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Increased *Oscillatoria* sp. Population on Integrated Cultivation Ponds of Rice and Tiger Shrimp (*Penaeus monodon*) in Idle Land

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***Abstract*— *Tiger shrimp culture that is maintained integrated with rice on idle land because of sea water intrusion has been tested in 2018 through the Innovative Adaptive Technology of Brackish Fisheries (INTAN-AP) pioneering from the Fisheries Research Center of the Human Resources Research Agency. There were 5 pond of rice fields used in the experiment in July-December 2018 in Oring Countryside, Lawallu Village, Barru Regency, South Sulawesi. Rice seeds of INPARI 34 and 35 varieties were kept in the paddy fields and PL 45 tiger shrimp were cultivated in the caren field, while re-fertilization was carried out using N, P, K fertilizers while shrimp were given commercial feed during cultivation based on weight gain per sampling. Plankton sampling was carried out in tiger shrimp ricecultivated land, every 7 days using plankton net mesh size No. 25, and then analyzed at the plankton laboratory in Research Institute for Coastal Aquaculture and Fisheries Extension in Maros. Then the data is calculated the abundance of the population then discussed descriptively. The results found that the population of Oscillatoria sp phytoplankton increases every time they conduct sampling until it reaches the peak of its population, along with the period of fertilizer application and the increase in the amount of feed given to tiger shrimp. The highest population peak at the 7th sampling in the pond 5 was 25,316 cells / L and in the pond 4 when the 6th sampling was 22,300 cells / L.*

***Keywords*— co-culture, rice, tiger shrimp, phytoplankton, Oscillatoria sp.**

I. INTRODUCTION

Tiger shrimp (*Penaeus monodon*) culture that is maintained integrated with rice plants on idle land due to the influence of sea water intrusion has been tested in 2018, which is a pioneering research program of the Research Center for Fisheries, Human Resources Research Agency of the Ministry of Maritime and Fisheries Affairs of the Republic of Indonesia. The land used is the pond rice fields owned by members of farmer groups that have long been neglected because they cannot be planted optimally because of the presence of sea water intrusion so that they are exposed to brackish conditions. In line with technological developments in the field of genetic engineering, varieties of rice seeds that are tolerant to saline conditions have been recommended by Indonesian Center for Rice Research, Sukamandi in the presence of INPARI 34 and INPARI 35 varieties that have been cultivated in the brackish land (Anonim, 2018).

Co-culturing shrimp/fish with aquatic plants, including natural macrophytes, rice and vegetables, is a recommend measure to re-use the residual nutrients and to reduce the eutrophication in aquaculture ponds (Henry-Silva and Camargo, 2006; LIU-Yaobin, *et al*., 2019). The results from paddy field have showed that rice-fish co-culture could enhance nutrients use efficiency and reduce nutrients loss to environment because of the complementary use of nutrients between fish and rice (Hu et al., 2013; Xie et al., 2011). Therefore, rice-fish co-culture may have the inherent advantage and great potential in the mitigation of gaseous N loss from aquaculture. Research from Fengbo Li (2019), indicated that rice-fish/shrimp co-culture was an efficient measure to mitigate the gaseous N loss from intensive aquaculture ponds.

The land used has been reconstructed into 2 parts, namely the paddy field for rice plants and caren as a location for raising tiger shrimp in a contiguous spread of location. In the process of maintaining the two commodities (rice and tiger shrimp), some of the same cultivation techniques ranging from land preparation in the form of land management, liming, repeated fertilization, eradication of pests, control of growth to harvest (Sahabuddin, 2019).

Specifically in the fertilizing activities on rice paddy fields and caren / tiger shrimp cultivation land using fertilizer made from N, P, and K, it is possible to create

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stimulation for the emergence of certain types of phytoplankton with a rapid rate of population growth due to high fertility so as to stimulate the high phytoplankton population. Aquatic fertility can be seen from the content of organic materials that exist in water, where the presence of organic materials is the main nutrient that can supply the needs of producer biota (producer) which in the end the producer is a food source for fish chicks, shrimp, and other types of aquatic biota. Phytoplankton is one of the factors that influence water quality fluctuations. Phytoplankton production in intensive aquaculture is influenced by the presence of nutrients in the water, especially nutrients from the nitrogen (N) and phosphate (P) groups. The availability of nutrients in intensive cultivation is determined by the presence of the amount of organic matter and the level of its breakdown by bacteria. The organic material comes from artificial feed that is not consumed (leftover feed) and excretion from shrimp (Budiardi *et al*, 2007). An increase in artificial feeding will increase the content of organic matter and nutrients which in certain limits will increase the primary productivity of waters (Boyd, 1979).

In the area of aquaculture, the presence of phytoplankton is very important because phytoplankton play a role as primary producers and contributors of dissolved oxygen in these waters, so that its existence can be used as an indicator of fertility in waters, in fertile and productive waters the abundance of phytoplankton is found to be more abundant (Yuliana, 2008).

Aquatic environmental conditions such as temperature, salinity, and nutrient content determine the amount and type of plankton that is in waters. If the salinity of pond water has the high amount of plankton, it is not different from the plankton in coastal waters, the salinity is very low then the type of plankton has no different from plankton fresh water (Sachlan, 1972). Abundance of plankton, especially phytoplankton in waters is influenced by the availability of nutrients, especially nitrogen (N) and phosphate (P). The composition and abundance of plankton in waters will change in response due to changes in physical, chemical, and biological environmental conditions (Reinolds et al., 1984).

Oscillatoria sp is a phytoplankton of the *Cyanophyceae* type (Guiry, and Guiry, 2019). Phytoplankton is often found abundant in brackish waters. Therefore, it is necessary to conduct studies and analyzes on the emergence and increase of *Oscillatoria* sp phytoplankton populations in co-culture of rice and tiger shrimp (*P. monodon*) on idle land.

II. METHODS AND MATERIAL

The research was conducted in July-December 2018 in the rice and tiger shrimp co-culture ponds in Lawallu Village, Barru Regency, South Sulawesi. Plankton samples were taken at the location of rice brackish water and tiger shrimp. The rice that grows in the paddy fields of INPARI 34 and 35 varietiesis recommended by Indonesian Center for Rice Research, Sukamandi. After planting rice in the paddy field, fertilizing I, II, and III using urea, SP_{36} and ZA fertilizers is conducted. Fertilization is carried out on caren land to grow phytoplankton before the spreading of the PL 45 tiger shrimp seeds.

Plankton sampling is conductede every 7 days, by filtering water in caren as much as 100 liters, then the results of 100 mL filter are put into a plankton bottle that gives lugol solution for analysis in the laboratory. Plankton abundance is analyzed based on the following formula, modification of the APHA formula (1989) :

$$N = \frac{A}{B} X \frac{C}{D} X \frac{E}{1} X \frac{1}{F}$$

Explanation:

N = Abundance (Ind/L)
A = ∑ SRC box (1000 boxes)
B = ∑ box of field of view (1 box)
C = ∑ seenInd.
D = ∑ observed box
E = water volume in sample bottle (ml)
F = volume of filtered water in the field

Fig.1: Sampling of plankton at the location of co-culture rice and tiger shrimp in Lawallu Village, Barru Regency, South Sulawesi.

Data from observations and phytoplankton density calculations were analyzed and population growth calculated then discussed descriptively related to the period of fertilizer application in the paddy fields and caren fields.

III. RESULTS AND DISCUSSION

Description of Oscillatoria sp phytoplankton

Oscillatoria sp phytoplankton reproduces by fragmentation, forming long cell filaments which can break into new fragments called hormogonia. Hormogonia can grow into new, longer filaments. Usually the filament breaks into a number of fragments called homogonia. Each hormogonium consists of one or more cells and grows into filaments with cell division in one direction. *Oscillatoria*sp also carry out photosynthesis, each oscillator filament consists of trichomes consisting of cell lines. The tip of the trichome oscillates like a pendulum in reproduction, it occurs only in a vegetative way(https://en.wikipedia.org/wiki/Oscillatoria).

Oscillatoria sp phytoplankton found in the field in shrimp rice brackish water as recorded on a microscope monitor screen is shown in Figure 2, while the pattern of population increase of *Oscillatoria* sp is shown in Figure 3, at the first sampling the lowest population number was in pond 3 which was 102 cells / L , the highest in the freshwater channel (SAT) is 510 cells / L. Freshwater channels are the main source of water that is pumped into each pond, in addition there are reservoirs that are a source of sea water to maintain the stability of brackish conditions with 5-7 ppt salinity.

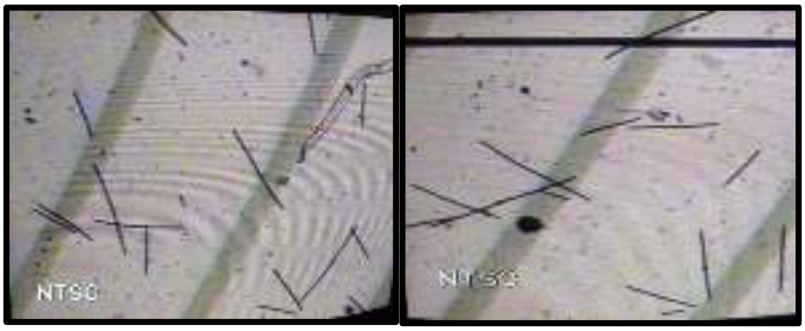

Fig.2: Abundance of Oscillatoria sp. results of observations on a microscope monitor screen

Population growth began to increase during the 2nd sampling, after supplementary fertilizers I was made on the paddy field, as well as the 3rd sampling the population increased especially in the pond 4 of 5,240 cells / L and pond 5 of the 3,500 cells / L population, this condition shows an indication of an increase in population after supplementary fertilizers I and II in the paddy fields. This condition can occur because the fertilizers used are N and P fertilizers, after soaking into the paddy fields can seep into the caren land, which can spur theincreasing nutrient content which is the main element that can increase the fertility of the waters so as to spur an increase in the population of *Oscillatoria* sp phytoplankton, as Ariadi *et al* (2019) that the high density of *Oscillatoria* sp as a type of *Blue Green Algae* plankton is caused by pond conditions that are eutrophic or hyper-eutrophic. Furthermore, *Oscillatoria* sp phytoplankton can capture nitrogen diffusion well so that the population is easy to bloom (Aliviyanti *et al*, 2017).

At 5th sampling, population surge after the 3rd supplementation fertilization, the presence of nutrient seepage (nutrient) can stimulate fertility. Pond environmental conditions will affect the composition, abundance and distribution of plankton physical, chemical and biological contained therein. Reinolds *et al*. (1984), argues that plankton abundance in waters is influenced by several environmental parameters and physiological characteristics.

According to Pirzan and Utojo (2010), pond water quality that is well managed in a range that is in accordance with the growth of plankton as a natural feed of aquaculture organisms can increase pond productivity. The highest abundance of *Oscillatoria* sp. in pond 5 is at the 7th sampling valued at 25.316 ind / L. When the abundant population of *Oscillatoria* sp can interfere with the growth of tiger shrimps because it will be a competitor in oxygen absorption, then it causes obstructions of sunlight to penetrate the water surface due to the dense population of the plankton so that the water color changes to dark green. This can happen due to the condition of pond waters that are green and the presence of excessive nutrient input such as nitrates and phosphates resulting in nutrient enrichment (blooming). The high population of toxic phytoplankton in a waters can cause various negative consequences for aquatic ecosystems, such as the reduction of oxygen in the water which can cause the death of various other aquatic creatures (Damar, 2006).

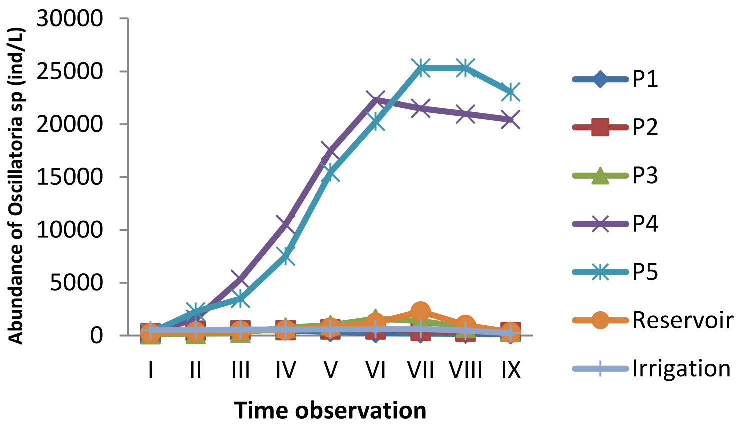

Fig.3: Increased of Oscillatoria sp phytoplankton population during the period of rearing co-culture tiger shrimp and rice

In other conditions the lowest abundance in the first pond when the last sampling with a population of *Oscillatoria* sp phytoplankton was only 110 Ind / L. The existence of plankton in ponds besides functioning as fish and shrimp feed can also act as one of the ecological parameters that can describe the fertility of a pond area. The presence of plankton, especially phytoplankton, plays a very important role in aquatic ecosystems, including pond waters. Phytoplankton act as primary producers and contributors of dissolved oxygen in the waters, so that their existence can be used as an indicator of the fertility of water. The higher the abundance of phytoplankton, the more fertile the waters (Yuliana, 2008).

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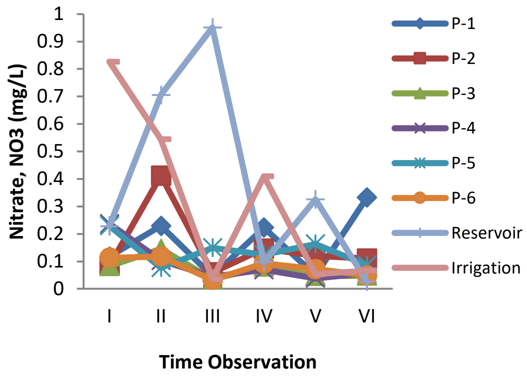

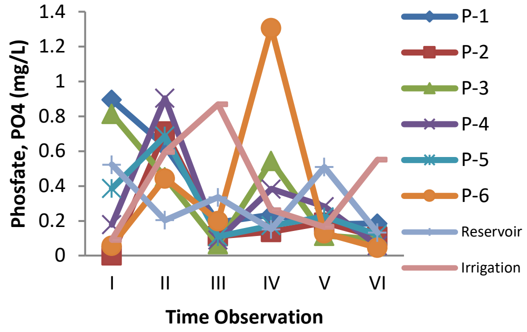

Fig.4: Phosphate and nitrate content in the rearing pond of co-culture tiger shrimp and rice during the experiment

The highest concentration of nitrate content in pond 2 when 8th sampling was 0.562 mg / L and the highest phosphate in 10th sampling pond 4 was 2.6474 mg / L, after the 3rd suplementation fertilizing, the high concentration of nutrient content spurred the increase *Oscilatoria* sp. population, but during the observation the content of nitrate and phosphate was still within the limits tolerated by *Oscillatoria* sp. phytoplankton. Usman et al (1995) stated that the nitrate optimum for algae growth ranged from 0,900-3,500 mg/L. According to Aziz et al (2015) the total value of P in brackish water ponds ranged from 0.62-5.88 mg/L. Phosphorus content in waters is influenced by the presence of phosphorus-containing materials in the waters, such as phosphorus fertilization (SP fertilizer). The lowest limit for phosphate concentration for optimal algae growth ranges from 0.018-0.090 mg/L P-PO_4 and the highest limit ranges from 8.90-17.8 mg/L P-PO_4, if nitrogen is in the form of nitrate. If N is in the form of ammonium, the highest limit is 1.78 mg /L P-PO_4 (Andarias 1991). According to Rudiyanti *et al*. (2010), in order to be able to grow algae optimally, suitable environmental elements are required, such as nitrate and phosphate content, temperature, water depth, brightness, salinity, acidity and soil texture.

IV. CONCLUSIONS

The increase of *Oscillatoria* sp phytoplankton population occurred during the 5th sampling in pond 5, occurring after suplemenatation I, II and III fertilizing in paddy field. Fertilization contributed to the increase in peak population of *Oscillatoria* sp in caren.

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