# Evaluation of the USGA sand-based rootzone with various organic amendments for growing creeping bentgrass.

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## Introduction

Addition of sphagnum peat as an organic amendment to sand-based root zones has been recommended by the United States Golf Association (USGA) when constructing golf greens. However, sphagnum peat (SP) can lead to environmental issues (wetland destruction) and agronomic issues (decomposition, hydrophobicity, reduction in shear strength, etc.). Over the duration of this study (6 years), a loss of nearly half of the soil organic matter (OM) from the original SP content occurred. In contrast the stoloniferous mat layer saw a nearly doubling of OM. As a creeping bentgrass green ages, this bi-layered rootzone can create management challenges of soil moisture and surface firmness for superintendents and their staff. This can negatively impact playability for golfers. Several other organic amendments (vermicompost, biochar, biosolids, etc.) are well known for their instrumental agronomic role as soil amendments in agriculture. Therefore, organic amendment alternatives in sand-based root zones of golf greens may offer both environmental and agronomic benefits.

## Objectives

- To compare the substitution of the organic component in USGA's standard mix of 15% sphagnum peat + 80% sand v/v.

## Material and methods

- **Site Description:** The nursery green was established during September, 2015 at North Shore Country Club, Glenview, Illinois.
- **Experimental Design:** A completely randomized design of 11 treatments with 3 replications (due to space limitations, A11 received 2 replicates). Treatments differed according to soil amendment(s) used (Table 1).
- **Site Preparation:** Existing turf and soil were removed to a depth of 16". Pea gravel was added to a depth of 4" and the remaining 12" comprised the root zone. The area was subdivided into 32 treatment plots by installing temporary plywood partitions (Fig. 1). Each plot measured 5' x 9'. Mixing of sand and amendments occurred by a concrete mixer. Each mixed treatment was then delivered to their respective plots (Fig. 2).
- **Turf Establishment:** Creeping bentgrass (*Agrostis stolonifera* L.) cultivars 'V8' and 'OO7' as a 50/50 blend were used for turfgrass establishment. Seeding rate was 1.5 lbs./1000 sq ft and delivered using a rotary spreader. A bunker raking vehicle with a deep lug tread pattern drove over plots to create good seed-to-soil contact. Judicious use of N-P-K fertilizers with micronutrients were utilized for turf establishment.

| Treatment | Soil Amendment Mixtures Description (% v/v) |
|---|---|
| A1 | 15% sphagnum peat + 85% sand (Industry Standard) |
| A2 | 10% biocharged turf media + 90% sand |
| A3 | 5% vermicompost + 5% biochar + 90% sand |
| A4 | 5% CarbonizPN Soil Enhancer + 95% sand |
| A5 | 5% biochar + 15% sphagnum peat + 80% sand with a pre-plant vermicompost applied to top 4 inch. |
| A6 | 15% sphagnum peat + 85% sand with a pre-plant vermicompost raked into top 4 inch |
| A7 | 15% sphagnum peat + 85% sand with a pre-plant vermicompost raked into top 4 inch |
| A8 | 5% vermicompost + 5% pre-conditioned biochar + 90% sand |
| A9 | 5% biochar + 10% biosolids + 85% sand |
| A10 | 5% biochar + 10% vermicompost + 85% sand |
| A11 | 5% biochar + 10% composted biosolids + 85% sand |

Table. 1. Soil amendment mixtures as treatments.

Fig. 1. North Shore CC staff building temporary plywood partitions.

Fig. 2. North Shore CC staff filling soil amendment mixtures.

### Measurements

- Turfgrass Quality (TQ): Turfgrass quality was visually rated on a scale of 1-9, with 9 = best and 6 = acceptable.
- Rooting Depth (cm): Rooting depth was estimated using a single 4" diameter soil core sample.
- Dollar Spot (%): Dollar spot was visually rated per 5' x 9' plot.
- Moss (%): Moss was visually rated per 5' x 9' plot.
- Nematode count: Nematodes were extracted using a modified sucrose flotation technique. A 100 gram soil sample was combined (6 cores ½" x 2") from each plot for extraction. Counts used a 1 ml aliquot at 40-100X.
- Normalized difference vegetation index (NDVI): NDVI was determined by using Trimble GreenSeeker Handheld Crop Sensor.

### Data Analysis

- Statistical Analysis System version 9.4 was used for data analysis (SAS Institute Inc. Cary, NC). Fisher's LSD procedure was used to determine the significance at p=0.05.

## Anova Table

| | Source | 18-Aug-21 | 31-Aug-21 | 1-Oct-21 | 4-Oct-21 | 11-Oct-21 | 4-Nov-21 |
|---|---|---|---|---|---|---|---|
| Root Length | Trt | NS | NS | - | NS | - | - |
| Dollar Spot (%) | Trt | - | - | NS | NS | NS | - |
| Nematode (All types) | Trt | - | - | - | NS | - | - |
| T.Q. | Trt | - | - | NS | - | NS | - |
| NDVI | Trt | - | - | * | - | NS | - |
| Moss (%) | Trt | - | - | - | - | - | * |

Table. 2. Summary ANOVA table for evaluated parameters. ' NS ' represent non-significance and ' * ' represents significant difference among treatments based on fisher's LSD procedure using P=0.05. ' – ' represent data is not collected.

## Results

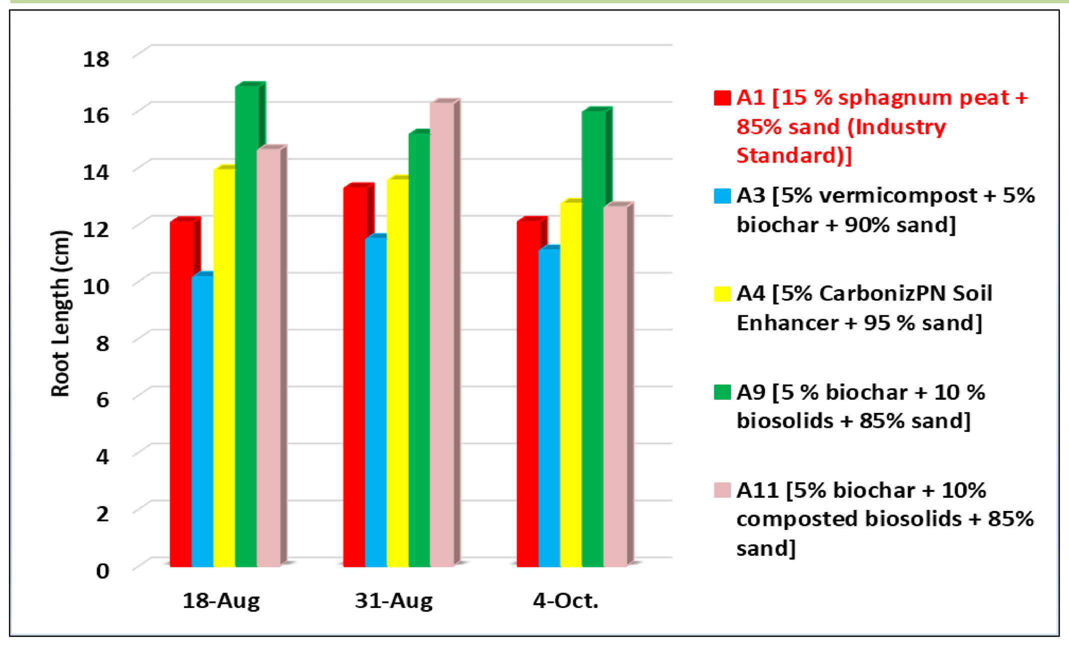


Fig. 3. Root length (cm) of turfgrass core samples from amendment treatments A1, A3, A4, A9, and A11. Not significantly different on any date. Only select treatments are displayed to illustrate trends.


Fig. 4: Washed roots from each amendment treatment (1 replicate), 18-Aug-2021.

| Amendments | T.Q. (1-Oct) | T.Q. (11-Oct) | NDVI (1-Oct) | NDVI (11-Oct) |
|---|---|---|---|---|
| A1 | 4.7 | 5.3 | 0.69b | 0.69 |
| A2 | 6.0 | 5.3 | 0.73ab | 0.72 |
| A3 | 4.3 | 6.0 | 0.68b | 0.70 |
| A4 | 6.7 | 6.0 | 0.70ab | 0.70 |
| A5 | 6.7 | 6.7 | 0.72ab | 0.72 |
| A6 | 4.7 | 5.3 | 0.68b | 0.70 |
| A7 | 4.3 | 4.7 | 0.70ab | 0.70 |
| A8 | 6.3 | 5.7 | 0.71ab | 0.70 |
| A9 | 7.3 | 7.0 | 0.75a | 0.72 |
| A10 | 6.3 | 5.3 | 0.70ab | 0.70 |
| A11 | 5.5 | 6.0 | 0.69b | 0.69 |

Table 3. Turfgrass quality (TQ) and Normalized difference vegetation index (NDVI). Means within column followed by same letter are not statistically different (p=0.05).

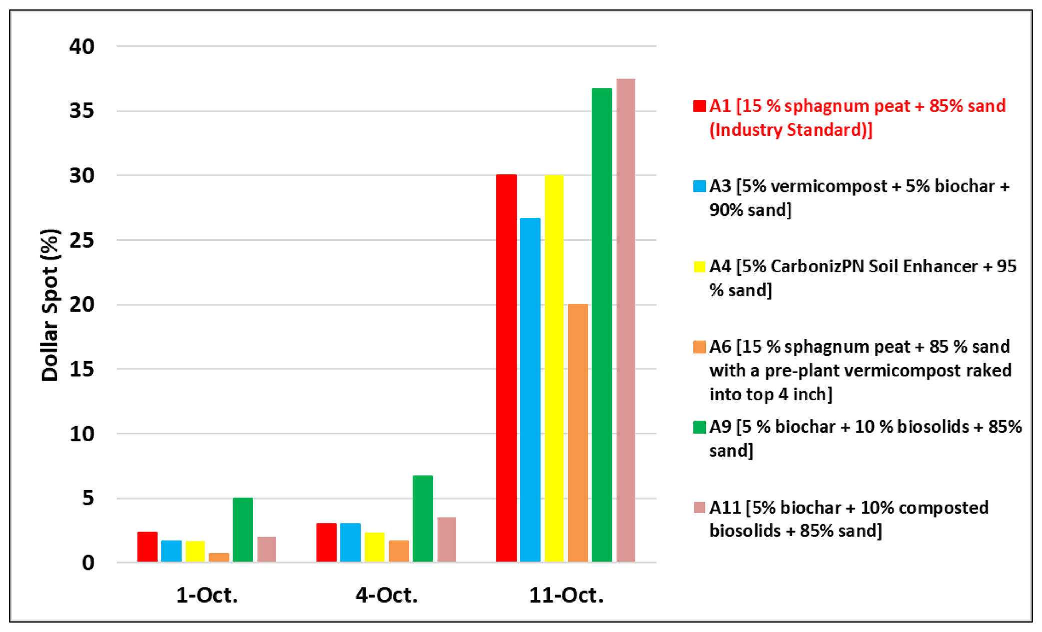


Fig. 5. Dollar spot infestation among selected treatments A1, A3, A4, A6, A9, and A11. No significant difference among treatments means on any date. Only select treatments displayed.

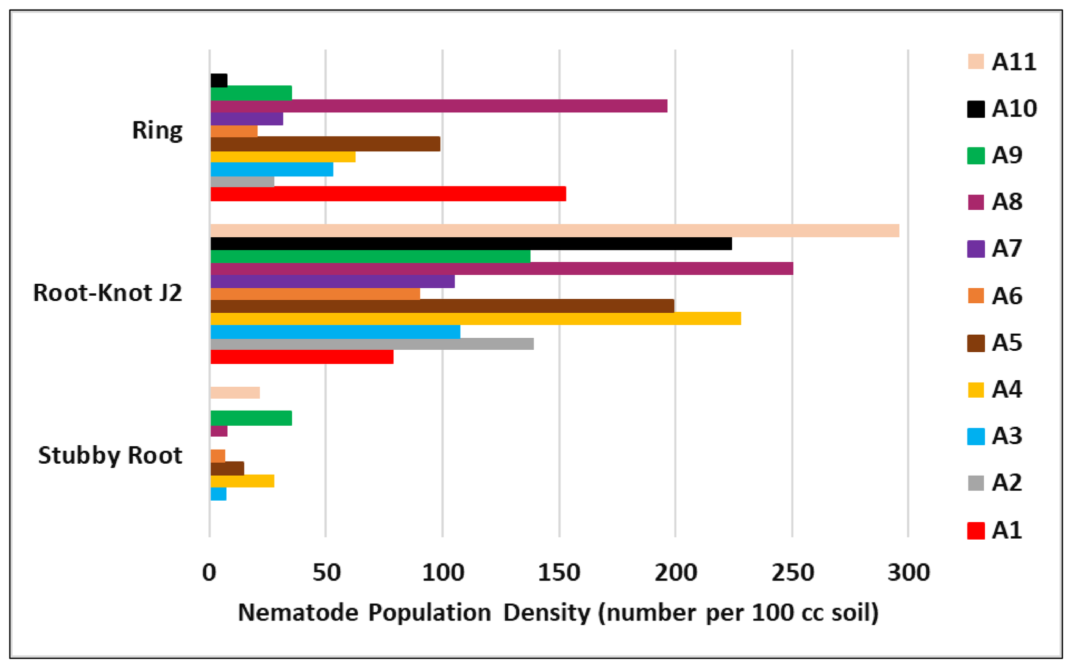


Fig. 6. Select root-feeding nematodes among amendment treatments on Oct 1, 2021. Not statistically different (p=0.05).

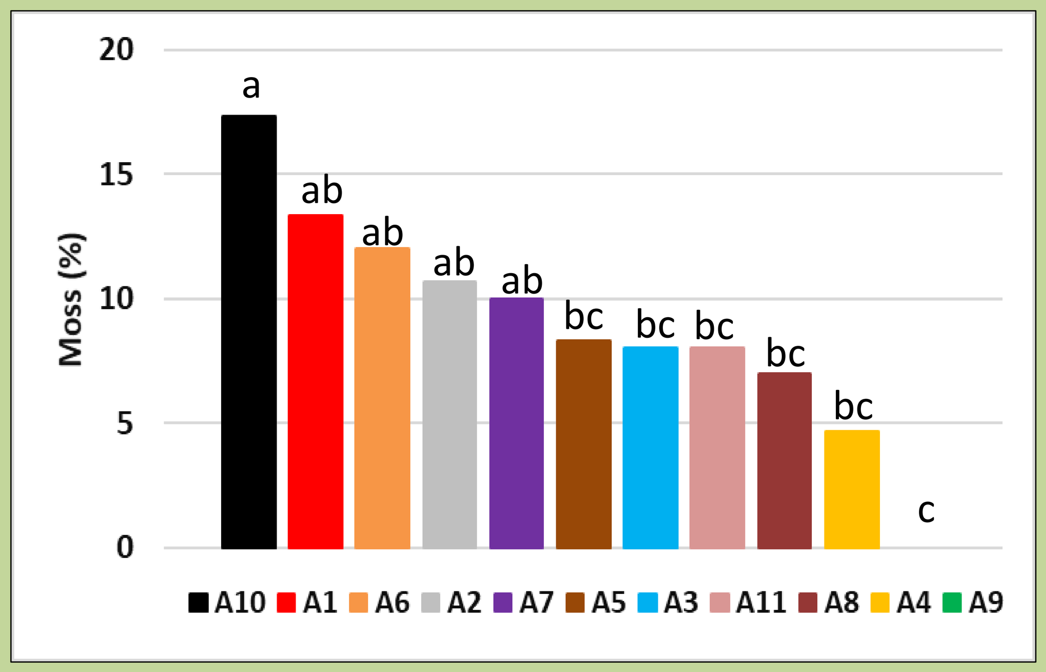


Fig. 7. Moss infestation among amendment treatments on Nov 4, 2021. Means followed by same letter are not statistically different (p=0.05).

Fig. 8. J2 root knot nematode.

Fig. 9. Male root knot nematode.

Fig. 10. Root knot nematode trapped by a nematode trapping fungi.

Fig. 11. Moss infestation: **A1** [15 % sphagnum peat + 85% sand (Industry Standard)]

Fig. 12. Moss not able to infest: **A9** [5 % biochar + 10 % biosolids + 85% sand]

## Results and Discussion

- **Rooting Depth:** No significant differences for rooting depth were observed among the 11 amendment treatments. However, in treatments containing biochar and biosolids (A9, and A10, and A11) roots were visually longer and denser in comparison to other amendments containing sphagnum peat (A1), vermicompost (A3), and carbonizPN soil enhancer (A4) (Fig. 3). The image of washed roots also showed those trends (Fig.4). This suggests that both biochar and biosolids are good amendment choices/alternatives in the sand-based golf green rhizosphere.
- **Dollar Spot:** Not significantly different. Nevertheless, treatments having biochar and biosolids (A9 and A11) tended to be most vulnerable to dollar spot disease, while vermicompost and sphagnum peat amendments (A1 and A6) were less so.
- **Sphagnum peat:** Sphagnum peat treatments saw unacceptable turf quality on both dates rated. A9 (Biochar + biosolids) amendment had highest NDVI on first rating date and saw acceptable TQ on both rating dates. Certain alternative amendments to sphagnum peat may provide an advantage in sand-based systems where creeping bentgrass is used.
- **Moss:** No infestation of moss was observed in treatment A9 (Biochar + biosolids). A9 appeared as a dense and healthy turfgrass stand with excellent turf quality ratings and high NDVI values. In contrast, moss was highest in A10 followed by A1 (Industry Standard). We speculate that our A1 sphagnum peat rootzone may have created increased soil moisture during wet periods which then reduced plant density. Thin turf is known to exacerbate moss establishment in creeping bentgrass greens.
- **Nematodes:** Dense populations of root-knot nematodes were found in all treatments. Other nematodes were ring and stubby root. The rapid establishment of root-feeding nematodes in this study could have been caused by regular use of contaminated sand for top-dressing purposes. Alternatively, nematodes may have entered from surrounding native-soil bluegrass rough areas.

## Conclusions

- Amendment treatments were not significantly different for most of the evaluated parameters. A major limitation of this study, as dictated by available space, was that 3 replications were used. Thus, treatment differences may have been obscured by known heterogeneous aspects of establishing rootzones. However, NDVI and moss data as well as trends observed throughout allow the conclusion that biochar + biosolids can be used to replace sphagnum peat in USGA's sand-based root zone for greens. This study will continue given root zone amendments x moss establishment has not previously been reported to our knowledge.

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