Improving Procedures for Testing Putting Green Materials

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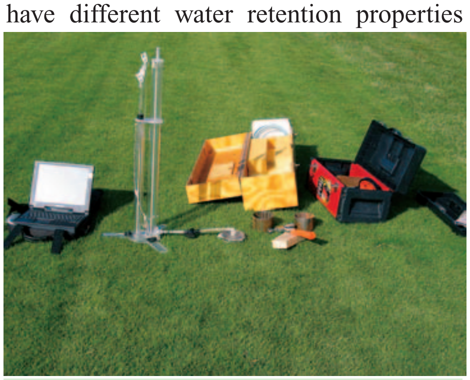
Objectives:

1. To evaluate new testing procedures for water and air in rootzone materials.
2. To quantify water content and movement as affected by rootzone depth, as well as rootzone materials.
3. To understand water movement in a rootzone profile as affected by grass root systems, topdressing, and organic matter/thatch layers.

Start Date: 2004
Project Duration: three years
Total Funding: $33,000

USGA recommends that total porosity be 35-55%, non-capillary porosity be 15-30% and capillary porosity be 15-25%. The current USGA recommendation listed saturated water conductivity of 15-30 and 30-60 cm hr^{-1} as normal range and accelerated range, respectively. The confidence interval for particle size analysis is +/-10 to 35%, and that for water conductivity is +/-20% using the USGA specified procedures. The inconsistency of those test results for rootzone materials between and within the labs has caused inconvenience in bidding and contracting processes during the construction. The difficulties encountered in locating quality materials plus the high price of sand materials that conform to USGA specifications forced many putting greens to have been constructed using native soil or local alternative materials.

Results from last year's study showed that procedures of wetting affected water retention properties. Current laboratory testing procedures use a drying process to determine air porosity and capillary porosity after wetting from the bottom of the samples. However, rootzones in the field are wetted from the top and may have different water retention properties and infiltration rates. Adding organic materials to sand can sometimes increase the degree of hydrophobicity which prevents complete wetting of samples as required before testing water retention and water conductivity. Hydrophobicity may also increase the chance of trapping air in the samples to be tested.



Testing procedures being developed by scientists at North Dakota State University can be used to determine water movement in the field in addition to samples prepared in the laboratory.

We tested sand materials that conform to the USGA recommendations and their sand/peat mixtures with different testing solutions (i.e. tap water, de-ionized water, and $CaSO_4$ solution. We also tested the materials with different wetting procedures (i.e. saturating from the bottom of samples and applying vacuum to the samples during wetting). Results showed that using de-aired $CaSO_4$ solution combined with vacuum during the wetting of samples increased accuracy and consistency of water retention tests.

By using the new wetting procedures we were also able to demonstrate certain improvement in consistency of saturated water conductivity tests. However, saturated water flow is usually only a short period during a rain event. Saturated water conductivity is only one fraction of the water movement characteristics of rootzone materials. Water conductivity increases exponentially with degree of saturation and a small variation at the saturating point can cause dramatic differences in saturated conductivity. Thus, variation in saturation may be only one of the contributing factors to the low repeatability of saturated water conductivity results. Other factors affecting the accuracy of the saturated water conductivity tests include the soil packing process, dissolved air in testing water, organic matter, and clay type and amount in the mix.

We adapted a tension infiltrometer to the test of water retention and water conductivity. Comparisons of different versions of tension infiltrometers showed that differential transducer automated and two-gage transducers automated tension infiltrometers can test the water retention and water conductivity in a few hours instead of a few days by traditional methods. This method needs only to load the sample in the beginning of the test and eliminated the process of repacking and transferring of samples for different tests. Another advantage of this method is that the same device can be used for both laboratory samples and undisturbed rootzones in the fields. Therefore, the test results are not only useful for greens construction, but also are of important on-site values.

The next step of our research is to automate the infiltrometer to make the water retention and water conductivity test as simple as to load a uniform sample to a test ring. The system will be tested for different sands and sand/organic materials. The system will also be tested under layered rootzones constructed in the laboratory and in the field conditions to further understand the water movement for different conditions.

Summary Points

- Water retention and water conductivity of rootzone material or in a putting green rootzone are two important properties that are connected by soil water potential. In order to understand the water holding and water movement properties of a rootzone, both water retention and water conductivity have to be viewed as a continuously changing curve instead of one data point.
- Automated infiltrometers can be used to determine water retention and water conductivity in a few hours. This will eliminate many artificial errors associated with sample preparation and test procedures.
- Curves are generated rather than a single point to represent water conductivity.
- The proposed test methods can also be used to estimate soil physical parameters that better reflect field conditions and therefore offer agronomic value.