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The effect of thallus spreading method on productivity of *Gracilaria* sp. culture

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Abstract. The aim of this study was to determine growth of (*Gracilaria* sp.) with different spreading time of thallus. The study was conducted from March to April 2017 in pond located in Domas Village, Serang Region, Banten Province. The experiment followed completely randomized design with the treatment of different time on spreading of seaweed thallus during the culture period (45 days). Treatments were without spreading (as control), spreading every 2 weeks, and spreading every 3 weeks. The observed variables were weight of seaweed thallus and several water quality parameters. Analysis of seaweed weight used ANOVA test and Tukey HSD test. The results showed that the spread seaweed thallus had a significant effect on weight gain in 0.05 level. It used 100 gram *Gracilaria* sp. as initial weight, treatment without spreading thallus produced 508 gram, spreading every 2 weeks produced 906 gram and spreading every 3 weeks produced 790 gram. Based on the weight gain of thallus, seaweed culture by spreading thallus every 3 weeks and 2 weeks seem to be able to increase productivity by 56 % and 78 %, respectively.

1. Introduction

Gracilaria is one of the most in-demand aquaculture commodities in Indonesia. The agar contained in *Gracilaria* is commonly used as an emulsion-making material, thickener, filler and gelling agent. The production value from 2010 to 2014 was 22,474.60 tons; 18,337.00 tons; 77,616.61 tons; 98,475.62 tons and 57,454.00 tons [1].To increase the value, production from cultivation is required.

Despite the high demand of *Gracilaria* sp., its production from cultivation still faces some problems. Although Indonesia has a potential land with potential development up to 2,297.248 ha [1], the productivity is still not optimum. Therefore, some steps are needed to improve the production. One of the solutions to increase the production is to cut thallus periodically or called as spreading.

The purpose of this study is to identify the effect of thallus spreading with different frequencies to increase *Gracilaria* sp. productivity. This study is expected to provide information about the frequency of the spreading of *Gracilaria* sp. to produce maximum weight that can increase the productivity of pond.

2. Methodology

The study used such tools as sampling frame (bamboo and net), water level, refractometer, secchi disk, and scales. The materials used were *Gracilaria* sp. seed, pH paper, potassium test kit, phosphate test kit and nitrate test kit. The method used in this study was completely randomized design with three treatments and three replications. The treatment in this study was control without spreading (treatment

A), spreading every 2 weeks (treatment B), and spreading every 3 weeks (treatment C). The study procedure started from preparation of sampling frame, growth monitoring, until the measurement of water quality.

The preparation of sampling frame was done by installing the bamboo and net with a size of 25 cm x 25 cm x 40 cm. The total sampling frame was 39 frames. The seeds were placed on nine sampling frames. The weight of the seeds used was 100 grams each frame.

Growth monitoring was done by measuring the weight once a week for 45 days of maintenance. At the time of weight measurement, the spreading was done according to the provision of each treatment. In treatment A, spreading was not performed. In treatment B, spreading was performed three times during the experiment, and in treatment C, spreading was done twice during the experiment. The results of weight measurement were analyzed using ANOVA test, followed by Tukey test as advanced test.

Water quality measurements were carried out periodically. Measurements of temperature, salinity and depth were done twice a day, and transparency measurement was done once a day. Parameters of nitrate, phosphate and potassium were measured once a week.

3. Results and discussion

3.1. Growth monitoring

The spreading treatment had a beneficial effect. The final weight of the treatment without spreading, spreading every 3 weeks, and spreading every 2 weeks were about 5 times, 8 times, and 9 times respectively, compared to the initial weight. With the initial weight of 100 grams, treatment without spreading produced 508 gram; the treatment of spreading every 2 weeks produced 906 gram, and the treatment of spreading every 3 weeks produced 790 gram.

Spreading provided an opportunity to increase the productivity of pond. Treatment of spreading every 3 weeks increased productivity by 56 % (the difference to control was 282 gram) and treatment of spreading every 2 weeks by 78 % (the difference to control was 398 gram).

The specific growth rate (SGR) of *Gracilaria* sp. fluctuated in every measurement. The average growth rate during observation on treatment without spreading was 3.6 %. With the treatment of spreading every 2 weeks, the growth rate was 5.1 % and the rate from spreading every 3 weeks was 4.7 %. All of the average growth rate was more than 3%. So, the values were profitable because they are more than 3 % [2]. The results of weight measuring are described in table 1, figure 1 and figure 2.

Spreading every 2 weeks produces the highest productivity than other treatments. Spreading every 2 weeks made the *Gracilaria* sp. density in the pond more distributed than spreading every 3 weeks and without spreading. These conditions made the absorption of nutrients more effective to produce maximum growth.

Table 1. Weight and growth rate of *Gracilaria* sp.

Date	Average of weight (g)			Growth rate (%)		
	A	B	C	A	B	C
11/03/2017	100	100	100	-	-	-
18/03/2017	146	160	137	5.5	7.0	4.6
25/03/2017	152	219	206	0.6	4.6	6.0
01/04/2017	209	285	259	4.6	3.8	3.3
08/04/2017	339	420	378	7.2	5.7	5.5
15/04/2017	423	501	402	3.2	2.5	0.9
22/04/2017	475	785	690	1.7	6.6	8.0
25/04/2017	508	906	790	2.2	4.9	4.6

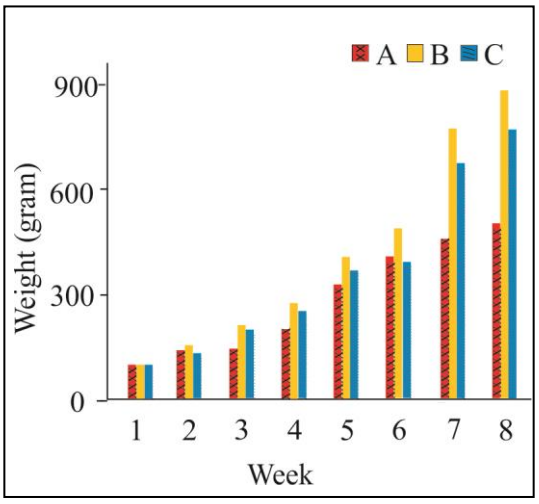

Figure 1. Average weight of *Gracilaria* sp.

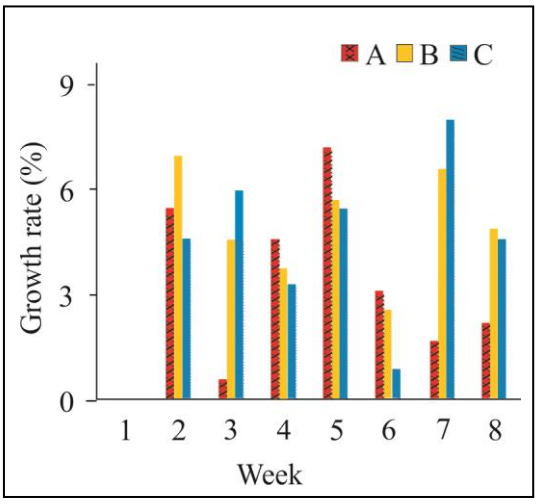

Figure 2. Growth rate of *Gracilaria* sp.

Data of *Gracilaria* sp. weight were analyzed with ANOVA test at 0.05 level. After the normality and homogenity of the data had been ensured, the result of F calculate was 24.34 with F standard of 5.14. Because F calculate is more than the F standard, then H_0 is rejected. So, spreading thallus strongly affects the growth of *Gracilaria* sp.

Tukey HSD test was used as advance test after the result was obtained from ANOVA test. Two conclusions can be drawn from the Tukey HSD test. First, the treatment without spreading was significantly different from spreading every 2 weeks and spreading every 3 weeks. Second, spreading every 2 weeks was not significantly different from spreading every 3 weeks.

3.2 Water quality

The measurement of water quality parameters revealed that the water quality generally did not meet the required standard value of *Gracilaria* sp. The results of water quality parameter measurement during observation are described in table 2.

Table 2. Measurement results of water quality parameters.

Parameters	Standard value	Reference	Measuring value
Temperature (˚C)	25-28	SNI 7578:2010 [4]	27-39
Transparency(cm)	50-70	SNI 7578:2010 [4]	11-22
Salinity ($g.L^{-1}$)	15-30	SNI 7578:2010 [4]	20-31
pH	6.8-8.2	SNI 7578:2010 [4]	6-8
Nitrate ($mg.L^{-1}$)	0.1	Effendi, 2003 [6]	0-12.5
Phosphate	5-20 $\mu g.L^{-1}$	Boyd, 1990 [7]	0.1-0.5 $mg.L^{-1}$
Potassium ($mg.L^{-1}$)	380	Effendi, 2003 [6]	210-380
Water depth (cm)	50-75	SNI 7578:2010 [4]	11-22

The measurement showed that the temperature is higher than SNI of 25-28˚C. The temperatures directly affected the metabolism rate in thallus. The temperatures which were too high made the thallus wilted because the habitat was not appropriate. This means that the temperatures directly affected plant physiology [3].

Penetration of light or transparency during measurement always reached the bottom because the water level was too low, about 11-22 cm. The depth did not match the standard of 50-70 cm [4]. The transparency and temperature stratification are strongly associated with growth. The higher intensity of the sun and the more optimum temperature conditions result in better growth [5].

The measured nitrate reached 12.5 $mg.L^{-1}$. This value was higher than the value of natural waters of 0.1 $mg.L^{-1}$ [6]. Nitrate was a major component of the nutritional supply for *Gracilaria* sp. However, if the nitrate value reached 0.2 $mg.L^{-1}$ eutrophication will occur [6].

Phosphate measurements showed a high phosphate content of 0.1-0.5 $mg.L^{-1}$. Phosphate was one of essential ingredients for the growth of *Gracilaria* sp.. The phosphate value in natural waters was 5-20 $\mu g.L^{-1}$ [7]. Besides *Gracilaria* sp., in the waters, there were phytoplankton that required orthophosphate of 0.27-5.51 $mg.L^{-1}$ for optimal growth [8]. During the observation, the value obtained was 0.1-2.0 $mg.L^{-1}$. This means that the availability of phosphate in the water was guaranteed. Phosphate has an effect on growth because it is a nutrient needed to grow and develop. It because one form of phosphate was the orthophosphate required in the formation of cells [9].

The minimum potassium value of this area was 210 $mg.L^{-1}$ while its maximum value was 380 $mg.L^{-1}$. The results of potassium measurements reached the standard in natural waters of 380 $mg.L^{-1}$ in only one measurement. The results below the standard values would cause growth problems because potassium was an essential element for plants [6].

The suitable parameters with *Gracilaria* sp. were salinity and pH. Salinity was at optimum value of 15-31 $g.L^{-1}$. The results of pH measurements on all ponds showed the value between 6 and 8. From these results, pH was always close to the standard value of 6.8-8.2 [4]. The pH correlated with oxygen in the water. This stability indicated the fulfillment of oxygen supply from photosynthesis thallus and the need of aquatic organisms because the higher carbon dioxide content caused the pH of water to decrease [10].

4. Conclusion

Gracilaria need to be spread to increase productivity. Spreading increased productivity by 56% (spreading every 3 weeks) and 78 % (spreading every 2 weeks).

5. References

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