Testing Alternative and Sustainable Growing Mediums and Essential Nutrient Sources in the Aquaponics System

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Micronutrients

Methods

- Filled 15 one gallon jugs with hose water
- Measured out 3 grams of seaweed, ash and bat guano and 18 grams of nails
- Put the materials in tied coffee filters inside the jugs Air-stones simulated the aquaponics system by providing oxygen
- Water quality was tested every week for potassium, phosphorous, and iron by a colorimeter Salinity was tested with a salinometer. Tilapia fingerlings were added to the jugs for 48 hours to test for toxicity

The essential nutrients setup with the one gallon jugs, the testing reactants, and the colorimeter.

The cups for the micronutrients experiment. From left to right: coconut cups, charcoal cups, Rockwool cups, glass cups.

Results

Concentrations of iron, potassium, phosphate, and salt increased in their respective gallon jugs by the conclusion of the experiment.

- Probability Values (P-value):
- Potassium, 0.007 Iron, 0.048 Salinity, 0.019 Phosphate, 0.077

Figure 1

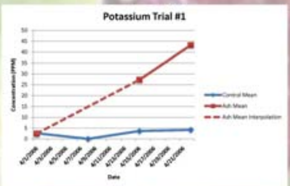

Figure 2

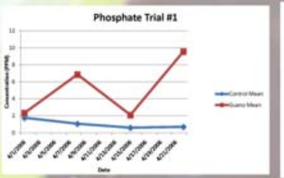

Figure 3

Figure 4

Introduction

Aquaponics is the combined cultivation of plants and fish in a recirculating system. Aquaponic systems integrate the waste products from the fish tanks into the hydroponic component of the system. Nitrifying bacteria detoxify the fish wastewater so that the water filtered by the plants can recirculate back into the fish tanks (Rakocy et al. 2006).

Aquaponic systems are versatile and can operate in areas with limited water access. Since the water re-circulates in a closed environment, there is minimal water loss (Rakocy et al. 2006). In addition, the nutrient-rich water decreases the need for chemicals which can pollute groundwater, rivers, lakes, and oceans (Jones 2006).

One drawback of many aquaponic systems is that they do not have enough potassium or phosphate to properly support fruiting plants. Therefore, certain plants cannot grow successfully without the introduction of extra nutrients (GROLive!).

The recent economic collapse in southern Eleuthera has caused residents to become more reliant on marine resources (Danylchuck). This increased dependence on fisheries has prompted The Cape Eleuthera Institute (CEI) to create and maintain an aquaponics system that could be functional, sustainable, and economically feasible for people throughout the Bahamas to replicate.

In the CEI system, there are a few key unsustainable aspects. For instance, the growing medium currently used, Rockwool, requires a lot of energy to produce and import, is not reusable, and does not biodegrade. In addition, the system does not have enough iron, phosphate, and potassium to support fruiting plants. For one experiment, we hypothesized that when grown in Australian Pine charcoal (*Casuarina sp.),* glass, and wild cotton, green romaine lettuce (*Latuca sativa longifolia*) would achieve comparable growth rates to the green romaine lettuce grown in Rockwool. For the other experiment, we hypothesized that iron nails, casuarina ash, and bat guano would introduce iron, potassium, and phosphorous, respectively, to filtered rainwater. We also tested seaweed to see if it would leach potentially harmful salt into the system.

Growth Mediums

Methods

- Measured glass, cotton, and charcoal into the grow cups
- Put seeds in coconut coir in the cups to germinate
- Put into grow beds
- We measured leaf count, leaf height, and mortality rates. We also recorded the final harvest weights of the lettuce.

Results

Overall effectiveness of Rockwool in comparison to:

- Cotton: Rockwool achieved a P-value of 0.018 PPM.
- Glass: Rockwool achieved a P-value of 0.045 PPM.
- Charcoal: Rockwool achieved a P-value of 0.026 PPM.

According to the height data the mediums ranked Rockwool > Charcoal > Cotton > Glass. The leaf count values for Rockwool consistently outnumbered the leaf count values for the experimental mediums throughout the experiment.

For the graphs, we excluded mortality rates from the averages to compare only the plants that lived for each particular growing medium.

Figure 5

Figure 6

Figure 7

Discussion

For the micronutrient experiment, the results confirmed our expectations that iron, phosphorus, potassium, and salt would leach into water. After four weeks of nutrient infusion, the concentration levels of each nutrient rose significantly. The water quality results supported the hypothesis that iron nails, casuarina ash, and bat guano would introduce iron, potassium and phosphorous, respectively. Phosphorous concentrations increased for the first week and then decreased. We suspect that this was due to algae bloom growing on the inside of the container and consuming the phosphate. Evaporation of water from the salinity jugs made most of the salt stick to the container causing test numbers to decrease. The inconsistency of the survival rates could be from lack of water access because some of the grow cups were submerged at different levels in the grow beds due to the inconsistent widths of the styrofoam rafts. The water absorption ability of the cotton medium was greatly compromised due to amphipods consuming almost the entirety of the organic matter out of the grow cups.

Discussion

In our growth medium experiment, our hypothesis was not supported. For leaf count and plant height, none of the lettuce plants grown in alternate growth mediums achieved comparable results, defined for this experiment as within 10% when the mortality rates were included, to those grown in Rockwool. We decided that in terms of time, resource, and financial management, a decrease in success for lettuce output greater than 10% would not be feasible for a system, regardless of potential environmental benefit. Glass and charcoal cannot absorb water to the extent that Rockwool can, so the seed plot of coconut coir needs to be submerged. From our observations of the grow beds, grow cups were often at different levels on the floating raft due to the degraded Styrofoam substrate, causing some grow cups to be without water and some to fall through the raft. There was also likely an outside influence that was unaccounted causing such variation of survival rates between the replicas.

Acknowledgments

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Literature Cited

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