Significantly more NH_4^+-nitrogen leached from pure sand than for 20 percent (v:v) amended mixtures. Leaching losses ranked in decreasing order: pure sand > Greenschoice = Isolite > Peat > Profile > Ecolite. The most effective amendments, Profile and Ecolite, reduced NH_4^+-nitrogen leaching compared to pure sand by 75 and 88 percent, respectively.

Further studies with Ecolite and Profile had the following results. Increasing Profile and Ecolite rates from 1 to 20 percent resulted in stepwise decreases in NH_4^+-nitrogen loss. Although 20% amendment may be the most effective rate for retaining NH_4^+, it may not be economically feasible. Amendment at 10 percent significantly reduced NH_4^+-nitrogen leaching by 63 and 79 percent compared to pure sand for Profile and Ecolite, respectively.

Ecolite and Profile (10% v:v with sand) incorporated at three rootzone depths significantly decreased NH_4^+-nitrogen losses by approximately 25 percent, compared to pure sand. Again, there was a step-wise reduction of NH_4^+-nitrogen leaching reduction with increasing amendment depth. Incorporation of 10 percent amendment through the entire 30 cm rootzone resulted in the least NH_4^+-nitrogen leaching loss, with a significant difference noted between Profile and Ecolite. Losses were decreased by 65 and 80 percent for Profile and Ecolite, respectively.

Large quantities of $N0_3^-$-nitrogen(>90%), were recovered in leachate from all treatments under all experimental conditions. Peak $N0_3^-$-nitrogen concentrations of over 70 mg L^{-1} in pure sand leachate were observed.

Grow-in and Cultural Practice Inputs on USGA Putting Greens and Their Microbial Communities

University of Nebraska

Dr. Roch Gaussoin

Start Date: 1996
Number of Years: 5
Total Funding: $100,000 (Co-funded with the GCSAA)

Objectives:

1. *Evaluate grow-in procedure effects on putting green establishment and performance, and develop criteria and recommendations for new putting green readiness for play.*
2. *Determine grow-in procedure impacts on root zone physical and chemical properties.*
3. *Evaluate post grow-in cultural practice effects on putting green long-term performance.*
4. *Determine temporal and spatial (by depth) patterns of rhizosphere community development in golf greens during accelerated and controlled grow-in of select root zone mixes and during long-term green maintenance.*

The five year project is composed of three phases, One: Construction and Grow-in, Two: Microbial Community Assessments, and Three: Grow-in Procedure Impacts on the Long-term performance of the Putting Green. Phases I and II will span three-year periods, while Phase III will involve experiments repeated over the five years of the project.

Two separate USGA-specification root zone mixtures - one composed of sand and peat (80:20 ratio) and one a combination of sand, soil, and peat (80:5:15 ratio) - were developed in 1996. Materials used for construction complied with USGA Greens recommendations for physical characteristics and organic matter content. First year greens (1997 Greens) were constructed in late summer of 1996, allowed to settle over the winter, and were seeded with Providence creeping bentgrass (1.5 lbs/1000 ft^2) in the spring (May 30) of 1997. Second year greens (1998 Greens) were constructed in the summer of 1997, allowed to settle over the winter, and were seeded with Providence creeping bentgrass (1.5 lbs/1000 ft^2) in the spring (May 27) of 1998.

Preliminary results indicate the following trends. Microbial biomass was not affected by root-zone mix or grow-in procedure on plots established in 1997. Microbial biomass increased over 200% from spring to fall and decreased 40-60% as sampling depth increased. Water infiltration from these same plots were- not affected by root-zone mix or grow-in procedure when measured in 1998.

For two consecutive years, it was found that higher inputs would initially increase cover during grow-in. However, this increase may not translate to earlier opening for play if environmental stress conditions occur that result in damage to lush, immature turf.

The root zone mix containing soil established faster and recovered from environmental stress better than a soil-less mix. A soil-containing mix also will be harder and may result in longer ball roll distance. Addition of soil to the root zone mix did not effect water infiltration during the establishment year.

Assessing Differential Root Zone Mixes for Putting Greens Over Time Under Two Environmental Conditions

Rutgers/Cook College

Dr. James Murphy

Start Date: 1996
Number of Years: 5
Total Funding: $100,000 (Co-funded with the GCSAA)

Objectives:

1. *Evaluate grow-in procedure effects on putting green establishment and performance, and develop criteria and recommendations for new putting green readiness for play.*
2. *Determine grow-in procedure impacts on root zone physical and chemical propeties.*

3. *Evaluate post grow-in cultural practice effects on putting green long-term performance.*

Field Research. The primary objective of the 1998 growing season was to evaluate the establishment of creeping bentgrass as affected by the sand size distribution and amendment used in root zone mixes. The 37 root zone treatments constructed in either one or two microenvironments of the field research facility at North Brunswick, NJ were seeded to L-93 creeping bentgrass turf on 31 May 1998.

Location Effect. Environment (location) did affect establishment ratings for a few observation dates; however, there was not a strong influence on the establishment of creeping bentgrass in these two studies. It is expected that environment will have a greater effect on performance of turf maintained at a lower cutting height (< 5/32-inch) and receiving compaction treatment during 1999. No significant interaction between location and root zone treatment was observed during the 60-day evaluation period of bentgrass establishment.

Sand Size Distribution Study. Two finer sand size distributions (not meeting USGA guidelines) had a better rate of establishment than coarser sands. This was likely due to better moisture retention and subsequently better nutrient availability in those finer sands. The coarsest sand size established well; however, after 60 days, the performance of the plots declined. This may be an initial indication of the limitations of coarser sands.

Amendment Study. A greater affect on the establishment of bentgrass was observed in the amendment study compared to sand size distribution study. Generally, increasing the rate of amendment with soil and peat enhanced establishment. This was likely due to increased fertility and/or moisture retention in these mixes. However, establishment ratings for the 20 percent soil or peat treatments 40 days following establishment were similar to respective lower amendment rate plots. This may indicate the development of stresses associated with low air-filled porosity in the root zone. As expected, the greater fertility of ZeoPro plots enhanced establishment. Both ZeoPro and Profile (inorganic) amendments enhanced establishment up to 40 days compared to unamended sand. ZeoPro maintained high establishment ratings up to 60 days following treatment; whereas, Profile plots were more similar to the unamended sand after 40 days. Additional establishment data for all amendment treatments constructed in the enclosed environment are currently being summarized.

Laboratory Research. Research studies in the laboratory have been conducted to evaluate the influence of sample preparation on saturated hydraulic conductivity (K_{sat}). The saturated hydraulic conductivity (K_{sat}) measurement continues to be a highly variable measurement within and among USGA testing. An understanding of the source of this variability would improve testing procedures and benefit the golf course construction industry. A possible source of the variability is the phenomenon of air entrapment within 46 saturated" laboratory packed cores. Four studies assessed the influence of core diameter, antecedent moisture content prior to saturation, and saturation method on K_{sat} variability, as affected by air entrapment.

Effects on K_{sat}. Increasing core sample diameter (2- to 3-inches) resulted in higher sample densities and lower K_{sat} rates. K_{sat} rates for sand:peat and sand samples increased as the sample moisture content at time of saturation decreased. Greater sample moisture content at saturation apparently results in a sufficient amount of "pore necks" being filled with water that subsequently encloses air-filled pores during saturation (entrapped air). Conversely, a relatively dry sample provides open passages for the expulsion of air during saturation. Thus, dry sample cores did not entrap as much air during saturation and have higher K_{sat}.

Vacuum saturation procedure demonstrated the importance of removing entrapped air from core samples. Vacuum saturation of sample cores increased K_{sat} rates compared to saturation at standard air pressure. Temperature affects the solubility of gases in water. Water and room temperature can vary greatly within and between laboratories over time, and consequently could influence the air entrapment and K_{sat} of core samples. These factors are currently being evaluated for their effect on K_{sat} by varying water temperatures relative to ambient air temperatures in the lab. I

Organic Matter Dynamics in the Surface Zone of a USGA Green: Practices to Alleviate Problems

University of Georgia

Dr. Robert Carrow

Start Date: 1996
Number of Years: 5
Total Funding: $100,000 (Co-funded with the GCSAA)

Objectives:

1. *Determine the effectiveness of selected fall/spring-applied cultivation on enhancement of bentgrass root development, water infiltration, and soil oxygen status during spring and fall root development periods.*
2. *Determine the effectiveness of selected summer-applied cultivation, topdressing and wetting agent practices on bentgrass root maintenance and viability, water infiltration, and soil oxygen status during the summer months when root decline occurs.*
3. *The best treatments from the above objectives will be combined to develop an integrated year-round program for maximum root development and maintenance during stress periods.*

Organic matter accumulation occurs even under excellent management and regardless of specification (i.e., it is not dependent on specifications) due to the abundance of roots produced by bentgrass within this surface zone along with any