Cultivation of Seaweed E. spinosum in Open Waters Using Bags Methods around Pahawang Island Waters, South Lampung

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Cultivation of Seaweed *E. spinosum* in Open Waters Using Bags Methods around Pahawang Island Waters, South Lampung

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Abstract Seaweed cultivation in Pahawang Island waters have a serious problem like predators from Baronang fish and sea turtle, strong current and big waves also give big impact for seaweed cultivation at there. Bag nets is one of method who can be a solution for that problems. The aim of this research are want to know about daily growth rate (DGR) and absolute growth rate (AGR) from seaweed *E. Spinosum*. This research has been done in August – September 2019. The net bags was designed to be strong enough for protect seaweed from predation and strong current at there. The net bags prepared are 56 nets, with initial weight of seaweed 50 grams. The result of this research show the daily growth rate (DGR) was 5.6 % each day and for absolute growth rate (AGR) was 304.9 grams. The growth rate is good enough because growth more than 2% each day.

Keywords Net Bags; Seaweed; *Euchema spinosum*; Pahawang Island; Lampung

Background

Indonesia is one of the world's richest nations in terms of seaweed diversity, some of seaweed in indonesia have high economic value such as *Eucheuma sp, Gracilaria sp, Gelidium sp, Sargassum sp, Caulerpa sp* and *Turbinaria spp*. Methods that have been developed in seaweed cultivation such as the long line method, the floating raft method, the off-bottom method (Hendri et al., 2017; Hendri et al., 2018; Hendri et al., 2020).

These method before have a several weakness, like can't protect fully and have potential to attacked from predators like baronang fish, sea turtle and others. Besides that, these method can't applied in open waters who have strong current and big waves because part of seaweed (thalus) can broke, predators also can make seaweed broke and it can be a disease for seaweed.

This problem make cultivation seaweed in Pesawaran regency, Pahawang Island is not optimal. Almost 4 years cultivation seaweed in this place are stopped. Needed new method for cultivation seaweed to handle seaweed from strong current, big waves and predators.

Pahawang waters have strong current and big waves because it near with high seas especially in dusun Jelarangan. Strong current can make thalus broke, because it very sensitive to broke. Even though if managed properly by using the right cultivation methods, strong currents and waves are actually beneficial because it can stimulate the growth of seaweed thalus, beside that strong current can preventing the attachment of the substrate to the thalus and also better for distribution of nutrients.

1 Materials and Methods

1.1 Time and place

This research has been done in July - September 2019 on Pahawang Island, Jelarangan Hamlet, Pesawaran District. The map of the research location is presented in Figure 1.

1.2 Tools and materials

Seaweed *E.spinosum* seeds used in this research came from seaweed farmers in Ketapang District, South Lampung Regency. That seeds firstly came from the Lampung Center for Fisheries and Aquaculture (BBPBL). The initial weight of seaweed used was 50 grams and was planted in 56 nets. The tools and materials in this study are presented in Table 1.

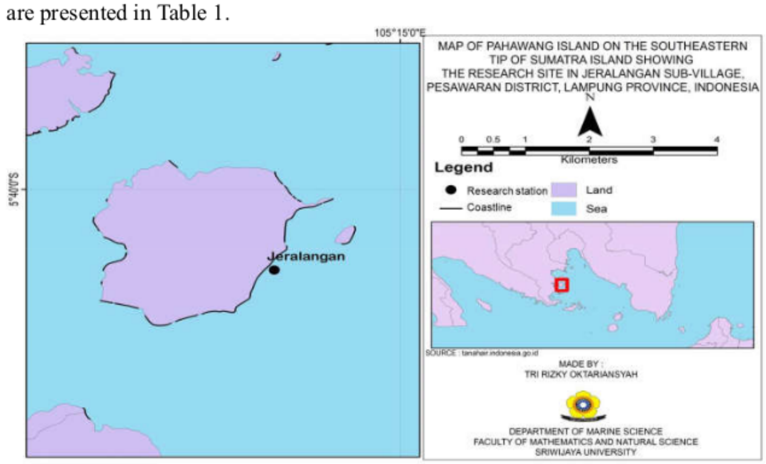

Figure 1 Map of Pahawang Island on the southeastern tip of Sumatra Island showing the research site in Jeralangan sub-village, Pesawaran District, Lampung Province, Indonesia

Table 1 Tools and materials

No	Tools and materials	Function
1	*E. spinosum*	Seeds
2	Digital scales	Seaweed scales
3	2' Polyethylene Rope	Material of net bags
4	4" Polyethylene Rope	Anchor rope
5	Net bag Ø40 cm	Seaweed place
6	Termometer	Temperature scale
7	pH meter	pH water scale
8	*Handrefraktometer*	Salinity scale
9	*Current meter*	Current scale
10	Bamboo	Place of net bags
11	19 ' bolt iron	Raft straps
12	Boat	Transportation
13	DO meter	Dissolved oxygen scale
14	*Sechi disk*	Transparance water scale
15	Live fest	Bag nets fest

1.3 Research methods

Cultivated *E. Spinosum* in this research used by bag-nets, it tied to a raft. The raft was made of bamboo 10~15 cm in diameter and 4 m × 5 m in size. Every side of raft is given an anchor for make the raft stable and fixed. Every side of the raft given a polyethylene rope 2 "as a place to tied a net bag with a spacing of 40 cm. The net-bag is specially designed (Figure 2), has a length of 50 cm, is round in shape with a diameter of 40 cm. On the inside of the net bag is given a framework of wire (3 wire frame) which is circular in function as a framework so that the net can remain in the desired position. Wire made of stainless steel and given a plastic hose for avoiding sea water.

Total of net-bag planted was 56 units, and each net-bags has 40 cm distance. Cultivated *E.spinosum* seaweed has an initial weight of 50 grams, it placed in a net bag and given a rope to hang seaweed to remain in the middle of the net-bag. The net is cleaned every week from substrate and biota that are stuck at the net. Environmental factors are measured three (3) times during the research.

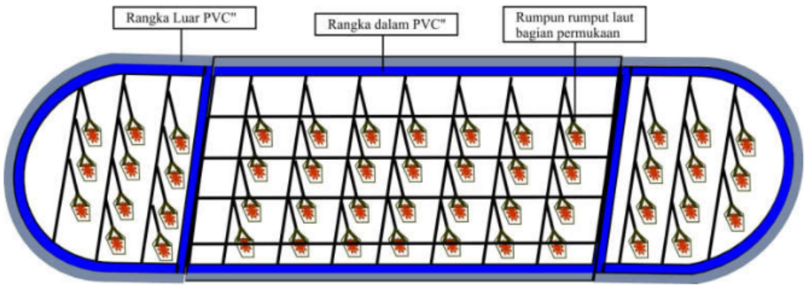

Figure 2 Design of PVC or bamboo rafts of *E. spinosum* culture using the bag net method

1.4 Observation variable

1.4.1 Daily growth rate

Daily Growth Rate (DGR) is the relative growth of seaweed per unit time (% / day) (Mtolera et al., 1995; Gerung and Ohno, 1997; Aguirre-von-Wobeser et al., 2001; Bulboa et al., 2007 ; Hayashi et al., 2007; Hori et al., 2009),

$DGR = [(Wt / Wo) ^\wedge (1 / T) -1] \times 100\%$ ……………………………………………………… (1)

Information:

DGR: Daily Growth Rate

Wt: Weight after 1 day (gram)

Wo: Initial Weight (grams)

T: Time

1.4.2 Absolute growth rate

The absolute growth rate is the final weight (Wt) minus the initial weight (Wo) (Hendri et al., 2018), with the following formula;

$AG = Wt\text{-}Wo$ …………………………………………………… (2)

Information:

AG: Absolutely Growth

Wo: Weight of the test plant at the start of maintenance (grams)

Wt: Weight of the test plant at the end of maintenance (grams)

2 Results

2.1 Aquatic quality parameters

The quality of the waters are determining success of seaweed cultivation. The quality of waters including physical, chemical and biological, that factor can inhibit and can also accelerate the growth of seaweed itself. Each parameter has a different value in seaweed growth. If the water parameters meet the criteria of seaweed growth, the growth of seaweed will be good and the carrageenan content in seaweed will be better too. The results of measurement of environmental parameters can be seen in Table 2.

Table 2 Measurement of Pahawang Island Waters Quality (Jelarangan village)

No	Environmentak parameters	Value
1	Temperature (°C)	28.5
2	Salinity (ppt)	33.5
3	Transparance of water (%)	100
4	Depth (m)	9
5	Current speed (cm/s)	49.5
6	Dissolved oxygen (ppm)	7.0
7	pH	7.9

The temperature of the waters at the study site is very suitable to support the optimum growth of seaweed. This is same with the opinion of WWF (2010) seaweed growth in the temperature range of 26°C~32°C.

The optimum water temperature seaweed metabolism process will be in optimum conditions too. Sources of nutrients come into thalus will be relatively used optimally to spur growth. Temperatures that are too low or too hot can stress the seaweed. Thalus will break easily and attack diseases such as ice-ice will attack easily.

The depth of the waters of the study is 9 m and is on the edge. The transparance of water is 100% and sunlight reaches the bottom of the water properly. This condition is supported by a substrate of water in the form of coral and sand fragments. So that the substrate stirring process at high tide or low tide and by currents or waves does not have a big effect on the brightness of the waters at this location. Good transparance and penetrate the bottom of the water will support the process of photosynthesis to be more optimal. Seaweed that will carry out photosynthesis and this process will be disrupted if the penetration of sunlight is blocked by sediment or susbtrat which is stirred and floated in the water column.

Relation of water depth on the growth rate of seaweed research has been done quite a lot, according to Hendri et al. (2017), Gracilaria Sp can still grow well to a depth of 630 cm with a DGR of 2.15% / day (0 cm) and the lowest of 1.84% / day (630 cm). While the type of *E.cottoni* growth rate is smaller with the highest DGR value 1.59% / day (0 cm) and the lowest 1.33% / day (630 cm) (Hendri et al., 2018). While in other studies on the type of *E.cottonii*, the growth rate at a depth of 25 cm has the highest growth rate with a value of 5.12% and the lowest at a depth of 75 cm with a value of 3.13% (Susilowati et al., 2012).

E. spinosum is a type of marine plant that really needs salinity. Salinity is one of the parameters that is closely related to osmotic pressure in the thalus of seaweed, this condition will affect its balance. Aquatic salinity for marine organisms is an important environmental factor. Each marine organism has a different tolerance to salinity for survival.

Salinity at this location is in very good condition to support the growth of seaweed. According to Lüning (1990) Gracilaria sp lives well at 15~22 ppt salinity, except the *Fucus vesiculosus* species has a wider tolerance with a range of 8~34 ppt. Different with the *Euchemic* species have a much narrower tolerance range of 30~35 ppt (Dawes, 1981). Low or high salinity will inhibit the growth of seaweed and can even make seaweed die. According to Yuliyana et al. (2015) salinity affects the growth (DGR) of latoh seaweed (*C. lentillifera*). The best growth at salinity was 30 ppt (3.53% / day), 35 ppt (2.82% / day), 25 ppt (1.84% / day) and the lowest was 20 ppt (1.42% / day) on a laboratory scale.

Low and high salinity will affect the growth of seaweed. Seaweed (*E.spinosum*) can die and be damaged by bad salinity. Salinity can make plasmolysis in cell walls seaweed. According to Xiong and Zhu (2002) the effect of salinity on plants is very complex, it can cause ionic, osmotic and secondary. Seaweed from the Euchema sp need high salinity in the range of 31~35 ppt, with an optimum salinity of 32~33 ppt. Higher or lower salinity will cause growth to be disrupted and can cause damage to the thalus (death). This is in accordance with the opinion of Beveridre (1987) in Iksan (2005) stating that salinity is closely related to osmotic pressure, the higher the salinity, the greater the osmotic pressure this condition is related to the osmoregulation process in the body of an organism. Seaweed Eucheuma sp grows well in high salinity.

Other researchers have the same opinion about the salinity range for Euchema sp, Soegiarto et al. (1978) a good salinity range of 32~35 ppt, Dawes (1981) argues, a good salinity range of 30~35 ppt while Zatnika and Angkasa (1994) ranged from 28 to 34 ppt. Low salinity (<30 ppt) will damage the seaweed (thalus) which is characterized by the emergence of white at the tips of the thalus (Collina, 1976 in Iksan, 2005). 33.5 ppt salinity at the research location is very suitable and is in the optimum range for growth *E. spinosum*.

Current speed at the research is quite strong 49.5 cm/sec. The recommended current speed for seaweed cultivation ranges from 20~40 cm/sec (Hendri et al., 2017; Hendri et al., 2018). Strong current speeds coupled with large waves (> 2m) can break the thalus. A broken talus will be washed away and carried by the current. However, strong currents and large waves can also have a positive impact, especially on the distribution of nutrients and air exchange (oxygen and CO_2). Even strong currents can prevent the attachment of the substrate to the thalus. Substrate attachment can disrupt the entry of nutrients into the thalus and block sunlight during photosynthesis.

Current speed and wave at this research did not have big impact for thalus fracture. The netting protects the thalus broken by the waves and currents. Factually, currents and waves have a positive impact that can be obtained seaweed optimally. Good nutrient distribution, thalus washing (flushing) from the substrate attachment and optimum photosynthesis are important factors for the growth of *E. spinosum* at this research.

The dissolved oxygen and pH values at this study site are already in good condition to support the growth rate of seaweed. The value of pH and dissolved oxygen which is sufficient will help the process of metabolism and accelerate the rate of growth.

3 Discussion

3.1 Growth of seaweed

The net-bag used in this study are designed to protect *E.spinosum* from its predators (Baronang Fish and Turtles). The net is made from a kind of nylon rope that is strong enough. In addition, the bag nets are expected to protect the thalus from being hit by strong currents and waves. Even if it is broken, the fracture remains in the net. The visual observation result shows that the predator cannot touch the seaweed in the net (Figure 3; Figure 4).

Based on the results of the study, the average weight gain of *E. spinosum*, measured for five (5) weeks, showed quite good growth. Observation and weighing results are seen in Figure 5 and Table 3.

Growth of *E. spinosum* weight during the study (35 days) look in Table 3.

Figure 3 *E. spinosum* net and its predatory fish

Figure 4 The *E. spinosum* net and its predatory fish

Figure 5 weighing *E.spinosum* seaweed

Table 3 Growth of *E. spinosum* in a net bag (35 days)

Number of nets	Weight (gram)	Number of nets	Weight (gram)	Number of nets	Weight (gram)
1	411	21	356	41	324
2	386	22	322	42	357
3	377	23	342	43	360
4	390	24	331	44	343
5	357	25	341	45	363
6	358	26	343	46	321
7	371	27	363	47	322
8	401	28	345	48	323
9	356	29	342	49	322
10	356	30	345	50	302
11	387	31	329	51	324
12	377	32	400	52	321
13	388	33	377	53	329
14	328	34	368	54	320
15	323	35	380	55	331
16	426	36	381	56	327
17	367	37	390		
18	386	38	389		
19	376	39	345		
20	356	40	325		

The total final weight of *E.spinosum* from 56 planted nets is 19875 grams with an average of 354.91 grams per bag net. The highest weight in the 1st and 16th bag nets weighing 411 grams and the lowest in the 50th bag nets weighing 302 grams. On average there is an addition of 6-8 times the initial weight which has an initial weight of 50 grams. For more final weight E. *spinosum* in this study can be seen in Table 3 and Figure 6.

Daily growth rate (DGR) in this study ranged from 5,138% / day to 6,018% / day. The DGR value is very good for seaweed cultivation because it has a value of > 2% / day. According to Ask and Azanza (2002) the value of DGR is good for growth> 2% / day. Other studies mention the same good DGR value> 2% days (Indriani, H., dan Sumiarsih, 1995; Hendri et al., 2017; Hendri et al., 2018). The value of this daily growth rate is much better than previous research Hendri et al. (2017) 1.5%~2% / day, Wijayanto et al. (2011) <2% / day.

Better DGR value happen because of several factors. The current speed at the research is quite large (49.5 cm.det) which has a positive effect on preventing the attachment of the substrate to the thalus so that photosynthesis can proceed well and the distribution of nutrients is well. The designed bag-nets are quite effective in preventing predation from predatory fish (baronang/samadar) and turtles. The broken thalus is still in the net and does not drift along with the current. The full DGR values are presented in Figure 7.

Beside a good flow, optimum salinity is also one of the environmental parameters that are having effect of the high growth rate (DGR) in this study. Salinity 33.5 ppt is the optimum value for the growth of seaweed species Euchema sp. This is consistent with the results of research by Soegianto et al. (1978) 32~35 ppt, Dawes (1981) 30~35 ppt and Zatnika and Angkasa (1994) 28~34 ppt. Low salinity will trigger slow growth and cause white spots on the thalus. This condition can make the thalus to become brittle and broken. This high DGR value is highly recommended for seaweed farming. DGR value> 2% / day is a good value for seaweed cultivation business.

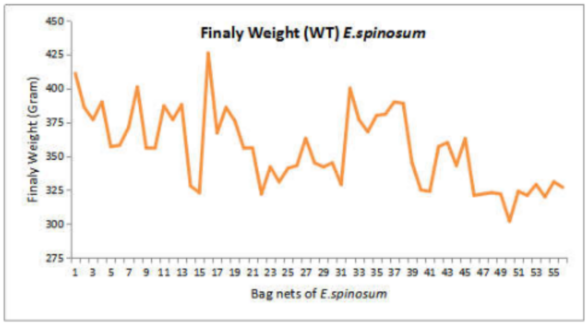

Figure 6 Absolute Growth Rate (AGR) of *E. Spinosum*

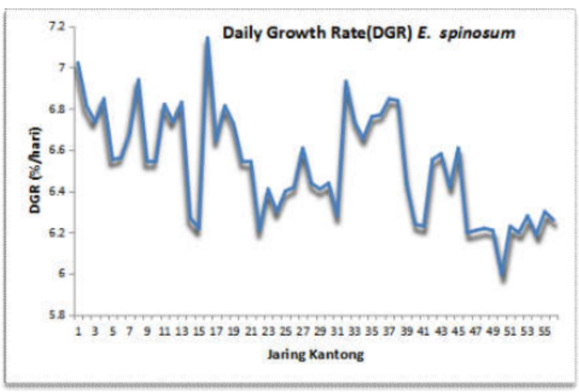

Figure 7 Daily Growth Rate (DGR) of *E. spinosum*

4 Conclusions and Suggestions

4.1 Conclusion

Based on the results of research that has been observed in the cultivation of seaweed *Eucheuma spinosum* which has been conducted for 5 weeks using the bag net method, the following conclusion are:

1) Daily growth rate (DGR) in this study ranges from 5,138% / day to 6,018% / day.

2) The total final weight of *E.spinosum* from 56 planted nets is 19875 grams with an average of 354.91 grams per bag net. The highest weight in the 1st and 16th bag nets weighing 426 grams and the lowest in the 50th bag nets weighing 302 grams

3) The absolute growth rate or absolute growth (AG) of a total of 56 bag nets is 17075 grams with an average of 304.91 grams. The highest absolute growth rate is 426 grams and the lowest is 302 grams.

4.2 Suggestion

Suggestions can be given from the results of research that has been done:

1) The framework of the bag net needs to be strengthened and ensured not to leak (plastic hose) so as not to damage the wire (corrosive).

2) It is necessary to design a better one at the top of the bag net so that sunlight can more easily enter and make easy binding.

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