Effect of different seedling weights on *Kappaphycus alvarezii* growth

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Abstract: Seaweed *K. alvarezii* is one of leading commodities in aquaculture because this seaweed species produces carrageenan which has high economic value. This study aimed to determine effect of different seedling weights on the growth of seaweed *K. alvarezii*, and to determine which seedling weight had the best effect on seaweed growth. Planting process was carried out using longline method. Size of longline construction used was 10 m x 20 m, with a length of 20 m and a distance of 1 m between each ropes. Each rope line contained about 66 clumps of seedlings with a distance between clumps of 15 cm. Thallus weight used was 30 gr, 50 gr, 70 gr for each treatment. The highest mean value of absolute weight growth of seaweed *K. alvarezii* was found in treatment C (thallus weight 70 gr) with an average value of 99.27 gr, followed by treatment A (thallus weight 30 gr) of 51.95 gr and the lowest value found in treatment B (thallus weight 50 gr) of 51.65 gr.

1. Introduction

Seaweed is one of coastal resources that has a fairly high economic value and is an export commodity in Indonesian aquaculture sector because of its high demand in the world market. Therefore, its production capability must continue to be improved to meet market needs which are increasing every year [1]. Seaweed *Kappaphycus alvarezii* is commonly cultivated in Indonesia and is known for its good quality and has high market demand as material for carrageenan industry [2]. This is what makes this seaweed one of leading commodities in world trade and Indonesia is one of the countries that supply this species raw materials [3].

Seaweed *K. alvarezii* is one of the leading commodities in aquaculture because this type of seaweed produces carrageenan which has high economic value. Carrageenan is very important products to be used as a stabilizer, thickener, gelling, emulsifier, and other functions. This product is widely used in the food, medicine, cosmetic, textile, paint, toothpaste, and other industries [4].

One of parameters for the success of seaweed cultivation is growth, so growth is one of the biological aspects that must be considered. The growth of *K. alvarezii* was influenced by internal and external factors. Internal factors that influence the growth of *K. alvarezii* include type, strain, thallus section, and age. While external factors include condition of the physical environment, water chemistry, and culture management [1].

Seaweed seedling weight is a factor supporting growth and carrageenan content of *K. alvarezii*. Good growth rate and carrageenan content will be obtained when using proper weight of seaweed seedlings. Appropriate seedling weight requirement range from 50-100 grams [5]. Currently, the seaweed seedlings supply is lowering due to declining quality of seaweed growth [6]. This encourages
us to study the provision of superior seedlings that can supply the needs of seedlings for seaweed cultivators or seaweed farmers. One of culture method to supply good quality seedlings is longline method. Thus, it is necessary to conduct a research on cultivation of seaweed *K. alvarezii* to determine its optimal growth rate. This study aimed to determine effects of different thallus weights on growth of seaweed *K. alvarezii*, and to determine which thallus weight has the best effect on the growth of seaweed *K. alvarezii*.

2. Material and methods

2.1. Location and time
This research was conducted at Kastela Village, Ternate Island District, Ternate City. The research was carried out for 45 days.

2.2. Seedlings and planting process
Seaweed *K. alvarezii* seedlings used in this study came from seaweed cultivated plants obtained from seaweed farmers in Bobanehena village, Jailolo District, West Halmahera Regency.

The planting process is carried out using longline method. Size of longline construction used was 10 m x 20 m, with a length of 20 m and a distance of 1 m between each rope-lines. Each rope line contained about 66 clumps of seedlings with a distance between clumps of 15 cm. The thallus weight used was 30 gr, 50 gr, 70 gr for each treatment.

2.3. Implementation procedure and observation
This experimental study consisted of three treatments and two replications. The treatment tested was different thallus weights. Those three treatments were: treatment A with thallus weight 30 gr; treatment B with thallus weight 50 gr, and treatment C with thallus weight 70 gr. Procedure for observing and measuring growth rate of *K. alvarezii* was carried out by weighing weight gain of seaweed directly at each planting point using an analytical balance. Meanwhile, observations of water quality parameters (depth, brightness, current velocity, temperature, pH, salinity, and dissolved oxygen) were carried out every week.

2.4. Data analysis
The data analysis used in this study was a completely randomized design. To find out difference effects among treatments, an analysis of variance (ANOVA) was performed. If the treatment gave a different effect, further test with the Least Significant Difference (LSD) test was carried out.

Absolute weight growth of cultivated seaweed *K. alvarezii* was calculated using formula according to [7], as follows:

\[ W = W_t - W_0 \]

Where, \( W \): absolute weight growth (gr); \( W_t \): seedling weight at the end of the study (gr); and \( W_0 \): seedling weight at the beginning of the study (gr).

3. Result

3.1. Absolute weight growth
Results of observations of absolute weight growth of seaweed *K. alvarezii* are presented in Figure 1.

Figure 1 shows that the highest average value of absolute weight growth of seaweed *K. alvarezii* that was found in treatment C (thallus weight 70 gr) with an average value of 99.27 gr, followed by treatment A (thallus weight 30 gr) of 51.95 grams, and the lowest one was found in treatment B (thallus weight 50 gr) of 51.65 gr. Results of analysis of absolute weight growth variance are shown in Table 1.
Results of analysis of variance showed that F count > F table (5%), so difference was very significant. To determine difference effects among treatments the BNT test was used, and the result is presented in Table 2.

The result of LSD test (Table 2) also shows that treatment C - A and treatment C - B had a very significant different effects. Treatment A and B did not have significant different.

3.2. Water quality parameters
Result of water quality parameters measurement during the study is presented in Table 3.
4. Discussion

4.1. Absolute weight growth

Study results showed that treatment C with thallus seedling weight of 70 gr gave the best results compared to other treatments. Differences in absolute weight growth observed among treatment were due to differences in weight of initial thallus seedlings used. The higher weight of thallus seedlings, the better seaweed growth. The absolute growth of seaweed with a larger initial weight would give better results compared to a small initial seedling weight. These could be explained for seaweed developed vegetatively and its weight gain was influenced by shoot growth. Thus, the greater weight of seedlings made it easier for shoots to develop more quickly [3].

According to [8], seaweed that adapts more quickly to environmental condition will be able to grow quickly so that it may growth optimally. In other words, waters with optimal conditions can increase the growth of seaweed [9]. Furthermore, it has been reported that initial seedling weight in range of 50-100 gr could stimulate growth of seaweed.

4.2. Water quality

4.2.1. Depth

Result of observation of water quality parameters (Table 3), showed that water depth at cultivation location of K. alvarezii was 90 cm at high tide and 40 cm at low tide. The depth of a waters is closely related to productivity, vertical temperature, light penetration, density, oxygen content, and nutrients. Depth is a determining factor for seaweed cultivation locations because depth is related to the penetration of sunlight which has an important effect on growth. The value of the depth of water used for seaweed K. alvarezii cultivation was still feasible to support growth of seaweed K. alvarezii. Water depth ranged from 30 cm at low tide and 100 cm at high tide still supported the growth of seaweed K. alvarezii cultivation [5].

4.2.2. Brightness

In natural waters, water clarity is very important because it is closely related to photosynthetic activity, and is one factor that determine light penetration in sea water. Factors that can affect water clarity are mud content, plankton density, and other dissolved materials. Good water brightness for normal and ideal seaweed growth is up to 5 meters or at a depth sunlight can still penetrate the surface layer to a depth of 10 meters. The results of measurement of water brightness during the study showed a range of 40-65 cm. Brightness less than 1 meters or greater than 1.5 m was still feasible to support the growth of cultivated seaweed K. alvarezii [5].

4.2.3. Current velocity

Current velocity is a very vital factor among other factors because it causes the water mass to become homogeneous, and the transport of nutrients takes place better and smoother. Sufficient water movement will avoid the accumulation of dirt on seaweed thallus, help ventilation, and prevent large fluctuations in salinity and water temperature [12]. Current velocity obtained in this study ranged from 20 to 40 cm$^{-1}$. The current velocity range obtained was still suitable for cultivation of K. alvarezii. Current velocity in the range of 20-40 cm$^{-1}$ is still suitable for seaweed cultivation [10].

4.2.4. Temperature

Water temperature has a vital role in water quality and the health of aquatic organisms. Physical, chemical, and biological characteristics of sea water are affected by changes in temperature [10]. Temperatures also affects solubility of oxygen, photosynthesis process, metabolism, and sensitivity of organisms to toxic substances (toxins) [11].

The water temperature for seaweed cultivation may range from 20 to 32°C [12]. The increase in high temperature will cause the seaweed thallus to turn pale yellow and unhealthy. Lower water temperature to 20°C will cause seaweed growth to slow [10]. The water temperature obtained during
the study ranged from 28.42 to 29.86ºC. This result were still suitable for growth of cultivated seaweed *K. alvarezii*.

4.2.5. pH

pH value shows the degree of acidity or alkalinity of sea water because pH has a great influence on aquatic plants and animals. Water pH condition is often used as an indicator of good or bad living environment [13]. Every living organism has a certain tolerance to pH. Seaweed grows at pH of 7-9 with optimal pH for seaweed growth *K. alvarezii* is 7.3-8.2 [5]. The pH value obtained in this study ranged from 7.5 to 8.3, so that this pH value was still feasible to support the growth of seaweed *K. alvarezii*.

4.2.6. Dissolved oxygen

Dissolved oxygen is a major component for the metabolism of aquatic organisms used for growth, reproduction, and algal fertility. Oxygen produced from seaweed, is a continuation of the life of aquatic biota because it is needed by aquatic animals and plants, including bacteria for respiration. Seaweed grows well in waters that have dissolved oxygen content of 3-8 ppm [5], and > 4 ppm [3]. The results of the dissolved oxygen measurement obtained in this study ranged from 3.3 to 5.3 ppm, so it was still feasible to support the cultivation of seaweed *K. alvarezii*.

4.2.7. Salinity

Salinity can affect physiological processes in marine algae through changes in the movement of water molecules and ions in cell membranes. In seaweed cultivation, salinity plays an important role in the growth process [13]. Furthermore, it is said that seaweed grows at high salinity. The decrease in salinity due to incoming fresh water will cause the growth of seaweed to become abnormal. Therefore, in the cultivation of seaweed should be far from the mouth of the river.

Salinity 28-32‰ is very suitable for seaweed growth. For optimal growth of *K. alvarezii*, the required salinity ranges from 28-34‰ with an optimum value of 33‰ [5]. The salinity obtained in this study ranged from 31.6 to 32.9‰. The salinity value obtained is still feasible to support the growth of cultivated seaweed *K. alvarezii*.

5. Conclusion

Based on the study results, it can be concluded as follows: use of different thallus weights gave different effects on absolute weight growth of seaweed *K. alvarezii*. Use of thallus seedling with weight of 70 grams gave the best results for absolute weight growth of seaweed *K. alvarezii*.

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