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 test new methods in the field *in situ* samples against laboratory samples.
3. To integrate the measurement of water retention and water conductivity in one process.

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% for putting green rootzones. 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 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.

Testing procedures using a TDR-infiltrometer can be used to determine water retention and movement simultaneously in the field, as well as in the laboratory.

Preliminary studies showed that wetting solution, wetting direction, and wetting methods during the process of sample saturation all affect the consistency of test results. Even with the consistency improvement, however, two fundamental issues are still left unaddressed in the current test procedures. One is total volume of available water in the rootzone as a capacity factor affected by rootzone depth. The other is simplification of test procedures that apply both in the laboratory and in the field.

Measuring water content at different pressure heads generates a more informative picture of the water holding/release characteristics of a rootzone. Both total volume of water and air can be integrated with mathematical models as shown in the results of the first year study. It is important to understand the buffering capacity of the rootzone and to budget the water supply.

Research conducted in the second year of the study indicated that a tension infiltrometer equipped with a differential transducer could be effectively used for predicting unsaturated water conductivity at various pressure heads. There are two advantages to this approach. One is to measure water conductivity in unsaturated range where it is less sensitive to the degree of saturation compared to saturated conditions. A second advantage is to be able to use the same device *in situ* as in the laboratory.

We focused on simplifying and automation of the test procedures in the last year's research. Using the tension infiltrometer equipped with TDR for water level monitoring, we were able to monitor water level without the need for calibration that is required for transducers. Water content in the sample immediately below the infiltrometer was also measured with a TDR probe at the same time infiltration was measured. Thus, the soil water retention and water conductivity can be measured simultaneously, whereas in the traditional procedures, water retention and water conductivity are measured in two separate steps.

In general, using the TDR equipped tension infiltrometer reduced the turn over time from one week to two days. Confidence intervals of the water holding and water conductivity test results can be reduced among and within laboratories. Soil hydraulic properties from the laboratory test can be compared with the field performance because of this consistent methodology.

The TDR-infiltrometer method can also be used to collect soil water movement information to be used for subsurface irrigation control and estimation of chemical movement within soil profiles.

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.
- An automated TDR-infiltrometer can be used to determine water retention and water conductivity in a few hours. This eliminates many artificial errors associated with sample preparation and test procedures.
- Curves are generated rather than a single point allowing for putting green construction and design according to the soil water properties.
- The proposed test methods can also be used to estimate soil physical parameters that better reflect field conditions and therefore of more agronomic value.