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Original Research Article

THE GROWTH AND YIELDS OF LETTUCE (LACTUCA SATIVA L.) ON A AQUAPONIC NFT (NUTRIENT FILM TECHNIQUE) SYSTEM WITH THREE DIFFERENT TYPES OF FISH

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ABSTRACT

Introduction. Lettuce Cultivation (Lactuca sativa L.) with an aquaponic system can be used as an alternative to meet the food needs of the community in the midst of reduced agricultural land. The purpose of this research is to determine the types of fish that affect the growth and yield of lettuce (Lactuca sativa L.). The types of fish used in this research were tilapia, catfish and goldfish measuring 6-8 cm with a stocking density of 20 individuals. The observation variables included number of leaves, chlorophyll and wet weight of lettuce (Lactuca sativa L.). **Methods.** The research data were analyzed using One Way Anova Test and Duncan Multiple Range Test (DMRT). **Result and Analysis.** The results showed that goldfish gave optimal results on the number of leaves and wet weight of lettuce (Lactuca sativa L.), while catfish gave optimal results on the lettuce (Lactuca sativa L.) chlorophyll. **Discussion.** The different types of fish have a significant effect on the number of leaves, chlorophyll content and wet weight of lettuce plants (Lactuca sativa L.). the goldfish treatment (P3) gives optimal result on the number of leaves and wet weight of lettuce plants, while catfish treatment (P2) gives optimal results on chlorophyll of lettuce plants in the NFT aquaponic system.

Keywords: Aquaponics, Growth, Lettuce, Types of Fish, Yields

INTRODUCTION

Indonesia is one of the countries that has highest population with 270.2 million people in September 2020. According to Central Bureau of Statistics data from 2018, the amount of unprocessed rice crops decreased from 7.75 million hectares in 2017 to 7.1 million hectares in 2018. These numbers demonstrate a very big reduction. The loss of agricultural land in Indonesia is a result of land conversion, one of which is the change of agricultural land into non-agricultural land, that ultimately has a detrimental influence on the environment and land potential. Lettuce is one type of vegetable that has several nutrients and can be used to meet community nutrition needs. According to Teuku (2016) in terms of climatology, technical and business aspects, lettuce plants are feasible to cultivate in order to meet high consumer demand and considerable for international market opportunities. Innovative agricultural technology is required to enhance vegetable production on dwindling agricultural land. One of technologies used for it is aquaponics.

Aquaponics is an integrated closed-loop multi-trophic food production system that combines elements of a recirculating aquaculture system (RAS) and hydroponics (Delaide *et al.*, 2016). The term "aquaponics," which refers to the co-cultivation of fish and plants, is frequently used as a response to the rising food demand in metropolitan settings. Hydroponics and aquaculture work best together because they create a favorable climate for both. In order to feed bacteria as well as the roots of plants, filtered aquaculture effluent is supplied into the hydroponic method. After the accumulated nutrients are removed, this water is put back into the tanks used for fish aquaculture (Rajalakshmi and Manoj, 2022). In other words, aquaponics is a hybrid of aquaculture and hydroponics that can recycle nutrient-rich water by using a small amount of water for integrated development of fish and plants. Aquaponics is an alternative method of growing plants and fish in the same location (Taofik, Qurohman and Akhlasa, 2020).

Aquaponics, also known as aquaculture integration with hydroponic plant production, aims to reduce the detrimental effects of aquaculture on the ecosystem while maximizing resource use efficiency. Aquaculture and hydroponics are combined in these integrated systems because fish excrete ammonia (NH3) waste, which nitrifying bacteria then transform to nitrate (NO3). The water-filtering, nutrient-rich aquaculture effluent is used to fertilize plants for production before being returned to the aquaculture unit, released into the ecosystem, or used in another manner (Wallace-Springer *et al.*, 2022). Due to their commercial worth, and use as agricultural products in everyday food menus, lettuce plants are grown in aquaponic systems (Putri and Rochdiani, 2022). Decoupled aquaponic systems have the ability to be among the most efficient sustainable production systems for the co-production of plant-based foods and animal proteins. Here, soilless plant production using hydroponics is mixed with the production of fish using recirculating aquaculture systems, which recycles the nutrients released into the water during fish metabolism (Monsees *et al.*, 2019).

The choice of fish species used in the aquaponic system affects the growth of the lettuce itself. Different fish species used in identical aquaponic systems affect the growth of plant species and the oxygen levels (Knaus and Palm, 2017). The types of fish that can be used in aquaponic systems are consumer fish that are generally cultivated by Indonesians, such as catfish, tilapia, carp, goldfish, and others. One type of farmed fish that has been extensively developed in Indonesia is tilapia (Oreochromis Niloticus). According to Gafur (2021) because they can live in habitats with different salt concentrations and in clear or turbid water conditions, tilapia and goldfish are cultivated for consumption. In addition to being disease-resistant, catfish also produce organic waste as sediment from metabolic waste.

Based on the research result from Luciano (2016), it stated that supplemental fertilization with commercial products is not required because the residual water from the tilapia intensive farming can provide enough nutrients for lettuce production. This allows for competing lettuce production against other methods of production like traditional hydroponics and the traditional soil system. Currently hydroponic systems may combine fish production with the provision of a more than sufficient organic nutrient stream for plant growth that satisfies hydroponic industry plant growth standards as well as significant, commercial scales of fish production, yielding two commercially viable crops from a single input source—fish feed (Lennard and Ward, 2019).

Previous research from Abdel (2021) stated that the growth of tilapia, the water quality, and lettuce yield had all been affected by fish stocking density. The most lettuce was produced when there was the least amount of stocking intensity. The main causes of lettuce's poor development and yield were its unbalanced pH and temperature, as well as its low concentrations of nutrient’s potassium, phosphorus, nitrogen, and iron. In addition, research conducted by Hefni (2017) stated that In T2 (Nile tilapia and romaine lettuce) and T3 (Nile tilapia, romaine lettuce, and addition of bacteria), romaine lettuce development was well observed by the colour of the fresh green leaves, and there were no indications of nutritional deficiency. Nutrition from fish culture may be used in romaine vegetables. This mineral was produced by the decay of fish waste and uneaten food.

On the contrary, the research result by de Farias Lima (2019) found that the productivity of 120 shrimps was adequate, but it was inappropriate for lettuce nutrition, which has demonstrated a lower yield than conventional hydroponics. The concentration of nutrients in the culture water and lettuce output were found to be strongly correlated. The shrimp farming effluent may be handled in a household hydroponic lettuce production, but it is recommended that the system be supplemented with nutrients like calcium, magnesium, and potassium for a commercial production. The low level of macronutrients was the major reason for the low growth and yield of lettuce. It has been showing that with an increased stocking density of fish, the leaf nutrient content of butterhead lettuce for K, Calcium (Ca), Magnesium (Mg), Sodium (Na), iron (Fe) and Copper (Cu) was increased. The higher leaf content for the N, P and Manganese (Mn) was obtained at lower stocking density (A. R. Al Tawaha *et al.*, 2021).

METHOD AND ANALYSIS

Time and Location

This research was conducted in March-May 2022. The research takes place in Biology Laboratory of Biology Study Program, Faculty of Science and Technology, Universitas PGRI Adi Buana Surabaya.

Tools and Material

The research subjects were 20 fish, each measuring 6 to 8 cm, including tilapia, catfish, and goldfish, Prima Feed fish feed, lettuce plant seeds (Lactuca sativa L.), rockwool, Malang sand, aqua bides, and 80% acetone. The research tools used were hydroponic gutters, tarpaulin ponds, pipes, net pots, pH meter, TDS meter, seedling trays, rockwool puncher, ruler, cuvette, pestle and mortar, spectrophotometer, centrifuge, spatula, analytical balance, pipette, watch cup, centrifuge tube, and cover net.

Research Design

This research used experimental research methods with a completely randomized design (CRD). The treatment given in this research was to distinguish the effect of fish species on lettuce growth in aquaponic systems and was conducted with 6 repetitions as follows:

1. P1: The treatment of 20 tails per species of tilapia
2. P2: The treatment of 20 tails per species of catfish
3. P3: The treatment of 20 tails per species of goldfish

Data collection

a. Number of leaves

The number of leaves of lettuce plants observed were 45 days old with fully open leaves.

b. Total Chlorophyll

Lettuce plants that aged 45 days old were calculated for its total chlorophyll absorbance using a spectrophotometer with the Wintermans and De Mots formula:

Chlorophyll a (mg/L) = (13,7 x OD 665) – (5,76 x OD 649)

Chlorophyll b (mg/L) = (25,8 x OD 649) – (7,60 x OD 665)

Chlorophyll total (mg/l) = 20,0 (OD 649) + 6,10 (OD 665)

Description: OD (optical density)

c. Wet weight

The wet weight of lettuce plants (Lactuca sativa L.) was taken at the age of 45 days.

Data Analysis

The data collected from the observation of the number of leaves, total chlorophyll and wet weight of lettuce plants (Lactuca sativa. L) were analysed using one-way analysis of variance (one-way anova) at a significance level of 0.05. When the results of Anova test are significant, the Duncan Multiple Range Test (DMRT) is conducted to determine the difference between treatments and distinguish which treatment that gives the optimal results.

RESULT

Number of leaves

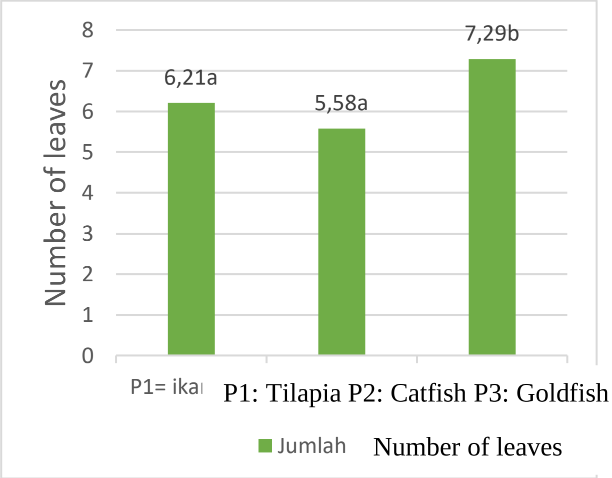

Figure 1. Number of leaves of lettuce plants (Lactuca sativa L.) with three different fish species (tilapia, catfish, goldfish) in NFT aquaponic system.

Based on the picture above, it can be seen that there is a significant difference in the number of leaves of lettuce plants in the treatment of tilapia (P1), catfish (P2) and goldfish (P3). The optimal number of leaves of lettuce plants is found in the goldfish treatment (P3) with a total of 7.29 leaves, while the tilapia treatment (P1) is 6.21 leaves and the catfish treatment (P2) is 5.58 leaves. Compared to tilapia and catfish, goldfish have a lower rate of feeding, which results in a higher volume of leftover feed that can supply enough nutrients for plant growth. This is in accordance with Wijaya (2018) it claims that there are differences depending on the number of fish consumed. More food waste will offer nutrients sufficient for the growth of lettuce plants, including the number of leaves, while fish feed provides nitrogen and phosphorus elements (Manik and Arleston, 2021).

Total Chlorophyll

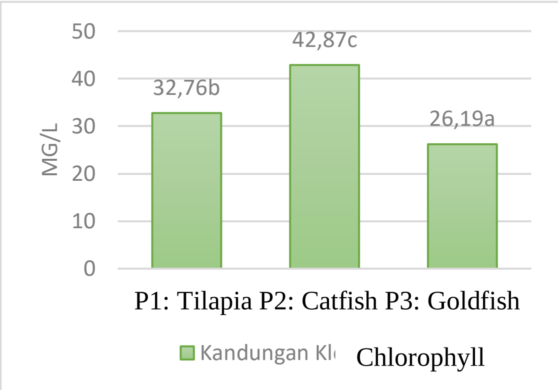

Figure 2. The chlorophyll of lettuce plants (Lactuca sativa L.) with three different fish species (tilapia, catfish, goldfish) in NFT aquaponic system

Based on the picture above, it can be seen that there is a significant difference in the chlorophyll of lettuce plants in the treatment of tilapia (P1), catfish (P2) and goldfish (P3). The figure above shows that the catfish treatment (P2) gives optimal results on chlorophyll of lettuce plants of 42.87 mg/l, while the tilapia treatment (P1) is 32.76 mg/l and the goldfish treatment (P3) is 26.19 mg/l. The chlorophyll in plants cannot be separated from environmental factors called temperature. There are significant temperature differences in tilapia, catfish, and goldfish rearing ponds that affect the chlorophyll in lettuce plants.

Wet weight

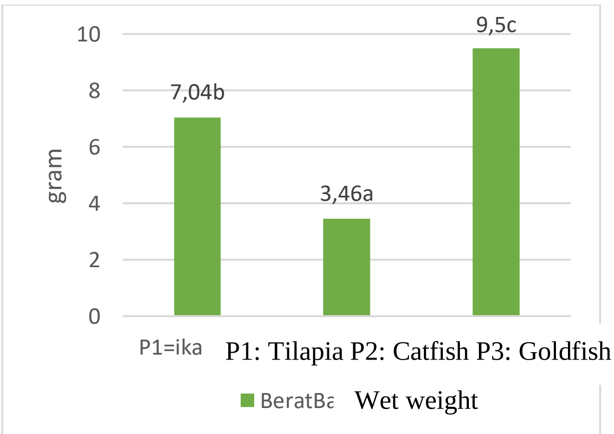

Figure 3. Wet weight of lettuce plants (Lactuca sativa L.) with three different fish species (tilapia, catfish, goldfish) in NFT aquaponic system.

The figure above shows a significant difference between the treatments of tilapia (P1), catfish (P2) and goldfish (P3). It shows that the most optimal wet weight of lettuce plants is in the treatment of goldfish (P3), which is 9.50 g, while in the tilapia treatment (P1) the wet weight is 7.04 g and in the catfish treatment (P2) 3.46 g. This is due to the fact that goldfish have a slower rate of consumption than tilapia and catfish, which results in more feed staying in the goldfish rearing pond and more nutrients available to plants. TDS levels in goldfish rearing ponds tend to be higher than in tilapia and catfish, which the high TDS indicates that dissolved solids containing nutrients in the pond are also high (Farida, Abdullah and Priyati, 2017). The goldfish treatment had higher pH and temperature level than the tilapia and catfish treatments. This is conveyed by Tancung (2007) which states that high pH and temperature describe high ammonia levels.

DISCUSSION

Nitrogen is essential to plants for the vegetative growth of plant organs like roots, stems, and leaves, as well as for the production of chlorophyll. According to Rusanti (2020), plant needs in the form of nitrogen produced by decomposing bacteria can be supported by the nitrate content in pond water. The measurement of water quality which includes TDS in the rearing pond shows a significant difference. Since the carp raising pond has greater TDS levels than the tilapia and catfish rearing ponds, it is assumed that the dissolved solids created from the remaining fish feed are equally high and can satisfy the nutritional requirements required by plants (Farida, Abdullah and Priyati, 2017).

The temperature used in the treatment of tilapia and goldfish is higher than that used in the catfish treatment. In accordance with the statement of Andarwulan and faradila (2012) that high temperatures will break down the proteins that has a function as chlorophyll protectors resulting in unstable chlorophyll. Fish feed contains protein called ammonium and phosphor, which affect chlorophyll levels in plants. Catfish that belong to the carnivorous fish group have a short intestine for rapid the food digestion process and the released contains elements that help the production of chlorophyll (Burhanuddin, 2015).

The increase in the number of leaves will be directly proportional to the increase in wet weight. Rahmina (2017) stated that the increase in the number of leaves affects the wet weight of the plant, The weight of the plant will increase along with the number of leaves. Carbohydrate-containing feed residues in carp rearing ponds can increase the wet weight of plants. This is conveyed by Wasonowati (2011) that the acceleration of growth is influenced by the availability of carbohydrates, the speed of cell division, extension and tissue formation.

CONCLUSION AND SUGGESTION

Conclusion

The different types of fish have a significant effect on the number of leaves, chlorophyll content and wet weight of lettuce plants (Lactuca sativa L.). the goldfish treatment (P3) gives optimal result on the number of leaves and wet weight of lettuce plants, while catfish treatment (P2) gives optimal results on chlorophyll of lettuce plants in the NFT aquaponic system.

Suggestion

Based on the results of this research, it is recommended to use goldfish for aquaponic cultivation with lettuce (Lactuca sativa L.).

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