Simulation of Putting Green Hydrology

Edward McCoy
The Ohio State University

Objectives:

1. Identify the appropriate soil hydrology model capable of simulating existing data and extending the range of conditions corresponding to actual putting greens.
2. Validate and calibrate the model using existing data on water infiltration, redistribution, drainage and turf uptake under prescribed experimental conditions.
3. Use the model to generate simulations of putting green hydrology for a variety of realistic and interesting green constructions and enviornmental scenarios.

Start Date: 2001
Project Duration: 2 years
Total Funding: $28,850

Most putting greens constructed today have high sand content rootzones to minimize soil compaction. This rootzone is placed within an excavation of the native soil that commonly has a much smaller hydraulic conductivity. A challenge with this form of greens construction is achieving the proper balance between air-filled and water-filled porosity, both uniformly across the green and throughout the season. This research investigates putting green construction issues and their impact on seasonal soil moistures, turf water use, and drought avoidance.

The research was conducted as a water balance study where daily measurements were made of rain or irrigation amounts, rootzone water contents, drainage volumes, reference evapotranspiration (ET) and turf ET from experimental greens. Additionally, water was withheld for two intervals during the study. Construction issues within the 2-tier, USGA-style greens, included sand texture (coarser or finer) rootzone amendment (none, sand + peat, or sand + peat + soil) and depth (9 or 12 inches).

As expected, rootzone water contents fluctuated throughout the study period depending on the frequency of rain or irrigation. Overall, the unamended rootzones had the lowest water contents and the peat + soil amended rootzone the highest. Amendment effects were greater for the coarser than the finer sand rootzones. Surprisingly, the shallower rootzones were only slightly wetter than the deeper rootzones and the similarity of their water contents is explained by differences in drainage.

Researchers constructed a series of replicated, enclosed rootzones to measure the effects of rootzone depth and composition on the water use rate of putting greens.

Thus, where the 12-inch rootzone quickly drained excess water and reached an equilibrium state, the 9-inch rootzone showed continuous slow drainage for more than a week following heavy rain. The shallower rootzone also showed a greater fluctuation in rootzone water content, achieving lower values when irrigation was withheld. This occurred because turf water uptake spanned the entire rootzone so that the shallower rootzone contained a smaller moisture reserve.

Although measurable differences occurred, cumulative turf ET was largely unaffected by the treatments of this study. The overall mean turf ET was 16.7 cm (6.6 inch). This value was about 60% of the ETgage reference and yielded a daily ET rate of 0.27 cm (0.11 inch). Additional visual observations revealed that the finer sand + peat rootzone gave superior drought avoidance and the 9-inch rootzone showed symptoms (algae and moss) of excessive soil wetness. These visual indications, however, appeared unrelated to soil water status measurements.

The treatments of this study and instrumentation at hand showed that relatively subtle greens construction differences show measurable responses in soil water behavior. Our current efforts in simulating putting green hydrology is hoped to reveal a mechanism for the biological system response to rootzone water status.

Summary Points

- Relatively subtle modifications in rootzone composition can exhibit measurable differences in seasonal water contents.
- A 9-inch rootzone exhibits greater fluctuation in soil water content that a 12-inch rootzone.
- Cumulative turf ET over a 2-month period was largely unaffected by greens construction treatments and was about 60% of the ETgage reference.
- Visual indications of drought avoidance and excessive soil wetness were related to construction treatments, but appeared unrelated to soil water status measurements.