Available online at www.sciencedirect.com

ScienceDirect

Agriculture and Agricultural Science Procedia 10 (2016) 255 – 260

Agriculture and Agricultural Science Procedia

5th International Conference "Agriculture for Life, Life for Agriculture"

Pilot Aquaponic Growing System of Carp (*Cyprinus carpio*) and Basil (*Ocimum basilicum)*

Radu Mihai FILEP[a]*, Ștefan DIACONESCU[a], Mioara COSTACHE[b], Mala-Maria STAVRESCU-BEDIVAN[a], Liliana BĂDULESCU[a], Carmen Georgeta NICOLAE[a]

[a]*University of Agronomic Sciences and Veterinary Medicine of Bucharest, 59 Marasti Blvd, 011464, Bucarest-1, Romania*
[b]*The Fish Culture Research and Development Station of Nucet, County Dâmbovita, 137335, Nucet, Romania*

Abstract

The aquaponic recirculating systems are integrated systems that combine fish and plant culture. These systems consist of two components: aquaculture and hydroponics components. In these systems the nutrients necessary for plant growth are resulted from the metabolism of food by the fish. This was obtained by recirculation of water, with a pump, from the fish tank to the hydroponic component and back to the fish tank. The experiment was conducted in the laboratory of Fisheries and Aquaculture of the Faculty of Animal Husbandry of University of Agronomic Sciences and Veterinary Medicine of Bucharest for 6 months. The system developed here, is a 1 m^2 area of plant growth and 0.45 m^3 of water in aquaculture component. In the hydroponic component river gravel was selected to support the plants and offer support for the growth and developing of nitrifying bacteria. The species cultivated were cultured carp (*Cyprinus carpio*) and basil (*Ocimum basilicum*). On average, there was obtained a quantity of about 1 kg basil leaves in a period of 60 days of growth. It has been found that the species of plants grown in this system, namely basil (*Ocimum basilicum*) grown with carp (*Cyprinus carpio*), has a faster and better development compared to conventional growth. Use of basil as a purifying plant, resulted in the removal of nitrates, being not necessary to add additional water, as in classical recirculating systems, where is necessary to replace daily approx. 10% of the volume of the culture water being necessary to add into the system only water lost through evaporation. According to the results the basil is suitable for aquaponic system with carp culture. The basil was grown much better than the conventional cultivation.

Peer-review under responsibility of the University of Agronomic Sciences and Veterinary Medicine Bucharest

*Keywords:*aquaculture, aquaponics, basil, carp, soilless culture.

* Corresponding author. Tel.: +40 21-318-25 64 Fax: +4021-318-28 88.
E-mail address: radu.filep@gmail.com

Peer-review under responsibility of the University of Agronomic Sciences and Veterinary Medicine Bucharest
doi:10.1016/j.aaspro.2016.09.062

1. Introduction

Aquaponics involves a dynamic interaction between fish, plants, bacteria and their aquatic environment (Klinger-Bowen et al., 2011). Fish and plants are dependent on nutrients and solutes and water quality, generating and using these products of metabolism from each other. Just having a balance between these metabolic products, we can have a good harvest healthy fish and plants healthy.

We should start the system to be "on", which means that the system must develop a bacterial population nitrified to convert ammonia resulting from excretion of fish into nitrite, which is made of species like *Nitrozomonas* and then nitrites are converted to nitrate by *Nitrobacter* species (Bernstein, 2013).

To follow the development of these bacteria need certain tests aiming the amount of ammonia, nitrates and nitrites in the water. If there is a buildup of ammonia, fish feed must be stopped until it turns to nitrite and then to nitrate which will subsequently be consumed by the growing plants.

An aquaponic system must be the most focused to search viable combinations of local plants and fish combinations (Ehud et. al, 2014).

2. Materials and Methods

Description of the system. Aquaculture component (Figure 1) consists of a tank with dimensions of 1.00 m (L) x 0.62 m (l) x 0.8m (h), resulting a total volume of 0.496 m^3, the volume of water will be 0.450 m^3 (450 l).

Fig. 1. Fish in Aquarium.

Hydroponic component (Figure 2) is made of OSB, internally lined with 0.5 mm sheet folded into two layers, to prevent leakage. OSB is made of a parallelepipedic box with dimensions of 1.25m (L) x 0,85m (l) x 0.35 m (h), there by to obtain a plant growth area of 1.06 m^2 and a volume of 037 m^3.

The box was filled with the graded gravel with size ranging from 8 to16 mm. Gravel was used because it works to support plant roots and support the development of nitrification bacteria (www.backyardaquaponics.com).

The water pump used was flow adjustable from 150 to 1000 l/h flow rate was adjusted to achieve a full cycle of filling and emptying of hydroponic component in an hour (Figure 3).

Fig. 2. Hydroponic component.

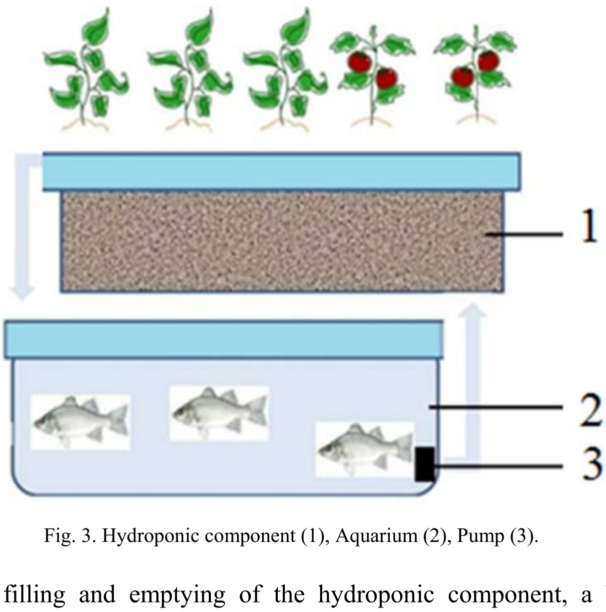

Fig. 3. Hydroponic component (1), Aquarium (2), Pump (3).

To achieve the cycle of filling and emptying of the hydroponic component, a bell siphon was used, the components of this are: PPR pipe 20 mm; 20mm adapter - 1/2"; Flexible hose 1/2"; PVC pipe 50 mm (Figure 4).

Oxygen enrichment of water was achieved using a high performance aerator with two diffusers and adjustable airflow that can reach up to 400 l/h. The reason for choosing this aerator was motivated by the need of oxygen for growth and fish welfare and needs of nitrifying bacteria to oxidize ammonia and form the nitrates required plant growth.

Fig. 4. Bell siphon.

Fish stocking was done at start up August 3, 2015 with 12 fish of the species carp (*Cyprinus carpio*). To ensure plant growth the light was provided by a 600 W horticultural lamp (Figure 5).

Fig. 5. Horticulture lamp.

The plant species selected for rearing is basil. Basil choice was made for the following reasons:

- Growth and development needs a minimum temperature of 20 degrees Celsius, the temperature that is favourable for the carp growth;

- Basil needs high humidity for growth and development, and aquaponic system can provide adequate moisture by evaporating water. Feeding fish was performed twice per day; the feed used is a granulated feed of 2 mm with the following nutritional values: 30% crude protein; 7% crude fat; 5% crude fibre; crude ash 7.5%; 0.85% Calcium; Sodium 0.25%; Phosphorus 1.15%.

Testing the significance of the results was performed using Fisher's exact test. Fisher's exact test was used to determine whether the three samples or not there are significant differences in terms of performance character average weight, number of branches, number of leaves. Establishing the value of Fisher was done using analysis of variance with two sources of variation: intergroup and intragroup.

3. Results and Discussions

The experiment was conducted in a period of 180 days, August 3, 2015 - January 30, 2016 respectively. Planting basil was done at the beginning of the experiment. 10 cm high seedlings grown in trays filled with nutritive substrate on an alveolar peat. Harvesting basil was performed three times during the study period, once every 60 days, monitoring the number of branches per plant, number of leaves per plant and the total weight of the leaves. A teach harvest, plants were cut leaving the15 cm from the stem and leaves at the bottom of the plant for it to continue growth and development. In the first harvest were obtained 939g fresh basil leaves, the second crop were obtained 1.130 g basil leaves the third crop was obtained 1.213 g basil leaves (Table 1).

Table 1. Results obtained in three harvests.

Results from the first harvest				Results from the second harvest				Results from the third harvest			
Plant ID No.	Ramifications No.	Leaves No.	Weight (g)	Plant ID No.	Ramifications No.	Leaves No.	Weight (g)	Plant ID No.	Ramifications No.	Leaves No.	Weight (g)
1	7	260	169	1	8	255	175	1	8	248	171
2	7	81	82	2	7	87	103	2	7	89	103
3	6	85	57	3	8	84	91	3	9	82	112
4	6	71	65	4	6	69	89	4	8	78	115
5	8	159	99	5	8	146	120	5	8	143	141
6	11	171	123	6	10	177	113	6	10	169	129
7	9	113	75	7	9	115	97	7	8	119	101
8	9	124	111	8	9	127	131	8	10	130	131
9	7	130	92	9	7	135	105	9	7	133	105
10	8	102	66	10	8	101	106	10	8	99	115
$\bar{X} \pm s_{\bar{X}}$	7.8± 0.49	129.6± 17.77	93.9± 10.69	$\bar{X} \pm s_{\bar{X}}$	8.0± 0.37	129.6± 17.28	112.0± 7.99	$\bar{X} \pm s_{\bar{X}}$	8.3± 0.34	129.0± 16.11	121.3± 6.82
Total weight (g)			939	Total weight (g)			1120	Total weight (g)			1213

The centralization of the amount of harvested leaves every 60 days is shown in Figure 6.

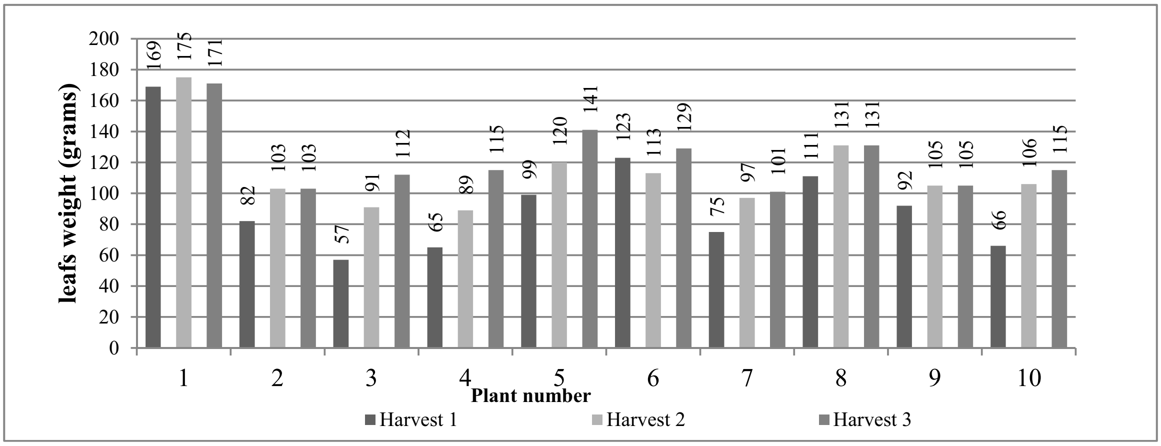

Fig. 6. The total weight of the leaves at each harvest.

By comparison, experimental results similar to which we had access, allow to appreciate that the proposed method can be effective. There by according to Boxer, Arabella and Philippa Back in The Herb Book, London: Octopus Books Limited, 1980, basil (*Ocimum basilicum*) grows to a height of 1-2 feet (30-60 cm) and according to Muenscher, Walter Conrad and Myron Arthur Rice, in Spice Garden and Wild Pot-Herbs, Ithaca, NY: Cornell University Press, 1978, the basil produces leaves about 2 inches (5.08 cm) in length. In the aquaponics system designed, built and tested, basil has reached the height of 103 cm length 13 cm leaf plants with an average height of 86 cm. According to Fisher test F calculated is lower than F spread sheet so it concludes that there are no significant differences between the three groups (Table 2).

Table 2. Results of Fisher's test.

Source of variation	Sum of squares	Mean of squares	Fisher 0.05
Between batches	4192.87	2096.43	2.801
In batch	20209	748.481	

4. Conclusions

- During the course of the experiment the amount of water in the system has remained relatively constant, being necessary to add in to the system only water lost through evaporation.
- Maintain functional system is possible through permanent control of water chemistry and adaptation of a proper administration regime for fish feeding.
- Use of basil as a purifying plant, resulted in the removal of nitrates, being not necessary to add additional water, as in classical recirculating systems, where is necessary to replace daily approx. 10% of the volume of the culture water.
- On the same surface can get two productions with high economic value: fish and plants.
- By comparison, in this system, the basil was grown much better than the conventional cultivation reported by the specialty literature consulted.

5. Acknowledgements

This research work was a part from PhD thesis elaboration "Rearing some fish species in aquaponic systems" and was carried out with the support of Faculty of Animal Science, University of Agronomic Science and Veterinary Medicine of Bucharest.

References

Bernstein, S., 2013. Aquaponic gardening, New Society Publishers, Gabriola Island, Canada.
Elia E., Popa D.C., Nicolae, C.G., 2014. Startup Stages of a Low-Tech Aquaponic System. Scientific Papers. Series D. Animal Science. Vol. LVII, 263-269.
Howerton R., 2011. Testing your Aquaponic System Water: A Comparison of Commercial Water Chemistry Methods, www.ctsa.org.
Klinger-Bowen Ruth Ellen, C., Clyde, S., Tamaru, Bradley K., 2011. Fox Kathleen McGovern-Hopkins.
www.backyardaquaponics (accessed on 01.06.2015)