Executive Summary

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

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The initial study investigating the effects of inorganic amendments on sand-based rootzone mixes has been completed. Three very uniform sands (coarse, medium and fine) were amended with Irish sphagnum peat, Profile®, Greenschoice®, Isolite®, and Ecolite®. The amendments were used at 10% and 20% by volume. PVC cylinders, 30 cm deep, were filled with the various mixes. Soil physical properties, including bulk density, saturated conductivity, air-filled pore space and water-filled pore space were determined. Moisture profiles were generated with depth of the soil columns. The results indicate that the inorganic amendments did improve soil moisture holding capacity, but much less so than did the peat. Saturated hydraulic conductivity was high in all soils, probably due to the highly uniform sands used.

Nutrient retention studies indicated that none of the amendments reduced nitrate leaching, but that Ecolite® and Profile® were very efficient at retarding ammonium leaching. Rate and positioning effects of amendment on nutrient leaching is presently under investigation. These data have implications for fertility practices in new putting greens.

The field installation, consisting of 60 mini-putting greens, has been completed. Each green is equipped with its own drainage system, which will also permit application of SubAir® treatments. The plots were seeded October 3 with L93 bentgrass. Germination was adequate in all but the pure sand plots, and it is probable that they will need to be reseeded in the spring.

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Goals:

- *Determine the laboratory and field physical and microbiological properties of sand amended with organic and inorganic materials.*
- *Determine creeping bentgrass morphological and physiological responses under low oxygen situations.*
- *Evaluate soil physical and plant responses to forced air injection and water evacuation.*

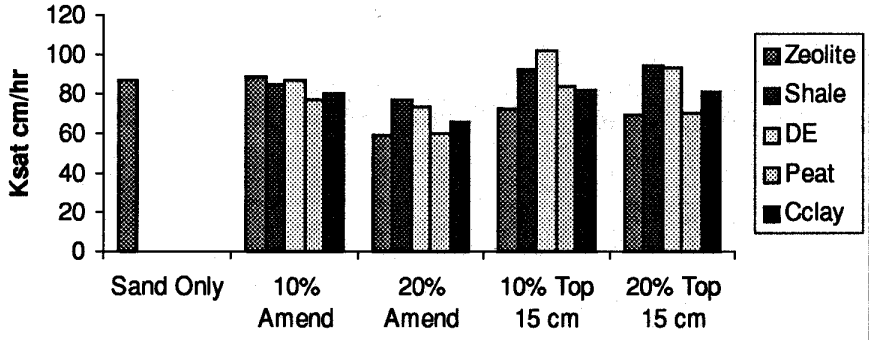
Summer months in the Southeastern United States are characterized by hot, humid conditions with periods of heavy rainfall. These environmental conditions are unfavorable for sand based putting greens which are designed to maintain a perched water table. The perched water table may create a zone of limited aeration. Some putting greens may not dry out sufficiently, due to high humidity and low evapotranspiration, and the oxygen levels may remain low for extended periods. This study is designed to investigate the use of alternative construction materials and technologies to improve or maximize aeration at lower depths in the putting green rootzone and also to quantify creeping bentgrass physiological response to low soil aeration.

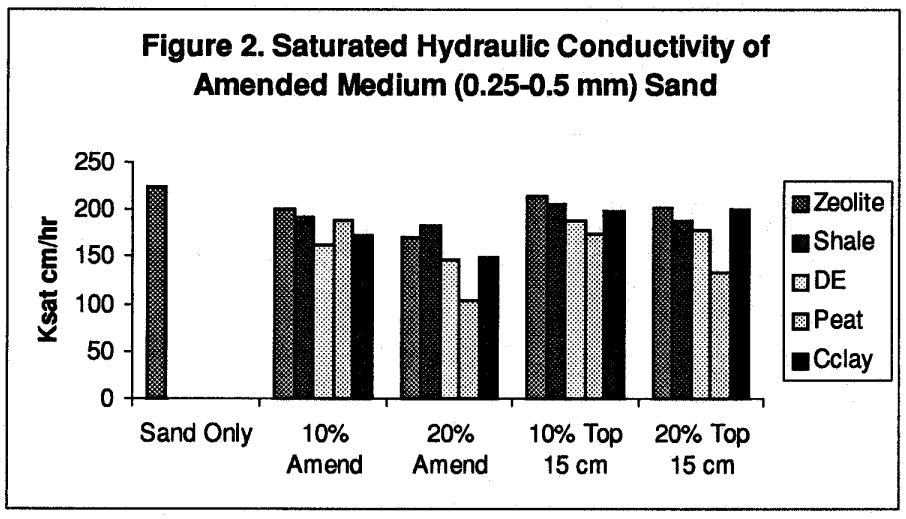
Peat moss has been traditionally mixed with sand to increase nutrient and water holding properties of putting green soils. There is increased interest in the use of peat substitutes, particularly the inorganic amendments, because they tend to be stable compared to peat. Thus, these materials should have a permanent effect on soil properties. A laboratory study was conducted in 1997 to evaluate four inorganic amendments: calcined clay, diatomaceous earth, expanded shale and zeolite

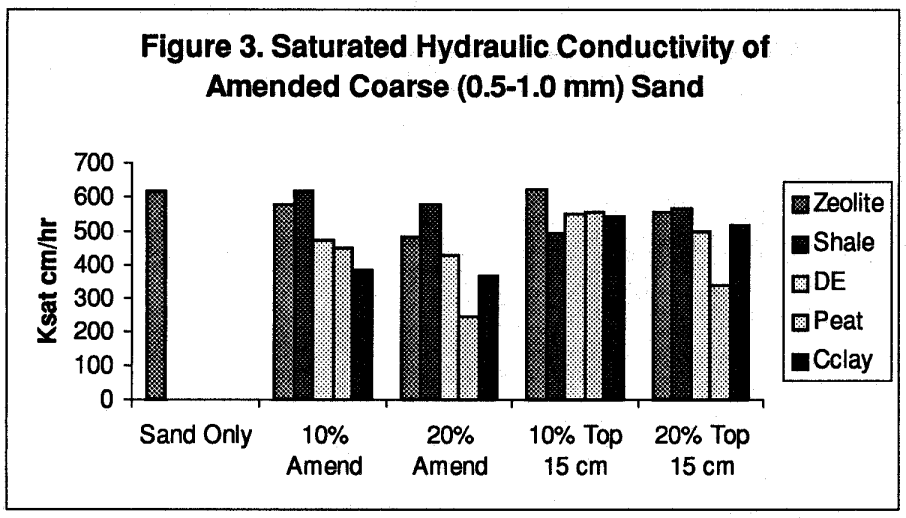
combined with sands from three size classes; coarse (1.0-0.5 mm), medium (0.5-0.25 mm) and fine (0.25-0.1 mm). Amendments were evaluated at the following rates: 10 and 20% amendment (v:v) throughout the entire 30 cm rootzone and 10 and 20% amendment incorporated only in the top 15 cm. The inorganic amendments were compared to 100% sand and sand combined with Irish sphagnum peat at the same mixture ratios.

Physical properties of these rootzone mixtures and the amendments alone were analyzed. Saturated hydraulic conductivity values for all mixtures were well above the recommended levels for accelerated conductivity. This was attributed to the extreme uniformity associated with the narrow sand classes used. In most cases amendment decreased conductivity, compared to 100% sand, but never below recommended levels (Figure 1,2,3). Amendment particle size appeared to be highly linked to conductivity reductions. Peat moss caused the greatest reduction followed by the relatively medium textured calcined clay. The expanded shale, diatomaceous earth and zeolite particles tended to be relatively coarse textured and conductivity reductions were not affected as much.

Figure 1. Saturated Hydraulic Conductivity of Amended Fine (0.1-0.25 mm) Sand







To characterize moisture retention with depth, drained columns were sampled for mass moisture content in 2 cm increments from 2 cm to 26 cm below the rootzone surface. Sand amended with peat moss resulted in the greatest moisture in all sand classes. Inorganic amendments had the greatest effect on moisture retention in the coarse textured sand. Compared to 100% sand, inorganic amendment increased volumetric water retention 5-7% depending on amendment. However, inorganic amendments were never superior to sphagnum peat which increased water retention to roughly 10-12 % compared to pure sand. Some small improvements, in aeration 3-4% volumetric increases, were

observed in the medium and fine textured sand below 20 cm in the rootzone. This could be advantageous for improved bentgrass rooting particularly in summer months, when soil aeration may be a problem.

Preliminary nutrient retention studies have been conducted to evaluate the amendments for reducing ammonium nitrate leaching. Initial results indicate that calcined clay and zeolite have a very strong affinity for the monovalent ammonium ion. The other amendments have limited nutrient retentive properties in comparison to these materials. However, these amendments do improve the nutrient retention of pure sand. Further studies are underway. From the physical property and nutrient studies it appears that increasing amendment amounts has a positive influence on moisture and nutrient holding capacities of most sands classes.

A second aspect of this study has been initiated using nutrient solution culture to determine the effect of low oxygen conditions on creeping bentgrass root morphology and physiology. This work is been conducted in the N.C. State Phytotron. Initial results indicate that all cultivars of creeping bentgrass investigated (Penncross, L-93, G-2, A-4, Providence and Crenshaw) produce lysigenous aerenchyma tissue when grown under low oxygen conditions. Aerenchyma is thought to increase oxygen diffusion down a root and improve root oxygen status under anoxia. It also appears there are differences in root cortical cell size between creeping bentgrass cultivars. However, no difference in root weight or clipping yields was noticed between cultivars following aerenchyma formation. Summer bentgrass decline in the field is associated with reduced root growth. It is conceivable that aerenchyma may make bentgrass more susceptible to traffic damage or other stresses. Future studies will may address this possibility.

Based on laboratory information rootzone mixtures were selected and installed in the field at the N.C. State, Turfgrass Research Laboratory, in Raleigh, during late summer/early fall of 1997. Five rootzones; 100% quartz sand and 90% sand combined with four amendments at 10% (v:v) were installed in 60 test greens. The amendments selected for field investigation were calcined clay, expanded shale, zeolite and sphagnum peat moss. These five rootzones will be evaluated under three drainage situations; gravity drainage, water evacuation and water evacuation combined with air injection (Sub-Air), scheduled to begin late spring 1998. Rootzone properties to be measured include soil gas composition, various physical properties. In addition microbial populations will be monitored comparing the inorganic amendments ton 100% sand and sand peat mixtures through the grow-in period. Test greens were seeded October 6, 1997 and grow in practices have commenced.