not treated.Relation to earlier papers**: **Paper 408 showed that water evaporates and salt does not, so even drinkable water kills the land——its scope note stated that it followed a single mass balance and that capillary rise was not the subject. There the amounts of water in and out were followed. Here, of the water left in the soil, the part held weakly enough for plants to draw is counted.Paper 722 is also cited——there one pore radius set the pressure that stops water. Here the suction window corresponds to a window of pore radius, and only water in pores within it is available.**What is added is **setting water held beside water available for three soils**, **showing that clay holds 1.230756 times what loam holds while giving 0.477674 of its available water**, **reading the suction window as a window of capillary radius**, and **placing the separator on total water against water in the window**.

1. Notation and the Question

Setting: **the strength with which soil holds water is expressed as suction h (cm of water), and its common logarithm is pF. Water content θ (volume fraction) is related to suction by the van Genuchten equation, and suction is read as the radius r of a perfectly wetted capillary.**

$$\theta(h) = \theta_r + \frac{\theta_s - \theta_r}{\left[1 + (\alpha h)^n\right]^{1-1/n}}, \qquad \mathrm{pF} = \log_{10} h, \qquad r = \frac{2\gamma}{\rho g h}$$

Field capacity is taken as pF 1.7 and permanent wilting point as pF 4.2; the water between them is available water.

Question: **does a soil that holds more water give plants more water?**

2. Available Water Lies Inside a Window

Computation 2.1: **the suctions at the ends of the window and the corresponding capillary radii were derived.**

quantity	field capacity (pF 1.7)	wilting point (pF 4.2)
suction (water column)	**50.118723** cm	**15848.931925** cm
capillary radius	**29.623795** μm	**0.093679** μm

> **Observation 2.2**
>
> **the suction ratio across the window is 316.227766, and so is the ratio of radii.Water in wider pores drains under gravity; water in narrower pores cannot be drawn by plants——available water is the water in pores from 29.623795 μm down to 0.093679 μm.**

3. The Soil That Holds More and the Soil That Gives More

Computation 3.1: **with representative values for sand, loam and clay, water content at both ends of the window and available water were derived.**

soil	at field capacity	at wilting point	available	share not released
sand	**0.058710**	**0.045001**	**0.013709**	**0.766498**
loam	**0.302259**	**0.088069**	**0.214190**	**0.291370**
clay	**0.372008**	**0.269694**	**0.102313**	**0.724971**

> **Observation 3.2**
>
> **clay holds the most water of the three.At field capacity it holds 1.230756 times what loam holds——ranked by “water retention”, clay comes first.**

> **Observation 3.3**
>
> **this is the core: yet clay gives less available water.Its available water is 0.477674 of loam’s, and it keeps 0.724971 of what it holds even at wilting point——much of clay’s water sits in pores narrower than the window.**

Observation 3.4

sand holds little to begin with.Its available water is 0.064003 of loam's; its large share not released, 0.766498 , arises because it has already drained almost fully at the window's upper end——neither the share nor the amount alone tells the available water.

4. The Separator

Observation 4.1

the separator is whether the water counted is all the water in the soil or the water inside the suction window.By total, clay is first; inside the window, loam is first——"high water retention" does not mean a good soil until one says whether water outside the window is counted.

Observation 4.2

beside Paper 408.Paper 408 followed the balance of water and salt in irrigation, and set capillary rise aside ——there the amount of water mattered; here the same amount divides into usable and unusable by how strongly it is held.

Observation 4.3

beside Paper 722 as well.Paper 722 showed that one pore radius sets the pressure that stops water——here the distribution of pore radii divides water into available and unavailable.

Observation 4.4

what is not said.Values are representative, the window's ends are conventions, and water movement, salts and roots are not treated——what is shown is that water held and water available are different numbers, even reversing the ranking.

5. Roll Call and Closing

1. **suction ratio 316.227766** (Computation 2.1): **the window's width.**
2. **capillary radius 29.623795 µm** (Computation 2.1): **the wide end.**
3. **0.093679 µm** (Computation 2.1): **the narrow end.**
4. **clay 0.372008** (Computation 3.1): **holds the most.**
5. **1.230756 times loam** (Observation 3.2): **first in retention.**
6. **loam 0.214190** (Computation 3.1): **gives the most.**
7. **clay 0.102313** (Computation 3.1): **its available water.**
8. **0.477674 times** (Observation 3.3): **the core.**
9. **not released 0.724971** (Observation 3.3): **pores narrower than the window.**
10. **total or inside the window** (Observation 4.1): **the separator; Paper 408 and Paper 722.**

Closing: **The soil that holds the most water is not necessarily the soil that gives the most.Water a plant can use lies in a suction window from pF 1.7 to 4.2, a ratio of 316.227766, which is the water in pores from 29.623795 µm to 0.093679 µm——water in wider pores drains, and water in narrower pores cannot be drawn.On representative retention curves, clay holds 0.372008 at field capacity, 1.230756 times loam, but gives only 0.102313, which is 0.477674 of loam's 0.214190, and keeps 0.724971 of what it holds even at wilting point——ranking by retention and ranking by available water swap places.The separator is whether the water counted is all the water in the soil or the water inside the suction window.Placed among the earlier papers——Paper 408 followed the balance of water and salt, and Paper 722 set the pressure that one pore radius needs to stop water; this counts how a window of pore radius divides the available water.To be honest——values are representative, the window's ends are conventions, and water movement, salts and roots are not treated.**

References

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