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

Jorge Calabria, George Dick, Robert Bair, Onur Ozcan Daniel Yeh, Ph.D.





BACKGROUND

DECENTRALIZED TREATMENT

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

NUTRIENT MANAGEMENT

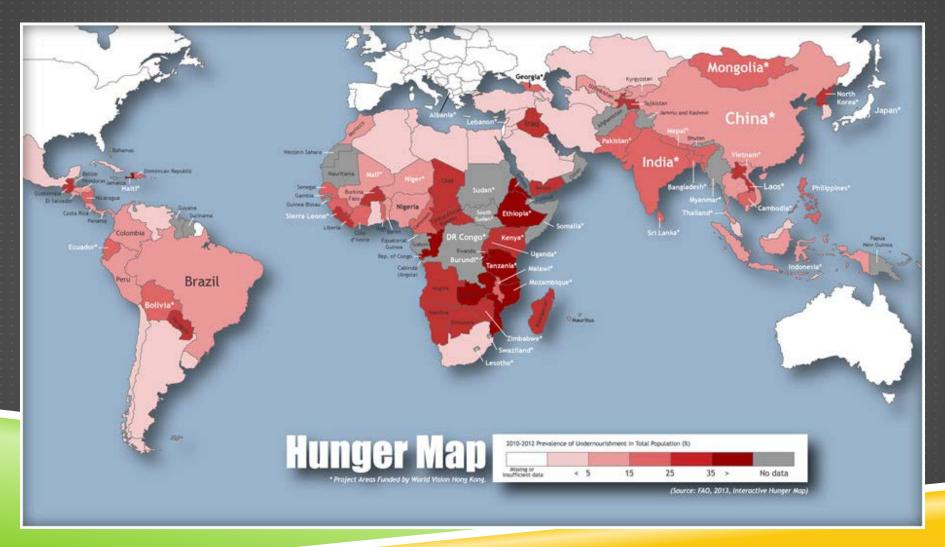
- Nitrogen cycle management
- Phosphorus production
- Urban Agriculture





FOOD

How will we feed 7 billion+ people?



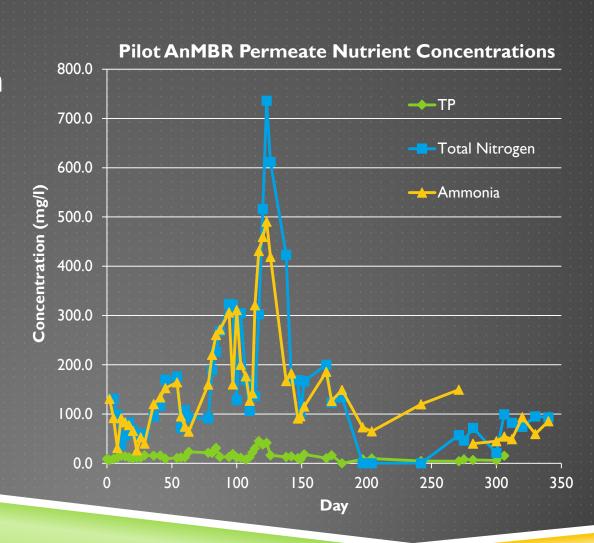
WASTEWATER AS A RESOURCE

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

~ George Tchobanoglaus

ANAEROBIC MEMBRANE BIOREACTOR (ANMBR)

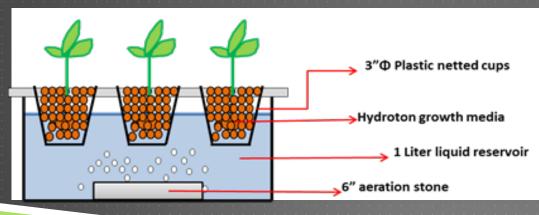
- Anaerobic Digestion
- Membrane
 Ultrafiltration (0.03 micron)
- Outputs:
 - Biogas
 - Permeate containing:
 - ▶ Water
 - Nutrients



HYDROPONICS GROWTH: LABORATORY TRIAL

Hydroponic grow bed:

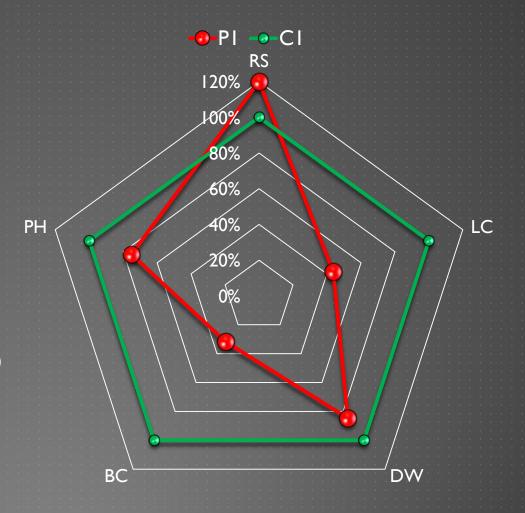
- I Liter of nutrient solution
- (3) 3" diameter net cups with hydroton media
- 6" aeration stone
- Additional nutrient solution: pH adjusted permeate (nitric acid added: pH=6.5)



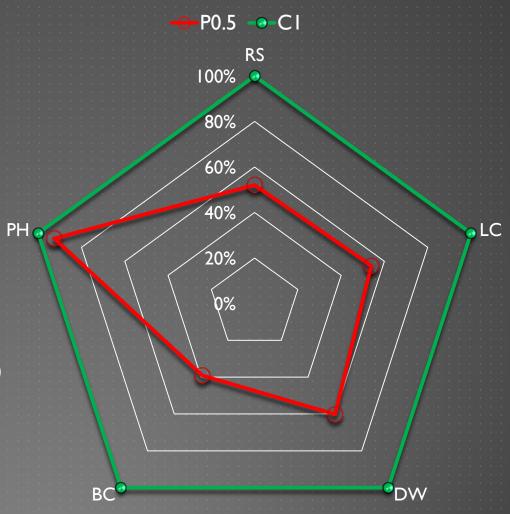




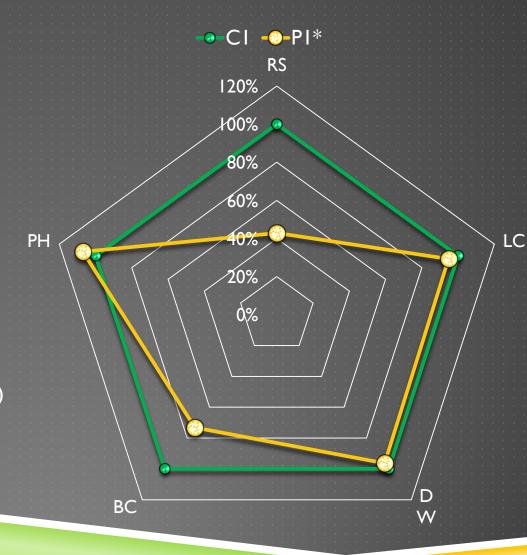
- Nutrient solutions:
 - ► AnMBR permeate (P1)
 - ▶ 50% Dilution of Permeate (P0.5)
 - ▶ pH Adjusted Permeate (PI*)
- Compared to performance achieved by commercial fertilizer (CI)
- Six growth performance parameters:
 - ▶ Plant Height (PH)
 - Root-to-Shoot Weight Ratio (RS)
 - Leaf Count (LC)
 - Final Dry Weight (DW)
 - Bloom Count (BC)



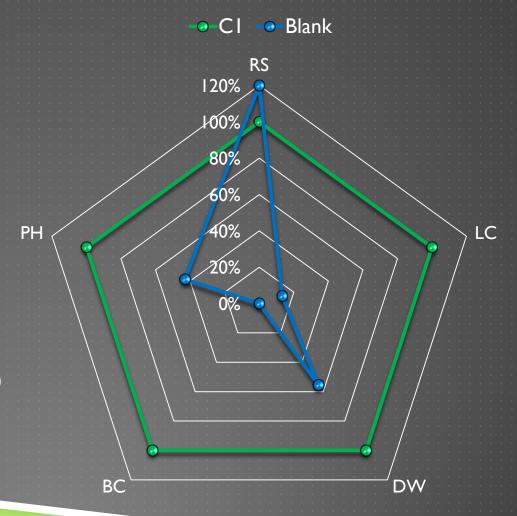
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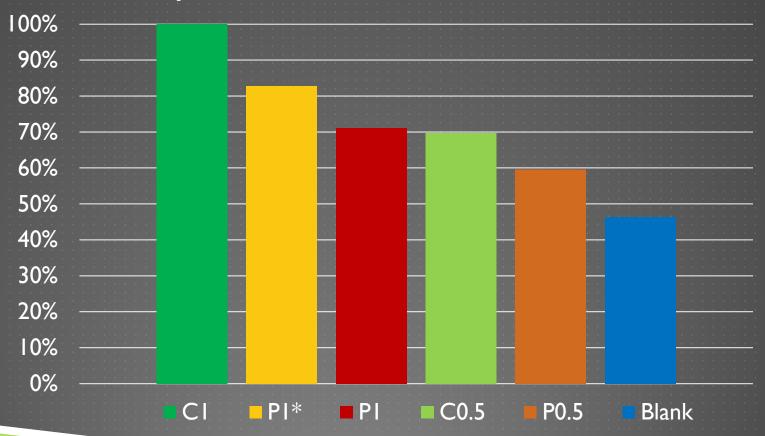
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▶ Normalized Composite Growth Score



Deficiency Symptoms

- Plants grown in pure permeate solution (NG) experienced scorching of older leaves
- Potentially attributable to ammonia-induced deficiency of another nutritive cation



INTEGRATING WASTEWATER TREATMENT AND AGRICULTURE: THE B.B.R.A.T.S. MODEL



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 NH₄+:NO₃- Ratio
 - Inhibits uptake of other cations causing deficiencies of K⁺, Ca²⁺, and Mg²⁺
- Additional permeate polishing processes could improve growth performance
 - Promote nitrification
 - Increase micronutrient concentrations
 - Ensure safety

Plant Food for Vigorous	PONICS Ground
10 - 5 - 14 GUARANTEED ANALYSIS	- Julia
Total Nitrogen (N)	10.0%
1.5% Ammoniacal Nitrogen (N)	
8.5% Nitrate Nitrogen (Ñ) Available Phosphate (P ₂ O ₅)	5.0%
Soluble Potash (K ₂ O)	14.0%
Calsium (Ca)	6.0%
Magnesium (Ma)	2.0%
Calcium (Ca)	
Sulfur (S)	3.0%
3.0% Combined Sulfur (S)	
Iron (Fe)	0.12%
0.13% Chalated Iron (Fo)	
Manganese (Mn)	0.05%
0.05% Chelated Manganese (Mn)	
Derived from: Ammonium Molybdate, Ammonium Nitrate, Calcium Sulfate, Copper Sulfate, Iron DTPA, Magnesium Sulfate, M	Calcium Nitrate, anganese EDTA,

Potassium Borate, Potassium Nitrate, Potassium Phosphate and Zinc Sulfate.

Information regarding the contents and levels of metals in this product is available on the internet at http://www.aapfco.org/metals.htm

 AnMBR Permeate Nutrient Concentrations (mg/L)			
	NH4	TP	TN
 average	173	51	189
SD	118	28	152

ACKNOWLEDGEMENTS





National Science Foundation WHERE DISCOVERIES BEGIN

This material is based upon work supported by the National Science Foundation under Grant No. 1243510. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.



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