Universiti Malaysia KELANTAN

"INFLUENCE OF LIGHT INTENSITY AND GROWTH PERFORMANCE OF *Acacia mangium* : SEEDLINGS IN UMK JELI CAMPUS".

by

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

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DECLARATION

I declare that this thesis entitled "INFLUENCE OF LIGHT INTENSITY AND GROWTH PERFORMANCE OF *Acacia mangium :* SEEDLINGS IN UMK JELI CAMPUS." is the result of my own research except as cited in the references. The thesis not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : NURHIDAYAH MAISARAH BINTI ZULFIKAR

Date : 06.06.2024

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"INFLUENCE OF LIGHT INTENSITY AND

GROWTH PERFORMANCE OF *Acacia mangium* : SEEDLINGS IN UMK JELI CAMPUS.

ABSTRACT

Acacia mangium was a fast-growing tree species widely used in reforestation and agroforestry programs due to its adaptability and economic valued. This study examined the comparison of seedling growth rates understorey and the opened canopy environment of *Acacia mangium* and examined the light intensity of *Acacia mangium* seedling growth. Through the implementation of this method, the growth performance of *Acacia mangium* seedlings was carried out with correlation regression to distinguish between diameter, height, leaf and roots and based on shade or non-shade. In addition, this studied also examines the germination of seeds *Acacia mangium*. Overall result of germination tests was was 42% that lived as a result of the seed germination test conducted for 10 days. In addition, the temperature was also studied to saw the growth probability of *Acacia mangium* seedlings according to the temperature in Jeli, Kelantan. Apart from that, the growth of *Acacia mangium* was taken under shade and non-shade with a total of 70 seedlings that was shade had a total of 10 seedlings while non-shade had 60 seedlings of *Acacia mangium*. Although, this study was able to examine light as the main energy source for photosynthesis that allows seedlings to synthesize food from CO2 and water. Photosynthesis increases when there is sufficient light which accelerates the growth and development of seedlings. On the other hand, in low light conditions, seedlings may show morphological changes in leaves such as larger and thinner leaves to catch more light. Finally, this studied was useful in forest management for future planning.

"PENGARUH KEAMATAN CAHAYA DAN PRESTASI PERTUMBUHAN *Acacia mangium* : ANAK POKOK DI KAMPUS UMK JELI.

ABSTRAK

Akasia mangium ialah spesies pokok yang cepat tumbuh digunakan secara meluas dalam program penanaman semula hutan dan agroforestry kerana kebolehsuaian dan nilai ekonominya. Kajian ini mengkaji perbandingan kadar pertumbuhan anak benih bawah tingkat dan persekitaran kanopi terbuka *Akasia mangium* dan mengkaji keamatan cahaya pertumbuhan anak benih *Akasia mangium*. Melalui pelaksanaan kaedah ini, prestasi pertumbuhan anak benih *Akasia mangium* telah dijalankan dengan regresi korelasi untuk membezakan antara diameter, ketinggian, daun dan akar serta berdasarkan naungan atau bukan naungan. Tambahan pula, kajian ini juga mengkaji percambahan biji benih *Akasia mangium*. Keseluruhan keputusan ujian percambahan ialah 42% yang hidup hasil daripada ujian percambahan biji benih yang dijalankan selama 10 hari. Selain itu, suhu juga dikaji untuk melihat kebarangkalian pertumbuhan anak benih *Akasia mangium* mengikut suhu di Jeli, Kelantan. Selain itu, tumbesaran *Akasia mangium* diambil di bawah teduhan dan tidak teduh dengan jumlah 70 anak pokok yang diteduhkan mempunyai jumlah 10 anak benih manakala bukan teduhan mempunyai 60 anak benih *Akasia mangium.*Walaupun, kajian ini dapat mengkaji cahaya sumber tenaga utama untuk fotosintesis yang membolehkan anak benih mensintesis makanan daripada CO2 dan disiram. Fotosintesis meningkat apabila terdapat cahaya yang mencukupi yang mempercepatkan pertumbuhan dan perkembangan anak benih. Sebaliknya, dalam keadaan cahaya malap, anak benih mungkin menunjukkan perubahan morfologi daun seperti kiri lebih besar dan nipis untuk menangkap lebih banyak cahaya. Akhir sekali, kajian ini berguna dalam pengurusan hutan untuk perancangan masa hadapan.

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LIST OF ABBREVIATION

Et al	and others
UMK	Universiti Malaysia Kelantan
cm	centimetre
x	times
mm	millimeter
NCEP	National Centers for Environmental Prediction
CFSV2	Climate Forecast System Version 2
JMA	Japan Meteorological Agency
ECMWF	European Centre for Medium-Range Weather Forecasts
IRI	International Republican Institute
ENSO	El Nino-Southern Oscillation
IOD	Indian Ocean Dipole

LIST OF SYMBOL

&	and
,	comma
.	full stop
“	quotation mark
( )	parentheses
-	hyphen
;	semicolon
:	colon
’	apostrophe
%	percentage
°c	degrees celcius

CHAPTER 1

INTRODUCTION

1.1 Background of Study

According to Koutika (2019) *Acacia mangium*, a fast- growing tree native to parts of Indonesia, Papua New Guinea and Australia, had been cultivated outside its native environment and introduced into humid tropical lowland regions of Asia, south America and Africa over the last few decades. This versatile tree was utilized in forestry, agroforestry, and the rehabilitation of damaged areas. Additionally, it had been imported outside of its natural range and was quite invasive in several areas. This studied examines the data supporting both its cleared advantages and detrimental effects on biodiversity.

Other than that, according to Willdenow and Von (2020), description of *Acacia mangium* were Phyllodineous, green leaf with pointy twigs. Leaf blades were around 13–20 x 3–7 cm. The leaf blade had one almost straight side and one sharply bent side. Three or four longitudinal, anatomizing veins were typically more noticeable than the others. Compared to the veins closed to the curved side, the two veins next to the straighter blade margin stick together for a longer period of time. A little gland that was often visible at the intersection of the petiole and leaf blade.

Apart from that, importance of studied about *Acacia mangium* was to understanding *Acacia mangium* growth patterns ecologically supports attempts to conserve biodiversity and restore ecosystems. Being a species with rapid growth and adaptability, it was essential to reforestation initiatives, particularly in regions that had been damaged or cleared of trees. It was beneficial to ecosystem restoration because of its adaptability to a variety of climates and soil types. It also helps stabilize soils, reduces erosion, and promotes the returned of biodiversity by giving avariety of animal species with habitat and food supplies (Otsamo, 2002). Furthermore, researching the development patterns of *Acacia mangium* advances our knowledge of plant physiology and how plants react to various environmental elements including light intensity, substrate composition, and container attributes. It provides information on how plants adjust to various environments, which helps with the creation of more effective farming methods and environmentally friendly forestry and agroforestry systems.

Other than that, because of its favourable wood qualities, including as its straight trunk formation, quick early growth, and adaptability for a range of industrial used, *Acacia mangium* was mostly grown for lumber in Malaysia. The species had been widely planted as part of reforestation initiatives, especially in degraded areas and former logging sites, where it had improved biodiversity and helped restore forests. Its application in agroforestry systems had drawn interest as well. Because of its capacity to fix nitrogen, which enhances soil fertility and promotes the development of other plants, it was an important part of mixed plantings (Koutika & Richardson, 2019).

In addition, *Acacia mangium* wood was used in several sectors, including as furniture manufacture, pulp and paper manufacturing, building, and wood-based manufacturing. Its superior wood was ideal for a variety of used due to its exceptional durability and decay resistance. Furthermore, by stabilizing soil, reducing erosion, and offering a variety of animal species. Many alien species, it also presents certain issues due to its quick growth and reproduction, which might made it invasive in some habitats. Overall, *Acacia mangium* had became an important species in Malaysian agroforestry systems, lumber production, and reforestation efforts due to its quick growth, diversity, and capacity to adapt to the country's natural circumstances. Its significance in Malaysia's forestry and environmental sectors was highlighted by its involvement in sustainable forestry practices and economic contributions (Adam *et.al*, 2012).

1.2 Problem Statement

Acacia mangium, a genus of trees commonly found in tropical forests, requires understanding its seedlings' growth and development for effective forest management and restoration. However, there's limited knowledge about how these seedlings respond to varying light conditions, especially in the under story and open canopy areas of the forest. This research aims to bridge this gap by investigating the growth patterns and morphological characteristics of *Acacia mangium* seedlings in both shaded under story and well-lit open canopy environments. By comparing seedling height, diameter, leaf shape, size, and color, the study aims to determine significant differences in growth and development between the two light regimes. The findings will provide valuable insights into the light requirements and adaptability of *Acacia mangium* seedlings, informing decisions on forest management practices and the selection of appropriate species for reforestation projects local and internationally.

1.3 General Objectives

This study aims to understand how the difference in the amount of light, which affects the growth of *Acacia mangium*. By investigating, these factors together, provide the knowledge on how to contribute *Acacia mangium* effectively by sustainable forestry and agroforestry.

1) To identify the germination rate of *Acacia mangium*.
2) Compared *Acacia mangium* growth under different light intensity (understory vs open canopy environment).

1.4 Scope of Study

Further research is needed to understand the growth of *Acacia mangium* because currently there is no study of how factors such as light can affect the growth of *Acacia mangium*. Closing this knowledge gap is important to determine the growth factors of *Acacia mangium* in diverse environments, thus increasing the effectiveness of forestry and agroforestry practices. This study aims to understand how different factors such as light can relate to plant diameter, stem, leaves and roots. The goal is to find the best conditions for growing *Acacia mangium*. In a sustainable practice and way, the scope of the new study provides a simple land reduction that can be useful for coltraly *Acacia mangium* in different environments.

1.5 Significance of Study

The study is considered important because it can contribute to increasing the cultivation of *Acacia mangium*. By studying how factors such as light affect its growth, this effort was made to identify the character growth of the tree. The broader goal is to improve understanding of how these factors interact, leading to the development of more efficient and sustainable forestry practices. Potential outcomes include interest in better environmental outcomes and restoration. Therefore, this study has significance for both researchers and practitioners in forestry.

CHAPTER 2

LITERATURE REVIEW

2.1 Family Fabaceae

According to Tekdal (2021) with 740 genera and 19,400 species, the Fabaceae family are the third biggest plant family in the world, behind the Orchidaceae and Asteraceae families. It comprises around 12 percent of all flowering plants. This family includes a large number of trees, shrubs, and herbaceous plants that are valuable economically. Also, legumes are one of the essential components of many vegetation types in the world. Many legumes are colonized in inefficient places, and they have atmospheric nitrogen fixation capacity through the nodules in their roots. Three subfamilies make up the Fabaceae family: Papilionoideae, Mimosoideae, and Caesalpinioideae. Members of the subfamily Papilionoideae, commonly referred to as legume plants, are domesticated food and decorative plant products. Legume crops are crucial for ensuring food security.

Although the mass population might get adequate calories from the intensive production of staple crops like rice, wheat, and rice, their protein composition frequently lacks some critical amino acids. Vitamins A, B, C, phosphorus, iron, calcium, and potassium are abundant in legume plants. Due to these benefits, edible legumes are vital nutrients that people should eat while the globe struggles with starvation and malnourishment. Legumes are high in nutrients, but they also increase the inorganic nitrogen in the soil by binding free nitrogen from the atmosphere.

2.2 *Acacia mangium*

The local name of *Acacia mangium* were (Sabah Salwood, Mangium, Hickory Wattle, Brown Salwood, Black Wattle); Filipino (Maber); Indonesian (Tongke hutan, Nak, Mangge hutan); Malay (mangium); Polynesia (Arr); Spanish (Zamorano); Thailand (Krathinthepha, Kra thin tepa); Trade name (Brown Salwood).

Apart from that, petuncles canescent or pubescent, about 10 mm long; flowers on somewhat loose spikes, up to 10 cm long, solitary or in pairs in the top axils. The calyx was 0.6–0.8 mm long and had small, blunt lobes. About twice as long as the calyx was the corolla. About 3–4 mm long stamens. ovary pubescent in density (Willdenow & Von, 2020).

In addition, pods depressed between seeds, membrane- or somewhat woody-textured, coiled, linear, and 3-5 mm broad. The seeds are lustrous black, about 5 mmlong, and aligned lengthwise in the pod. Beneath the seed is an orange funicle that isfolded and forms a cupular, fleshy structure like an aril. Lastly, cotyledons were 4-5 mm long and oblong or obovate. Two leaf: one pinnate and the other bipinnate. By the time left reached the fourth or fifth stage, their petioles had enlarged and became flat. Tenth leaf stage: phyllodineous leaf that were narrowly elliptic or narrowly obovate, slightly uneven on the sides, glabrous, and typically had three main veins running from base to apex. There was also typically a gland on the leaf blade margin near the petiole junction, small, triangular stipules, and a stem that was typically strongly winged. Germination period for seeds: 8 to 2933 days (Willdenow & Von, 2020).

Next, the biology of *Acacia mangium* then revealed that the plant blooms early and that viable seed may been collected 24 months after planting. About 6-7 months passed between the development of flower buds and pod maturity. Being a hermaphrodite, the tree typically outcrosses and had a propensity to self. Insects were typically pollinators, with trigona and apis species acting as active pollen carriers. After planting, *Acacia mangium* took 18 to 20 months to began flowering and producing seeds. Mature fruits occur 3-4 months after planting period. In its native range in Australia, flowers were present in may and the seeds mature in October- December around Indonesia, the fruits ripen around July, whereas in Papua New Guinea, they did so in late September (Awang & Taylor, 2021).

Lastly, similar to its natural habitat in Australia, *Acacia mangium* grows well in coastal tropical lowland forests. According to Wilson (2016), natural habitat in it can be found naturally at the edges of mangrove stands, in the area where lowland primary forests transition into rivers and grasslands, and in recently disturbed areas, particularly those affected by fire. However, it is more frequently found in marginal communities or larger disturbances within closed-forest, typically in areas with low fertility. Apart from that, the species could be able to live in subtropical dry to wet forest life zones, which include Colombia and Costa Rica, as well as tropical extremely dry to moist forest life zones.

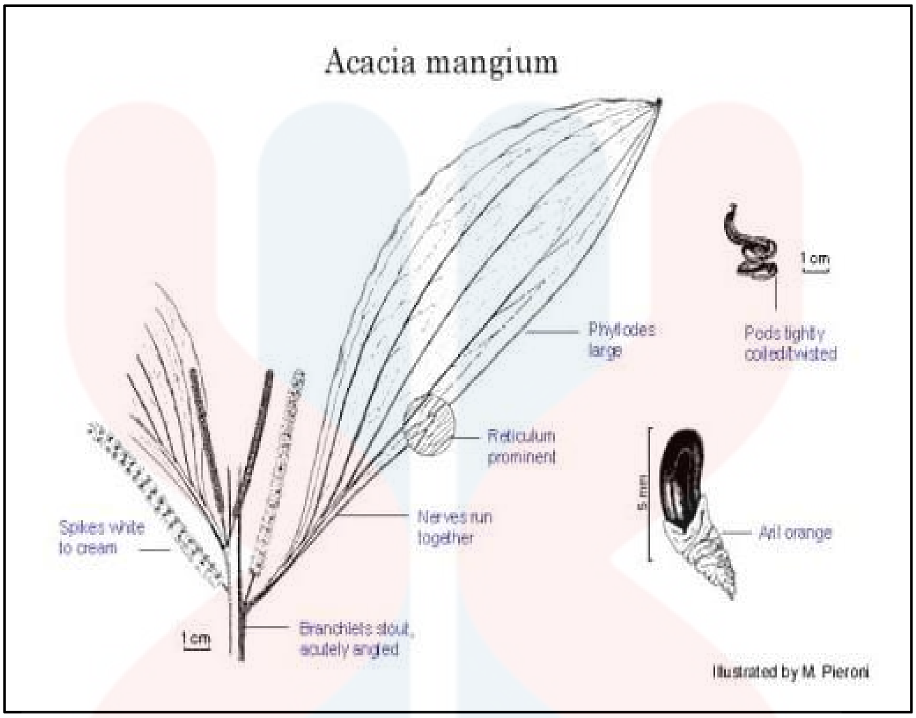

Figure 2.1: Anatomy of *Acacia mangium*
Source: Maslin (2018)

2.3 Light intensity and plant growth

According to Baligar (2020) maintaining the metabolic processes required forplant growth and biomass formation requires an ideal level of light. In addition, various light regimes have shown plant responses, such as modifications in *Acacia mangium* leaf area, stem elongation, flowering patterns and overall plant architecture, all of which are affected by changes in light conditions. Furthermore, the research highlights how important it is to take into account not only light intensity but also photoperiod and light spectral makeup to fully understand the growth response of *Acacia mangium*. Different wavelengths of light affect various physiological functions and developmental pathways in plants, which have an influence on growth and production in different ways.

2.4 Growth performance of *Acacia mangium*

2.4.1 Leaf

Phyllodineous, green leaves with pointy twigs. Leaf blades are around 13–20 x 3–7 cm. The leaf blade has one almost straight side and one sharply bent side. Three or four longitudinal, anatomizing veins are typically more noticeable than the others. Compared to the veins close to the curved side, the two veins next to the straighter blade margin stick together for a longer period of time. a little gland that is often visible at the intersection of the petiole and leaf blade (Hambali, 2019).

Figure 2.2: Leaves of *Acacia mangium*
Source: Krisnawati, H., Kallio, M. & Kanninen, M (2011), December 5, 2023

2.4.2 Stem

According to Sethikumar (2013) *Acacia mangium* stems usually had a cylindrical form and smoothed bark, however they could wrinkle with age. Its fast vertical elongation during growth enables it to attain remarkable heights in a comparatively short amount of time. Furthermore, the high-quality timber on the *Acacia mangium* stem was highly valuable commercially since it was valued for its strength, durability, and resistance to rot. Because of the ecological and economic advantages of this species, it had been the subject of much researched, which had improved our knowledge of its growth mechanisms and their used in sustainable forestry methods.

Figure 2.3: Stem of *Acacia mangium*
Source: Australia, A. O. L. (2013), December 2013

2.4.3 Root

*Acacia mangium o*ften referred to as black wattle, depends on its root system for growth and survival in a variety of environmental circumstances. *Acacia mangium* liked many other leguminous plants, had a symbiotic connection with rhizobia, which were bacteria that fix nitrogen and lived in nodules on the roots of the plant. Because of this relationship, the tree may better flourished in soils deficient in nutrients by converting atmospheric nitrogen into a form that could been used by plants. *Acacia mangium* had a broad, shallow root system that enables it to effectively took nutrients and watered from the soil's surface. Because of its versatility, it was a good choice for revegetation initiatives in placed that had been eroded or damaged, since its roots may stabilize the soil and stopped erosion. Furthermore, the biomass of the roots (Silva, 2003)

Figure 2.4: Root of *Acacia mangium*
Source: C. Mohammed (2012), June 21, 2016

CHAPTER 3

MATERIALS AND METHODS

3.1 Study Area

The study will be conducted at Mosque UMK Jeli campus, Kelantan. Figure 3.1 the area of this place with the coordinate of 5.74597° N, 101.8658° E.

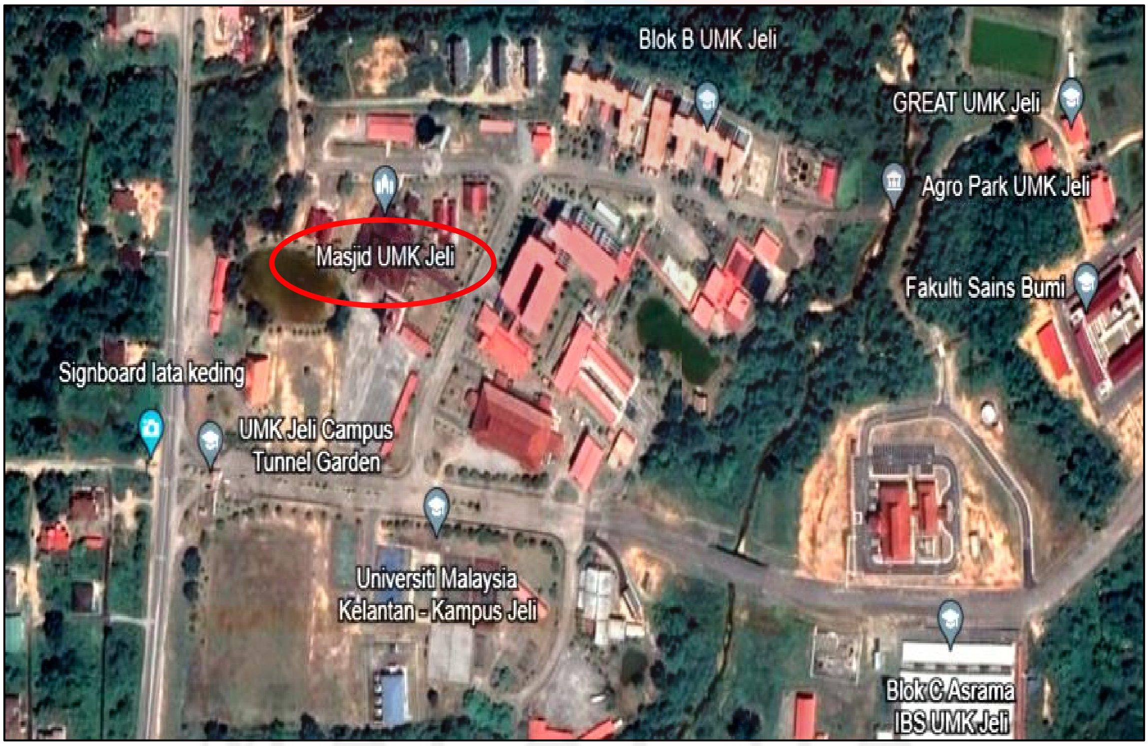

Figure 3.1: Location of UMK Mosque Jeli campus, Kelantan (Source:Google earth, 2023)

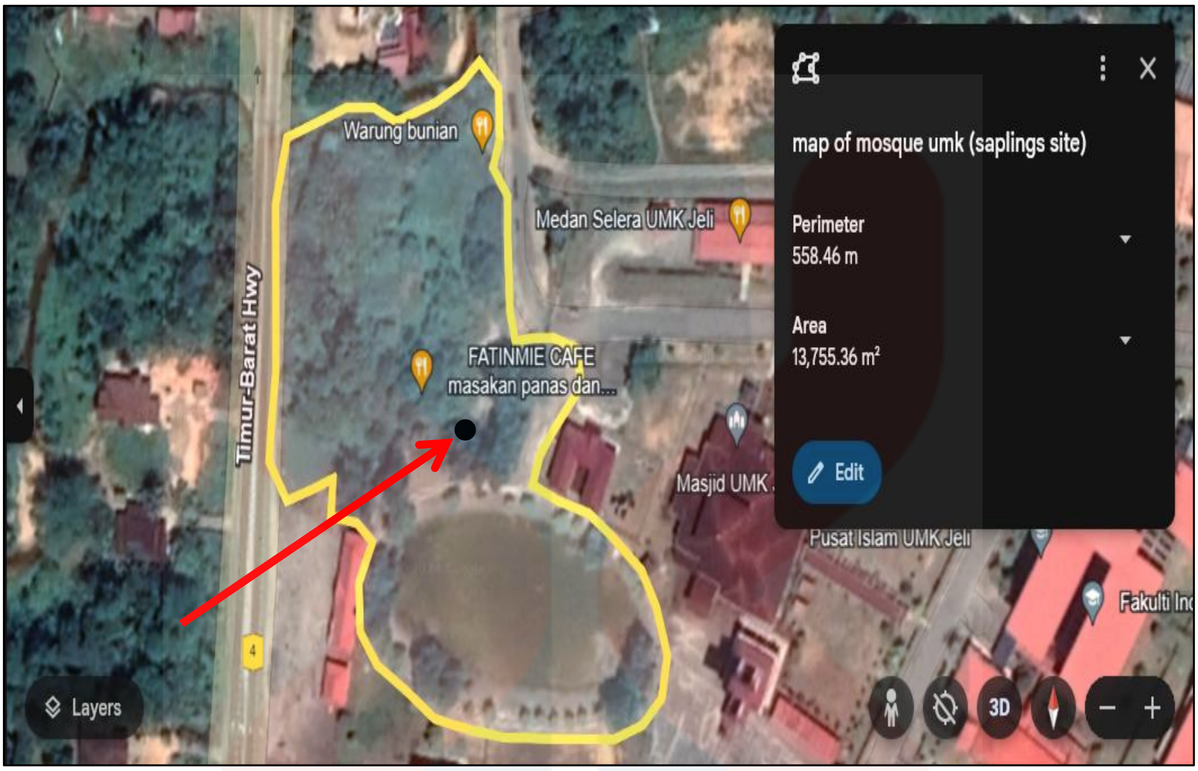

Figure 3.2: Polygon of Mosque UMK, Jeli, Kelantan

Figure 3.2 shows the researched area studied was in the UMK mosque, Jeli. There were 4 *Acacia mangium* parent trees found in the mosque area that measured no more than 5 meters in each tree. Next, the height of the location study site was estimated not to exceed 500 meters from the top of the location to the bottom of the location. In addition, the environmental conditions in the studied area were hot and cloudy according to the weather from time to time. Finally, the polygon recorded in the studied area was found to had a parameter length of 558.46 m and a total area of 13,755.36 m2.

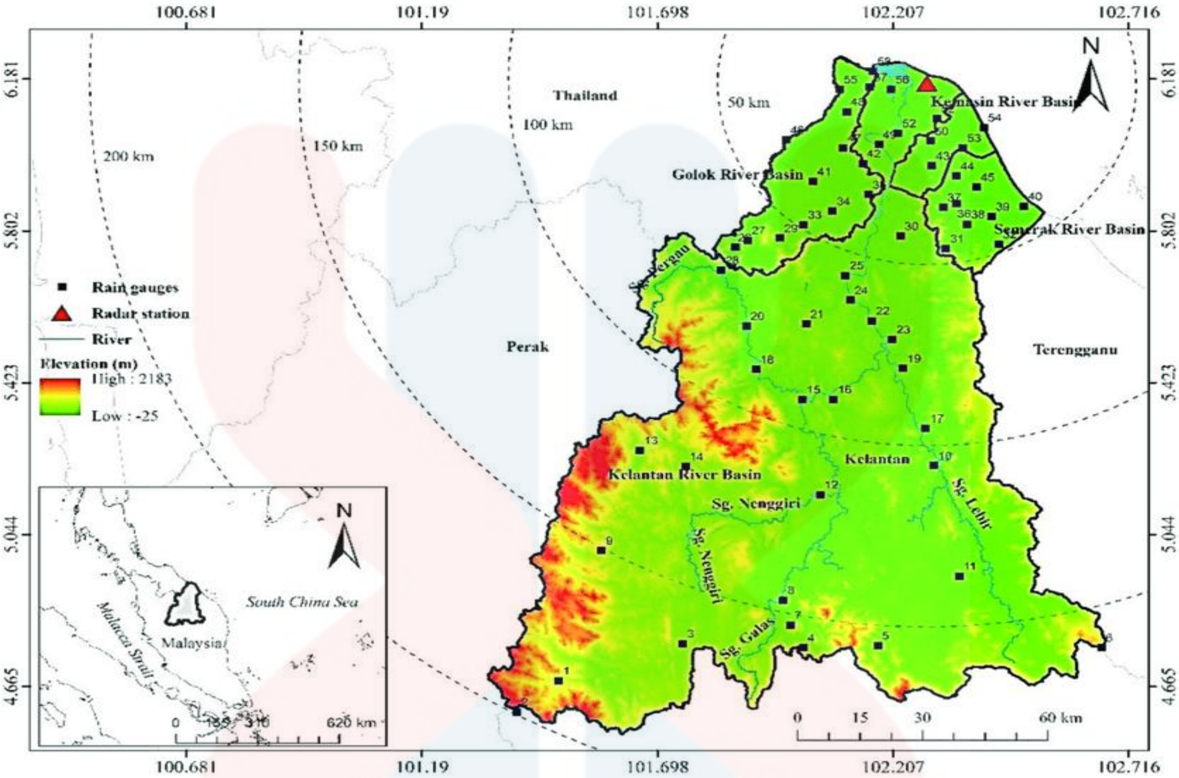

Figure 3.3: Map temperature of Kelantan

Figure 3.3 shows the regular temperature range that this area experiences during a specific time period typically a year or a month is referred to as the average temperature in Jeli, Kelantan at 2024. The typical annual temperature range in Jeli, Kelantan, was between 23°c and 32°c. The month of highest temperature are April during which the average temperature reaches up to 25.5 °C. January has the lowest average temperature of the year. It is 22.7 °C. These temperature patterns were influenced by a number of variables, such as the region's geographic location, elevation, closeness to water bodies, and wind patterns at the moment. Jeli, which was in Malaysia's state of Kelantan, enjoys a tropical environment with consistently high temperatures. The mid-to-high-20s and even low-30s celcius were common daytime highs, creating a warm and muggy atmosphere. Though they could dropped a little at night, overall temperatures stayed mild in comparison to colder regions.

3.2 Temperature by month

According to Barros (2020), climate graph show about Jeli temperature. In January 2024, the average minimum and maximum temperatures were forecast have been between 22°c and 30°c. The average temperature progressively rose throughout the month, peaking in March and April at 28°c and 29°c, respectively. The months of May and June offered even greater the temperatures with averages of 30°c and 31°c. The hottest months were July and August with average temperatures ranging between 32°c and 37°c.

Other than that, as the months draw to an end, the weather progressively cools, with averages decreasing to 30°c and 29°c in September and October, respectively. The autumn months of November and December offered considerably lower temperatures, with averages ranging from 25°c to 24°c. Overall, the weather in January 2024 was projected have been mild, with a steady increase in the months followed by a fell in the autumn months (Barros, 2020).

The highest low temperature recorded was in the month of August which was as much as 28°c, this happened because the excessive rain factor caused the temperature to become humid while the lowest low temperature was recorded in the month of January which recorded a total of 22°c. This happens because of the rain reduction factor that causes the temperature to be high and causes the temperature reading to increase. This can invite optimal growth of *Acacia mangium*.

Apart from that, the highest high temperature recorded was in the month of August which was as much as 37ºc, this happened because of many factors that occurred including open burning, vehicle smoke and so on which caused the temperature to increase with the height while the lowest low temperature was recorded in the month of January which recorded the total as much as 30ºc. This happens because of the height of chemicals that cause the temperature to be high and cause the temperature reading to increase. This can invite the growth of acacia but will have a negative impact on the plant.

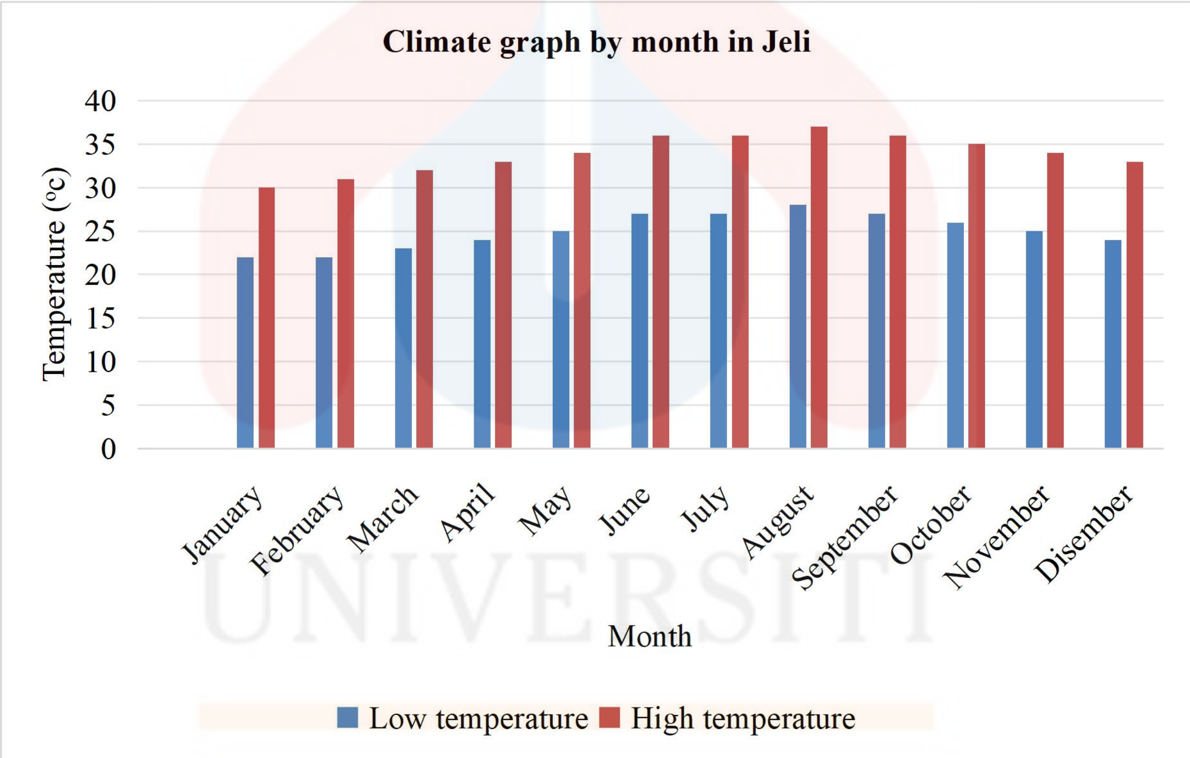

Figure 3.4: Climate graph by month in Jeli on 2024, Kelantan

Next, according to the Nuri (2019), the long-term weather forecast for June to November 2024 was based on the consensus of multiple climate forecast models, including NCEP Coupled Forecast System Model Version 2 (CFSV2), JMA ensemble forecast system (Tokyo Climate Centre), world meteorology organization lead centre for multi-model ensembles of long range forecasting, European Centre for Medium Range Weather Forecasts (ECMWF), Seasonal Climate Forecasts, and International Researched Institute for climate society (IRI). El-nino Southern Oscillation (ENSO) and Indian Ocean Dipole (IOD) were two global phenomena that influence the country's weather patterns.

Next, el nino conditions were weakening and a transition from el nino to neutral ENSO was expected in the nearest period until June 2024. The latest Ocean Nino Index (ONI) in the area nino 3.4 monitoring for February, March and April 2024 was 1.1°c. The el nino phenomenon could caused drier weather conditions and usually occurs within 9-12 months as well sometimes it could last up to two year (Nuri, 2019).

Table 3.1: Hypothesis of temperature during an el-nino event in Kelantan 2024

Month	Temperature (°C)	Temperature (°F)
Jan 2024	25.5	77.9
Feb 2024	26.2	79.2
Mar 2024	26.8	80.2
Apr 2024	27.2	81.0
May 2024	27.5	81.5
Jun 2024	28.0	82.4
Jul 2024	28.5	83.3
Aug 2024	28.5	83.3
Sep 2024	28.1	82.6
Oct 2024	27.8	82.0
Nov 2024	27.5	81.5
Dec 2024	27.2	81.0

Apart from that, figure 3.5 shows hypothesis of temperature el nino event in Kelantan, according to Abdul Rahim *et al* (2024), climate scientists were watching the potential for another el nino event in Kelantan, Malaysia, in 2024. El nino was a natural climate phenomena that caused the pacific ocean's surface temperature to rose, affecting worldwide weather patterns significantly. During el nino episodes in Kelantan, temperatures could reached 27°c on average. Forecast models predict moderate to intense el nino conditions in the second half of 2024. This could caused a spike in temperatures in Kelantan with daytime temperatures reaching 30°c or higher during the event's peak. This could threatened the growth of *Acacia mangium* and at the same time would caused the growth of *Acacia mangium* have been stunted.

In addition, el nino a complicated climatic phenomena significantly affects the growth of *Acacia mangium* seedlings in Kelantan. During an el nino, the trade winds that provided rainfall to the region diminish, resulting in a lengthy drought. As a result, the seedlings were susceptible to water stressed which could lead to slower growth and higher mortality. Warmer temperatures and UV radiation during el nino occurrences could increase stressed on seedlings, making them more vulnerable to disease and pests. La nina episodes, characterized by colder temperatures and higher rainfall could improved seedling growth and development (Mohd Shahrul, 2023). The study indicated that seedlings exposed to el nino circumstances during their early growth stages experienced slower growth rates, reduced root depth, and greater mortality compared to those exposed to la lina conditions. Climate variability impacts forest ecosystem management, emphasising the necessity for sustainable forestry techniques that include the effects of el nino on *Acacia mangium* seedlings.

3.3 Materials

3.3.1 Introduction and the materials

Figure 3.6: Plantnet apps
Source:https://medium.com/@duyguozbagci/plantnet-and-the-importance-of-user-contribution-402c3ccf597e

Figure 3.6 shows its main used was to identified plants. The main function of used the application was to studied or identified *Acacia mangium* saplings along with the details provided.

Figure 3.7: Smartphone
Source : Bonnington, C. (2015, February 10)

Figure 3.7 the purpose of used the smartphone was to captured photos of *Acacia mangium* seedlings, took photos of growth performance, the studied area, and took photos of the activities carried out while measured the distance between the mother tree and the sapling. Next, smartphone also used for take note data that are collected.

Figure 3.8: Measuring tape
Sources : Amazon.in/stanley-stht36127-812-plastic-measuring-yellow, 2024

Figure 3.8 a measuring tapa was used to measured the distance from the parent tree to the sapling used a 7 m long measurement. This happens repeatedly until enough data was needed.

Figure 3.9: Tagging
Source: lucasproductsandservices.com, 2023

Figure 3.9 shows the tagging use for tag the 70 *Acacia mangium* seedlings at UMK mosque, Jeli with the lable " Saplings of *Acacia mangium*. Next, the tagging was used for the purpose of knowing the pointed of *Acacia mangium* seedlings that were around the studied area.

3.4 Method

3.4.1 *Acacia Mangium* Selection

The criteria of the tree being studied must been *Acacia mangium* saplings from the first week to the 14 weeks. This was because, this studied was conducted to measured the diameter, height, number of leaf and roots of *Acacia mangium* saplings within 14 days only.

3.4.2 Independent Variable

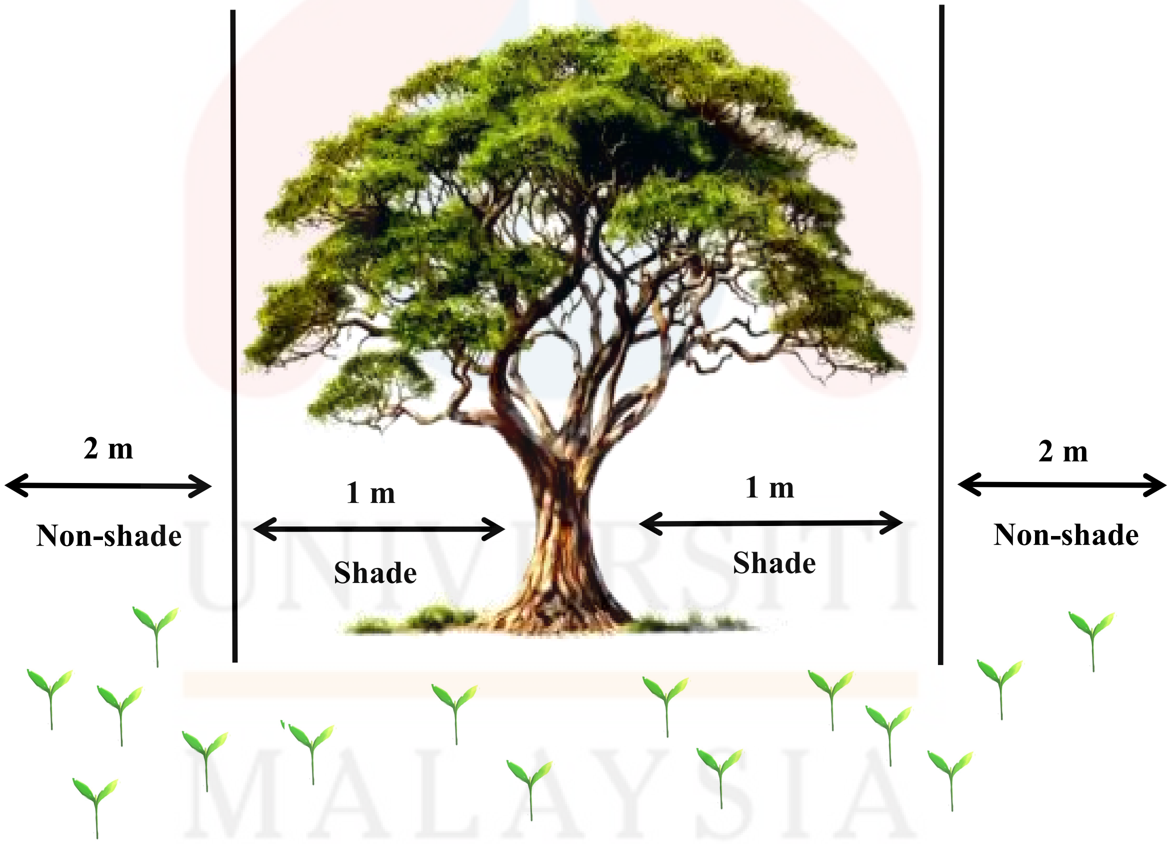

Figure 3.10: Design sample of *Acacia mangium* seedlings

The light intensity itself is most likely the independent variable in the context of researching *Acacia mangium* complete light intensity. Specifically, the amount of light exposure that *Acacia mangium* plants receive may be controlled or altered. In the context of researching the effect of light intensity on the developmentof *Acacia mangium*, partial shade was equivalent to a moderate amount of sun exposure. The aimed of this experimental set-up was to simulate a situation where the *Acacia mangium* was partially not completely deprived of light, but received less sunlight compared to full exposure. Partial shade played an important role in understanding how *Acacia mangium* responds to moderate light levels.

Besides that, *Acacia mangium* specimens exposed to low light levels areoften situated in regions with restricted or obstructed sunlight, resulting in an environment with inadequate illumination. The purpose of these settings is to replicate situations where plants would be exposed to significantly lower light intensities than they would be in full sunshine or moderate shade, such as places lacking direct sunlight or extensive canopy cover.

3.4.3 Dependent variable

An essential growth metric that gauges the tree's vertical length from base to main stem tip. The *Acacia mangium* plant's overall growth performance and vitality may been inferred from its height. Next, the breadth or girth of the main stem or trunk was frequently used to determine the age, structural integrity, and accumulation of woody biomass in a tree. For the tree to absorb nutrients and water, to anchor itself, and to remain stable overall, its roots must had certain characteristics, including length, depth, volume, and architecture. The development and survival of the tree were supported by a well-developed root system, particularly in the early stages and under unfavourable climatic circumstances. Lastly, the combined dried weight of the tree's above-ground (leaves, stems) and below-ground (roots) components, which indicate how productive and efficiently it used its resources. In *Acacia mangium*, biomass accumulation was a key indicator of productivity and growth.

3.4.4 Data collection

Data collection carried out on *Acacia mangium* was taken within 2 week only to measure the growth of *Acacia mangium* for leaf, stem and root. During the 2 week, every day it is necessary to come to the study site to collect data according to the type of light intensity which are shade and non-shade.

3.4.5 Statistical Analysis

A preliminary summary of growth patterns, variability, and trends of A*cacia mangium* measurement centers was provided by descriptive statistics. Next, in this researched also used correlation regression to determine the difference between height, number of leaf and roots as well as shade and non-shade light.

3.5 Research flow chart

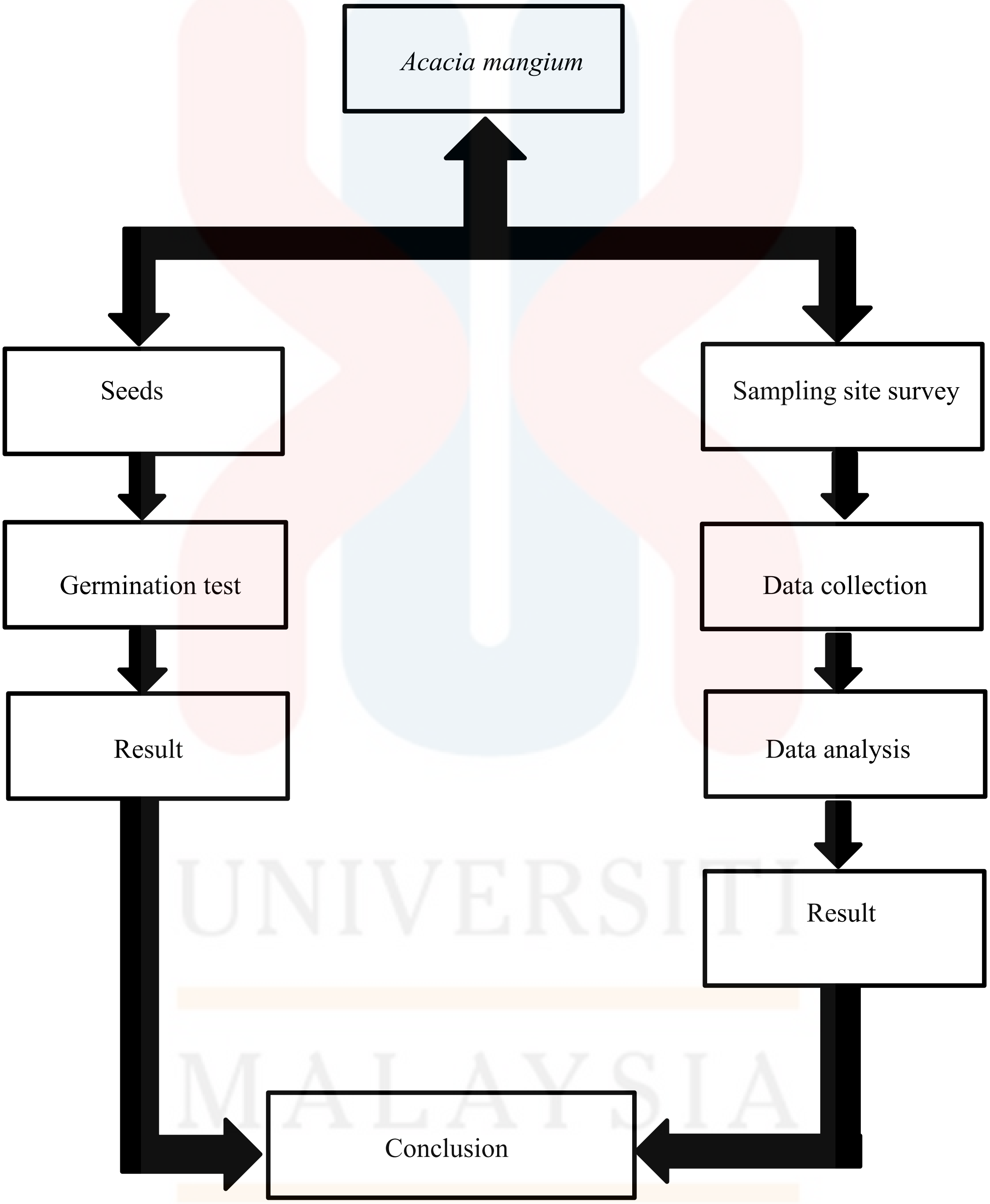

Figure 3.11: Research flow chart

CHAPTER 4

RESULT AND DISCUSSION

4.1 Seed Germination of *Acacia mangium*

The results showed that plants and pre-seedling treatments could had variable effects on *Acacia mangium* seed germination. The effects of treatments on the germination of *Acacia mangium* species after 2, 4, 6, 8, and 10 days were presented and their relationship with time was shown in figure 4.2 (Tadros *et a*l, 2011). As could been expected, the lowest germination observed in the table was on the third day which was no proliferation occurred on that day while the highest proliferation was on the 18 days where the proliferation was as much as 14%. Overall percentage of seed germination were 42%.

Figure 4.1: Seeds Germination of *Acacia mangium* (Day 9-18)

Other than that, according to Smiderle, Mourao Junior, and Sousa (2005), the number of days taken to complete germination was recorded for each replication that had 100 seeds for every two replications that used from A4 paper, each layer had more than four A4 paper to did the germination test of *Acacia mangium*, so a total of 200 seeds of *Acacia mangium* was used. It took 18 days starting from 01 April 2024 to 10 April 2024 and took results from the 2, 4, 6, 8, and 10 days.

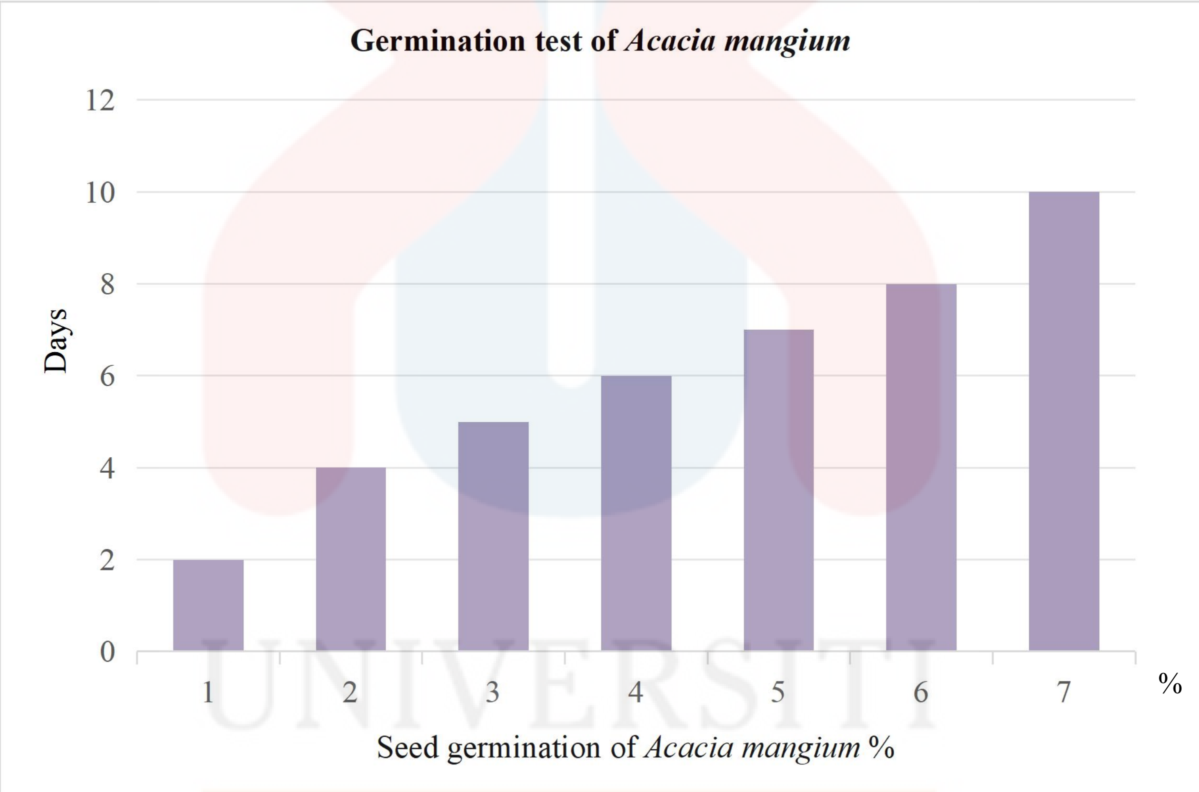

Figure 4.2: Seed germination of *Acacia mangium*

The seed has to be threated first before germination test took placed (Senthilnathan, 2012). Among the challenges was that the seeds did not grow within one week because of the wrong approach thus the seedling have been contaminated with bacteria and fungi. Another approach has been made, thus time by using a boiling water. The seed were put in a heatproof container and boiling water was pour over it. The seed also was to be soaked overnight to make sure it has swollen. Seed that not swollen should be threated again.

Next, according to William (2018), studies have revealed that seeds treated with boiled water had a better germination rate than seeds treated with tap or distilled water. The boiling procedure can degrade or eliminate some of the inhibitors found in the seed coat, resulting in faster and more uniform germination. In one study, seedlings treated with heated water had a 92% germination rate compared to only 65% when treated with tap water (Lee, 2020). Another study discovered that boiling water treatment enhanced germination rates by up to 30% over untreated seeds (William, 2018).

Aside from that, factor effecting germination are *Acacia mangium* seeds showed a reasonably broad temperature tolerance for germination with optimum temperatures ranging from 25°c to 35°c (Wang *et al*., 2018). Seeds exposed to temperatures above 40°c or below 15°c may have lower germination rates or possibly inhibited germination altogether. This study found that temperatures ranging from 28°c to 32°c were best for the germination of *Acacia mangium* seeds, with an average germination rate of roughly 80% (Liu *et al*., 2019). Germination dropped dramatically at temperatures above 35°c, and was virtually totally inhibited at temperatures above 40°c. Seeds exposed to temperatures below 20°c, on the other hand, may exhibit lower germination rates, but to a lesser extent (Ahmed, 2022).

Fluctuating temperatures could had a significant effect on seed germination, and *Acacia mangium* seeds were no exception. For example, studied had found that repeated temperature fluctuations between 20°c and 30°c could increase seed germination, while constant temperatures may inhibit germination (Zhang *et al*., 2020).

Apart from that, this study discovered that *Acacia mangium* seeds were photosensitive and responded differently to varied light intensities and wavelengths. *Acacia mangium* seeds require low to medium light intensity, with optimal germination rates observed at 50-100 µmol m-2 s-1 (Mai *et al*., 2018). Next, study indicate that seedlings exposed to strong light intensities (above 200 µmol m-2 s-1) may experience reduced germination rates or possibly full inhibition due to photoinhibition (Li *et al.* , 2019). Seeds exposed to low light intensity (below 10 µmol m-2 s-1) may had impaired or delayed germination due to insufficient photosynthesis and nutrient availability (Wang *et al.* , 2018).

Besides that, this studied found that *Acacia mangium* seeds had a rather good viability with germination rates ranging from 70% to 90% (Mai *et al*., 2018). However, seed viability could been influenced by a variety of factors such as storage conditions, moisture levels, and handling techniques. Next, this studied discovered that seeds maintained in high humidity or wet circumstances had viability after a few weeks (Wang *et al*., 2019).

Last but not least, the viability of *Acacia mangium* seeds could been influenced by the quality of the parent plant. Seeds from healthy and robust parent trees were more viable than those from stressed or injured trees (Zhang *et al*., 2019). Furthermore, genetic heterogeneity in seed populations might influence seed viability with some genotype exhibiting higher germination rates than others (Liu *et al*., 2020).

4.2 Light intensity of *Acacia mangium*

Light intensity taken was shade and non-shade. At shade light intensity there were as many as ten *Acacia mangium* seedlings growing around the light. Light intensity of non shade there were as many as sixty seedling found at that light intensity. The site of the study are mosque UMK. Overall total of seedlings are 70.

Other than that, according to John (2021), *Acacia mangium* worked best with full sun exposure or otherwise. This was because, they would grew best in direct morning light, but in summer they needed protection from strong afternoon sun. In addition, *Acacia mangium* got at least 3–6 hours of sunshine every day for good development. This was actually only a minimal needed; most plants that could tolerate partial sun could also tolerate full sun; nevertheless, they were more adaptable than plants that require full sun or partial shade since they require less light for photosynthesis (Andrade, 2019).

Apart from that, when *Acacia mangium* received too little sunlight, they may turn pale green or showed drooping yellow leaf. Although it was normal for some leaf to fell off, if the leaf fell off but no new leaf grew to replaced them, this was a sign that something was wrong. If *Acacia mangium* received insufficient light to grew, the new growth was often thin, pale, and vulnerable to insect attacked. Paying attention to these signs and changing the plant's lighting conditions would made a significant difference (John, 2021).

Next, Although bright morning sun and full sun exposure could been very beneficial for *Acacia mangium*, hot midday sun could been too much to handle. If planted in the ground, the sun would usually increase slowly enough throughout the season for *Acacia mangium* to gradually adapt to its intensity (John, 2021). But potted plants that had been indoors or in sheltered locations would often suffer injury when suddenly placed in a location where the sun shines directly on them during the hottest part of the day. To protected this plant from the heat of the sun during the day, plant it or placed it in a location that was shaded during the day by trees and taller plants or by buildings or landscape features.

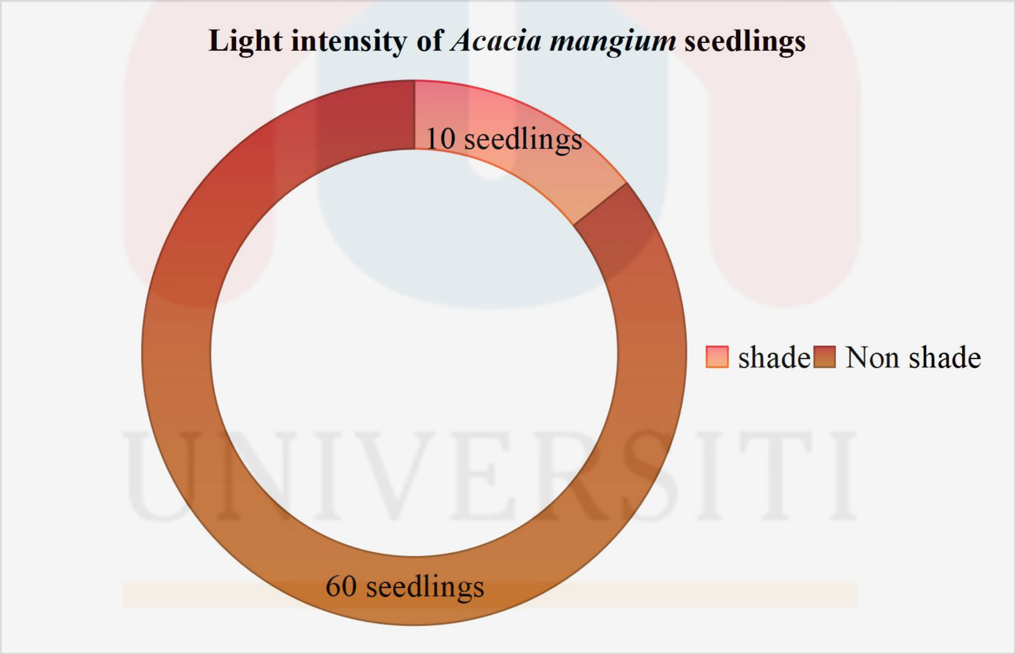

Figure 4.3: Light intensity of *Acacia mangium* seedlings.

Apart from that, figure 4.3 shows the light intensity of *Acacia mangium* seedlings according to shade and non-shade. The shade there were as many as 10 A*cacia mangium* seedlings, while in non-shade there were as many as 60 seedlings recorded. This was said have been so because, shade contains little sun exposure which prevents the growth of *Acacia mangium* seedlings, while no shade produces many *Acacia mangium* seedlings because the plant needed a process for photosynthesis (Chen, 2019).

Figure 4.4: Open canopy of *Acacia mangium* seedlings

Figure 4.4 shows taken in the open canopy area near the UMK mosque, Jeli. The picture shows the size between the mother tree and the young tree which had a length of 168 cm or equal to 1.68 m. They are have 60 seedling of *Acacia mangium* was collected. The *Acacia mangium* thrives in an environment with an open canopy because it gave the tree enough light and airflow while still offering some protection from harsh weather. When a tree had an opened canopy, it may grew quickly, expanding its canopy to occupy the available area (Orwa, 2009). Additionally, the open structure promotes adequate air circulation which lowers the danger of pests and insects and helps to prevent fungal illnesses.

Furthermore, a more uniform dispersion of sunlight was made possible by the opened canopy, which was necessary for biomass production and photosynthesis. The flexibility of *Acacia mangium* to a broad range of settings, including tropical forests, savannas, and grasslands, contributes to its capacity to flourished under opened canopy situations. Under these circumstances, the tree may develop quickly and out compete other plants for resources by used its deep root system to collected nutrients and water. All things considered, *Acacia mangium* thrives under an open canopy setting where it may develop quickly and realize its full potential (Orwa, 2009).

Figure 4.5: Light green leaves of *Acacia mangium* seedlings

Figure 4.5 shows are being in an open canopy, the tree usually got a lot of sun exposure, and light green leaf could appeared as a result. However, the phenomenon was not specific to *Acacia mangium* and many tree species grown in open or in full sun showed the same symptoms. Leaf greening could been caused by a number of different factors including the tree responding to environmental stressed, nutrient deficiency, or pest or disease infestation. If the photosynthetic apparatus of leaf was overactive due to direct sunlight, it may unnecessarily started producing excess levels of reactive oxygen species, which were not neutralized during metabolism, could lead to oxidative stressed (Delong, 2024).

Next, light green was also common in open canopy environments because there was that we called no overhead cover which could affect the development of light green leaf. This was because without the closed canopy, leaf could encounter too much sunlight due to accumulation as well as the expanding their water stressed. A similar result could occur if the opened canopy made access of the tree to nutrients and water in the soil even more difficult, thereby subjecting the tree to nutrient deficiencies or water stressed.

Figure 4.6: Larger size of *Acacia mangium* leaves

Figure 4.6 shows the large size of *Acacia mangium* seedlings in open canopy environments could been attributed to several factors. One of the primary reasons was the abundant availability of light, which was a critical resource for photosynthesis. In an open canopy environment, the seedling was not shaded by taller trees, allowing it to received an adequate amount of direct sunlight. This enables the seedling to undergo rapid growth and development, as it was able to utilize the available light to produced energy-rich biomass (Zhang, 2019).

Furthermore, the open canopy habitat may create a more stable and beneficial microclimate for the seedling. The lack of shadowing can lead to more stable temperature and humidity levels, which can encourage healthy growth and development. In addition, the open canopy environment may lower the risk of pests and diseases seen in denser woods (Alcantara *et al*, 2017).

Figure 4.7: Dark leaves of *Acacia mangium* seedlings

Figure 4.7 shows dark green leaves of *Acacia mangium* seedling on under story, where the canopy was dense and filtered sunlight prevails, tended to exhibit a darker green color. This was because the reduced light intensity promotes the production of more chlorophyll, allowing the leaf to adapt to the lower light conditions. The darker green color was a result of the increased chlorophyll content, which helps the seedlings to optimize their photosynthetic activity (Lukyani, 2023).

Apart from that, in order to cope with the reduced light levels, the seedlings' leaves have also become thicker and more succulent, increasing their surface area and increasing their capacity to absorb light. As a result, the photosynthesis activity of the seedlings increases and they are able to absorb more photons (Lukyani, 2023). There is more chlorophyll in the soil, the seedlings have also become a darker shade of green. The blue and red portions of the spectrum, which are less prevalent in the under story, may be absorbed by the seedlings more readily thanks to this deeper shade of green. The seedlings can boost their photosynthetic activity and energy production by taking in more light at these wavelengths.

Figure 4.8: Small size of *Acacia mangium* seedlings

Figure 4.8 shows the small size of *Acacia mangium* seedling. Under story of *Acacia mangium* leaf tended have been smaller than when grown in full-sun environments. This occurs because the canopy limits the amount of light that reaches the plants, causing a decrease in photosynthesis. Therefore, the foliage of *Acacia mangium* that grows beneath the canopy tends to had reduced leaf size, shorter stems, and a denser overall appearance. This adjustment helps the tree save energy and resources since it could not out compete other plants for light in the shaded area. The leaf were positioned in a denser arrangement along the stem, leading to a decrease in the total leaf area per stem, ultimately aiding in energy and resource conservation. Moreover, the leaf might also thicken their cuticle to decrease watered loss and avoided drying out, and could became more fleshy, storing watered and nutrients to aid the tree's survival in dimmed environments (Khazimah *et al*, 2015).

4.3 Growth Performance *of Acacia mangium* Seedlings

Based on the results that had been obtained at Table 1, there were 70 *Acacia mangium* seedlings found in the study area which was in the UMK mosque, Jeli. In this study, seedling diameter (mm), seedling height (cm), number of leaf and short root was taken for each seedling. The main purpose was to take determined the growth performance of *Acacia mangium* seed sampled (Amish Choudhury, 2020).

Based on the observations made, the figure 4.9 shows that the highest seedling diameter (mm) was in the number of classes 10-19 category, was a total of 33 seedlings. This happens because there were many saplings that had a diameter below 19 mm while the least amount was in the number of classes 40-49 category which had only one seedling.

Table 4.1: Average values of diameter

Average values of diameter				
Total number of individual				
Class category	Stem Diameter (mm)	Seedling Height (cm)	Number of Leaves	Short Root (cm)
0-9	24	25	70	59
10-19	33	36	0	6
20-29	3	4	0	5
30-39	2	3	0	0
40-49	1	2	0	0

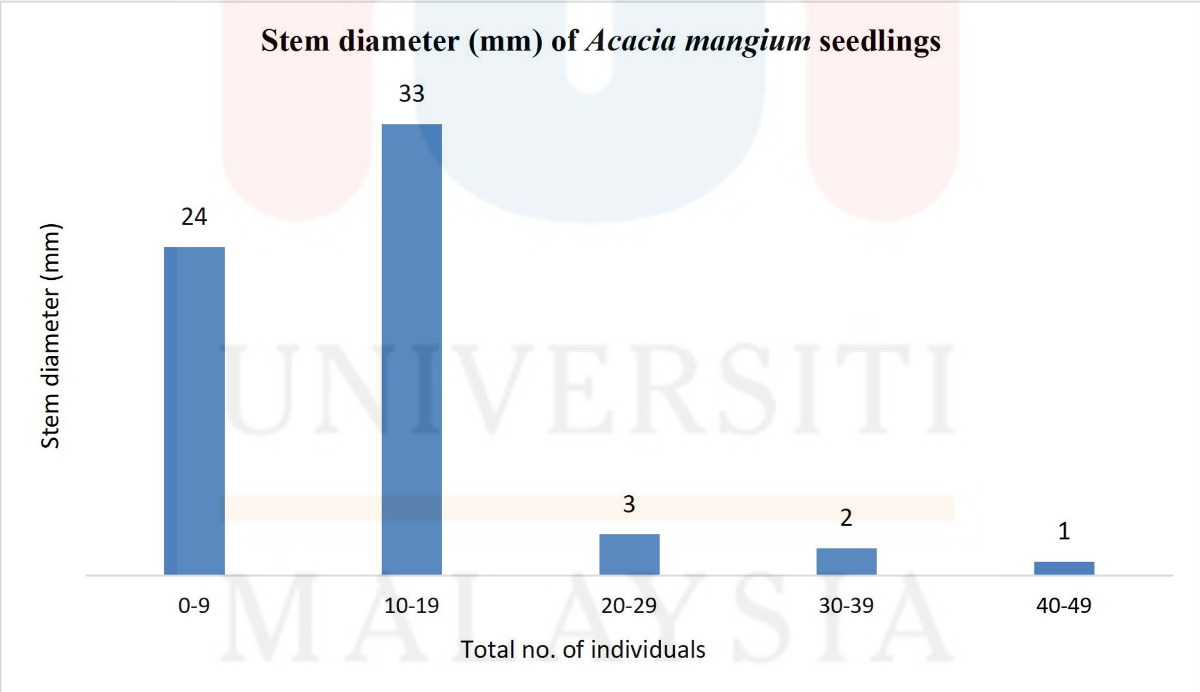

Figure 4.9: Seedling diameter (mm)

Referring to the results obtained, figure 4.10 shows that the highest number of seedlings in seedling height (cm) was in the category 10-19, which was as many as 36 saplings that was recorded, such a thing happens because the total height was below the category 10-19 and below while the total the least was in the 40-49 category. This happens because there were 2 saplings that had a height of 40 cm and 41 cm in the 40-49 category.

Next, between the differences found in figure 4.10 and figure 4.11 was the height, where seedlings height had a relatively high height range which was as many as 36 seedlings of *Acacia mangium* compared to seedling diameter which was a total of 33 seedlings of *Acacia mangium* in the category classes 10-19, while the total the fewest seedlings were recorded in figure 4.11 where seedling diameter had a total of 1 seedling and seedling height had a total of two seedlings in the classes 40-49 category.

Aside from that, a crucial factor in *Acacia mangium'* growth and development was the correlation between seedling diameter and height. According to Aloy *et al* (2014), there was a positive association between the two, as seedlings with a lower diameter often had a bigger height. This resulted from a number of variables that might have an impact on the shape and pace of growth of seedlings, including soil type, nutrient availability, and environmental influences. This was because, seedlings growing in nutrient-poor soils, for instance, could have bigger diameters but those growing in more rich soils would have grown taller because of the increased availability of nutrients.

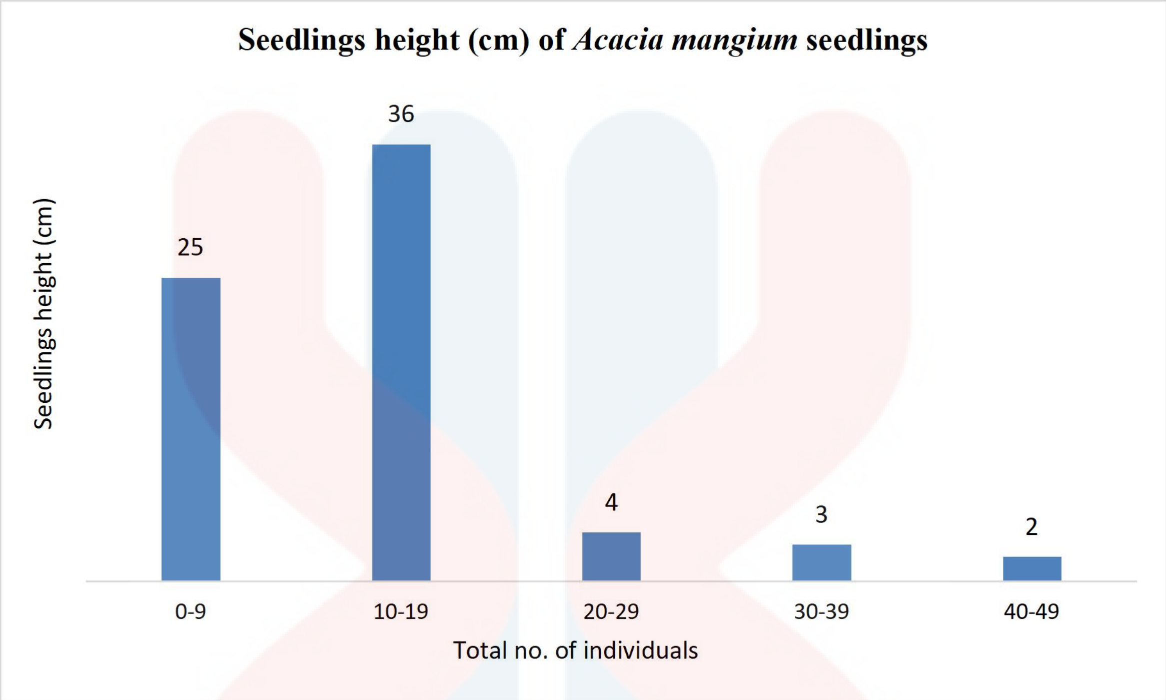

Figure 4.10: Seedling height (cm)

Based on figure 4.11, the highest data was in the 0-9 category. This was because, 70 *Acacia mangium* seedlings had less than 10 leaf based on the one week data been recorded. In addition, the data that had the fewest records includes 10-49 categories. This happens due to, the number of leaf would grew according to the week from the third week until the 8 week was recorded. The third and fourth weeks of the seedlings would produced 2-3 leaf, the fifth and sixth weeks would had 4-6 leaf , the seventh and eighth weeks would produced 8-10 leaf. As a result, 70 trees were in the 0-19 category (Abdullah *et al*, 2015).

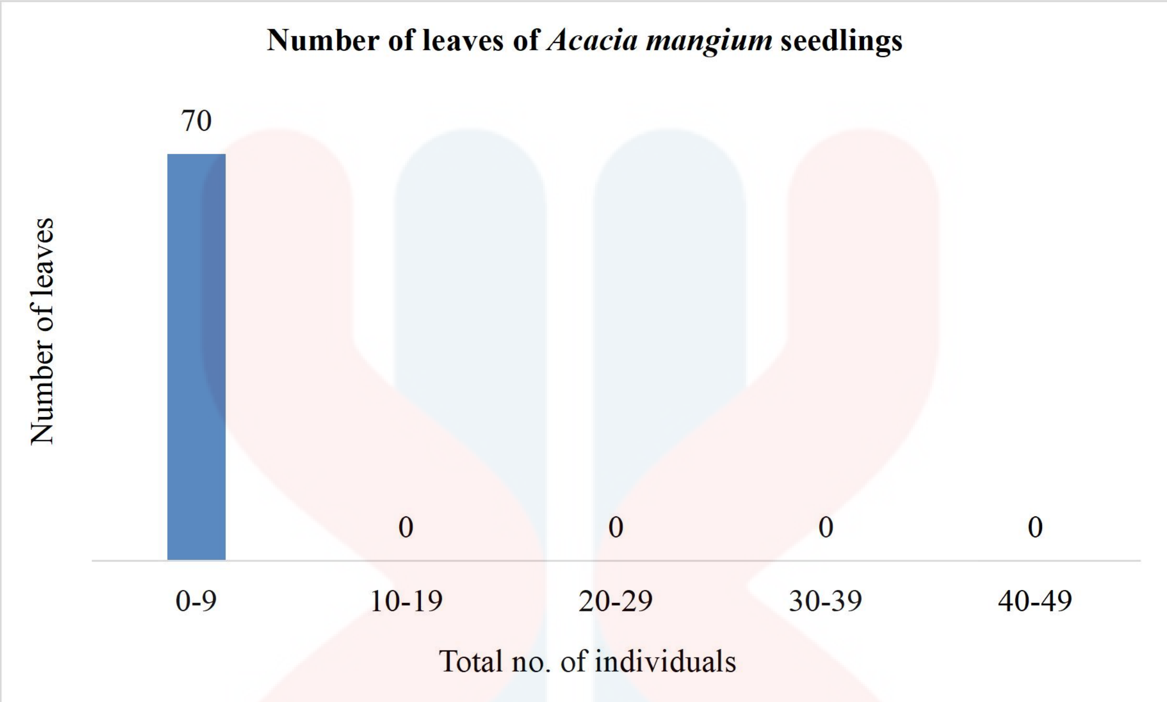

Figure 4.11: Number of leaves

Based on figure 4.12, the data that had been taken had the highest amount in the 0-9 category. This was because, 70 *Acacia mangium* saplings had a root size of no more than 10 cm. In addition, the data that had the fewest records includes 40-49 categories, which had as many as 5 *Acacia mangium* seedlings recorded. This happens because sunlight, moisture, nutrients played an important role in the optimal growth of *Acacia mangium* (Wijayanto, 2010).

Next, the seedlings involved in the 0-9 category amount to 24 seedlings that have a shorter and denser root system. This was because the plant dedicates more resources to leaf growth and development, which allows it to capture more light and photosynthesize. However, this means the plant has fewer resources for root growth and development, resulting in a shorter root system. Conversely, plants with shorter root systems may have fewer leaves. This is because they invest more resources in root growth and development to access limited water and nutrients. By allocating more energy to its roots, these plants can take advantage of underground resources and thrive in water-scarce environments (Zhang et al, 2012).

Lastly, figure 4.12 it was shown that the estimated saplings that were in the shade as many as 10 while not shaded as many as 60 saplings of *Acacia mangium* that was found and recorded. In total, the number of one parent tree was equal to 70 recorded A*cacia mangium* seedlings.

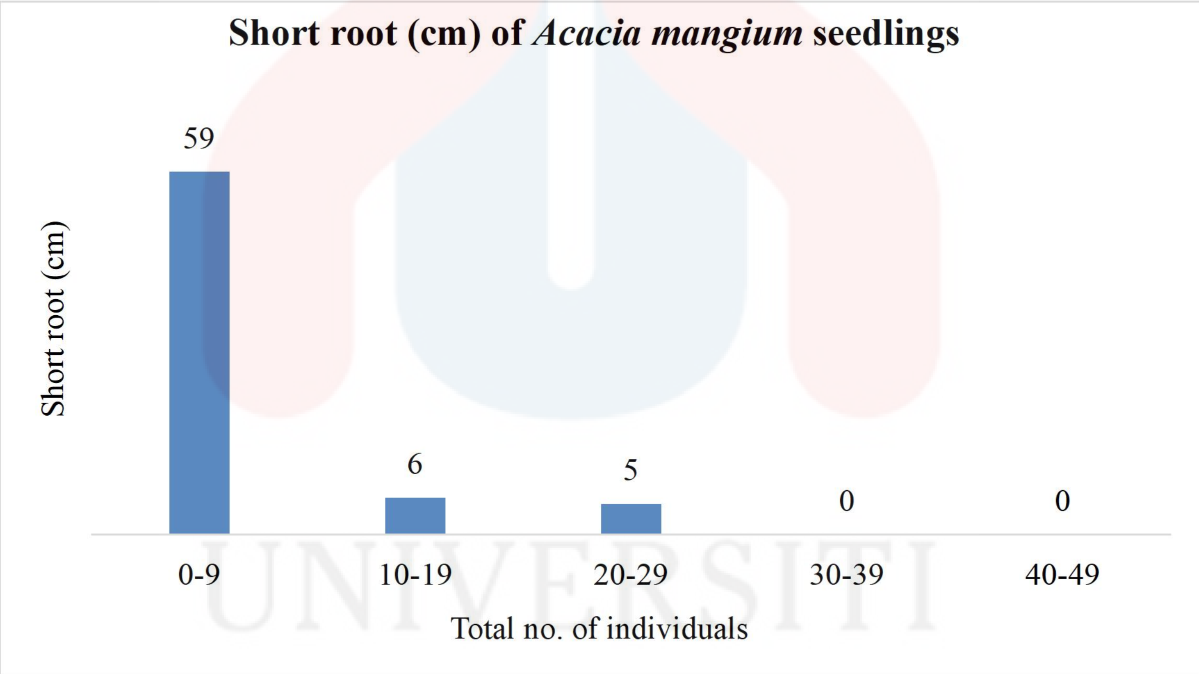

Figure 4.12: Short root (cm)

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Seed germination test was done to study the growth rate of *Acacia mangium* trees and the results were found that only 42% grew during the 10 days of the study. The factor that causes the growth rate of the seeds to be small is because the time taken is too short, the period of this study should be done for a month to see the optimal growth rate of *Acacia mangium*.

Besides that, the studied found that el nino events had a major impact on the growth and development of *Acacia mangium* seedlings, leading to lowered growth rates and increased mortality during droughts. El nino episodes could significantly impact forest management and conservation efforts, especially in placed relying heavily on forest resources.

Next, this study shows a significant effect of light intensity on the growth performance of *Acacia mangium* seedlings. The results show that increasing light intensity leads to better growth parameters, including stem height, diameter, leaves and roots. The optimal light intensity range for *Acacia mangium* seedlings found to be shade and non-shade. This finding has important implications for the growth of *Acacia mangium*, as it shows that providing sufficient light intensity can increase the growth and development of these seedlings In addition, this study highlights the potential of *Acacia mangium* to be used as a model species to study the effect of light intensity on the growth and development of trees, the optimal environmental conditions for *Acacia mangium* seedlings and can inform the development of sustainable forestry practices." Moreover, *Acacia mangium* seedlings are more prone to high sunlight because it stimulates the production of chlorophyll, the green pigment responsible for photosynthesis. This allows plants to absorb more light and produce more energy. Furthermore, it stimulates the release of nutrients from the soil, making them more available to plants. This can lead to better nutrient uptake and better growth.

Apart from that, the recovery of *Acacia mangium* seedlings is difficult due to the high seedling death rate, particularly in the early phases of growth. Despite the significance of *Acacia mangium* as a nitrogen-fixing species and a rich timber resource, restoration efforts are sometimes hampered by a lack of acceptable nursery conditions, insufficient soil preparation, and inadequate protection from harsh weather conditions. Furthermore, *Acacia mangium* seedlings are sensitive to harsh temperatures, dryness, and weed competition, which can result in lower germination rates, slowed growth, and higher mortality. As a result, there is an urgent need for effective restoration measures that can increase *Acacia mangium* seedling survival and growth rates.

Besides that, this studied was limited to a single placed, which did not reflect other areas with varying environmental variables. Furthermore, the sample size of *Acacia mangium* seedlings was modest, which may not had provided a thorough understanding of the effect of light intensity on growth performance. Furthermore, the studied measured only a few variables, including height, diameter, leaf, and roots. In addition, the studied did not account for other environmental variables that could influence growth performance, including as humidity, and soil quality. As a result, the findings of this studied may not been applicable to other settings or conditions. Despite these limitations, this study gives useful information into the effect of light intensity on the growth performance of *Acacia mangium* seedlings at the UMK Jeli Campus and can serve as a foundation for future research in this area.

Last but not least, there were many saplings in the unshaded area, which was as many as 60 saplings in the area, this was because it was affected by direct sunlight which caused the growth of *Acacia mangium* seedlings well while in the shaded area as many as 10 saplings was found in that area while in the shaded area as many as 10 saplings was found in that area.

5.2 Recommendation

Some recommendations for improving the *Acacia mangium* germination test were utilize more exact means of measured light intensity, such as a photometer, to determine the amount of light in lux or umol/s. This would result in more accurate data and more exact controlled over lighting settings. Next, the second was to employ a controlled environment to maintained regular temperature and humidity levels, which could assist limit variation in outcomes. Furthermore, used seedlings of comparable age and size could assist reduce variability and improved results accuracy. Furthermore, perform numerous replications of the experiment to guaranteed that the results were accurate and representative of the population. This could been accomplished by the used of a randomized whole blocked design or a split plot design, which could assist reduce error and improved result accuracy.

Apart from that, some suggestions could been made to helped seedlings grew and develop better were supply adequate light intensity to the seedlings, which was critical for their growth and development. This could been accomplished by planting it in a location with adequate natural light or by utilizing additional lighting, such as LED lights. The second was to did additional researched on the impact of light intensity on the growing performance of *Acacia mangium* seedlings in various habitats and situations. This would assist in determining the appropriate light intensity for the seedlings' growth and development. Other environmental elements that could affect the growth performance of *Acacia mangium* seedlings include temperature, humidity, and soil quality.

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APPENDIX

Growth characteristic of *Acacia mangium*			
No.	Leaf	Stem (cm)	Root (cm)
1	5	9.7	3.0
2	7	13.5	5.5
3	7	17.0	9.0
4	8	17.0	8.0
5	5	12.0	5.0
6	5	15.5	9.0
7	7	12.5	7.0
8	6	6.0	4.0
9	7	11.0	7.0
10	9	11.0	8.0
11	9	12.0	8.0
12	5	7.0	6.0
13	6	6.0	5.0
14	4	4.0	5.0
15	7	6.5	5.0
16	6	6.5	7.0
17	4	7.0	6.0
18	5	5.0	4.0
19	8	12.0	9.0
20	7	17	9.0
21	5	15.0	8.0
22	9	17.0	9.0
23	4	13.0	10.0
24	7	10.0	8.0
25	8	9.0	5.0
26	9	17.0	9.0
27	7	16.0	9.0
28	4	7.5	5.0
29	5	10.5	7.0
30	5	11.5	6.0
31	5	8.5	5.0
32	12	30.0	25.0
33	4	10.0	9.0
34	7	17.0	9.0
35	8	29.0	18.0
36	7	14.0	9.0
37	7	19.0	10.0
38	12	30.0	23.0
39	8	19.0	10.0
40	8	18.0	10.0

Growth Performance of *Acacia mangium*			
No.	Leaf	Stem (cm)	Root (cm)
41	4	8.0	5.0
42	3	10.5	8.0
43	6	31.0	20.0
44	6	40.0	27.0
45	3	23.0	16.0
46	5	10.0	7.0
47	3	8.0	5.0
48	4	8.0	5.0
49	4	23.0	10.0
50	3	8.0	5.0
51	3	10.0	6.0
52	4	7.0	5.0
53	3	6.5	5.0
54	8	18.0	9.0
55	7	16.0	7.0
56	4	9.0	6.0
57	5	6.0	5.0
58	4	8.0	5.0
59	5	11.0	6.0
60	6	13.0	7.0
61	4	12.0	7.0
62	6	13.0	8.0
63	8	17.5	7.0
64	4	8.5	6.0
65	5	8.0	6.0
66	5	7.5	5.0
67	4	6.0	5.0
68	8	16.5	9.0
69	8	15	8.0
70	6	11.5	7.0

Data collection of *Acacia mangium* seedlings

Took measurements from the mother tree to the child tree

Small size of *Acacia mangium* seedlings under 10 cm

Small size of *Acacia mangium* seedlings upper 10 cm

Measure diameter and height of *Acacia mangium* seedlings


Measure root of *Acacia mangium* seedlings