Increasing Tomato Plant Production Using Bato Buckets and Mineralization

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INTRODUCTION
Aquaponics is a closed sustainable system that reuses water from aquaculture tanks and nutrients from fish waste to further nourish plant growth. It aims to form a relationship between both vegetable and fish production, by combining aquaculture and hydroponics. Compared to traditional farming, aquaponics produces 150-200% more food per square foot. It only requires 5-10% of the water needed for soil-based agricultural production (Thomas 2017). Economically, aquaponics would reduce agricultural imports for the Bahamas, lifting some of the $3.1 billion trade deficit.

Aside from economical and sustainable benefits, aquaponics has the potential to improve food security and nutrition. Fish is the fastest growing industry for food globally. In 2009, it accounted for 17% of the global intake of animal protein. Fish contain essential micronutrients, minerals, and vital amino acids that help counter malnutrition (Béné et al. 2015). Fish are also a great resource for low-income families. Aquaponics has the potential to drastically improve food security with fewer environmental impacts.

METHODS

The overarching goal in aquaponics is to be a model for sustainability and to improve food security at The Island School and throughout the Bahamas. The Island School imports 89% of its food, which means that The Island School is 89% food insecure. However, the aquaponics team has harvested approximately 500 pounds of lettuce since the start of the 2018 spring semester. One of the goals in aquaponics is to increase fruiting vegetables, like tomatoes. To increase production in tomatoes would decrease the need for importation, and therefore, lower the carbon footprint. In order to achieve these goals, we used two different methods: mineralization and the bato bucket system.

Bato Bucket System
Bingoli Cherry Tomatoes require structure for plant roots, making a media-based solution favorable. A Bato or Dutch Bucket system is a media-based form of growing plants. The media retains water and allows plants to grow deeper roots and pull nutrients from the media. The media’s added surface area acts as an additional bio filter where more nutrients can be produced. The buckets are watered with an irrigation line that pumps water directly from the grow beds. Overflow pipes sit at the bottom of the buckets to let out any excess water back into the grow bed.

RESULTS

Our system has nine consecutive buckets, each containing one of three different types of media: coconut husk, clay pellets and pumice. The coconut holds water extremely well but offers little aeration due to its density. Pumice and clay pellets must be mixed and imported but offer great aeration due to the high surface area. Each bucket contains 25 L of the buckets contain plants started in the bucket, while the other 3 contain plants that were grown for a month in the raft system. In the raft system we have two control plants. The plants are then compared to the control to see if the experiment is working.

Mineralization
In an aquaponic system, nutrients are largely produced by converting ammonia fish waste into nitrates through a biofilter. However, this does not produce enough nutrients for fruiting vegetables. Therefore, the aquaponics team focuses on mineralization, the bacterial degradation of fish waste to batteressed nutrients using oxygen. After removing the two air stones from our vessel to allow solids settle to the bottom, the aquaponics team takes out one gallon of mineralized water daily. That one gallon is then manually emptied into the larger aquaponics system and put one gallon of fresh fish waste into the mineralization vessel. Background research by Rakocy (2007) suggests that mineralization can yield essential macronutrients for tomato growth. Every other day, the mineralization water is tested for ammonia, nitrite, nitrate, phosphorus, and potassium.

DISCUSSION

The tomatoes grown in the Bato Bucket system were much more successful than the plants grown in the traditional raft system. However, these plants were bullied, meaning they were vegetative, and lacked fruit. This is potentially due to a nutrient imbalance, specifically the ratio between nitrogen, phosphorus, and potassium (N:P:K). Through the process of mineralization, this ratio could have been corrected, however, that was not the case. As illustrated in figure 7, the nitrogen and phosphorus levels did not meet the recommended nutrient concentrations. However, for nitrogen specifically this is not such a bad thing, because if the nitrogen levels were at the recommended nutrient concentration it would not sustain fish life, which is an integral part of an aquaponics system.

CONCLUSION

Based on the data collected and presented, the Bato Buckets and the mineralization vessel have not produced the anticipated results. This might be the result of an incorrect nitrogen, phosphorus, potassium (N:P:K) ratio. In the future, the Aquaponics team hopes to make improvements upon the existing systems to produce tomatoes, as well creating a system that will improve the N:P:K ratio. This might mean implementing a fertilizer spray, to supply the plants with the correct ratio of nutrients. Aquaponics will also continue being the main supplier of lettuce at The Island School, as well as continuing research into other forms of plant production to further food security on campus.

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LITERATURE CITED