The Effects of a Variable Depth Rootzone Mix on Moisture Retention in a Sloping USGA Putting Green

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The United States Golf Association (USGA) introduced guidelines for constructing putting greens over 30 years ago and since then the USGA green has become the standard for golf course putting greens. The concept behind the USGA recommendations for putting green construction is to build a green that provides a measure of resistance to compaction in the rooting zone and drains quickly to an optimum soil moisture level. Specifications for a USGA putting green require that the sandy rootzone mixture be placed at a uniform depth of 12 inches across the entire surface of the green. If greens lacked slopes, there is little doubt that most, if not all, USGA greens would perform well. However, with the slopes present on putting greens today, the USGA greens do not always perform ideally. The uniform rootzone mix depth does not account for the lateral flow of water in a sloping rootzone. Lateral flow occurs in sloping soil profiles when gravitational and surface tension forces acting on the water become larger than the attraction of water to the soil. This lateral flow causes lower water contents in high areas of the putting green and higher water contents in low areas. The resultant problems are particularly evident at the higher elevations of the green where hand syringing is often necessary to prevent turf loss.

The objectives of the research are to investigate whether or not altering the rootzone depth, decreasing it in high areas and increasing it in low areas, will increase the water content near the soil surface in high areas and decrease the water content of the rootzone mix in low areas. In 1998, a 10,000 ft^2 research putting green was constructed at the Hancock Turfgrass Research Center at Michigan State University. The green was divided into 12 separate plots. Each plot received one of three rootzone mixes; straight sand, sand/peat, or sand/soil. Three plots (one of each rootzone type) have a rootzone mix with a uniform 12 inch depth (USGA green) and three have a rootzone mix depth varying from 8 inches at higher elevations to 16 inches at lower elevations (MSU green). A series of 120 Time Domain Reflectometry (TDR) probes and cables were buried in the soil to measure soil moisture in 4 inch increments at several locations in every plot. The plots are arranged in a two factor complete randomized split-block design and are replicated twice. A Rainbird irrigation system was installed to provide uniform irrigation coverage for the entire green. The green was seeded with creeping bentgrass (*Agrostis palustris*) cultivar 'L-93' in June of 1998.

In 2000, data were collected on soil moisture, leaf surface temperature, turfgrass quality and color, root weights, and quantity of drainage water from various regions of the green. Soil moisture readings were collected for five different 'dry down cycles'. A dry down cycle consisted of irrigating the green until it was near field capacity and then withholding irrigation for 4 to 5 days. A hand-held TDR unit was used to measure volumetric soil moisture content in the 0-4 inch depth.

At the 0-4 inch depth there were significant differences in soil moisture content between construction types and among locations on the green. At the beginning of a dry down cycle on August 31, when the rootzone is near field capacity at TDR locations 1 and 3, the MSU green had lower volumetric soil moisture content than the USGA green (Table 1). There were no differences in volumetric soil moisture content between the greens at TDR locations 2 and 4. Furthermore, it was evident that there were no differences in volumetric soil moisture content among TDR locations for the MSU green. However, for the USGA green the peak of the slope, TDR location 2, had significantly lower soil moisture content values than TDR locations 1 and 3.

Table 1. Volumetric soil moisture content at the 0-4 inch depth on August 31, 2000.

	Construction Type	
TDR Location	MSU Green	USGA Green
1	17.5 B[†]a[‡]	24.2 Aa
2	20.8 Aa	17.5 Ab
3	16.2 Ba	23.4 Aa
4	17.6 Aa	22.5 Aab

[†] Means in a row followed by the same capital letter are not significantly different according to Fischer's protected LSD (p=0.05).

[‡] Means in a column followed by the same small case letter are not significantly different according to Fischer's protected LSD (p=0.05).

On September 3, four days after an irrigation event, the MSU green had lower volumetric soil moisture content values at TDR locations 1, 3, and 4 (Table 2). As on August 31, there were no differences in soil moisture content among the locations for the MSU green, indicating that the MSU green had uniform soil moisture across the entire slope of the green. Across the slope of the USGA green, volumetric soil moisture content values were lower at the peak of the slope, TDR location 2.

Our initial results indicate that altering the rootzone depth decreases soil moisture content near the putting green surface in lower regions of the green and increases soil moisture content near the putting green surface in higher areas of greens.

Although the differences were not statistically significant at this time, volumetric soil moisture content was greater at the peak of the slope, TDR location 2, for the MSU green. The results confirm our initial hypothesis that altering the rootzone depth will decrease moisture content in lower regions and increase moisture content on elevated areas of greens.

Table 2. Volumetric soil moisture content at the 0-4 inch depth on September 3, 2000.

TDR Location	Construction Type	
	MSU Green	USGA Green
1	14.1 B[†]a[‡]	21.2 Aa
2	14.5 Aa	11.3 Ab
3	14.8 Ba	20.8 Aa
4	13.6 Ba	19.1 Aa

[†] Means in a row followed by the same capital letter are not significantly different according to Fischer's protected LSD (p=0.05).

[‡] Means in a column followed by the same small case letter are not significantly different according to Fischer's protected LSD (p=0.05).

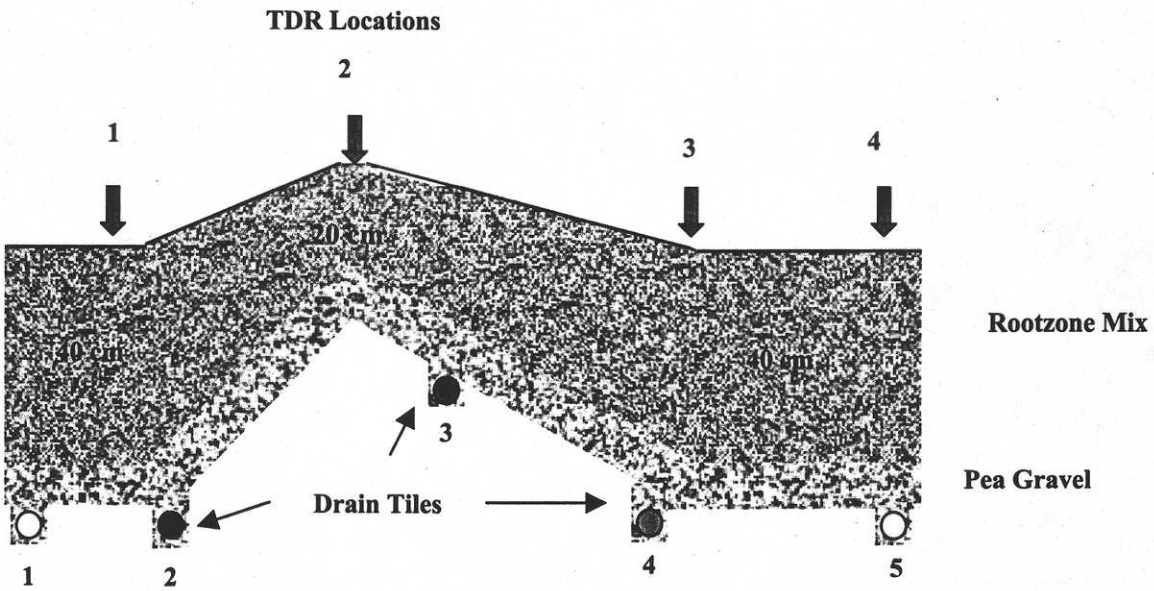

Figure 1. Cross section through the variable depth rootzone, MSU green.

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