Original Research Article

Growth of Lettuce and Water Spinach Plant in Koi Fish (*Cyprinus carpio*) Culture in Aquaponics System

ABSTRACT

This research aims to determine the growth of lettuce and water spinach plants as biofilter in koi fish (*Cyprinus carpio*) aquaponic system. Research was carried out at the Laboratory of Fisheries, Ciparanje, Faculty of Fisheries and Marine Sciences, Universitas Padjadjaran from March to April 2018. Research was carried out experimentally using Randomized Block Design (RBD) with 2 treatments and 6 repetitions. The treatment used in the research is a combination of koi and land water spinach, and a combination of koi and lettuce. The parameters observed were fish growth, fish survival, increase in length of plant stems and increase in leaf strands. The research shows that the use of land water spinach plants as an aquaponic system biofilter is more effective than lettuce. The combination of koi fish and land water spinach plants produced the highest productivity of plants, with stem length of 39 cm and the addition of 15 leaflets. This combination also produced the highest absolute growth of 3.93 grams / fish and survival rate of 100%.

Keywords: Aquaponics, Biofilter, Water spinach, Koi, Lettuce

INTRODUCTION

Cultivation activities produce solid waste and liquid waste from faeces and fish feed residues. The accumulation of waste can cause a decrease in water quality which affects physiological processes, behavior, growth, and mortality of fish. Therefore, management of water quality is needed in fish culture's media (Gunardi and Hafsari, 2008).

Aquaponics is a combination of aquaculture and hydroponics that aims to maintain fish and plants in a system that is interconnected. The interaction between fish and plants produces an ideal environment for fish and plant to grow bigger, so it is more productive than conventional methods (Fathulloh 2015). Aquaponics system reduces organic materials by absorbing wastewater from cultivation processes using plant. Plants are grown in hydroponic systems with roots submerged in water (Widyastuti 2008). The plants function as biofilter which will break down toxic substances into substances that are not harmful to fish while supplying oxygen to the water used for cultivating fish (Fathulloh, 2015).

Vegetable plants that are often used in aquaponic systems are including lettuce (*Lactuca sativa L.*) and water spinach (*Ipomoea reptans P.*). According to Rokhmah (2014), lettuce is a plant that is widely used in aquaponic systems, because it is short lived and is relatively less problematic with pests compared to fruiting plants. Land water spinach is a fast-growing plant,

has lush roots and is not too strong, and its maintenance requires continuous water (Nugroho and Sutrisno 2008).

The different types of plants will produce different uptake of organic matter, so that the use of both types of plants in aquaponic systems can reduce organic materials. The koi fish is used to see the growth response of the two types of plants. In addition, koi is a species of fish that has economic value that encourages the community to increase production through intensive cultivation. Koi carp is an economically important freshwater ornamental fish cultured in Indonesia with annual production of cultured was 83,885 MT in 2012 (Kumar et al, 2015).

The purpose of this research is to determine the effectiveness of lettuce and land water spinach plants as bio filter in koi fish culture in aquaponics system.

METHODS AND MATERIALS

Time and Place

Research was conducted in March to April 2018 at the Ciparanje Fisheries Cultivation Laboratory, FPIK Unpad, while water quality tests were carried out at the Ecology Laboratory, Center for Research and Development of Natural Resources and Environment (PPSDAL) of Universitas Padjadjaran.

Research Materials

The vegetables used in this study were land lettuce and water spinach aged 1 to 2 weeks from seeding. Rockwool served as the place for the roots of plants to stick, so the plants can be stuck firmly in the pot. Koi fish used in this experiment were about 3-7 cm long.

Research Tools

Two pieces of fiber tub with a diameter of 30 cm and a depth of 100 cm were used as the container for the fishes. Pump was used to draw water from the cultivation container to the 4" PVC pipe. Two pieces of pumps with a size of 90 watts (4 meters) and 25 watts (2 meters), and one heater for stabilizing water temperature were also used. 4" PVC pipe and ½" PVC pipe was placed to drain water and retain water for the plants. As many as 228 pieces of Plastic cups were used as a place to put the plants. Kenko brand digital scales with accuracy of 0.1 gram was utilized to measure fish weight.

Research Methodology

The research methodology used in this study was the experimental method, by conducting trials using lettuce and water spinach plants, and koi fish. The experimental design used was Randomized Block Design (RBD) with 2 treatments repeated 6 times.

Research Procedure

Container Preparation

The container used in this research were two tubular fiber with a diameter of 30 cm with a depth of 100 cm.

Fish Acclimatization

Fish acclimatization was done so that the fish could adapt to the new environment and the fingerlings could adjust when the research process took place. The newly purchased fingerlings were stored in an acclimatization container (fiber tub) for 1 week so that the fish did not get stressed and to reduce the high mortality value. Feeding was carried out on a regular basis adlibitum 2 times a day (8:00 a.m. and 8:00 p.m.) so that the fingerlings continue to get food intake during the adaptation process.

Preparation of Aquaponic Installation

The recirculation aquaponics system was installed as such, where the fish and plants were kept in separate container placed on a multilevel iron rack. Then, the water in the container which the fish were kept was flowed into the plant containers using 4" PVC pipe. One end of 4" PVC pipe on the top shelf was hollowed out and connected to the ½ " pipe PVC which has been installed with a water pump as a tool to suck up water up to the plant maintenance container. After that, under the drainage pipe there was a small tub acting as a water reservoir. The water in the storage container were flowed back through the ½ " PVC pipe using a water pump, so that the water could rise again to the fiber tub where the fish were kept.

Seeding

The seeding process was done by planting lettuce seeds and water spinach on the net pot using soil and rockwool. Lettuce and water spinach were sown for 2 weeks before planting in the growing media on aquaponic media.

Research Implementation

Research was carried out for 30 days. The density of koi fish was as much as 354 fishes. Feeding was done twice a day at 07.00 and 15.00 WIB with feeding rate of 10% of total body weight of fishes. After that, the number of fish that die was counted every day. The weight and length of fish seeds were measured once a week to 30% of the total fish sample. Observation of plants was carried out once a week by measuring the length of the plant stems and increasing leaflets.

Observation Parameters

Fish Growth

The growth of the fish was measured by weighing the initial and final sample weight, then measuring the total length of the fish. Absolute growth and growth rate were calculated using the following formula (Ogunji et al 2008):

a. Absolute growth

$$PM = Wt - Wo$$

b. Growth rate

$$SGR = (Ln\ Wt - Ln\ Wo) : T \times 100\%$$

Keterangan :
SGR = Specific Growth Rate (%)
Wo = Initial weight of fish (g)
Wt = Final weight of fish (g)
T = Cultivation period (days)

Rate of survival

Fish survival was calculated using the following formula (Effendie 1979):

$$SR = Nt/No \times 100\%$$

Keterangan :
SR = Survival of fish sample (100%).
Nt = Number of test fish at the end of the study (fish)
No = Number of test fish at the beginning of the study (fish)

Plant Observation

Measurement of the length of plant and counting the increase of leaflets were carried out regularly once every 7 days, starting from the beginning of the research until the last day of observation.

Data Analysis

The results of the data were analyzed descriptively through observational studies with supporting data and related literature. Furthermore, the data were analyzed using analysis of variance (F-test) with the confidence level of 95% to determine the effect of each treatment on the length of the plant stem and the addition of leaflets. If there are significant differences between treatments, then the data is analysed with Duncan's multiple distance test with α level of 5% (Gasperz 1991).

RESULTS AND DISSCUSSIONS

Fish Growth

At the beginning of the experiment, the average weight of koi fish was 0.88 grams / fish and increased after 30 days of cultivation. The final weight of koi fish was 3.93 grams / fish (Fig 1).

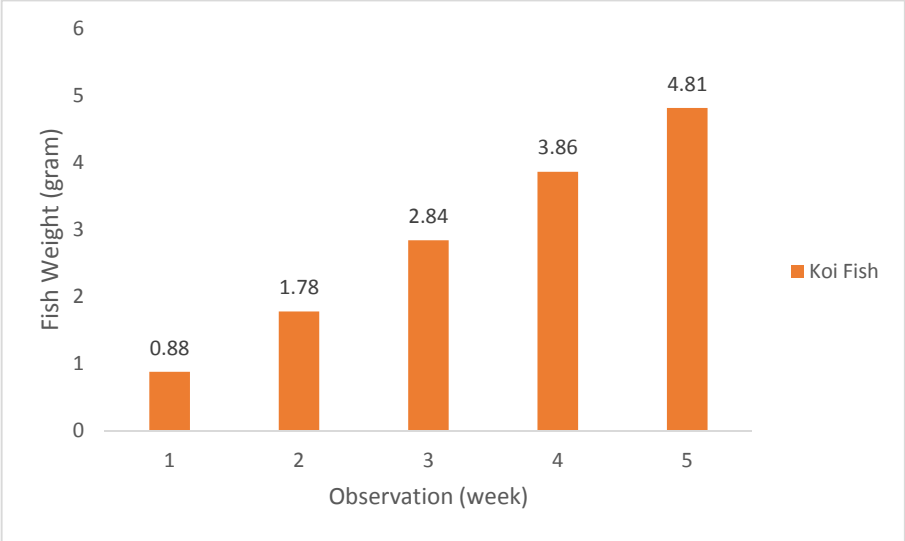

Figure 1. Average weight increase of koi fish

The average growth rate in koi fish is 0.057%. Feeds with high protein content will support fish growth, especially the increase of biomass in fish. Feed protein nutrition for enlargement of koi fish ranges from 32% - 41%. The high protein requirements are mostly used to increase the colour brightness, so that the feed given with the protein content is still insufficient for the growth of koi fish (Ayu, 2013). Growth in koi fish is not optimal because when viewed from its physiology, koi fish do not have a stomach so that the digestibility runs longer and the feed that had been eaten will be decomposed slowly in the enlarged front intestine (Ratna Ayu 2012).

Rate of Survival of Fish

Survival is closely related to whether or not food is adequate, fish health, and whether cultivation environments is good or bad (Rika 2008). The protein content in feed can be used as a form of antibody that function against foreign substances that enter the body of the fish (Mudjiman, 2008). The environmental conditions of the research site are supported by the hygiene of the cultivation media. According to Sari (2014), materials that are not useful and even detrimental to fish will be sedimentated at the bottom of the cultivation container. Nitrogen cycle occurs in cultivation container due to the presence of decomposing bacteria and also inorganic materials (from food waste and fish metabolic waste). Aquaponics system reduces the waste by absorbing the wastewater using plant roots, so that the remaining absorbed feed undergoes an oxidation process with the help of oxygen and bacteria (Dauhan et al. 2014).

Based on 30 days of cultivation period, the survival rate of fish which cultivated in the aquaponics system showed an outstanding value, with 100% of survival rate of koi fish.

The Growth of Leaf and Length of the Plants

The average length of water spinach plants at the end of cultivation period ranged from 38.7 cm - 39.0 cm, while the lettuce plants were 19.0 cm - 20.7 cm (Figure 2). According to

Wasonowati (2013), plant growth is influenced by internal and external factors. Internal factors that influence plant growth are related to physiological processes, while external factors that affect plant growth including solar radiation, temperature, water, and nutrient supply. There are 3 important things that affect stem growth, like the presence of light, growth regulators and nutrients. The availability of water and nutrients affects the growth of segments, especially by cell expansion. Plants that lack light will show symptoms of etiolation, where plants will grow very fast in dark places but the condition of plants is weak and the stems are not sturdy (Siswadi and Teguh, 2015). The increase of plant height and number of leaves, is in line with increasing plant age (Edi, 2014).

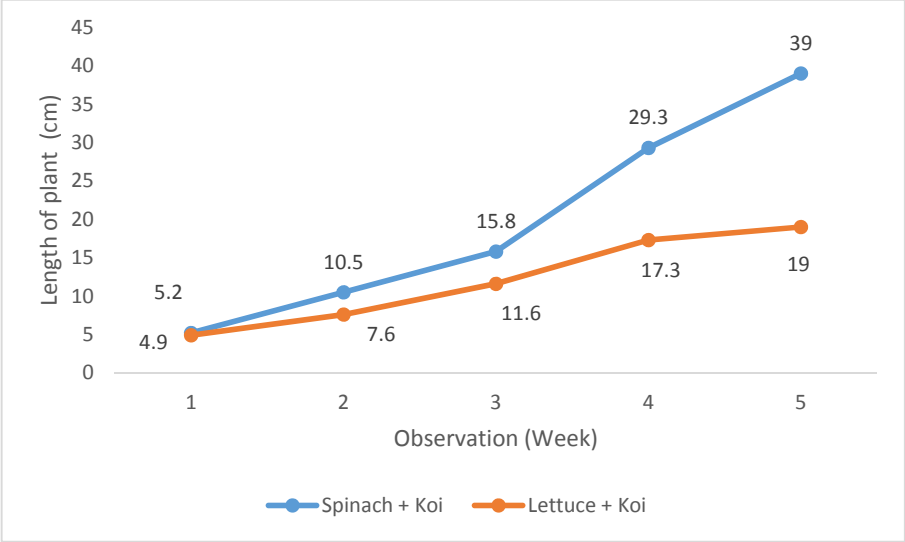

Figure 2. The growth of plant length

The increase in the number of leaflets during the research ranged from 12-15 stands of leaves in water spinach plants, whereas in lettuce plants there were 9-13 strands of leaves (Figure 3). At the beginning of planting, the plants have an average of 4 leaves each. But after the cultivation period, each treatment of plants had a different number of leaves. The highest leaf growth was found in treatments with water spinach plants and koi fish, which had 19 leaves. The addition of leaf blade occurs because of the availability of sufficient nutrients to be absorbed by plants.

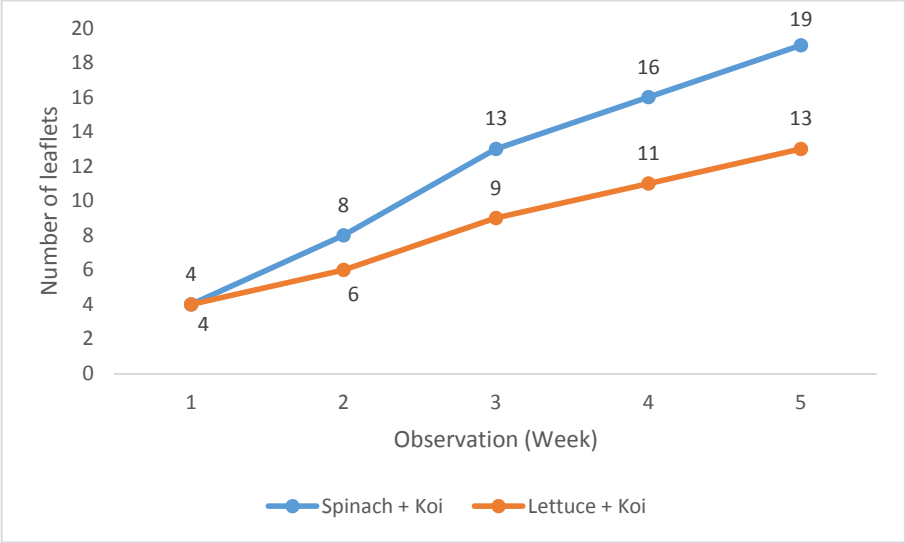

Figure 3. The number of leaves

Leaves are vegetative organs of plants, their numbers greatly affect plant growth because the leaves are the organ where photosynthesis occurs. The more leaves there are in plants, the greater the production will be. In addition, the results of photosynthesis will affect plant growth and development (Mayani 2015). Plants that do not get additional nitrogen will grow stunted and the leaves formed will be smaller, thinner and the number will be lesser, while the plants that get enough nitrogen then the leaves formed will be larger and wider (Lakitan, 1996).

CONCLUSION

The result of this research showed that the use of water spinach plant as an aquaponic system biofilter is more effective than lettuce. The combination of koi fish and water spinach plant produced the highest productivity of plant, such as stem length of 39 cm and the addition of 15 leaflets. The combination also produced the highest absolute growth of 3.93 grams / fish and survival rate of 100%.

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