Use of Aquaponics as a Secondary Crop and Effluent Treatment in Ponds, Raceways, and Recirculating Tank Systems

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Abstract

The objective of this study was to investigate the growth and nutrient uptake potential of native ornamental plant species, Crimson-eyed Rosemallow (Hibiscus moscheutos L.), and Blue Flag iris (Iris versicolor L.), integrated into three different freshwater aquaculture production systems which primarily dominate in the Northeast U.S. which include: flow-through raceways, recirculating systems and ponds. These systems are relatively expensive to operate and are faced with increasing environmental regulations associated with effluent management. West Virginia University has partnered with University of Maryland and Delaware State University to evaluate the integrating aquatic ornamental plant culture with aquaculture and artificial wetlands to develop a new alternative crop with minimal infrastructure requirements yet high returns than typical foodfish species currently produced by recirculating systems. This systems was the only system not producing quality plants being produced. A negative result was the lack of insect protection reducing the salability quality of the ornamental plants (Fig 11.).

Research Objectives

To conduct a plant species/market survey to determine which plants are most suitable for the aquaculture systems. To evaluate and demonstrate 3 different aquaponics systems at three different locations based on different fish culture systems: flow-through raceway (WVU) (Fig 1.), baitfish ponds (DSU) (Fig 2.), and recirculating tanks (UMD) (Fig 3.). To provide growers with technical support and assistance.

Methods

Research Site: Three research sites were used based on the aquaculture production system: trout flow-through raceway (WVU), striped bass recirculating tank (UMD - Maryland), and a baitfish pond (DSU - Delaware).

Plant Selection: Two plants species (Crimson-eyed Rosemallow and Blue Flag iris) were selected for growing in the three different systems based on hardiness and potential salability of aquatic based ornamental plants. The striped bass recirculating tank system only had the Crimson-eyed Rosemallow growing in the system.

Experimental Design: Each plant species were randomly placed in a single growing channel. Each species had three replications for a total of six channels at each research site (Fig 4., 5., & 6.). Each plant channel was 5.5 x 0.6 x 0.23 meters and contained 72 plants.

Data Collection: Plant biomass was recorded at the beginning and end of the fish growing season (April - September) to determine a relative growth rate. Initial plant size were assessed prior to the placement of plant in the respective pond cells. In addition, plant tissue samples were tested for total nitrogen (TN) and total phosphorus (TP) to determine nutrient availability. All data were analyzed using the General Linear Model (GLM) of SAS to determine the significance of treatment effects.

Results & Discussion

Overall: The plant growth channels were found to be quite manageable for plant production. This system was labor efficient and required no watering of the plants. Utilizing the floating raft system, plants were easily rotated to account for nutrient gradients within the plant growth channels.

WVU - Trout flow-through raceway: Iris and hibiscus plants had limited growth as compared to the two other systems (Fig 7. & 8.). This is most likely because of the lower water temperatures (5°C) with the limited nutrient availability as compared to the other two systems. Plants grown in the plant growth channels as compared to plants grown conventionally (utilizing a 20-20-20 slow release fertilizer) in a greenhouse were significantly smaller (Fig 9. & 10.). Nutrient removal from the fish effluent was negligible and insignificant. This systems was the only system not growing directly outside which utilized a high-tunnel structure with netting on the sides to exclude insects which resulting in salable weight by more than 500% and 550%, respectively. A negative result was the lack of insect protection reducing the salability quality of the ornamental plants (Fig 11.).

UMD - Striped bass recirculating tank: Hibiscus plants has a significant increase in growth as compared to the trout flow-through system. There was a 15.4% and 8.7% reduction of N and P respectively from the fish effluent used for plant production. A negative component of this system is that there was severe insect damage to the plants because of the lack of insect protection reducing the salability quality of the ornamental plants (Fig 11.).

DSU - Baitfish Pond: Although the changes in nutrient levels between plant channel in-flow and out-flow were not large enough to be statistically significant, there was a clear trend towards a reduction in total phosphorus as affected by plant uptake. Similarly, both the Crimson-eyed Rosemallow and the Blue Flag iris appeared to thrive in the integrated system, increasing in weight by more than 350% and 550%, respectively. A negative result of this system is that there was a severe insect damage to the pond because of the lack of insect protection reducing the salability quality of the ornamental plants (Fig 12.).

Conclusion

Research indicates that utilizing fish effluent as a nutrient source is limiting in flow-through systems as compared to pond and recirculating systems. There is potential for reducing nutrients in a recirculating system for plant growth. Utilizing fish production with a high tunnel structure could provide a sustainable growing system with limited with minimal infrastructure requirements yet higher returns than typical foodfish species currently produced by the growers. Further evaluation is needed and ongoing of each of the three aquaponic systems.

Literature Cited


