Water-repellent soils Part I: Where are we now?

Localized dry spot and water-repellent soils continue to plague turfgrass venues.

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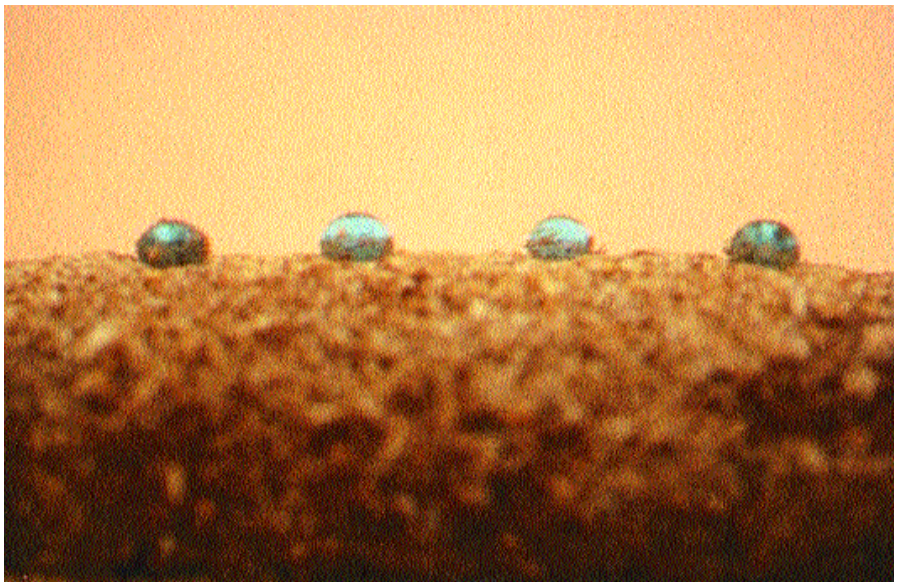
Editor's note: This is the first of a two-part series about localized dry spot and hydrophobic soils on the golf course. In the July 2002 issue of GCM, *the authors will answer eight more questions that superintendents commonly ask about problems with water-repellent soils.*

Localized dry spot (LDS) caused by water-repellent soil continues to be a problem for many golf course superintendents. Over the past several years, we have spent considerable time investigating this common soil condition. Here we bring the reader up-to-date with our most recent findings and understanding of this perplexing problem.

What causes hydrophobic soil?

Although hydrophobic soil has several possible causes, researchers generally agree that an organic coating on the soil particles causes the problem. This coating does not necessarily cover the soil particle(s) completely nor is it always very thick. A thin and/or partial covering of the soil particle can render it water-repellent. The coating is believed to originate from living or decomposing plants and/or microorganisms, but its exact chemical nature is not completely understood.

Many types of organic compounds in the soil can contribute to water repel-



Photos courtesy of Keith Karnok

The presence of water-repellent soil can be determined by conducting a water-droplet-penetration time test. If the droplet stays on the surface of the soil core more than five seconds, the soil is considered hydrophobic.

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Key points

- An organic coating on soil particles is the cause of water-repellent soil.
- Coarse-textured, sandy soils are most likely to become water-repellent.
- Wetting agents can effectively alleviate water repellency in soil.
- It's best to treat the entire green with a wetting agent.

lency. Likewise, water-repellent soils have been associated with a wide range of plant species,including trees,shrubs, crops and grasses. Our research has shown the development of water-repellent soils in the presence of tall fescue, zoysiagrass, bermudagrass and creeping bentgrass. Although we have not confirmed our theory, we believe hydrophobic soil can develop in the presence of all turfgrass species. We have found that, although the degree of soil water repellency did differ, a nonhydrophobic sand green planted with 26 cultivars and six blends of bentgrass did suffer significant levels of soil water repellency four years after establishment.

How deep into the soil profile does the hydrophobic condition penetrate?

It is well documented that the degree of soil hydrophobicity is most severe at shallower soil depths. The most severe water repellency usually occurs in the top 1 to 2 inches of the profile. However, on occasion, we have found hydrophobic soil at a 6-inch soil depth.

Are certain soils more prone to becoming water-repellent than others?

Coarse-textured, sandy soils are most likely to become water-repellent. Although high-clay-content soils have been known to become water-repellent, sand's relatively small surface area per unit of volume makes sands much more susceptible than clays. In many cases, adding small amounts of clay or other materials with a high surface area can reduce or even eliminate water repellency of a predominately sand medium. However, this practice may create other problems such as reduced water infiltration, layering, increased likelihood of compaction, etc.

LDS appears primarily in the summer. Does that mean the soil isn't hydrophobic during the winter?

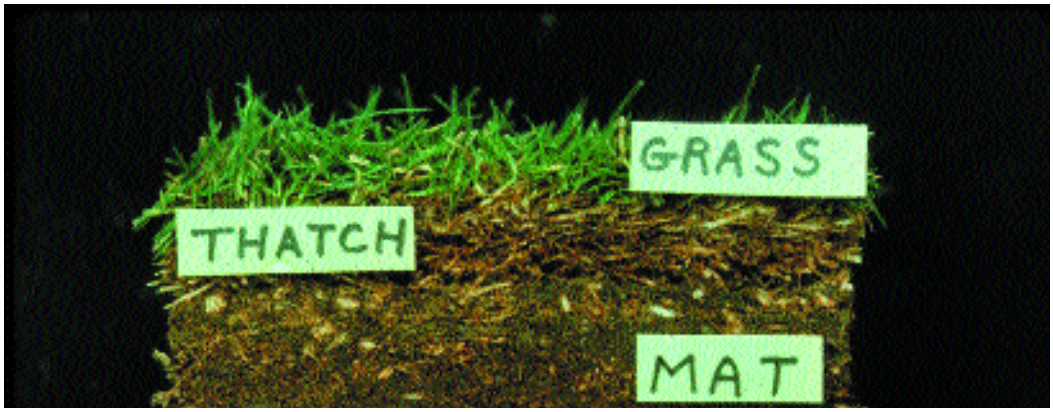
Soil hydrophobicity is influenced by season and soil moisture content. In most cases, soil hydrophobicity decreases (but does not disappear) during the winter months and is most severe during the summer. This seasonal variation may be due to temperature and/or soil moisture conditions. Long, hot, dry periods are most conducive to the formation of hydrophobic soil. Likewise, extremely wet weather can lessen or even eliminate hydrophobicity for several weeks. There appears to be a critical moisture content for each hydrophobic soil. When soil moisture is above this critical point, the water-repellency effect is temporarily eliminated. When soil moisture falls below this critical point, the soil returns to a hydrophobic condition. It is unclear what governs this critical moisture point, but it varies among soils and is largely influenced by soil texture.

How do I know if water-repellent soil is causing the LDS?

Before beginning any management program to alleviate LDS, try to determine its cause. To determine whether the soil is water-repellent, remove intact soil cores with a soil probe and allow them to air-dry for several days. Water repellency is determined by placing small drops of water at increments of ½ inch on the surface of the core, starting at the soil surface. If the droplet remains on the surface of the soil for more than five seconds, the soil is hydrophobic. The longer the droplet persists, the more water-repellent the soil. In extreme cases, the length of time can exceed several minutes.

What is the most effective management practice in combating water-repellent soil?

Considerable research has been conducted at the University of Georgia and other universities showing clearly wetting agents can effectively alleviate water



Thatch (mat) or organic matter accumulation can greatly affect wetting agent performance.

repellency in soil. Although many of the currently available sand substitutes may be effective, little is known about how they can be used to correct water repellency. With the variety of wetting agents currently available (more than 30), the superintendent has a lot of choices.

If wetting agents are the best tool for managing water-repellent soil, which one is best?

For many reasons, few studies have compared the wetting agents commonly used today. First, what criteria should be used in determining "best?" Best means different things to different superintendents. For example, cost is a major factor for many superintendents, but costs vary significantly among wetting agents. Therefore, the budget will often dictate which wetting agent will be used.

Many superintendents believe duration of effectiveness is most important. Some superintendents favor a single season-long application, whereas others prefer shorter-term wetting agents that allow them to decide whether repeat applications are necessary.

Certainly, potential phytotoxicity is a major issue for all superintendents. Some superintendents consider safety to the turf their greatest concern. We know through research that there are significant differences among wetting agents in terms of potential phytotoxicity. Some can be applied in the heat of the summer with little or no irrigation without fear of burning, but others must be irrigated immediately after application to avoid burning.

Of primary importance to all superintendents is the overall ability of the wetting agent to reduce soil water repellency, but unfortunately, from a research standpoint, this is difficult to measure. First, evidence shows that wetting agents do differ in performance depending on the degree of soil water repellency. However, conducting this research is challenging because finding enough hydrophobic soil with the same or a similar degree of water repellency is difficult. Some factors to consider when selecting a wetting agent are the formulations available (liquid, granular, pellets, fertilizer-wetting agent combination, etc.), ease of handling, shelf life, availability and technical support from the manufacturer.

Should I treat only 'hot spots' or the entire green?

The occurrence of LDS shows that hydrophobic soil can vary significantly

across a green. Because soil water repellency varies, one would expect the overall wetting and drying characteristics of the soil across the green to also vary. This variation can result in nonuniform shoot and root growth. Therefore, treating the entire green with a wetting agent allows more uniform wetting of the soil and more uniform turfgrass growth. In some cases, it will be necessary to come back and spot treat areas that continue to show LDS. These areas will most likely be the most hydrophobic or highly stressed areas of the green or turf area.

Will treating the whole green result in the less hydrophobic areas holding too much water?

Our research shows clearly this is not the case. Regardless of the degree of soil water repellency, the soil will not hold more water than its normal field capacity after treatment with a wetting agent. However, with nonhydrophobic, coarse-textured soils, the soil surface may drain and dry out faster if a wetting agent is applied. The amount of organic matter accumulation in the surface of the profile can significantly affect the amount of water retained, but at this time we are unsure of the mechanisms involved.

Do certain wetting agents tend to hold water at the soil surface to prevent the soil from drying out?

Under continued wet conditions, some greens treated with a wetting agent can be slow to dry, and their surface stays soft and moist for an extended period of time. The problem does not seem to be a particular wetting agent, but rather the amount of organic matter (thatch or mat) present.A green that has a significant amount of organic matter in the surface of the profile will retain water longer when treated with a wetting agent. On the other hand, the rate of dry-down of a hydrophobic soil with little or no organic matter in the surface appears to be unaffected by a wetting agent. To confuse the issue even more, a nonhydrophobic, coarse-textured soil with no thatch or mat accumulation will dry out faster when treated with a wetting agent when there is adequate subsurface drainage.

The key in all these scenarios is organic matter and whether the soil is water-repellent. Wetting agents may have different effects in any one of the above situations.

There are more questions than answers concerning the management of water-repellent soils and the use of wetting agents on turfgrass. Currently, several studies are under way that will help us make specific recommendations to superintendents who have to combat this problem on a daily basis. n

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