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GROWTH OF *Caulerpa* sp. CULTIVATED WITH THE LONGLINE METHOD IN ROMPO VILLAGE, LANGGUDU DISTRICT, BIMA REGENCY

Pertumbuhan Caulerpa sp. Budaya Dengan Metode Garis Panjang di Desa Rompo Kecamatan Langgudu Kabupaten Bima

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ABSTRACT

Macroalgae that exist in Indonesia and have the potential to be cultivated apart from the *Glacilaria* sp. and *Eucheuma* sp. is a type of seaweed *Caulerpa* sp. The aim of this research was to determine the effect of different planting distances and depths on the growth and antioxidants of *Caulerpa* sp. which is cultivated using the longline method. The research was carried out in the waters of Rompo Village, Langgudu District, Bima Regency, West Nusa Tenggara. The research method was a factorial Completely Randomized Design (CRD) with two factors. The first factor is the planting distance consisting of 3 treatments. The second factor is depth consisting of 2 treatments. The combination of distance and depth in this study is; A: plant distance 20 cm - 50 cm depth, B: plant distance 30 cm - 50 cm depth, C: plant distance 40 cm - 50 cm depth, D: plant distance 20 cm - 100 cm depth, E: plant distance 30 cm - depth 100 cm and F: planting distance 40 cm - depth 100 cm. The results showed that different planting distances had a significant influence at the 5% level on the growth of Caulerpa sp. and there is no interaction between the JT factor (Planting Distance) and the KD Factor (Depth) on the absolute growth rate of *Caulerpa* sp. Absolute growth rate of *Caulerpa* sp. The best treatment was obtained from a planting distance of 30 cm with a depth of 50 cm, namely 111 ± 27 grams with a specific growth rate of 2,477 ± 412b %/day. The highest antioxidant content was obtained at a planting distance of 40 cm with a depth of 50 cm, amounting to 45.57%. The conclusion of this research is that the interaction between the planting distance factor and the depth factor has no effect on the absolute growth and specific growth of *Caulerpa* sp. Different depths have a significant influence on the antioxidant content of *Caulerpa* sp.

ABSTRAK

Makroalga yang ada di Indonesia dan berpotensi untuk dibudidayakan selain *Glacilaria* sp. dan *Eucheuma* sp. merupakan jenis rumput laut *Caulerpa* sp. Tujuan penelitian ini adalah untuk mengetahui pengaruh jarak tanam dan kedalaman tanam yang berbeda terhadap pertumbuhan dan antioksidan *Caulerpa* sp. yang dibudidayakan dengan metode longline. Penelitian dilakukan di perairan Desa Rompo, Kecamatan Langgudu, Kabupaten Bima, Nusa Tenggara Barat. Metode penelitian yang digunakan adalah Rancangan Acak Lengkap (RAL) faktorial dengan dua faktor. Faktor pertama adalah jarak tanam yang terdiri dari 3 perlakuan. Faktor kedua adalah kedalaman yang terdiri dari 2 perlakuan. Kombinasi jarak dan kedalaman pada penelitian ini adalah; A : jarak tanaman 20 cm - kedalaman 50 cm, B : jarak tanaman 30 cm - kedalaman 50 cm, C : jarak tanaman 40 cm - kedalaman 50 cm, D : jarak tanaman 20 cm - kedalaman 100 cm, E : jarak tanaman 30 cm - kedalaman 100 cm dan F : jarak tanam 40 cm - kedalaman 100 cm. Hasil penelitian menunjukkan bahwa perbedaan jarak tanam memberikan pengaruh nyata pada taraf 5% terhadap pertumbuhan *Caulerpa* sp. dan tidak terdapat interaksi antara Faktor JT (Jarak Tanam) dan Faktor KD (Kedalaman) terhadap laju pertumbuhan mutlak *Caulerpa* sp. Laju pertumbuhan mutlak *Caulerpa* sp. Perlakuan terbaik diperoleh pada jarak tanam 30 cm dengan kedalaman 50 cm yaitu 111 ± 27 gram dengan laju pertumbuhan spesifik 2.477 ± 412b %/hari. Kandungan antioksidan tertinggi diperoleh pada jarak tanam 40 cm dengan kedalaman 50 cm yaitu sebesar 45,57%. Kesimpulan penelitian ini adalah interaksi faktor jarak tanam dan faktor kedalaman tidak berpengaruh terhadap pertumbuhan absolut dan pertumbuhan spesifik *Caulerpa* sp. Kedalaman yang berbeda memberikan pengaruh yang signifikan terhadap kandungan antioksidan *Caulerpa* sp.

Kata kunci	*Rumput laut, anggur laut, jarak tanam, kedalaman, antioksidan*
Keywords	*Seaweed, sea grapes, plant spacing, depth, antioxidants*
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INTRODUCTION

Indonesia as a maritime country has bright prospects for developing and empowering marine biological resources. One component of biota which is a marine biological resource is macroalgae. Macroalgae which are commonly found in the sea are also known as seaweed. One type of seaweed that has the potential to be cultivated besides *Glacilaria* sp. and *Eucheuma* sp. is a type of seaweed *Caulerpa* sp. This type of seaweed is popular with both domestic and foreign communities such as Japan, China and the Philippines because it has very important economic value as a fresh food ingredient and as an ingredient for medicines (Susilowati et al., 2017). Caulerpa is one of the species.

Chlorophyceae (green algae) have abundant photosynthetic pigments, namely chlorophyll a and b, which can function as antioxidants. Antioxidants are compounds that can prevent the free radical oxidation process because they contain folic acid, thiamine and ascorbic acid (Fatmawati et al., 2019).

The potential of the *Caulerpa* type of seaweed has been widely developed and cultivated in the community, considering that this *Caulerpa* type of seaweed has many very diverse benefits, including being able to treat or prevent cancer, help reduce cholesterol levels and can function to remove toxic substances in the body. Currently, the way to obtain Caulerpa is only based on extractive products or simply collecting it directly from the beach. So it has great potential to be developed and cultivated (Noor Mahmudah & Juli Nursandi, 2014).

Caulerpa is often found in protected places with clear water. The water flow is not too strong and the bottom is smooth due to sedimentation. *Caulerpa* diversity is highest in the tropics, namely in the culitoral zone and decreases in the inner zone. In the sublittoral zone, *Caulerpa* grows attached to coral or creeps under the coral canopy in Prod'homme Van Reine and Trono (2011) (Saptasari, 2012).

Distribution of *Caulerpa* sp. quite widespread, especially in tropical climates because this type requires sunlight for its photosynthesis process. Type *Caulerpa* sp. found in most parts of Asia, namely, Indonesia, Thailand, Malaysia, Japan, China, the Philippines, Korea, as well as other locations around the Asian region. Distribution of Caulerpa sp. also found on small islands in Indonesia and Nusa Tenggara (Razai et al., 2019).

Cultivation of *Caulerpa* sp. It has begun to be developed in Indonesia, such as on the island of Java, where people use sea grapes as a water quality neutralizer in shrimp ponds, meanwhile in the NTB region itself no one has started cultivating it. Cultivation activities have not been utilized because they still rely on catching from nature. Apart from that, sea grape cultivation is relatively new, so people do not yet know the weight of seeds according to the criteria, depth, cultivation methods applied, controls during the production process and planting distances used in cultivation activities (Iskandar et al., 2017). Differences in water depth cause The intensity of sunlight varies in water zones so that the photosynthesis rate of seaweed will be different. The distance between planting seeds affects the movement of water which carries nutrients for seaweed (Darmawati et al., 2016). Increasing the photosynthesis process will cause metabolic processes, thereby stimulating seaweed to absorb more nutrients to grow. Therefore, it is very important to carry out research on the effect of different planting distances and depths on *Caulerpa* sp. using the longline method so that later it can become information and knowledge material for cultivators who cultivate sea grapes.

RESEARCH METHODS

This activity was carried out for 30 days. Located in Rompo Village, Langgudu District, Bima Regency. Analysis of antioxidant content was carried out at the Analytical Chemistry Laboratory, Faculty of Mathematics and Natural Sciences, Mataram University.

The tools and materials used in this research are scales, stationery, thermometer, pH meter, refractometer, raffia rope, talis ris, stones, emebr, distilled water, camera, nitrite kit, nitrate kit, phosphate kit, tissue and *Caulerpa*.

This research method uses a factorial Completely Randomized Design (CRD) with two factors. The first factor is planting distance consisting of 3 treatment levels. The second factor is depth consisting of 2 levels of treatment. The treatment in this research is the result of a combination of factors from all levels of treatment. Thus, in this study there were 3x2 combinations or 6 combinations.

Table 1. Treatments applied at different planting distances and depths.

Treatment		
Planting Distance (JT)	Depth (KD)	
	50 cm (KD1)	100 cm (KD2)
20 cm	JT1KD1	JT1KD2
30 cm	JT2KD1	JT2KD2
40 cm	JT3KD1	JT3KD2

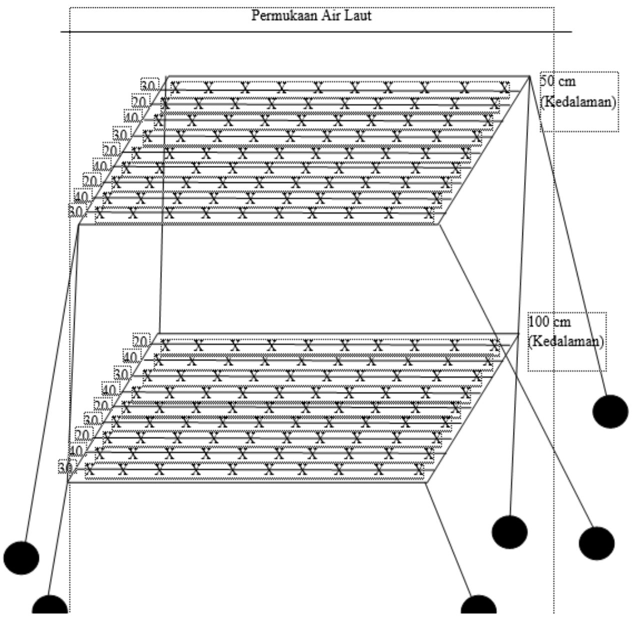

Figure 1. Layout of the Experimental Unit

The research stage carried out is the longline preparation stage by preparing the tools and materials that will be used to make the longline cultivation construction. The longline was made from 10 mm polyethylene rope with a length of 11 m and a width of 3 m. In the longline there are 4 ropes with a distance between the ropes of 50 cm. The longline is placed in a predetermined location with a depth of 50 cm and 100 cm at the lowest tide. The length of the longline used is 5 × 5 meters. In the preparation stage for *Caulerpa* seeds, the sea grape seeds used are seeds taken directly from nature. Sea grape seedlings were weighed with the same initial seed weight, namely 100 grams. Tie the seeds to the ris rope using raffiah rope with a distance between the seeds of 20 cm, 30 cm and 40 cm. The ris rope used is 11 m long. In the longline, the distance between ris ropes, respectively 20 cm, 30 cm and 40 cm, is placed with a depth of 50 cm and 100 cm. The *Caulerpa* planting stage involves taking 100 grams of sea grape seeds that have been weighed. tied to a rope at a distance of 20 cm, 30 cm, and 40 cm with a rope length of 11 meters stretched over wood which is used as a weight and marker for cultivation samples. The *Caulerpa* maintenance stage is as long as the sea grapes (*Caulerpa*) are in the cultivation container, during that time several activities continue to be carried out to ensure the sea grapes (*Caulerpa*) are in good condition. Some activities that are routinely carried out are controlling plants, cleaning mud, and checking whether there are damaged or dead Caulerpa. The final stage of observing growth is taking samples of Caulerpa sp. in each treatment, namely in the plant spacing treatment (J1, J2, and J3) and in the depth difference treatment (KD1 and KD2). weighed Caulerpa sp. in each treatment at predetermined times on days 0, 10, 20 and 30. Antioxidant tests were carried out on Caulerpa sp.

The parameters used to test research results include:

1. Absolute Growth Rate

According to Kasim et al., (2017), absolute growth can be measured using the absolute growth formula as follows:

$$G = Wt - Wo$$

Information:

G = Average absolute growth (gr)
Wt = Seedling weight at the end of the study (gr)
Wo = Seedling weight at the start of the study (gr)

2. Specific Growth Rate

According to Kasim et al., (2017), specific growth can be measured using the specific growth formula as follows:

$$SGR = \frac{(Ln\,Wt - Ln\,Wo)}{t} x\ 100\%$$

Information:

SGR = Specific daily growth rate (%/day)
Wt = Average weight of fish at the end of the study (gr/head)
Wo = Average weight of fish at the start of the study (gr/head)
t = Time (maintenance length)

3. Number of Thalus Circles

To count the number of dots on Caulerpa sp. This is done by counting the number of dots in the thalus at a predetermined time, namely on days 0, 10, 20 and 30.

4. Water Quality

Water quality data is supporting data which includes temperature, salinity, pH, current speed, nitrate, phosphate and dissolved oxygen (DO). Water quality sampling is carried out once every 10 days in the morning.

5. Antioxidant Analysis

According to (Molyneux, 2004 in Rahmawati, 2016) the antioxidant activity of a sample is determined by the amount of DPPH radical absorption inhibition by calculating the percentage (%) of DPPH absorption inhibition using the following formula:

$$\% \, inhibisi = \frac{(Absorban \, blanko - Absorban \, sampel)}{Absorban \, blanko} x \, 100\%$$

Information:
% Inhibition = Tingkat inhibisi
Absorbent blank = Serapan radikal DPPH
Sample absorbance = Serapan sampel dalam radikal DPPH

The data from the results of this research are absolute growth data and relative growth as well as analysis of antioxidant content. To determine the effect of the treatment given using analysis of variance (ANNOVA), then Duncan's multiple area test was carried out to determine the differences between each treatment.

RESULTS AND DISCUSSION

1. Absolute Growth Rate

Table 2. Absolute Growth Rate of *Caulerpa* sp. (g)

Perlakuan		Ulangan				
JT (cm)	KD (cm)	1	2	3	Average	Rerata±SD
20	50	67	68	45	180	60 ±13[a]
20	100	75	29	41	145	48±24 [a]
30	50	100	142	92	339	111±27[b]
30	100	85	96	101	282	94±8[b]
40	50	72	69	51	192	64±11[a]
40	100	62	41	45	148	49±11[a]

Note = letters that are not the same indicate significant differences between treatments at the 5% level.

2. Specific Growth Rate

Table 3. Specific Growth Rate

Perlakuan		Ulangan				
JT (cm)	KD (cm)	1	2	3	Average	Rerata±SD
20	50	1,709	1,729	1,239	4,677	1,559±0,278[a]
20	100	1,865	0,849	1,145	7,431	1,286±0,412[a]
30	50	2,31	2,946	2,174	4,931	2,477±0,235[b]

30	100	2,051	2,243	2,327	3,859	2,207±0,523[b]
40	50	1,808	1,749	1,374	6,621	1,644±0,142[a]
40	100	1,608	1,145	1,239	3,992	1,331±0,245[a]

Note = letters that are not the same indicate significant differences between treatments at the 5% level.

3. Number of Caulerpa Circles

Table 4. Number of *Caulerpa Circles*

Treatment		Test				
JT (cm)	KD (cm)	1	2	3	Average	
20	50	818	823,25	818,5	819,917	ab
20	100	928	922,75	926,5	930,833	a
30	50	1010	779,5	1003	906,917	a
30	100	926	932	933,25	925,750	a
40	50	890,5	897	933,25	930,417	a
40	100	702,25	721,25	732,5	718,667	b
Value BNJ = 150, 140						

Note = letters that are not the same indicate significant differences between treatments at the 5% level.

4. Antioxidant Analysis

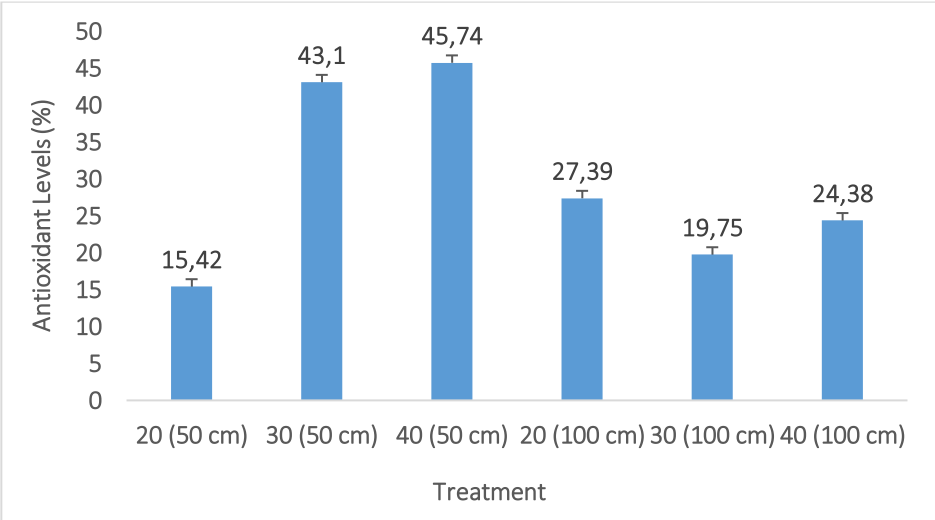

Figure 2. Antioxidant content

5. Water Quality

Table 5. Water Quality Measurements

No	Parameters	Results Environment	Range Water quality	Library Sources
1.	Salinitas	28-29 ppt	22-34 ppt dan 30-34 ppt	Fatmawati (2019)
2.	Suhu	27,4-27,5 ^{o}C	20-30 ^{o}C	Dahlia & Rejeki (2017)
3.	pH	7,7-7,8	6,5-8,5	Fatmawati (2019)
4.	Nitrit (mg/l)	0,05	0,001 mg/l	Putri (2019)
5.	Fosfat (mg/l)	0,1	0,1 ppm	Darmawati (2016
6.	Kecapatan Arus	2,31-3,70 m/s	40-50 cm/s	Novianti (2015)
7.	Nitrat (mg/l)	10	0,09- 3,5 mg/l	Suparjo (2008)

1. Absolute Growth Rate

The results of cultivation carried out for 30 days using 3 plant spacing treatments and 2 depth treatments for the growth of seaweed *Caulerpa* sp. best with the influence of different planting distances and depths and the results obtained were that different planting distances influenced absolute growth significantly at the 5% level. Meanwhile, the depth factor could not have a significant influence on the growth of *Caulerpa* sp. and there was no interaction between planting distance and depth factors on the absolute growth of *Caulerpa* sp.

Based on the results of research during 30 days of maintenance which can be seen in (Table 6), it can be seen that the absolute growth of *Caulerpa* sp. was highest in the plant distance treatment of 30 cm with a depth of 50 cm with an absolute growth value of 111 ± 27b grams and the lowest was in the plant distance treatment of 20 cm with a depth of 100 cm is 94 ± 8b grams. The difference in growth of each treatment shows that the seaweed *Caulerpa* sp. Carrying out adaptation mechanisms to the environment, especially to different light at different depths. Besides that, adaptation to other factors such as current speed, dissolved nutrients and temperature is related to thallus growth. Even though depth does not have a significant effect on the growth of *Caulerpa*, the role of depth is needed for the growth of *Caulerpa*, as it is known that *Caulerpa* seaweed, like other chlorophyll plants, requires nutrients as raw materials for the photosynthesis process for its growth. Sufficient sunlight greatly determines the speed at which seaweed meets its nutritional needs such as nitrogen (N) and phosphorus (P) for growth and cell division. Apart from absorbing nutrients, the method used can also influence the growth of seaweed. The long line method is a method carried out on the surface of waters where there is high light intensity. As stated by Azizzah (2006), seaweed is a chlorophyll plant that requires sunlight for its growth, so that seaweed growth is only limited to shallow areas. This is also reinforced by the statement from Susilowati (2012), which stated that the less than optimal growth rate was caused by the lack of light intensity entering the waters.

In this study, the absolute height of growth in the 30 cm planting distance treatment, this is because the 30 cm planting distance significantly influences the growth of seaweed from the aspect of nutrient supply obtained by the seaweed. Nutrients needed by seaweed for its growth include nitrate and phosphate. This is in accordance with Darmawati's (2015) statement that seaweed planting distances can influence competition for nutrients. Planting distance is related to the movement of water carrying nutrients and other water physics, both horizontally and vertically. This makes the growth process more effective. This condition really supports the growth of cultivated seaweed.

The results of Univariate Analysis of Variance (ANOVA) showed that the effect of different planting distances had a significant influence on the growth of *Caulerpa* sp., because there were significant differences, so a further Tukey/BNJ test was carried out to see the effect between treatments. The Tukey/BNJ follow-up test in the plant distance treatment of 20 and 40 cm with a depth of 50 cm and 100 cm did not have a significantly different effect on the growth of *Caulerpa*, but the plant distance treatment of 30 cm with a depth of 50 cm and 100 cm had a significantly different effect on the growth of *Caulerpa*. growth of *Caulerpa* sp. According to Prihaningrum et al., (2011), the distance between planting seeds affects the movement of water which carries nutrients for seaweed. Based on tests that have been carried out for absolute growth, results were obtained that were significantly different in different plant spacing treatments. This is confirmed by Darmawati (2017), that the planting distance will affect water movement and will avoid the accumulation of dirt in the thallus which will help with ventilation so that the photosynthesis process needed for seaweed growth can take place and prevent large fluctuations in salinity and temperature. Ardiansyah (2020) also stated that seaweed growth is influenced by the distance between the seeds.

2. Specific Growth Rate

The Anova results showed that only the plant spacing treatment had an influence on the specific growth rate of *Caulerpa* sp. Meanwhile, the depth factor could not have a significant influence on the growth of *Caulerpa* sp. and there was no interaction between planting distance and depth factors on the absolute growth of *Caulerpa* sp.

The results of the average specific growth value of *Caulerpa* sp. The best for 30 days was achieved by a planting distance of 30 cm with a treatment depth of 50 cm where the average value of specific growth rate = 2.477 ± 0.235b %/day. Meanwhile, the lowest growth was in the 20 cm planting distance treatment with a 100 cm depth treatment, where the average value of specific growth rate = 1.286 ± 0.412a %/day. In the 20 cm plant distance treatment, the growth was the lowest compared to other plant distance treatments, this was because the plant distance of 20 cm during the maintenance period of the seaweed thallus was intertwined so that it disrupted water traffic which carried the nutrients needed by the seaweed, apart from that the seaweed At a planting distance of 20 cm, many micro plants (moss) were found attached, disrupting the growth of seaweed due to competing for nutrients with the moss plants. This is supported by the opinion of Anggadireja (2006), that plants around cultivated plants interfere with the growth of seaweed. The decrease in seaweed growth at a planting distance of 20 cm was due to the seaweed thallus being close together and resulting in a lack of sunlight needed for the photosynthesis process. Masyahoro and Mappiratu (2009) stated that the seaweed planting distance affects the area of the seaweed thallus exposed to sunlight so that it will indirectly affect the photosynthesis process which supports the growth of seaweed. Different planting distances had a very significant influence on the growth of Caulerpa sp., because there were significant differences, so a further Tukey/BNJ test was carried out to see the effect between treatments. Further test results showed that the treatment with a planting distance of 20 cm and 40 cm with a depth of 50 cm and 100 cm did not have a significantly different effect on the growth of Caulerpa sp., however the only thing that could provide a significantly different effect was the treatment with a planting distance of 30 cm with depth of 50 cm and 100 for Caulerpa growth. This is in accordance with the statement from Darmawati (2016), that planting distance can influence the movement of water which carries nutrients so that the growth of Caulerpa racemosa. increase, and obey. Even though depth does not have a significant effect on the growth of *Caulerpa*, the role of depth is needed for the growth of Caulerpa, as it is known that Caulerpa seaweed, like other chlorophyll plants, requires nutrients as raw materials for the photosynthesis process for its growth. Burhanuddin (2014), stated that light is one of the factors that influences aquatic vegetation, because it functions as energy for the photosynthesis process.

3. Number of Caulerpa Circles

The results showed that the growth of seaweed *Caulerpa* sp. can be seen from the growth in the number of dots every 10 days. This result was proven by analysis of the average growth in each treatment. The results of analysis of variance (ANOVA) show that the influence of planting distance and depth influences the growth of the number of *Caulerpa* sp. significantly at the 5% level, and there was an interaction between the planting distance factor and the depth factor on the growth of the number of *Caulerpa* sp. The highest growth was found in the plant distance treatment of 30 cm with a depth of 50 cm with a value of 930,833 dots and the lowest was in the plant distance treatment of 40 cm with a depth of 100 cm with a value of 718,667 dots. This was supported because the nutrients were met within a month of the maintenance period. The difference in the number of *Caulerpa* sp. dots is thought to be influenced by nutrients obtained in poor waters such as high waves, causing *Caulerpa* sp. one with another carried by the current and gathered into one. This is in accordance with the opinion of Yudasmara (2014), who states that external factors such as the physical and chemical environmental conditions of waters can inhibit the growth of seaweed. Physical factors such as pH, temperature, salinity, and N and P elements are among the chemical elements present in the water that support the growth of sea grapes. Besides that, the more the number of dots on Caulerpa, the better its growth, this is because the thalus dots have the function of absorbing food in the water using the cells found in the thalus dots. This is in accordance with the opinion of Kurniawan (2018), that seaweed has a thallus as a replacement for the role of leaves, stems and roots, which functions as a food absorber through the cells in the thallus.

Different planting distances and depths had a significant influence on the growth of *Caulerpa* sp., and there was an interaction between the planting distance factor and the depth factor significantly on the number of *Caulerpa* sp. dots, because there were significant differences so a further Tukey/BNJ test was carried out to see the effect between treatments. Tukey/BNJ further test on treatment with 20 cm planting distance and depth 50 cm was not significantly different from the 40 cm plant spacing treatment with 100 cm depth treatment, however in the 40 cm plant spacing treatment with 100 cm depth it was significantly different in all treatments whereas in the 20 cm plant spacing treatment with 100 cm depth, the plant distance was 30 cm with a depth of 50 cm, a plant distance of 30 cm with a depth of 100 cm, and a plant distance of 40 cm with a depth of 50 cm, significantly different only in the treatment with a plant distance of 30 cm with a depth of 100 cm. According to Atmajaya (1979) the role of depth on seaweed growth is related to vertical temperature stratification, light penetration, oxygen and nutrient content. Based on tests that have been carried out for the growth of the number of spheres, results were obtained that were significantly different in different treatments and depths. This is confirmed by Darmawati (2017), that an important factor that influences the growth of seaweed depends on the intensity of sunlight to carry out photosynthesis, where through this process the seaweed cells can absorb nutrients thereby stimulating the growth of seaweed.

4. Antioxidant content

From the results of the analysis of the antioxidant content of *Caulerpa* sp. (Figure 5), shows that different treatment depths have an influence on the antioxidant content of *Caulerpa* sp. The antioxidant content of different depths experienced increases and decreases in antioxidant content values. This is influenced by both physical, chemical factors and the content test process carried out during laboratory tests, so it can be concluded that the highest antioxidant content is found in the treatment depth of 50 cm with a planting distance of 20 cm, 30 cm and 40 cm. shows that the lower the depth of cultivation, the higher the antioxidant content. This is related to the penetration of sunlight which can enter the waters due to Caulerpa sp. is a green algae that contains a lot of chloryl pigments a and b. This is in accordance with the opinion of Kune (2007), that depth is one of the determining factors in the growth of sea grapes. As planting depth increases, the penetration of incoming light becomes lower, and oxygen circulation becomes lower.

From several studies that have been carried out on *Caulerpa* sp. can produce secondary metabolites that function as antioxidants. Chew et al., (2008) stated that in its development, apart from being a food ingredient, *Caulerpa racemosa* is also widely used for medical purposes because it contains antioxidants. *Caulerpa racemosa* is able to ward off free radicals because this type of algae contains folic acid, thiamine and ascorbic acid.

Caulerpa sp. also contains caulerpenin which shows bioactivity against human lne cells and has anticancer, antitumor and antiproliferative properties. The research results of Aryudhani (2007) show that Caulerpa racemosa sea grapes contain phenolic compounds as non-nutritional components. This component is thought to function as an antioxidant. According to Santoso et al., (2002) said that Caulerpa racemosa originating from Indonesia and Japan contains polyphenolic components. The polyphenol component contained in *Caulerpa racemosa* is catechol, where catechol is included in the phenol group of antioxidants. Phenol group antioxidants are antioxidants that are widely used because they do not contain toxins. The role of depth and planting distance factors on the antioxidant content of seaweed is closely related to light penetration, planting distance is related to water currents that carry nutrient elements. Nutrients are one of the factors that play a very important role in supporting the photosynthesis process for the growth and quality of seaweed. Therefore, to support the quality of seaweed (antioxidant content) it is necessary to provide nutrients in the waters. Illustrimo et al., (2013), stated that the seaweed growth process itself is very dependent on the intensity of sunlight to carry out the photosynthesis process, where through this process the seaweed cells can absorb nutrients thereby stimulating the daily growth of seaweed through division activity. cells and will affect the quality of seaweed. Apart from the factors above, differences in antioxidant content can also be caused when sampling sea grapes using different branches/thallus to test antioxidant content which will result in high and low results obtained.

5. Water Quality

During maintenance, temperature values range between 27.4 - 27.5℃. A good temperature range to support the growth of *Caulerpa racemosa* seaweed is between 27-32℃ (Fatmawati, 2019). The pH value (Degree of acidity) during maintenance ranges from 6.5-7.8. This is in accordance with the opinion of Fatmawati (2019), who states that the appropriate pH value for seaweed is in the range of 6.5 - 8.5, 4 - 6.4, and 8.5- 9. During maintenance, the salinity value in cultivation activities sea grapes range from 28-29 ppt. This is in accordance with the opinion of Fatmawati (2019) who states that the salinity values suitable for seaweed growth are 22-34 ppt and 30-32 ppt. The phosphate value in sea grape cultivation activities is 0.1 mg/l. This is in accordance with the opinion of Darmawati (2016), who states that the phosphate content is not more than 0.1 ppm, if there is a minimum of 0.01 mg/l of phosphate in seawater, then the growth rate of most aquatic biota will not be hampered. However, if the phosphate level is below this critical level (0.01 mg/l), the cell growth rate will decrease further. The research results obtained from sea grape cultivation activities were 0.05 mg/l. These results are in accordance with the opinion of Putri et al., (2019), who stated that natural waters generally contain niitrite of 0.001 mg/l and should not exceed 0.06 mg/l. Compared with the nitrate concentration, the measured nitrite concentration was much smaller. The current speed value obtained in sea grape cultivation activities was 2.31-3.70 m/s. This is in accordance with the opinion of Novianti (2015), that the current range that is good for seaweed growth is 40-40 cm/s. The nitrate value measured during sea grape cultivation activities was 10 mg/l.

This value is considered high for seaweed growth because according to Suparjo (2008), the nitrate content in the waters is 0.09-3.5 mg/l for seaweed growth to absorb nutrients. The high value of nitrate in these waters can be caused by a high input of organic material from land activities which can be in the form of land erosion or household waste, agricultural waste in the form of fertilizer residue carried directly by sea waters or it can also be caused by current speeds that are too high. This is in accordance with the opinion of Patty (2015), that the presence of low and high nitrate content in certain conditions in waters can be caused by various factors, including the presence of currents that carry nitrate and the abundance of phytoplankton.

CONCLUSION

The conclusions obtained in this research are as follows:

1. The interaction between the JT (Planting Distance) factor and the KD (Depth) factor significantly influences the number of dots and significantly affects absolute growth and specific growth.
2. In the Caulerpa sp. antioxidant test. that the highest antioxidant content was obtained in the treatment with a planting distance of 40 cm with a depth factor of 5o cm of 45.57%.

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