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A comparative study of aquaponic methods: Raft vs gravel filtration

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Introduction

Soilless agriculture or hydroponics entails growing vegetation without a substrate, and using chemicals as fertilizer (Jones 1997). Aquaculture is the captive cultivation of aquatic organisms for human use (Howerton 2001). The combination of both the practice of hydroponics and aquaculture creates yet another system of soilless cultivation, aquaponics. Aquaponics differs from hydroponics and aquaculture in that fish are grown simultaneously in the same water, producing byproducts that fertilize the plants instead of chemical additives. Aquaponics creates a mutualistic relationship between fish and plant such that as the plants absorb the waste products of the fish, they also filter the water. Fish can then thrive in a relatively pollutant free environment. Growth continues until both fish and plants are harvested as food products (Whitton 2009). Some of the advantages of an aquaponic system are: 100% control of nutrition levels, high yields on a small footprint, lower costs due to recirculating water system, and easy management of disease and pests (Hershey 1994).

Of the two most prevalent aquaponic systems in use today, the most common is the raft system (Mackowaik 1989). This system utilizes a floating raft to suspend the roots of the plants into the liquid medium. This type of system is considered static because the roots of the plants are always in direct contact with the still, nutrient rich water. The second type of system is a very dynamic gravel filtration system. In this system, gravel is used as a growth medium. This provides the roots of the plants something to grip creating stabilization. The water is then pumped up into the gravel bed until it reaches a certain point at which time it activates a negative pressure siphon draining the tank. Once drained, the tank fills again acting in a cyclic manner aerating the gravel. Though it has been shown that both types of aquaponics are successful forms of alternative agriculture, very little research has been done comparing the two methods (Emberger 1991). The purpose of this study is to compare the two aquaponic systems in order to determine which is the most effective when growing the herb basil.
Methods

Figure 1- Complete raft, and gravel filtration aquaponics system.  

An outdoor system was constructed using two large 55 gallon food grade, closed top, plastic barrels. One of the barrels was cut in half vertically, and the two halves were laid on their sides. These two halves acted as the growth beds. The second barrel was fixed with an underwater pump and PVC pipes and filled with approximately 15 lbs of Tilapia (54, 3” fish) (*Oreochromis mossambicus*). (figure 1)

The first growth bed consists of the raft method. In this system, a 2’x4’ piece of poly styrene is cut to fit in the half barrel. This poly styrene is then painted with water base latex paint on the surface exposed to the sun. Holes were then cut into it to fit the 3” mesh pots and 6” waste collection area.

The second growth bed is the gravel filtration system. In this system, an 8” standpipe is fit with a water siphon system. (figure 2) This siphon is then protected with a segment of 4” pipe in order to keep the gravel out. Once in place the barrel is filled with previously washed black cinders.

All of the barrels were fitted with custom wood cradles in order to secure and prevent them from tipping over. The barrels were also tied down with nylon safety chords in order to prevent rotation. Both systems were fed water from a 500 Gal per hr underwater fountain pump. This pump came from the bottom fish tank containing the tilapia, and pumped water at equal rates into the two growth beds. The fish were grown simultaneously with the basil. The nitrogenous wastes of the fish in the water were used as the fertilizer for the basil in both tanks.
Basil seeds were sprouted indoors using standard germination methods and grown until they achieved a height of 1 inch measured from tip to tip. The aquaponic system was placed in an area where it would receive at least 4 hrs of direct sunlight per day. Nutrient levels were monitored in the fish tank until they reached the optimum concentrations at which point the seedlings were placed in the tanks. Ten seedlings were suspended in the water on the floating raft system. Ten more were placed in the gravel filtration system, and ten more were placed in dirt to the side of the system for comparison. Readings were taken in the water systems every two days measuring the pH, nitrates, nitrites, hardness, and alkalinity throughout the growth period (31 days). At the end of the growth period, plant biomass from the two systems was harvested, weighed, measured, and compared statistically (one way ANOVA) to determine which method was superior.

Results

Due to recent changes in my methods I do not yet have 50% of my data. I have had the opportunity to attend an aquaponics workshop at UH, as well as travel with Dr. Bybee to Olamana Gardens in Waimanalo, as well as the WCC Aquaponic Research Station in Kaneohe in order to talk to the experts on the island, and learn how to better design my study. I am currently in the process of collecting all of my materials to construct the system. I will be here all summer working on this project and it is planned to start May 5th, repeated in July, and analyzed in Bio 493 during the month of September.

Works cited


