Growth of Seaweed Gracilaria Verrucosa Fertilized with Vermicompost

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Abstract

Optimum seaweed growth by using inorganic fertilizers is not a wise move considering the recent increase in consumers who want products that are free of pesticide residues and artificial fertilizers. The purpose of this study was to analyze the optimal dose of vermicompost fertilizer to produce daily specific growth rates and best G. verrucosa seaweed biomass production. From the results of the study it was found that the higher dose given would result in the highest daily specific growth rate (SGR) and the highest biomass production compared to the treatment without the application of vermicompost fertilizer (control). From the statistical analysis of normality test, homogeneity of SGR and Biomass Production showed the distribution of normal and homogeneous data, then for ANOVA test showed that the treatment of vermicompost fertilizer gave significant effect ($p<0.05$) to SGR and Biomass Production. The highest SGR was obtained at treatment A (dose 300 g /m^3) of 2.75%/day and the lowest in treatment F (control) of 1.63%/day. The highest biomass production was obtained at treatment A (dose 300 g/m^3) of 109.17 g and the lowest in treatment F (control) was 49.7 g.
Keywords: Gracilaria verrucosa, vermicompost fertilizer, Daily Specific Growth Rate (SGR), Biomass Production

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I. INTRODUCTION

Utilization of organic fertilizer is needed to fulfill the nutritional needs of seaweed [1]. *G. verrucosa* seaweed as chlorophyll plants require nutrients as raw materials for photosynthesis that support the growth of seaweed [2]. Organic fertilizer in the form of vermicompost contains various nutrients needed for seaweed to grow and play an important role in stimulating the vegetative growth of seaweed. During the vermicompost process, essential plant nutrients such as nitrogen and phosphorus required by plants, which are present in the diet are transformed through the activity of microorganisms into a form that is more readily absorbed by plants [3]. But there is no research data that provides the utilization of vermicompost on the growth of seaweed, especially Gracilaria verrucosa. Furthermore, needed to find out the optimal dose of vermicompost fertilizer to produce the Daily Specific Growth Rate and the best biomass Production of *G. verrucosa* .

II. MATERIAL AND METHODS

A. Research Sites

This research was conducted in open space in the pond area of Maliwowo Village, Angkona District, East Luwu Regency, South Sulawesi Province, March to April 2012 for 42 days.

B. Design and Variable Research

The experimental design used in this study was a Complete Randomized Design (CRD) with 6 treatments and 3 repetitions. The treatment performed was a dose of vermicompost fertilizer different; treatment A dose of vermicompost fertilizer 300 g/m^3, treatment B dose of vermicompost fertilizer 250 g/m^3, treatment C dose of vermicompost fertilizer 200 g/m^3, treatment D dose of vermicompost fertilizer 150 g/m^3, treatment E dose of vermicompost fertilizer 100 g/m^3 and F control treatment (without fertilizer application).

C. Method of Collecting Data

Seaweed biomass production, observed from the beginning to the end of the study, to calculate absolute growth used the formula $H = Wt - Wo$, H: production of biomass (g), Wt: final weight (g), Wo: initial weight (g). The daily specific growth rate of seaweed is calculated using the formula [4]. SGR = {ln Wt – ln Wo/t} x 100%, SGR: daily specific growth rate (%), t: number of observation days (days). Water quality data collection for temperature, salinity and water pH is done every 7 days in the morning (09.00 AM) and afternoon (15.00 PM). Measurement of nutrient content of water and soil in the form of nitrate, ammonium and phosphate was done at the beginning and end of the study. Temperature was measured by thermometer, salinity using hand-refractometer and water pH using pH Fix 0-14, then for soil pH was done laboratory test extracted by using H_2O ratio 1: 2,5 done at beginning and end of research, at each treatment. Nitric acid content analysis (NO_3) was analyzed with phenolic sulfuric acid [5], while phosphate (PO_4) was analyzed by degestei sulfuric acid and ammonium (NH_4) was measured using a neslerization spectrophotometer [6]. Analysis of soil nutrient content in the form of nitrate (NO_3) was analyzed with phasol sulfate acid by AAS method, phosphate soil content (PO_4) was analyzed by HAS solution of AAS method, determination of ammonium content (NH_4) was analyzed by using standard solution of H_2SO_4 and distillation Semi-micro Kjehldal [7].

D. *Data Analysis*

Each parameter was the production of biomass, and the daily specific growth rate is evaluated using two statistical analyzes. First, test the normality of Kolomogorov-Smirnov (K-S), then test homogeneity using Levene test. Second, the test of Analysis of Variance (ANOVA) if the data is normally distributed and homogeneous, if the real effect is done further testing by using benferoni test. Data that is not normally distributed and homogeneous is transformed ($x = \sqrt{y}$). While the nutrient content of NO_3, NH_4 and PO_4 in water and soil, along with water and soil quality parameters were analyzed descriptively based on the life eligibility for Gracilaria verrucosa seaweed.

III. RESULTS AND DISCUSSION

A. *Daily Specific Growth Rate (SGR)*

Table - 1
Daily specific growth rate (SGR) seaweed *Gracilaria verrucosa* fertilized with different doses of vermicompost

Dose of Vermicompost Fertilizer (g/m^3)	*Specific Growth Rate (%/day)*
(A) 300	*2,75±0,09[a]*
(B) 250	*2,53±0,07[a]*
(C) 200	*2,35±0,18[a]*
(D) 150	*2,27±0,25[a]*
(E) 100	*2,21±0,14[a]*
(F) Control	*1,63±0,29[b]*

Description: different letters in the same column show significant differences between treatments at 5% level.

The result of calculation of seaweed analysis of variance (ANOVA) showed that vermicompost fertilizer gave significant effect ($p<0,05$) to daily specific growth rate (SGR). The results were followed by benferoni test, which showed that the application of vermicompost fertilizer to give the best daily specific growth rate (SGR) of *G. verrucosa* was treatment A (fertilizer dose 300 g/m^3) of 2.75 ± 0.09%, B (fertilizer dosage 250 g/m^3) of 2.53 ± 0.07%, C (fertilizer dosage 200 g/m^3) of 2.35 ± 0.18%, D (fertilizer dosage 150 g/m^3) of 2.27 ± 0, 25%, and E (fertilizer dosage 100 g/m^3) of 2.21 ± 0.14% significantly different ($p<0.05$) with F (control) treatment of 1.63 ± 0.29%. The higher the dose given then the more effective seaweed in absorbing nutrient fertilizer elements. This is in accordance with the opinion of [8] states that the higher the dose of compost fertilizer given to seaweed thallus growth will be faster, this is because compost fertilizer contains many micro and macro elements required in the preparation of proteins, nucleic and other organic compounds so as to increase the growth rate of seaweed.

B. *Biomass production*

Table - 2
Biomass production Seaweed Gracilaria verrucosa fertilized with different doses of vermicompost

Dose of Vermicompost Fertilizer (g/m^3)	*Biomass Productin (g)*
(A) 300	*109,17±5,86[a]*
(B) 250	*95,03±4,52[ab]*
(C) 200	*84,23±9,86[ab]*
(D) 150	*80,30±13,46[b]*
(E) 100	*76,83±7,48[bc]*
(F) Control	*49,7±12,48[c]*

Description: different letters in the same column show significant differences between treatments at 5% level.

The result of calculation analysis of variance (ANOVA) of seaweed showed that vermicompost fertilizer gave significant effect ($p<0,05$) to *Gracilaria verrucosa* seaweed biomass production. The best biomass production was treatment A (fertilizer dosage 300 g/m^3) of 109.17 ± 5.86 g, giving a significant difference ($p<0.05$) to the treatment D (fertilizer dosage 150 g/m^3) of 80, 30 ± 13.46 g, E (fertilizer dosage 100 g/m^3) of 76.83 ± 7.48 g and treatment F (control) of 49.7 ± 12.48 g. Then treatment B (fertilizer dosage 250 g/m^3) of 95.03 ± 4.52 g, C (fertilizer dosage 200 g/m^3) and D (fertilizer dosage 150 g/m^3) of 80.30 ± 13.46 g, gave a significant difference ($p < 0.05$) to F (control) treatment. The low production of seaweed biomass in F (control/no fertilizer) treatment was due to the lack of micro and macro nutrients needed by seaweed in maintenance containers to produce high biomass production. With the existence of fertilizer solution containing many nutrients will help the nutrient deficiency provided by the waters as a natural growing environment that will be used by seaweed to produce maximum production. With the availability of nutrients will greatly help the growth and development of seaweed. Vermicompost fertilizer contains many micro and macro nutrients, a number of organic acids, and plant growth hormones. [9] stated that a sufficient nutrient content can then be used as a chlorophyll-forming element in the photosynthesis process. Photosynthesis activities will then produce a number of basic materials such as glucose and other materials for tissue formation, and increased growth.

C. *Nutrient Water*

Table - 3
Nutrient water during the study

Dose of Vermicompost Fertilizer (g/m³)	*Nutrient Water (ppm)*		
	PO_4	*NH_4*	*NO_3*
(A) 300	*0,26 - 0,59*	*0,163 - 1,276*	*0,023 - 0,575*
(B) 250	*0,27- 0,47*	*0,14 - 0,902*	*0,027 - 0,583*
(C) 200	*0,31 - 0,671*	*0,338 - 1,176*	*0,037 - 0,593*
(D) 150	*0,27 - 0,504*	*0,157 - 0,606*	*0,02 - 0,085*
(E) 100	*0,26 - 0,504*	*0,178 - 0,391*	*0,026 - 0,046*
(F) Control	*0,25 - 0,457*	*0,225 - 0,727*	*0,021 - 0,065*

The value of the phosphate range (PO_4) of water obtained during the study was 0.250 - 0.671 ppm. From the concentration of phosphate obtained, belong to a high fertility rate. According to [10] states that the low fertility levels of phosphate levels ranges from 0 to 0.02 ppm, moderate fertility rates ranging from 0.021 to 0.05 ppm and high fertility above 0.05 ppm. According to [11] good phosphate values for seaweed growth ranged from 0.09 to 1.80 ppm. Phosphorus is one of the nutrients needed by seaweed to enhance growth and quality, phosphorus is used in the form of phosphate (PO_4) which plays an active role in protein formation in the process of photosynthesis. From the results obtained that there is a decrease in PO_4 concentration conducted at the beginning and end of the study, the decrease of nutrient concentration due to seaweed has the ability to absorb nutrients one of which is the phosphate element which is a source of nutrients for the growth of seaweed that is easy to decompose and absorbed by plants, Which serves to spur growth and accelerate the formation of seaweed spores [12].

In addition to phosphorus elements, seaweed also requires nitrogen, nitrogen is absorbed by seaweed in the form of nitrites, nitrates and ammonium. N serves to assist the process of forming chlorophyll, photosynthesis, protein, fat and other organic compounds [13]. The range of ammonium (NH_4) water content was 0.140 - 1.276 ppm, and nitrate (NO_3) water was 0.02 - 0.593 ppm. The value is feasible for seaweed cultivation. According to [14] the concentration of nitrate and ammonium is good for seaweed ranged from 0.01-3.50 ppm.

D. *Soil Nutrients*

Table - 4
Soil nutrients during the study

Dose of Vermicompost Fertilizer (g/m³)	*Soil Nutrients (ppm)*		
	PO_4	*NH_4*	*NO_3*
(A) 300	*10,98-12,65*	*0,85-8,65*	*4,52-10,65*
(B) 250	*14,25-18,65*	*1,67-6,85*	*6,85-12,54*
(C) 200	*15,75-19,65*	*1,89-9,32*	*9,32-13,25*
(D) 150	*16,32-20,85*	*2,12-7,63*	*9,00-14,25*
(E) 100	*17,65-18,32*	*1,97-8,24*	*7,85-14,63*
(F) Control	*11,98-19,66*	*0,56-7,56*	*6,36-9,85*

While the range of phosphate (PO_4) of soil obtained during the study ranged from 10.98 to 20.85 ppm. Based on the value of soil fertility in this case is the phosphate content of soil classified as not in accordance with soil fertility factor limits. However, the phosphate content in the soil can be increased by the application of basic fertilizer, ie the application of fertilizer when the water is not yet filled in the cultivation container, so it will be marginal or suitable enough and even very appropriate [15].

The soil NH_4 content in this study ranged from 0.56-9.32 ppm whereas for NO_3 the soil ranged from 4.52 to 14.63 ppm For NH_4 there was an increase in soil content carried out at the beginning and end of the stud The soil NH_4 content in this study ranged from 0.56-9.32 ppm whereas for NO_3 the soil ranged from 4.52 to 14.63 ppm. For NH_4 there was an increase in soil content carried out at the beginning and end of the study, NH_4 elements were ions of NH_3 or Ammonia that is toxic, this is related to the low soil pH obtained in this study have an effect on the increase of NH_4 on soil. While NO_3 there was a decrease in the content of soil at the beginning and end of the study. The decrease of NO_3 content at the end of the research is caused by acid pH at soil so that macro nutrient content is one of the decreasing Mg (Magnesium) element in soil which has function to stabilize soil pH into base, if Mg and acidic pH then SO_4 in H_2S form will increase in waters, So that nutrients such as N, P and other macro nutrients will be bound and micro nutrients will increase [16].

E. Water and soil quality

Table - 5
Water and soil quality during the study

Vermicompost Fertilizer (g/m^3)	*Parameters of water and soil quality*			
	Temperature (°C)	*Salinity (ppt)*	*Water pH*	*Soil pH*
A (300)	*28-30*	*14-16*	*7*	*4,93 - 5,77*
B (250)	*28-30*	*14-16*	*7*	*4,90 - 5,69*
C (200)	*28-30*	*14-16*	*7*	*4,88 - 5,68*
D (150)	*28-30*	*14-16*	*7*	*4,80 - 5,42*
E (100)	*28-30*	*14-16*	*7*	*4,49 - 5,45*
F (Control)	*28-30*	*14-16*	*7*	*4,86 - 5,68*

Temperature is an important physical factor, for the growth of seaweed. Temperature directly affects seaweed in the process of photosynthesis, metabolic processes, and the reproductive cycle [17]. Water temperature in the cultivation container ranges from 28-30°C which is still in a reasonable range for the growth of seaweed.

Salinity is an important factor for seaweed growth. Low salinity range can cause seaweed growth to be abnormal. Water salinity during the study ranged from 14 to 16 ppt. The results suggest that seaweed can still grow at a low salinity range, proving that Gracilaria verrucosa is a type of seaweed that can live on a wide salinity. According to [18], salinity range for seaweed cultivation ranges from 15-30 ppt and optimal for seaweed growth ranges from 20-25 ppt.

Pondus Hydrogeni (pH) is a measure of the concentration of hydrogen ions and shows the acid or base properties of a waters [19]. Pondus Hydrogeni (pH) water during the study was 7. [20] stated that the optimum pH for seaweed cultivation ranged from 6.8 to 8.2. PH of water in this research is 7 hence container of the research place pertained pertinent waters high productivity [21]. While on soil, the pH range obtained during the study was 4.49-5.77, low pH on the soil showed that the soil was acidic. According to [22] states that the nitrification process can still occur at soil pH 3.8. With optimal growth obtained with a soil pH range of 5-8.5.

IV. CONCLUSION

Fertilizer vermicompost is an environmentally friendly fertilizer which is 100% organic fertilizer that does not contain any chemicals, made from worm waste and fermented organic waste, this fertilizer has been proven to increase the growth of seaweed Gracilaria verrucosa. The result showed that the higher dose of vermicompost fertilizer given would result in the highest daily growth rate (SGR) and Biomass Production compared with the treatment without vermicompost fertilizer (control).

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