Executive Summary

Evaluation Of New Technologies In Construction And Maintenance Of Golf Course Greens

Daniel C. Bowman, Thomas W. Rufty, Jr., Arthur H. Bruneau,
Richard J. Cooper, and D. Keith Cassel
North Carolina State University

Three very uniform sands (coarse, medium and fine) were amended with Irish sphagnum peat, Profile®, Greenschoice®, Isolite®, and Ecolite® at 10% and 20% by volume. Soil physical properties, including bulk density, saturated conductivity, air-filled pore space and water-filled pore space were determined, as were soil moisture profiles. The results indicate that the inorganic amendments did improve soil moisture holding capacity, but much less so than did the peat. Moisture retention curves indicate that a considerable portion of the amendment-held water is unavailable to roots. Saturated hydraulic conductivity was high in all soils, probably due to the highly uniform sands used.

None of the amendments reduced nitrate leaching, but Ecolite® and Profile® were very efficient at retarding ammonium leaching. Rate and positioning effects of amendment on nutrient leaching have been determined. These data have implications for fertility practices in new putting greens.

The effect of the intermediate gravel layer and gravel size (fine and medium) on soil water retention was investigated. Soil water content was reduced by the presence of the gravel layer but was unaffected by gravel size. The gravel layer functioned essentially as a continuation of the sand rootzone with regards to drainage. Treating the gravel with a hydrophobic sealant reduced drainage and increased water content in the sand profile. This indicates that there is adequate continuity of water across the sand/gravel interface to permit normal drainage, and raises question about the concept of the perched water table.

Sixty mini-putting greens were used to evaluate SubAir® treatments. Air evacuation or injection had little or no effect on soil temperature. Rootzone gases were also unaffected by SubAir® treatments, with O_2 and CO_2 remaining at near-optimum levels throughout the season. SubAir® treatments were effective at reducing soil moisture throughout the profile, by approximately 3-4%.

Soil microorganism populations increased rapidly during the first months following seeding, independent of rootzone mix, and have remained fairly stable thereafter. It appears that the concept of a sand rootzone being "sterile" and in need of microbial inoculation is suspect. Some data indicate that seasonal root dynamics may regulate microbial activity by altering the amount of sugars and other substrates in the rootzone.

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Laboratory evaluations of sand size, inorganic amendments and sphagnum peat moss for their influence on rootzone physical properties and nitrogen retention.

The phase of this study involving sand size, amendment rate and amendment incorporation depth for amendment effect on physical properties and nitrogen retention is complete. Our data indicate that although inorganic amendments significantly alter and improve the physical properties of unamended sands they are inferior to sphagnum peat moss for increasing water retention even when used in droughty sands at 20% by volume. Regarding nitrogen retention, of the amendments tested, the inorganic amendments Ecolite and Profile were most effective at reducing ammonium losses from rootzone mixtures fertilized with ammonium nitrate. None significantly decreased nitrate leaching.

Laboratory investigations on the influence of sub-surface gravel size on water retention in sand rootzones.

The influence of the intermediate gravel layer and also gravel size (fine and medium) on water retention by three typical sands (uniform medium, medium-coarse, and uniform coarse) was investigated. Simulated rootzones were constructed with 30 cm of each mixture over each gravel sub-layer. In-situ moisture characteristic curves of each rootzone mixture were determined. Sand size had the most significant effect on water retention and ranked medium>even>coarse with peat moss significantly increasing water retention when incorporated into each sand. Soil water content was reduced by the presence of the gravel layer but was unaffected by gravel size. A 30 cm sand rootzone over a 10 cm gravel layer had essentially the same moisture profile as a continuous 40 cm sand rootzone. Treating the gravel with a hydrophobic sealant reduced drainage and increased water content in the sand profile. This indicates that there is adequate continuity of water across the sand/gravel interface to permit normal drainage, and raises question about the concept of the perched water table.

Field evaluations of sand-based rootzones amended with inorganic amendments and sphagnum peat moss and the effect of sub-surface water evacuation and air-injection on rootzone performance.

This phase of the study evaluated the effects of soil amendment and drainage treatment. Drainage treatments are: conventional gravity drainage, water evacuation, and water evacuation followed by air-injection.

Turfgrass Establishment: Creeping bentgrass establishment was slow during the early months of the study. This was primarily due to the medium/coarse sand used for construction. Although this sand alone would be undesirable under most circumstances it provided an excellent test for amendment performance. Seedlings on amended rootzones generally established better than on unamended sand with sphagnum peat being the most effective amendment. The inorganically amended rootzones were superior to unamended sand but seedlings reached full cover less rapidly than with sphagnum peat as an amendment.

Water and Gas Contents: Sub-surface water evacuation significantly reduced soil water content. However, the reductions were small, ≈ 3-5%, which may not be agronomically important in this particular sand. This demonstrates that the SubAir technology functions as advertised and that it may be useful in removing excess water from a finer textured, and thus wetter rootzone. With the single exception of one sampling date, the gas contents of the rootzones remained very close to atmospheric concentrations (20% O_2, <1% carbon dioxide) throughout both growing seasons. This was probably due to lack of significant thatch on the young turf that might restrict oxygen diffusion, and the highly porous structure of the sand.

Turfgrass Quality and Seasonal Rootmass: Turfgrass quality was not affected by drainage treatment, but was affected by rootzone composition. Turf on unamended sand had lower quality than when grown on amended rootzones. Rootzones amended with sphagnum peat, Ecolite and Profile performed similar and Greenschoice amended sand had intermediate quality between unamended sand and the other inorganic amendments. Drainage treatment also had no effect on rootmass. Rootmass declined approximately 40% between May and September, most likely due to the extremely high and prolonged soil temperatures (> 30 °C) observed at both 10 and 20 cm rootzone depths during July and August.

Soil Microbial Dynamics in sand-based rootzones amended with sphagnum peat moss or inorganic materials.

This field study was conducted to monitor the microbial properties of five newly constructed sand-based rootzone mixtures planted to creeping bentgrass during the first two years of turfgrass growth. Microbial populations were determined for bacteria, fungi, *Actinomycetes* spp., and aerobic spore formers (*Bacillus* spp.) using selective media. Additionally, ammonium and nitrite oxidizers and denitrifiers were estimated by the most probably number method. During the second year, microbial biomass carbon was determined by the fumigation extraction method.

Within six months of seeding, bacteria exceeded 10^6 per gram of dry soil, similar to typical levels in a mature putting green. Bacteria were the most numerous of the microorganisms, followed by actinomycetes, fungi, and *Bacillus* spp., respectively. Initially, fluorescent *Pseudomonas* spp. were more numerous than fungi, but this was reversed after six months. First year microbial populations declined slightly during the summer, perhaps due to temperature effects or the declining root system. Populations were relatively steady during year two. This may be due to an accumulation of organic substrate and the increased presence of survival structures. In general, rootzone amendments had little effect on microbial populations, suggesting that environmental factors and perhaps the actively growing root system have a more significant effect on promoting microbial activity.

Microbial biomass C (year two) displayed a pronounced seasonal pattern. Biomass was highest in the spring at >50 μg C per gram soil but declined sharply in early summer to <20 μg C per gram soil. It is intriguing to speculate that microbial populations are intimately linked to root exudation, and that the rapid decline could then be due to a reduction in root growth or leakage. However, the cause of this decline is unknown, and we are continuing our measurements to determine if a similar pattern is observed during year three.