Original article

Budidaya rumput laut *Gracillaria* sp. menggunakan metode *longline* dengan jarak tanam berbeda

Cultivation of seaweed Gracillaria sp*. Using longline methods under different space of planting*

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Abstract

One of the most species that using in seaweeds farming is Gracilaria sp. The success of farming, is determined by several factors such as plant spacing. The aim of this study is to determinine the best plant spacing for seaweeds farming and water quality of farming location. The study was held in the village of Kahyapu, Enggano Island, Bengkulu province from March until May 2015. The research was held using experimental methods that refers to Meylia (2015). Seaweeds is grown using three plant spacing (20, 25 and 30 cm) for 42 days. Wet weight of seaweeds was measured every week. Water quality was measured at the beginning, middle and end of the study. Data of wet weight and absolute growth rate were analyzed using a completely randomized design (CRD) factorial at the 95% confidence level with two factors, plant spacing and farming periode. Duncan Multiple Test (DMRT) was used if there is a significant difference. The results showed that the interaction between plant spacing and farming periode has siginificant effects to wet weight. Duncan test showed that more extensive planting space and the longer the cultivation, the wet weight will be higher. The rate of absolute growth is affected by plant spacing and observation times. Based on the Duncan's test, wider spacing can increase the growth rate. Plant spacing of 30 cm is the best treatment. Water quality (temperature, salinity, pH, brightness and water current) during farming was suitable for seaweeds growth.

Keywords*: farming, Gracillaria sp., growth rate, plant spacing*

Introduction

For a long time ago, seaweeds has been known by the public, especially as food. Nowadays, the use of seaweeds is not merely as food but also in industry, cosmetics and pharmaceuticals. This causes an increasing demand in the world market. Indonesia is known as one of the seaweeds-producing countries in the world. Seaweeds was found in large quantities in Indonesia, which is about 8.6% of the total marine biota (Dahuri, 1998). Surono (2004) states that the waters of Indonesia as a tropical regions have 6.42% of seaweeds biodiversity from the total of seaweeds in the world. Wawa (2005) adds that the area of seaweeds's habitat in Indonesia reached 1.2 million hectares, the largest in the world. It is confirmed that Indonesia has the potential of seaweeds abundant and needs to be developed.

Seaweeds farming in Indonesia experiencing significant growth for the last few years, due to increasing demand in the world market. In addition, seaweeds farming is also relatively easy, cheap and seaweeds has economic value. It is also stated by Ditjenkanbud (2005) that the cultivation of seaweed has several advantages due to the simple technology, can produce products that have a high economic value with low production costs, so it has potention to empower coastal communities.

Seaweeds production determined by the success of seaweeds farming. In order to achieve maximum production, there are several factors are important : the choice of the right location, the use of good seed according to the criteria, the type of farming technology that applied, the control during the production process, and the post-harvest handling of seaweeds (Winarno, 1990). Mamang (2008) added that the successful of seaweeds farming is supported by several factors, both internal and external factors. Internal factors such as the origin of thallus, seed weight and the spacing used while external factors related to site selection according to the type of seaweeds, also factors that are closely related to the characteristics of the local marine environment.

The seaweeds that has an important economic value comes mostly from red seaweed species (Rhodophyta), among others *Gracillaria* sp., *Gelidium* sp., *Eucheuma cottonii* and *Eucheuma spinosum*. *Gracillaria* sp. is often used as a seed in the seaweeds farming because it has several advantages, cosmopolite (widespread in Indonesian), can produce high biomass, a wide tolerance to environmental factors such as temperature and salinity, and the economic value of its derivatives is high (Marinho-Soriano et al., 2009).

Several studies have been conducted to obtain optimal farming methods. But information about the proper use of plant spacing for seaweeds farming is still limited. Spacing is one of the technical factors that influence the growth of seaweeds because of its relationship with the absorption of nutrients (Prihaningrum *et al*., 2001). The wider the row spacing, the movement of water in bringing nutrients are also getting better. However, the spacing is too high will have an impact on the production cost i(causes higher costs) and efficiency in the area of cultivation used. So, it is necessary to do research on proper planting space to optimize seaweeds farming.

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Materials and methods

This research was conducted in the Village of Kahyapu, Enggano Island, Bengkulu province during March untill May 2015. The choice of location research based on availability *Gracillaria* sp. which is used as a seed in farming. The research was held using experimental methods that refers to Meylia (2015). The seeds that used has criterias : still fresh, brightly colored and takes from the young thallus. The weight of seaweeds used is 50 grams with three different plant spacing (20, 25 and 30 cm). Each row spacing repeated three times and each replication consisted of three clumps of seaweeds. Seaweeds cultivation using longline methods, where the seaweeds randomly tied on a rope stretched across the water surface and equipped by anchor and buoy. With this method, seeds are cultivated will always inundated by sea water at high tide and low tide. Construction of seaweed cultivation can be seen in Figure 1.

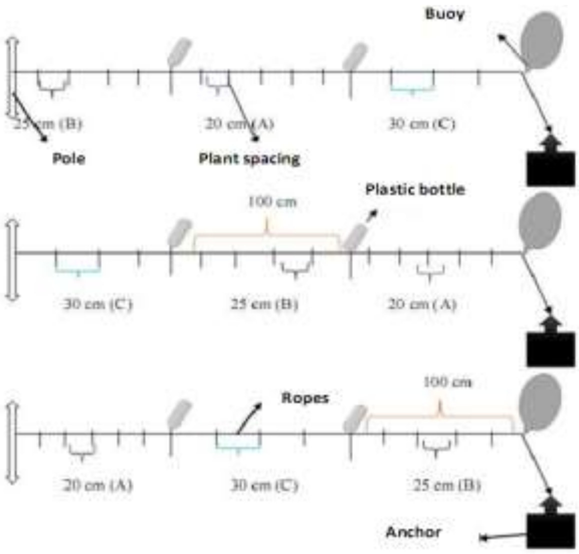

Figure 1. Construction of seaweed farming (Meylia, 2015).

Seaweeds farming was carried out for 42 days and measurements of seaweeds's wet weight was done every week. Absolute Growth Rate is calculated using Effendie (1997) :

$$\Delta W = Wt - Wo$$

Where ∆W is the absolute growth in grams, Wt is the wet weight of the day t (g) and Wo is the initial wet weight (g). Water quality include temperature, salinity, pH, brightness and water current, measured at the beginning, middle and end of the study.

Data of seaweeds's wet weight and absolute growth rate were analyzed using a completely randomized design (CRD) factorial with two-level factors in the confidence level (α) of 95%. For data wet weight of seaweed, the first factor is the plant spacing (20, 25 and 30 cm) and the second factor is the farming periode (0, 7, 14, 21, 28, 35 and 42 days). As for the data of absolute growth rate, the first factor is the plant spacing (20, 25 and 30 cm) and the second factor is the observation time (1^{st}, 2^{nd}, 3^{th}, 4^{th}, 5^{th}, 6^{th}). Each treatment was repeated three times. If there are differences, then continued with Duncan Multiple Range Test (DMRT).

Results and discussions

Wet Weight of Seaweeds

Based on this study, the wet weight of *Gracillaria* sp. during cultivation ranged from 56.67 to 163.33 grams, which is the initial wet weight was 50 grams (Figure 2). Analysis of variance showed that the interaction between plant spacing and farming periode has significant effect to the wet weight of seaweeds ($p < 0.05$) at 95% confidence level. The Multiple Duncan test indicates that the wider row spacing and the longer cultivation produces the higher wet weight.

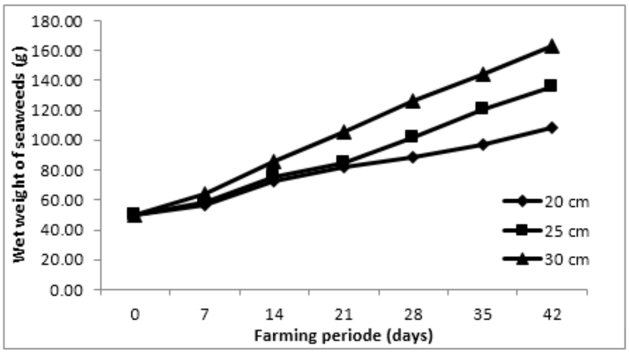

Figure 2. The wet weight of seaweeds under various plant spacing during research

The higher of wet weight along with the increasing distance due to the reduction in competition between plants. Alifatri (2012) states that a spacing have an impact on competition between thallus's growth, both in terms of utilization of space, sun and nutrient substances that are required in photosynthesis and nutrient absorption. The more narrow row spacing, the movement of water that carries nutrients needed by seaweeds is getting limited so that the growth of seaweeds become obstructed. A similar opinion was also expressed by Prihaningrum *et al*., (2001), the wider spacing makes the more extensive movement of water that carries nutrients so can be increasing of the seaweeds growth.

Absolute Growth Rate

The results showed that absolute growth rate ranged from 5.44 to 21, 67 grams (Figure 3). Analysis of variance showed that the interaction between plant spacing and time of observation has not significant effect on the absolute growth rate of seaweeds ($p > 0.05$) at the 95% confidence level. However, both of plant spacing and time of observation has significant effect on the absolute growth rate of seaweeds ($p < 0.05$) at 95% confidence level. The Multiple Duncan test indicates that the wider of plant spacing produces the higher absolute growth rate. Meanwhile, the increasing observation time to a certain extent, produces the higher absolute growth rate.

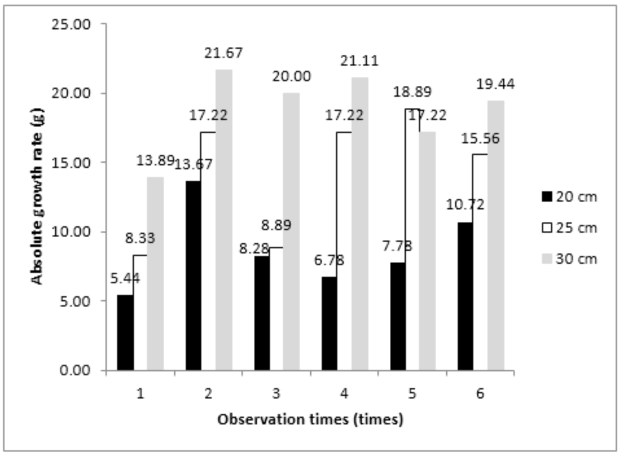

Figure 3. The absolute growth rate of seaweeds under various plant spacing during study

Seaweeds growth is influenced by many factors, one of them is the availability of nutrients for photosynthetic process. Thirumaran and Anantharaman (2009) suggest that the growth rate of seaweeds is the result of a complex interaction between sunlight, temperature, nutrient and water movement. Some of these factors can interact to influence the growth of a species and degradation of a factor (eg nutrients) can be compensated by other factors (eg water movement). Spacing can affect the movement of water that carries nutrients to the seaweeds. The wider of row spacing makes the movement of water current that bring nutrients are getting better so thallus can absorb nutrients in sufficient quantities for photosynthesis.

Beside nutrients, light or sunlight also affect the growth of seaweed. The quality and quantity of light is important in the response of photosynthesis and metabolism patterns. Photosynthesis and metabolism patterns changed by depth but the changes depending on the brightness and naturally dissolved particles (Loban, 1997). The more narrow row spacing, the penetration of light entering the waters are fewer. Narrow plant spacing causes the surface waters would be covered by seaweeds, causing competition in the absorption of sunlight. Boyd (1988) states that the light penetration in water is very influenced by the intensity and angle of incidence of light on the water surface, water surface conditions, and the total suspended solid in the water.

Beside plant spacing, seaweeds growth was also influenced by the duration of farming. In contrast to the wet weight which is continued to increase with the length of the cultivation, the growth rate will increase in beginning of farming but decrease with the length of cultivation. This is related to the age (seaweeds getting older) and wet weight of seaweeds (getting higher) . According to Sahabuddin and Tangko (2008), cells and tissues of young thallus provide optimal growth. Widyanto and Suliso (1977) says that the speed of absorption of minerals by young plants is larger than old plant. The higher of wet weight also causes competition for space, sunlight, and nutrients getting high so that the growth rate of seaweeds tends to decrease as the length of the cultivation.

Water Quality

Water quality (temperature, salinity, pH, brightness and water current) during the study are presented in Table 1. Overall, water quality on farming area are suitable for seaweed growth.

Table 1. Water quality measurements on farming location

	Parameter	Value	Standard	References
1	Temperature (°C)	29	25-30	Ditjenkanbud (2005)
2	Salinity (‰)	31	18-32	Kadi and Atmadja (1988)
3	Acidity (pH)	7	7-8,5	Aslan (1998)
4	Brightness (%)	100	There are still sunlight	-
5	Water current (cm/s)	29	20-40	Anggadiredja *et al.* (2008)

Temperature

The average temperature in the study site was 29 °C. Temperature can affect the photosynthesis in the ocean, both directly and indirectly. Direct influence of temperature is to control the enzymatic reaction in the process of photosynthesis. High temperatures can increase the maximum rate of photosynthesis (Tomascik *et al*., 1997). According Alifatri (2012), adaptability of *Gracilaria* sp. on temperature are varies, depending on where the seaweeeds alive so it is possible will have optimal growth in the area that have suitable temperature.

Salinity

The average value of the salinity in the study site is 31 ‰ and it is suitable for seaweeds growth. Salinity is influenced by several factors, among others, the supply of fresh water to sea water, rainfall, seasons, topography, tidal and evaporation (Nybakken, 2000). In addition Nontji (1993) also stated that the distribution of salinity is influenced by various factors such as patterns of water circulation, evaporation, rainfall and river flow.

Acididity (pH)

The average pH of the study sites is 7. This value is suitable for the growth of seaweeds. The pH value in the waters relatively constant so it rarely be the limiting factor for the growth of seaweeds.

Brightness

Brightness is closely related to the depth and particles dissolved in the water. Seaweeds require bright waters in order to be able to use sunlight for photosynthesis. In the study site, the brightness of the waters reached 100%, which indicates that sunlight can penetrate untill the bottom of the waters.

Water current

The average water current at the study site is 29 cm / s. Water current has an important role for the growth of seaweeds. According to Sunaryat (2004), water current affect the fertility of seaweeds because the movement of water makes nutrients that are needed can be well supplied and distributed and then absorbed through the thallus. Substitution of water is continuously needed so that there is always a mass of water that brings a complete nutrient composition in sufficient's amount (Vairappan and Chung, 2006). But if the water current was too strong can broke the construction of seaweeds farming and thallus will be damaged.

Conclusion

Based on the research, it can be concluded that the interaction of plant spacing and farming periode has significantly affect the wet weight of seaweeds, where more extensive planting space and the longer the cultivation, the wet weight will be higher. The rate of absolute growth is affected by plant spacing and observation time. Based on the Duncan's test, wider spacing can increase the growth rate. Plant spacing of 30 cm is the best treatment. Water quality (temperature, salinity, pH, brightness and water current) during farming was suitable for seaweeds growth.

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