ASSESSING MACARANGA SEEDLING GROWTH AND DEVELOPMENT IN FOREST UNDERSTOREY AND OPEN CANOPY AREAS IN UNIVERISTI MALAYSIA KELANTAN, JELI CAMPUS.

by

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A report submitted in fulfillment of the requirements for the degree of Bachelor of Applied Science in Natural Resources with Honours

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DECLARATION

I declare that this thesis entitled "ASSESSING MACARANGA SEEDLING GROWTH AND DEVELOPMENT IN FOREST UNDERSTOREY AND OPEN CANOPY AREAS IN UNIVERISTI MALAYSIA KELANTAN, JELI CAMPUS." is the result of my own research except as cited in the references. The thesis not been accepted and not been allowed for any research and is not concurrently submitted in candidature of any other research.

Signature :

Name : **SITI NUR HIDAYAH BINTI AMILKADO**

Date :

ACKNOWLEDGEMENT

In the name of Allah, the Most Beneficent, the Most Merciful. All praises and thanks to Allah, lord of universe and all that exists. Prayers and peace be upon His prophet, Muhammad, the last messenger of all humankind.

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LIST OF ABBREVIATION

ASEAN	Association of Southeast Asian Nations.
EXCEL	Spreadsheets to organize numbers and data with formulas and functions.
BAP	6- Benzylaminopurine, Benzyl adenine
FSB	Faculty of Earth Science
GA3	Gibberellic acid
PGR	Plant Growth Regulator
UMK	Univeristi Malaysia Kelantan

LIST OF SYMBOL

°C	Degree Celsius
°F	Fahrenheit
%	Percentage
Mgl-1	Milligrams per litre
Cm	centimetre
Km	Kilometre
mL	Mililitre
&	And
()	Parentheses
;	Semicolon
:	Colon
° N	North
° E	East

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"Assessing Macaranga seedling growth and development in forest uderstorey and open canopy in Universiti Malaysia Kelantan, Jeli Campus."

ABSTRACT

This study was conducted at campus, Universiti Malaysia Kelantan. The objective of this study is to test the germination period and development of seedlings in the laboratories of *Macaranga tanarius* (L) and compare seedlings growth rates understorey and open canopy environment on seedling morphology. Seeds and seedlings were obtained and collected from the Faculty of Earth Sciences (FSB), Universiti Malaysia Kelantan (UMK), Jeli Campus. This research problem statement, including Macaranga seedlings, is important for forest management and restoration efforts. Therefore, as many as 500 seeds tested in the laboratories to determine the number of seeds that live, germinate, and can grown, which is as much as 68% (340 seeds). Three plant growth regulators (PGRs), namely GA3, BAP, and kinetin, at three concentrations, were also applied to seeds as a pretreatment to test germination. The use of GA3 at 10 mg/L only succeeded in producing germination. As for the seedlings, there are 62 that have been identified in the observations that have been carried out. The data was analysed using Excel, which is arranged according to each group to determine if there is a difference between the trees that grown under the canopy and those that grown outside the canopy. This means there are factors that can affect the growth rate, the number of leaves, and the height of the Macaranga tree. The results of the processed data shows that the seedlings that live in an open canopy environment are higher, with as many as 34 seedlings compared to those that grow under the canopy, which have as many as 28 seedlings.

"Menilai pertumbuhan dan perkembangan pokok Macaranga di kawasan hutan yang pokok tertutup dan kanopi terbuka di Universiti Malalaysia Kelantan, Kampus Jeli."

ABSTRAK

Kajian ini telah dijalankan di kawasan sekitar campus, Universiti Malaysia Kelantan. Objectif kajian ini adalah untuk menguji tempoh percambahan dan perkembangan anak benih di makmal *Macaranga tanarius* (L) dan membandingkan kadar pertumbuhan anak benih bawah tingkat dan persekitaran kanopi terbuka pada morfologi anak benih.. Benih-benih dan anak-anak pokok *Macaranga tanarius* (L) telah diperolehi dan dikumpul daripada Fakulti Sain Bumi (FSB), Universiti Malaysia Kelantan (UMK), Kampus Jeli. Pernyataan masalah kajian ini, termasuklah anak benih Macaranga adalah penting untuk pengurusan hutan dan usaha pemulihan. Oleh itu, sebanyak 500 biji benih yang telah diuji dimakmal dalam menentukan bilangan biji benih yang hidup, bercambah dan boleh berkembang adalah sebanyak 68% sahaja (340 biji benih). Tiga pengawal selia pertumbuhan tumbuhan (PGR), iaitu GA3, BAP dan kinetin pada tiga kepekatan turut digunakan pada biji benih sebagai prarawatan untuk menguji percambahan. Penggunaan GA3 pada 10 mgl-1 telah berjaya menghasilkan percambahan. Manakala bagi anak pokok pula, terdapat 62 anak pokok yang telah dikenalpasti dalam pemerhatian yang telah dijalankan. Data dianalisis menggunakan EXCEL iaitu disusun mengikut kumpulan masing-masing untuk menentukan sama ada terdapat berbezaan antara pokok yang tumbuh dibawah kanopi dan yang tumbuh diluar kanopi. Ini bermakna, terdapat faktor yang boleh mempengaruhi kadar pertumbuhan , bilangan daun dan ketinggian pada pokok Macaranga. Hasil daripada data yang diproses menunjukkan bahawa anak pokok yang hidup dalam persekitaran kanopi yang terbuka adalah lebih tinggi iaitu sebanyak 34 anak pokok berdanding dengan yang tumbuh dibawah kanopi iaitu sebnayak 28 anak pokok..

CHAPTER 1

INTRODUCTION

1.1 Background of Study

According to Govaerts, R., *et al* (2019), was describes about the Macaranga is a genus of pioneer trees commonly found in tropical forest. Understanding the growth and development of Macaranga seedlings is crucial for forest management and restoration efforts, as they play key role in the regeneration of disturbed areas. One of the main factors influencing seedlings growth is light availability. Macaranga seedlings can be found in both shaded understorey and well-lit open canopy environments. In general, seedlings of pioneer species like Macaranga are adapted to grow in high light conditions and may struggle in deep shade.

Previous studies have shown that Macaranga seedlings exhibit different growth pattern and morphological charateristics depending on the light environment. For examles, seedling in open canopy area tend to have faster growth rates, larger leaves, and more robust stems compared to those in the understorey. However, there is still limited information on the specific growth and development of Macaranga sedlings in different light regimes. Most studies have focused on the genus as a whole or on other pioneer species species. More research is needed to understand the light requirement and adaptability of Macaranga seedlings to inform forest management decisions and reforestation efforts.

By comparing the growth and morphology of Macaranga sedlings in understorey and open canopy enviroment, this study aims to provide valuable into the light preferences and growth potential of this importat pioneer genus. The findings can help guide the selection of appropeite Macaranga species for restoration projects and inform management practies that promote natural regenerartion in disturbed tropical forests. (Ferry Silk, 2003).

1.2 Problem Statement

Macaranga is a genus of trees commonly found in tropical forests, and understanding the growth and development of Macaranga seedlings is crucial for forest management and restoration efforts. However, little is known about how these seedlings respond to varying light conditions, particularly in the understorey and open canopy areas of the forest. This research aims to address this gap by investigating the growth patterns and morphological characteristics of Macaranga seedlings in both shaded understorey and well-lit open canopy environments. By comparing seedling height, diameter, leaf shape, size, and color, the study seeks to determine if there are significant differences in growth and development between the two light regimes. The findings of this research will provide valuable insights into the light requirements and adaptability of Macaranga seedlings, which can inform decisions regarding forest management practices and the selection of appropriate species for reforestation projects.

1.3 Objective

The objectives of this research which are:

i. To test the germination period and development of seedlings in the laboratories.
ii. To compare seedlings growth rates understorey and open canopy environment on seedling morphology.

1.4 Scope of Study

The scope of this study examines how different light conditions in a forest affect the growth of Macaranga seedlings. It compares seedlings growing in shaded areas with those area with more light. The research aims to understand how seedlings adapt to varying light levels and how this affect their growth and survival. By studying the effect of light on seedlings, the study can help predict how forest will recover and change over time.

1.5 Significance of Study

The significance of this study on Macaranga seedlings growth and development in forest understorey and open canopy enviroments lies in its contribution to understanding how these seedlings adapt to varing light conditions. By comparing seedling growth and morphology in shaded understorey and well-lit open canopy areas, the research aim to identify the key properties of tree seedlings regulating their growth responses to enhanced light conditions. This knowledge is crucial for predecting forest regeneration and succession processes, as well as informing forest management practies that promote the growth and survival of Macaranga seedlings.

CHAPTER 2

LITERATURE REVIEW

2.1 Previous Studies of Macaranga Ecology and Physiology.

2.1.1 Morphology and Anatomy of Macaranga Species.

The genus Macaranga family (Euphorbiaceae) well knowns as Mahang in local name contains about 280 species, and it is found in west Africa and the south Pacific islands. Numerous habitat types are home to them, including sandy-loam and limestone soils, dry to swampy or even flooded terrain, and the understorey of forests to entirely open scrub vegetation (Whitmore 1975). They also show a great variety of life-histories, with typical shade-pre-ferring forest understory species as well as typical shade-avoiding pioneer species (Silk *et.al*, 2000). According to Elias and Sun (1985) and Fiala *et.al,* (1999), certain species are also myrmecophytic, whilst others are not. The focus of diversity for this genus is Borneo and New Guinea (Whitmore, 1969). The species include pioneers that require bright light and understory shrubs and small trees that can withstand shadows. Macaranga's large stem densities and variety of species (about 55 reported).

Both genera are members of the tribe Acalyphee, subfamily Acalyphoideae. *Mallotus* is a member of the subtribe Rottlerinae, but Macaranga is the only genus in the sub-tribe Macaranginae (Webster, 1994). The groups' arrangement within various subtribes implies that the genera are fairly unique and distinct from one another. Nonetheless, it is frequently challenging to distinguish them morphologically.

The standard Malaysia name as well the ASEAN Standard Name for the timber *Macaranga* spp. There are vernacular names of this plant including, *Benuah* (Sarawak), *kubin* (Peninsular Malaysia), *linkabong* (Sabah), *mahang* (Peninsular Malaysia) with different epithets, *marakubong* (Sabah), *merkabong* (Sabah), *mesepat* (Peninsular Malaysia), and *sedaman* (Sabah) with different epithets are examples of vernacular names. Some of the more notable species are *M. gigantea, M. hosei, M. hypoleuca, M. lowii, M. pruinosa,* and *M. winkleri.* The heartwood, which is pale yellow-brown and sometimes has a pink tint, cannot be distinguished from the sapwood. Also known as *Mavu (Fiji); Mahang Kapur and Mahang manggong* (Indonesia); Petawaing (Myanmar); *Macaranga* (Papua New Guinea); *Hamindang* (Philippines); *Lau-pata* (Samoa Islands); and *Lo* (Thailand).

The ants reside within the hollow stems of the plants, where they get their nourishment from the food bodies the plants generate and the honeydew that is collected from scale insects housed inside the stems. Only occupied Macaranga plants have these association-specific scales. The Macaranga species (Euphorbiaceae), which are paleotropical trees, coexist well with ants.

2.1.2 Factor Affecting Macaranga Growth

These plants have mechanisms that allow them to withstand the intense biotic stress brought on by the high herbivore and pathogen pressure that is typical of many secondary forests. Nutrients are frequently limiting for plant development and reproduction in the tropics, this is particularly true for the severely degraded soils found in many open, secondary systems. According to Burslem (2004) was mentioned that the processes of recovery after disturbance are described by the mechanisms of forest regeneration, which are influenced by changes in microclimate and resource availability brought about by gap construction. Both sexual and vegetative mechanisms of reproduction are used in the process of regeneration. It starts with the germination of seeds, which either come from the seed bank in the buried soil or enter the gap after it has been formed, or it starts with the release of seedlings and saplings that were already there when the gap was formed (advanced regeneration). Some trees possess mechanisms that increase the likelihood that they germinate and grow rapidly in response to the environmental conditions that are stimulated by gap creation.

According to Heather *et.al,* (2013), it was describes that insect–plant interactions, biomechanical aspects can have intricate ecological and evolutionary ramifications. Certain insects have developed defensive mechanisms that enable them to securely ascend on slick, greased, or sticky surfaces. For instance, the majority of insects are unable to climb the slippery, waxy stems of many *Macaranga spp* ant plants; nevertheless, the specialist ant partners of these trees are able to do it with ease, as they are known as "waxrunners." In addition to providing a more effective biotic defence against herbivory for the host plant by shielding the resident ant colonies from predators and competition, the Macaranga "wax barriers" also serve as an ecological isolation mechanism between various ant partner species that are either waxrunners or non-waxrunners.

The evolutionary arms race that has been outlined for chemical adaptations may be analogous to the cycle of biomechanical adaptations and counteradaptations. It is likely that mechanical elements play a larger and more ecologically significant role in plant-insect connections than has previously been acknowledged. Studying mechanical adaptations for plant–insect interactions in isolation is challenging due to the intricate physiological processes of plant surfaces and tissues, and mechanical adaptations may be difficult to find in interactions that are more generalized. Selection pressures are only strong enough to produce unique effects in high-specificity associations (e.g., specific pollination syndromes, ant-plant mutualisms) or in environments where a single function predominates (e.g., plant carnivory). The physical modification of insect behaviour by plant surface topography is one understudied area where mechanical impacts are anticipated to be found in future research. Insects may be directed by the physical characteristics of plants since they are tactile learners, and plants may have evolved to take advantage of these sensory cues.

An extensive collection of pharmacological medications and insecticides are derived from the chemical compounds that evolved during insect-plant interactions. Plants' mechanical defences might be just as helpful. Novel synthetic coatings and surfaces, with potential applications ranging from fluid handling and biomedical devices to antifouling materials, have previously been inspired by the slick surfaces of plants.

2.1.3 Macaranga as a Pioneer Species

Macaranga is a plant species that can be found in most tropical and subtropical area. The medium-sized Macarang tree, which is native to southeast Asia, Australia, and the western Pacific islands, is grown in tropical climates all over the world for a variety of purposes, such as shade, firewood, lumber, and traditional medicinal items. Being a pioneer plant that grows quickly, secondary forests and cleared rainforests are common places to find it growing. Its spread is promoted by disturbance and hence rapidly colonises gaps or borders in well-developed rainforest (Australian Tropical Rainforest Plants, 2010). Macaranga is found mostly in regions with mean yearly rainfall of 950–4000 mm, at elevations ranging from 800 m to close to sea level (Florabank, 2015). It thrives in a variety of soil types including clay, loam and sand, and is rather prevalent in lowlands (World Agroforestry Centre, 2015).

2.1.4 Function in Ecology and Ecosystem.

The overuse of fossil resources for industrial purposes has come to the attention of humanity due to climate change and price fluctuations of fossil fuels in recent decades. Many efforts are focused on finding sustainable productions that don't harm the environment or ecosystems in order to build a sustainable future (Tukker *et. al,* 2017). The idea of a biorefinery is significant because it has the potential to significantly improve human society and advance the circular economy (Hingsamer & Jungmeier, 2019). Taiwan's low-lying regions are home to the macaranga, which is the main species of tree in tropical secondary forests (Tseng *et. al,* 2003). This plant, which is soft and comparatively light, can be utilized to manufacture wooden cases. Farmers in the area used to gather the Macaranga's high-fiber leaf biomass for their animals. This plant's fast growth, salt tolerance, drought resistance, and great wind resistance make it an appealing choice for planting as a biomass feedstock. Under the tree shade, the allelopathic macaranga plant displays a weed exclusion pattern (Tseng *et. al,* 2003). In order to protect itself from herbivores, the secret extrafloral nectar attracts predators and parasitoids (Heil *et.al,* 2001).

2.2 Light Requirement for Tropical Tree Species

According to Strauss-Debenedetti and Bazzaz, (1991), Davies, (1998); Davidson *et. al,* (2002) and Craven *et. al,* (2007) was mentioned that seedlings grow differently due to different leaf morphological and anatomical reactions to intense light. Slow-growing trees have lower photosynthetic rates and smaller, thicker leaves that increase drought tolerance, whereas fast-growing trees have large leaves that maximize light interception, high rates of carbon assimilation, and a greater susceptibility to drought. High trichome density, thick epicuticular waxes, elevated concentrations of pigments that protect against light damage, altered chloroplasts, and altered leaf movements are some other adaptations to intense light. These changes lessen damage to photosynthetic components and improve control over the physiological function of leaves.

CHAPTER 3

MATERIALS AND METHOD

3.1 Study Area

The study site was established in Universiti Malaysia Kelantan, Jeli (5.7007° N/101.8432° E). Seedlings was collected at the nearby forest area by the campus. This research was conducted at Faculty of Earth Sciences (FSB), covers an area of 31.66025 KM, almost all of areas, which is forested and has various species of trees. The trees found here are made up of various types and canopies, each of which functions as a substitute for the native trees. In this areas, there are trees that get direct light and some that do not get direct light. Figure 3.1 shows the Map Faculty of Earth of Science (FSB), Universiti Malaysia Kelantan (UMK).

Figure 3.1: Map of Faculty of Earth Science, Jeli Campus, Universiti Malaysia Kelantan. (Source: Google earth, 2023)

3.1.1 Temperature by Month in Jeli, Kelantan.

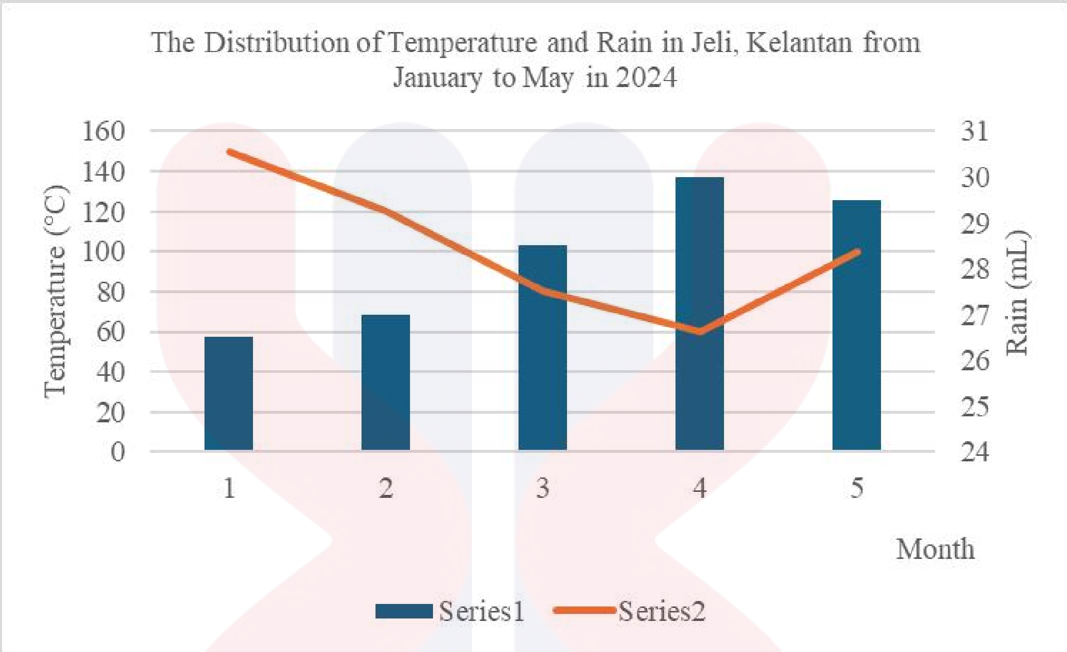


Figure 3.2: The Distribution of Temperature and Rain in Jeli, Kelantan from January until May 2024.

According to Shamsudin, (2023) was decribes, it can be said that every year from May to the end of August, Malaysia will experience extreme hot and dry weather and can cause drought in agricultural and forest areas. Based on the graph, the distribution of temperature in Jeli, Kelantan, from January until May 2024 is increasing; that is, starting in January, it was recorded as much as 26.5°C, followed by February, which was as much as 27°C, which is an increase of 0.5°C in that month. In March, the average temperature that has been recorded is also increasing, which is 28.5°C compared to February; this means that the temperature has increased by 1.5°C throughout the month. While for April, it is the highest temperature ever recorded among the months involved, which is 30°C ± 1.5 °C, which increased in that month. In May, it was the second-highest month after April, but there was a decrease of 0.5°C throughout the month.

Based on the graph, the rainfall in Jeli, Kelantan, from January to May 2024 is uncertain, this can be seen starting in January, it is recorded as much as 150mL and is also the highest distribution compared to other months. Followed by February was 120mL, which is a decrease of 30mL from January. Next, the March recorded readings of 80mL and decreasing as in February, this can be seen the difference between the months is as much as 40mL. For the April, it is said to be lower and decreasing which is as much as 60mL and is one of the months with the least amount of rainfall , this can be proven to have occurred a decrease of 20mL from March. In May, the distribution of rainwater that fell increased to 100mL, which is an increase of 40mL from the month of April.

Since this study was conducted around the month shown, that is, from January to May in 2024, the sampling was based on and took into account the distribution of temperature and rainfall in the study area. Therefore, it is possible that it also affects the rate especially the *Macaranga spp* trees in there area. In addition, it is also a factor that can encourage the growth and development of trees including the height and number per leaves on each seedling there.

3.2 Material

3.2.1 Collection of Macaranga Seedlings

In this study, the seeds and seedlings were collected and used by the Faculty of Earth Science (FSB) at Universiti Malaysia Kelantan (UMK). Besides, all of these items were identified and tagged during site selection. To find a Macaranga specimen that is suitable for the study. Later, all the mature trees selected were identified for data collection. Figure 3.3 shows the *Macaranga tanarius* (L) mature tree, Figure 3.4 shows the seedlings of the *Macaranga tanarius* (L) tree, and Figure 3.5 shows the tag of the seedlings.

Figure 3.3: *Macaranga tanarius* (L) Mature Tree.

Figure 3.4: Seedlings of *Macaranga tanarius* (L) Tree.

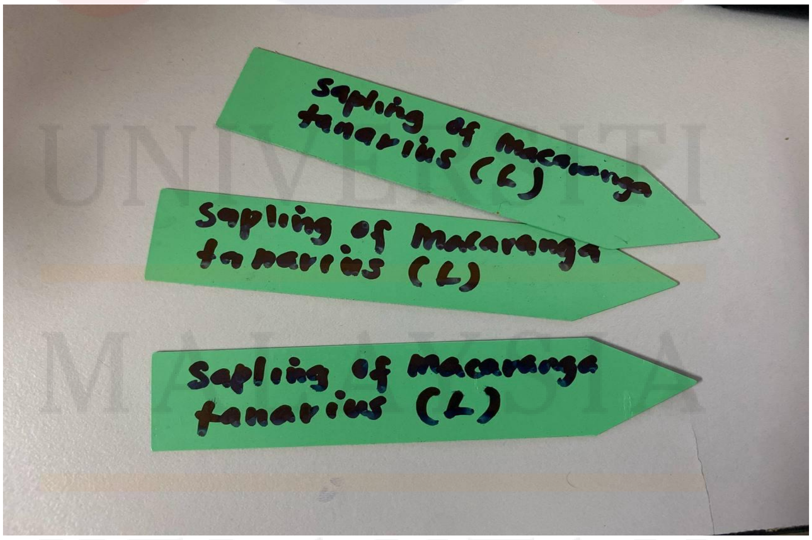


Figure 3.5: Seedlings Tagged of *Macaranga tanarius* (L) Tree.

3.2.2 Criteria of Species Selection.

Selected Macaranga species that are ecologically suitable for the reforestation target area consider factors such as climate to ensure they can thrive in the intended environment. Chosen the species known for rapid growth, as this is crucial for studying the effects of different light conditions on growth. The selected species should be able to survive and thrive in both bright and shaded environments.

The seedlings that have been successfully identified are given tags so that it is easy to count the number, measure the height, and count the number of leaves found on each seedling. Then were calculated the number of seedlings that live under mature trees, which means under canopy areas, and seedlings that can live in open canopy areas.

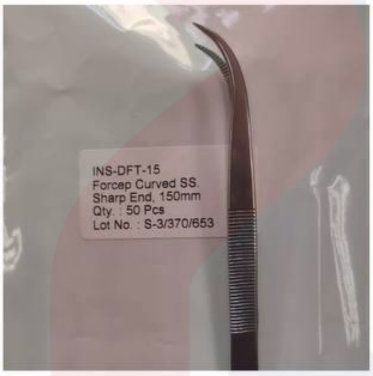
3.2.3 The Materials used in the Seed Germinations

In this research, the seeds used in the laboratories test for seed germination test is a *Macaranga tanarius* (L). We are used the fruits to test the seeds to see if they could survive in the environment and temperature. In this part, used materials such as seeds from its fruits, forceps, water, cutters, paper seeds, and a container.In this experiment, were used as many as 500 seeds, which are divided into two layer. There needed as many as 250 seeds in each stratum. It takes a day to open and take the seeds, then the bull is placed in a paper-lined for seeds in a container. After that, the seeds must sprinkled with enough water for the germination process. Through observations that have been made, there are seeds that germinate and can survive because they are influenced by certain factors. This process is run for a month to see and record the seeds that can survive and germinate with the mortality obtained. Figure 3.6 is shows the *Macaranga tanarius* (L) fruits and Figure 3.7 a) The seed of *Macaranga tanarius* (L), b) A water, c) forceps, d) A cutter, e) Seeds paper and f) Container 40cm x 35 cm .

Figure 3.6 : The *Macaranga tanarius* (L) Fruits.

a) The *Macaranga tanatius* (L) seeds.

b) A water.



c) Forceps.

d) A cutter.

e) Seeds paper.

f) Container 40cm x 35cm.

Figure 3.7 : a) The Seeds of *Macaranga tanarius* (L), b) a Water, c) Forceps, d) a cutter, e) Seeds Paper, and f) Container.

3.2.4 The Materials used in the Seedlings.

In this research, usually used common materials such as, tagging name, rubber gloves and PlanetNet Apps to conducted the cultivation of *Macaranga tanarius* (L) species. It also required two to three days for this studies data collection and sample counting. For the species we are searching for, we have utilised a tracking apps. This focus is to ensure that the seedlings are *Macaranga tanarius* (L). So, seedlings that have been identified must be tagged to facilitate the process of measuring and counting the average of height and number per leaves for each seedlings there. This part, were have conducted observations and collected data around at the Faculty of Earth Sciences (FSB). Figure 3.4 shows the tagging name of each seedlings. Figure 3.8 shows the sticker tag, Figure 3.9 is shows the rubber gloves, and Figure 3.10 is shows PlantNet Apps to easy identified the of *Macaranga spp*.

Figure 3.8 : Tagging for each Seedlings

Figure 3.9 : Rubber Gloves

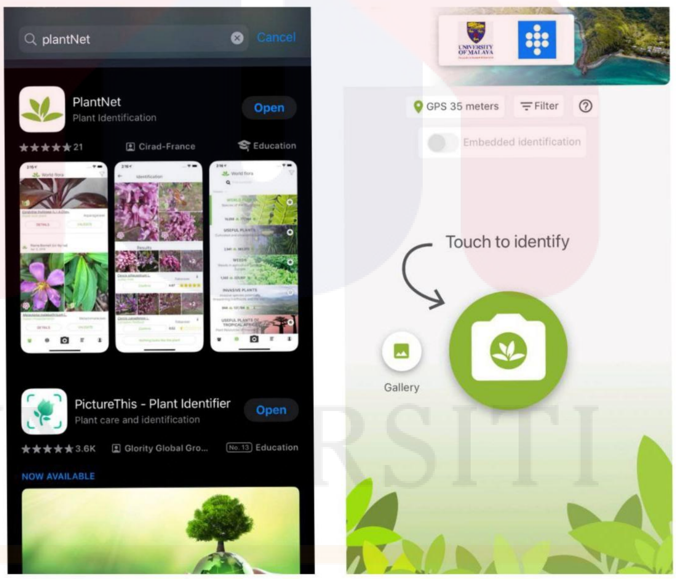


Figure 3.10 : PlantNet Apps

3.2.5 Experiment Design

a) *Macaranga tanarius* (L) Selection.

Within a week, the *Macaranga tanarius* (L) seedlings were taken in order to gather and count the sample. There were seven mature trees in this area. Every mature tree had three or four seedlings that were raised. For seedlings grown in open canopy or non-shaded areas, the range was 2-3 meters apart; for those living under the shaded/understorey areas, which are protected by the mother tree, the range was 1 metre. Differences in the size of the trees, the number of leaves per tree, and the height of the seedlings are probably possible. However, the probability of healthy growth in the tree as a result of an adequate and consistent light source and as impacted by a sufficient quantity of water can impact the development and growth of the tree. Figure 3.11 is shows the experimental design of this research.

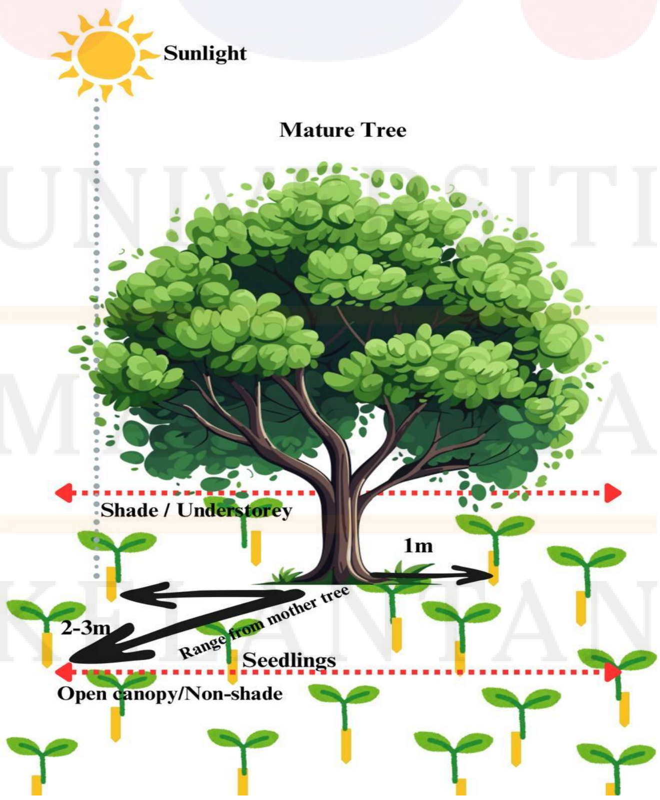


Figure 3.11: The Experimental Design of Research.

3.2.6 The Seedlings of Macaranga

This study used are randomly selected seedlings of *Macaranga tanarius* (L) from the study area. This seedlings was marked with tagging name of each sampling. Figure 3.12 shows the seedlings that has been selected as an examples.

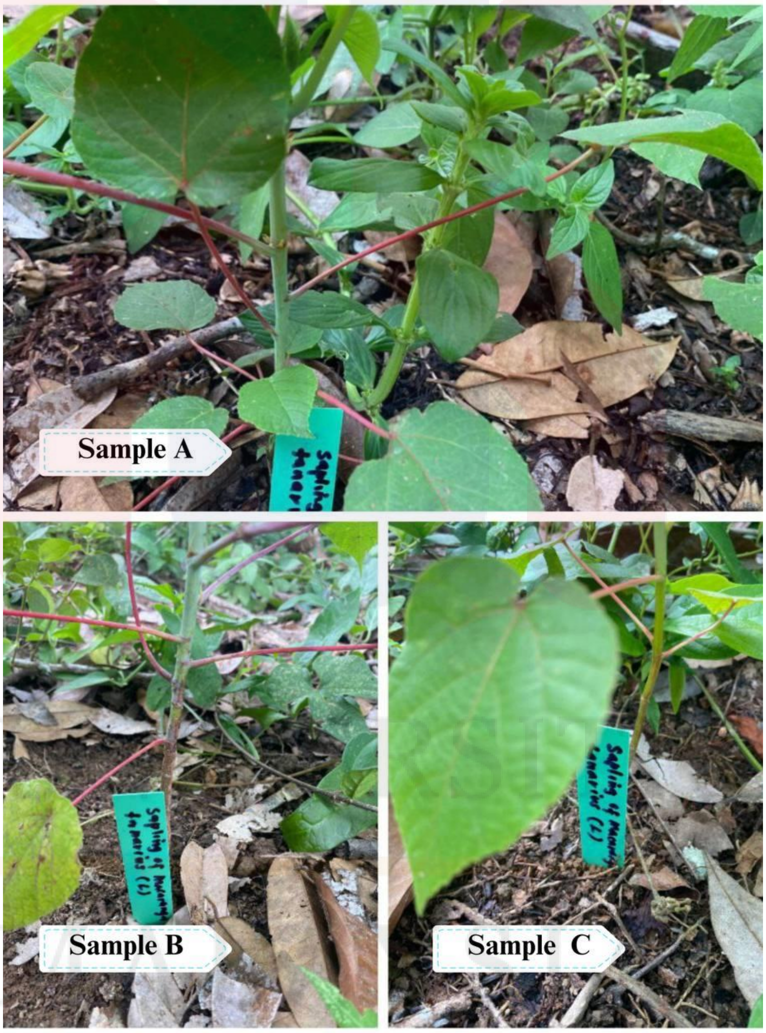


Figure 3.12 : The Random Seedlings with Tagged A, B and C.

3.3 Method

3.3.1 Data Collection

a) Growth Parameter

A flexible measuring tape for saplings is used to determine the height, diameter, and occasionally the circumference of young trees. This method to accurately monitor and record the growth and development of saplings. When measuring seedlings, a measuring tape can be used to track growth rates, evaluate the health of the plants, and gather information for this research. Figure 3.13 is shows the measuring tape for plants height.

Figure 3.13 : Measuring Tape for Plant Height

b) Independent Variable

Partial shadow in the context of the study on the impact of light intensity on Macaranga development was compared to a moderate level of sun exposure. but with less light than it would have with full exposure. In order to learn how this plant reacts to moderate light levels, partial shadow was crucial.

In addition, Macaranga specimens that are subjected to low light levels are frequently found in areas where sunlight is restricted or obscured, creating an environment that is not well-lit. These settings are intended to simulate environments such as areas without direct sunlight or dense canopy cover where plants would be subjected to light intensities much lower than those they would experience in broad sunlight or moderate shade.

c) **Dependent Variable**

A crucial growth measure that measures the vertical length of the tree from the base to the tip of the main stem. The height of the Macaranga plant can be used to estimate its general growth performance and vitality. These dependent variables help in quantifying growth and determining which environmental factors or treatments (such as nutrients, water, or light levels) have a positive or negative impact on seedling development. Each dependent variable requires specific tools or methods for accurate measurement. For instance, height is measured using a ruler

3.3.2 Research Flowchart

This research project conducted for one year, but must divided into two stage, considering that has two objectives which are laboratories test for seed germination which is needed as many as 500 total of seeds. So, only 340 seeds (68%) and for observation was (62 seedlings). First step, randomly selected the seeds from Faculty of Earth Science (FSB) for seed germination test. This test was taken as much 1 month, which is from 24th March 2024 to 24th April 2024, the seeds began to germinate after two weeks and continued for an additional two weeks.

Secondly, observation the seedlings around the faculty for measure the height, and number per leaves. In this experiment, were observing the seedlings either with different light intensity which are with shaded and non-shaded. Apart from that, was recorded and collected the data for each performance of seedlings. Then, processing it in the form of data analysis with represent it in a graph.

Finally, from all the result was taken, considering with discussion part collectively and supported by explanation and describes the factors. Figure 3.14 is shows the research flow of *Macaranga tanarius* (L).

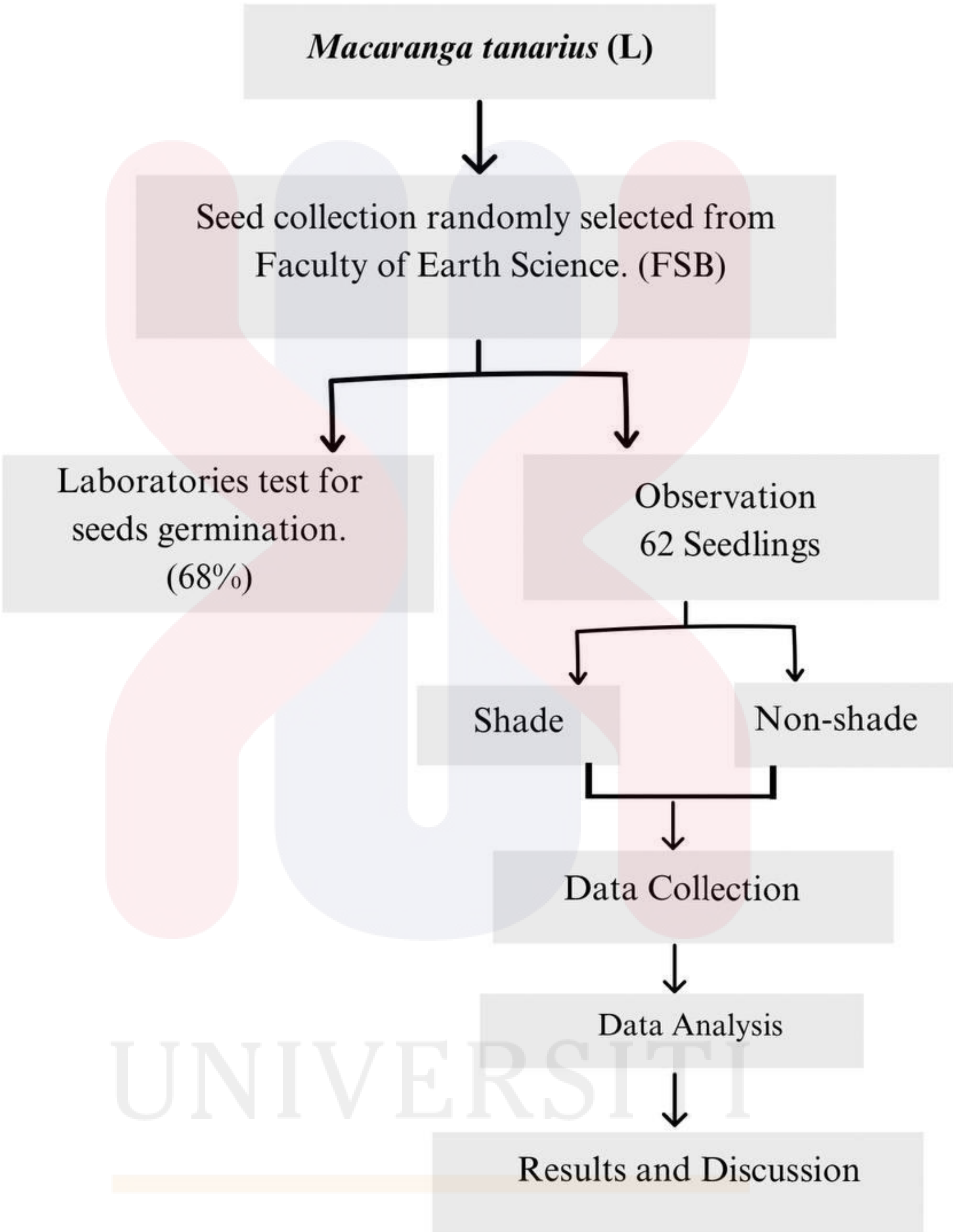


Figure 3.14 : Flowchart of Macaranga (Mahang).

CHAPTER 4

RESULT AND DISCUSSION

4.1 Germination Period of *Macaranga tanarius* (L).

Provided the seeds is from nearby faculty, as much as 500 seeds of *Macaranga tanarius* (L) has been divided into two layer. So, each layer was as much as 250 seeds, which were tested for purity and capacity to germinated it in a lab setting. The duration of time needed in germination to completing the laboratories test of every single seeds it was taken almost 1 month. Every single replicate was recorded. It begins after two weeks of seedlings grown. It was discovered that seeds germinated more readily when soaked in room temperature water as opposed to hot water, with germination rates of 68% respectively. (Koter and Rosdi, 2019)

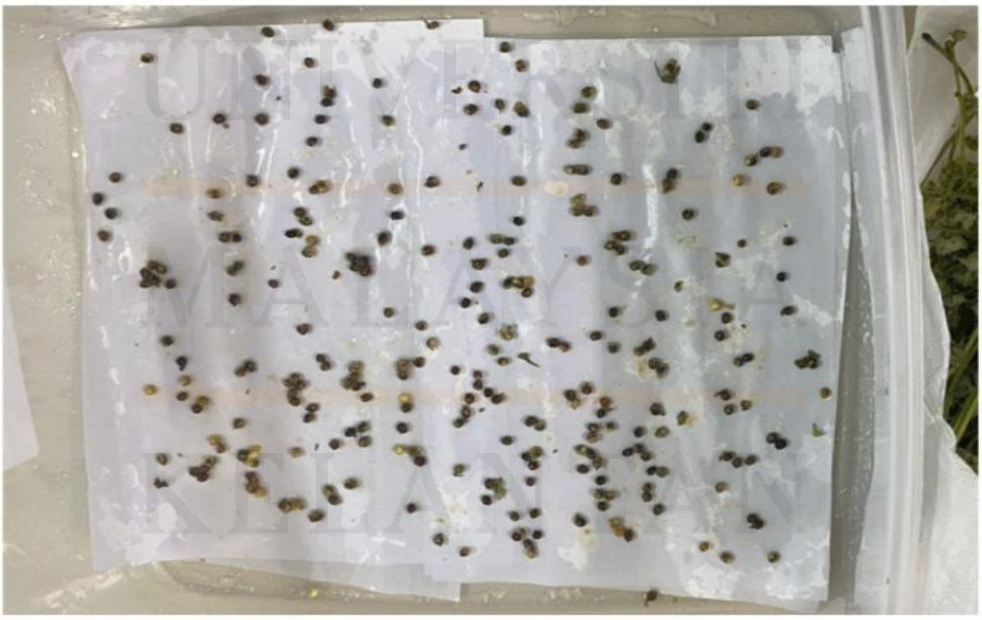
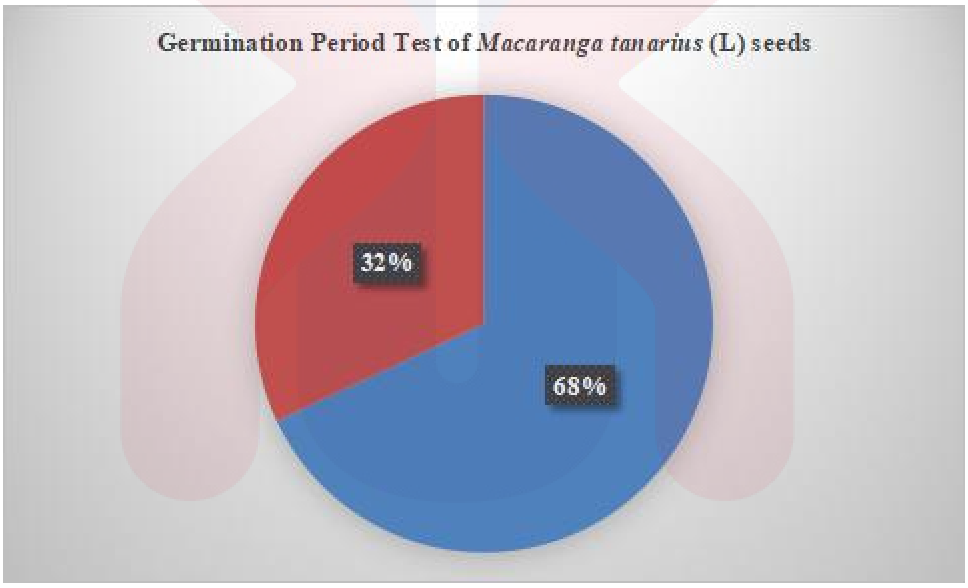


Figure 3.15 : Seeds Germination Test of *Macaranga tanarius* (L).

In this experiment, was conducted throughout 1 month for germination test of the seeds, it was started from 24th March 2024 until 24th April 2024. As a result, the seeds started to germinate after two weeks and lasted for another two weeks. Three plant growth regulators (PGR), namely GA3, BAP and kinetin at three concentrations also applied to the seeds as a pretreatment to test germination. The application of GA3 at 10 mgl-1 to managed the result germination. Figure 3.16 shown the percentage of germination period t of *Macaranga tanarius* (L) seeds.



.**Figure 3.16** : The Percentage of Germination Period Test of *Macaranga tanarius* (L) Seeds.

Based on Figure 3.16, from the 500 seeds of *Macaranga tanarius* (L), it has been proven that only 68%, which means as many as 340 seeds can germinates and survive. Whereas, for the 32% which means as many as 160 seeds that did not germinate and died. Therefore, there are factors that can also affect the rate of growth and germination of seeds.

Table 1.1 shows the seed germination of *Macaranga tanarius* (L) with boiling water.

	Seeds Germination Test														
Day	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30
Boiling Water	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Total : 68%															

Spraying a consistent quantity of water on seeds, such as, *Macaranga tanarius* (L) tree seeds, is important to ensure several critical factors in the seed growth and development process. In this experiment, were-on every day of this month, consistent watering is necessary to ensure that the seeds remain fertile and moist. Therefore, equivalent to as much as 4.5% per day must always be maintained consistently. Seeds need consistent moisture to begin the germination process. Sufficient water helps to soften the seed coat and activate the enzymes needed for germination. Inconsistent humidity can cause the seeds to experience dryness or excess moisture, both of which can damage the seeds.

Providing consistent amounts of water ensures that all seeds receive the same amount of water, which is important to ensure uniform growth. This helps in ensuring that all seedlings grow at the same rate and reduces competition between them for resources. Water helps in regulating the temperature around the seeds. Consistent water helps the seed's roots to develop well. Roots that develop in the right moisture conditions tend to be stronger and deeper, which is important for stability and access to nutrition in the long term aim the ideal temperature for seedling germination and growth.

Besides, excessive or inconsistent watering can cause seeds and seedlings to be more susceptible to diseases such as fungus. Too much water can cause excess moisture that supports fungal growth, while a lack of water can cause plant stress and weaken resistance to disease. Many fungi prefer warm conditions to grow. A warm, humid micro-environment can be produced where water builds up, which encourages the growth of fungi. Retention of moisture can be facilitated by stagnant water. Because of poor ventilation, moisture does not evaporate as quickly, which gives fungi time to grow and spread.

4.2 Seedling Length of Macaranga (cm)

From each replication of all the varieties/genotypes, ten normal seedlings at the time of the final count were chosen at random, and their length was measured in centimetres. These seedlings average length was determined.

4.3 Growth Performance of *Macaranga tanarius* (L).

Table 1.2 : Average Height of *Macaranga tanarius* (L) Seedlings in Habitat Growth with Different Shade and Non-shade.

Average of height (cm)	Shaded	Non-Shaded	Total
1-9	0	0	0
10-19	3	25	28
20-29	4	12	16
30-39	4	11	15
Total of seedlings		**62**	

From table 1.2, shows the average height of *Macaranga tanarius* (L) from 62 seedlings in natural growth with different shade and non-shade. Based on observations that have been carried out around the faculty, it was found that there are as many as seven of *Macaranga tanarius* (L) mature trees that live and grow here. In this mature tree, the seedlings that grow under shade areas around three to four seedlings.

Besides,, the plant height of *Macaranga tanarius* (L) seedlings in natural growth with different shade and non-shade shows the total of 62 seedlings observed. These can be divided into four groups, depending on the specific range indicated in the table. The highest average is in the 10 to 19 cm, represented by 28 seedlings. This means that these seedlings was grown for between weeks 4 and 7.This is followed by the category from 20 to 29cm with 16 seedlings. This means that these seedlings was geown between weeks 7 and 10. In the category 30 to 39cm there are 15 seedlings, which is a low number among the three categories present in the whole observation. This means that these seedlings was grown for between weeks 11 and 14.

Table 1.3: Average Nurmber Per Leaves of *Macaranga tanarius* (L) Seedlings in Natural Growth with Different Shade and Non-shade.

Number per leaves	Shaded	Non-Shaded	Total
1-5	4	35	39
6-10	3	24	27
11-15	1	2	3
16-20	0	1	1
Total of seedlings		**62**	

Apart from that, the average number per leaves of *Macaranga tanarius* (L) seedlings in natural growth with different shade and non-shade shows the total of 62 seedlings observed. These can be divided into four groups, depending on the specific range indicated in the table. The highest average is in the 1 to 5 category, represented by 39 seedlings. This means that these seedlings was grown for between weeks 1-2. This is followed by the category from 6 to 10 with 27 seedlings. This means that these seedlings was grown between weeks 3 and 5. In the category 11 to 15 there are 3 seedlings, while from 16 to 20 represented by only one which is a the lowest number among the three categories present in the whole observation. This means that these seedlings was grown for between weeks 5 and 7.

4.3.1 The Growth Condition Enviroment of *Macaranga tanarius* (L) of Seedlings with Shade and Non-shade.

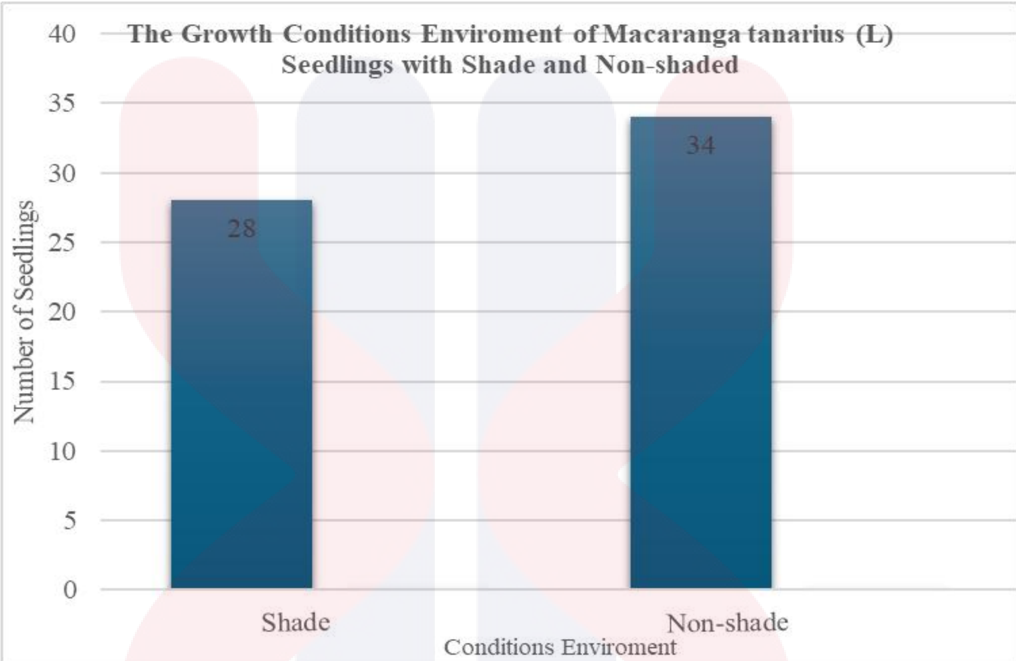


Figure 3.17 :The Growth Conditions Environment of *Macaranga tanarius* (L) Seedlings with Shade and Non-shade .

Based on observations that have been carried out around the faculty, it was found that there are as many as seven *Macaranga tanarius* (L) mature trees that live and grow here.The seedlings for each mature tree is around three to four trees that are shaded, while the rest are those that are non-shade under mature trees.

From on figure 3.17, shows the number of seedlings on shade and non-shade of growth rates that in open canopy which is non-shade area are expected to grow faster and taller thane those in understorey areas due to increased light availability. As a result, as much as 34 seedlings survive in non-shade areas while, on shade shown as much as 28 seedlings survive.

Besides, according to Yang (2022), similar to many plants, Macarangas need a sufficient amount of light every day in order to carry out photosynthetic processes efficiently. The still young provides the necessary energy to optimise the production of glucose, which is used as a building block and energy source for plant growth. As a result, this experiment proved that as many as 28 seedlings from 62 seedlings that grow understorey areas (under canopy). Photosynthesis is the process by which plants use light from the sun to convert carbon dioxide and water into glucose and oxygen. The most important source of energy for this process is the sun.

Next, according to Zakaria (2008), ecologist adaptation of many Macaranga species are known as pioneer plants that first colonized rocky or unstable areas. They usually adapt to grow rapidly in environments with changing weather conditions. This adaptation enables the Macaranga to grow rapidly and to withstand the demands of other competitors animals in terms of food, oxygen and water. Plant that solid and protected may not always provide the necessary results to support healthy and rapid growth. Macaranga trees are well equipped to live in this habitat characterized by high amount of sunlight, among others.

Apart from that, the seedling morphology of *Macaranga spp.* It is because of the seedlings in open canopy areas may have more robust and upright growth, while those in understory areas may have more sprawling or horizontal growth due to reduced light. Enough sunlight is needed for photosynthesis to occur (Valverde *el. a*l, 2022). *Macaranga tanarius* (L) generally favors direct sunlight over partial shade., is between 10-19 cm which is 28 seedlings, this seedlings growing and living between weeks four and seven The time and intensity of the light directly affects the amount accessible for growth and development.

4.3.2 The Differentiate of Average Height and Nurmber Per Leaves of *Macaranga tanarius* (L) Seedlings in Natural Habitat with Different Shade and Non-shade.

Figure 3.19, shows the differentiate of average height and nurmber per leaves of *Macaranga tanarius* (L) seedlings in natural growth with different shade and non-shade. As a results, the average height of *Macaranga tanarius* (L) seedlings in natural growth in shaded, because of the reduced light intensity in shadowed situations, the photosynthetic rate is decrease. Nevertheless, a lot of plants, like *Macaranga tanarius* (L), be able to with stand shaded.

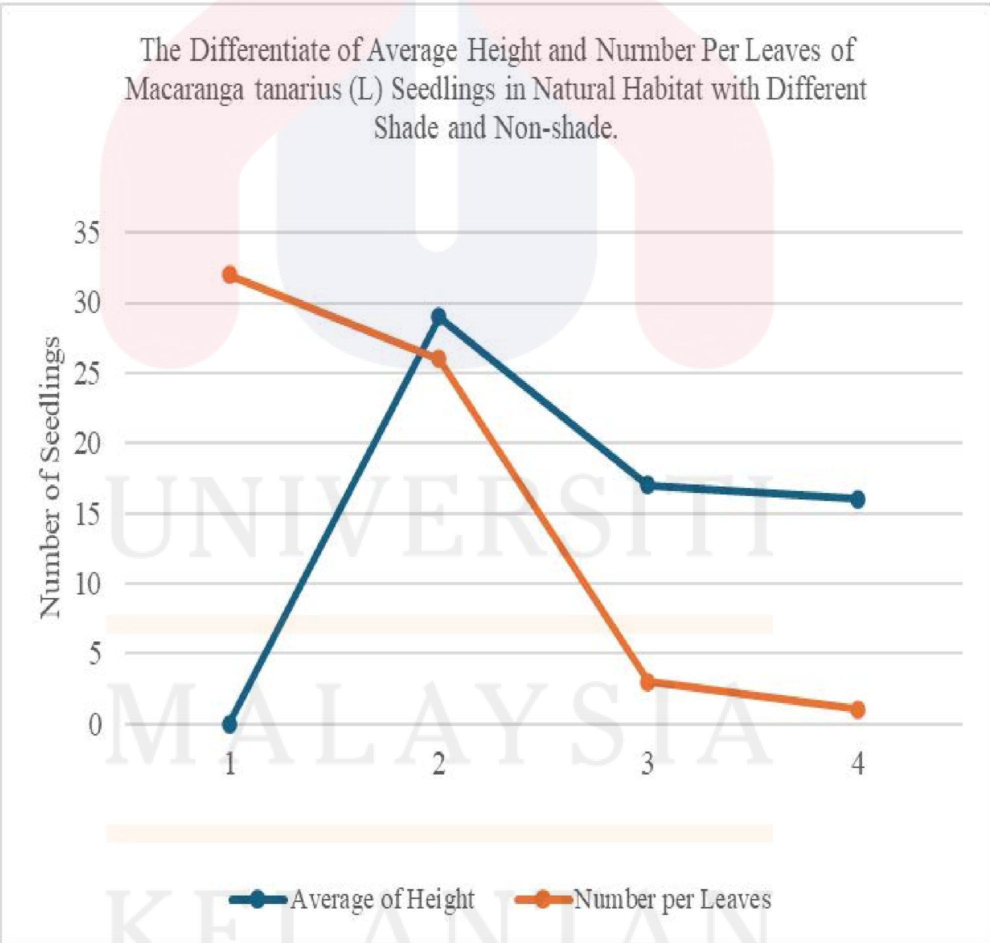


Figure 3.19 :The Differentiate of Average Height and Nurmber Per Leaves of *Macaranga tanarius* (L) Seedlings in Natural Habitat with Different Shade and Non-shade.

According to Melissa *et. al,* (2022), was describe plants cultivated in shade often undergo a process known as (etiolation), which is the growth of longer inter-nodes and higher leaves in response to increased light. This can cause a plant to grow taller than one cultivated in direct sunlight. This experiment demonstrated that up to 39 seedlings can generate one to five leaves in a single seedling. This is because, in an attempt to out-compete surrounding plants for light, seedlings concentrated more of their energy on growing taller. Photosynthetic rates are high in non-shaded areas, or full sunlight, because of the availability of light. This promotes quick, widespread growth. Plants that priorities the development of their leaves and roots over elongation is shorter and more resilient.

Furthermore, the number of leaves per *Macaranga tanarius* (L) sapling in natural growth in shade indicates that plants accustomed to shade generally generate fewer, bigger leaves in order to improve the quantity of light captured per unit area. This experiment shown that up to 34 seedlings can produce under non-shaded conditions. The leaves were thinner and wider in order to efficiently absorb more light. Restrictions in light levels can cause a reduction in leaf production by limiting resources. Under direct sunlight, plants tend to develop more little leaves. This can lower water loss and increase photosynthetic efficiency. To prevent harm from intense light and to minimize water loss, leaves may be smaller and thicker.

Besides, in order to out-compete nearby plants for light, height growth is essential. Larger, fewer leaves help absorb more light while consuming less resources. There is less competition for light when there is an abundance of it. Plants can concentrate on growing additional leaves in order to increase their ability to photosynthesize and absorb resources.

According to Catarina *et. al,* (2017), temperature affects how quickly metabolic processes take place inside plants. Warm tropical temperatures are often the best for *Macaranga tanarius* (L) growth in extreme heat temperatures higher than 40°C (104°F) may disrupt these processes, perhaps leading to injury or stunting plant growth. Enzymes involved in photosynthesis and other metabolic processes are influenced by temperature. These enzymes need the proper temperature to function properly.

However, because temperature variations and extremes can impact seed germination, growth rates (68%) which is as many as 340 seeds of *Macaranga tanarius* (L) , can germinates and survive. Whereas, for the 32% which means as many as 160 seeds that did not germinate and died. Therefore, there are factors that can also affect the rate of growth and germination of seeds. Overall plant health, harsh weather can also impede the growth of Macaranga trees. Extended exposure to high temperatures can cause thermal stress, which can harm enzymes and biological components. As an example, the phenomena of El Niño usually result in temperatures that are greater than usual. Raising the temperature has the potential to worsen water stress and even cause thermal stress by increasing evapotranspiration rates. Severe heat can cause tissue damage to plants, lower photosynthetic efficiency, and hinder growth. High temperatures above 35°C (95°F) can begin to stress many plants. When temperatures exceed 40°C (104°F), the stress can become more severe, potentially leading to stunted growth and damage to plant tissues. Besides, that persist can stress plants physiologically, which in extreme situations, kill them. Additionally, heat stress can interfere with the cycles of fruiting and flowering, which can reduce Macaranga reproductive performance. (Mirza, 2013)

CHAPTER 5

CONCLUSION

As a conclusion, from the 500 seeds that has been tested, the percentage germination of *Macaranga tanarius* (L) with germination rates it was a 68% respectively, which is as much as 340 seeds of *Macaranga tanarius* (L) , can germinates and survive. Whereas, for the 32% which means as much 160 seeds that did not germinate and died. The seeds sprouted more readily in room temperature water than in hot water. After two weeks, the seeds began to sprout and continued for an additional two weeks. In order to assess germination, the seeds were also pre-treated with three different amounts of plant growth regulators (PGRs), namely GA3, BAP, and kinetin. A dosage of 10 mgl-1 of GA3 applied of the seeds germinating.

In comparison to non-shaded areas, the understorey seedlings grow more quickly and to a greater height because of increased light availability. According to data analysis, *Macaranga tanarius* (L) has the highest average height and number of leaves per leaf of any plant; out of 62 seedlings, 34 grown in non-shaded areas, while only 28 grow in shaded areas. As a results, the seedlings in the understorey growing more sprawlingly or horizontally because of the less light, whilst the seedlings in the open canopy sections grew more robustly and erect.

Apart from that, the number per leaves of *Macaranga tanarius* (L) between understorey and open canopy environments are different for each leaf characteristics involves, leaf shape, leaf size and leaf color. As a result, the saplings that on non-shade is more larger and dark green leaves in open canopy areas may indicate higher photosynthesis capacity and growth potential compared to saplings in understorey areas. The leaf of *Macaranga tanarius* (L) between each environment show the different includes, for seedlings that non-shade are larger leaves than seedlings grow understorey show are small leaves.

All provenances in this study grew well and were well-adapted; nevertheless, there were notable differences in genotype and environmental factors such as temperature and moisture content. Additionally, *Macaranga tanarius* (L) growth is generally supported by tropical and subtropical environments. In general, the best temperature range for growth is between 20°C and 30°C (68°F and 86°F). An influence on physiological systems may occur outside of this temperature range.

In conclusion, the two objective of these studies are archived. This study suggest that *Macaranga tanrius* (L) as a potential species for reforestation. The data generated on growth and potential of the species can be used in planning for the establishment and management of reforestation in the future. It is a critical component of environmental conservation effort, and the successful established and growth of native tree species may a vital role in ecosystem reforestation.

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APPENICES

Appendix A :Average height of *Macaranga tanarius* (L) seedlings in natural growth with different shade and non-shade.

Natural Growth			
No	Height of saplings (cm)	Shade	Non-Shade
1	20.3	/	
2	14.2		/
3	20.4	/	
4	15.5		/
5	30.4	/	
6	28.4	/	
7	32.1	/	
8	35.2	/	
9	12.8		/
10	15.8		/
11	17.4		/
12	13.9		/
13	26.6	/	
14	14.7		/
15	34.3	/	
16	23.1	/	
17	33.2	/	
18	12.5		/
19	16.8		/
20	19.3		/
21	20.8	/	
22	24.7	/	
23	15.4		/
24	11.7		/

25	18.3		/
26	24.6		/
27	30.2		/
28	33.7		/
29	28.1		/
30	18.8	/	
31	25.2		/
32	30.2		/
34	17.8	/	
35	37.6		/
36	30.4		/
37	29.5		/
38	29.3		/
40	36.7		/
41	20.9		/
42	13.8	/	
43	19.5	/	
44	14.2	/	
45	13.8	/	
46	16.7	/	
47	16.2	/	
48	10.9	/	
49	18.3	/	
50	22.6		/
51	30.1		
52	15.4	/	
53	14.5	/	
54	30.6		/
55	11.9	/	
56	23.5		/
57	20.4		/
58	12.2	/	
59	10.3	/	

60	25.2		/
61	18.6	/	
62	27.3		/

Appendix B : Number per leaves of Macaranga seedlings in natural growth with different shade and non shade.

Natural Growth			
No	Number per leaves	Shade	Non-Shade
1	3	/	
2	3	/	
3	1	/	
4	3	/	
5	5		/
6	2	/	
7	4	/	
8	3	/	
9	2	/	
10	11		/
11	6		/
12	7		/
13	2	/	
14	4	/	
15	3	/	
16	12		/
17	3	/	
18	6		/
19	7		/
20	9		/
21	8		/
22	2	/	
23	4	/	
24	11		/
25	6		/
26	4	/	
27	3	/	
28	3	/	

29	8		/
30	10		/
31	5		/
32	5		/
33	5		/
24	4	/	
25	5		/
26	4	/	
27	5		/
28	7		/
29	5		/
30	6		/
31	8		/
32	6		/
33	16		/
34	6		/
35	6		/
36	5		/
37	5		/
38	4	/	
39	5		/
40	5		/
41	5		/
42	7		/
43	6		/
44	6		/
45	5		/
46	6		/
47	5		/
48	7		/
49	5		/
50	5		/
51	9		/

52	7		/
53	7		/
54	6		/
55	8		/
56	7		/
57	8		/
58	8		/
59	4		/
60	6		/
61	5		/
62	5		/

Appendix C : Day 1 of seed germinate

Appendix D : Measure the distance of the sapling from the mother tree.