Does Wetter Water Make Fatter Wallets?

Using Soil Wetting Agents

WASHINGTON STATE UNIVERSITY EXTENSION FACT SHEET • FS004E

Various soil wetting agents are marketed to improve water penetration and distribution uniformity, moisture retention, water use efficiency, and drainage. Commonly referred to as surfactants, their manufacturers claim these products make water "wetter." The question is, are they worth the money? The answer, as usual, is "it depends."

Water Repellency at the Molecular Level

The polar nature of water makes it want to stick together *(cohesion)*. Since a water molecule would rather be in with other water molecules, it exhibits an apparent repulsion of anything that is non-polar at the water surface interface, including air. This repulsion is referred to as surface tension. Most soil particles have negatively charged surfaces that attract the positively charged end of water molecules *(adhesion)* and cause water to stick to it. This makes most soils *hydrophilic* or "having an affinity for water." The combination of this attraction and surface tension creates capillary forces that draw water up into the cracks and spaces between soil particles and therefore enables soil to hold water in reserve for plant use.

Soil particles that have non-polar coatings become *hydrophobic*, or water repellent. Most of these coatings form from organic processes and compounds within the soil. Sandy soils (because of their low surface area-to-volume ratio), soils with high organic matter, and soils that cycle from wet to very dry are more susceptible to water repellency. Soils that are dry and/or have high organic matter are more prevalent near the soil surface, which is therefore where the related water repellency issues exist. Soils in fields or forests that have been burned also tend to exhibit water repellency issues.

Problems with Water-repellent Soils

Because water doesn't stick to hydrophobic soil particles as readily as hydrophilic soil particles, water tends to bead up on hydrophobic soil surfaces instead of going into the soil (poor infiltration). This results in higher runoff and poor water distribution uniformity. The water that does go into the soil tends to move in concentrated fingers of flow instead of uniform distribution throughout the soil profile. This causes localized dry spots in some places and deep percolation in others resulting in poor irrigation efficiency and crop performance.

How Soil Wetters/Penetrants Help

Surfactants or soil wetters/penetrants help overcome water repellency problems by adding molecules to water that have both a polar, hydrophilic (water loving) end and a non-polar, hydrophobic end; the non-polar end sticks to the water-repellent coatings on the soil and draws the water in behind it, encouraging the problem soil to become wet.

The large number of different soil surfactants available vary greatly in their molecular weight, size, shape, structure, methods used to bind soil, recommended application rates, and length of time they are effective in the soil. Be sure to read the label carefully to compare these different products.

Good for Everybody?

In order to test the efficacy of surfactants, two common southeastern Washington soils were obtained that had *no known water repellency issues* (Warden silt loam and Quincy sand). Four different surfactants were compared to a plain water control:

1 non-ionic, 2 block polymer, and 1 anionic. Laboratory tests were performed where untreated water and the 4 surfactants were applied at the labeled rate to measure the infiltration rate (how fast water goes into the soil; Fig. 1), soil water-holding capacity (how much water the soil can hold), unsaturated hydraulic conductivity (how good the soil is at moving water from wet to dry areas; Fig. 2), and capillary rise (the soil's ability to move water upwards; Fig. 3).

Figure 1. Soil columns used for infiltration rate experiments.

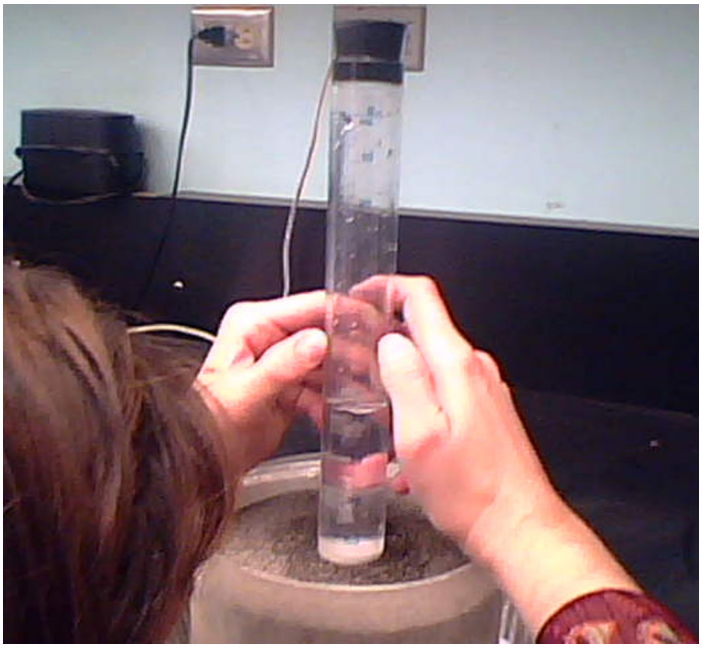

Figure 2. Testing unsaturated hydraulic conductivity.

Figure 3. Testing capillary rise.

These tests were performed with basic soil physics methods using 6-inch diameter clear soil columns and micro infiltrometers. Each test was replicated 4 times. No significant differences were found in infiltration rate, water content, unsaturated hydraulic conductivity, or capillary rise rates between the surfactant treatments and plain water for the tested soils. Although there are demonstrated benefits of using soil surfactants on water-repellent (hydrophobic) soils, such exhibits fail to substantiate claims that surfactants or soil penetrants/wetters provide any benefit for normal, non-water-repellent soils.

Water Repellency Test

The simplest way to determine the degree of a soil's water repellency is to place several droplets of water on a sample of air-dried, disturbed (powdered) soil. If it takes longer than 5 seconds for the water droplets to penetrate the soil, the soil may have some degree of water repellency and a surfactant or soil penetrant/wetter may provide some benefits. If the water droplets flatten out and go into the soil within 5 seconds, the soil can be considered normal, with *no* water repellency issues that use of a surfactant or soil penetrant/wetter would likely provide any improvement.

Other Solutions to Water Repellency

Low infiltration rates may be due to heavy textured soils (high clay content), compaction, poor tillage practices, and/or very dry soils. Water repellency issues can also be managed to a certain degree by not allowing soils to get excessively dry (irrigate more frequently in smaller amounts), good tillage practices (avoid compaction, maintain the soil structure, and increase surface storage through the use of a dammer/diker), and not burning fields.

Reference

Mobbs, T. 2010. Effects of four soil surfactants on five soil-water properties in agricultural sand and silt loam soils. MS thesis, Washington State University.

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