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Gracilario verrucose (Gracilariales, Rhodophyta) Growth with Heavy Bits and Different Plants Cultivated by Vertical Hanger Treatment Method in Empirical Water

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A B S T R A C T

Gracilaria is one type of seaweed producing agar (agarofit) that many found in Indonesian waters. In order to contain gelatin-based hydrocolide compounds commonly used as thickening agents in the food industry. Differences in early biomass and spacing significantly affect the growth of seaweed. This is very related to the competition of each individual seaweed in getting nutrients as food. The success of the planting system is influenced by the use of good seeds and the appropriate weight will increase the growth. This study aims to determine the effect of seed weight and spacing on the growth of seaweed *Gracilaria verrucosa* by using the method of vertical rope. The experimental design used was Factorial Design, where factor A (weight of seed 50 g, 100 g, and 150 g) and factor B (spacing of 20 cm, 30 cm and 40 cm). The observed variable is the specific growth rate. The result of variety analysis showed that the difference of seed weight and spacing significantly influenced (P <0.01) on *G. verrucosa* growth. Based on the results of research, the highest specific growth was found on seed weight factor of 50 g, ie 5.4% / day and 30 cm plant spacing factor of 4.2% / day.

Introduction

Seaweed cultivation plays an important role in the effort to increase Indonesia's fishery production capacity because seaweed is included in the fisheries revitalization program which is expected to play an important role in improving the welfare of the community (Handayani, 2006). The increase in its use is not only limited to food production but has expanded as in the use of seaweed as a product of beauty products, medicines, and raw materials for other industrial activities. White and Wilson (2015) stated that seaweed cultivation in ponds can economically increase income and provide added value for coastal communities, because people can utilize productive land for family welfare through seaweed cultivation. Seaweed cultivation has several advantages because it

uses simple technology, can produce high value production goods with low production cost, thus becoming a commodity for coastal community empowerment. Availability of seaweed in the natural amount is increasingly limited, so it takes cultivation techniques to increase the amount of seaweed production so that demand can be met in a sustainable manner.

Seaweed has been used as a vegetable, the ingredient for drug or pharmaceutical use, phycocolloid sources, feed ingredients and fertilizers (Armisen, 1995; Araño *et al.*, 2000; McHugh, 2003; Khordi and Ghufran, 2010). The content of amino acids, vitamins, and minerals Seaweed reaches 10-20 times compared to land plants. In addition, some types of seaweed contain important minerals that are useful for body metabolism such as iodine, calcium, and selenium (Burtin, 2006). Choudhury *et al.,* (2005), states that marine algae have potential as antibacterials, one of which is reportedly a methanol extract of 56 seaweeds derived from *Chlorophyta* (algae green), *Phaeophyta* (brown algae) and *Rhodophyta* (red algae).

The main obstacle in achieving the amount of production, allegedly one factor of the determination of initial seed weight. Therefore we need a study related to the good seedling weight in the growth of seaweed *Gracilaria verrucosa*. According to Wang *et al.,* (2018), a balance between nutrients and plant density is required for plants to grow without nutrient deficiency, planting seaweed with a low density stocking balance in nutrient absorption / kg body / hr is better than high stocking density. Seaweed research that tested is *Gracilaria verrucosa* with different seed weight and spacing, because the high density of the stocking, causing the space to become narrow, consequently difficult to grow. The purpose of this research is to know the specific growth of *Gracilaria verrucosa* seaweed which is cultivated with different seed weight and spacing in pond waters by using vertical strap method.

Materials and Methods

Location and research design

This research was conducted at Lakawali Beach Village, Kec. Malili, South Sulawesi Province. Laboratory analysis was conducted at Fisheries Laboratory, Hasanudin University, Makassar. Research begins with the preparation of the location of ponds that meet the criteria of determining success in the cultivation of seaweed G. verrucosa. Culture media in the form of rectangular plot made of bamboo and wood. The cultivation method uses a cultivation plot in which 1 plot contains 4 wooden stakes and 2 transverse woods as the main rope lever or rope by attaching a buoy to each end of the rope and stretch as a float buoy and weights.

Cultivation method

This research uses a vertical strap method. During the cultivation, activities carried out seaweed control/maintenance every 2 days by cleaning the moss and dirt inherent as well as disruption of pests. The growth rate was determined using the following formula (Mtolera *et al.,* 1995; Gerung and Ohno 1997; Aguirre-von-Wobeser *et al.,* 2001; Bulboa *et al.,* 2007; Hayashi *et al.,* 2007a, b, 2011; Hung *et al.,* 2009; Yong *et al.,* 2013): DGR = $[(W_t/ W_0)^{t/1} -1] \times 100\%$; DGR is daily growth rate (% day^{-1}), W_t is weight at t week, W_0 is weight at previous week dan t is long maintenance. Water temperature, salinity, pH, light intensity, nitrate, phosphate, ware daily monitored using thermometer, hand refractometer, spectrophotometer, and titration, respectively. Growth rate was analyzed applying Analysis of Variance (ANOVA) continued with Least Significant Difference (LSD).

Results and Discussion

Specific growth of seaweed

The results of the Variant Analysis (ANOVA) of the specific growth rate showed a growth difference between all treatments, *G.verrucosa* growth obtained during the study of Figure 1. The highest average *G. verrucosa* specific growth in factor A with weight of 50 g (5.4% / day) then weight of seeds 100 cm (3.7% / day) and the lowest weight of 150 cm (3.0% / day) seedlings. While on factor B with the highest planting distance that is planting distance 30 cm (4,2% / day) then spacing 20 cm (4.0% / day) and lowest at plant spacing 40 cm (3,8% / day) (Fig. 2). The interaction between the two factors did not have a significant effect on the specific growth of *G. verrucosa* (Figure 3). Variety analysis showed that the treatment of factor A and factor B had a very significant effect on the growth of *G. verrucosa* seaweed. Further test results of the Smallest Real Differences show very significant differences between treatments.

Based on the result of variance analysis, it can be seen that specific growth of factor A treatment with initial weight 50 g has better growth than treatment (100 g), and (150 g). Allegedly low weight of seaweed at the beginning of planting causes the absorption of nutrients in the process of metabolism of seaweed can work with the maximum. In accordance with the statement of Pongaraang *et al.,* (2013) that nutrient fulfillment greatly affects the growth of seaweed.

Figure.1 Specific growth rates of seaweed *G. verrucosa* on different seed weight with vertical strap method

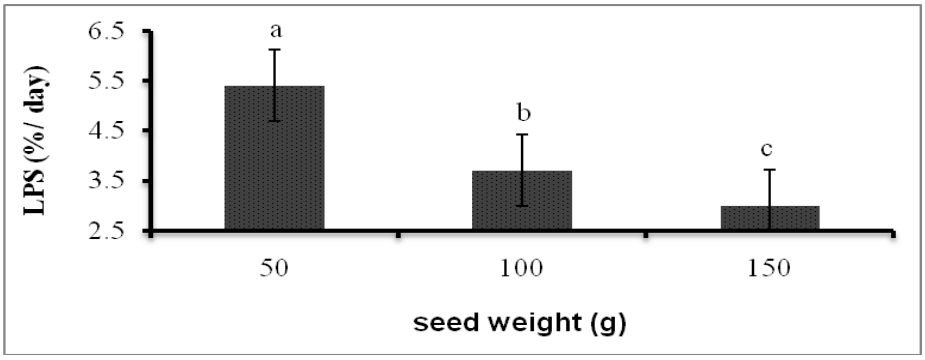


Figure.2 Specific growth rates of seaweed *G. verrucosa* on different seed weight with vertical strap method

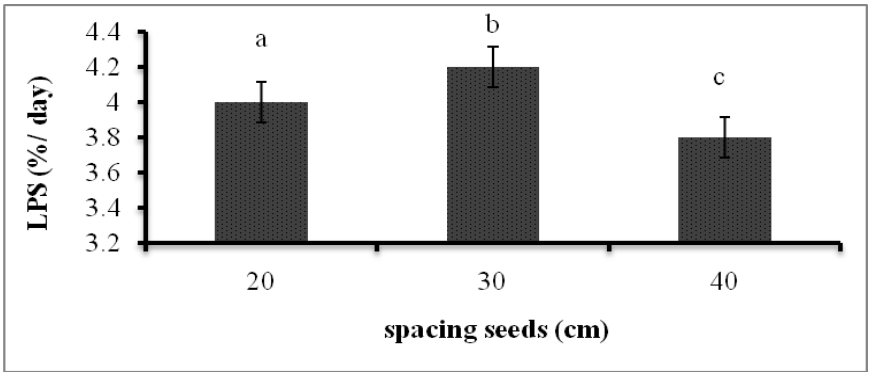
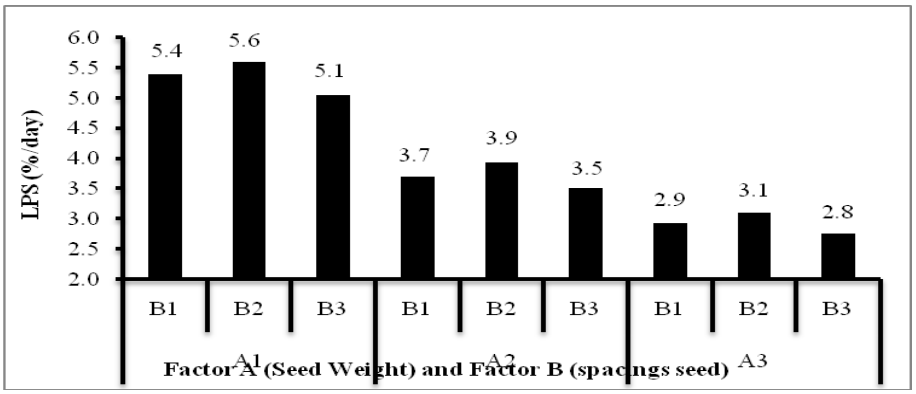


Figure.3 The interaction of specific growth rates of seaweed *G. verrucosa* Factor A (Weight Seed) and Factor B (Spacing Seed) vertical hanging rope method



The highest growth that occurred in this phase is suspected because *Gracilaria verrucosa* quickly adapt to the waters, nutrients are still quite a lot so it can support the growth rate of seaweed cultivated. The low rate of growth occurring in this phase is thought to be due to competition between the test plants in limited space utilization, so that branching and growth of new shoots marked by the number of branches become obstructed.

The high LPS in the treatment of seed distance 30 cm compared with the treatment of seedlings of 20 cm and 40 cm, it is suspected the distance between the seeds one with other seeds are close together so the competition to get very small nutrients that result directly to low growth, as well as treatment distance 40 cm seeds allegedly planted seeds do not get the optimal intensity of sunlight that resulted in low growth. Seaweeds can grow optimally if they have sufficient nutrient supply and continuously get good sun intensity to help the photosynthesis process. According to Qin (2018), the amount and quality of light is very influential in the process of photosynthesis because it can spur cell division activity resulting in the process of widening and extension where eventually the seaweed tends to grow well.

In addition, seaweed can utilize sunlight more optimally as an energy source for photosynthesis and can help seaweed to obtain nutrients or nutrients because increased photosynthesis process can increase the ability of seaweed to obtain nutrients or nutrients (Fernández-Segovia *et al.*, 2018). If the optimal spacing of seedlings will provide opportunities and more space for seaweed to absorb nutrients in the water as a source of nutrients. In addition, with optimal distance will help facilitate the process of photosynthesis because each branch has the same opportunity to obtain sunlight. This is in accordance with Romimohtarto (1987) statement, that the spacing of seedlings on rope generally ranges from 20 to 35 cm. If the spacing is too short, there will be a lot of seaweed bonds, so the opportunity of each seaweed branch to obtain nutrients as a food source is needed a bit and this will slow the growth (Widiastuti, 2011). This is in accordance with the statement Supratno (2007), a seaweed cultivation is said to be good if the average daily growth rate of at least 3%.

In conclusions, different seedlings and spacing have an effect on the specific growth of *Gracilaria verrucosa* maintained by vertical strap method. The seed weight 50 g and the spacing of 30 cm gives the best

specific *Gracilaria verrucosa* growth maintained by the vertical strap method

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