The Influence of Depth and *Sargassum* Weight on The Growth of *Kappaphycus alvarezii*

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Abstract - Kappaphycus alvarezii is one type of algae that is widely cultivated by coastal communities. Seaweed growth can be hampered due to fluctuating waters and extreme conditions. Where one of the factors that influence the growth of seaweed is the level of depth. Other factors that affect the growth of seaweed and can reduce production include changes in salinity, water temperature, light intensity, this is the main factor triggering the outbreak of ice-ice disease. When seaweed is stressed, it can facilitate ice-ice disease and epiphytic infections attack under stressful conditions Sargassum aquifolium contains active compounds that function as antibacterial, antiviral and anti-fungal substances used as a barrier to the development of bacterial pathogens so that they can increase grass yields. Alvarezii. The study was designed using Factorial Randomized Complete Design (CRD) with 2 factors, namely the level of depth of the sea surface (A) and the weight of Sargassum sp. (B). The first factor (A) consists of 3 levels, namely (A1: 30 cm depth) (A2: 45 cm depth), and (A3: 60 cm depth) (Grace, 2017). The second factor (B) consists of 4 levels, namely (B1: 0 grams), (B2: 15 grams), (B3: 25 grams) and (B4: 35 grams) with a distance of 30 cm between ropes. Based on these two factors, there are 12 combinations of treatments. Data from research results with growth variables analyzed the differences using *Analysis of variance* (ANOVA) at the error level of 5%. If there is a significant effect followed by W-Tukey's further test. The depth factor tends to be higher in depth of 60 cm and 30 cm and tends to be lower at a depth of 45 cm. Sargassum weighting factors tend to be higher in the 0 gr weight or control treatment compared to the weights of 15gr, 25gr and 35gr. There is no interaction between the two for the growth of seaweed on Kappapycus alvarezii.

Keywords: *Weight, Kappapycus alvarezii, sargassum, depth, verticulture*

I. INTRODUCTION

Kappaphycus alvarezii is one type of algae that is widely cultivated by coastal communities. This seaweed produces a type of kappa carrageenan which has strong gel-producing characteristics and many contain polysaccharides which are important sources for producing carrageenan in the world (Thirumaran and Anantharaman, 2009).

Seaweed growth can be hampered due to fluctuating waters and extreme conditions. Where one of the factors that influence the growth of seaweed is the level of depth. This can be seen from the intensity of light entering the waters when helping photosynthesis. This is in agreement (Doty, 1988), stating that the depth factor is closely related to vertical temperature stratification, sunlight penetration, density, oxygen content, and nutrients. Nutrient content needed for seaweed growth is also up to the optimum depth. Algae can grow well if available nutrient content in accordance with the required nutrients (Sulistijo, 2002). The growth rate will affect the production and content of carrageenan levels.

Other factors that affect the growth of seaweed and can reduce production include changes in salinity, water temperature, light intensity, this is the main factor triggering the outbreak of ice-ice disease. When seaweed is stressed, it can facilitate ice-ice disease and epiphytic infections attack in stressful conditions will free up organic substances, which causes the thallus to runny and stimulate bacteria and epiphytes to grow abundantly (Vairappan, 2006). Some studies have found that seaweed has the potential to inhibit the growth of Vibrio harveyi bacteria, namely Sargassum sp. and also has the potential as an antioxidant, as a raw material for making surfactants, (Pakidi and Suwoyo, 2017) hormones, vitamins, minerals, and also bioactive compounds (Putra, 2006). Where the Koivikko study also (2008) mentions that in brown algae Sargassum sp. found fluorotanine which is a phenolic compound which acts as a source of antioxidants. Sargassum extract in the fisheries field has been very often applied. The results of the study (Kusumaningrum et al., 2007) state that Sargassum aquifolium contains active compounds that function as antibacterial, antiviral and anti-fungal substances used as a barrier to the development of pathogenic bacteria so as to increase grass yields of K. Alvarezii (Nasmia et al. , 2016).

Vericultural or long line vertical cultivation methods are believed to be able to provide greater yields in the same area compared to the long line horizontal method (Wisnu et al., 2016). Therefore, research on combinations with verticultural systems has not been widely published for this reason.

Formulation of the problem
1. Are there depth interactions for growth on Kappaphycus alvarezii?
2. Are there interactions between the weights of Sargassum sp. for growth on Kappaphycus alvarezii?
3. Are there interactions between the depth and weight of Sargassum sp. for growth on Kappaphycus alvarezii?

II. THE RESEARCH METHOD

The research activity was carried out in September-December 2018, located in the village of Aeng Batu-batu, North Galesong District, Takalar District, South Sulawesi Province.

A. Preparation of Seaweed Seeds

Seaweed seeds used in this study were seeds of K.alvarezii and Sargassum sp. obtained from seaweed farmers around Sanrobengi Island and K.alvarezii seedlings in the village of Aeng batu-batu.

B. Implementation of Research

Seaweed maintenance activities last for 60 days beginning with planting seeds to harvesting and observing per 15 days. Vertical methods that have been put in accordance with the planned unit of the experiment. The level of depth with different levels is 30 cm, 45 cm and 60 cm and the weight of treatment (Sargassum sp.) Is (0 grams, 15 grams, 25 grams, and 35 grams). Where the weight of seaweed (K. alvarezii) weighs the initial weight of 25 grams.

C. Treatment and Design

The method used in this study is an experimental method with experiments in the field. The study was designed using Factorial Randomized Complete Design (CRD) with 2 factors, namely the level of depth of the sea surface (A) and the weight of Sargassum sp. (B). The first factor (A) consists of 3 levels, namely (A1: 30 cm depth) (A2: 45 cm depth), and (A3: 60 cm depth) (Grace, 2017). The second factor (B) consists of 4 levels, namely (B1: 0 grams), (B2: 15 grams), (B3: 25 grams) and (B4: 35 grams) with a distance of 30 cm between ropes. Based on these two factors, there are 12 combinations of treatments.

D. Absolute Growth

The absolute growth of seaweed is calculated using the Effendi formula (1970), namely,

$W = Wt - Wo$;
W = absolute growth (g)
Wt = Final weight of seaweed (g)
Wo = initial weights of seaweed (g)

E. Data analysis

Data from research results with growth variables analyzed the differences using *Analysis of variance* (ANOVA) at the error level of 5%. If there is a significant effect followed by W-Tukey's further test to compare the differences between treatments. As a tool for the statistical test, the SPSS version 23 software program is used. Supporting water quality data will be analyzed descriptively.

III. RESULTS

A. Absolute Growth

The results of the analysis of the average value of Kappaphycus alvarezii Absolute Growth maintained at different Sargassum depths and weights are presented in Table 1. Based on the results of the statistical analysis of depth significant effect ($p < 0.05$) on the absolute growth of Kappaphycus alvarezii while the weight of Sargassum did not significantly influence or ($p > 0.05$). The interaction between the depth and weight of Kappapycus alvarezii seaweed growth had no significant effect. This value shows the multiple values of depth between depth and weight on absolute growth. Kappaphycus alvarezii has a weak correlation. In (Table 1) above can be seen in the treatment of A3B4 (depth 60cm with the weight of Sargassum 35gr) get the lowest result with a value of 14.33 ± 14.50gr while the highest growth with a value of 41.00 ± 26.91gr obtained in treatment A2B1 (depth 45cm with weight Sargassum 0gr Control).

The results of the variance analysis showed that depth did not significantly influence ($P > 0.05$) on the daily growth rate of K. alvarezii seaweed, while the weight of Sargassum did not significantly influence ($P > 0.05$). The interaction between the depth and weight of Sargassum on K.alvarezii's seaweed growth had no significant effect. The highest daily growth rate was found in A2B1 treatment (45 cm depth and Sargassum weight 0 g) with values of 1.53% and SD ± 0.66% while the lowest was found in A2B3 treatment (45 cm depth and Sargassum weight 25 g) with values of 0.60% and SD ± 0.88% (Table 2).

Table 1: Absolute Growth of Kappaphycus alvarezii during the Study Depth

Depth / Weight of Sargassum	B1	B2	B3	B4	$\bar{A}$ Tukey
A1	25.67 ± 4.93	24.00 ± 9.00	25.33 ± 5.51	18.33 ± 18.45	$\bar{A}1$ 25.08^{ab}
A2	41.00 ± 26.91	25.67 ± 11.06	14.33 ± 21.22	30.67 ± 14.47	$\bar{A}2$ 17.50^{a}
A3	25.67 ± 28.29	19.67 ± 13.58	30.00 ± 4.58	14.33 ± 14.50	$\bar{A}3$ 32.58^{b}

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$\bar{B}$ Tukey	**30.78**	**23.11**	**23.22**	**23.11**	**0.371** / **0.624**

Description: *Numbers followed by different letters in the average column show significantly different based on the Tukey test*

Table 2. Daily Growth Rate (%) K. *alvarezii* during the study

Depth / **Weight of Sargassum**	**B1**	**B2**	**B3**	**B4**	$\bar{A}$ **Tukey**
A1	1.17 ± 0.17	1.10 ± 0.31	1.16 ± 0.19	0.79 ± 0.83	$\bar{A}$1 **1.05**
A2	1.53 ± 0.66	1.15 ± 0.38	0.60 ± 0.88	1.10 ± 0.41	$\bar{A}$2 **1.09**
A3	1.06 ± 0.99	0.95 ± 0.61	1.30 ± 0.14	0.67 ± 0.64	$\bar{A}$3 **0.99**
$\bar{B}$ Tukey	**1.25**	**1.06**	**1.01**	**0.85**	**0.91** / **0.49**

Description: *Numbers followed by different letters in the average column show significantly different based on the Tukey test*

B. Absolute Growth

Maximum production in seaweed cultivation can be fulfilled if it is supported by an environment that is suitable for its growth, such as substrate, light, nutrient elements and water movement (Gusrina, 2006) where it can determine the quality of seaweed. Sea algae growth is influenced by two factors, namely internal factors, and external factors. Internal factors that influence the growth of marine algae are species, thallus (seedlings) and age while external factors are plant spacing, initial seed weight, seed selection, plant care (Sugiarto et al., 1987).

The results showed that the effect of Sargassum depth and weight on the absolute growth of Kappahycus alvarezii for 60 days experienced low growth, this can be seen in (Table 3). Only the depth factor has a significant effect on absolute growth. Treatment with different planting depths results in different relative growth rates, where the smaller the amount of sunlight entering the waters will show a declining growth rate (Soegiarto et al., 1996). Depth is one of the factors that influence the absorption of light by seaweed because the intensity of light is perfectly received by the thallus and is a major factor in the process of photosynthesis that determines the level of growth of seaweed (Palegrin et al., 2007). This is presumably because light penetration is low when the high content of suspended particles in waters near the coast, due to tidal activity and also the level of depth (Hutabarat and Evans, 2008).

In the A3B4 treatment, the lowest growth was at a depth of 60cm and the weight of Sargassum 35gr with an average value of 14.33gr with SD ± 14.50gr. This condition is due to lack of light absorption because the deeper the water the intensity of light received decreases, the stronger the current reaches 1.50 m / sec and salinity up to 35 ppt. Saffo, (1987) adds that with increasing depth of light absorption the weaker. While the highest growth was obtained in A2B1 treatment with a depth of 45cm and weight of Sargassum 0gr with an average value of 41.00gr and SD ± 26.91gr. The study of Pongarrang, et al (2013) where to obtain more optimal production, cultivation can be done at 25cm depth because has a higher value than 15cm and 35cm depth and Susilowati et al (2012) study states that the treatment growth rate is 25cm higher than (50cm) and (75cm) and Akmal's research (2011) states that 20-100cm depth tends to be higher. Whereas the weight of Sargassum did not have a significant effect because this was because when the final measurement (harvest) was obtained that Sargassum in each sample almost the remaining number was not even present/missing. This situation is thought to have occurred because of the strong currents and weight of Sargassum which made the Sargassum fall down. The results of the post hoc advanced test analysis of the influence of depth showed a significant difference at 45cm and 60cm depth and between the two there was no significant effect. The level of depth from the results of the study was the best with a depth of 45cm (A2) while for good weights using the number of weights 35gr (B4).

Pujihastuti (2011) states that Seaweed can grow well and achieve high production if cultivated at the location of planting depth that is suitable with quality seeds because it is influenced by several parameters such as temperature, salinity, pH, DO, light intensity and nutrients. Nutrients are needed as an energy source that is used to compile various components of the cell during the process of growth and development in the process of photosynthesis because the process of photosynthesis is not only nutrients but also aided by sunlight (Glen and Doty 1990). Abdan et al., (2013) added that competition between thallus in terms of solar needs, nutrients and space greatly affected the growth of seaweed. This function accelerates growth and forms plant tissues (Romimohtarto and Juwana, 2001). Environmental parameters are also one of the factors that can affect the growth of seaweed, one of which is the value of the current velocity obtained must meet the standard value, where the current velocity is quite high during the maintenance period which ranges from 1.45 to 1.49 m / sec. It is this current velocity that supplies nutrients permanently, avoids materials suspended in water and epiphytes and small salinity and temperature fluctuations (Bulboa and Paula 2005). The current velocity can also cause the thallus to break, whereas if the current is weak, the bacteria become very motile and quickly attack the surface (Harrison and Hurd 2001).

IV. CONCLUSIONS

1. The depth factor tends to be higher in depth of 60 cm and 30 cm and tends to be lower at a depth of 45 cm
2. Sargassum weighting factors tend to be higher in the 0 gr weight or control treatment compared to 15gr, 25gr and 35gr weights.
3. There is no interaction between the two for the growth of seaweed on Kappapycus alvarezii

SUGGESTION

It is hoped that from the results of this study there will be further research with research other than extreme seasons with even greater initial weight and can be used with sargassum weights of 15 gr or 25 gr to minimize crop failure during an extream season.

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