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

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Micronutrients

Methods
- Filled 15-gallon jugs with rose water
- Measures out 3 grams of seaweed, ash, and bat guano and 18 grams of rails
- Put the materials in tied coffee filters inside the jugs. Aerostones 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. Titrations were added to the jugs for 48 hours to test for toxicity

Results
Concentrations of iron, potassium, and phosphate were increased in respective jugs by the conclusion of the experiment.

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 decompose the fish wastewater so that the water filtered by the plants can re-enter 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 that can pollute groundwaters, 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 fracturing plants. Therefore, certain plants cannot grow successfully without the introduction of extra nutrients (GRODive).

The recent economic collapse in southern Eleuthera has caused residents to become more reliant on marine resources (Dairyduch). This increased reliance on fisheries has prompted The Cape Eleuthera Institute (CEI) to create and maintain as 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, phosphorus, and potassium to support fracturing plants. For one experiment, we hypothesized that when grown in Australian Pine chow (Casuarina sp.), glass, and wild cotton, green romaine lettuce (Lactuca sativa longifolia) would achieve comparable growth rates to the green romaine lettuce grown in Rockwool. For the other experiment, we hypothesized that iron rails, 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 salts into the system.

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 rails, casuarina ash, and bat guano would introduce iron, potassium, and phosphorus respectively. Phosphorus and potassium 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 jugs were submerged at different levels in the growth beds due to the inconsistent widths of the styrofoam rafts. The water absorption ability of the cotton medium was greatly compromised due to amphibious consuming almost entirely of the organic material of the grow cups.

Growth Mediums

Methods
- Measured glass, cotton, and charcoal into the grow rafts
- Put seeds in coconut oil 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 0.18 PPM.
- Glass: Rockwool achieved a P-value of 0.05 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 last count values for the experiment mediums through all the experiments.

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

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 within 10% of the mortality rates were included to those grown in Rockwool. We decided that it terms of time resource, and financial management, a decrease in success for lettuce output greater than 10% would be not feasible for a system, regardless of potential environmental benefits. Glass and charcoal cannot absorb water to the extent that Rockwool can, so the seed pick of coconut only 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 likely an overall influence that was unaccounted causing such variation of survival rates between the replicates.