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Weight Gain of Seaweed *Kappaphycus alvarezii* (Rhodophyta, *Solierisceae*) and *Sargassum polycystum* (Paeophyta, Sargassaceae) Mix Cultured at Different Planting Distances

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ABSTRACT

This study was conducted to analyze the weight of *Kappaphycus alvarezzi* and *Sargassum polycystum* mixcultured at different planting distances. Statistical analyses showed that planting distance was significantly influence the growth of *K.alvarezzi* and *S. polycystum*. Difference in weight gain between both species be due to the difference in their morphology which affect water motion and nutrient uptake. Higher weight gain of *S. polycycstum* was obtained at wider planting distance (35 cm). High , and at 30 cm for *K.alvarezii*. *K.alvarezii* was more susceptible to competition for the environmental factors compared to *S. polycycstum*. Higher weight gain of *K.alvarezii* obtained in this mix-culture with *S.polycystum* compared to the *K.alvarezii* which was singly cultured by previously several workers.

Keywords : Mix-Culture, Planting Distance, Weight Gain, Water Quality Parameters, K. Alvarezii, S. Polycystum.

I. INTRODUCTION

The macroscopic marine algae Rhodophyceae (red algae) and Phaeophyceae (brown algae) are among the economically important marine natural resources of Indonesia and other tropical countries. They are commercial important seaweeds developed to supply local and global market as carrageenan and algin(ate) sources. Of hundreds seaweeds species, *Kappaphycus alvarezii* (Carrageenophytes) and *Sargassum polycystum* (Alginophytes) were exported recently.

Sargassum polycystum is cultivated for alginate, as emulsifier, thickener, stabilizer, and gel-forming agent in food industries. It is naturally growth in wave protected and coral reef area. In Indonesia. this brown seaweed is not yet popularly cultivated by the coastal communties. The most widely cultivated is *K.alvarezii.*

With their high commercial value and facts that both species naturally grow side by side in the sea, *K.alvarezii and S.polycystum* were tried to be cultivated together, and analyze the effect of spacing between the two on their growth.

II. METHODS AND MATERIAL

STUDY SITE AND TIME

The study was conducted on July 13 – September 7, 2016 at Jonggoa Waters, Batu-batu Village, District of Galesong Utara, Takalar Regency, 15 miles southward Makassar City, South Sulawesi Province, Indonesia.

CULTURE METHOD

Longline with bambo raft as frame was the culture method applied. *K. alvarezii* and *S. polycystum* (Figure 1) seeds were obtained locally at the study area. As much as 25 grams of *K. alvarezii* and *S. polycystum* seeds were tied intermittently at the longline ropes.

EXPERIMENTAL DESIGN

Randomized Complete Design was experimental design applied. Planting distances 25 cm, 30 cm, and 35 cm between *K. alvarezii* with *S.polycystum* were the treatments tried, each with three replicates.

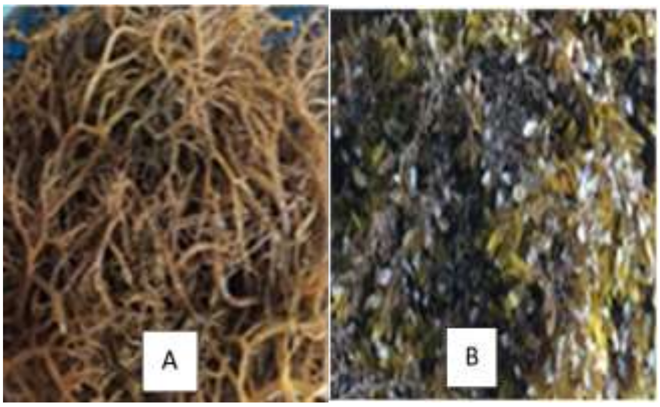

Figure 1. K.alvarezii (A) and S.polycystum (B)

PARAMETERS

Weight gain was computed at the end of stdy using the following formula :

W = Wt – Wo ; W = weight gain (g)
Wt = final weight of seaweed (g)
Wo = initial weight of seaweed (g)

Water quality parameters were analysed at the Water Quality Laboratory, Faculty of Marine Sciences and Fisheries, Hasanuddin University, Makassar, Indonesia. Water temperature, salinity, and current speed were measured daily using thermomemer, handrefractomete, and current meter respectively. Nitrate, ammonium, and phosphate concentrations were anlysed at the begining, the middle, and at the end of the experiment using spectrophometer.

DATA ANALYSIS

The weight gain data was statistically analysed using the Analysis of Variance (ANOVA) continued with W-Tukey. Water quality parameteres were descriptively analysed using table and references.

III. RESULTS AND DISCUSSION

RESULTS

*A*nalysis of Variance (Anova) showed that with mix culture of *K. alvarezii* and *S. polycystum*, planting distance was significantly influence (p<0,05) the weight gain of both species. W-Tuckey Test showed highest weight gain (810.00±166.469g) of *K. alvarezii* was recorded at 30 cm which was not significantly different with at 35 cm planting distance (458.67 ± 150.487g). Both weight gain were significantly higher compared to weight gain of 142.67±314.87g, at 25 cm planting distance (Figure 2).

Highest weight gain (1409±242.57g) of *S. polycystum* was obtained at 35 planting distance, which was not significantly different with 1074.20.66g the weight gain at 30 cm planting distance, but higher than weight gain at 25 cm distance.

Weight gain range of 142.67±314.874g - 810.00±166.469g of *K.alvarezii* in this experiment was higher compared to the range of 186.23-340.80 g recorded by Wenno (2014) and 114 – 192 g (Alimuddin, 2011) of *K.alvarezii* cultured singly at the same location.

Weight gain of *S. polycystum* was relatively higher (861.67±146.95g - 1409±242.57g) compared to *K. alvarezii* (142.67±314.87g - 810.00±166.469g), at al planting distances.

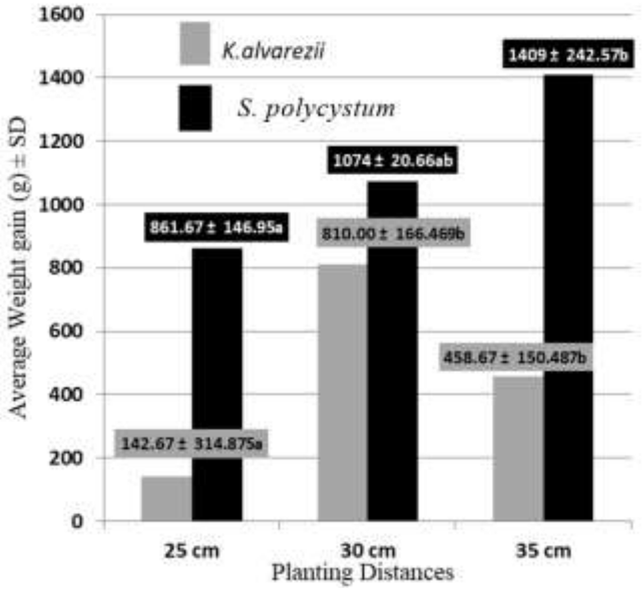

Figure 2. Weight Gain of K.alvarezii and S. Polycycstum at Different Planting Distances

DISCUSSION

Differences in weight gain of *K.alvarezii* and *S. polycycstum* at different planting distance possibly due to intraspecific competition of each species. Eah of this macroalga is susceptible to competition for water motion which influence nutrient kinetics (Harrison and Hurd, 2001; Kotiya, et.al., 2011; Edward and Connel, 2012), space, and light when these resources are in short supply in coastal ecosystems (Edward and Connel, 2012), although water current of 0,03 - 0,2 m/s in this study was suitable for both seaweed growth (Anggadiredja *et al.*,2008). The physiological and morphological differences between each species cause difference in response to the impact of different spacing then different in absorbing nutrients which in turn cause difference in the growth of the species. Higher weight gain of *S. polycycstum* was obtained at wider planting distance (35 cm) because of reduction the thickness of boundary layer between the water and thalli due to stronger water movement between the thallus. Acceleration the diffusion of nutrients into thalli cause these conditions (Neish 2005). This nutrient uptake was accounted for 81– 98% of the variation in weight gain of *K.alvarezii* (Glenn and Doty, 1992). In strong water movements condition that lift sedimentary particles onto the water surface l waters on the experimental site, *S.polycystum* thalli was protected from dirts and silt deposition (Sudjiharno, 2001) cause more nutrients carried by water current and absorbed by plants (Prihaningrum, *et al* 2001) as well as higher photosynthesis rate resulting higher weight gain of this species. Instead of at wider (35 cm) planting distances, higher weight gain of *K.alvarezii* obtained at 30 cm. This indicated that *K.alvarezii* was more susceptible to competition for the environmental factors compared to *S. polycycstum*.

More efficiently in uptaking nutrient via mass transport (Hurd *et al.* 1997) and in absorbing light (for photosynthesis and nutrients uptake) of *S.polycystum* caused its higher weight gain (*Endo et., al.*, 2013) than *K.alvarezii* due to leafy and blady thallus canopy of *S.polycystum* (Endo *et., al.*, 2013). Higher weight gain of *K.alvarezii* obtained in this mix-culture with *S.polycystum* compared to the *K.alvarezii* singly cultured by previously several workers, could be attributed to shading effect of thallus and *phlorotannins* content of brown algae *S.polycystum* (Hwang *et.al.*, 2004) which prevent attacks of herbivores that often attack *K.alvarezii*. The existence of phenols, the phlorotannins which form a complex with alginic acid of the cell wall (of the brown algae) (*Singh and Sidana,* 2014) is soluble in water (Maina, 2014), was diffused (exuded into the surrounding water media) by passing through the cell wall (Carlson and Mayer, 1983; Schoenwaelder and Clayton, 1998; Arnold and Targett, 2002; Koivikko *et al.,* 2005) then was absorbed by *K.alvarezii* thallus, further react with both proteinaceous and carbohydrate substances of the seaweed thallus (Swanson and Druehl, 2002). This compound perform the roles as chemical defenses (herbivore deterrents, antibacterial agents, and UV screens) (Hwang *et.al.*, 2004; *Singh and Sidana,* 2014; Kadam *et.al.*, 2015), deterring herbivores out from the lush canopy (Swanson and Druehl, 2002; Hwang *et.al.*, .2004; Amsler and Fairhead, 2006) of *K.alvarezii*, avoided the plant from bacterial infection (*Kim and Wijesekara*, 2011; Swamy, 2011; Singh and Sidana, 2014), help protect the algae against other predators and epiphytes (Ragan and Jansen, 1978), antifouling substances (Steinberg, 2011), protected the red algae from stress conditions (*Kim and Wijesekara*, 2011), such as inluence of UV radiation (Swanson and Druehl, 2002; *Kim and Wijesekara*, 2011). Together with the antibiotics and hormones contained in the brown seaweed thallus, these compunds synergically preventing the red seaweed from ice-ice bacteria and promoted the growth.

Nitrogen and phosphorous determine the growth (Neish and Shacklock, 1971; Neish *et al,* 1977; DeBoer, 1979; Lapointe and Ryther, 1979; , Rui *et al.* 1990; Chow, 2012), and the biochemical composition of algae (Michelon *et.al*, 2016). Although concentration of ammonium (0,06 – 0,12 mg/L) lower than nitrate (0,23-0,32 mg/L), absorption of ammonium is more important than nitrate (Dy and Yap 2001; Raikar and Wafar 2006). However both were considered to be in optimal concentrations for the seaweeds growth (Zatnika, 2009). Nitrogen metabolism in macroalgae is closely linked to photosynthetic carbon metabolism (Vergara *et al.*, 1998). Phosphate concentration at 0,09–1,80 ppm was laso suitable for seaweed growth (Ditjenkan Budidaya, 2005).

Recorded water temperature (28 – 30ºC) during the experiment (July to September) seems to be optimal for growth of *S. polycycstum* (Onho and Orosco, 1987; Angadiredja, *et al*, 2008), and optimal for *K. alvarezii* growth is 24-30°C (Glenn and Doty, 1990), although rather beyond the temperature for rapid increase in growth of *S. polycycstum* (22 to 28^{0}C) that was at normally prevails from September to December/January at Visakhapatnam, East Coast of India (Rao and Rao, 2002).

Recorded salinity range of 35 - 37 gL^{-1} was optimal for the growth of *K. Alvarezii* (Neish, 2005), and for *S. polycycstum* which was exhibited in the range of 20 – 40 g/L, and maximum growth was occurred at 32 g/L (Xiao zou *et.al.* 2017

IV. CONCLUSION

Difference in term of weight gain (growth rate) between both species could be due to the difference in their morphology, which may have effects nutrient uptake. Highest weight gain of *K. alvarezii* and *S. polycystum* was recorded at 30 cm and at 35 planting distance, respectively. This could be related to water motion between the plants, which influence nutrient uptake kinetics.

Higher weight gain of *S. polycycstum* was obtained at wider planting distance (35 cm). Instead of at wider (35 cm) planting distances, higher weight gain of *K.alvarezii* obtained at 30 cm. This indicated that *K.alvarezii* was more susceptible to competition for the environmental factors compared to *S. polycycstum*. Higher weight gain of *K.alvarezii* obtained in this mix-culture with *S.polycystum* compared to the *K.alvarezii* which was singly cultured by previously several workers, could be attributed to shading effect of thallus and *phlorotannins* content of brown algae *S.polycystum.* Recorded water qiality parameters were optimal for both species growth.

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