Introduction
Biosolids (BS) and biochar (BC) are two soil amendments that have been used to remedy urban soils, which often have poor water and nutrient retention due to anthropogenic influence. BS has been shown to greatly encourage tree health, but it has also contributed to nutrient leaching. BC, in contrast to BS, may slightly contribute to tree health, but it has also contribute to nutrient leaching. The goal of this research is to find a soil amendment, or combination of soil amendments, that will promote both tree and environmental health. When mixed in with several varieties of soil types and coverings, our hypothesis is that biochar will have a positive environmental impact and contribute slightly to tree health, while BS will greatly encourage tree health but have a less positive environmental impact. If BC and BS are combined in a one-to-one ratio, we hypothesize a more positive environmental impact than BS alone, and greater tree health than BC alone.

Methods
The research was conducted during the second summer (2016) of a study commenced in 2015. Seventy-two mesocosms of Ulmus parvifolia were studied in The Morton Arboretum’s Research and Tree Breeding Nursery. Soil Varieties

Full factorial with 3 replications. See Table 1.

<table>
<thead>
<tr>
<th>Soil Varieties</th>
<th>Treatment</th>
<th>Cell Type</th>
<th>Name</th>
<th>Composition</th>
<th>Treatment</th>
<th>Cell Type</th>
<th>Name</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS</td>
<td>1 gal. BC 1 gal. sand</td>
<td>Forest</td>
<td>5 gal. undersown topsoil</td>
<td>Turf</td>
<td>Phytumphosphorus</td>
<td>1 gal. sand</td>
<td>Forest</td>
<td>5 gal. undersown topsoil</td>
</tr>
<tr>
<td>BS+BC</td>
<td>1 gal. BC 1 gal. sand</td>
<td>Tree</td>
<td>5 gal. undersown topsoil</td>
<td>Mulch</td>
<td>2nd woodchip covering</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BS+BC</td>
<td>1 gal. BC 1 gal. sand</td>
<td>Urban</td>
<td>5 gal. undersown topsoil</td>
<td>Mulch</td>
<td>2nd woodchip covering</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Soil varieties: treatment, soil type, and cover.

Soil Respiration: Measuring a Healthy Tree

| Nutrient leaching: Collect leachate after each rain event, and analyze phosphate and nitrate concentrations using colorimetry | Soil respiration: LI-COR Biosciences (2010) LI-8100A | Volumetric Water Content (VWC): LI-8100A | Measuring a Healthy Tree | Chlorophyll: Treatment had the greatest effect on chlorophyll content both years, with BS and BS+BC contributing to higher chlorophyll levels. No difference appeared between BC and null. See Figure 4. | Relative Diameter Growth: BS and BS+BC contributed to a significantly greater diameter growth than BC and null. No difference appeared between BC and null. See Figure 5. | Soil Respiration: In 2015, BS and BS+BC contributed to significantly higher CO2 fluxes, and BC neither increased nor suppressed CO2 fluxes. In 2016, treatment had no significant effect on soil respiration. See Figure 6.

| Phosphate Leaching: No significant treatment effects appeared in 2015, but phosphate leaching was significantly greater with BS and BS+BC in 2016. BC neither increased nor suppressed phosphate leaching in either year. See Figure 2. | Nitrate Leaching: BS and BS+BC contributed to significantly higher nitrate leaching in 2015 and did not increase leaching in 2016. BC neither increased nor suppressed nitrate leaching either year. See Figure 3. | Volumetric Water Content, Twig Growth, Leaf Area, and Crown Rating: none showed treatment effects. |

Conclusion

- BS had a more negative environmental impact than BC and null, while contributing positively toward tree health in some ways. This was in general agreement with our hypothesis.
- BC neither contributed to nor suppressed any negative environmental impact, and it did not contribute to tree health, in contrast with our hypothesis.
- Many factors influence the function of biochar as a soil amendment, including the biochar feedstock, pyrolysis procedure, postproduction handling, and application rate.
- Although this biochar did not appear to influence environmental health or juvenile tree health, future studies should continue to explore the many variables that impact the function of bioschars.

Acknowledgements

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References


Figure 1. Seventy-two mesocosms arranged in The Morton Arboretum nursery

Figure 2. Phosphate trends from 2015-2016

Figure 3. Nitrate trends from 2015-2016

Figure 4. Treatment effects on RDG

Figure 5. Treatment effects on chlorophyll

Figure 6. Soil Respiration trends from 2015-2016