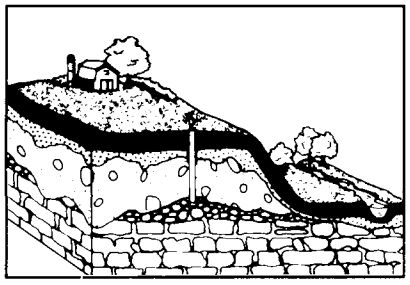

Soil Facts

Using Wetting Agents (Nonionic Surfactants) on Soil

Some soils, known as hydrophobic soils, *are difficult to wet because they repel water. The infiltration of water into these soils can often be improved by applying a* nonionic surfactant, *more commonly called a* wetting agent. *Wetting agents are detergent-like substances that reduce the surface tension of water, allowing it to penetrate and wet the soil more easily.*

Causes of Water Repellency

To understand how wetting agents work, it is necessary to know something about the three forces that affect the movement of water into the soil. The first is *gravity*; it is a constant force that pulls the water downward. The second is *cohesion*, the attraction of water molecules for each other. It is the force that holds a droplet of water together. It creates the droplet's *surface tension*, which causes the droplet to behave as if a thin, flexible film covered its surface, tending to keep the water molecules apart from other substances. The third force is *adhesion*, the attraction of water molecules to other substances. This force causes water molecules to adhere to other objects, such as soil particles.

The effects of these forces can be illustrated by placing a drop of water on a piece of newsprint and another drop on a piece of waxed paper. On the newsprint paper, the force of adhesion between the water molecules and the paper molecules is greater than the force of cohesion that holds the water molecules together. As a result, the water droplet spreads out and soaks into the paper. Certain organic substances such as wax, however, do not have an adhesive force for water. On the waxed paper, therefore, the water "beads up" — that is, the droplet remains intact. The water molecules are not attracted to the wax that coats the paper's surface; instead, the water molecules cohere to each other. When the adhesive forces between water molecules and an object are weaker than the cohesive forces between water molecules, the surface repels water and is said to be *hydrophobic*.

In hydrophobic soils, the soil particles are apparently coated with substances that repel water, much like wax. In studies of localized dry spots in turfgrass, the soil particles were found to be coated with a complex organic, acidic material that appeared to be the mycelium (growth structure) of a fungus.

Nonionic surfactants, or surface active wetting agents, reduce the surface tension of water, allowing the water molecules to spread out. When applied to water-repellent soils in high concentrations, surfactants can improve the ability of the water to penetrate the soil surface and thus increase the infiltration rate.

Problems with Hydrophobic Soils

Hydrophobic soils can cause problems on golf courses and other turf areas, in nurseries and greenhouses, and in open fields. Golf course managers commonly report problems with localized dry spots on their greens.

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Nursery operators sometimes encounter hard-to-wet media in pots and greenhouse beds. And North Carolina farmers who work the organic soils of the tidewater region or the "salt-and-pepper" soils found in Bladen and Pender counties complain that the soil wets too slowly, reducing crop productivity. Problems with hydrophobic soils are also commonly associated with citrus production areas, with locations where mine spoils have been deposited, and with burned-over forestland and grassland.

If water cannot readily penetrate and wet the soil, the availability of moisture to plants is reduced, decreasing the germination rate of seeds, the emergence of seedlings, and the survival and productivity of crop plants. Lack of sufficient water in the soil also reduces the availability of essential nutrients to plants, further limiting growth and productivity. In addition, water that cannot penetrate the soil runs off the surface and increases soil erosion. Water repellency often occurs in localized areas. As a result, the soil wets nonuniformly, and dry spots occur.

In most cases, low water infiltration rates are caused by factors other than water repellency. For example, water naturally moves more slowly into fine-textured (clayey) soils because the soil pores (spaces between the soil particles) are simply too small to allow rapid water movement. Cultural practices that promote good tilth and particle aggregation can improve the infiltration rate on these soils. Conversely, practices that degrade tilth and aggregation (such as working the soil when it is too wet), worsen the problem. Tillage pans and compaction by farm machinery also reduce infiltration. In these situations, wetting agents will have little or no effect.

Effectiveness of Wetting Agents

Extensive research has been conducted on hydrophobic soils and on the effectiveness of wetting agents. Some of these studies have focused on localized dry spots in turf grown on naturally sandy soils and on formulated materials high in sand content. These dry spots become a serious turf management problem during the summer months, especially during periods of drought. Despite frequent irrigation, the soil in these spots resists wetting, resulting in patches of dead or severely wilted turf. The water applied wets the turf but does not adequately penetrate the soil surface to reach the root zone.

In an Ohio study of dry spots in turfgrass, it was found that the hydrophobic condition was restricted to the top 1 inch of soil. The infiltration rate in the dry spots was only 20 percent of that measured in normal areas. In other investigations, the hydrophobic layer was from 5 to 18 inches thick. Applying wetting agents reduced the severity of the condition, but the most effective solution was to use wetting agents in combination with coring — making small holes in the soil surface to allow water to pass through the hydrophobic surface layer. Also, keeping the soil moist seemed to be the best defense against the development of dry spots. Allowing the soil to dry out intensified the problem.

Many California soil scientists and specialists in the management of turfgrass, rangeland, and forestland have tested the effects of wetting agents on the rate of water infiltration into disturbed and undisturbed soils. In general, the results have shown that the extent of improvement in infiltration rate is affected by the type of wetting agent used, its dilution, previous use of wetting agents on the soil, and the water content of the soil at the time water is applied. Several studies have shown that the infiltration rate of a hydrophobic soil, once it has been wetted, remains higher than it was before it was wetted, even if it is allowed to dry out again.

Effects on Plants

Tests have also been conducted to determine whether wetting agents have any toxic effects on plants. In tests on barley shoots grown hydroponically (that is, in a nutrient solution rather than in soil), a wetting agent concentration of 300 parts per million (ppm) in the solution caused a reduction of about 70 percent in the dry weight of the shoots. However, the same concentration in water applied to shoots growing in soil or in a sand-peat mixture *increased* shoot growth slightly. When wetting agents are applied to soil, the concentration would have to be much higher than 300 ppm before plant growth would be impaired.

Deciding When to Use a Wetting Agent

Sometimes advertisements for wetting agents and the labels on these products claim or imply that they are universally effective under all soil conditions. These claims are misleading. Tests in which wetting agents have been applied to normal,

wettable soils have failed to substantiate claims that these products will increase water infiltration, plant population, nutrient uptake, and crop yield. They are effective only on soils that are at least somewhat water repellent.

Several methods can be used to determine the extent to which a soil is water repellent. The most precise methods require laboratory facilities, but several tests can be conducted in the field. The one most useful for preliminary tests is simply to place a drop of water on the soil surface and observe how long it takes to penetrate the soil. On a wettable soil, the water drop will flatten and move into the soil within a few seconds. On more water-repellent soils, the drop of water will stand more upright and will move more slowly into the soil.

As mentioned earlier, water infiltrates more slowly into fine-textured soils than into most coarse-textured soils. Poor tillage practices can also reduce infiltration rates. Before spending money on a wetting agent, be sure that slow infiltration is being caused by water repellency, not some other factor. Wetting agents will improve infiltration rates only in soils that have water-repellent properties, regardless of their texture, tilth, and aggregation.

Source:

Sunderman, H. D. 1983. Soil Wetting Agents, North Central Regional Extension Publication 190. Colby, Kan.: Kansas State University, 4 pp.

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