Organic Amendment and Construction Method Effects on the Moisture Relations of Simulated Putting Greens

By David C. Rappold

The primary purpose of this study was to enhance understanding of the extent to which root zone mix composition and the absence of the intermediate ("choker") sand layer modify water retention, the percolation rate, and capillary rise of simulated putting greens. A secondary purpose was to determine to what extent bentgrass establishment influences putting green percolation rates.

METHODS

The simulated putting greens were constructed in 6-inch diameter, 15-inch high sec-tions of PVC pipe in the manner recommended by the USGA. Physical characteristics of the root zone mixes used, their organic matter contents based on weight loss upon ignition, and bulk densities in the greens are shown in Table 1. The pea gravel used consisted of predominantly rounded particles and was of sufficient fineness to permit elimination of the coarse intermediate sand layer. Sand suitable for the intermediate layer was obtained by screening out the finer material from mason's sand.

After packing, each green was wet until water flowed out of the bottoms of the cylinders. The greens were then allowed to drain for 24 hours, after which moisture content was measured with a time domain reflectometer (TDR) at depths of 2, 4, 6, 8, and 10 inches. Percolation rates were then measured with a falling head permeameter. The greens were then seeded to creeping bentgrass and the green surfaces kept moist until grass emergence was complete. After a growth period of 7 days, sufficient water was added to obtain drainage. Twenty-four hours later, TDR readings were taken and percolation rates measured. Capillary rise was measured in the laboratory with columns of root zone mix packed to the same bulk densities as in the greenhouse and then allowed to dry before water was introduced at the bottoms of the columns to saturate the pea gravel or pea gravel plus intermediate sand layer.

OBSERVATIONS

Effects of Root Zone Mix Organic Matter

The Greensmix 80/20 and Wolosek 80/20 have very similar particle size distributions, but differed substantially (1.2 vs. 3.3%) in organic matter content (Table 1). This may account for the observation that, when averaged over all depths (Table 2), the Wolosek 80/20 retained 36% more water than did the Greensmix 80/20. When the Greensmix 80/20 was amended with Canadian sphagnum peat to provide 3.1% organic matter (Table 1), average root zone moisture was increased only 7.7%.

The difference in moisture retention between the Greensmix 80/20 and Wolosek 80/20 was not, therefore, solely due to a difference in organic matter content. It is thought that type of organic matter also played a role. The peat in the Greensmix 80/20 is highly fibrous and brown in color, while that in the Wolosek 80/20 has very little fiber and is black in color.

The higher organic matter content of the Wolosek 80/20 likely accounts for the lower bulk density of this mix as compared to the Greensmix 80/20 (Table 1). While this signifies greater total porosity in Wolosek 80/20, the lower percolation rate and greater capillary rise of this mix (Table 2) suggests that the increase in porosity was mainly due to greater numbers of capillary pores.

Effects of the Intermediate Sand Layer

Although not confirmed by surveys, the perception is that most USGA-type putting greens are being constructed without the intermediate sand layer. In the present study, leaving out this layer has variable effects on the moisture relations of putting greens.

Table 1. Particle size distribution, organic matter content, and bulk density of the root zone mixes used.

Root zone mix	Fine gravel	Very coarse sand	Coarse sand	Medium coarse sand	Fine sand	Very fine sand	Silt +clay	Organic matter	Bulk density
	% by weight								$g\ cm^{-3}$
Greensmix 80/20	3.5	4.5	20.5	57.5	13.5	0.3	0.2	1.2	1.66
Greensmix 70/30	3.5	4.7	21.2	56.9	13.2	0.3	0.2	3.3	1.50
Wolosek 80/20	2.0	5.0	30.5	54.0	8.0	0.3	0.2	3.1	1.53

Table 2. Moisture relationships of simulated putting greens varying in construction materials and methods.

Root zone mix	Choker layer?	Water retention (inches) 2	4	6	8	10	Percolation rate Before seeding	After establishment	Capillary rise
		% volume					inches/hour		inches
Greensmix 80/20	Y	4.9	6.8	19.6	20.4	22.6	12.8	11.6	1.5
	N	4.6	6.8	23.4	29.4	30.9	14.4	14.5	1.9
Wolosek 80/20	Y	8.1	18.1	27.2	30.6	30.8	7.5	3.0	2.4
	N	5.6	17.4	28.7	31.6	32.3	10.8	3.4	3.2
Greensmix 70/30	Y	8.1	11.5	17.3	24.9	29.8	7.1	7.4	2.3

In the case of the Greensmix 80/20, leaving out the intermediate sand layer increased the average moisture content in the green from 14.9 to 19.0% (Table 2). However, leaving out the layer in the Wolosek greens had no influence on the average amount of water retained.

Percolation rates of the Greensmix and Wolosek greens were increased by leaving out the intermediate sand layer (Table 2). The increases in percolation rates ranged from 12.5 to 30.0%. This observation may relate to unconfirmed reports that greens drain more rapidly when constructed without the intermediate sand layer.

Absence of the intermediate sand layer also increased capillary rise of water in the two root zone mixes (Table 2). At first glance, the differences do not seem to be very great, but do represent 27 to 33% increases in height in the greens to which water will rise from a saturated pea gravel and/or intermediate sand layer.

Bentgrass Root Effects on Putting Green Percolation

A common perception is that laboratory measurements of root zone mix percolation rates do not accurately predict field percolation rates. One reason given for this is that grass rooting is predominantly in the larger, non-capillary pores, which significantly alters putting green percolation rates.

As shown in Table 2, bentgrass establishment did alter percolation rates, but the effect was root zone mix dependent. Bentgrass grow-in reduced the percolation rate of the Greensmix 80/20 greens by only about 8%. In contrast, percolation of the Wolosek greens was reduced 60 to 68%.

CONCLUSIONS

The amount and type of organic amendment used in putting green root zone mixes can markedly affect their moisture relations. Increasing the organic matter content from 1.2 to 3.3% may increase the amount of water retained by 30% or more, reduce percolation rates by 50% or more, and increase the height of water capillary rise by approximately 65%. The magnitudes of these effects are influenced by the type of organic amendment as well as amount.

Leaving out the intermediate sand layer in USGA putting greens can increase water retention by 25% or more, increase percolation rates by 12 to 30%, and increase water capillary rise by 27 to 33%. The actual amount of change is influenced by the type and amount of organic amendment in the root zone mix.

Turfgrass establishment on putting greens has been reported to decrease percolation rates by 40 to 50%. In this study, where bentgrass growth was limited to 7 days after emer-gence, declines in percolation rates ranged from 8 to 68%, the actual amount depending on the type and amount of organic amendment used in the root zone mix.

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