# Turfgrass Establishment on Various Rootzones

## A comprehensive study at Rutgers University sheds light on the efficacy of various rootzone amendments.

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Sand is commonly used to construct putting green rootzones and is often amended with organic amendments, such as peat or soil containing silt and clay to improve physical and nutrient properties for turf. Goals of amending sand include improving plant-soil relationships, altering the growing conditions on or beneath the playing surface, and minimizing soil and turf management problems.[20]

Materials other than peat that have been studied for amending sand include slag, calcined clay, expanded perlite and composted soil,[19] clinoptilolite zeolite,[12,14] rice hulls, sawdust, calcined clay and vermiculite,[15] bark,[2] perlite,[2,10] green waste, wood chips, pulp, sewage and plant residue and fibers,[9] and finer-textured soils.[3,4,7,17,18] Many of these previous reports emphasized physical properties of rootzone mixtures with some information provided on turfgrass response. Amending sand may alter nutritional properties of rootzones, depending on the properties of the amendment and amount added, the properties of the material being amended, and mixing uniformity.[20]

It is important to have a rapid and thorough establishment of turfgrass on newly constructed rootzones, as it can affect the initial revenues and use of a golf course. The objective of this field study was to examine the effects of rootzones varying in amendment type and/or rate, and consequently physical and nutritional properties, on the establishment of creeping bentgrass turf.

### SETTING UP THE EXPERIMENT

Three general classes of amendment materials were used (loam, organic, and inorganic) to construct the rootzones at various volume ratios. Rootzone treatments are described in Table 1. A commercially available medium-sized sand meeting USGA guidelines for sand size was used as the major component for rootzones except the 100% loam and 20% compost treatments. The 20% compost treatment used a sand considered too fine based on USGA guidelines. The 100% loam and 20% compost treatments were included for the purpose of comparison (i.e., relatively extreme rootzone properties).

Plots were fertilized with 10-10-10 and 12-24-14 (N-$P_2O_5$-$K_2O$) fertilizers, each at N rate of 1 lb. per 1,000 sq. ft. (total 2 pounds per 1,000 sq. ft. of N) before seeding with L-93 creeping bentgrass at 1 lb. per 1,000 sq. ft. Fourteen post-planting fertilizations were made to all plots except 100% loam and 20% compost during 1998, applying a total of 5.1, 2.5, and 2.8 lbs. per 1,000 sq. ft. of N, $P_2O_5$, and $K_2O$, respectively. The 100% loam and 20% compost plots received 13 post-planting fertilizations that amounted to 4.7, 2.5, and 2.8 lbs. per 1,000 sq. ft. of N, $P_2O_5$, and $K_2O$, respectively.

A fertilization of 46-0-0 at 0.3 lb. per 1,000 sq. ft. of N was required on the non-amended sand plots to produce sufficient turf growth to survive mowing. Five fertilizations were made to all plots between May 7 and June 1, 1999, applying a total of 2.1, 0.5, and 1.1 lbs. per 1,000 sq. ft. of N, $P_2O_5$, and $K_2O$, respectively. Irrigation was applied to supplement rainfall, and mowing was maintained at 0.5 inch until the height was gradually lowered to 0.125 inch by the end of May 1999. Plots also were topdressed with their respective rootzone mixes and core cultivated.

Visual ratings of turfgrass establishment and quality were taken, and turf cover for each plot was quantified via line-intersect counting. Samples from the 0- to 4-inch depth were collected in April 1999 to assess rootzone fertility. Three cores were taken from selected plots in 1999 and sectioned into 3-inch intervals to assess rooting.

### TURF ESTABLISHMENT RATINGS

Bentgrass establishment through 60 days after seeding (DAS) was better on most of the amended rootzone mixes compared to unamended sand. An acceptable establishment rating (5 or higher) was observed at:

- 13 DAS for 20% compost mixed with finer sand
- 17 DAS on 10% ZeoPro and 100% loam mixes

• 20 DAS for 20% sphagnum, 20% loam, and 20% Profile mixes
• 24 DAS for 10% sphagnum and 10% reed sedge, 20% Irish, and 10% Profile mixes
• 28 DAS for 5% reed sedge, 10% Irish, 5% Fertl-Soil, and 10% compost mixes
• 31 DAS for 5% loam
• 37 DAS for 2.5% loam, 5% sphagnum, 10% Isolite mixes
• 41 DAS for unamended sand, 10% Greenschoice, and 10% Kaofin mixes

Note that unamended sand and Kaofin plots received an additional 0.3 lbs. per 1,000 sq. ft. of N at 37 DAS to promote sufficient growth and enable turf to survive mowing, yet these plots remained the slowest to establish.

The 100% loam plots initially established turf very well until mowing was started, and then the turf establishment suffered. The decline in establishment resulted from mower scalping that was caused by lack of firmness (stability) in the soil under frequent irrigation and uneven settling of the loam.

**Table 1**
Description of materials and mixing rates used to amend a medium-sized sand and construct rootzones 12 inches deep over a 4-inch gravel layer, except where noted

| Amendment | Material Description | Volume Mixes Percent Amendment |
|---|---|---|
| None | Medium-sized sand | 0 |
| Loam | Loam mixed with medium sand<br>Sand Silt Clay (% by volume)<br>98.2 1.0 0.7<br>96.8 2.2 1.0<br>88.9 8.3 2.8 | <br><br>2.5<br>5<br>20 |
| Loam Over Subgrade | Rootzones constructed 12 inches deep over subgrade with drainage pipe (i.e., no gravel layer)<br>Sand Silt Clay (% by volume)<br>96.8 2.2 1.0<br>5.8 48.7 15.5 | |
| **Organic Amendments** | | |
| Sphagnum Peat | Sphagnum peat from Sun Gro, Canada | 5, 10, 20 |
| Reed Sedge Peat | Reed sedge peat from Dakota Peat, North Dakota | 5, 10 |
| Irish Peat | Sphagnum peat from Ireland | 10, 20 |
| Kaofin | Granulated recycled paper manufacturing by-product containing cellulose and kaolin from New Jersey (also containing surfactant) | 10 |
| Fertl-Soil | Spent mushroom soil compost from Pennsylvania | 5 |
| AllGro Compost | In-vessel composted biosolids from AllGro in New Hampshire | 10 |
| AllGro Compost with finer sand (AT Sales)* | Finer sand amended with in-vessel composted biosolids from AllGro, Pennsylvania | 20 |
| **Inorganic Amendments** | | |
| Isolite | Porous ceramic - diatomaceous earth | 10 |
| Axis | Porous ceramic - diatomite | 10 |
| Greenschoice | Porous ceramic - clay based | 10 |
| Profile | Porous ceramic - clay based | 10, 20 |
| ZeoPro | Nutrient charged clinoptilolite zeolite | 10 |
| ZeoPro surface 4-inch | Surface 4 inches of rootzone amended with ZeoPro overlying 8 inches of medium sand | 10 |
| ZeoPro Plus surface 4-inch | Surface 4 inches of rootzone amended with ZeoPro containing micronutrients overlying 8 inches of medium sand | 10 |

*Sand used to mix with 20% compost contained a high amount of fine sand based on the USGA guidelines for rootzone composition. All other mixes contain medium sand conforming to USGA size guidelines (see Table 1).

## TURF COVER

Turf cover measurements at June 22 and July 8 (22 and 38 DAS, respectively) reflected turf establishment ratings and indicated that the lower amendment rates of loam (2.5% and 5%), sphagnum (5%), reed sedge (5%), and Irish peat (10%) were not as effective in promoting establishment as were greater rates of those amendments. The 20% compost mixed with finer sand and 100% loam plots had the greatest turf cover compared to other mixes. While the 20% compost mix rapidly developed and maintained excellent turf cover, turf cover on 100% loam plots decreased from 92% to 82% by July 8. Again, this decline in turf performance on 100% loam plots was due to mower scalp caused by inadequate surface stability and uneven settling of the rootzone. Amending with 10% Kaofin, 10% Greenschoice, and 2.5% loam did not improve plant cover compared to unamended sand by July 8. Kaofin plots had the least turf cover compared to other plots on June 22 and July 8, which reflected the challenges of establishing turf on these plots.

Improved turfgrass establishment was attributed to improved soil physical and nutritional conditions. Bentgrass established most rapidly on the 100% loam, 20% compost, and 10% ZeoPro plots as would be expected on mixes with a high nutrient content. The positive turf response to the nutrient-charged ZeoPro amendment was expected.[1] Ferguson et al.[11] and Nus and Brauen[15] reported improved creeping bentgrass establishment in field trials using non-charged zeolite.

Increasing amendment rates of loam, sphagnum peat, Irish peat, and reed sedge peat improved the rate of establishment. Most amendments increased

Researchers at Rutgers University compared several organic and inorganic amendments for their physical and nutritional properties as well as their efficacy to improve establishment of creeping bentgrass over unamended sand.

CEC, although the level of CEC was less than 4 cmol $kg^{-1}$, which is considered low.[8] The majority of fertilizer N in this trial was in the form of ammonium. Thus, it is probable that the improved turf establishment on mixes with increased CEC was attributable to better nutrient retention, particularly ammonium nitrogen. Huang and Petrovic[13] and Ferguson and Pepper[11] reported increased ammonium retention in sand amended with non-charged zeolite, and Bigelow et al.[6] observed lower ammonium loss in leaching studies with Profile and non-charged zeolite.

Greater water retention (capillary porosity at or above the USGA recommended maximum of 25%) was often associated with rapid turf establishment. Murphy et al.[14] reported better turf establishment on mixes with capillary porosity of 25% (0.25 $m^3 m^{-3}$) or higher (the mixes in that study were not confounded by differences in nutrient retention). Greenschoice and Kaofin mixes were exceptions compared to other amended sand mixes and exhibited either similar or poorer establishment than unamended sand. These two mixes were very dry despite the light, frequent irrigation used during establishment, as evidenced by the low capillary porosity of these mixes, particularly Kaofin.

## TURF QUALITY

Turf quality ratings indicated that many mixes performed at a level that was consistent with observations made at early establishment. However, there were some mixes with dramatic changes in performance. Profile plots, which initially had established turf better than the unamended sand, became similar in turf quality to the unamended sand by October 1998. Eventually, turf quality on the Profile plots was lower than the unamended sand. The ZeoPro plots produced very high turf quality up to October 1998. However, quality declined to moderate and low acceptable levels by April and May 1999.

The Kaofin plots, which initially established very slowly (slower than unamended sand), achieved very high turf quality by October 1998 and maintained that level of quality into May 1999. This change in performance on Kaofin plots was attributed to the surfactant (droughtiness and phytotoxicity) dissipating from the Kaofin amendment, and subsequently turf growth improved. The 10% Greenschoice plots, which initially established at a rate similar or slightly less than the unamended, declined to unacceptable levels of quality by October 1998. Turf quality on Greenschoice plots was so poor in May 1999 that the plots nearly failed.

The 5% loam plots (over gravel and over subgrade) produced a moderate level (6.5 to 7.5) of turf quality. However, low acceptable quality levels were observed on 2.5% and 20% loam plots. Thus, turf responses suggested that the 20% loam mix was approaching excessive amounts of the amendment (i.e., silt and clay). As noted previously, surface instability on 100% loam plots continued to negatively impact turf performance from October 1998 to May 1999 to the point that quality was unacceptable by April 1999 and plots could be judged as failing.

The 10% and 20% Profile and 4-inch ZeoPro plots produced relatively low turf quality ratings that were less than the unamended sand in May 1999. Irrigation was not re-initiated until May 13, 1999. Thus, the improved nutritional characteristics of these mixes that were an asset under the frequent irrigation during seedling establishment were probably negated by the relatively low water availability (capillary porosity) in those plots when irrigation was more limited in 1999. Moreover, the greater ability to retain nutrients, particularly ammonium, probably became less important as fertilization was decreased towards a maintenance level over time and ammonium was depleted from the charged zeolite.

Similarly, low water retention was attributed to the poor turf performance on the 10% Greenschoice plots. Bigelow et al.[5] reported the inability of inorganic amendments to improve available water retention in sand mixes using standard laboratory techniques. In fact, some of their data indicated available water was decreased in sand mixes containing inorganic amendments. Our field data for turf performance on mixes containing inorganic amendments was in agreement with those findings.[5]

## ROOTING RESPONSE ONE YEAR AFTER SEEDING

Roots were observed at all depth zones for all mixes, and the relative differences in total root mass among rootzone mixes were generally evident in root mass assessed at all four 3-inch depth intervals. Greatest total root mass was found in the unamended sand, 2.5% and 5% loam, 5% loam on subgrade, 5% sphagnum, 10% and 20% Profile, and 10% ZeoPro mixes. Higher amendment rates of loam and peat in the rootzone mix decreased the total root mass to the point that the high amendment rates of sphagnum, reed sedge peat, and loam had considerably lower total root mass than unamended sand. The lowest total root mass was found in the 20% compost mixed with finer sand and 10% ZeoPro Plus (i.e., containing micronutrients) plots.

Thus, there was a relationship of lower root mass with mixes having greater water storage, yet these mixes also consistently produced high turf quality. Murphy et al.[14] observed that finer-textured and, consequently, wetter sand rootzones resulted in lower root mass at depths below 3 inches and better turf quality during the first year of establishment. These findings indicate that variation in water availability of sand-based rootzones can be sufficient to impact distribution of dry matter between roots and shoots.

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A more comprehensive paper on this project, including data on physical and nutritional properties of these rootzone mixes, can be found on the USGA's *Turfgrass and Environmental Research Online* at http://usgatero.msu.edu.

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