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 produces the highest productivity of plants, with stem length of 39 cm and the addition of 15 leaflets. This combination also produces 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 to grow 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 including lettuce (*Lactuca sativa L.*) and land 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 type of fish that has economic value that encourages the community to increase production through intensive cultivation.

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 Padjadjaran University.

Research Materials

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

Research Tools

Fiber tub with a diameter of 30 cm and a depth of 100 cm as many as 2 pieces is used as a container for the fishes. Pump is 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 place to drain water and retain water for the plants. Plastic cups as many as 228 pieces as a place to put plants. Kenko brand digital scales with accuracy of 0.1 gram to measure fish weight.

Research Methodology

The research methodology used in this study is the experimental method, by conducting trials using two types of plants and two different types of fish with the same treatment. 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 is two tubular fiber with a diameter of 30 cm with a depth of 100 cm.

Fish Acclimatization

Fish acclimatization is done so that the fish can adapt to the new environment and the fingerlings can adjust when the research process takes place. The newly purchased fingerlings are stored in an acclimatization container (fiber tub) for 1 week so that the fish do not get stressed and to reduce the high mortality value. Feeding is 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

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

Seeding

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

Research Implementation

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

Observation Parameters

Fish Growth

The weigh increase of fish is measured by weighing the sample weight, then measuring the total length of the fish. Absolute growth and growth rate are 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 is calculated using the following formula (Effendie 1979):

$$\mathbf{SR = Nt/No \times 100\%}$$

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 is 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 1994).

RESULTS AND DISSCUSSIONS

Fish Growth

At the beginning of the experiment, the average weight of koi fish was 0.88 grams / fish with a total length of 3.6 cm. After 30 days of cultivation, the final weight increases. Increase in weight in koi fish was 3.93 grams / fish with a total length of 7.3 cm.

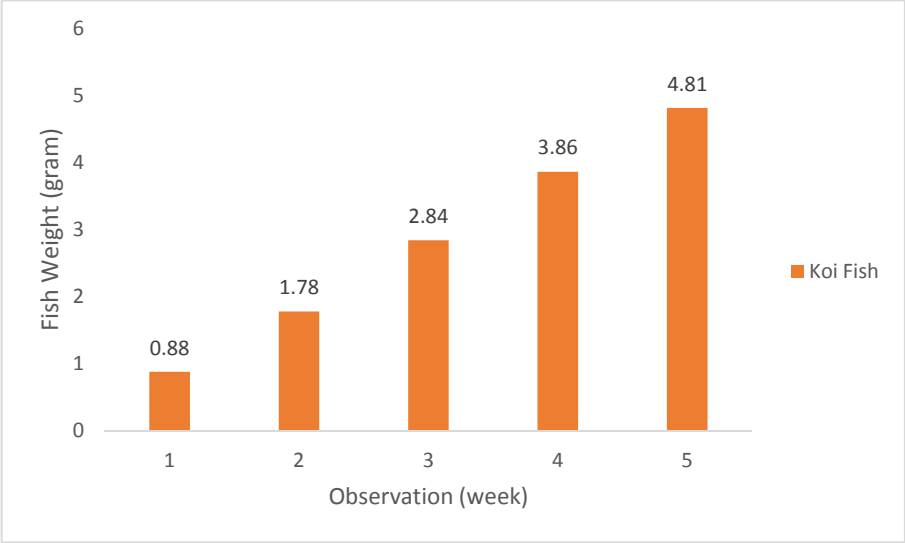

Figure 1. Average of weight increasing of koi fish

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 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).

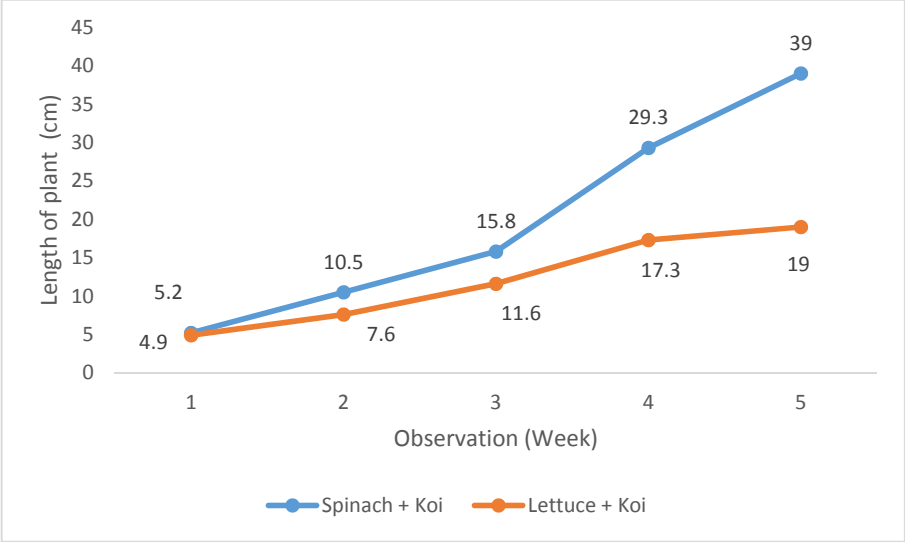

Figure 2. The growth of plant length

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 has 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.

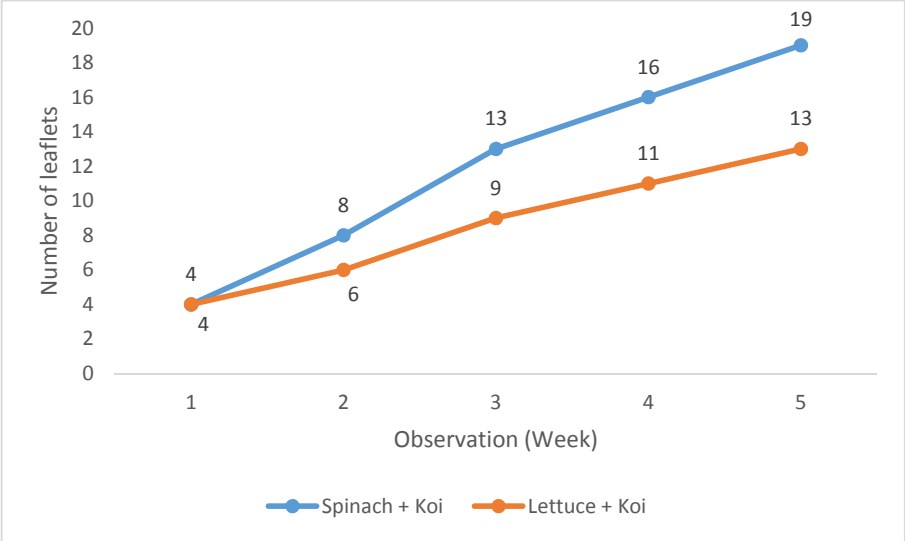

Figure 3. Graph of Number of Leaves

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 shows 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 produces 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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