# Optimizing Soil Amendment Characteristics for Improving Environmental and Resource Sustainability

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## ABSTRACT

By 2035, water demand is projected to exceed available supply in certain parts of central Florida. One of the main uses of water in many parts of Florida is residential irrigation. Past studies have shown that soil compaction is a significant issue in residential landscapes (Gregory et al, 2008; Bacon and Bean, 2019) and that incorporating compost is a potential means to address these issues (Bean and Dukes, 2016; Radovanovic and Bean, 2020). However, concerns about the introducing a nutrient source into watersheds, particularly in karst areas, have led to interest in evaluating whether reducing compost application rates provided similar results. In this study, soil samples were collected and analyzed from a 120-plot research study initiated to evaluate effects of different commercially available compost products, rates, and irrigation scheduling on turf quality responses. Five commercially available compost products (B, C, S, S2, and S3) applied at three rates (1, 2, and 4 cy/1,000 ft$^2$). Compost was incorporated into the top 6 in. of soil. Control plots received no compost or tilling. Plots were sodded with St. Augustine turfgrass. Soils properties were analyzed for soil texture, bulk density, organic matter content, and soil moisture. Compost amending caused a slight increase of sand and silt content, but all samples remained within the sandy classification. Increasing compost rates of decreased bulk densities from 1.67 g/cm$^3$ to 1.60, 1.53, and 1.51 g/cm$^3$ for 1, 2, and 4 yd$^3$/1000 ft$^2$, respectively. Similarly, organic matter and soil moisture also increased proportionally to compost amendment rates, however, only 2 and 4 yd$^3$/1000 ft$^2$ were found to be significantly different from control plots (organic matter: 1.4% vs. 1.6%, 2.1%, and 2.7%; soil moisture: 6.5% vs. 6.8%, 7.5%, and 9.5%). Different compost products did not produce significantly different bulk densities. All compost materials except S3 significantly increased soil moisture, while all but S2 and S3 significantly increased organic matter. These data provide important baseline information on the soil characteristics for a 2-year study evaluating compost amendments and irrigation in residential landscapes. These results suggest that even minimal amounts of compost incorporated into compacted sandy soils improves the quality and lowering compost rates from 4 to 2 and possibly 1 yd$^3$/1,000 ft$^2$ may sufficiently mitigate compaction and improve water retention in residential soils.

## OBJECTIVES AND METHODS

In August 2019, a 120-plot study was initiated at the Plant Science Research and Education Unit in Citra, FL, (**Figure 1**) through funding by Tampa Bay Water. The overall goal of the study is to build on previous field studies that indicate the potential for water conservation by amending compacted sandy fill soils with compost, and evaluate turf quality under varying compost rates, materials, and irrigation rates. Within the scope of this portion of the project, the objective were to evaluate the effect of five commercially available compost products (noted as B, C, S, S2, and S3) and at three rates (1, 2, and 4 yd$^3$/1,000 ft$^2$) on soil properties related to soil-water relationships.

The 120-plots were separated into two intersecting studies using 72 and 48 plots, respectively. The 72 plots were assigned treatments based on a randomized block design including four blocks, with six amendment treatments (a control and five commercially available composts referred to as b, c, s, s2, and s3) and three irrigation rates.

The 48 plots were also divided into four blocks, with four amendment treatments (a control and three amendments referred to as b, c, and s) and three application rates of 1, 2, and 4 yd$^3$/1,000 ft$^2$.

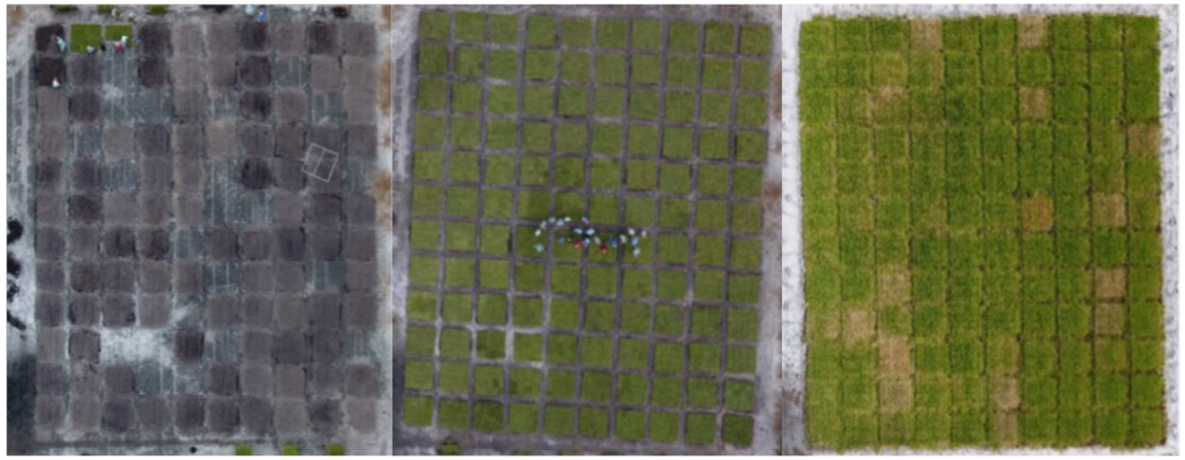

**Figure 1.** Plots with compost amendments incorporated (A) and sod laid (B) in August 2019 and during on-going study in June 2020 (C).

Compost materials were applied and tilled into the top 6 inches of their respective plots in August of 2019. Plots were then sodded with St. Augustine (Floratam) turfgrass and daily establishment irrigation commenced. Due to the 60-day establishment period running into the beginning of the dormant season (October), irrigation schedules (part of broader study) were not implemented until Spring of 2020. Instead, all irrigation schedules were uniform for all plots, except due to system leaks or errors, until April 2020 when irrigation treatments were begun.

Soil samples were collected from the top six inches of the profile on January 28, 2020, the day following an irrigation event. Samples were collected with a 1" push probe from five locations within each plot. Soil samples were then composited for each plot.

Moist soil samples were weighed for determining water content. Samples were then oven dried at 105 C for 72 hours and re-weighed. Oven-dried weights were recorded and divided by sampling volume to determine bulk densities. Samples were analyzed in the UF Pedology Lab to determine sand (0.5 – 2 mm), silt (0.002 – 0.5 mm), and clay (< 0.002 mm) fractions using laser diffraction. Organic matter was determined by Loss On Ignition (LOI; 500 C), which measures the percent change in weight of soil after burning off the organic matter. Due to interruptions of laboratory activities related to Covid-19, results from only 71 of the 120 samples for organic matter are included here. Data were statistically analyzed using ANOVA and post-hoc comparison of means using Tukeys HSD test across compost products and rates.

## RESULTS

**Soil Texture**

Unamended soils were dominated by coarse sand size particles (96%, v/v) followed by silt (3.3%) and clay (0.8%), which is classified as Sand texture based on USDA soil texture classification system. Amending soils did not change the texture classification as fractions of sand ranged from 95.0 – 96.8%, silt ranged from 2.5 – 4.1%, and clay ranged from 0.6 – 0.9%, leaving all plots within the Sand texture class. However, differences were significant for some compost types and rates (**Table 1**).

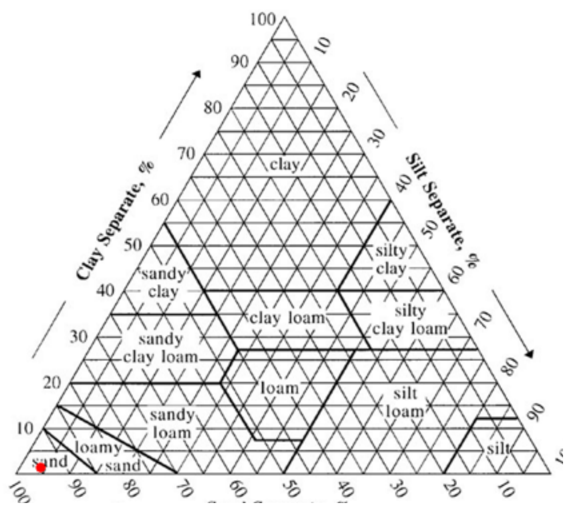


**Figure 2.** USDA Texture triangle with soil texture for this study indicated (Sand).

**Table 1.** Average soil texture composition by amendment type and rate. Different letters indicate significant differences based on Tukey's HSD test.

| | SAND | | SILT | | CLAY | |
|---|---|---|---|---|---|---|
| **TYPE** | | | | | | |
| **CONTROL** | 95.9% | c | 3.3% | a | 0.78% | a |
| **B** | 96.1% | ab | 3.1% | ab | 0.75% | a |
| **C** | 96.3% | a | 3.0% | b | 0.76% | a |
| **S** | 96.1% | abc | 3.2% | ab | 0.78% | a |
| **S2** | 96.0% | bc | 3.3% | a | 0.77% | a |
| **S3** | 95.9% | bc | 3.3% | a | 0.81% | a |
| **RATE** | | | | | | |
| **0** | 95.9% | b | 3.3% | a | 0.78% | ab |
| **1** | 95.9% | b | 3.3% | ab | 0.80% | a |
| **2** | 96.1% | ab | 3.2% | ab | 0.78% | ab |
| **4** | 96.2% | a | 3.1% | b | 0.76% | b |

### Bulk Density

Increasing compost amendment rates decreased bulk soil bulk densities, due to the tilling and relatively low material density of compost. Control (0 $yd^3/1000\ ft^2$) plots had a mean of 1.67 $g/cm^3$ with 1, 2, and 4 $yd^3/1000\ ft^2$ having bulk densities of 1.60, 1.53, and 1.51 $g/cm^3$, respectively. Notably, 1 $yd^3/1000\ ft^2$ was not significantly ($p < 0.05$) lower than the control, but 2 and 4 $yd^3/1000\ ft^2$ were and 4 $yd^3/1000\ ft^2$ was significantly lower than 1 $yd^3/1000\ ft^2$. Incorporating any of the compost amendments produced a similar effect with all but amendment B significantly lowering the control bulk density from 1.67 $g/cm^3$ to means between 1.51 and 1.56 $g/cm^3$ for all the compost products, independent of rates.

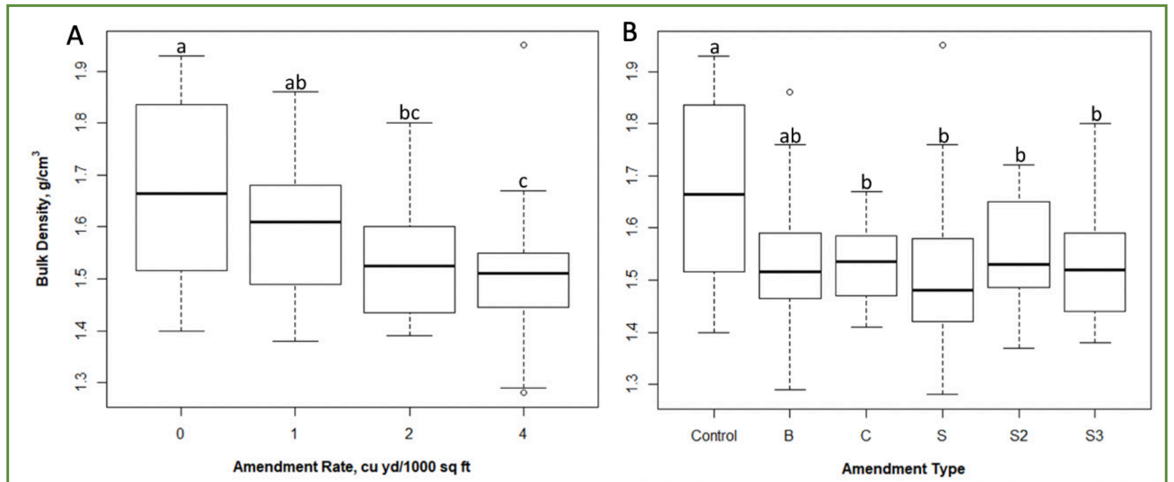


**Figure 3.** Box and whisker plots of bulk densities by compost amendment rate (A) and type (B). Different letters indicate significant differences based on Tukey's HSD test.

### Organic Matter

Organic matter results are summarized by compost amendment rate and plot in **Figure 2**. These results are only for 71 of the 120 plots, as the last batch of sample analyses were interrupted due to Covid-19. However, some clear trends emerge from the data. Increasing compost amendment rates increased organic matter content over the baseline mean of 1.4% (0 $cy/1{,}000\ ft^2$) to 1.6%, 2.1%, and 2.7% for 1, 2, and 4 $cy/1{,}000\ ft^2$, respectively. Notably, 2 $cy/1{,}000\ ft^2$ was significantly greater than baseline, but significantly lower than 4 $cy/1{,}000\ ft^2$. For compost amendment types, only two, S2 (2.1%) and S3 (2.0%), were not significantly greater than the control plots, both of which also had significantly lower organic matter content than amendment S (2.8%). Amendment C (2.2%) was also significantly lower than Amendment S.

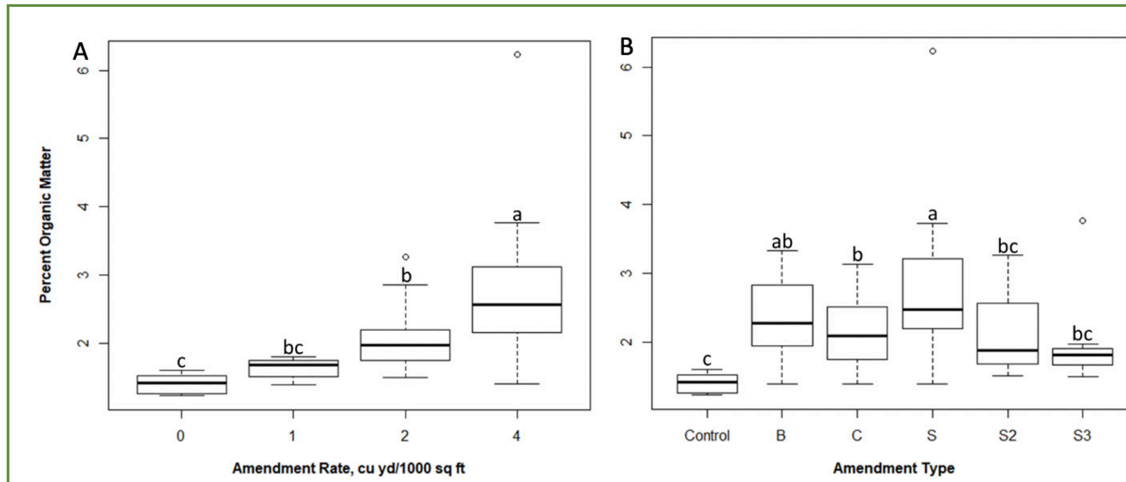


**Figure 4.** Box and whisker plots of organic matter (%) determined by Loss On Ignition (LOI) for compost amendment rates (A) and types (B). Different letters indicate significant differences based on Tukey's HSD test.

### Soil Moisture

Volumetric water content results are summarized in **Figure 3**. Soil samples were collected the day following an irrigation event, which would be expected to yield soil moisture content at or slightly below field capacity. As soil-water relationships are largely dependent on soil pore structure, which is influenced by bulk density and organic matter, results were anticipated to be similar. Increasing compost amendment rates was found to increase soil moisture as shown in **Figure 3A**. Non-amended control lots (0 $cy/1{,}000\ ft^2$) had an average water content of 6.5%, while amendment rates of 1, 2, and 4 $cy/1{,}000\ ft^2$ had average water contents of 6.8%, 7.5%, and 9.5%, respectively.

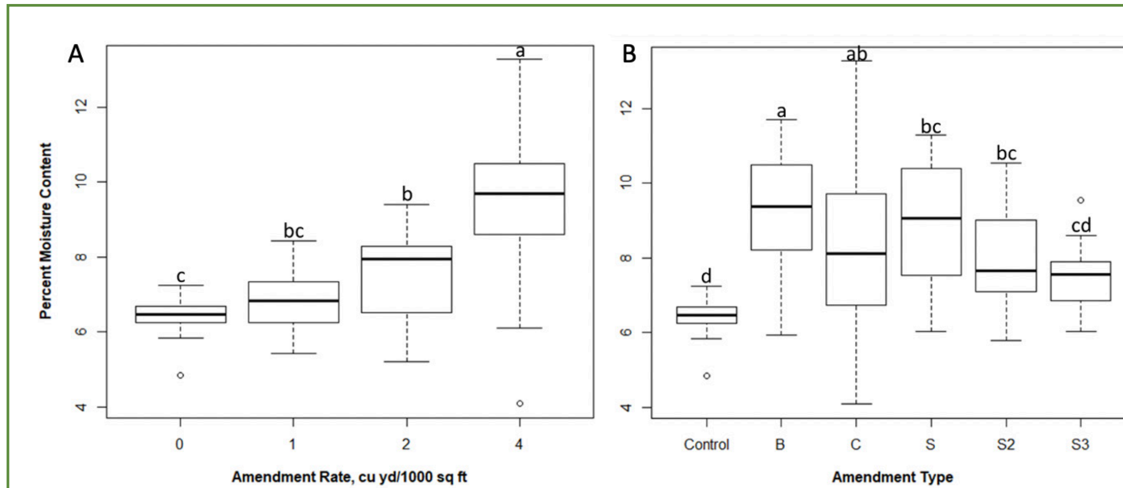


**Figure 5.** Box and whisker plots of volumetric water content by compost amendment rate (A) and type (B). Different letters indicate significant differences based on Tukey's HSD test.

# CONCLUSIONS

The objective of this study was to evaluate the effect of commercially available compost products and rates on soil-water properties. Soil textures for amended soils all remained within the sand classification. While differences were less than 1%, they were significant in some cases, with compost shifting the texture slightly coarser. Increasing amendment rates from 1 to 4 yd3/1,000 ft2 decreased bulk densities, and increased soil organic matter and soil moisture, however, differences were only significant for rates of 2 and 4 yd3/1,000 ft2. All compost amendments decreased bulk densities, with only Amendment B not significantly lower than non-amended soil. Amendments B, C, and S also significantly increased soil organic matter and moisture over non-amended control plots. Amendment S2 had significantly higher soil moisture but not organic matter while amendment S3 soil organic matter and moisture were not significantly different than control plots.

# REFERENCES

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