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Effect of Growing Season on Growth and Relation of Height and Above Ground Biomass of *Avicennia Marina*

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Abstract. Relation of height of seedling stands and above ground biomass is an important indicator of successful stand establishment and effectivity of carbon cycle which requires further study. This research aimed to study the growth level of *Avicennia marina* seedling planted in dry season and rainy season and to analyze the relation of mangrove stand height to above ground biomass of seedling for each season. This research was conducted through field experiment involving grouped random design including group of seedling plantation in dry season and rainy season with 40 replication for each group and 6 months of experiment period. Data collection including stand height above ground biomass, followed by data analysis on the relation of seedling height and above ground biomass. The result showed that the growth of mangrove stand planted in rainy season was better than those planted on dry season. Average height of mangrove *Avicennia marina* stand planted in dry season was 30,5 ± 7,3 cm while stand height of mangrove planted in rainy season was 42,7 ± 11,4 cm. Above ground biomass data showed the average of 4,1 ± 1,8 gr in the dry season treatment group and 6,6 ± 2,5 gr in the rainy season treatment group. Regression analysis on the relation of stand height and above ground biomass of *Avicennia marina* seedling showed that the above ground biomass was significantly affected by stand height both for dry season and rainy season treatments. But, there was a difference on the determination index and the coefficient of the effect on each treatment groups. The relation of stand height and above ground biomass was $Y = 0.1871\ X^{0.8832}$ with $R^2 = 0.2802$ for the dry season group and $Y = 0.0506\ X^{1.2892}$ with $R^2 = 0.743$ for the rainy season group. .

Keywords: *Avicennia marina*, height, above ground biomass, seedling, seasons

Introduction

The increasing degradation of mangrove ecosystem in the coastal area had altered the thread over ecosystem balance including ocean and land [1]. Mangrove ecosystem has importan roles in maintaining the balance of sediment transport [2], nutrient supply [3], nor habitat for flora and fauna in land and sea [4]. Unfortunately, the role of mangrove ecosystem was frequently ignored since its economic advantages had not been understood.

The increasing mangrove ecosystem degradation in the coastal area in Indonesia got worse as the increasing of massive development in the coastal area [5]. Deforestation, land conversion to ponds and settlements, and the increasing environmental pollution had became the driving factors which lead to the decline of mangrove coverage in Indonesia. Mangrove vegetations were cut causing the constriction of mangrove coverage over years [6]. Beside, the number of mangrove species had decreased as well caused by the decreasing the environment carrying capacity for certain mangrove species [7].

To maintain the sustainability and the role of mangrove ecosystem in the coastal area, conservation efforts and mangrove rehabilitation is required [8]. Unfortunately, the decrease of environment carrying capacity had impacted to the limitation of mangrove species which could be rehabilitated [9]. Coastal abrasion followed by increasing inundation level and further intrusion of sea water in the land had impacted the suitability for mangrove habitat [10]. Mangrove species which can be used for coastal rehabilitation are mostly consist of pioneer mangrove species such as *Avicennia marina*, *Rhizophora mucronata*, *R. apiculata*, *R. stylosa*, *Sonneratia alba* and *S. casiolaris* [11].

Growth effectiveness is an important factor in mangrove rehabilitation effort [12]. One of the important growth parameters for mangrove survival is its biomass, especially at seedling period [13]. The importance of mangrove stand biomass is for its relation to carbon cycle proceses. But, the biomass growth is highly related to height growth as relation of height – biomass [14]. Hence, information concerning the relationship pattern between mangrove height and biomass is required, especially at seedling period.

Generally mangrove biomass is devided into two parts, including root biomass (below ground) and stem to leaves (above ground) [15]. The growth of both parts of mangrove are varied caused by the variability of nutrient availability and richness around its growing environment [16]. When the nutrient availability is balanced, the height growth of mangrove would significantly effect the biomass growth. But, another important driving factor for mangrove growth is growing season which significantly effect the nutrient solubility and absroption by mangrove seedlings [17].

Avicennia marina is one of mangrove species which is frequently used in the rehabiliaton of mangrove ecosystem. To achieve an optimum survival rate in mangrove rehabilitation efforts, good mangrove growth quality is required. This could be observed from the growth of mangrove seedling in seeding period. Hence, the information concerning the growth level of mangrove seedling needs to be observed to define the seedling quality which would be used in mangrove ecosystem rehabilitation activities. This research aimed to study the growth level of mangrove seedling which is planted at dry and rainy seasons and to study the pattern of mangrove height and above ground biomass relationship with different seeding seasons.

Materials and Method

This research was conducted in the coastal area of Semarang City, specificaly in Tugu District. Mangrove seedling utilized in this research was *Avicennia marina* collected from mangrove ecosystem in coastal area of Tugu District, Semarang City. This research was conducted through experiment with grouped random design as the research design. Treatments grouping was based on plantation season, including first group which was planted in dry season and second group was planted in rainy season.

Experiment was involving 40 replication for each treatment groups. The experiment was conducted for 6 months for each treatments. Data observations including the height and above ground biomass of mangrove seedling. Data analysis was conducted through regression to understand the relation of seedling's height and above ground biomass. Assuming the relation was not linear, the formula of mangrove height and above ground biomass utilized in this research was:

$$\text{Log } Y = \log a + b.\log X \text{ or}$$

$$Y = a.X^b \quad (1)$$

Notation:

Y = seedling above ground biomass (gr)
X = seedling height (cm)
a and b = constants

Result and Discussion

The result of the research showed there were significant differences on seedling height and above ground biomass of *Avicennia marina* planted in dry and rainy seasons. Seedling height resulted from dry season plantation showed the range of 17.3 – 49.0 cm with average height of 30.5 ±7.3 cm. While seedling height resulted from rainy season plantation ranged from 24.0 – 68.0 cm with average height of 42.7 ± 11.4 cm. The analysis on the above ground biomass of mangrove seedling showed the range of 1.4 – 9.3 gr with the average of 4.1 ± 1.8 gr for dry season plantation and 2.9 – 12.6 gr with the average of 6.6 ± 2.5 gr for raiy season plantation.

Analysis on the relation of height and above ground biomass of mangrove seedling showed the relationship were significant for both treatment groups. Relationship pattern resulted from the analysis are shown in Figure 1.

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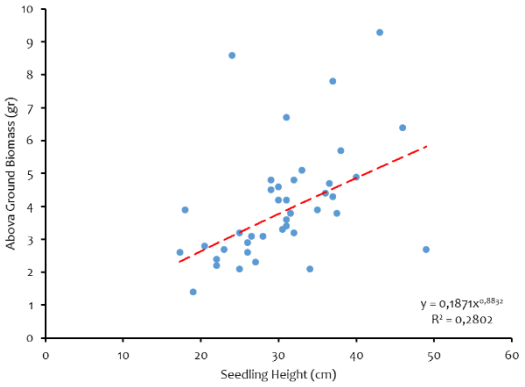
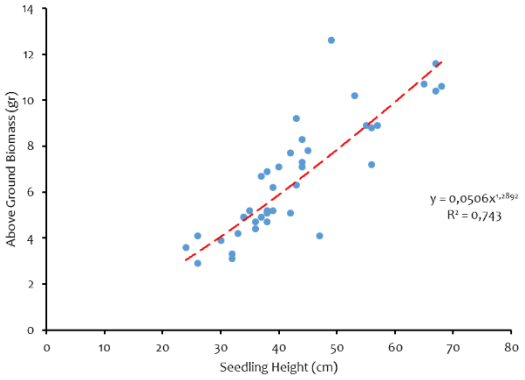


(a)



(b)

Figure 1. Relationship Pattern of Seedling Height and Above Ground Biomass of *Avicennia marina* for Dry Season lantation (a) and Rainy Season Plantation (b)

The result of the analysis on the relationship of seedling height and above ground biomass of Avicennia marina planted in dry season showed the relationship pattern of $Y = 0.1871X^{0.8832}$ with the determination coefficient (R) of = 0.2802 including probability level of 0.000 ($p < 0.05$). While the analysis on the relationship pattern of seedling height and above ground biomass for rainy season showed the equation for $Y = 0.0506X^{1.2892}$ including the determination coefficient (R) of = 0.743 and probability level of 0.000 ($p < 0.05$). The analysis result showed that above ground biomass of mangrove seedling planted in dry nor rainy seasons were both determined by seedling height significantly. Eventhough both treatments above ground biomas were affected by plant height, there were significant determination levels difference. In dry season plantation, the effect of seedling height was about 28.02% on the above ground biomass of Avicennia marina. above ground biomass of mangrove seedling was only effected by seedling height for 28.02%. While plantation of mangrove seedling in rainy season showed that 74.3% of above ground biomass was affected by seedling height.

Growth of mangrove is highly related to nutrient availability in the growing environment. As the nutrient availability increase, the growth of mangrove seedling should be better. While the availability of nutrient in the ecosystem is significantly affected by seasons [19]. A research conducted by [20] showed that rainy season was the best period for the growth of mangrove stands.

Generally, the growth of mangrove in the rainy season is better compared to dry season. Lower water salinity in the rainy season stimulate better height and stem diameter growth for mangrove seedling [21]. But, eventhough rainy season provide better growth of mangrove seedling, there were no significant effect of the biomass of the mangrove in both seasons [22].

According to [22], the height and diameter growth of matured mangrove occur in the rainy season. In dry season, the growth is inhibited and wood hardening process occur which effect on the increase of its biomass. But, the difference of both seasons are not significant. This processes occur since mangrove is a wetland vegetation which water availability exist the whole year. This result is vice versa to the result of this research which showed that there were significant difference on the plant height and above ground biomass of mangrove seedling. Suggested possibilities was that this research was only conducted for limited time period where each treatment was not continued to the following season to complete the seasonal variation.

Conclusion

The growth of *Avicennia marina* seedling planted in dry and rainy seasons were significantly different. Average mangrove height after 6 months plantation was 30.5 ± 7.3 cm for dry season plantation and 42.7 ± 11.4 cm for rainy season plantation. While the above ground biomass of the seedling in dry

season plantation was 4.1 ± 1.8 gr and 6.6 ± 2.5 gr for rainy season plantation. The growth pattern of mangrove seedling showed a significant difference. The effect of seedling height on the above ground biomass was higher in the rainy season than n the dry season. Relationship pattern of mangrove seedling height and above ground biomass for the dry season was $Y = 0.1871X^{0.8832}$ with $R^2 = 0.2802$ while for rainy sason was $Y = 0.0506X^{1.2892}$ dengan $R^2 = 0.743$.

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