**Ceriops tagal** Biomass and Chlorophyll Analysis in Various Nursery Media

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**Abstract**

*Ceriops tagal* is a major mangrove species that contributes significantly to the mangrove environment. *Ceriops tagal* is a species of mangrove that supports a variety of marine organisms, including fish, shrimp, nematodes, and other biota, as well as maintaining the mangrove ecosystem's stability. A nursery is required in the recovery process. The addition of husk and husk charcoal to nursery media can enhance water, air, and plant nutrient absorption space. The objective of this study is to (1) determine how different nursery media with a mixture of husk and husk charcoal affect mud media, and (2) find which nursery media has the best influence on biomass and chlorophyll content in *C. tagal* mangroves. This study began with the propagules of *C. tagal* being planted in different composition growing media with husk and husk charcoal, and then calculating the biomass in the root, stem, leaves, and hypocotyl, as well as the chlorophyll content in the leaves of *C. tagal* organs, using an ANOVA test. Then, for the wet biomass of the root, dry biomass of the stem, root, and wet and dry biomass hypocotyl of *C. tagal*, do an honest significant difference test of 5%. According to the findings, adding husk and husk charcoal to nursery media can increase the dry biomass of the root and stem, as well as the wet and dry biomass of the hypocotyl in *C. tagal*. Media 5 (mud + husk charcoal in a 2:1 ratio) and media 6 (mud + husk + husk charcoal in a 1:1:1) were the best media for increasing the biomass of the *C. tagal* in each organ. Environmental factors such as the pH content of the medium influence the increase in dry biomass of the root and stem, as well as the wet and dry biomass of the hypocotyl.

**Keywords**: biomass, *Ceriops tagal*, chlorophyll, nursery media

**INTRODUCTION**

*Ceriops tagal* (family Rhizophoraceae) is a major mangrove species that plays a vital role in the ecosystem services provided by mangroves. Various marine animals such as fish, shrimp, nematodes, and others rely on the mangrove ecosystem for their survival. For these aquatic species, this ecosystem has served as a home, a location to spawn, a place to store eggs, and a food supply (Kusumahadi et al., 2020). Aside from capturing waves, wind storms, coast protection, and abrasion, it also has a vital physical purpose (Efriyeldi et al., 2019).

*Ceriops tagal* offers medical properties, according to Sura et al. (2018), and can be used as a wound cleaner, for example. Furthermore, as a nutrient source, this species plays an important function in the mangrove ecosystem community. These nutrients come from the decomposition of *C. tagal* leaves, which form detritus that is consumed by aquatic creatures and provides fertility to the waters (Noor, 2006).

*Ceriops tagal* is one of the mangrove species which has a large area. According to Hanan et al. (2020), a mangrove ecosystem is made up of plants that grow between the sea and the land. In 2017, Indonesia's mangrove forest ecosystem covered 3,361,216 ha. There are issues in the mangrove environment that have resulted in a decrease in the area of the mangrove ecosystem, which happens every year. As a result, the rehabilitation of *C. tagal* species is necessary, and it necessitates correct cultivation to achieve positive outcomes.

Nurseries are the key factor in carrying out the rehabilitation process, aiming to protect mangroves and also the ecosystem of them (Hidayat et al., 2018). The selection of suitable seed types according to substrate conditions and the method of planting is an important process in rehabilitation. The selection of good seed that will be used must be done carefully to get the optimal of mangrove growth result (Kasman & Widi, 2020).

In research conducted by Kusuma et al. (2013), adding husk or husk charcoal can increase the growth of specific organs in mangroves. Adding it will increase the length of the roots, making it easier to absorb nutrients. Based on Simbolon & Setyono (2020), the husk and husk charcoal has a function, it can improve the
The qualities of proper mangrove nursery media include: a media condition that is not excessively dense, and the ability to assist the creation and growth of plant roots. It can also help with adequate absorption of air, water, and nutrients, and it can be easily purchased at a minimal cost. To loosen the soil, husk and husk charcoal can be utilized as nursery medium (Dewi et al., 2020).

The mangrove nursery media must have high porosity properties. This is due to the need for mangroves to get oxygen and water content (Hendriati & Novirina, 2013). The husk media and husk charcoal can bind water, does not rot easily, helps the aeration system, and as a source of inorganic substrates such as N, P, CEC for plants. The husk and husk charcoal can make the media more porous, thereby increasing the porosity and maintaining aeration of the media (Dewi et al., 2020).

Mangrove biomass is made up of leaf, stem, hypocotyl, and root biomass from mangrove vegetation. Because biomass is the result of the accumulation of organic components, it can be used to assess the growth of a plant. Before it is dispersed and stored by plants, biomass in plant components goes through a fairly complex process. CO2 in the air is absorbed by plants and transformed into carbohydrates, which are subsequently dispersed and stored by plants, biomass in plant for binding air and water thus the nutrients given to the media are easily absorbed through the roots.

MATERIAL AND METHODS

The research was conducted in a mangrove forest at Logending Beach in Ayah Village, Kebumen Regency, at 7°43'07" S and 109°23'33" E. The Toxicology Laboratory, Plant Physiology Laboratory, and ITMEL Laboratory of Jenderal Soedirman University, Purwokerto, analyzed the biomass and chlorophyll content. The research was conducted for nine months, starting from July 2020 until March 2021.

Ceriops tagal mangrove propagules, nursery media consisting of mud, husk charcoal, and husk, aquadest, MgCO3, and 80 percent aceton were used in this study. Polybag, paranet 65 percent, bamboo, raffia ropes, soil tester, boots, aluminium foil, spectrophotometer, beaker glass, reaction tube, oven, furnace, mortar, pestle, analytic scale, scissors, tray, camera, label, and stationery were among the instruments used in this study.

Research Procedure

The Plant Physiology Laboratory, Faculty of Biologi, Universitas Jenderal Soedirman, prepares the equipment and materials used to quantify biomass and chlorophyll content. The media was made by mixing each ingredient according to a predefined concentration ratio based on the experimental design's six-level nursery media code. Each piece of media is placed in a polybag with the proper code labeled on it.

Ceriops tagal mangrove propagules were taken in the Segara Anakan mangrove forest, Cilacap Regency. C. tagal mangrove propagules were taken using a random sampling technique. C. tagal mangrove propagules were taken with mature condition characterized with yellow neck cotyledon. Ceriops tagal mangrove propagules were planted in polybags containing different nursery media, namely six levels of nursery media. Polybag filled with nursery media as much as ⅔ of the polybag contents. C. tagal mangrove propagules are attached to each nursery media with a depth of ± 6 cm placed in Ayah Mangrove Forest under the paranet 65%.

Mangrove propagules that have been planted in various nursery media are cared for under the paranet, which provides shade and keeps the propagules moist. To prevent propagule loss, the propagule storage place must also be shielded from being damaged by waves (Pramudji, 2001). Maintenance of C. tagal mangrove propagules planted on different nursery media was carried out for two months with field observations carried out twice, in once time for every month.

Wet weight measurements were carried out by taking the roots, stems, hypocotyl and leaves of the mangrove C. tagal. The part that has been taken is then weighed using analytical scales. The weight obtained is entered in the data tabulation.

The calculation of biomass and chlorophyll content has a relationship, namely that biomass can show the efficiency value of the physiological processes of a plant, this is because the dry biomass produced is the result of a photosynthetic process that is running well. The biomass that occurs result from the plant's ability to absorb nutrients (Suhaila & Sulhaswardi, 2013).
Measurement of dry weight is carried out at the end of the observation by weighing the parts that have been dried in an oven at a temperature of 70°C until the dry weight is constant (Sofyan et al., 2014). Based on the Karenisekar & Insafitri (2020), time used in the oven for 48 hours. The weight obtained is entered into the data tabulation.

The method that used is a spectrophotometric (Kamble et al., 2015). Leaf samples that have been taken are cut into small pieces using scissors and weighed using analytical scales until they reach a weight of 0.5 g per sample. Maceration was carried out using a mortar and pestel that have been cooled before use. Then the 0.5 g of leaves were crushed using a mortar and pestle until the leaf texture became smooth, then added 12.5 mL of 80% acetone and 0.25 g of MgCO₃. The leaf extract was then put into a test tube and then centrifuged at 3000 rpm for 15 minutes. The absorbance value of the leaf extract was calculated using a spectrophotometer with a wavelength of 645 nm and 663 nm. The absorbance values obtained were entered into a data tab. Chlorophyll content can be determined using a formula:

\[
\text{Chlorophyll a (µg/ml) = 12.7 (A663) - 2.69(A645)}
\]

\[
\text{Chlorophyll b (µg/ml) = 22.9 (A645) - 4.08 (A663)}
\]

\[
\text{Total Chlorophyll (µg/ml) = 20.2 (A645) + 8.02 (A663)}
\]

Details:
A646 : absorbance values at λ646 nm of spectrophotometric results.
A663 : absorbance values at λ646 nm of spectrophotometric results.

The water content of the media was determined by taking a soil sample from each media and weighing it on analytical scales until it achieved a weight of less than 40 g. (initial weight or wet weight). Soil samples were wrapped in aluminum foil and dried at 70°C for a consistent medium weight. A formula can be used to calculate the amount of water in the media (Karenisekar & Insafitri, 2020):

\[
\% WC = \frac{A - B}{A} \times 100\%
\]

Details:
% WC : water content in value percentage,
A : wet weight of the sample,
B : dry weight of the sample.

Measurement of carbon content in media, soil samples that have been oven-dried at 70°C until their weight is constant, then burned in a 550°C furnace for 4 hours until the media has turned to ash. Using an analytical scale, the ash weight was recalculated. The formula is used to compute the weight of the ash obtained (Karenisekar & Insafitri, 2020):

\[
\% \text{ ash content} = \frac{(Z - X)}{Y} \times 100\%
\]

Details:
X : weight of aluminium foil,
Y : dry weight of sample media,
Z : weight of sample media after been heated with furnace and weight of aluminium foil.

Measurement of carbon content in the media is carried out using a formula (Karenisekar & Insafitri, 2020):

\[
\text{C (gram)} = \frac{\text{DW (gram)} - \text{AC (gram)}}{\text{Y}}
\]

Details:
C : Carbon
DW : Dry Weight of sample media
AC : Ash Content from the result in the above equation

A soil tester was used to measure the pH of the media, which was applied directly to the media. The pH value of the media can be determined by observing the movement of the soil tester needle. In the data tabulation, the pH value of the media collected was recorded.

Analysis of the Total Nitrogen (N) content in the media is used the Kjeldahl method (Balai Penelitian Tanah, 2005). Analysis of the Phosphorous (P) content in the media used HCl 25% extraction method, while analysis of the Cation Exchange Capacity (CEC) content with the colorimetric method to test soil fertility (Balai Penelitian Tanah, 2005). A more detailed explanation regarding the analysis of the content of N, P, CEC is listed in Appendix 4.

Based on Nursin et al (2014), Cation Exchange Capacity (CEC) is a soil chemical property linked to soil fertility. By extracting soil samples from each media and analyzing them at the Wahana Laboratory in Semarang, the concentration of N, P, and CEC in the media was measured. The data produced from the analysis test were entered into the data tabulation after it was completed.

Data Analysis
The research was carried out experimentally with a Completely Randomized Design (CRD) with six levels of nursery media to be tested, there are:

M1 : Pure mud
M2 : Mud + Husk (1:1)
M3 : Mud + Husk (2:1)
M4 : Mud + Husk charcoal (1:1)
M5 : Mud + Husk charcoal (2:1)
M6 : Mud + Husk charcoal + Husk (1:1:1)

Each media level was tested three times. The results of the root, stem, leaf, hypocotyl, and chlorophyll content measurements were evaluated using ANOVA with a test level of 5% and 1%. Then, using the honest significant difference test (HSD) with a 5% test level, the secondary data were evaluated using descriptive analysis, and finally, conclusions were drawn.
### Table 1. The Honest Significant Difference Test of *Ceriops tagal* Organs

| Treatment | Wet Biomass Hypocotyl (g) | Dry Biomass Root (g) | Dry Biomass Stem (g) | Dry Biomass Hypocotyl (g) |
|-----------|---------------------------|----------------------|----------------------|---------------------------|
| M1        | 7.82(ab)                  | 0.07(a)              | 0.03 (ab)            | 3.16 (ab)                 |
| M2        | 7.73(ab)                  | 0.18 (bc)            | 0.04 (ab)            | 2.86 (a)                  |
| M3        | 6.65 (a)                  | 0.08(a)              | 0.03(a)              | 2.50 (a)                  |
| M4        | 6.74 (a)                  | 0.14 (ab)            | 0.03 (ab)            | 2.60 (a)                  |
| M5        | 8.73 (b)                  | 0.25(c)              | 0.04 (ab)            | 3.65 (b)                  |
| M6        | 7.99(ab)                  | 0.23(c)              | 0.16 (b)             | 3.11 (ab)                 |

Details: Unequal letters (a, ab, bc and c) in the column indicate the real increase the wet biomass of hypocotyl and dry biomass root, stem, and hypocotyl of at each organ of *C. tagal*; (M1) Pure Mud, (M2) Mud + Husk (1:1), (M3) Mud + Husk (2:1), (M4) Mud + Husk charcoal (1:1), (M5) Mud + Husk charcoal (2:1), (M6) Mud + Husk + Husk charcoal (1:1).

#### Graphic 1

The Honest Significant Difference Test of *Ceriops tagal* Organs

Details: A (Wet Biomass of Hypocotyl), B (Dry Biomass of Root), C (Dry Biomass of Stem), D (Dry Biomass of Hypocotyl); (M1) Pure Mud, (M2) Mud + Husk (1:1), (M3) Mud + Husk (2:1), (M4) Mud + Husk charcoal (1:1), (M5) Mud + Husk charcoal (2:1), (M6) Mud + Husk + Husk charcoal (1:1:1).

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**RESULT AND DISCUSSION**

The hypocotyl, roots, and stems of the biomass content in each organ have a high significant value, according to the findings of this study. This reveals that a novel media composition with a blend of husk and husk charcoal can promote the growth of *C. tagal* organs when compared to mud-only medium. According to the report of Hendriati & Noviriana (2013), the media in which mangroves grow must have a certain level of porosity, allowing for the growth of mangroves, water intake, and respiration. Husk media and husk charcoal have been shown to improve nutrient and oxygen absorption by *C. tagal* mangroves.

Treatment of diverse media compositions in the leaf organ had little effect on increasing biomass in wet and dry biomass in *C. tagal* leaf organs. This is due to a physiological process that occurs in mangroves naturally, according to Widyasari (2010), the more leaves a tree has, the more sunlight it can receive for photosynthesis, but when the leaves do photosynthesis, carbohydrates are absorbed and transferred to other sections of the tree.

As a result, the biomass content of the non-photosynthetic section will be higher than that of the photosynthetic leaves. Meanwhile, study of chlorophyll content in *C. tagal* leaves revealed that media treatment with various compositions had no effect on chlorophyll content increase in *C. tagal* leaves. This can be caused by mangroves being planted for two months in media with varying compositions that are not ideal, resulting in insufficient chlorophyll content in the leaves. According to the Adip et al (2014), the taller the tree, the easier it is for the leaves to absorb sunlight, causing the chlorophyll content in the leaves to increase. Based on table 1 and graphic 1, the best media for raising the biomass of wet and dry biomass of hypocotyl, as well as dry biomass of root, was media with a composition of mud + husk charcoal in a ratio (2:1) or media 5. The best media for raising the biomass of dry biomass of root and stem of *C. tagal* organs was media 6 with a composition of mud + husk charcoal + husk in a ratio of 1:1. According to Sofyan et al (2014), this was attributable to the media structure with the inclusion of husk charcoal, which had a larger
Carbon content and superior ability of husk charcoal in media drainage, as compared to husk and 100% mud treatment.

The addition of organic matter to the mangrove nursery media in the form of husk charcoal will increase the dry biomass in each organ at the same time in the wet and dry biomass of hypocotyl and dry biomass stem organs of C. tagal. The modified media contains organic matter particles that allow the pore space to serve as a source of water, air, and penetration space. More pore space causes root system growth and makes it simpler for roots to absorb water and nutrients, which can lead to an increase in hypocotyl moist biomass (Hanafiah, 2007). The addition of husk charcoal and husk creates an area that the roots can penetrate thus that the absorption of nutrients by the roots is easier and more abundant. Thus the organs in other parts such as stem and hypocotyl will experience good growth (Kusuma et al., 2013).

The pH of the two media, namely on media 5 with a pH of 6 and on medium 6 with a pH of 5.5, supports the following: both pH values are the most stable pH values compared to other nursery media (Table 2). The availability of dissolved oxygen required for mangroves to carry out their breakdown process is influenced by pH. The bacteria that carry out the decomposition process will reduce if the dissolved oxygen level is low, and the availability of nutrients required by mangroves will drop (Sari et al., 2016). Table 2 shows the value of environmental factors' influence on each medium. The carbon content of each medium varied between 9.02 percent and 18.02 percent, with the carbon content of C. tagal mangroves falling into the medium category. This has an impact on the biomass of C. tagal. The carbon value is related to the biomass value of C. tagal; the greater the biomass value, the greater the carbon value. The value of the carbon content of organic matter is 47% of the total biomass (Badan Standarisasi Nasional, 2011).

However, on the value of water content in the media, the total of the media ranged between 16.89% and 41.13%. The highest value of water content found in media 4 which has a composition in the form of mud and husk charcoal with a ratio of 1:1 with a value of 41%. The addition of husk charcoal is able to bind water thus it can facilitate the C. tagal to absorb nutrients for increasing the amount of biomass in C. tagal organs. This provide evidence that the media containing husk charcoal can give a significant value of biomass content in C. tagal organs (Naimnule, 2016).

The determination of the pH value greatly affects the biochemical processes in the media, if the pH has decreased, there will be a decrease in dissolved oxygen while the need for oxygen use is very much needed. The optimal tolerance relationship is around 7 - 8.5. However, the pH in the mangrove nursery media with a value of 5 - 6 is classified as low but in the mangrove the pH still in the tolerance range (Wantasen, 2013).

It is used to determine the nutrient content of each N, P, and CEC substrate when calculating Nitrogen, Phosphorous, and Cation Electron Capacity from diverse nursery media. The element N is necessary for the production of amino acids, nucleic acids, and proteins, all of which are essential for plant metabolism. Element P is a type of organic material that can be obtained from artificial fertilizers or soil minerals. Based on Fajar et al. (2013), the value of the N content of each medium is included in the moderate group because the value is in the interval 0.21 - 0.50%. Each media is included in the moderate group in the P element because it is 20-40%. The CEC level for each medium was classified as moderate because it was in the 20-40% interval. According to Asninadar et al. (2019), CEC (Capacity Exchange Cation) is the amount of positive charge of cations absorbed by soil colloids at a specific soil pH. Medium CEC levels in the C. tagal nursery media are caused by the pH content which tends to be less than optimal so that it will interfere with the soil cation exchange process which will inhibit the process of supplying nutrients used as a measure of the fertility of a plant. But overall, measurements of the media show a fairly good fertility value because the levels are at moderate intervals. Based on Kurniawan et al. (2017), if there is a lack of nutrients, it will affect the growth of a plant.

### Table 2. Result of Environmental Factors Measurement Analyses of Ceriops tagal in Different Nurseries Media

| M   | WC (%) | CC (%) | pH  | N (%) | P (%) | CEC(me/100g) |
|-----|--------|--------|-----|-------|-------|--------------|
| M1  | 16.89  | 9.42   | 5   | 0.3   | 0.039 | 0.26         |
| M2  | 40.32  | 18.02  | 5   | 0.34  | 0.043 | 0.25         |
| M3  | 23.75  | 14.13  | 5.5 | 0.26  | 0.044 | 0.31         |
| M4  | 41.13  | 14.21  | 5   | 0.32  | 0.045 | 0.22         |
| M5  | 25.17  | 9.02   | 6   | 0.29  | 0.041 | 0.28         |
| M6  | 32.57  | 13.66  | 5.5 | 0.25  | 0.038 | 0.36         |

Details: (M1) Pure Mud, (M2) Mud + Husk (1:1), (M3) Mud + Husk (2:1), (M4) Mud + Husk charcoal (1:1), (M5) Mud + Husk charcoal (2:1), (M6) Mud + Husk + Husk charcoal (1:1:1); M (media); WC (Water Content); CC (Carbon Content); N (Nitrogen); P (Phosphor); CEC (Cation Exchange Capacity)
CONCLUSION
This study conclude that changing the nursery media can alter hypocotyl wet biomass, root dry biomass, stem dry biomass, and hypocotyl dry biomass in C. tagal mangroves. The optimum media for enhancing C. tagal growth are media composed of mud + husk charcoal in a 2:1 ratio (medium 5) and media composed of mud + husk + husk charcoal in a ratio (1:1:1) (medium 6).

REFERENCES
Adip, M. S., Boedi, H. & Frida, P., 2014. Nilai Hue Daun Rhizophora : Hubungannya Dengan Faktor Lingkungan dan Klorofil Daun di Pantai Ringgung, Desa Sidodadi, Kecamatan Padang Cermin, Lampung. Diponegoro Journal of Maquares, III(2), pp. 20-26.

Asnindar, Korja, I.N. & Rukmi, 2019. Sifat Kimia Tanah Pada Hutan Mangrove di Desa Tolai Barat Kecamatan Torue Kabupaten Parigi Moutong. Warta Rimba, 7(3), pp. 113-120.

Badan Standarisasi Nasional, 2011. Pengukuran dan Perhitungan Cadangan Carbon - Pengukuran Lapangan untuk Penaksiran Cadangan Carbon Hutan (Ground Based Forest Carbon Accounting). s.l.:Badan Standarisasi Nasional.

Balai Penelitian Tanah, 2005. Petunjuk Teknis Analisi Kimia Tanah, Tanaman, Air dan Pupuk. Bogor: Badan Penelitian dan Pengembangan Pertanian, Departemen Pertanian.

Dewi, A.F., Tika, M.S. & Hifni, S.C., 2020. Pengaruh Media Tanam Pasir, Arang Sekam, dan Aplikasi Pupuk LCN Terhadap Jumlah Tunas Tanaman TIN (Ficus carica L.) Sebagai Sumber Belajar Biologi. Jurnal Bioeducation, VII(1), pp. 1-7.

Efriyeldi, Aras, M., Joko, S., Nursyirwani., Elizal., Elifs, S., 2019. Peningkatan Nilai Ekonomi Ekosistem Mangrove melalui Pengelolahan Buah Api-api (Avicennia sp) Sebagai Bahan Makanan di Desa Sungai Kayu Ara Kabupaten Siak. Journal of Rural and Urban Community Empowerment, I(1), pp. 1-8.

Fajar, A., Dedy, O. & Alirman, A., 2013. Kesesuaian Jenis untuk Perencanaan Rehabilitasi Ekosistem Mengrove di Desa Wawatu Kecamatan Moramo Utara Kabupaten Konawe Selatan. Jurnal Mina Laut Indonesia, III(12), pp. 164-176.

Hanafiah, K. A., 2007. Dasar-dasar Ilmu Tanah. Jakarta: Raja Grafindo Persada.

Hanafiah, K., 2007. Dasar-dasar Ilmu Tanah. Jakarta: Raja Grafindo Persada.

Hanafiah, K., 2007. Dasar-dasar Ilmu Tanah. Jakarta: Raja Grafindo Persada.

Hendriati, N. & Novirina, H., 2013. Desalinasi Air Payau Menggunakan Tanaman Mangrove. Jurnal Ilmiah Teknik Lingkungan, V(2), pp. 1-10.

Heriyanto, T., Bintal, A., Insaniah, R. & Fitri, A., 2020. Analisis Biomassa dan Cadangan Karbon pada Ekosistem Mangrove di Kawasan Pantai Berpasir Dewa Kawal Kabupaten Bintan. Jurnal Manajemen Riset dan Teknologi, II(1), pp. 31-41.

Hidayat, N.C., Raden, A. & Nirwani, S., 2018. Kajian Program Rehabilitasi Mangrove di Desa Banyu Urip Kecamatan Ujung Pangkah Kabupaten Gresik. Journal of Marine Research, VII(1), pp. 27-34.

Kamble, P.N., Giri, S.P., Mane, R.S. & Tiwana, A., 2015. Estimation of Chlorophyll Content in Young and Adult Leaves of Some Selected Plants. Universal Journal of Environmental Research and Technology, V(6), pp. 306-310.

Karensikar, C. & Insafitri, 2020. Stok Serapan Karbon pada Jenis Mangrove yang Berbeda (Rhizophora stylosa, Avicennia marina dan Bruguiera gymnorrhiza) di Perairan Tuban. Journal Trujoyo Juvenil, I(2), pp. 220-226.

Kasman & Widi, A., 2020. Kajian Perencanaan Rehabilitasi Mangrove di Kotabaru. Jurnal Neoteknika, VI(1), pp. 1-12.

Kurniawan, A., Titiek, I. & Koesriharti, 2017. Pengaruh Aplikasi Pupuk N dan K Terhadap Pertumbuhan dan Hasil Tanaman Pakcoy (Brassica rapa var. chinensis) Flamingo F1. Jurnal Produksi Tanaman, V(2), pp. 281-289.

Kusuma, A.H., Munifatul, I. & Endang , S., 2013. Pengaruh Penambangan Arang dan Abu Sekam dengan Proporsi yang Berbeda Permeabilitas dan Porositas Tanah Liat serta Pertumbuhan Kacang Hijau (Vigna radiata L). Buletin Anatomi dan Fisiologi, XXI(1), pp. 1-9.

Kusumahadi, K.S., Ahmad, Y. & Rizky, G.M., 2020. Analisis Keanebaragan Jenis Vegetasi Mangrove di Kawasan Hutan Lindung Angke-Kapuk dan Taman Wisata Alam Angka-Kapuk Muara Angke Kota Jakarta Utara. Jurnal Ilmu dan Budaya, XLI(69), pp. 8123-8134.

Naimmu, M.A., 2016. Pengaruh Takaran Arang Sekam dan Pupuk Kandang Sapi Terhadap Pertumbuhan dan Hasil Kacang Hijau (Vigna radiata L). Savana Cendana, 1(4), pp. 118-120.
Ceriops tagal Biomass and Chlorophyll Analysis; Herna Maghfira R.J, Erwin Riyanto Ardli, Elly P.

Noor, Y.R., 2006. *Panduan Pengenalan Mangrove di Indonesia*. Bogor: Wetland International-Indonesia Programme.

Nursin, A., Wardah & Yusran, 2014. Sifat Kimia Tanah Pada Berbagai Zonasi Hutan Mangrove di Desa Tumpapa Kecamatan Balinggi Kabupaten Parigi Moutong. *Warta Rimba*, II(1), pp. 17-23.

Pramudji, 2001. Upaya Pengeololahan Rehabilitasi dan Konservasi pada Lahan Mangrove yang Kritis Kondisinya. *Oseana*, XXVI(2), pp. 1-8.

Puspitasari, D.P., 2017. C/N Rasio pada Serasah Daun dan Ranting Mangrove (Avicennia alba) di Unit Pelaksanaan Teknis (UPT) Budidaya Air Laut dan Payau, Probolinggo Jawa Timur. Malang: Universitas Brawijaya.

Sari, L.K., L. Adrianto., K. Soewardi., A. S. Atmadipoera. & E. Hilmi. 2016. Sedimentation in Lagoon Waters (Case Study on Segara Anakan Lagoon). *AIP Conference Proceeding*.

Simbolon, B.H. & Setyono, Y.T., 2020. Manfaat Kompos Limbah Kulit Kopi dan Sekam Padi Terhadap Pertumbuhan Pembibitan Tanaman Kopi (Coffea canephora P.). *Jurnal Produksi Tanaman*, VIII(4), pp. 370-378.

Sofyan, S.E., Melya, R. & Duryat, 2014. Pemanfaatan Limbah Teh, Sekam Padi, dan Arang Sekam Sebagai Media Tumbuh Bibit Trembesi (Samanea saman). *Jurnal Sylva Lestari*, II(2), pp. 61-70.

Suhasila, Z.S. & Sulhaswardi, 2013. Perbandingan Campuran Meida Tumbuh dan Berbagai Konsentrasii Atonik untuk Pertanaman Bibit (Eucalyptus pelliita). *Jurnal Dinamika Pertanian*, XXVIII(3), pp. 225-236.

Sura, M.B., Nalini, D. & Mangala, G.P., 2018. Two New Cerioptins (A-B) from The Mangrove Ceriops Tagal. *Chemistry Select*, Volume III, pp. 8926-8929.

Wantasen, A.S., 2013. Kondisi Kualitas Perairan dan Substrat Dasar Sebagai Faktor Pendukung Aktifitas Pertumbuhan Mangrove di Pantai Pesisir Desa Basaani, Kabupaten Minahasa Tenggara. *Jurnal Ilmiah Platax*, 1(4), pp. 204-209.

Widyasari, N.E., 2010. Pendugaan Biomassa dan Potensi Karbon Terikat di atas Permukaan Tanah pada Hutan Gambut Merang Bekas Terbakar di Sumatera Selatan, Bogor: Institut Pertanian Bogor.