

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

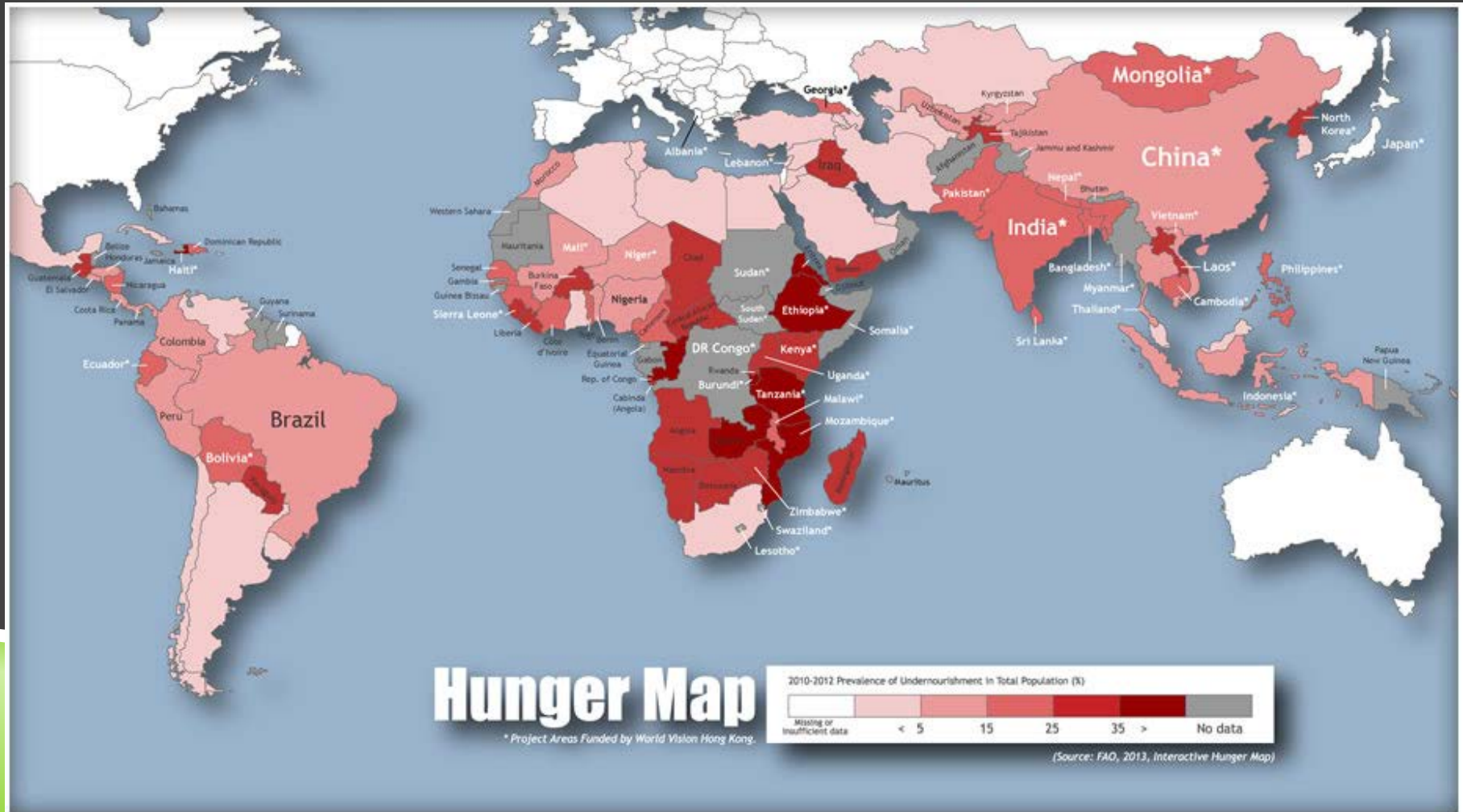
NUTRIENT MANAGEMENT

- ▶ Nitrogen cycle management
- ▶ Phosphorus production
- ▶ Urban Agriculture



FOOD

How will we feed 7 billion+ people?



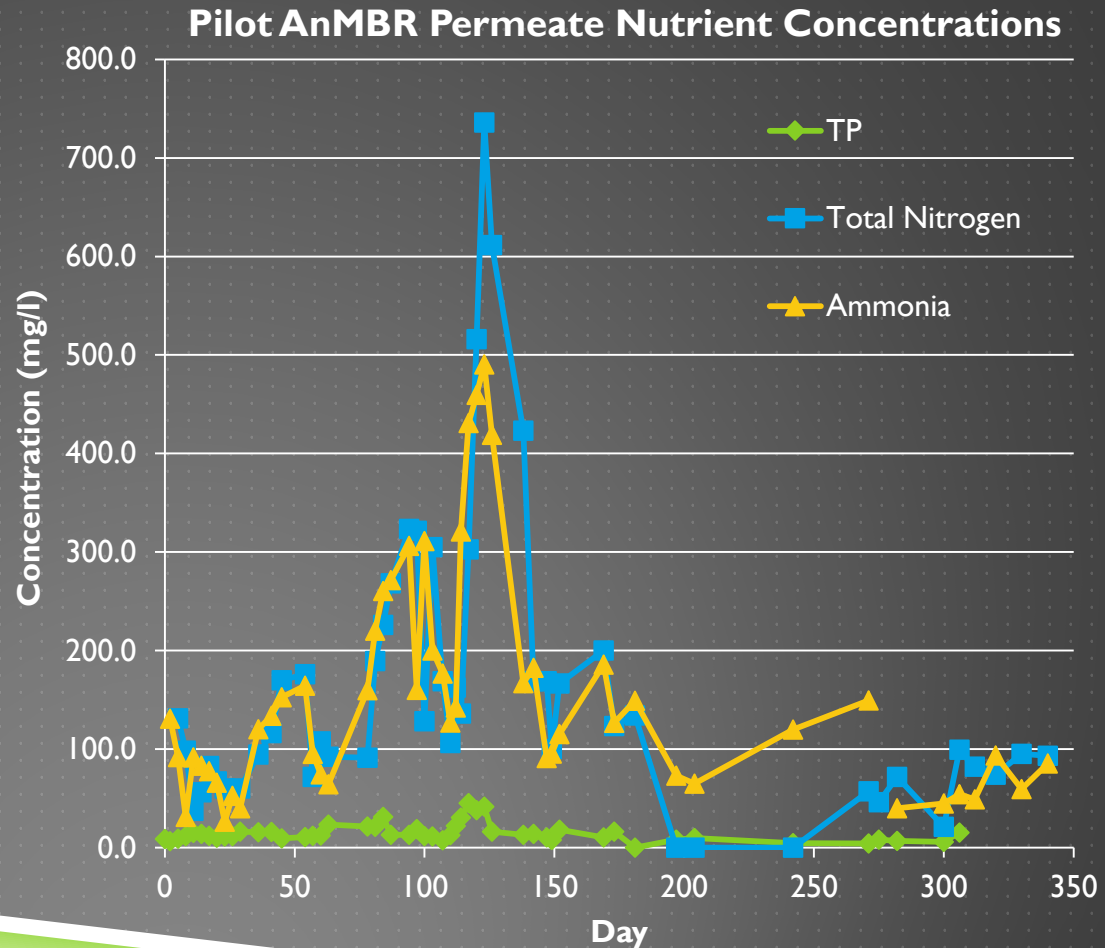
WASTEWATER AS A RESOURCE

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

~ George Tchobanoglaus

ANAEROBIC MEMBRANE BIOREACTOR (ANMBR)

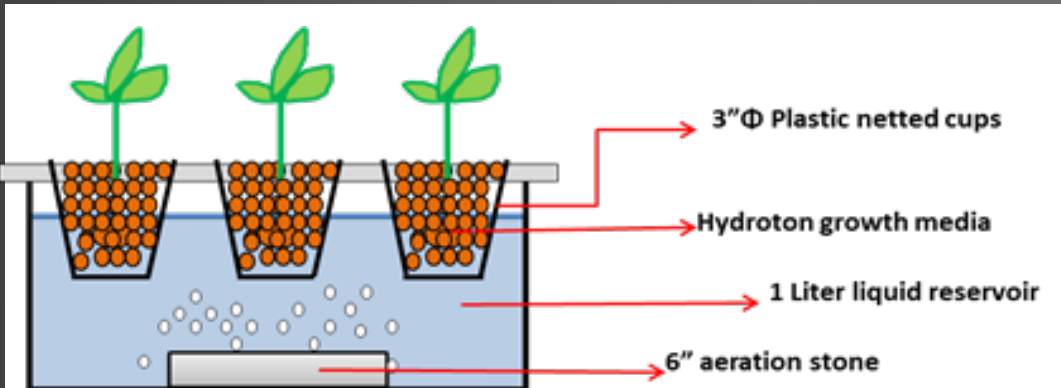
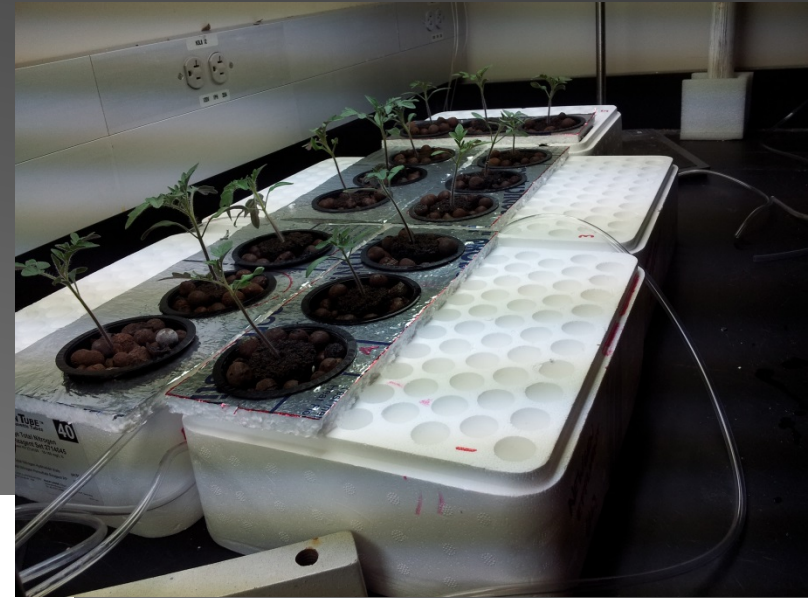
- ▶ Anaerobic Digestion
- ▶ Membrane Ultrafiltration (0.03 micron)
- ▶ Outputs:
 - ▶ Biogas
 - ▶ Permeate containing:
 - ▶ Water
 - ▶ Nutrients



HYDROPONICS GROWTH: LABORATORY TRIAL

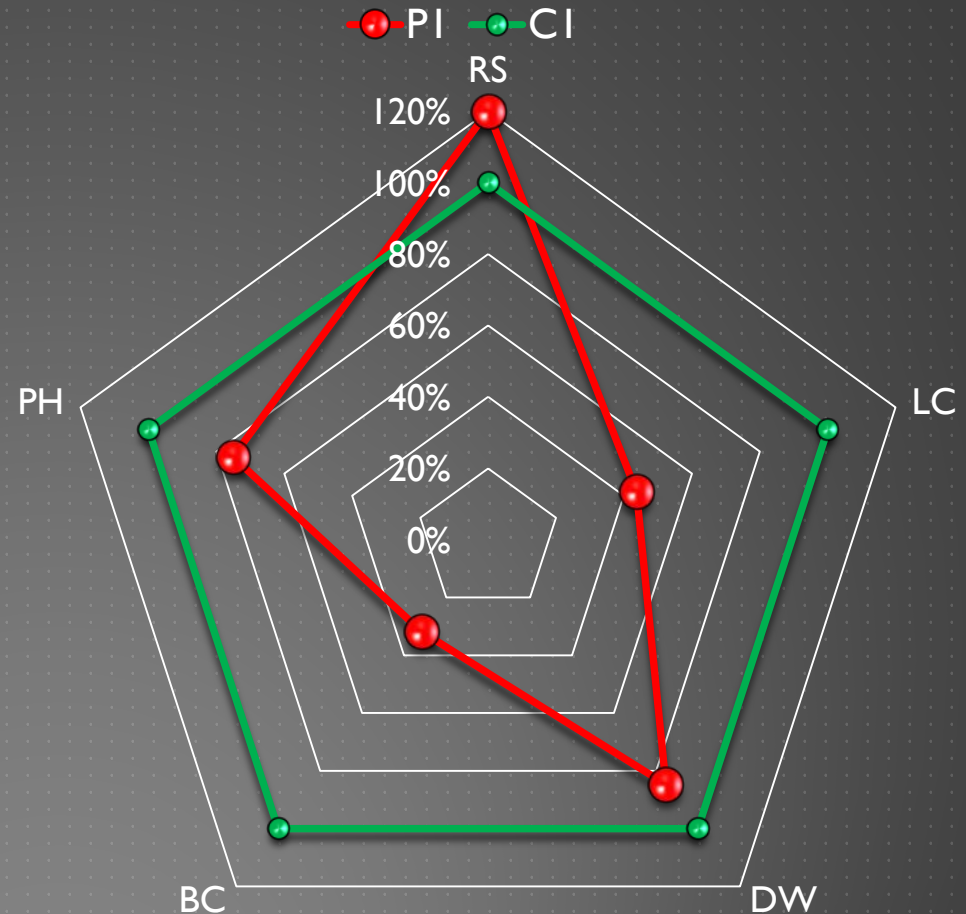
Hydroponic grow bed:

- 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)



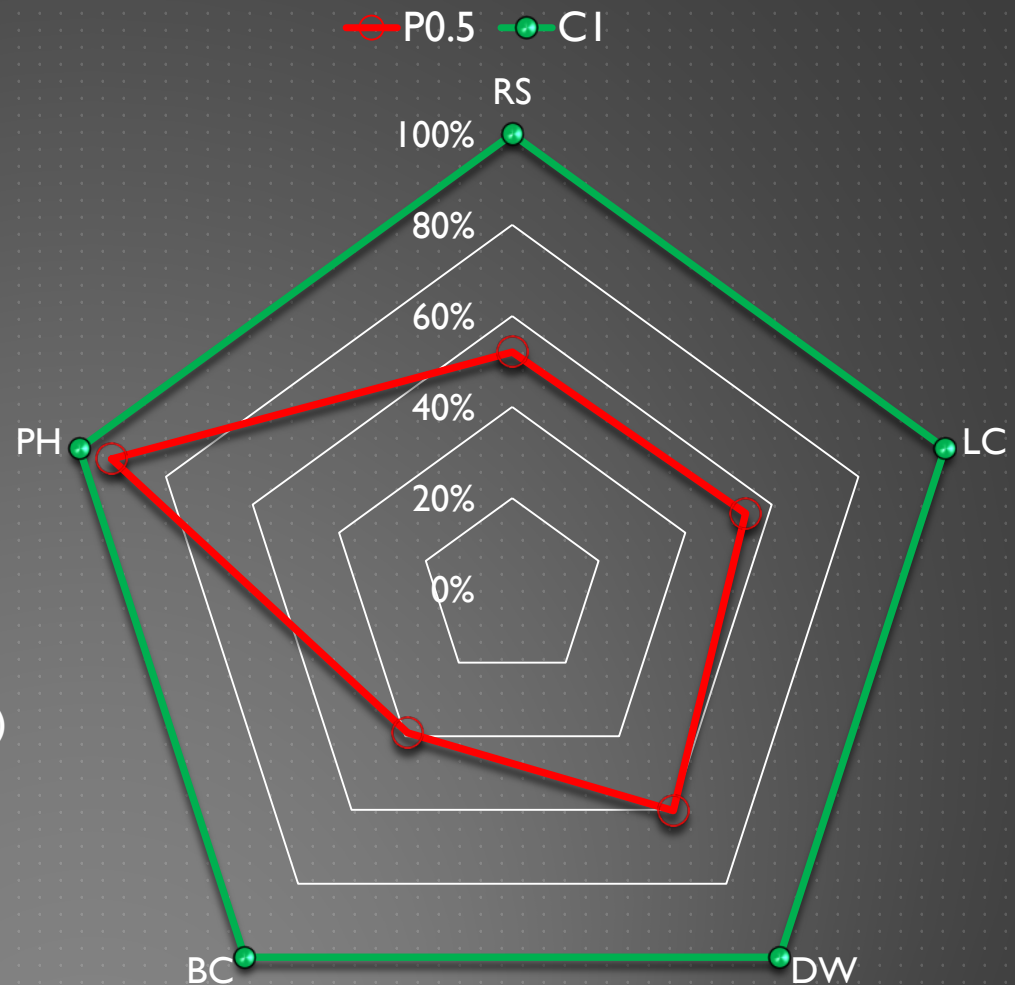
HYDROPONICS GROWTH: LAB TRIAL RESULTS

- ▶ Nutrient solutions:
 - ▶ AnMBR permeate (PI)
 - ▶ 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)



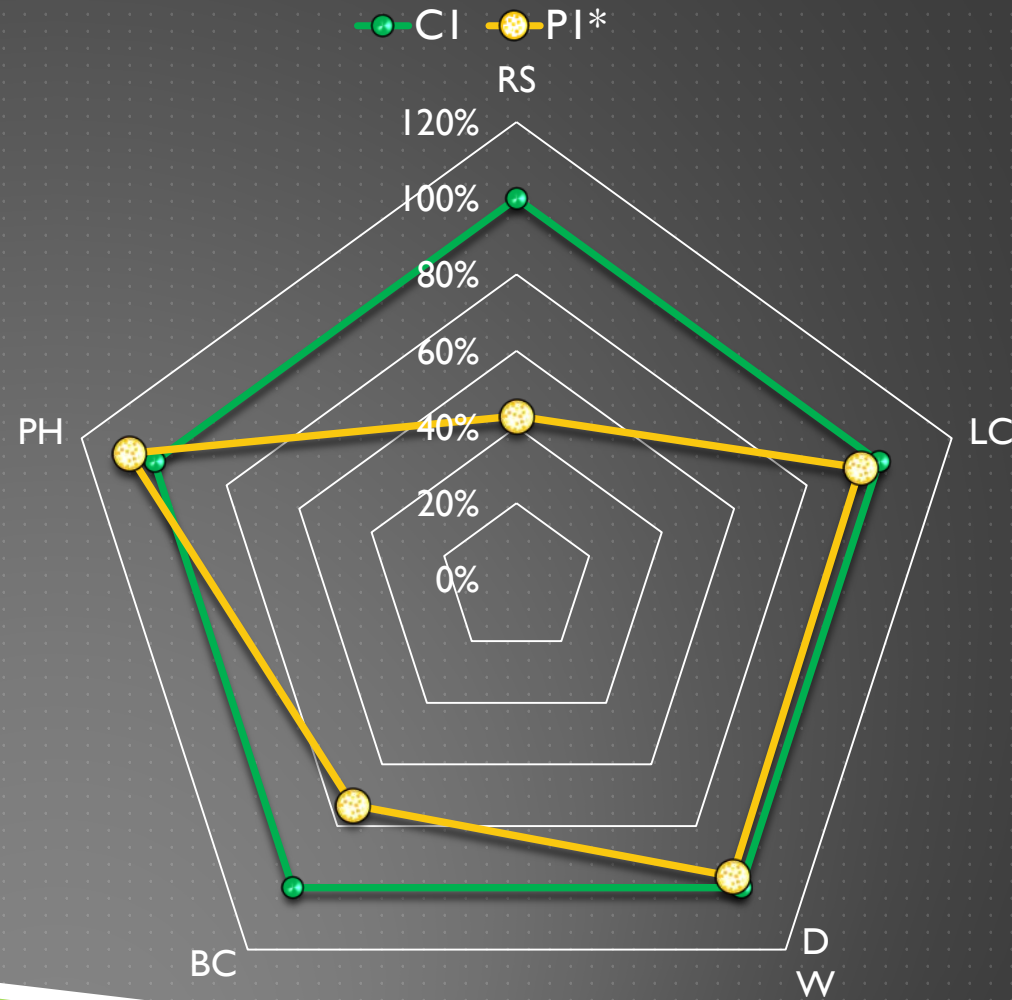
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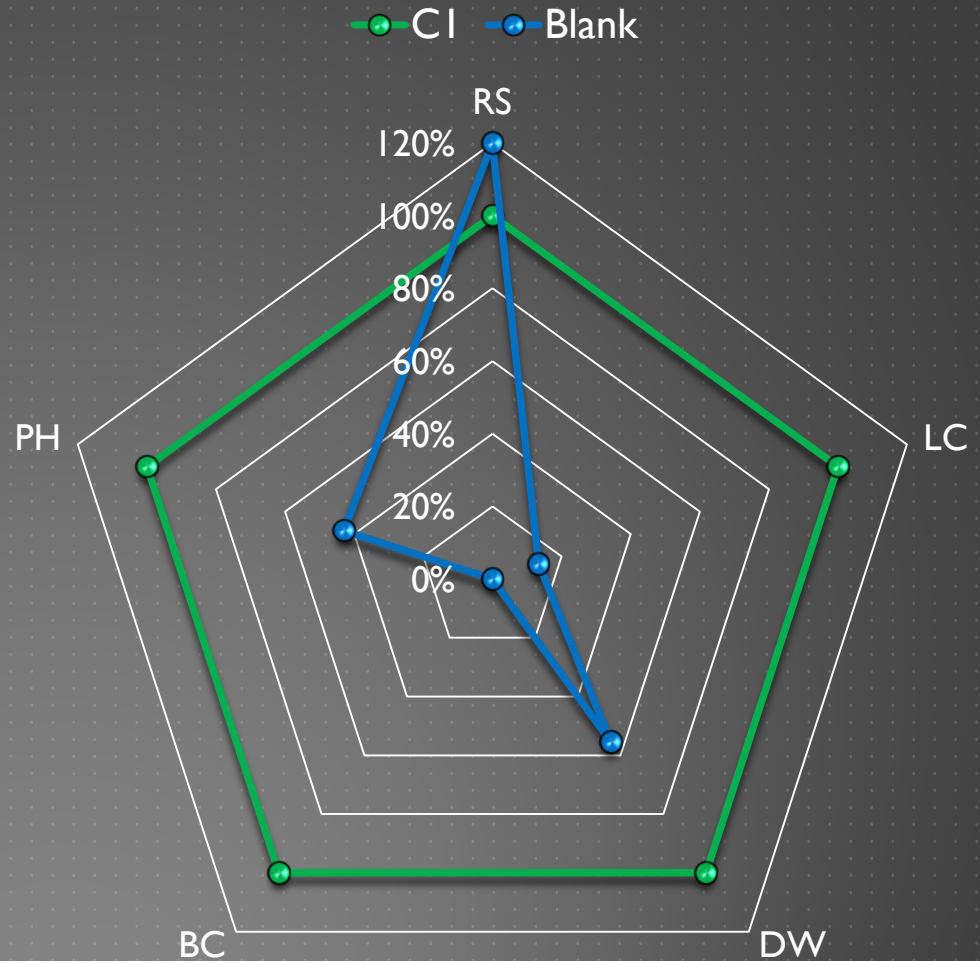
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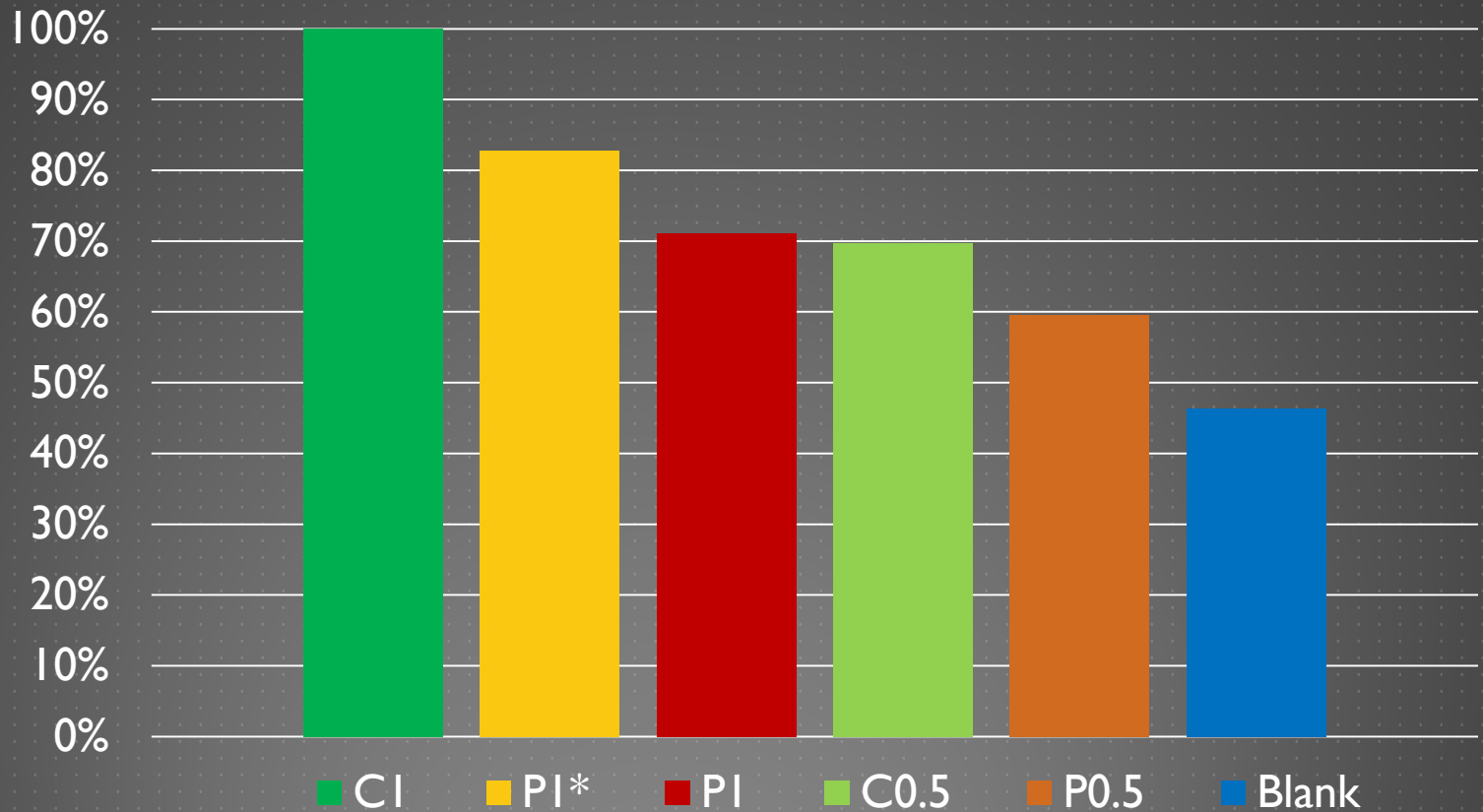
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HYDROPONICS GROWTH: LAB TRIAL RESULTS

► Normalized Composite Growth Score



HYDROPONICS GROWTH: LAB TRIAL RESULTS

▶ 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

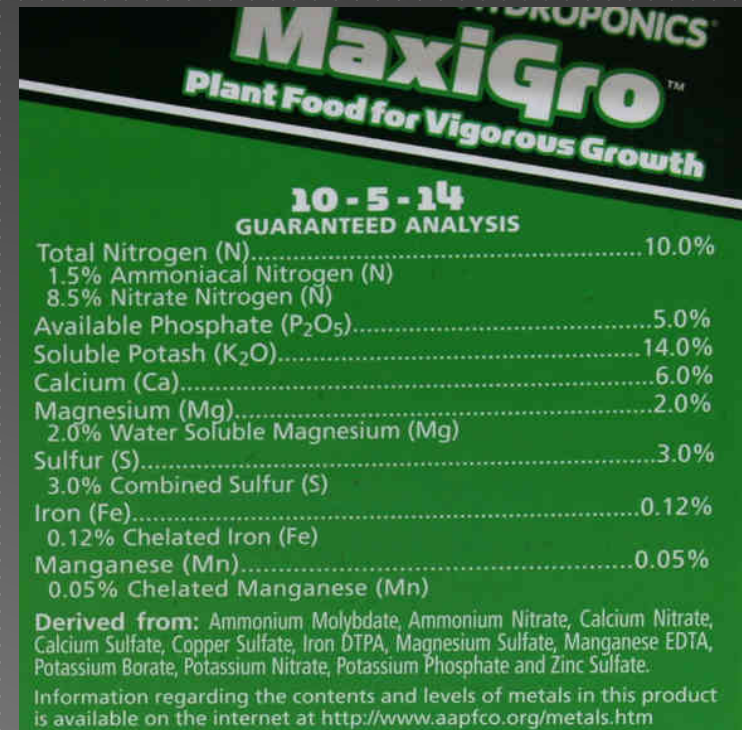


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CONCLUSIONS

- ▶ AnMBR permeate supported supports hydroponic cultivation but with less than optimal performance resulting from:
 - ▶ Lower concentrations of phosphorus
 - ▶ High $\text{NH}_4^+:\text{NO}_3^-$ 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)			
	NH4	TP	TN
average	173	51	189
SD	118	28	152

ACKNOWLEDGEMENTS



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