METER
ENVIRONMENT

SOIL SENSORS HELP SOLVE PUTTING GREEN WATER DISTRIBUTION ISSUES

Distribution of soil water in high-sand-content putting greens is a major concern for golf course superintendents. Gravel is commonly used as a component of a sand-based root zone to increase moisture retention, but due to gravity, the contour and slope of a putting green significantly affect moisture retention. Coarse-textured soils often become too dry in higher elevations and too wet in lower elevations. This hampers performance and increases water and labor inputs.

To fix this problem, Thomas Green, a graduate student at Michigan State University, and a team of researchers are assessing the impact of gravel layer particle size and slope on soil water content in a variable-depth, high-sand content root zone. He says, “Due to lack of published research and the USGA’s wide-ranged specification for gravel selection based on the root zone material, determining the optimal bridging, filtering, permeability, and uniformity factors capable of increasing root zone soil moisture uniformity is critical.”

VALIDATING PREVIOUS TURFGRASS EXPERIMENTS

Green and his team set out to validate previous turf experiments done at MSU which showed that increasing the particle size difference between the gravel and root zone (sand) layers, in combination with a variable-depth root zone (shallower at the slope apex, deeper at the slope base) would improve soil moisture uniformity.

He says, “We wanted to retain this moisture consistently throughout the whole profile over the entire green. Our experiments decreased the root zone depth in relation to our gravel layer. So at the peak, we reduced the root zone, and in the valleys, we increased the root zone to eliminate wet spots where water accumulates.”

WATER POTENTIAL IS THE KEY

Green says the goal was to manipulate the “head” (or water potential) in the peaks and valleys. He explains, “We tested particle size differences between a high-sand, root-zone mix and the gravel layer. Past studies show that the greater the difference between the root zone particle size and the gravel particle size, the more water is retained at the interface. Essentially in the valleys, we increased the depth of the sand layer to create (in physics terms) a large head that forced more water to drain. At the top of the green, we did the opposite and made a thin layer of sand so more water was available. Basically, it was all about manipulating the water potential or tension on the water to retain the right level of moisture.”

The diagrams below illustrate the physics of how this works:

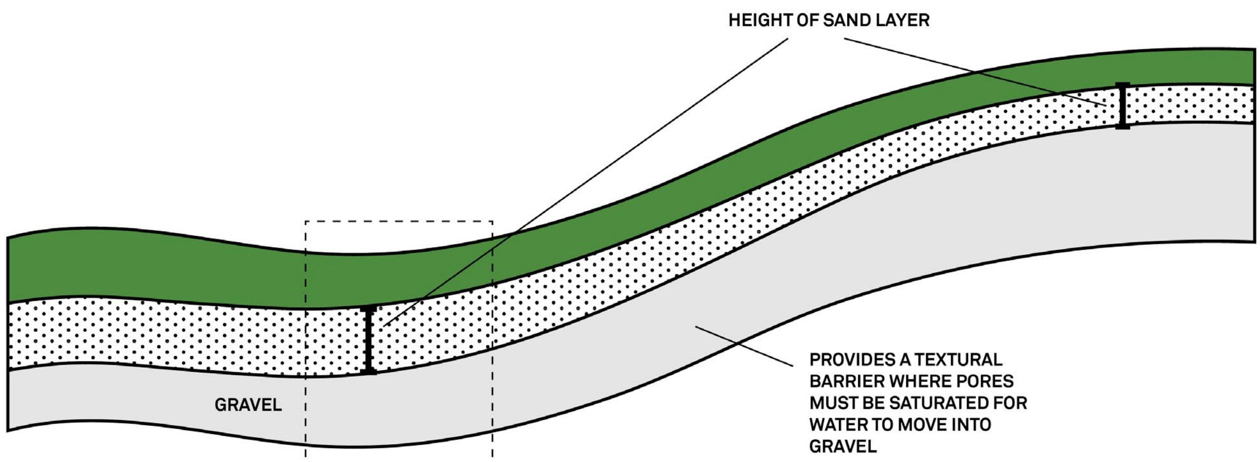

Figure 1. Diagram of sand and gravel layers beneath a putting green

In Figure 1, the gravel provides a textural barrier where pores must be saturated for water to move into the gravel.

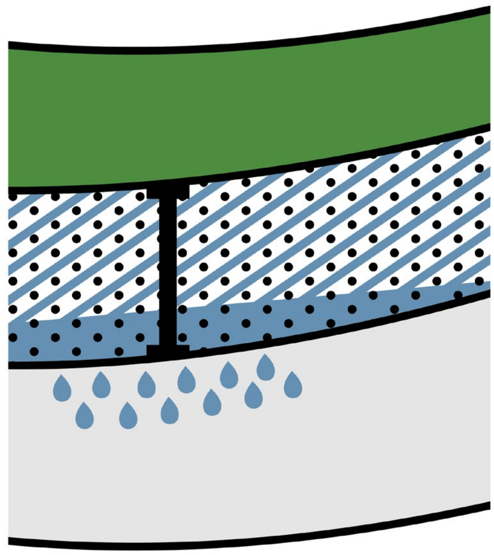

Figure 2. Closeup of the tall sand layer in the valley

In Figure 2, cohesion of water molecules together and adhesion to soil particles ties water together and exerts downward force or tension on water at the top of the profile. The larger the height from the top of the profile to the saturated surface, the more tension on the water (lower water potential).

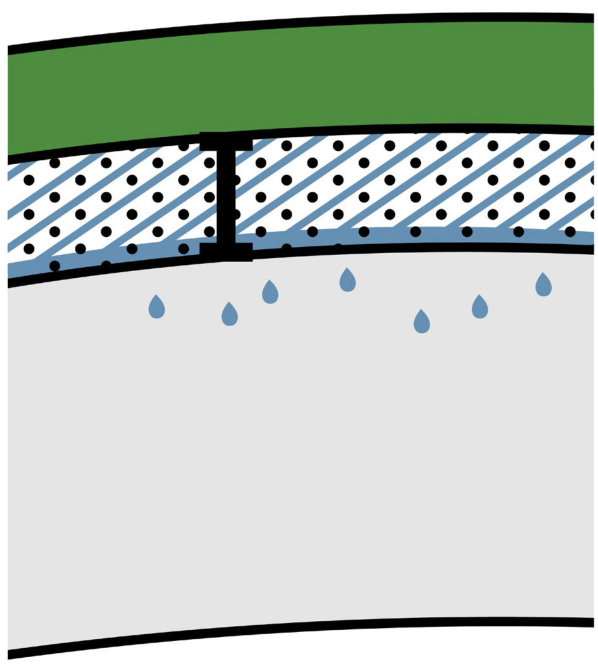

Figure 3. Closeup of the short sand layer at the peak

In Figure 3, shorter height above the saturation zone reduces the tension in the top layer of soil (higher water potential). Thus, the high part of the green with the thinnest sand layer will have less tension and more water than the thick layer in the lower part of the green. To visualize what soil tension is like, think of people hanging on people (Figure 4). The more people there are, the more “pull” will be exerted on the top person.

ELIMINATING EDGE EFFECTS

Green used METER soil moisture and temperature sensors at three different depths along with METER data loggers to validate that the water was in the right place. He inserted the sensors into an enormous box that mimicked a putting green. “I created a 4-ft x 4-ft module to simulate a sloping green. I had to figure out how large it should be to eliminate edge effects (water preferentially moving toward the container edges). The soil moisture sensor helped me determine just how large this box had to be to get accurate measurements.”

Green says the surface measurements were the most important, “I was interested in that top depth because in a golf setting, that’s where you need to control moisture. In a putting green, turfgrass roots aren’t very deep because the grass is so short.”

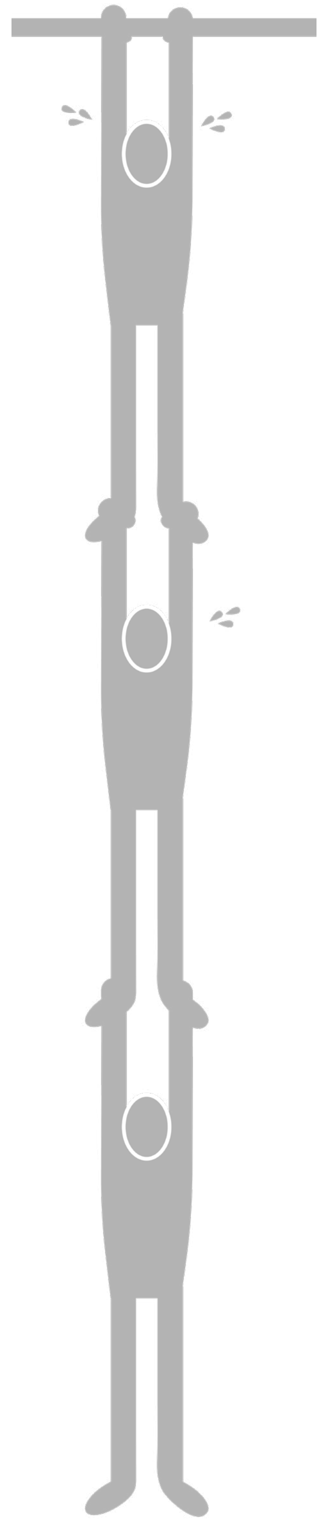

Figure 4. Soil tension is like people hanging on people. The more people there are, the more “pull” will be exerted on the top person.

Figure 5. Green used soil moisture sensors and data loggers to validate that the water was in the right place

USGA HAS ADOPTED THE NEW METHOD

Green says the results turned out as expected. “We expected that if we increased the gravel particle size difference and reduced sand depth, we would see increased water retention in our root zone profile, and that’s exactly what happened. The great thing is the USGA has now somewhat adopted these new recommendations. More and more golf courses are going to this construction method. It’s good for the industry because they’re conserving water.”

In the future, Green says he’d like to explore some research done by F.W. Taylor in the early 1900s. Taylor thought about using a vertical sand or gravel strip contoured on a slope to form a barrier to water moving downhill instead of plastic or polyethylene. This idea is illustrated beautifully in the classic 1950s era film by Dr. Walter Gardner.

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