Agronomic and Environmental Impacts of Biosolids Application to Bahiagrass Pastures

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What are “Biosolids”? 

- Biosolids are the by-product of the treatment of domestic sewage
- Sewage sludge undergoes pathogen control treatment that meet regulatory requirements
- Sewage sludge that is disposed of by landfill or incineration is NOT considered biosolids

Domestic sewage | Industry
---|---
Pre-treatment
Wastewater treatment facility
Sewage sludge | Landfill or incineration
Kill pathogens | Remove solids
Effluent | Biosolids
Land application
Are all Biosolids Materials the Same?

- Biosolids composition and characteristics vary considerably
- State regulation: Chapter 62-640, FL Administrative Code (FAC) regulations. Regulated by FL-DEP
- Two types of residuals: Class A (AA) or Class B

Class A and Class B refer to the pathogen level.

- **Class AA (exceptional quality)**
  - contain minute levels of pathogens
  - no restrictions (bagged and marketed to the public)

- **Class B**
  - contain small, but compliant amounts of bacteria
  - restrictions for crop harvest, grazing animals (30-d restriction), and public contact

Both materials are required to meet strict pollutant criteria.

Benefits

- Nutrient source (macro and micro)
- Improves soil quality
  - Physical: water holding capacity, aggregation, porosity
  - Chemical: SOM, exchange capacity, retardation of contaminant movement
  - Biological: microbial activity
- Reclamation of disturbed lands
- Carbon sequestration, reduce energy consumption, reduce GHG emissions
Risks

- Odors (sulfur compounds. Nuisance; no data demonstrating human toxicological effects)
- Nutrients (N and P)
- Pathogens – human disease
- Contaminants of emerging concern (antibiotic resistant bacteria, pharmaceuticals, personal care products, flame retardants, estrogen compounds, endocrine disruptors, nanoparticles)

No documented scientific evidence suggesting that Part 503 has failed to protect human health
When practiced in accordance with federal regulations, land application of biosolids presents negligible risks to consumers, crop production, and environment

Biosolids “dilemma”

- Nutrients in biosolids are more slowly released and less leachable than when supplied as manures or fertilizers
- Unbalanced N:P ratio in biosolids vs. crop requirements
- Eutrophication: P is limiting nutrient in most water bodies. Concentrations as low as 0.02 mg L⁻¹ can cause accelerated eutrophication

- N-based rates provide excess P (Bahiagrass: 80-160 lb N/A; 10-17 lb P/A N:P ratio of 4:8 N:1 P)
- P-based rates very low (~1-2 T/A)
  - Impractical
  - Uneconomical
  - Require greater land area
  - Require supplemental N
Research Project Goals

1. Generate and disseminate science-based data based on field experiments,
2. Demonstrate the environmental advantages of using biosolids-P and -N compared to commercial fertilizer,
3. Demonstrate the sustainability of the land application of biosolids to pastures in Florida.

Objectives

1. To establish a long-term, instrumented field trial designed to evaluate the agronomic benefits of biosolids application on forage production.
2. To evaluate the effects of co-application of biosolids and biochar (also known as “black carbon”) on soil chemical (C, N, and P dynamics) and physical properties (water holding capacity, aggregate stability)
3. To monitor N and P losses via leaching and gas emissions

Materials and Methods

- Treatments: 3 Biosolids + commercial fertilizer (N and P) applied either alone or in combination with biochar (1% wt. basis). Biosolids and fertilizer were applied at a rate of 160 lb plant available N/A.
- Why biochar?
  - C-rich material that can act as a strong sorbent that can control excess N and P in soil and water
  - Non-hazardous residuals
  - Low cost
  - Improve soil chemical, physical, and biological properties
Materials and Methods

Initial Soil Characterization

Biosolids and Biochar Characterization
Monitoring Instruments

Response Variables

- Forage were harvested at 6 wk intervals for yield, nutritive value, and tissue N and P determination
- N and P leaching using drain gauge lysimeters
- Water table, soil moisture levels, and drainage volume
- Greenhouse gas emissions using static chambers
- Soil chemical, physical, and biological responses (N, P, C, and water-holding capacity)
Preliminary Results

*Data refer to 2 harvest events (June 22 and Aug. 17) in 2017.
**Preliminary Results**

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10% increase in bahiagrass yield

- **Control (no biochar)**
- **Biochar**

**Preliminary Results**

*Data refer to 1 harvest event (June 22) in 2017.*

**Preliminary Results**

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**Sources:**

- Control
- Class AA
- Class B_Bradenton
- Class B_St Pete
- Inorg fertilizer
Preliminary Results

**N₂O Fluxes**

- **Control**
- **Biosolids**
- **Biosolids+Biochar**
- **Inorg. Fertilizer**

**Water table vs. Precipitation - Biosolids Project**

- **Water table level (cm)**
- **Precipitation (cm)**

**Treatment Sampling Date**

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<td>Leachate NO₃-N (mg)</td>
<td></td>
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<td>Control</td>
<td>0.1±0.4</td>
<td>0.2±0.07</td>
<td>0.3±0.25</td>
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<td>Biosolids</td>
<td>0.2±0.1</td>
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<td>0.1±0.06</td>
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<td>0.3±0.4</td>
<td>0.2±0.03</td>
<td>0.3±0.25</td>
<td>0.3±0.08</td>
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<td>Inorg. Fertilizer</td>
<td>0.3±0.2</td>
<td>1±0.15</td>
<td>3±18</td>
<td>12±4.9</td>
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<tr>
<td>Inorg. Fertilizer+Biochar</td>
<td>0.3±0.3</td>
<td>3±0.13</td>
<td>4±18</td>
<td>7±15.9</td>
<td>0.1±0.05</td>
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<td><strong>P value</strong></td>
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<td>0.3</td>
<td>0.087</td>
<td>0.03</td>
<td>0.5</td>
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<td><strong>Significance</strong></td>
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Preliminary Results

Additional Studies

1. Laboratory characterization
   - Comparative bioavailability and leachability to fertilizer-N
2. Greenhouse studies
   - Impacts of biosolids + biochar on bahiagrass responses
3. Simulated rainfall studies
   - Amendment and management effects
4. Trace organics
   - Ciprofloxacin and azithromycin

THANK YOU!

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