Observation of morphological and physiological characteristics on Abangares Mahogany (Swietenia macrophylla King.) In South Sulawesi

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Observation of morphological and physiological characteristics on Abangares Mahogany (*Swietenia macrophylla King.*) In South Sulawesi

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Abstract. The one of identification system using morphophysiological analyses for breeding program Mahogany is needed. Mahogany (*Swietenia macrophylla*) is a tree species which is easy to cultivate as it is able to thrive in a great variety of habitats and soil types. Here, we present a study on the relationship between morphological and physiological parameters on S. macrophylla. The study was carried out in a seed orchard of Mahogany in genetic resource area of 2nd Forest Seed/Seedling Office, Gowa district, South Sulawesi, Indonesia, in October 2017 up to March 2018. Morphological and physiological analyses were performed on 31 S. macrophylla leaf samples. The morphological parameters consisted of leaf color, leaf shape, leaf tip, leaf base, leaf margin, upper leaf surface texture, leaf venation, and tree diameter. Meanwhile, the physiological ones were chlorophyll content, leaf area, and water content. Leaf samples were divided into three colors, two leaf shapes, and three leaf base shapes. They also had tapered leaf tip, pinnate venation, and glabrous leaf surface. The chlorophyll content and leaf area had a very low coefficient correlation, whereas leaf area and water content showed very high coefficient correlation. The relation between morphology and physiology could be determined by the correspondence between chlorophyll content and leaf color. The higher chlorophyll content, the greener the observed leaf.

1. Introduction

Mahogany (Swietenia sp) is commonly planted as a protection tree due to its resistance to heat and high adaptability to a great variety of environments. This species has been developed since Dutch colonization in Java Island and has high economic value. Thus it is suitable to be cultivated as industrial raw materials. Furthermore, besides as industrial material, it is also suitable for furniture, carving crafts, and handicrafts as having strong reddish timber. Its timbers' quality is almost as good as teaks' thus it is often known as the second excellent timber after teak. Based on its leaf, it is divided into two classes, small leaf mahogany (*Swietenia mahagoni*) and big leaf mahogany (*Swietenia macrophylla*). The small leaf variety has better quality than the big one.

Ecophysiological parameters are valuable tools for understanding the complex processes of interrelated physiological functions. The one study examined the physiology and anatomy characteristic of two leading apple cultivars in Korea [1]. S. macrophylla thrives easily in a broad range of soil types and regions. Study on S. macrophylla [2] stated that the genetic diversity of this species is quite high. Some information about genetic diversity and mating system in trees also was previously reported by [3-5]. Having high genetic diversity causes a high level of phenotype variation, and consequently, analyses on morphology and physiology need to be done [6].

Plant morphology is required for determination and classification of a species into its class correctly by identifying the plant visually. The observations are performed on roots, trunk, leaves, and inflorescences that provide information on both quantitative and qualitative specific characteristics, particularly shape, size, color, and texture [7]. Meanwhile, physiological observations encompass chlorophyll and water contents that can present metabolic processes in the plants. Both observations are important in identification and genetic relationship studies among plant individuals.

Here, we present morphological and physiological identifications and their correlations of Abangares S. macrophylla in Genetic resources area of 2nd Forest Seed/Seedling Office in Gowa. Findings of this study will be complemented the information of previous studies on genetic diversity [3] and pollen dispersal pattern [2] of this population. Thereby, we will be able to distinguish between S. macrophylla and other Mahogany species.

2. Material and Method

The study was conducted in October 2017 to March 2018. Leaf samples selected in this present study were 20% (31 tree individuals) of mahogany (*Swietenia macrophylla*), big leaf mahogany variety, originated from Abangares provenances that randomly collected at genetic resource area of 2nd Forest Seed/Seedling Office, Gowa district, South Sulawesi, Indonesia.

Morphological and physiological analyses were done in Biotechnology and Tree Breeding Laboratory, Faculty of Forestry, Hasanuddin University, Makassar, South Sulawesi, Indonesia.

Sample collection

An adult leaf was collected from the base of each tree and then stored in an envelope with tree code on it. Morphological observations in this study were adult leaf color, leaf shape, leaf tip, leaf base, leaf margin, upper leaf surface texture, leaf venation, and tree diameter. Physiological observation consisted of chlorophyll content, leaf area, wet weight, dry weight, and water content contained in the leaf.

Leaf area (cm^2) was measured using leaf area meter. Chlorophyll content was measured by chlorophyll meter (SPAD-502) at three leaf parts (base, middle, and tip without leaf venation). The mean of measurements was then calculated with the formula of $Y = 0.0007x - 0.0059$, where Y = chlorophyll content and x = measurements of the chlorophyll meter (SPAD-502) (Farhana, et al., 2007). Water content was assessed using the oven method (SNI 01-2891-1992 point 5). Leaf samples were weighted to determine the wet weight and followed by drying the leaves in the oven at 60^0C for 48 hours. After drying, the leaves were reweighted to represent the dry weight. At last, the water content (%) for each sample was calculated with ((wet weight-dry weight) / wet weight) x 100%).

Data analysis

All morphological variables (except for tree diameter) were presented in tables and figures. All statistical data analyzed using R software were in the form of the variance, standard deviation and coefficient correlations between leaf area and chlorophyll content and also between leaf area and water content.

3. Results and discussion

3.1. *Morphological Characteristic*

Morphological characteristics of *S. macrophylla* in the research plot showed different leaf colors, 18 dark green, 12 green, and one yellowish green, respectively. S. macrophylla leaf color is generally red and then changed over time into green [8]. On another hand, young leaves have

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greener color due to the distribution nutrients to leaves. Leaves undergoing senescence tend to receive more nutrients and have more chlorophyll content than the young ones [9].

Table 1. Leaf color

No.	Leaf color	Figure	Tree code
1.	Dark green		2, 4, 39, 40, 112, 145, 176, 202, 159, 161, 153, 149, 113, 97, 61, 26, 72, 21
2.	Green		81, 80, 111, 135, 144, 168, 170, 65, 76, 131, 70,116
3.	Yellowish green		67

The variations on leaf color proved that there were varieties in pigmentation types contained in the leaves. Chlorophylls in young leaves are in the form of protochlorophyll and leaves will change to green after protochlorophyll transformation [10]. Most of the chlorophylls are located in the leaf but there are also chlorophylls that can be found in roots, trunks, fruits, seed, and even inflorescence but only in limited number. Distribution of chlorophyll in a tree is varied, for instance, chlorophylls in leaf base are different from in leaf tip, middle, and margin. The differences in chlorophyll number can eventually lead to a wide variety of leaf color [11].

Leaf shed process will be followed by color changing. As water supply is crucial in plant photosynthesis, the low water content will limit even prohibit photosynthesis process, and consequently water keeps evaporating, chlorophyll content reduces, and leave change into yellow or brown color and at last shed the leaves [9].

Temperature plays a role in leaf color change. However, [12] stated that mahogany grown in high altitude areas (lower temperature) show color changing at almost the same time as the ones grown in lower areas (higher temperature). It is indicated that leaf color change on mahogany tends at a similar level.

There were different leaf shapes on the observed S. *macrophyllas'* leaves. As many as 21 ovals and ten lanceolate leaf shapes were found in the observation. In contrast to [13] that reported S. macrophylla has oblong leaves, this study observed two types of leaf shapes (oval and lanceolate). It was assumed to be induced by internal and external factors.

Table 2. Leaf shape

No.	Leaf shape	Figure	Tree code
1.	Oval		2, 4, 40, 81, 112, 111, 145, 170, 176, 202, 159, 149, 131, 113, 72, 70, 67, 61, 26, 21, 76
2.	Lanceolate		39, 80, 135, 144, 168, 161, 153, 97, 65, 116

Internal factor influenced leaf shape is a gene. Gene is a *hereditary substance* which inherited from parents to their progenies. Genes control the characters and traits of an organism that regulate plant shape, inflorescence color, fruit flavor, and so forth. They also control metabolism processes in the plants which code plant growth and development [14].

External factor affecting plant morphology is an environment where the plant is grown. Those environmental factors are soil type, water supply, light intensity and exposure duration, growing space, and temperature. Information about soil type where the research conducted is latosol which composed a high amount of iron and aluminum oxides with red, brown, or yellowish in color. Its texture is generally clay and having fast to low infiltration [15]. Water affects the morphology of the plant. Physiologically, plants that grow in a dry area with limited water supply develop spongy tissues in the trunk for storing the water.

Furthermore, another adaptability of plants against limited water is changing their leaves from standard size to sharper and smaller (sword-shaped) in order to reduce transpiration [16]. Mahogany needs low light intensity for growing and over time requires full-time light, also known as a semi-tolerant plant [17]. Good growing space accompanied by sufficient carbohydrate will support canopy growth and cause leaf number and tree height becoming genetic characteristics which positively affected the tree development [18]. A plant requires a specific temperature during its life. Improper temperature will inhibit plant development [12].

S. *macrophyllas'* leaf tip is tapered. [13] reported leaf tip of S. macrophylla is generally acutus which is if both leaves edges on the right and left sides of leaf midrib gradually go up and merge at the top forming a sharp angle.

Table 3. Leaf tip

No.	Leaf tip	Figure	Tree code
1.	Tapered		All trees

In contrast to [13] who stated that S. macrophylla has acute leaf base, here, we observed 12 obtuse leaves, 16 acute leaves, and three inequilateral leaves, respectively.

Table 4. Leaf base

No.	Leaf base	Figure	Tree code
1.	Obtuse		2, 40, 81, 80, 112, 202, 149, 131, 113, 72, 61, 26
2.	Acute		39, 135, 145, 144, 168, 170, 159,161, 153, 97, 70, 67, 21, 65, 76, 116
3.	Inequilateral		4, 111, 176

The difference in the shape of leaf base is assumed due to several factors, undesired mixing in plant materials (with other provenances) during planting and environment condition. Several environmental factors affecting plant growth are sunlight, temperature, humidity, soil nutrition, shade, and competitor. Based on these environmental factors, the air becomes a vital factor that influences the anatomical structure of leaf because the leaf is a central part of a plant that has direct interaction with the surrounding air and thus it can affect activities in the leaf.

Leaf margins of the observed leaves consisted of 30 entire leaves and one repand leaf. The observation was in contrast to [13] who reported that S. macrophylla only has the entire leaf margin. It was presumed that there was because of likely accidental misplanting with plant materials from other provenances. Therefore, it is necessary to do further analysis on the genetic diversity of S. macrophylla in this research side, in particular for tree #116.

Table 5. Leaf margin

No.	Leaf margin	Figure	Tree code
1.	Entire		2,4, 39, 40, 81, 80, 112, 111, 135, 145, 144, 168, 170, 176, 202, 159, 161, 153, 149, 131, 113, 97, 72, 70, 67, 61, 26, 21, 65, 76
2.	Repand		116

There was only one leaf venation type in the observed samples, pinnate leaf venation. [13] described pinnate leaf venation possessed by S. macrophylla as veinlet arranged at both sides of vein/midrib.

Table 6. Leaf venation

No.	Leaf venation	Figure	Tree code
1.	Pinnate		All trees

The leaf surface texture of all samples was glabrous which smooth and shiny leaf without any hair. It was supported by [8] who showed that S. macrophylla has glabrous leaf texture on its surface.

Table 7. Leaf surface texture

No.	Leaf surface texture	Figure	Tree code
1.	Glabrous		All trees

Tree diameter was grouped into six classes with a range between 12,10 cm to 38,32 cm. The lowest class was on 12,10 - 16,47 cm and the highest one was 33,96-38,32 cm. The highest number of tree was in class 25,22 cm – 29,58 cm (nine trees), whereas that of the lowest one was in class 29,59 – 33.95 (none). Frequency distribution of tree diameter is presented in Figure 1. Mean of tree diameter were 23,31 cm. Meanwhile, standard deviation and variance of the observed samples were 6,856 cm and 47,017 cm2, respectively. The previous study by [19] also analyzed standard deviation (1,50 cm) and mean of tree diameter (6,31 cm) on two-year S. macrophylla.

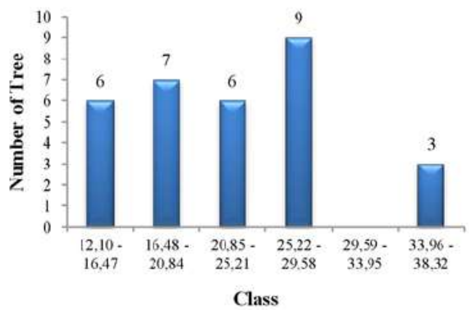

Figure 1. Frequency distribution of tree diameter of Abangares S. macrophylla in genetic resource area of 2nd Forest Seed/Seedling Office, Gowa

Diameter is one of the observation variables used for determining the growth of a plant. Diameter growth is influenced by photosynthesis activity. Diameter growth takes place when photosynthesis results for respiration, leaf replacement, root development as well as height are achieved [20].

The difference on tree diameter is assumed to be as the results of the influence of genetic and environmental factors. At least there are three environmental factors and one genetic factor that can affect diameter and height of the tree, which are soil nutrients, humidity, light as well as genetic characteristics of height and diameter growth of a tree [20].

Genetic factors have inherently controlled a trait, thus it is conserved in a specific environmental condition. The conserved traits of the tree encompass morphology, growth rate, and wood color. Although mutation may occur, it is scarce.

The environmental factor that can influence the size of tree diameter is quality of growing condition. According to [17] the quality of growing condition induces variation on tree growth and wood formation. Good Environment condition produces trees with superior characters, and vice versa, due to different nutrient and water supplies. This study site was categorized as low soil fertility because there were many rocks around the tree which could inhibit tree growth.

Moreover, tree stand density also takes a part in diameter development. Low density will eliminate competition between trees and every tree will be exposed to sunlight evenly. The tree tends to accelerate canopy formation if growing space allows it to be exposed by full-time light. On another hand, planting with high tree density speeds up the contact among tree canopies and forms competition among trees in the stand. If the competition begins, the growth will be focused on tree height and natural canopy shedding at the lowest branches. On this condition, diameter growth will be inhibited [17].

Physiology Characteristic

Chlorophyll is a photosynthetic pigment in a plant that absorbs red, blue, and purple lights, and reflects green light as its characteristic color. Higher chlorophyll content in the leaf, the higher productivity, and index of a plant will be. Leaf possessing high chlorophyll content is expected to be more efficient in absorbing energy from sunlight for photosynthesis process.

Mean of chlorophyll content was 0,03138. The measurement showed 0,00282 of standard deviation, whilst the variance of it was 8,0048. Chlorophyll content was grouped into six classes (0,023803 up to 0,036090) where the highest frequency was in class 0,030043 – 0,032058 (12 trees) and the lowest one was in class 0,023803 – 0,026010 (1 tree, tree #153)

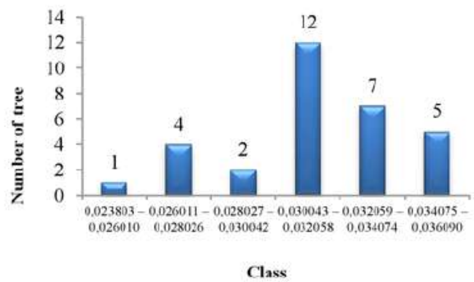

Figure 2. Frequency distribution of chlorophyll content of Abangares S. macrophylla in genetic resource area of 2nd Forest Seed/Seedling Office, Gowa

An approach to determine chlorophyll content in a leaf is by measuring the greenness of the leaf. The greener leaf is assumed containing higher chlorophyll. The measurement detected green and dark green leaves had high chlorophyll. Tree #2 (Table 1) contained high chlorophyll (0,03299) with dark green color. On the contrary, tree #67 which had yellowish green leaf had low chlorophyll content (0,02774).

Rahayu et. al [21] explained that chlorophyll content directly regulates photosynthesis process and eventually controls plant growth and development. The mechanism of chlorophyll in increasing the quality and production of the plant begins when chlorophyll actively converts CO_2 and H_2O into carbohydrates ($C_6H_{12}O_6$) and oxygen with the help of sunlight. The produced energy is then utilized by the plant in growth processes and the formed carbohydrates become dry ingredients that accumulate nutrient in the form of proteins and other substances in the plant [22]. High chlorophyll content will increase the rate of photosynthesis, and finally, it improves the quality and production of dry ingredients [23].

Leaf area was divided into six frequency classes between 22,7 cm^2 and 91,28 cm^2. The lowest frequency of leaf area was in class 57,00 – 79,85 cm^2 (one tree), whereas the highest one was in class 22,70 – 34,13 cm^2 and 34,14 – 45,56 cm^2, ten trees, respectively (Figure 3). Mean of leaf area, standard error and variance were 45,1, 18,120, and 328,352, respectively.

Leaf area can represent chlorophyll content comprised in a leaf [24]. Also appointed that leaf area is associated with an increase in chlorophyll content which has a positive contribution in photosynthesis, growth rate as well as plant productivity.

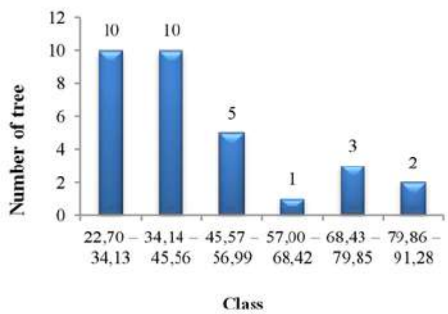

Figure 3. Frequency distribution of leaf area of Abangares S. macrophylla in genetic resource area of 2nd Forest Seed/Seedling Office, Gowa

The broader surface of the leaf is expected to have more amount of chlorophyll. For instance, as in tree #61 with fairly large leaf area (81,4 cm^2), it also had a considerable amount of chlorophyll (0,03285). Unlike tree #61, tree #67 had small leaf area (25,5 cm^2) that caused it also had low chlorophyll content (0,02774). However, correlation analysis detected a very weak correlation between leaf area and chlorophyll content (0,20).

Similar to chlorophyll content and leaf area, water content was also grouped into six classes. The highest frequency of it was in class 46,96 – 63,04 % (ten trees), while the lowest frequency was in class 46,96 – 49,64 % (one tree). Mean of water content, standard error, and variance, respectively, were 57,06%, 3,60%, and 12,97.

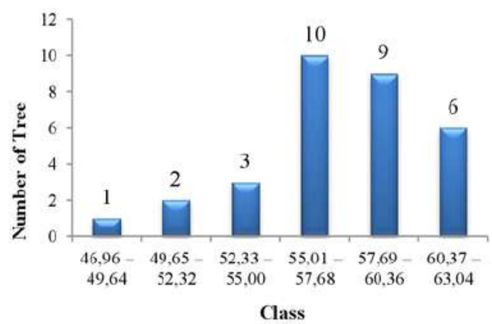

Figure 4. Frequency distribution of water content of Abangares S. macrophylla in genetic resource area of 2nd Forest Seed/Seedling Office, Gowa

The existence of water plays a crucial role in plant growth and development. The growth of a plant can be measured by dry weight and its relative growth rate. Dry weight in the form of total biomass is the accumulation of metabolic process in the plant. Plant biomass comprises photosynthesis results, nutrients, and water. Dry weight is able to present plant productivity as 90% of photosynthesis results accumulated into dry weight.

Water requirement for every plant is varied according to the plant type and growth phase. In the dry season, plant experiences water stress because limited water supply in the root areas and evapotranspiration rate exceeds water absorption by the roots [25]. Transpiration is controlled by internal and external factors. Internal factors consist of leaf size, leaf thickness, cuticular leaf waxes, leaf surface texture, as well as stomata number, shape, and location. Meanwhile, external factors are humidity, temperature, wind, light, and water content. Coefficient correlation between water content and leaf area was 0,91 which indicated a very strong correlation. [25] mentioned that leaf area influences

the transpiration rate. It is because large leaf has more stomata number, and thus the transpiration rate will be increased.
In this research used SPAD chlorophyll meter reading (SCMR), the same as can use to measured photosynthetic characteristics and water use efficiency (WUE) at 7 and 30 days after imposing drought in *arthicoke Jerussalem*. The result indicated that Jerusalem artichoke genotypes subjected to drought had dark leaf color than did Jerusalem genotypes grown under irrigated conditions.

In most plants, the leaf functions as a solar panel, where photosynthesis converts carbon dioxide and water into carbohydrates and oxygen. To produce structures that can optimally fulfill this function, plants precisely control the initiation, shape, and polarity of leaves. Moreover, leaf development is highly flexible but follows common themes with conserved regulatory mechanisms. Physiological analysis on leaf area was affected by provenance but not by leaf collecting position. Chlorophyll content was affected by both provenance and collecting position. Meanwhile, water content was not affected by provenance, but by collecting position. According to chlorophyll content can be measured by greenness level of the leaf. The greener of a leaf, the higher the chlorophyll content in it.

More recent work has shown that mechanisms used the leaf to experiments[26,27], and [28] this shows how much important information can be obtained from plant leaves. [29] also reported decreasing on chlorophyll content and distribution of nutrients induce color changing from green to orange, reddish yellow, or purple on the leaves of Teak. Leaves exhibit considerable morphological diversity within and between species. Other research to show how the leaf development framework is rewired to produce the amazing diversity of leaf shape among species and cultivars [29,30]

4. Conclusion

S. macrophyllas' leaf color was divided into three, dark green, green and yellowish green. Leaf shape was grouped into oval and lanceolate. All observed leaves had tapered leaf tip with three types of leaf base, obtuse, acute, and inequilateral. In addition, the evaluated leaves showed two leaf margins (entire and repand), pinnate leaf venation, and glabrous upper leaf surface texture. The highest frequency of tree diameter was in class 25,22 – 29,58 cm as many as nine trees.

The highest frequency of chlorophyll content wan in class 0,030043 – 0,032058 (12 trees), whereas that of the highest frequency for leaf area was in class 22,70 – 34,13 and class 34,14 – 45,5 (10 leaves, respectively). Furthermore, that of the highest for water content was in class 55,01 – 57,68 % (ten trees). There was a very low correlation between chlorophyll content and leaf area (0,207). Conversely, a very strong correlation was detected between water content and leaf area (0,91).

The relation between morphology and physiology of Abangares S. macrophylla in genetic resource area of 2nd Forest Seed/Seedling Office was presented on correspondence between chlorophyll content and leaf color. The higher chlorophyll content, the greener the leaves were observed.

References

[1] Bhusal N S J B T-M Y 2018 Comparisons of physiological and anatomical characteristics between two cultivars in bi-leader apple trees *Sci. Hortic* **231** 73–81
[2] Sari 2017 Pola Penyebaran Serbuk Sari Mahoni (Swietenia mahagoni (L.) Jacq) Berdasarkan Marka Molekuler Mikrosatelit (Universitas Hasanuddin)
[3] Restu., M G and S H L 2017 High Outcrossing Rate And Pollen Dispersal Distance Of Diospyros Celebica Bakh, An Endem. Tree Species Sulawesi Island, Indones. *Biotropia* **24** 3–173
[4] Gusmiaty, M.A. Arsyad, S.H. Larekeng, A.S. Zulfiana N A dan I 2018 Amplifikasi Penanda SSR untuk Analisis Keragaman Genetik Jati (Tectona grandis Linn. f.) Provenansi Sulawesi Tenggara *Prosiding Seminar Nasional Silvikultur V* (Makassar) pp 388–95

[5] Larekeng., SH, M. Restu, Gusmiaty S M and B B 2018 Moderate Level of Genetic Diversity in Anthocephalus macrophyllus Roxb, an endemic tree of Sulawesi and Its Implication in Conservation *Int. J. Agric. Syst.* **6** 74–81
[6] Martawijaya, A., Kartasujana, I., Kadir, K., Prawira S 2005 *Atlas Kayu Jilid I, II, III Departemen Kehutanan.* (Bogor: Institut Pertanian Bogor) p 89
[7] Yulia, N, D. dan J 2007 Tinjauan Terhadap Morfologi Tanaman dan Anatomi Daun *Bul. Kebun Raya Indoesia* **10** 49–52
[8] Samsi 2000 Analisis Keragaman Genetik pada Tanaman Mahoni Daun Besar (Swietenia macrophylla King) di Kebun Benih Parung Panjang (Bogor: Institut Pertanian Bogor) p 26
[9] Nurdin., Kusharto, C., Tanziha, I., Januwati M 2009 Kandungan Klorofil Berbagai Jenis Daun Tanaman dan Cu-Turunan Klorofil Serta Karakteristik Fisiko-Kimianya *Gizi dan Pangan* **4** 13–9
[10] Sumenda, L., Rampe, H., Mantin F R 2011 Analisis Kandungan Klorofil Daun Mangga (Mangifera indica L.) pada Tingkat Perkembangan Daun yang Berbeda *J. Bioslogos* **1** 20–4
[11] Adip, M.S., Hendrarto, B., Purwanti F 2014 Nilai Hue Daun Rhizophora: Hubungannya dengan Faktor Lingkungan dan Klorofil Daun di Pantai Ringgung, Desa Sidodadi, Kecamatan Padang Cermin, Lampung *Manag. Aquat. Resour.* **3** 20–6
[12] Rahayu, D., Rahayu, W, P., Lioe, , N., Herawati, D., Broto, W. A 2015 . Pengaruh Suhu dan Kelembapan Terhadap Pertumbuhan Fusarium verticillioides Bio 957 dan Fumonisin B1 **35** 156–62
[13] Prasetyono. 2012 Serangan Penggerek Pucuk Mahoni (Hypsiphylla robusta Moore) Pada Tegakan Mahoni Daun Lebar (Swietenia macrophylla King) Umur Satu Tahun di Tasikmalaya (Bandung: Akademi Kehutanan Bandung) p 67
[14] Ai N dan B 2011 Konsentrasi Klorofil Daun sebagai Indikator Kekurangan Air pada Tanaman. *J. Ilm. Sains* **11** 166–73
[15] Murasa, H., Sumono. I N 2016 Kajian Penyebaran Air di Daerah Perakaran pada Beberapa Jenis Tanah dan Tanaman dalam Skala Laboratorium *Ketekhnikan Pertan.* **4** 102–8
[16] Purwito, A., Sari, L., Sopandie D 2015 Karakterisasi Beberapa Morfologi, Anatomi dan Fisiologi Mutan Gadum (Triticum aestivum L.) Dewata dan Selayar di Dataran Rendah Tropis *Widyariset* **1** 21–30
[17] Paembonan 2012 *Hutan Tanaman dan Serapan Karbon* (Makasar: Masagena Press)
[18] Rochman F dan H 2017 Keragaan Karakter Morfologi, Stomata, dan Klorofil Enam Varietas Tembakau Lokal Tulungagung. *Bul. Tanam. Tembakau, Serat dan Miny. Ind.* **9** 15–23
[19] Rahmadi 2012 *Pertambahan Diameter dan Tinggi Jati (Tectona grandis) pada Umur 3 Tahun di Kelurahan Karya Merdeka Kecamatan Samboja* (Samarinda : Manajemen Hutan Politeknik Pertanian Negeri Samarinda) p 34
[20] Davis L . dan K N J 1987 *Forest Management* (New York: . Mc Graw-Hill Book Company) p 146
[21] Long, SP, Zhu, XG, Naidu S & O 2006 Can Improvement in Photosynthesis Increase Crop Yields *Plant, Cell Environ.* **29** 315–330
[22] Hynninen P & L 2002 he Fungtions of Chlorophylls in Photosynthesis. Physiology and Maintenance *EOLSS* **5** 222–58
[23] Li, R, Guo, P, Baum, M, Grando S & C 2006 Evaluation of Chlorophyll Content and

Fluorecence Parameters as Indicators of Drought Tolerance in Barley *Agric. Sci. China* **5** 751–757

[24] Sulistyaningsih, E., Kurniasih, B. K 2005 Pertumbuhan dan Hasil Caisin pada Berbagai Warna Sungkup Plastik. *Ilmu Pertan.* **12** 122–6

[25] Papuangan, N., Nurhasanah., Djurumudi M 2014 Jumlah dan Distribusi Stomata pada Tanaman Penghijauan di Kota Ternate *Bioedukasi* **3** 287–92

[26] Shi, J., J.Dong, J.Xue, H. Wang, Z.Yang, Y.Jiao L X and H H 2017 Model for the role of auxin polar transport in patterning of the leaf adaxial-abaxial axis. *Plant J* **92** 469–80

[27] K., Saini, M.N. Markakis, M. Zdanio, D.M. Balcerowicz, T. Beeckman, L.D. Veylder, E.Prinsen G T S B and K V 2017 Alteration in auxin homeostasis and signaling by overexpression of PINOID kinase causes leaf growth defects in Arabidopsis thaliana *Front. Plant Sci* **8** 1009

[28] A., Runions M T and P 2017 A common developmental program can produce diverse leaf shapes *New Phytol* **216** 401–18

[29] Tsukaya 2014 Comparative leaf development in angiosperms *Curr. Opin Plant Biol* **17** 103–9

[30] Tsukaya 2018 Leaf shape diversity with an emphasis on leaf contour variation, developmental background, and adaptation *Semin. Cell Dev. Biol* **79** 48–57

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