Effect of Modification of Mangrove Seedling Media on the biomassand total chlorophyll of leaves of *Rhizophora mucronata*, *Ceriops tagal* and *Bruguiera gymnorrhiza*

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Abstract. Indonesia has the largest area of mangroves in the world (3.31 million ha), however 1.8 million among these hectares (over 40%) need to be rehabilitated due to damage. In order to restore mangroves, seedlings must be accessible in sufficient quantity. Several mangrove nurseries still apply traditional techniques, resulting in the slow growth and poor quality of the seeds. This research is expected to provide a solution for Indonesia's need for seedlings for mangrove rehabilitation. The study was conducted using experimental methods and a factorial, completely randomized design. The media, a combination of mud, husk, and sand, were investigated in six different combinations, and the seed species determinants included *Bruguiera gymnorrhiza*, *Ceriops tagal*, and *Rhizophora mucronata*. Biomass and the total chlorophyll content of the leaves of the mangrove seedlings were the variables that were observed. The average comparison test will be used after the ANOVA analysis of the data with 95% and 99% confidence levels. The results showed that each species' biomass and total chlorophyll concentration varied significantly. *Rhizophora mucronata*, *Bruguiera gymnorrhiza*, and *Ceriops tagal*, respectively, had total leaf chlorophyll concentrations of 43.35, 46.39, and 63.57 $g.g^{-1}$ FW. All species had a seed biomass of 8.42, 35.11, and 59.76 gr WW after two months of planting. Except for biomass of *Rhizophora mucronata*, the total chlorophyll content and biomass of each species were unaffected by the variations in planting media.

Keywords: mangrove nursery; propagule; medium combination, biomass, chlorophyll

INTRODUCTION

Resources and environmental services provided by mangrove ecosystems are important for both the humans and the environment. Mangroves provide a variety of resources and provisions, including timber, fiber, food, medicine, colors, and more. Regulatory and supporting roles are part of the mangrove ecosystem's ecological as well as environmental services. Moreover, mangroves support human culture or cultural services (Clough, 2013). Serving as a nursery, spawning, and feeding ground for estuarine and marine biota, including biota with considerable economic significance, are examples of environmental services (Ardli, et al., 2015).

Over the past four decades, as mangrove areas have reduced, consequently have the ecosystem services and functions provided by mangroves. According to Kuswandono (2019), management is urgently required to restore up to 1.8 million hectares of Indonesian mangroves. Mangrove conversion efforts into other land uses are mostly responsible for the damage suffered to mangroves. This brings a number of problems including decreased fish production, reduced biodiversity of mangrove ecosystems, loss of habitat and nursery areas, reduced productivity of mangroves and also waters, soil acidification, pollution, and seawater intrusion. (Ardli & Wolff, 2009; Ardli, et al., 2012; Koswara, et al., 2017).

The size and impact as indicated above have made rehabilitation of damaged mangrove regions a key concern. Availability of good quality seeds and sufficient in terms of quantity, is a challenge that must be solved. Throughout practically all of Indonesia, *Rhizophora* is the dominating genus in mangrove environments. In projects to transplant mangroves in degraded areas, numerous varieties of this genus from various research are frequently utilized. This is due to *Rhizophora's* good salt tolerance range at the time of seed germination (Basyuni, et al., 2018), can grow in a variety of soil and sediment conditions (Amaliyah et al., 2018); examples include Segara Anakan, which is located on the southern coast of Java (Nordhaus, et al., 2019). The coastal regions of southern Java are often habitat to relatively dense populations of *Ceriops* (Koswara, et al., 2017; Nordhaus, et al.,2019; Rahman, et al., 2019).

The availability of high-quality and sample supplies of mangrove seedlings frequently sets limits on mangrove rehabilitation programs. Also, there isn't a simple mangrove seedling procedure that yields acceptable outcomes. Research is therefore required on mangrove seedling techniques and medium modification. The objectives of this study were to determine the optimum seedling procedures for *Bruguiera*, *Rhizophora*, and *Ceriops*, as well as which seedling media had the greatest impact on the growth of these three plant species. Growth, biomass, and the survival rate of mangrove seedlings are research variables. This research should result in new innovation that will support the availability of seeds, particularly those from the *Rhizophora* genus.

METHODS

The materials used in this study were propagules of *Rhizophora mucronata*, *Ceriops tagal* and *Bruguiera gymnorrhiza*, as well as planting media. The equipments used in this study were seed plots, salt-refractometers, thermometers, as well as soil testers, meters and digital scales.

Research design

This study used an experimental method with a completely randomized design with factorial design. The factors tested were the type of growing media (10 levels) and planting methods (2 levels). The experiment was repeated 5 times. Research variables include growth, biomass and survival rate of mangrove seedlings. Supporting parameters measured include soil salinity, soil temperature, air temperature, soil texture, soil water content, soil pH, and light intensity. The treatment applied was the planting medium type factor (A), consisting of a comparison between mud, husk charcoal, husk with each level:

level	mud	Husk chacoal	husk
1	3	0	0
2	2	1	0
3	2	0	1
4	1	1	1
5	1	2	0
6	1	0	2

The fundamental method and the stage method are both parts of planting method type factor (A). Five repetitions totaling 100 experimental units (10 x 2 x 5). Plant height, plant weight, and the number of living plants were the main parameters that were measured. The main parameters and secondary parameters were measured every month for a total of six months.

Data Analysis

The data were analyzed using ANOVA at the 95% and 99% confidence levels and continued with Duncan's comparison test if the variables had a significant effect on the response.

Research location

Field data collection was carried out on the coast of Kebumen, Central Java at coordinates 07º34'29.42"S - 07º47'32.39"S and 108º46'30.12"E - 109º03'21.02"E. Data processing and analysis was carried out on the Faculty of Biology UNSOED Purwokerto.

RESULT

A. Environmental factors

The environmental factors data obtained as follows:

Table 2. The data of environmental parameter measurements in the experimental unit.

Parameter	1	2	3	4	5	6
N total (%)	0.32	0.30	0.26	0.25	0.34	0.29
P (HCl 25%) (%)	0.045	0.039	0.044	0.038	0.043	0.041
K (me/100gr)	0.22	0.26	0.31	0.36	0.25	0.28
Water content (%)	41.13	16.89	23.75	32.57	40.32	25.17
Total organic (%)	14.21	9.42	14.13	13.66	18.02	9.02
pH of media	4.5 - 5	4.5 - 5	4.5 - 5.5	5 - 5.5	4.5 - 5	5 - 6
Temperature (°C)	27	27	27	27 - 28	27 - 28	27

Note : 1 - mud : charcoal husk (1:1), 2 - mud, 3 - mud : husk (2:1), 4 - mud : husk : charcoal husk (1:1:1), 5 - mud : husk (1:1), and 6 - mud : charcoal husk (2:1)

According to the data in Table 2, husk and charcoal husk addition has an impact on the amount of the major nutrients in the media, particularly the P and K values. The pH level of the media can also be raised by adding husk charcoal. Because it possesses the necessary qualities to bind water readily, not easily agglomerate, good porosity, low weight, and sterility, charcoal husk is frequently used as a planting medium. It is also relatively inexpensive and simple to produce. Husk charcoal has a pH of 6.8 and contains a variety of nutrients, including 0.3% N, 15% P2O5, 31% K2O, and others (Naimnule,2016).

In an effort to rehabilitate land and stimulate plant development, charcoal husk is a soil restoration material that can enhance soil properties. With the addition of charcoal husk to poorly drained planting soil, mung bean (Vigna radiata L.) growth can enhance pore space and hasten groundwater drainage. The combination of husk charcoal and husk ash creates a space that the roots can penetrate, facilitating easier and more plentiful nutrient absorption. Because husk ash contains SiO2, P, and K that are produced during the ashing process by burning at high temperatures, chaff ash can enhance P and K elements (Kusuma, et al., 2013). Moreover, straw charcoal can respond effectively to the plant's dry weight and moist weight (Sukaryorini & Arifin, 2007). The planting medium will next be supplemented with husk charcoal and husk ash, which should provide the plants additional nutrients and air.

B. Biomassa

Rhizophora mucronata had the greatest ash-free dry weight among the three studied species of mangrove seedlings, coming in at 12.962 grams, followed by *Bruguiera gymnorrhiza* at 4.202 grams, and *Ceriops tagal* at 1.767 grams (Figure 1 and Table 3).

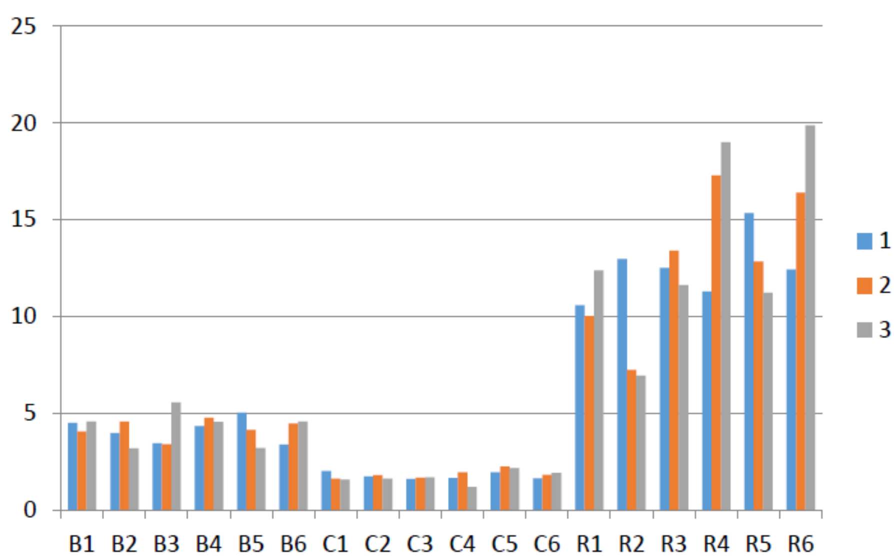


Figure 1. Histogram of biomass *Bruguiera gymnorrhiza* (B1-6), *Ceriops tagal* (C1-6), *Rhizophora mucronata* (R1-6) seedling

Table 3. Biomass average (AFDW) for each species

Rata-rata (gram AFDW)	
Bruguiera gymnorrhiza	4.202
Ceriops tagal	1.767
Rhizophora mucronata	12.962

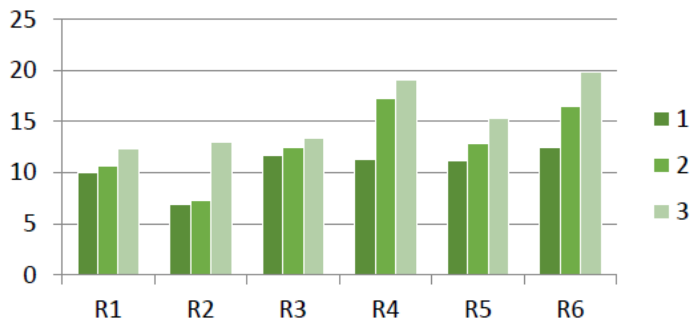


Figure 2. Histogram of seedling biomass *Rhizophora mucronata*

Table 4. Variance analysis of biomass *Rhizophora mucronata* seedling.

Anova	dB	JK	KT	FH	0,05	0,01
Group	2	72.424	36.212	14.795**	4.10	7.56
A	5	115.497	23.099	9.438**	3.33	5.64
Error A	10	24.475	2.448			

Tabel 5. Perbandingan rataan kandungan total klorofil pada species *Rhizophora mucronata*.

		R6	R4	R5	R3	R1	R2	
		16.23	15.86	13.13	12.51	10.99	9.05	note
R6	16.23	0						a
R4	15.86	0.37	0					a
R5	13.13	3.09	2.73	0				a
R3	12.51	3.72	3.35	0.63	0			ab
R1	10.99	5.23	4.87	2.14	1.51	0		b
R2	9.05	7.18	6.81	4.09	3.46	1.95	0	b

Note : 1 - mud : charcoal husk (1:1), 2 - mud, 3 - mud : husk (2:1), 4 - mud : husk : charcoal husk (1:1:1), 5 - mud : husk (1:1), and 6 - mud : charcoal husk (2:1)

Tukey HSD (ω): 4.43

Tabel 6. Analisis of variance of biomass of mangrove.

ANOVA	dB	JK	KT	Fh	.05	.01
A	2	1248.14	624.07	1186.18	5.14	10.92
Error A	6	3.16	0.53			
B	5	41.89	8.38	2.49	2.53	3.7
AB	10	74.88	7.49	*2.22	2.16	2.98
Error B	30	101.05	3.37			

C. Chlorophyll Total

The chlorophyll contained in the leaves of the mangrove seedlings varied with the highest average at *Ceriops tagal*, *Bruguiera gymnorrhiza*, and *Rhizophora mucronata*.

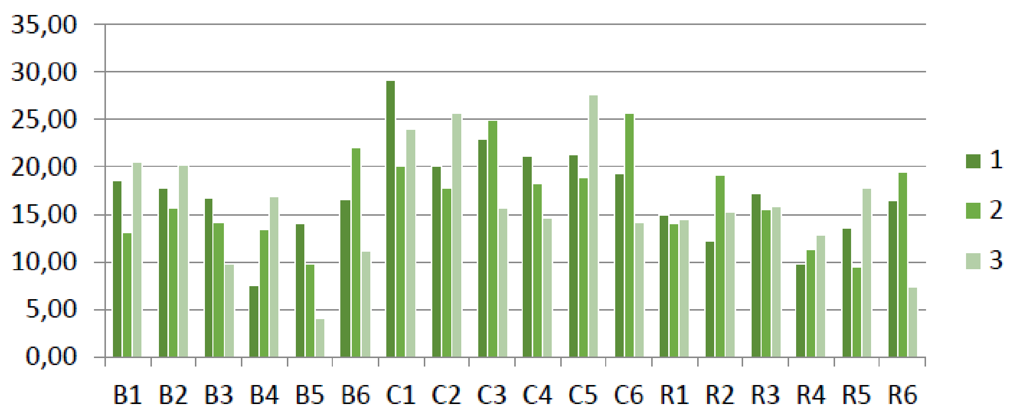


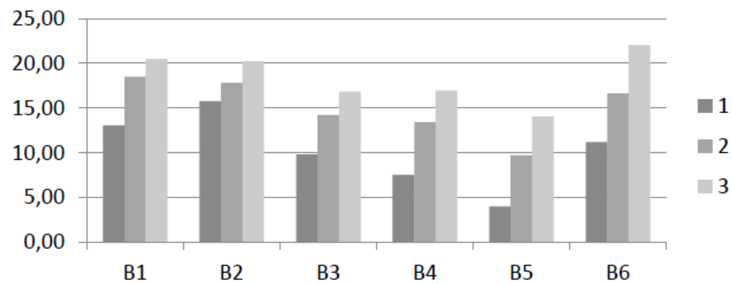
Figure 3. Histogram of chlorophyll total (µg.g^{-1}) of *Bruguiera gymnorrhiza* (B1-6), *Ceriops tagal* (C1-6), *Rhizophora mucronata* (R1-6)

Table 7. Average of chlorophyll total (µg.g^{-1}) of leaves

Species	Average **(µg.g^{-1})**
Bruguiera gymnorrhiza	14.57
Ceriops tagal	21.18
Rhizophora mucronata	14.24

Table 8. Analysis of variance of the chlorophyll total of mangrove.

ANOVA	dB	JK	KT	Fh	.05	.01
A	2	552.23	276.11	**74.02****	5.14	10.92
Error A	6	22.38	3.73			
B	5	148.12	29.62	1.50	2.53	3.7
AB	10	138.60	13.86	0.70	2.16	2.98
Error B	30	592.32	19.74			



Gambar 4. Histogram of chlorophyll total (μg.g^{-1}) of *Bruguiera gymnorrhiza*.

Tabel 9. Average comparison test of the chlorophyll total of *Bruguiera gymnorrhiza*.

		B2	B1	B6	B3	B4	B5	
		17.94	17.36	16.62	13.62	12.63	9.25	note
B2	17.94	0						a
B1	17.36	0.58	0					a
B6	16.62	1.32	0.74	0				ab
B3	13.62	**4.32**	**3.74**	3.00	0			bc
B4	12.63	**5.31**	**4.72**	**3.98**	0.98	0		cd
B5	9.25	**8.69**	**8.11**	**7.37**	**4.37**	3.38	0	d

The overall chlorophyll content and biomass of each species are greatly impacted by variations in the growth medium.

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