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How do sand-soil-compost rootzones work for athletic fields?

DURING THE PAST 20 YEARS, the sports turf industry has experienced significant growth due to increased demand for quality playing fields. During this time there was movement away from natural soil fields to more sand-based fields in an effort to reduce challenges of overuse. One challenge for turf managers working sand-based fields though is that surface stability can sometimes be lacking.

With sports such as football, extreme shearing and torque can be placed on turfgrass plants both at and below the surface. These forces are also exerted on the rootzone. When sand is moist, it is relatively stable, though it is a media lacking cohesion. Therefore, increases in surface instability can be linked to sand.

Selection of materials to formulate the appropriate rootzone medium is one of the most important factors influencing field performance. In a desire to achieve an ideal rootzone, more research is needed on rootzones that incorporate sand, soil, and organic amendments in varying ratios to determine a standard mix. One objective would be the comparison of selected soil- and sand-based root one mixtures for their response to surface traction, surface hardness, infiltration and turf appearance. Work conducted at the University of Missouri Turfgrass Research Center earlier this decade in Columbia, studied sand-soil rootzones that combined both laboratory analysis and field investigations.

>> Table 1. Description of the treatments for the experiment along with organic matter content.

Treatment Name	Volume Ratio[1]	Rootzone Components	Organic Matter Content (%)
SandP10	90/10	Sand/Peat[2]	0.5
SandSoil10	90/10	Sand/Soil[3]	0.2
SandSoil15	85/15	Sand/Soil	0.33
SandSoil20	80/20	Sand/Soil	0.36
SandSoil30	70/30	Sand/Soil	0.40
Soil	100	Soil	0.21
SandSoil20C5	75/20/5	Sand/Soil/Compost[4]	0.70
SandC15	85/15	Sand/Compost	1.10
Sand	100	Sand	0.10

[1]Incorporated on a volume to volume basis.
[2]Sphagnum peat moss.
[3]Mexico silt loam, A horizon material (28.3% sand, 53.5% silt, 18.2% clay).
[4]Fine grade, sterilized steer manure.

>> Table 2. Physical properties of the rootzone mixes at initiation of the experiment.

Treatment	Bulk Density	Saturated Hydraulic Conductivity	Total Porosity	Air-filled Porosity	Capillary Porosity[1]
	g/cm^3	in/hr	% (v/v)	% (v/v)	% (v/v)
SandP10	1.58	17.06	40.38	22.25	18.13
SandSoil10	1.61	9.19	39.25	24.73	14.52
SandSoil15	1.59	6.78	40.00	26.55	13.45
SandSoil20	1.63	4.70	38.49	24.47	14.02
SandSoil30	1.66	3.68	37.36	24.26	13.10
Soil	1.18	0.07	55.47	17.79	37.68
SandSoil20C5	1.60	5.35	39.62	22.46	17.16
SandC15	1.52	12.88	42.64	21.60	21.04
Sand	1.62	15.70	38.87	27.26	11.61

[1]Capillary porosity is determined from water retention at -12 inches water potential.

Rootzone treatments

Rootzone treatments selected for the study are listed in Table 1, which included sand + organic amendments, soil, sand + soil and sand-only rootzones. The sand used for the sand-based rootzone treatments met the USGA standard recommendations for particle size distribution. The Soil rootzone treatment consisted of 100% topsoil removed from near the study site, since silt loam topsoil is very common throughout the Midwestern US. Sand/soil mixes ranged from 10% to 30% soil by volume and are referred to as SandSoil10, SandSoil15, SandSoil20, and SandSoil30 treatments. Three additional sand-based treatments included compost (fine grade, sterilized steer manure) or peat: SandSoil20C5 (20% soil, 5% compost), SandC15 (15% compost), and SandP10 (10% peat). The nine rootzones were mixed off-site and trucked into place on a laser graded sub-base. Each plot was 10x10-feet and measured 6 inches in depth. Plots were sodded using a blend of Abbey, Viva, Buckingham, and Ascot varieties of Kentucky bluegrass.

Laboratory analyses were conducted to determine physical characteristics of the rootzone treatments and included saturated hydraulic conductivity, bulk density, and rootzone water retention. Total porosity was calculated using bulk density, capillary porosity was determined from water retention, and air-filled porosity was calculated as the difference between total and capillary porosity.

Field measurements included turfgrass quality (scale of 1 to 9, where 1=dead or dormant, 9=ideal), shock attenuation measurements (with a 5 lb portable Clegg Impact Tester), surface traction measurements (using a shear unit developed by Canaway and Bell), and infiltration (using double ring infiltrometers).

Sand-soil rootzones maintain adequate performance characteristics after 2 years that allow for safe, playable fields

Physical property results of the rootzone mixes are shown in Table 2. The treatment effects on saturated hydraulic conductivity were most pronounced ranging from 0.07 to 17 inches/hour. The lowest values were for the Soil treatment and the highest for the SandP10 and Sand treatments, which were expected. Evaluating the logarithm of saturated hydraulic conductivity versus the amount of silt plus clay in the rootzone mix (Sand, SandSoil10, SandSoil15, SandSoil20, SandSoil30 and Soil treatments) provided a linear relationship (coefficient of determination of 0.998). This illustrates the effect that additions of silt plus clay have on reducing the relative transport of water through the rootzone. Results from this study are similar to those reported by Jason Henderson in 2005 while at Michigan State. Henderson indicated that only mixes with less than 10% silt plus clay produced acceptable drainage levels (6 to 8 in/hr) which was the case for the SandSoil10 treatment (7.4% silt + clay) and the SandSoil15 treatment (11.0% silt + clay).

Rootzone hardness

Mean shock attenuation (Gmax values, dimensionless unit) had few differences in 2000. The SandSoil20 and SandSoil20C5 treatments had significantly higher shock attenuation readings on the initial collection date (late summer, 2000); the Sand treatment had the lowest value. One year after establishment, SandSoil15, SandSoil20, SandSoil30, Soil, SandSoil20C5, SandC15, and Sand treatments had higher Gmax values. SandSoil15, SandSoil20, SandSoil30, Soil, SandSoil20C5, and SandC15 also had higher Gmax values in early fall of 2001; these treatments all had greater than 15% fine particles. Although treatments did show differences in 2001, most treatments were still within acceptable ranges (60-80 Gmax). Treatments in the study that never reached 80 Gmax included the SandP10, SandSoil10, and SandC15. SandSoil15, SandSoil20, SandSoil20C5, and Sand treatments exceeded 80 Gmax on only one of the six sampling dates. The SandSoil30 and Soil treatments exceeded 80 Gmax on two of the six sampling dates. In 2000, the average Gmax value for all treatments increased from about 50 to 60 from late summer to fall. In 2001, the average Gmax value exceeded 80 one year after establishment.

In fall of 2000, significantly higher shear values were measured for the SandSoil15, SandSoil20, and SandSoil30 treatments relative to the Sand treatment. Surface traction improved throughout the study. Traction readings increased over the length of the study for all treatments and were within acceptable ranges even though significant differences among treatments were not observed on three of five sampling dates. Our study found a range of 27.3 lbf•ft (Sand - fall, 2000) to 47.9 lbf•ft (SandSoil30 - fall, 2001). An additional observation occurred with the dense turfgrass cover of this study; the shear instrument sheared the grass plants and thatch layer but not the roots or rooting material, giving inconclusive readings of overall system traction. Lack of simulated traffic and a dense turf cover were factors that contributed to limited measurable differences among treatments.

Water infiltration rates

The Soil treatment had the lowest infiltration rates for the three sampling dates ranging from 75 to 233 times lower than the next lowest treatment. This result was expected, due to the smaller pore sizes of the silt loam soil used in this study compared to the other treatments. Evaluating the logarithm of infiltration rate for the three sampling dates versus the amount of silt plus clay in the rootzone mix (Sand, SandSoil10, SandSoil15, SandSoil20, SandSoil30 and Soil treatments) provided a linear relationship (coefficient of determination of 0.963). This illustrates the effect that additions of silt plus clay have on reducing the relative transport of water through the rootzone. In comparing the regression relationship for field infiltration with that for saturated hydraulic conductivity (previously discussed), a similar relationship was found with the slope decreased by about 20% and the intercept increased by about 1% for the field infiltration function. The linear correlation between the saturated hydraulic conductivity and average field infiltration values was very close.

The Sand and SandP10 treatments had the highest infiltration rates and were not significantly different; however, the SandSoil10 treatment was also not significantly lower than these two treatments for both evaluation dates in 2000. In addition, the SandSoil15 treatment was not significantly lower than the Sand and SandP10 treatments on the second evaluation date in 2000 and the Sand treatment in 2001. It has been suggested that soil can be incorporated with sand to a maximum amount of 15-20% by volume (for soil in this study it would be 11.0% to 14.6% silt + clay) before infiltration rates would reach unacceptable levels (< 6 in/hr); this supports the data from Jason Henderson in 2005 where he again indicates that mixes should have less than 10% silt plus clay. The SandSoil10 and SandSoil15 treatments support those findings.

Quality differences among treatments did occur throughout the study. In 2000, treatments with 20% or greater soil and treatments with compost additions were not significantly different from the highest values. This was most likely due to increased moisture retention compared to the SandP10 and Sand treatments. The SandSoil10 treatment was at or above the minimum acceptable level of 5.0 in 2000, but below acceptable levels in 2001. On all rating dates, the Soil treatment had the highest quality. Quality for the SandC15 treatment was not significantly different than the highest level for any date and was attributed to higher CEC (data not shown) and better soil physical properties (Table 2). ■

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Quick summary

An evaluation of surface hardness, traction, infiltration and turfgrass quality for soil-sand-compost rootzones during the non-play establishment phase of a Kentucky bluegrass field found few differences in surface hardness or traction. The SandSoil10 treatment allowed similar infiltration to the SandP10 and Sand treatments and higher infiltration compared to other soil-based rootzones; however, this treatment experienced some low turfgrass quality values.

Compost treatments increased turfgrass quality but these had lower infiltration than the SandP10 and Sand treatments. Relative to cost savings, results suggest that 10 to 15% volume replacement of silt loam soil with a sand mix will not substantially reduce infiltration and will maintain turfgrass quality. The major advantage of using soil with sand-based rootzones is a decrease in the frequency of irrigation and fertilization.

While most treatments gave satisfactory turfgrass quality, absence of player and equipment traffic precludes any prediction for long-term success. Follow-up research that emphasizes player traffic on sand-soil rootzones should provide additional information in making long-term decisions. The major contribution this research offers the athletic field industry is a sand-soil rootzone study that combines both laboratory analysis and field investigations. In conclusion, these sand-soil rootzones appeared to maintain adequate performance characteristics after two years that would allow for safe, playable athletic fields.