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Original Paper

Study on Growth Rate and Seaweed Eucheuma spinosum And Euchema cottoni in Waters of Kutuh Village, South Kuta Sub-District, District of Badung-Bali

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***Abstract*:** Seaweed is a non-fish fishery commodity. The market demand for seaweed, both from the domestic and foreign markets has a bright future as a trade commodity on the international market. Bali is one of the islands of seaweed producers in Indonesia. Seaweed production in Bali in 2008, decreased to 15.2% compared to that in 2007. The purpose of this study was to determine how big the difference between the growth rate of E. cottonii seaweed and that of E. spinosum. Seaweed cultivation was conducted using raft off the base (off bottom method) of 2 units with the size of 5 x 2.5 meters each. Spacing of each seed was 25 -30 cm. Seed weight of seaweed E. cottonii and E. spinosum is equal to 100 grams. Maintenance time was for 40 days, and the sampling was done once every 10 days as many as 10 samples of seaweed. The results showed that seaweed E. cottonii had faster growth compared with E. spinosum. Seaweed daily growth of the species E. spinosum in the first 10 days was faster than the seaweed of the species E. cottonii. However, the second 10 days to the third 10 days E. cottonii seaweed growth was faster than E. spinosum. The average weight of Euheuma cottonii for 40 days planting was 189.29 grams while the average weight of Eucheuma spinosum was 185.55 grams. Water condition in the location of research was still in the normal range for the growth of two species of seaweed cultivated.

***Keywords*:** Growth; Seaweed; Eucheuma spinosum; Euchema cottoni

1. Introduction

Seaweed is a non-fish fishery commodity. Foreign demand for Indonesian seaweed in 1990 amounted to 10779 tons with a total value of US $ 7.16 million it kept increasing and ever reached 28104 tons in 1995 with a total value of US $ 21.30 million (Junaidi et al., 2007).

Bali is one of the islands of seaweed producers in Indonesia. Seaweed production in Bali in 2008 decreased to 15.2% compared to that in 2007. One of the centers of cultivation of seaweed in Bali is in the village of Kutuh, sub-district of South Kuta, Badung, from the above data the researcher deems it necessary to do other research on the growth of seaweed in order to improve seaweed production and utilization of cultivated land which is still not optimal.

The objective to be achieved in the implementation of this study was to determine how big the difference between the growth rate of E. cottonii seaweed and E. spinosum in the waters of Kutuh Village, South Kuta-Bali Badung regency

2. Methods

2.1. Research Methods

The method used in this study was a sample survey method or field survey (Hadi, 1986). Data would be analyzed using T test, and then the results of the analysis were displayed in tables and graphs as well as descriptive information.

Weight measurement data of seaweed was analyzed using t-test. T-test was used to compare between the two examples and different types (Romimohtarto and Heilbron, 1999).

Seaweed cultivation was conducted using a raft off the base (off bottom method) of 2 units with straps size of 3 meters each. Spacing of each seed is 15-20 cm. Type of seaweed used is Eucheuma cottoni and Eucheuma spinosum. Seed weight of E. cottonii and E. spinosum seaweed is equal to ± 100 grams. Maintenance time was for 40 days, and the sampling was done once every 10 days as many as 10 samples of seaweed.

2.2. Main Parameters

Calculation of absolute growth was done by using an absolute formula, standard and average daily growth according to Effendi (1997).

1. Absolute Growth

$$G = Wt - Wo$$
$$Gr = Wt - Wo / t \quad (1)$$

Specification :

G : Absolute Growth

Gr : Daily Growth Rate

Wt : weight at the time of observation (gr)

Wo : Initial Weight (grams)

t : time (days)

2. Absolute Growth

$$SGR = \frac{\ln wt - \ln wo}{t} x100\% \quad (2)$$

Specification :

SGR: Standard Growth Rate (%)

lnwt : Seaweed Final Weight (grams)

lnwo : Seaweed Start Weight (grams)

t : time (days)

3. Average Daily Growth

$$ADG = \sqrt[t]{\left(\frac{wt}{wo} - 1\right)} x100\% \quad (3)$$

Specification :

ADG : Daily Growth (%)

Wt : Weight after t days (gram)

Wo : Initial Weight (grams)

t : time (days)

2.3. Supporting Parameters

Measured parameters are temperature, pH, salinity, currents and brightness. The parameters measured in situ at each weight measurement of seaweed.

2.4. Data Analysis

Analysis of the data used was t-test. T-test can be divided into two, namely the t-test were used to test

the hypothesis of 1-sample and t-test used for hypothesis testing of 2-sample.

3. Results and Discussion

3.1. Seaweed Growth

Based on the measurement results of the average growth of 10 first ten days, Eucheuma cottonii was equal to 130.89 grams, while the Eucheuma spinosum growth during the first ten days was 134.11 grams. During the growth in the first ten days, there was a difference between the two species, in which Eucheuma spinosum had faster growth than Eucheuma cottonii. The results of data analysis using t-test showed that there is a difference in both of the average weight of a sample of the first ten days. It is shown by the significant value of α> 0.05. This value is stated that the two species have different growth rates, i.e. t count > t table where t count was -1.409 and t table was 1.734.

Measurement of growth of the second 10 days on Eucheuma cottonii amounted to 168.26 grams, while the Eucheuma spinosum amounted to 168.31 grams. Eucheuma spinosum had faster growth than Eucheuma cottonii. The results of data analysis using t-test, showed that there was a difference in both the average weight of a sample of the second ten day. It is shown by the significant value of α> 0.05. This value is stated that the two species have different growth rates, i.e. t count > t table where t count was -0.009 and t table was 1.734.

Observations and Measurements on the third 10 days of Eucheuma cottonii's growth amounted to 207.82 grams while the growth in Eucheuma spinosum amounted to 203.65. In the third ten days of this observation, there was a difference where Eucheuma cottonii had faster growth compared with Eucheuma spinosum. The results of data analysis using t-test, showed that both the average weight of a sample of the third ten days there was a difference. It is shown by the significant value of α> 0.05. This value is stated that the two species have different growth rates, i.e. t count > t table where t count was 0.840 and t table was 1.734.

In the observation and measurement of the fourth ten days, the growth of Eucheuma cottonii reached 250.20 grams, while the growth of Eucheuma spinosum reached 236.13. Growth in Eucheuma cottonii was faster than Eucheuma spinosum. On the fourth 10 days of measurement, the two species had very low growth; this is because at the fourth 10 days of seaweed cultivation, both species were attacked by pests, small fish around the site. The results of data analysis using t-test showed that there was a difference in the average weight of both samples during the fourth ten days. It is shown by the significant value of α> 0.05. This value states that the two species had the same growth rate, i.e. t count > t table where t count was 4.067 and t table was 1.734.

From the data analysis results, it can be seen that the average weight of Euheuma cottonii for 40 days planting was 189.29 grams while the average weight of Eucheuma spinosum was 185.55 grams. From these data, there was evidently a weight difference between the two species.

3.2. Absolute Growth

Results calculated for absolute growth rate and daily growth rate are shown in Table 1. Based on the results of the calculation, the average value of the absolute growth between E. Cottonii and E. Spinosum can be seen in Figure 1.

Table 1. Absolute growth rate (G) and Daily Growth Rate (Gr).

Parameters	Seaweed species	10 day (1)	10 day (2)	10 day (3)	10 day (4)
Absolute growth rate (G) (gr/10 day)	*Eucheuma cottonii*	30.31	37.37	39.56	42.38
	Eucheuma spinosum	33.50	34.20	35.34	32.48
Daily Growth Rate (Gr) (gr/day)	*Eucheuma cottonii*	3.03	3.74	3.96	4.24
	Eucheuma spinosum	3.35	3.42	3.53	3.25

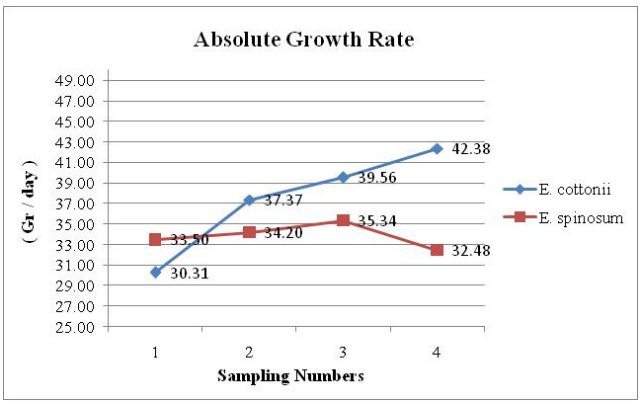

Figure 1. Graph Absolute Growth Rate

Absolute growth rate in E. cottonii and E. spinosum is noticeable. At the first sampling, the absolute growth rate of E. spinosum was faster than that of E. cottonii, i.e. the rate of growth in E. cottonii amounted to 30.31 g / 10 days, whereas the growth rate of E. spinosum 33.50 g/10 days.

In the second sampling, the absolute growth rate of E. cottonii was faster than that of E. spinosum, i.e. the rate of growth in E. cottonii amounted to 37.37 g/10 days, whereas the growth rate of E. spinosum was 34.20 g/10 days.

In the third sampling, the absolute growth rate of E. cottonii was faster than the absolute growth rate of E. spinosum, i.e. the rate of growth in E. cottonii was 39.56 g/10 days and the rate of growth of E. spinosum was 35.34 g/10 days.

While in the fourth sampling, the absolute growth rate of E. cottonii was faster than the absolute growth rate of E. spinosum, i.e. the rate of growth of E. cottonii was 42.38 g/day, while the rate of growth in E. spinosum was 32.48 g/10 days. In the measurement of the growth rate of the fourth 10 days seaweed growth of E. Spinosum species tended to decline, it is because the seaweed is disturbed by pest, which is eaten by fish.

From the analysis, the calculation of daily growth rate values between Eucheuma cottonii and Eucheuma spinosum were obtained. This can be seen in Figure 2.

Daily growth rate in E. cottonii and E. spinosum is noticeable. At the first sampling, E. spinosum daily growth rate was faster than the daily growth rate of E. cottonii, the daily growth rate of E. cottonii was 3:03 g /day, while the daily growth rate of E. spinosum was 3:35 g / day.

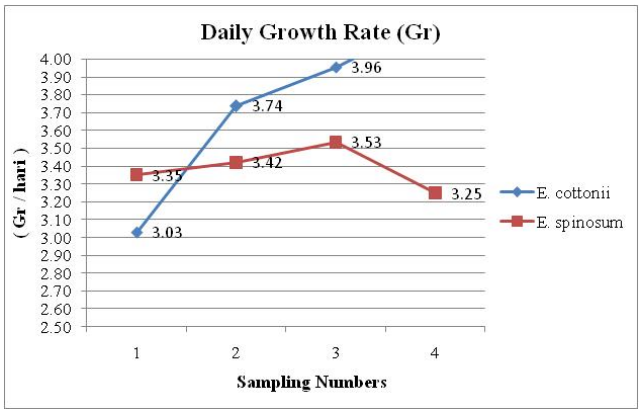

Figure 2. Graph Daily Growth Rate

In the second sampling, daily growth rate of E. cottonii was faster than the daily growth rate of E. spinosum, the daily growth rate of E. cottonii was 3.74 g / day, while the daily growth rate of E. spinosum was 3.42 g/day. In the second 10-day sampling measurement, daily growth rate of E. cottonii was likely to increase from the first 10 days of measurement, from 3:03 g / day to 3.74 g / day. In E. spinosum, daily growth rate also increased, namely 3.35 g / day up to 3.42 g/day.

In the third sampling, daily growth rate in E. cottonii was faster than the daily growth rate of E. spinosum, namely daily growth rate of E. cottonii was 3.96 g / day, while the growth rate of E. spinosum was 3.53 g / day. Daily growth rate of E. cottonii tended to increase the daily growth rate measurements the second 10 days, i.e. from 3.74 g / day down to 3.96 g / day. Similarly, the daily growth rate of E. Spinosum tended to increase from 3.42 g / day up to 3.53 g / day.

In the fourth sampling, daily growth rate in E. cottonii was faster than the daily growth rate of E. spinosum, namely daily growth rate of E. cottonii was 4.24 g / day, while the growth rate of E. spinosum was 3.25 g / day. Daily growth rate in E. spinosum tended to decrease from measurements daily growth

rate of the third 10 days, i.e. from 3.53 g / day down to 3.25 g / day. Decreased daily growth rate in E. spinosum was caused by pests, namely fish.

3.3. Standard Growth

At the first sampling, standard growth rate of E. spinosum appeared higher than E. cottonii, which is standard on the growth rate of E. cottonii, i.e. 2.63%, while the standard growth rate of E. spinosum was 2.87%.

In the second sampling, standard growth rate of E. cottonii looked higher than the standard growth rate of E. spinosum, which is standard on the growth rate of E. cottonii of 2.51%, while the standard growth rate of E. spinosum was 2.27%. In the standard growth rate of seaweed species E. Spinosum, there was a decline compared to the first 10 days of sampling, i.e. from 2.87% down to 2.27%.

In the third sampling, standard growth rate of E. cottonii looked higher than the standard growth rate of E. spinosum, which is standard on the growth rate of E. cottonii at 2.11%, while the standard growth rate of E. spinosum was 1.91%. In both species of seaweed decreased percentage of growth rate compared to the standard second 10-day sampling, in which the standard growth rate of E. cottonii decreased from 2.51% to 2.11%, while the decline in the growth rate of E. spinosum was from 2.27% up to 1.91%.

Fourth sampling measurements, the standard growth rate of E. cottonii looked higher than the standard growth rate of E. spinosum, namely the standard growth rate of E. cottonii was 1.86%, while the standard growth rate of E. spinosum was 1.48%. Of both species, there was a percentage decrease in standard growth rate compared with the third sampling, namely the E. cottonii from 2.11% to 1.86%, whereas in E. spinosum from 1.91% down to 1.48% as seen in Figure 3 and Table 2.

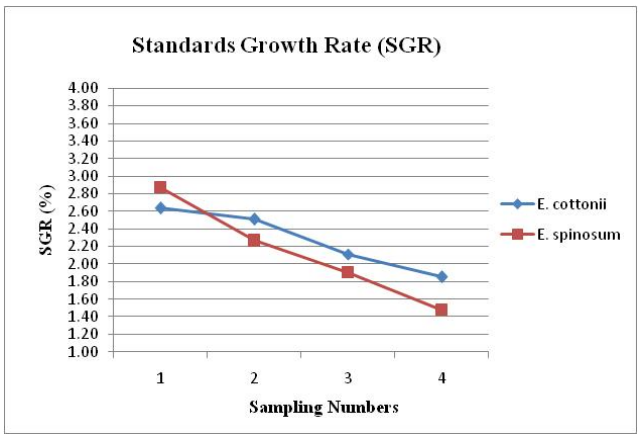

Figure 3. Graph of Standard Growth Rate

Table 2. Standards Growth Rate (SGR)

Seaweed species	10 day (1)	10 day (2)	10 day (3)	10 day (4)
Eucheuma cottonii	2.63	2.51	2.11	1.86
Eucheuma spinosum	2.87	2.27	1.91	1.48

3.4. Average Daily Growth

From the calculation of Average Daily Growth (ADG) obtained value growth rate between E. cottonii and E. spinosum are presented in Figure 4 and Table 3.

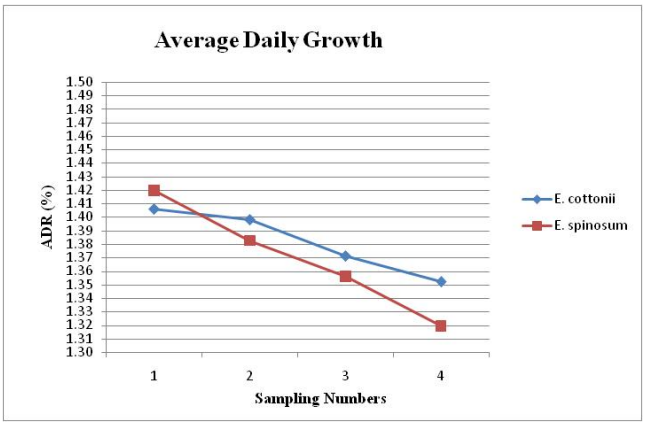

Figure 4. Graph Average Daily Growth

Based on the analysis, average daily growth of seaweed on the first sampling, showed that the average daily growth results are not much different, i.e the percentage of E. cottonii average daily growth is 1.41%, whereas in E. spinosum is 1.42 %.

In the second sampling, the percentage of average daily growth in E. cottonii looked higher than the

percentage of average daily growth of E. spinosum, i.e. the percentage of average daily growth of E. cottonii was 1.40%, while the percentage of average daily growth in E. spinosum was 1.38%. In percentage of average daily growth both types of seaweed decreased compared to the first 10 days of sampling, namely the E. cottonii from 1.41% down to 1.40% while the E. spinosum decreased from 1.42% to 1.40%.

Table 3. Average Daily Growth (ADG)

Seaweed species	10 day (1)	10 day (2)	10 day (3)	10 day (4)
Eucheuma cottonii	1.41	1.40	1.37	1.35
Eucheuma spinosum	1.42	1.38	1.36	1.32

In the third sampling, the percentage of average daily growth in E. cottonii looked higher than the percentage of average daily growth of E. spinosum, i.e. the percentage of average daily growth of E. cottonii was 1.37%, while the percentage of average daily growth in E. spinosum was 1.36%. In both species of seaweed, there was a decrease in the percentage of average daily growth compared to the second 10-day of sampling, where the percentage of average daily growth of E. cottonii decreased from 1.40% to 1.37%, while the decline in the growth rate of E. spinosum from 1.38% to 1.36%.

In the fourth sampling measurements, the percentage of average daily growth in E. cottonii looked higher than the percentage of average daily growth of E. spinosum, i.e. the percentage of average daily growth of E. cottonii was 1.35%, while the standard growth rate of E. spinosum was 1.32%. Of both species, there was a daily percentage decline in growth rate compared to the third sampling, namely in the E. cottonii from 1.37% to 1.35%, whereas in E. spinosum from 1.36% to 1.32%.

3.5. Supporting Parameters

In general, water conditions for the cultivation of seaweed was still within tolerated limits for seaweed cultivation of E. Cottonii and E. Spinosum. Water quality parameters measured during the process of observation and calculation of seaweed weight, measurement of water quality parameters underwent three repetitions, i.e. morning, afternoon, and evening time. The results of measurements of water quality parameters can be seen in Table 4, namely:

Table 4. Average results of measurements of water quality for seaweed cultivation.

Parameters	Sampling Numbers				
	0	1	2	3	4
Salinity (‰)	34.3	34.4	34.8	35.4	34.4
Temperature (^{0}C)	29.8	30.8	28.6	28.3	29.7
pH	8.6	8.5	9.1	9.2	9.1
Flow (m/sec)	0.1	0.1	0.1	0.1	0.1
Visibility (%)	100	100	100	100	100

4. Conclusions and Suggestions

4.1 Conclusions

From the results of this study can be concluded that:

1. E. Cottonii seaweed and E. Spinosum were cultivated on the same methods and locations, seaweed E. cottonii had faster growth compared with E. spinosum.
2. The daily growth of seaweed of E. spinosum species during the first 10 days was faster than seaweed of the species E. cottonii. However, during the second 10 days to the third 10 days, E. cottonii seaweed growth was faster than E. spinosum.
3. The average weight of Euheuma cottonii for 40 days planting was 189.29 grams while the average weight was 185.55 grams Eucheuma spinosum.

From these data, there was a weight difference between the two species.

4. Conditions of waters in research location were still in the normal range for growth of the two species of seaweed cultivated.

4.2. Suggestions

The suggestion that can be made from the research activities of seaweed growth rate is that that further research needs to be done, with different treatment methods, i.e. having to do with the methods of cultivation and treatment place or a different location, so as to know the different growth in different locations.

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