Biochar and Mill Ash Use as Soil Amendments to Grow Sugarcane on Sandy Soils in South Florida

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INTRODUCTION

- The sugarcane industry is one of the most important contributors to Florida’s agricultural economy.
- Likely expansion of sugarcane production into less productive sandy soils located northwest of the Everglades Agricultural Area (EAA) which are characterized with very low organic matter (OM) content, water holding capacity (WHC), and nutrient retention that results in lower yields.
- Use of agricultural and urban organic residues as soil amendments has the potential to:
  - Increase agricultural production by improving soil properties
  - Improve water quality through nutrient adsorption
  - Reduce waste and contribute to carbon sequestration.

RESULTS AND DISCUSSION

Feedstock and Biochar Characterization

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Zn</th>
<th>Mn</th>
<th>Cu</th>
<th>Fe</th>
<th>Al</th>
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<tbody>
<tr>
<td>Biochar</td>
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<td>3710</td>
<td>14118</td>
<td>1356</td>
<td>27</td>
<td>40</td>
<td>6</td>
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<td>9805</td>
<td>13675</td>
<td>3143</td>
<td>61</td>
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<td>11</td>
<td>323</td>
<td>600</td>
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<td>14442</td>
<td>6209</td>
<td>76</td>
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<td>Amendment</td>
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<td>6411</td>
<td>27782</td>
<td>1727</td>
<td>61</td>
<td>228</td>
<td>2</td>
<td>54</td>
<td>781</td>
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<td>HB biochar</td>
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<td>75904</td>
<td>91310</td>
<td>43077</td>
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<td>312</td>
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<td>5701</td>
<td>5304</td>
<td>7524</td>
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<td>2140</td>
<td>3709</td>
<td>11593</td>
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<td>90</td>
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</table>

- Biochar nutrient concentration was greater compared with the feedstocks.

Soil Analyses

- RH2 and AS6 had significantly greater TP and MS-P compared with the control throughout the experiment.
- RH2 significantly increased CEC over time, while soil amended with AS6 kept a constant CEC after 9 months.
- OM increased with application rates of 2% and AS6. Also, OM did not significantly decrease over time showing the ability to increase stable OM over time.
- Soil pH shifted from slightly acidic to neutral or basic with treatment incorporation.

CONCLUSIONS

- Nutrient concentration was greater in the biochars compared to the feedstocks.
- RH biochar has greater potential to be used as a soil amendment for improving short-term nutrient availability due to its lower C/N ratio.
- RH2 and AS6 applications showed the most promising effects in terms of improving soil properties by adding available P and increasing CEC.
- The effects of RH2 and AS6 on soil properties and their supply of Si were probably the factors that most contributed to the enhancement of sugarcane yields in this experiment.
- Amendment incorporation to the sandy soil did not increase P or N leaching over time.
- Mill ash and the tree biochars used in this experiment had no negative effects on sugarcane growth or soil quality; but only RH2 and AS6 resulted in significantly agronomic benefits and have the most potential to be used as soil amendments in sandy soils located northwest of the EAA.

METHODOLOGY

- Mill ash and three biochars were incorporated at 1% and 2% (by weight) in 70 gallon lysimeters to grow sugarcane.
- A control without amendment and a standard commercial practice of mill ash applied at 6% were also included. Experiment design was a randomized block including nine treatments and the control with four replications of each.
- Recommended fertilization was applied equally to treatments and control.

OBJECTIVES

1. Determine the effects of mill ash and three biochars applied at two ratios (1% and 2% w/w) on sugarcane plant growth and yield.
2. Evaluate the effectiveness of the amendments to improve soil physiochemical properties of sandy soils.
3. Evaluate the influence of the amendments on drainage water nutrient composition.

RESULTS

- Leaf Tissue Analysis
- Plant Growth and Yield
- Water Analyses
- Future Research

Figure 1. Monthly plant measurements of top visible dewlap (TVD) height.

Figure 2. Biomass yield of plant cane harvest.

Figure 3. Sucrose yield of plant cane harvest.

Figure 4. Total phosphorus of the soil over time.

Figure 5. Cation exchange capacity of the soil over time.

Figure 6. Total dissolved P in water over time.

Figure 7. Nitrate in water over time.

- Compared with the control, application of RH2 resulted in 37% and 38% increase in biomass weight and sucrose yield, respectively.
- AS6 resulted in 33% increase of biomass weight and sucrose yields.
- Positive response with RH2 and AS6 could be due to higher nutrient availability and improvement in soil properties with the addition of these amendments.

- RH amendments had significantly higher TP, TDP, and SRP in comparison with the control and all treatments, except HM2. However, after April, there were no differences in P leaching compared with the control, which shows the amendments did not increase P release over time.
- Sharp decrease in nitrate and ammonium after first rainfall event displays a common issue in sandy soils of south Florida.

- Study the use of AS and RH amendments over several ration crops in a field experiment.
- Evaluate the effects of nutrient retention, leaching, and runoff at the field scale.
- Economic analysis with costs of pyrolysis to process biochars, and costs of rate applications and spreading for both mill ash and biochars.
- Estimate the possible losses of amendment during application due to wind erosion, and assess safety issues during handling.