HYDROPONIC FERTIGATION WITH ANAEROBIC MEMBRANE BIOREACTOR (ANMBR) PERMEATE - A TOOL FOR WASTEWATER NUTRIENT RECOVERY

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BACKGROUND

DECENTRALIZED TREATMENT

- Urbanization
- Site specific re-use opportunities
  - Reclaimed water for irrigation

NUTRIENT MANAGEMENT

- Nitrogen cycle management
- Phosphorus production
- Urban Agriculture
FOOD

How will we feed 7 billion+ people?
WASTEWATER AS A RESOURCE

“WASTEWATER is a RENEWABLE RECOVERABLE SOURCE of POTABLE WATER, ENERGY, and RESOURCES.“

~ George Tchobanoglaus
ANAEROBIC MEMBRANE BIOREACTOR (ANMBR)

- Anaerobic Digestion
- Membrane Ultrafiltration (0.03 micron)
- Outputs:
  - Biogas
  - Permeate containing:
    - Water
    - Nutrients

Pilot AnMBR Permeate Nutrient Concentrations

- TP (Total Phosphorus)
- Total Nitrogen
- Ammonia

Concentration (mg/l) vs. Day

Graph showing nutrient concentrations over time.
HYDROPONICS GROWTH: LABORATORY TRIAL

Hydroponic grow bed:
- 1 Liter of nutrient solution
- (3) 3” diameter net cups with hydroton media
- 6” aeration stone
- Additional nutrient solution: pH adjusted permeate (nitric acid added: pH=6.5)
HYDROPONICS GROWTH: LAB TRIAL RESULTS

- Nutrient solutions:
  - AnMBR permeate (P1)
  - 50% Dilution of Permeate (P0.5)
  - pH Adjusted Permeate (P1*)

- Compared to performance achieved by commercial fertilizer (C1)

- Six growth performance parameters:
  - Plant Height (PH)
  - Root-to-Shoot Weight Ratio (RS)
  - Leaf Count (LC)
  - Final Dry Weight (DW)
  - Bloom Count (BC)
HYDROponics growth: lab trial results

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  - Tap Water (Blank)

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- **Compared to performance achieved by commercial fertilizer (C1)**

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HYDROPONICS GROWTH: LAB TRIAL RESULTS

Normalized Composite Growth Score
Deficiency Symptoms

- Plants grown in pure permeate solution (NG) experienced scorching of older leaves
- Potentially attributable to ammonia-induced deficiency of another nutritive cation
Biorecycling and Bioenergy Research and Training Station (BBRATS) at Learning Gate Community School in Lutz, FL.
CONTINUED GREENHOUSE OPERATION

November 2013
CONTINUED GREENHOUSE OPERATION
CONTINUED GREENHOUSE OPERATION

April 2014
CONCLUSIONS

- AnMBR permeate supported supports hydroponic cultivation but with less than optimal performance resulting from:
  - Lower concentrations of phosphorus
  - High NH$_4^+$:NO$_3^-$ Ratio
  - Inhibits uptake of other cations causing deficiencies of K$^+$, Ca$^{2+}$, and Mg$^{2+}$

- Additional permeate polishing processes could improve growth performance
  - Promote nitrification
  - Increase micronutrient concentrations
  - Ensure safety

### AnMBR Permeate Nutrient Concentrations (mg/L)

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<th>NH4</th>
<th>TP</th>
<th>TN</th>
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<tr>
<td>average</td>
<td>173</td>
<td>51</td>
<td>189</td>
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<tr>
<td>SD</td>
<td>118</td>
<td>28</td>
<td>152</td>
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