Available online at IJMARCC, Website: http://ejournal.undip.ac.id/index.php/ijmarcc
International Journal of Marine and Aquatic Resource Conservation and Co-existence
Research Article, 1 (1): 6-11, October 2014

The Improvement of the Survival, Growth and Production of Vaname Shrimp (*Litopenaeus vannamei*) and Seaweed (*Gracilaria verucosa*) based on Polyculture Cultivation

Titik Susilowati[1),2)], Johanes Hutabarat[2)], Sutrisno Anggoro[2)] and Muhammad Zainuri[2)]

[1)] Postgraduate Programe Doctoral of Coastal Resources Management, Diponegoro University
[2)] Faculty of Fisheries and Marine Science, Diponegoro University,
Jl. Prof. Soedarto SH. UNDIP, Tembalang, Semarang. 50275
Email: titiksusilowatijepara@gmail.com; sutrisno.anggoro@yahoo.co.id;
jhutabarat@undip.ac.id; muhammad.zainuri@yahoo.co.id

Received: February 20, 2014, Accepted: April 24, 2014

ABSTRACT

The presence of aeration on the cultivation of polyculture system can eliminate oxygen depletion at night while the intensity of light would effect the seaweed *Gracilaria verucosa* to perform photosynthesis. The supplies of oxygen is to eliminate the oxygen depletion at night until morning, and propose the efficiency of feeding activity, and also stabilize the water quality. The purpose of this research is to improve the survival, growth and production of vaname shrimp, and *Gracilaria verucosa.* This research was conducted in Jepara Brackishwater Aquaculture Research and Development Center (BBPBAP), from May until August 2013. A number of 75 shrimps and 1,750 g *Gracilaria vericosa* were cultivated in the 800 L tank, which observed for 96 days. There are four type of treatments, oxygen supply O1 (3,500 lux light intensity), O2 (Aeration with 700 mL minute^{-1} speed), O3 (light intensity and aeration), O4 (without light and aeration), three replications. This research was conducted using an experimental Randomized Block Design. The survival rate and growth of shrimp (*Litopenaeus vannamei*) showed a highly significant ($p < 0.01$) different between the treatments, while the growth and biomass production of seaweed (*Gracilaria verucosa*) showed a significantly ($p < 0.05$) different. The three treatments of oxygen and light supply, aeration and the combination of light and aeration, it can be concluded that survival, growth and production of vaname shrimp and *Gracilaria verucosa*. The combination of light and aeration treatment is the best, it can be concluded survival rate of shrimp (94.64%) compare to the treatment without oxygen (45.24%). Absolute growth rate of shrimp increased from 9.57 g to 12.97 g. The specific growth rate of shrimp increased from 4.73% to 5.07%. The biomass production of shrimp increased from 181.56 g m^{-2} to 883.95 g m^{-2}. The combination of light and aeration can improve the absolute growth rate of *Gracilaria verucosa* from 25.86 g to 52.724 g. The specific growth rate of seaweed increased from 1.77% to 2.64% then biomass production of *Gracilaria verucosa* also to increase from 2,557.76 g to 5,063.2 g.

Key words: *Litopenaeus vannamei*, *Gracilaria verucosa,* oxygen supply

INTRODUCTION

Polyculture is one of aquaculture system, which involved two biota in same media, in order to optimalize the land utilization. This culture system is expected to produce vaname shrimp (*Litopenaeus vannamei*) as the main target, while the seaweed (*Gracilaria verucosa*) is a complement product, to increase the added value and are expected to support government in the pond revitalization program and contribute in increasing production for export (Directorate General of Fisheries, 2005; Anggadireja *et al*., 2006; Anam, 2007; Ambas, 2006).

The problems in the cultivation of vaname shrimp and *Gracilaria verucosa* polyculture with high stocking density is the decrease of oxygen during the night. The dissolved oxygen can be decline to 2.8 ppm in the night. This is due to the process of metabolism and respiration both on vaname shrimp and seaweed (*Gracilaria verucosa*) on night, which cause dissolved oxygen deficiency.

The presence of aeration on the cultivation of polyculture system can eliminate oxygen depletion at night while the intensity of light would affect the seaweed *Gracilaria verucosa* to perform photosynthesis. The presence of light will increase the water temperature which related to the feeding activity (Tandler and Manson, 1982). The supplies of oxygen is to eliminate the oxygen depletion at night until morning, and propose the efficiency of feeding activity, and also stabilize the water quality (Gufran and Tancung, 2007).

The approach is based on the application farming / polyculture vaname shrimp and *Gracilaria verucosa,* which can be done on the high stock density, It need the supply oxygen from the outside, especially in the night, which the seaweed can not provide the oxygen. In the night can be met through applied of oxygen supply.

MATERIAL AND METHOD

This research was conducted at the Aquaculture Center Jepara. The samples used were vaname shrimp (*Litopenaeus vannamei*) and *Glacilaria verucosa* that obtained from Brackishwater Aquaculture Research and Development Center (BBPBAP), Jepara.

This research used a box shaped plastic container with a width and height of 1 m^3 x 1 m^3 x 1 m^3 each, placed on three concrete tank and media as high as 80 cm.

The material used in this study is vaname (*Litopenaeus vannamei*) post larvae aged 30 days (PL-30) weights about 0.1 grams and about 1.2 cm long, *Gracilaria verucosa* seeds, blowers, pipe, aeration, electrics scale, water quality checker, refracto meter, line, pipe and shrimp feed. Cultivation media is sea water with salinity 30 ppm. Shrimp larva and *Gracilaria* stocked with 75 shrimps / 1,750 g / container density and cultivation about 96 day. Before stocked in to medium, larva were weighedwith an electric balance with a precision 0.001 and 100 gr. During the research, shrimp are feeding by commercial feed twice a day in 06:00 am and 18:00 pm. Phosphate and nitrate observations performed at the beginning until end of the study. Shrimp and seaweed sampling are performed 12 days.

Water sources used consisted salinity of 30 ppt of from coastal waters around BBPBAP. To maintain the water quality of the media, the remnants of feed losses upon water replacement every 4 days by 75%. To maintain the solubility of oxygen, the oxygen measurements were taken 6 hours. The study was designed with a randomized block design. The treatment is O1 (3,500 lux light intensity), O2 (Aeration with 700 mL $minute^{-1}$ speed), O3 (light intensity and aeration), O4 (without light and aeration). Each treatment performed three replications.

Data collected includes: survival (%), specific growth rate of shrimp and seaweed, absolute growth of shrimp and seaweed, shrimp production and seaweeds production, growth measurements (*Gracilaria verucosa*) performed every 12 days through the weighing vaname shrimp and *Gracilaria verucosa*. Shrimp survival was calculated by comparing the number of test sample that live at the end of the study and the number of sample alive at the start of the study. Determination of survival used by Karim (2007) :

$$SR = \frac{Nt}{N0} X100\%$$

Where:

SR	=	the survival rate of sample (%)
Nt	=	the number of sample that live at the end of the study
N_0	=	the number of animals that live at the beginning of the research

The measuring of absolute weight rate of samples was measured with formula that was used by Karim (2007), which was

$$G = W_t - W_0$$

Where:

G	=	for absolute weight for prawn (gr)
Wt	=	final weight of prawn (gr)
W_0	=	for initial weight of prawn (gr)

Absolute weight rate of seaweed were measured with formula that was used by Masyahoro and Mappiratu (2010), which was

$$G = \frac{Wt2 - Wt1}{t2 - t1}$$

Where:

Wt_1	=	the weight of seaweed on day t_1 (gr)
Wt_2	=	the weight of seaweed on day t_2 (gr)
t_1	=	the time of observation of first sample (day)
t_2	=	for time of observation of second sample (day)

Daily specific growth rate of prawn were measured with formula that was used by Karim (2007):

$$SGR = \frac{LnW_t - LnW_0}{tX100\%}$$

Where:

SGR	=	for daily specific growth rate (%)
W_0	=	average weight in the beginning of research (gr)
Wt	=	the average weight on t time; and
T	=	the period of research

Prawn biomass production were measured based by multiplying individual average weight and the total of prawns that still lived at the end of research by using method that was used by Karim (2007). Biomass production (P) of *Gracilaria* sp. were measured based by the difference of weight at the end of the research and the initial weight of these seaweed, using formula that was used by Masyahoro and Mappiratu (2010):

$$P = \left(\sum W_t - \sum W_0\right)$$

Where:

Wt	=	the final weight of seaweed (gr)
W_0	=	the initial weight of seaweed (gr)

Physical and Chemical parameters of the media were also measured during the research which consists of: temperature; dissolved oxygen (DO); pH; ammonia; nitrate; nitrite and phosphate. Water temperature; pH and DO were measured with water quality checker, while ammonia; nitrite; nitrate and phosphate were measured with spectrophotometer.

The data that was obtained before being analyzed the variance, were measured with Tukkey additive linear model in order to obtain the variety of additive. Barlett homogeneity variance model was used for obtaining data homogeneity of its variance, and Liliefors test for normality was used to obtain the distribution of data. If F value showed any effect of the treatment, then it was followed by Duncan multiple range test to find the difference average middle weight the research, and followed by polynomial orthogonal test to find the optimal dissolved oxygen.

RESULT AND DISCUSSION

Survival rate, Absolute Growth, Specific Growth Rate and Production of Vaname prawn served in Table 1

Survival rate, absolute growth rate, daily specific growth rate and biomass production of vaname prawn were significantly affected ($p < 0.01$) by oxygen supply. These, based on Table 1 showed that the highest absolute survival rate and daily specific growth rate were resulted from oxygen supply from aerator with lights and aeration combination (dissolved oxygen 5.89 ppm and 6.39 ppm.

The high survival rate, absolute growth rate, and specific growth rate of vaname prawn were heavily influenced by dissolved oxygen in the media. Because vaname prawns were cultured together with *Gracilaria verucosa* with high stock density (75 prawns m^{-2}) in the night require high amount of oxygen for respiration, while the seaweed only provides oxygen in daylight, thus oxygen in the media was supplied with aerator and sunlight adding more dissolved oxygen (DO), hence oxygen reduction at night could be dealt with, and the cultivated vaname prawn respiration could be fulfilled. According to Fujaya (2004), the reduction of oxygen supply in water could affect the physiologist of prawn's respiration, and only prawn with proper respiration system that could only live.

Based on the research the survival rate, growth rate, and production if O4 treatment were the lowest among other treatment, this was caused by the absent of oxygen supply at night, and thus led to reduction of high amount oxygen supply. According to Boyd (1990), oxygen supply can increase the food appetite, and thus energy that was needed for prawns for body metabolism would be lesser and provided more energy for growth, and the low amount of oxygen concentration in water could decrease food appetite for prawns and thus led to poor growth. Oxygen is needed for prawn, particularly for respiration and physiologist process that oxidize carbohydrates and release energy that's used for nutrients and food. That`s why if oxygen supply depleted, prawn's ability to consume the food would be limited that may lead to poor growth rate and poor food conversion. Low concentration of oxygen is one of the main problems that caused prawns become stressed out, reduced appetite, and growth rate, susceptible to disease, and finally leads to death. (Ghufran and Tancung, 2007), in the culturing of vaname prawn and *Gracilaria verucosa,* the presence of seaweed can boost oxygen supply in cultured media in daylights, but to manypresence of seaweed may reduce oxygen supply in water at night.

Survival rate of vaname prawns were heavily affected by physical, chemical parameter of the media, food availability, and osmotic pressure. The rate of survival showed an interaction between environmental capacity and food. Enough food availability and envronmental capacity that included dissolved oxygen and salinity of the media will make energy be efficient and thus can be used for metabolism and also sustaining their lives. The highest rate of prawn`s survival was on media with salinity of 30 ppt, dissolved oxygen of 6.4 ppm and 6.9 ppm, showed that media with this condition can sustain vaname survival rate. In that condition, vaname still had the ability to face the osmotic pressure happily and this can sustain their survival rate.

According to Boyd (1990), dissolved oxygen (DO) is one of the main abiotic factors that can support any aquatic organism to grow. Thus it isvery important to know the optimum dissolved oxygen based on the needs of the organism so that it can sustain its live the high growth rate and biomass production might be caused by the salinity of the media which was at 30 ppt salinity, osmolarity of the media and vaname hemolymph was close to media isoosmotic, and thus vaname ideal osmotic level was on salinity of 30 ppt which was low for vaname osmoregulation, hence the energy provided for growth was high. The growth of vaname basically very dependent on energy that is provided, how the energy is used in its body and theoretically body growth will only commenced if the minimum needs is accomplished. Vaname prawn received its energy by consuming food and the energy is used for various activities, including osmoregulatory activity. Fast growth rate is very dependent on food efficiency and also low osmotic activity. Low activity will also reduce Na^{+} -K^{+} ATP enzymes activity and reduced active transportation of Na^{+} -K^{+} and Cl^{-} and thus the energy that was used (ATP) for osmoregulatory activity will be lesser, providing additional energy for growth (Anggoro, 1992).

Daily specific growth rate is lower in treatment without oxygen supply caused by shrimp levels of osmotic work is higher, so energy use is also high for osmoregulation and decrease energy portion for growth. The highest specific daily weight growth rate in this research is higher than the result of research Sakdiah (2009), in the research, vaname shrimp were maintained with stocking density 5 shrimps / 312.5 g *Gracilaria verucosa* in 100 L of maintenance media, the survival rate only reach 84%.

Growth and survival rate will decide vaname shrimp biomass production, oxygen supply in maintenance media very real influence ($p > 0.01$) vaname shrimp biomass production. The highest vaname shrimp biomass production which produced in media combination with light and oxygen supply and also aeration, and the lowest is in media without oxygen supply. So, biomass production is very determined by ability to control environmental factors especially oxygen. Media with oxygen supply and aeration or combination aeration and light is the best carrying capacity for attainment of the maximum level of vanamei shrimp production.

When viewed from the aspect of environmental physiology, oxygen supply is one of abiotic external factor that take effect is quite important for aquatic biota including vaname shrimp (Sakdiah, 2009; Ghufran and Tanjung, 2007). The role of oxygen as maintenance media of vaname shrimp will give effect in growth, and survival rate, here in after determines the production of biomass.

Relation between oxygen supply and survival rate (SR), absolute growth (PM), Specific growth rate (SGR), and biomass production (PB) is patherned quadratic with each regression equation.

$$SR(\%)Y= -17.14X^2 + 225.91X-6533.92 \quad (R^2 = 0.995)$$
$$PM(g)Y= -0.9833X^2 +13.374X -32.32 \quad (R^2 = 0.925)$$
$$SGR(\%)Y = -0.096X^2 +1.3031X+ 0.6967 \quad (R^2 = 0.925)$$
$$PB(g)Y = -42.9333X^2 +889.58X-3140 \quad (R^2 = 0.872)$$

Based on these equations it can be predicted that the optimum oxygen supply which produces survival rate, absolute growth, specific growth rate and biomass production respectively in 5.52 ppm; 5.54 ppm; 5.54 ppm and 5.54 ppm. These equations describe that shrimp survival rate and growth process does not take place in a simple, but complex. Among other enzymatic reactions involving during metabolism, osmotic regulation etc.

Absolute growth (PM), Daily specific growth rate (SGR) and Seaweed (Gracilaria verucosa) biomass production presented in Table 2

Absolute growth rate, daily specific growth rate and biomass production of *Gracilaria verucosa* were significantly affected ($p < 0.01$) by oxygen supply. Based on Table 2 showed that absolute growth and highest daily specific growth rate is resulting in oxygen supply with aeration and combination between light and aeration. Light intensity take effect in spore production and seaweed growth, so the presence of a combination treatment with light and aeration very influential on seaweed growth, because tetraspore developments will take place as well if aquatic temperature on the range 25-30 °C and salinity 15-30 ppt (Anggadiredja, 2006). Speeds of movement of the water mass also have a role in maintain the circulation of nutrients which is useful for growth.

The main nutrient content required, like nitrogen and phosphate, very influence on reproductive stadia. When both nutrients are available then seaweed gametophyte fertility rising rapidly. In cultivation of double patterning, presence vaname shrimp will produce nutrient that can be use for seaweed growth, and the wide availability of nutrients will take effect on seaweed growth (Masyahoro and Mappiratu, 2009). Nitrogen and phosphate required seaweed for its growth and mostly of phosphate absorbed as orthophosphate, where as nitrogen absorbed as nitrat, nitrit also ammonium (Dawes, 1981). Handayani (2004) said that elements that are needed seaweed are an element N. Nitrogen required as energy supplier in photosynthetic. Except element N, plants also need the other elements like phosphor and potassium, as complementary and balancing growth. Nitrogen (N) and phosphor (P) are nutrients that determine fertility of waters. According to Nicholls (2003), nitrogen is the element that required by plants for photosynthetic, and important component in protoplasm. Nitrogen is basic material source of life that found in every living cell and become part of the plant body composition. Syahputra (2005) said that, plants utilize nitrogen in the form of nitrat ions, which have a role in speed up plants growth, increase the plant height, stimulate germination, synthesize chlorophyll for photosynthetic. Phosphate contributes to fatten and make plant heavy. When plants deficient nitrogen and phosphate then the plants become stunted and yellowish leaf color. Role of phosphate as a source of nutrients is important for seaweed growth. Phosphate required as the basic composer of protein material and formation of chlorophyll in photosynthetic process. According to Harris (2008), seaweed can utilize dissolved N fro shrimp excretion in multy tropic media from 0.6 ppm become 0-0.125.

High of growth and *Gracilaria verucosa* production in cobination treatment of light and aeration, so the temperature is relative higher than treatment without light. According to Aslan (1998), temperature has important role for life and seaweed growth. Waters temperature can take effect on several seaweed physiological functions like photosynthetic; respiration; metabolism; growth and reproduction.

Presence of light can be use for photosynthetic in seaweed growth. According to Lobban and Horrison (2004), light intensity is one of limiting factor affecting forming cells and spore growth in seaweed's body. When light intensity is strong, growth rate and high absolute weight can be reached in light intensity 3,500 lux.

Gracilaria verucosa needs nutrient and light in its growth, by using chlorophyll to catch light energy and store it in form of chemistry energy as adenosine triphosphate (ATP). Then, chemistry energy used to change anorganic carbon (CO_2) to be organic carbon, in photosynthetic (Komarudin, 2007).

In the night, dissolved oxygen will be decrease caused by absence of seaweed photosynthetic. Observation of oxygen at night in treatment without light and aeration, dissolved oxygen is 2.3-3.3 ppm and in treatment with aeration and light has dissolved oxygen on the range 4.8-6.9 ppm, so aeration supported *Gracilaria verucosa* to do respiration at night.

Relation oxygen supply (X) with absolute growth (PM), Specific growth rate and biomass production is patterned quadratic with each regression equation:

$$PM(g): Y = 3.592X^2 - 23.014X + 54.427 \quad (R^2 = 0.871)$$

$$SGR(\%): Y = -0.033X^2 + 1.032X - 2.599 \quad (R^2 = 0.905)$$

$$PB(g): Y = 126.70X^2 + 398.36X - 2656.3 \quad (R^2 = 0.872)$$

These equation describes that *Gracilaria verucosa* growth process beside influenced by oxygen supply, also influenced by other environment.

Physics and Chemical Water Parameter

Phisics and water chemical parameter from rearing medium presented in the Table 3. According to Boyd (1990) that the optimum temperature for shrimps polyculture with seaweed in 26 up to 31 °C. The worth of pH approximately is 7.5 up to 8.5 with Dissolved Oxygen more than 3 ppm. The wort of Amonia must be less than 0.1 ppm with nitrite must be less than 0.5 ppm. The rearing medium water quality study, it can be stated that water quality of all experiment pond had good water quality for supports this shirmps polyculture.

CONCLUSION

Based from the results of this research it can be conclude that the oxygen supply in the polyculture of shrimps (*Lithopenaeus vannamei*) and seaweeds (*Gracilaria verucosa*). Combination of ligh and aeration can be increasing the survival rate of vaname shrimp (*Litopenaeus vannamei*) from 45.245 into 94.64%. The absolute growth has a weight increased from 9.57 g into 12.97 g. The specific growth rates have a weight increased from 4.75% into 5.07%. The Biomass productions also have increased from 181.56 g m^{-2} into 883.95 g m^{-2}. The oxygen supply from absolute growth rate of *Garcilaria verucosa* is 25.86 g into 52.72 g. In the specific growth rate obtain results be increase in 1.77% into 2.64% then Biomass production of *Gracilaria verucosa* also increase from 2,557.76 g into 5,063.2 g.

ACKNOWLEDGEMENTS

I want to thank to reviewers for critical and editorial comment to the manuscript.

REFERENCES

Ambas, I. 2006. Sea Weed Culturest is Raining of Marinculture (2nd Oremap Selayar District). Mattirotasi foundation. 40 p.

Anam, M.S. 2007. The Guide of Sea Weed, Milk Fish, and Shrimps in Brackish Water Pond Polyculture. Food Security and Agricultural Extension Office District of Pasuruan.3-6 pp.

Anggadiredja. 2006. The Sea Weed (Potency of Sea Weed Culture, Processing and Distribution). Penebar swadaya; Jakarta.. 147 p.

Anggoro, S. 1992. The Osmotic Effect of Various Salinity from Medium Againts Hatchability and Vitality Tiger Shrimp Egg (*Penaeus monodon*). Doctoral. IPB; Bogor. 218 p.

Aslan, L. 1998. Sea Weed culture. Kanisius; Yogyakarta. 97 p

Boyd. 1990. Water Quality in Pond for Aquaculture. Brimingham publishing co. Brimingham. Alabama; USA. 299 p.

Dawes, C.J. 1981. Marine Botany. University of South Florida; USA. .229 p.

Directorate General of Fisheries. 2005. The Guide Sea Weed Culture. Marine and Fisheries Department; Jakarta. 24-27pp.

Fujaya, Y. 2004. Basic of Fish Fisiology for Developing Fisheries Technology. Rineka Cipta; Jakarta. 179 p.

Ghufran, M.H., and A.B. Tanchung. 2007. Water Quality Management in Aquaculture. Rineka Cipta; Jakarta. 208 p

Handayani, S. 2004. Study Carachterization of Dissolved Nutrien in Tanjung Kelor Jepara. Institute Technology Bandung. Bandung. Accessed June 2013 at www.geoph.itb.ac.id.

Harris, E. 2008. Role of Sea weed (*Galcilaria* sp.) from Oxygen Production at Multy Tropic Shrimp Culture System. 2nd National Symposium Aquaculture Biotechnology at August 2008. Bogor.

Karim, M.Y. 2007. The Effect of Osmotic Various Medium Salinity of Vitality of Female Mud Crab (*Scylla olivacea*). *Journal Protein*. 14 (1): 65-72.

Kholifah, U., N. Trisyani., and I Yuniar. 2008. The Effect of Different Stocking Density Againts Survival Rate and Growth from Tiger Shrimp Polyculture (*Penaeus Monodon* Fab) and Milk Fish (Chanos Chanos) in The Brackis Water Pond Net, Brebes Central Java. *Journal Neptunus*. 14 (2): 152-158.

Komarudin, U. 2007. Culture of *Gracillaria* spp. in Brackish Water Pond (Selection of Location, Design, Contruction, and Land Preparation). Marine and Fisheries Department, Directorate General of Aquaculture. Center For Development Of Brackish Water Aquaculture; Jepara (BBPBAP). 31 p.

Lobban, C.S., and Harrison. 2004. Seaweeds Wcolology and Physiology. Cambrige University press; New York. 227 p.

Masyahoro, A. and Mappiratu. 2009. Study of Technology for Seaweeds Culture In Palu Bay. Report on The Implementation of Research. Colaboration of Regional Development and Planing Board with PKSPL-Tropis. Horticultur Faculty of UNTAD. 152 p.

Masyahoro, A., and Mappiratu. 2010. Respons from a Variety of Different Depths Againts Seeds of Seaweeds and Harvest Time *Eucheuma cottonii* in Palu Bay. *The Magazine of Litbang Sulteng* III(2): 104-111.

Murachman, N., Hanani., Soemarno, and S. Muhammad. 2010. Polyculture Models of Tiger Shrimp (*Pennaeus monodon*), Milk Fish (*Chanon chanos*) and Sea Weeds (*Gracillaria* sp) in Tradional Scale. *Journal of Developing and Natural Sustainable* 1 (1): 1-10.

Nicholls, R.E. 2003. Hydroponic Plant Without Soils. Dahar prize; Semarang 85-86 pp.

Sakdiah. 2009. Nitrogen Utilization of Waste Vaname Shromp (L. vannamei). By Seaweed (Gracilaria verucosa) Polyculture Farming System. Graduate School of Bogor Agricultural University. 212 p.

Syahputra, Y. 2005. Growth of Caraginan Content in Seaweeds Culture *Eucheuma cottonii* in Variety Different Environmental Condition and Various Planting Distance in Lhok Seudu Bay. Thesis. IPB; Bogor. 91 p.

Tandler, A., and C. Manson. 1982. Light and Food Density Effect on Growth and Survival of Larvae Gilfheard Seabream (*Sparis Aurata Linnaeus*). *Journal of The Word Marine Culture Societes* 14: 103-109.

ATTACHMENT

Table 1. Survival Rate (SR), absolute growth (AG), Specific growth rate (SGR) and biomass production vaname shrimp (*Litopenaeus vannamei*)

Oxygen supply / Oxygen dissolved (ppm)				
Parameter	O1(5.39)	O2(5.89)	O3(6.39)	O4(4.89)
SR	73.57 ± 2.08^{b}	86.19 ± 2.16^{a}	94.64 ± 1.56^{a}	45.24 ± 1.66^{c}
Absolute Growth	11.16 ± 0.12^{b}	12.37 ± 0.16^{a}	12.97 ± 0.11^{a}	9.57 ± 0.18^{c}
SGR	4.91 ± 0.01^{b}	5.01 ± 0.01^{a}	5.07 ± 0.01^{a}	4.75 ± 0.22^{c}
Biomass Production	499.72 ± 28.98^{bc}	721.36 ± 39.37^{ab}	883.95 ± 29.79^{a}	181.56 ± 14.94^{c}

Description: Different letter in same line its showed a realize different in level test 5% ($p < 0.05$)

Table 2. Absolute Growth (AG), day specific growth rate (SGR) and biomass production *Gracilaria verucosa*

Oxygen supply / Oxygen dissolved (ppm)				
Parameter	O1(5.39)	O2(5.89)	O3(6.39)	O4(4.89)
Absolut Growth	29.80 ± 0.51^{b}	50.66 ± 0.44^{a}	52.74 ± 0.58^{a}	25.86 ± 0.68^{c}
SGR	1.89 ± 0.02^{b}	2.55 ± 0.01^{a}	2.64 ± 0.01^{a}	1.77 ± 0.01^{c}
Biomass Production	2831.2 ± 62.99^{c}	4742.6 ± 47.71^{b}	5063.2 ± 56.22^{a}	2557.76 ± 30.59^{d}

Description: Different letter in same line its showed a realize different in level test 5% ($p < 0.05$)

Table 3. Physical and chemical water parameter in polyculture of vaname shrimp *(Litopenaeus vannamei*) and seaweed (*Gracilaria verucosa*)

Oxygen supply / Oxygen Dissolved (ppm)								
Oxygen	**Temperature**	**Salinity**	**pH**	**NH3**	**NO2**	**Fosfat**	**CO2**	**NO2**
O1 (4.8-7)	27-31	29-30	7.5-8.0	0.01-0.02	0.30-0.33	0.21-0.32	tt-0.48	0.03
O2 (5.8-7)	25-31	29-30	7.5-8.0	0.01-0.02	0.31-0.34	0.22-0.31	Tt	0.02
O3 6.8-7	27-31	29-30	7.5-8.0	0.01-0.03	0.31-0.33	0.32-0.35	Tt	0.01
O4 2.8-7	27-31	29-30	7.5-8.0	0.01-0.04	0.31-0.32	0.29-0.33	0.44-3.98	0.84