The Cause And Control Of Localized Dry Spots On Bentgrass Greens

Research is yielding new-found insight and encouraging new observations, but authors recommend a cautious approach as the search for answers continues.

Localized dry spot (LDS) is a term used to describe the occurrence of an irregular area of turfgrass that for no apparent reason begins to show signs typical of drought stress. A common symptom is the loss of plant rigidity to a point that "footprinting." or

Keith J. Karnok
and
Kevin A. Tucker
University of Georgia

the inability of the plant leaves and stems to return to an erect or normal position, occurs following compression by footstep. Footprinting is often followed by a dark blue-green color of the leaves and stems, which is usually followed by severe wilting and eventual death of the tissue. What is most perplexing to superintendents is that LDS symptoms may occur even after normal irrigation.

There are several possible causes of LDS. including excessive thatch, compacted soil, poor irrigation coverage, steep sloping grade (water run-off) or hydrophobic soil. If a superintendent is experiencing LDS. it is important that he try to determine the cause. Once the cause if known, the problem may be corrected. Although all the causes of LDS may prove to be challenging to correct, perhaps the most difficult is hydrophobic or water-repellent soils.

Over the past several years, the occurrence of LDS on golf course putting greens has been reported across the country. Localized dry spots appear to be most prevalent on greens built mainly of sand and established to bentgrass. It is now thought that in many cases, these LDS are the result of hydrophobic soil. Little is known or understood about the occurrence of hydrophobic soils. Scientific literature does show that water-repellent soils have been reported to occur in many different places, including citrus groves, forests and grassland areas. Little research has been published on LDS as caused by hydrophobic soils on golf greens. Perhaps the most significant work was done in 1978 on an experimental putting green at Ohio State University.

If localized dry spots are allowed to progress unchecked, the result may be a significant loss of turfgrass.

Research on LDS has been under way in the department of agronomy at the University of Georgia for the past several years. The remainder of this article will focus on the results of that research.

Experimental Procedures And Results

The first step in trying to obtain a better understanding of the causes of LDS on golf course putting greens was to sample actual sites that had reported the continual occurrence of the problem. Therefore, five golf courses and the experimental green at the University of Georgia Turfgrass Plots were selected. The first objective was to determine the cause of the LDS areas. Soil samples were taken from dry spots and immediately adjacent (1 to 2 inches) healthy areas from each of the test locations.

These samples were taken back to the University of Georgia for a thorough laboratory analysis. First, the moisture content of LDS soil was found to be significantly lower at all test locations than soil from immediately adjacent healthy areas. LDS soil averaged about 3 percent moisture content, and soil from adjacent healthy turf areas was almost 21 percent. Although this test confirmed the presence of dry soil, it in itself did not reveal the cause. Therefore, a test — the water droplet penetration time test — was used as quick and accurate determination of the presence of water-repellent soils.

Our studies have consistently shown that coarse-textured soils are much more likely to become hydrophobic . . .

DRY SPOT

This test, which can be used by a golf course superintendent, simply involves the placement of small drops of water along the length of intact soil cores at 1/2 inch intervals. The length of time (seconds) required for the droplet to penetrate into the core is recorded. Penetration times greater than 10 to 15 seconds usualy indicate a hydrophobic condition. In this study, soil from LDS from all test locations showed penetration times greater than 20 seconds. The greatest times were recorded in the top 2 inches of the LDS soil profile. At depths greater than 2 inches, the degree of water repellency usually decreased. The average water droplet penetration times from adjacent healthy areas at all depths was less than 3 seconds, which showed these soils to be virtually non-hydrophobic.

The result of the water droplet penetration time test and soil moisture content clearly demonstrated the presence of a hydrophobic condition. The next question was: Why was the soil from LDS areas hydrophobic while soil immediately adjacent to these LDS was not? Was there a soil chemical or soil physical property difference between the two areas?

Soil Physical Analysis

A physical analysis of the soil from each of the sampling locations was conducted. Healthy areas were compared with LDS areas. Although the soil tested from all locations was predominantly sand (92 percent), there was no significant difference between LDS and healthy areas in terms of sand particle size, silt, clay or organic matter content.

Although the physical analysis provided no apparent clues as to the cause of hydrophobicity, it was important to determine whether a particular soil particle size was more prone to becoming hydrophobic than another. This was determined by passing the hydrophobic soil through a series of soil sieves. Each of the resulting fractions was then tested via the water drop test. In general, the larger the particle size, the less hydrophobicity found. Very coarse and coarse sand fractions showed the least tendency to be water repellent. It should be noted that regardless of size, all soil particles in the top inch were extremely hydrophobic. However, our studies have consistently shown that coarse-textured soils (sands

Initial symptoms of localized dry spot (top) are signs typical of drought stress, including darker color and loss of turgor or wilting. As they progress, symptoms include severe wilting and tissue desiccation (bottom).

> Although some progress has been made in understanding localized dry spots as caused by hydrophobic soils, there is still much to be learned.

DRY SPOT

in general) are much more likely to become hydrophobic than fine-textured soils such as silts or clays.

A complete chemical analysis of soil from LDS and healthy areas showed no significant difference in the quantity of the major or minor nutrients present, including P, K, Ca. Mg, Zn, Mn, B and NO3. or soluble salts and pH. The chemical analysis provided no apparent clues.

Electron Microscopy

Several particles of sand from both LDS and healthy areas were viewed with a scanning electron microscope. Under this high magnification, sand particles from healthy or non-hydrophobic areas appeared clean with relatively smooth surfaces. In contrast, sand from LDS or hydrophobic areas appeared to have a covering or coating over much of the particle.

A similar observation was made several years ago by researchers at Ohio State University. In that earlier research as well as the present study, this coating is thought to be an organic acid called "fulvic acid." Fulvic acid is produced by certain microorganisms in the breakdown of soil organic matter. When this material is dry, it becomes extremely hydrophobic. As fulvic acid is formed in the soil, it appears to drape around and get caught in the cracks and crevices of individual sand grains. The result is a high degree of water repellency, particularly as the coated sand is allowed to dry out.

It should be pointed out that the breakdown of soil organic matter, resulting in the production of fulvic acid and several other closely related organic acids, is a completely natural phenomenon. Unfortunately, when the process takes place in a soil type that has little water-holding capacity such as a high sand content putting green, the hydrophobicity characteristic becomes even more pronounced.

Preliminary Control Studies

Several laboratory and some field studies have been conducted to determine whether the coating could be removed or altered or whether the physical properties of the soil could be changed to reduce the degree of hydrophobicity.

Various laboratory studies suggested that the coating could be completely or partially removed with various treatments. For example, a 20 percent solution of Tide laundry detergent as well as a separate treatment with the wetting agent Aqua-Gro at 64 oz./l.OOO square feet appeared to remove the coating from the surface of the sand particles. Although lower rates of Aqua-Gro (16 and 32 oz./l.OOO square feet) did not have an observable effect on the coating, the degree of hydrophobicity was reduced. This was probably a result of a temporary change in the surface tension of the water rather than any direct effect on the coating.

The coating was removed following treatment with hydrogen peroxide as well as a complete restoration of the water-holding capacities of the soil. In fact, our laboratory studies showed that the coating is loosely bound to the sand particles, and even large volumes of water can wash the coating from the surface. Unfortunately, when these treatments were tried under field conditions, the results were inconsistent and thus inconclusive.

One of the more effective treatments under trial conditions has been a single application of Aqua-Gro at 64 oz./l.OOO square feet. Although this rate is several times greater than label recommendations, it has been found to be more effective under the conditions of our studies. Although some phytotoxicity has been reported with Aqua-Gro at recommended rates, we found this to be a minor problem even at the 64 oz. rate. Our research has indicated that little phytotoxicity would occur providing that the material was washed off the leaves immediately (within a few minutes) after application. It is particularly important to wash the wetting agent off the leaves and stems when temperatures rise above 85 F and humidity is high.

It should be remembered that regardless of our findings, the manufacturer's label rate is an initial 16 oz./l.OOO sq. ft. followed by an 8 oz. monthly application. Until more research can be conducted on the effectiveness of ultra-high rates, a golf superintendent would be well-advised to adhere to label recommendations. Undoubtedly, other wetting agents are effective in combating hydrophobic soils. In fact, a study was recently completed at the University of Georgia in which the effectiveness of several wetting agents was evaluated under extreme hydrophobic soil conditions. The results of this study will be published shortly.

As mentioned above, under field conditions many treatments were less effective than when conducted in the lab. This may have been in part due to the inability of the materials to move freely past the turf cover and other soil surface organic matter such as thatch. Therefore, in an attempt to overcome this surface barrier, a preliminary study using a high-pressure injection system manufactured by Cross Equipment Co., Inc., in Albany, Ga., was initiated on the experimental green at the University of Georgia turfgrass plots. This sprayer operates at 2,000 psi and has the capability of injecting materials up to 3 to 5 inches in a sand-based green. Initial results look very promising, and the study will be continued and expanded this year.

Although some progress has been made in understanding LDS as caused by hydrophobic soils, there is still much to be learned. Thanks to past and ongoing financial support by the Georgia Golf Course Superintendents Association, this research will be continued in a multidisciplined manner. Researchers working in the areas of soil physics, soil microbiology, soil fertility and turfgrass management will join forces in an attempt to elucidate specific causes and control measures for this chronic problem.

(The authors would like to thank Mike Beall, research associate, for his technical assistance.}

Reprinted with the permission of the Golf Course Superintendents Association of America.