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**EVALUATING AND COMPARING THE SOIL
PROPERTIES OF *Durio zibethinus* IN THE
DISTRICTS OF PASIR MAS AND JELI,
KELANTAN.**

By

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DECLARATION

I declare that this thesis entitled " Evaluating and comparing the soil properties of *Durio zibethinus* in the districts of Pasir Mas and Jeli, Kelantan." is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and was not concurrently submitted in candidature of any other degree.

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ACKNOWLEDGMENT

In the name of Allah, Most Generous, Most Merciful.

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EVALUATING AND COMPARING THE SOIL PROPERTIES OF *DURIO ZIBETHINUS* IN THE DISTRICTS OF PASIR MAS AND JELI, KELANTAN.

ABSTRACT

This study investigates the soil characteristics that affect the development of *Durio zibethinus* (durian) in the Pasir Mas and Jeli districts of Kelantan, Malaysia. Durian, known for its distinct taste and scent, was a prominent agricultural commodity in Malaysia. However, its production has difficulties associated with soil quality. The objective of this research was to assess and contrast the soil properties of various areas in order to improve durian cultivation. The results of our study indicate that the soil in Jeli has a greater concentration of organic matter and improved drainage in comparison to Pasir Mas, which was distinguished by elevated nutrient levels. The soil research revealed that the average pH of Jeli's soil was 6.5, suggesting a slightly acidic climate that was favorable for durian cultivation. On the other hand, Pasir Mas had a pH of 7.0. The variations in these characteristics are directly related to the growth measurements of durian trees. This research establishes a correlation between soil qualities and durian development, offering useful information for local farmers. It suggests that managing soil conditions might result in increased fruit output and improved quality. This study has ramifications that go beyond local practices and contribute to a greater knowledge of sustainable agricultural methods in durian growing. The primary objective of this effort was to facilitate the conversion of Kelantan's durian plantations into agricultural systems that are both more efficient and environmentally sustainable.

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MENILAI DAN MEMBANDINGKAN SIFAT-SIFAT TANAH DURIAN KAMPUNG DI DAERAH PASIR MAS DAN JELI, KELANTAN.

ABSTRAK

Kajian ini menyiasat ciri-ciri tanah yang mempengaruhi perkembangan *Durio zibethinus* (durian) di daerah Pasir Mas dan Jeli Kelantan, Malaysia. Durian, terkenal dengan rasa dan baunya yang tersendiri, merupakan komoditi pertanian yang terkenal di Malaysia. Walau bagaimanapun, pengeluarannya mempunyai kesukaran yang berkaitan dengan kualiti tanah. Objektif penyelidikan ini adalah untuk menilai dan membezakan sifat-sifat tanah di pelbagai kawasan bagi meningkatkan penanaman durian. Hasil kajian kami menunjukkan bahawa tanah di Jeli mempunyai kepekatan bahan organik yang lebih besar dan saliran yang lebih baik berbanding dengan Pasir Mas, yang dibezakan oleh paras nutrien yang tinggi. Kajian tanah mendedahkan purata pH tanah Jeli ialah 6.5, menunjukkan iklim yang sedikit berasid yang sesuai untuk penanaman durian. Sebaliknya, Pasir Mas mempunyai pH 7.0. Variasi ciri-ciri ini secara langsung berkaitan dengan ukuran pertumbuhan pokok durian. Penyelidikan ini mewujudkan korelasi antara kualiti tanah dan pembangunan durian, menawarkan maklumat berguna untuk petani tempatan. Ia mencadangkan bahawa menguruskan keadaan tanah mungkin menghasilkan peningkatan pengeluaran buah dan kualiti yang lebih baik. Kajian ini mempunyai kesan yang melangkaui amalan tempatan dan menyumbang kepada pengetahuan yang lebih besar tentang kaedah pertanian mampan dalam penanaman durian. Objektif utama usaha ini adalah untuk memudahkan penukaran ladang durian Kelantan kepada swastem pertanian yang lebih cekap dan mampan alam sekitar.

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KELANTAN

TABLE OF CONTENT

	PAGE
DECLARATION	I
ACKNOWLEDGMENT	II
ABSTRACT	III
ABSTRAK	IV
TABLE OF CONTENT	V
LIST OF TABLES	VII
LIST OF FIGURES	VIII
LIST OF EQUATION	VIII
CHAPTER 1 INTRODUCTION	
1.1 Background of the Study	1
1.2 Problem Statement	1
1.3 Objective	2
1.4 Scope of Study	2
1.5 Significance of Study	3
CHAPTER 2 LITERATURE REVIEW	
2.1 Characteristics of <i>Durio Zibethinus</i>	4
2.2 Pharmacological study	5
2.2.1 Antidiabetic	6
2.2.2 Anticholesterol	6
2.2.3 Antibacterial	6
2.2.4 Antioxidants	7
2.2.5 Digestive	8
2.2.6 Anti-inflammatory	8
2.2.7 Neuroprotective Effect	8
2.3 Medicinal properties	9
2.4 Soil Properties	11
2.5 The Physical Properties of Soil	12
2.6 The Chemical Properties of Soil	13
2.7 Importance of <i>Durio zibethinus</i> Plantation	14
CHAPTER 3 MATERIALS AND METHODS	
3.1 Study Area	18

3.2	Material	19
3.3	Method	20
3.4	Data Analysis	21
CHAPTER 4 RESULTS AND DISCUSSION		
4.1	Overall Soil Properties for <i>Durio zibethinus</i>	24
4.2	Discussion on the Standard Deviation of Soil Properties in Pasir Mas and Jeli.	27
4.3	T-Test of Soil Properties	30
4.1	Overall Soil Properties for <i>Durio zibethinus</i>	32
CHAPETR 5 CONCLUSION AND RECOMMENDATIONS		34
REFERENCES		35
APPENDIX		40

LIST OF TABLE

	PAGE
TABLE 3.1: SHOWS THE FUNCTION OF MATERIAL.	19
TABLE 4.1: MEAN OF SOIL PROPERTIES FOR DURIO ZIBETHINUS ORCHARD AT STUDY AREA IN AYER LANAS, JELI AND PASIR MAS, KELANTAN.	25
TABLE 4.2: STANDARD DEVIATION SOIL PROPERTIES FOR <i>DURIO ZIBETHINUS</i> ORCHARD AT AYER LANAS, JELI AND PASIR MAS, KELANTAN.	27
TABLE 4.3: T-TEST OF THE SOIL PROPERTIES ON THE ORCHARD IN AYER LANAS, JELI, AND PASIR MAS, KELANTAN	30

LIST OF FIGURE

	PAGE
FIGURE 2.1: MALAYSIA DURIAN EXPORT	15
FIGURE 3.1: SAMPLING SITE AT AYER LANAS JELI, KELANTAN MAP.	18
FIGURE 3.2: SAMPLING SITE AT PASIR MAS, KELANTAN MAP.	19
FIGURE 3.1: ILLUSTRATION OF SOIL SAMPLING DESIGN SITE.	20

LIST OF EQUATION

	PAGE
Equation 3.1: Organic matter formula.	21
Equation 3.2: water content formula	22

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Durian (*Durio zibethinus*) was a tropical fruit native to Southeast Asia, highly prized for its unique flavour and aroma. Malaysia was a leading producer and exporter of durian, with Kelantan being one of the major durian-growing states. However, durian production in Kelantan faces challenges in optimizing fruit yield and quality. One crucial factor influencing durian growth was soil quality. Understanding the soil properties and comparing for each district was essential for improving orchard management practices and maximizing durian production in Jeli and Pasir Mas, Kelantan.

1.2 Problem statement

Little research has been conducted to specifically examine the relationship between soil properties and the growth of durians in orchard plantations located in Jeli and Pasir Mas, Kelantan. A site-specific investigation was essential because of potential variations in soil conditions and durian cultivars specific to the area, which may differ from those found in other locations.

1.3 Objective

The study was carried out to achieve the following objectives:

1. To determine the soil properties at Jeli and Pasir Mas Kelantan.
2. To compare the soil properties of *Durio zibethinus* at Jeli and Pasir Mas Kelantan.

1.4 Scope of study

1.4.1 Unveiling the Secrets Beneath the Soil

It analyzes various soil properties in Jeli and Pasir Mas orchards. This includes factors like texture, pH, organic matter content, and micronutrients that durian trees need to thrive. By understanding the soil's makeup, we can gain valuable insights into its ability to support healthy durian growth.

1.4.2 Identifying Durian Growth in Kelantan:

In addition to that, we will be concentrating on the durian trees themselves. Among the many growth factors that we will measure are the tree's height, and stem diameter. Taking into consideration these aspects, we can determine the degree to which the durian trees are flourishing in the soil conditions of Jeli and Pasir Mas. With the use of this tailored method, we can look further into the link between the qualities of the soil and the growth of durian that was peculiar to these Kelantan regions. To maximize the potential of Kelantan's durian output and optimize orchard management techniques, the findings will give useful knowledge that may be utilized. An assortment of techniques, including sampling design, soil sample and analysis, tree diameter, tree height, and statical analysis, will be utilized in this study.

1.5 Significance of study

There was a lack of research that explicitly investigates the connection between the characteristics of the soil and the growth of durians in orchard plantations situated in Jeli and Pasir Mas, Kelantan. It was necessary to do a site-specific analysis because the soil conditions and durian cultivars in the area may be different from those in other places. The findings of this study have the potential to contribute to the enhancement of the quality of *Durio zibethinus* in Malaysia. The durian was the most famous fruit and was responsible for the nation's wealth.



CHAPTER 2

LITERATURE REVIEW

2.1 Characterwastic of *Durio zibethinus*

Durio zibethinus, sometimes known as durian, was a tropical fruit renowned in Southeast Asia for its unique taste. *Durio zibethinus* belongs to the genus *Durio*, family Malvaceae, and kingdom Plantae, as per its scientific classification. It was identified by the GRIN taxon ID 14755. The ACIR community. Durian trees are typically large, perennial, and can grow up to 50 meters tall, with a cylindrical trunk that can exceed a meter in diameter. The tree's bark was rigid and red wash, often exhibiting vertical features. The durian tree possesses a remarkable characteristic in the form of its extensive root system. This enables it to firmly establish itself in the often-unstable tropical soils and effectively extract nutrients and water. The durian tree has uncomplicated, oval-shaped leaves that are arranged in an alternating pattern along the branches. often, their length ranges from around 10 to 15 centimeters, while their width was often between 4 and 6 centimeters. The upper surface of the leaves was lustrous and has a deep green colour, while the underside was covered in silvery or golden scales. This characteristic helps to minimize water loss through transpiration in the tree's hot and humid habitat. The source of this information was a book written by Ken Fern in the year 2000. *D. zibethinus* was an annual fruiting plant that exhibited a rous growth model, which was characterized by the predominance of stem development through continuous monopodial orthotropous, usually referred to as sustainable

growth. The blossoming of durian trees was a yearly occurrence that often takes place at the beginning of the rainy season. The flowers are exceptionally large, typically white or pale yellow, and emit a potent fragrance that lures bats and insects, the primary agents of pollination. Nocturnal pollinators play a crucial role in ensuring the successful fertilization of flowers, which ultimately results in the growth of fruits. The durian tree was mostly known for its fruit, which was renowned for its distinctive aroma and taste. The durian fruit was of considerable size, ranging from one to three kilograms, and was encased in a coarse, spiky husk. The shape of the fruit can range from rectangular to spherical, while its colour can vary from green to brown. Internally, the fruit was divided into compartments filled with luscious, pudding-like flesh that varies in colour from light yellow to deep red. This meat was highly esteemed for its opulent and intricate taste, blending sweet and savoury flavors with a powerful and occasionally contentious aroma. (Sihaloho, 2021.)

2.2 Pharmacological study

2.2.1 Antidiabetic

Diabetes mellitus was a metabolic disorder that was categorised under the endocrine system, and it was a complication of diabetes that caused death. Antidiabetics are drugs that are given constantly to reduce the amount of sugar in the bloodstream. *D. zibethinus* fruit exhibits antidiabetic activity due to the presence of secondary metabolites, including polywasoprenoid alcohol. (Basyuni et al., 2019) Furthermore, the fruit of *D. zibethinus* was rich in flavonoids, including catechins, quercetin, polyphenols, and tannins. Quercetin can be used in antihyperglycemic therapy because of its aldose-reductase inhibitory properties. The study by Muhtadi et al. on the experimental research proved that *D. zibethinus* ethanol extract has an

antidiabetic effect on alloxan induced diabetogenic male white rats at doses of 125, 250, and 500 mg/kg BW. (Muhtadi et al, 2015)

2.2.2 Anticholesterol

Hyperlipidemia, commonly referred to as cholesterol, was the increase in blood protein levels due to the heredity or diet of the person. Anticholesterol products are used to manage heart cholesterol products that are above normal limits. *D. zibethinus* fruit was one of the fruits that exhibit anticholesterol activity. The study used albino male mice which were weighed and caught in the weighing range of 150-300 grams, the rodents were then fed on high-fat diets for 28 days. According to the study carried out by Muhtadi et al 2015., it can be concluded that *D. zibethinus* fruit possesses anticholesterol properties. This research proved that the feed supplementation with *D. zibethinus* fruit extract at a dose of 500 mg/kg BW lowers the blood cholesterol levels in mice. In the test, there was a lot of activity noted when compared with the positive control known as Cholestyramine. (Muhtadi et al 2016)

2.2.3 Antibacterial

Research by Chigurupati et al. Chigurupati et al. (2018) has shown that the *D. zibethinus* fruit fights off *Staphylococcus aureus* with a minimum inhibitory concentration (MIC) of 250 µg/ml, achieving inhibition zones of 10.3±0.58 mm, and it also battles *Bacillus subtilis*, reaching zones of 10.0±0.58 mm, through the method of well diffusion. In the following analysis, the durian fruit demonstrated a nonreactive region towards *Pseudomonas aeruginosa* (11.2±0.76 mm) and *Escherichia coli* (12.0±1.00 mm). (Chigurupati et al., 2017).

2.2.4 Antioxidants

Vinay et al used the DPPH method to assess the antioxidant potentiality of the *D. zibethinus* fruit. This was attributed to the antioxidant activity of the percentage of inhibition or capture of free radicals, its IC₅₀ value being 370µg/ml. (Sp et al., 2019) Subsequently, in other investigations, the IC₅₀ value of *D. zibethinus* fruit with ethyl acetate solvent was 48.04 ppm, and durian fruit exhibited potent antioxidant properties. (Aruan et al., 2019) *D. zibethinus* fruit ethanol extract showed the highest antioxidant activity against DPPH radical with an IC₅₀ value of 11. 21 µg/ml, while the standard curve of ascorbic acid showed that the compound has a 50% inhibition at a concentration of 6.56 µg/ml. Due to the high phenolates and flavonoids contents on the ethanol extract of *D. zibethinus* fruit, it is possible to act as an electron donor, such as a hydroxyl group, to form non-radical DPPH-H forms in homogenous systems. (Evary & Nur, 2018) In other studies the methanol extract from the fruit of *D. zibethinus* possesses appreciable antioxidant potential in a dependant manner on the dose; its inhibitor concentration value was determined as 102.37±1.98, 19.50±1.44, 280.79±22.80, 154.67±5.84, 770.52±19.28, 324.63±17.61, 4.45±1. 13 and 63. 95±14. Respectively for DPPH, ABTS+, reductive capacity (Fe³⁺), reductive capacity (Cu²⁺) antioxidant activity (O₂⁻), antioxidant activity (OH), inhibition of lipid peroxidation, capability test and correction (Fe²⁺).

2.2.5 Digestive

Digestive was used to refer to a substance that was used to facilitate the digestive system of the intestines and stomach. Amylase was one of the active substances present in the fruit of *D. zibethinus*. Amylase was said to partake in the process of intracellular digestion of starch granules in *D. zibethinus* fruit maturation plastids, which hasten the transformation of starch molecules from carbohydrates to sugars. DzAmy3 was a plastid α -amylase from *D. zibethinus* that plays a role in improving digestion. (Posoongnoen et al.,2015).

2.2.6 Anti-inflammatory

To determine the anti-inflammatory activity of *D. zibethinus* fruit the mature fruit was wasolated first and anti-inflammatory activity was examined by incubating the fruit extract with U937 cell culture activated with lipopolysaccharide (LPS) based on the study of Chingsuwanrote et al These observations suggest that *D. zibethinus* fruit extract significantly reduces the secretion of IL-8 by 23-36 % of cells at 0.1 and 0.20 mg/ml. From this, it can be deduced that the fruit skin extract of *D. zibethinus* has anti-inflammatory effects. This anti-inflammatory effect was wrought by the active polyphenol compounds found in *D. zibethinus* fruit. (Chingsuwanrote et. al., 2016)

2.2.7 Neuroprotective Effect

Alzheimer's disease was a neurological chronic disorder, which was complex and characterized by memory loss, progressive defects in cognitive function and severe behavioral disorders. The compounds in *D. zibethinus* that are believed to be involved in Alzheimer's disease include polyphenols and flavonoids which exhibit antioxidant

activity, inhibit aggregation of A β peptide, reduce activity of acetylcholinesterase enzyme, and protect nerves. In line with the mentioned study conducted by Plekratoke et al., the ethanolic extract of *D. zibethinus* fruit triggers neuroprotection through amyloid anti-beta peptide 1-42 toxicity in SH-SY5Y neuroblastoma cells. The same harmful effects on nerves as those caused by the A β 1-42 peptide can be prevented or protected against by both the ethanol extract and the fat-eliminated ethanol extract. At concentrations ranging from 1 to 100 micrograms per milliliter, the cellular mechanism of SH-SY5Y and CE cells can alleviate the cell death caused by A β 1-42 peptides. The loss of cellular viability induced by the A β 1-42 peptides can be ameliorated by an ethanol extract that exhibits lipid-eliminating properties at a concentration range of 10-100 μ g/ml. According to the anti-aggregation test, the exposure of the *D. zibethinus* fruit can hinder the aggregation of A β . (Plekratoke et al. 2018)

2.3 Medicinal properties

Several components of the durian plant have been examined for their possible medicinal properties, in addition to their culinary uses. One of the substances included in the fruit was polyphenols derived from *D. zibethinus* was. The extract of *D. zibethinus* contains a significant amount of phenolates and flavonoids, which have the potential to act as antioxidants. The sample from the *D. zibethinus* species shows the greatest levels of antioxidant capacity when tested against DPPH, with an IC₅₀ value of 11.21 micrograms per milliliter. Compared to the standard ascorbic acid, the concentration required to achieve a 50% inhibition was 6.56 μ g/ml. The high phenolic and flavonoid content present in the ethanol extract of the *D. zibethinus* fruit can be credited for its impressive antioxidant capabilities. These compounds facilitate the transfer of electrons, such as hydroxyl groups, to reactive species, leading to the

creation of non-radical DPPH-H forms within heterogeneous systems. Consequently, *D. zibethinus* fruit exhibits significant potential as an antioxidant. (Yayu Mulsiani Evary, et al., 2018). Antioxidants are chemical compounds that safeguard cells by providing electrons to free radicals, thereby counteracting the detrimental impact of free radicals. Peptides can be either endogenous, meaning they are produced by the body, or exogenous, meaning they are obtained from the diet.

Natural antioxidants generated from fruits, vegetables, and other plant-based foods are particularly effective in alleviating oxidative stress. Antioxidants can restrict or slow down the cellular damage caused by free radicals, which are unstable molecules produced by the body as a reaction to environmental factors and other stressors. (Megan Ware, 2023) Further investigation has uncovered that the fruit of *D. zibethinus* possesses an enzyme referred to as amylase, which serves a pivotal function in the process of starch digestion. The DzAmy3 protein, which was a type of amylase, was thought to play a vital role in the digestive process. This protein can impede the growth of *Escherichia coli* germs that reside in the gastrointestinal tract. *D. zibethinus* exhibits anti-inflammatory properties because of the presence of caffeic acid and quercetin. Caffeic acid demonstrates anti-inflammatory properties by inhibiting the release of interleukin 8, 1 β , and 6, in addition to TNF-alpha, from epithelial cells that have been stimulated by lipopolysaccharide (LPS). Furthermore, it could suppress 12-O-tetradecanoyl-phorbol-13-acetate (TPA), a substance that triggers skin inflammation when applied topically.

This was achieved by reducing the activity of myeloperoxidase, which was accountable for the thickening of the skin. (Posoongnoen, S. et al., 2015) Akiyama et al. (2001) found that the antibacterial properties of *D. zibethinus* are due to the

presence of tannins in the plant. Tannins exert their antibacterial activity by causing the disintegration of bacterial cell membranes. Tannins, which are astringent compounds, can form complex compounds with enzymes or microbial substrates. Tannins could form intricate connections with metal ions, which can potentially amplify the toxicity of these compounds. Furthermore, tannins can constrict cell walls or cell membranes, thereby disrupting the permeability of the cells.

2.4 Soil Properties

Soil composition may be utilized to ascertain the characteristics of the soil. This was determined by the abundance of different biotic and abiotic components. The soil's physical and chemical features are influenced by the interplay of these constituents. Moreover, soil was a dynamic and permeable substance that exists in the topmost layer of the Earth's crust. It was formed by the process of weathering under varying circumstances. Soil has several functions, including catalyzing biogeochemical cycles, functioning as a reservoir for nutrients and water, and facilitating the breakdown of organic compounds. Weathering was the geological process influenced by factors such as geology, topography, climate, and biology that leads to the formation of soil.

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2.5 The Physical Properties of Soil

2.5.1 Soil Texture

Durian trees are capable of thriving in several soil types, although they prefer well-draining sandy loam or clay loam soil for best development and fruit production. The presence of clay in the soil facilitates the preservation of a greater amount of organic matter for decomposition, as opposed to sandy soil. Increased porosity facilitates water penetration and promotes unrestricted root growth (Sachidanand et al., 2019). Due to the sensitivity of durian roots to stagnant water and soil compaction, the presence of soil that promotes root development was crucial for achieving a healthy crop and maximizing production.

2.5.2 Soil Structure

Durian trees may thrive in both sloping and level terrains, however, locations with an inclination of 18 degrees are unsuitable for cultivation. This was due to its potential to induce erosion was issues, hence posing a threat to the ecology. The soil must possess a minimum effective rooting depth of one meter.

2.5.3 Soil Density

In Malaysia, the soil typically has a bulk density ranging from 0.8 to 1.9 mg/m³ due to its tropical climate (Sung, et al., 2017). Soil compaction was linked to bulk density. The compaction of soil hinders root penetration due to a reduction in accessible pore spaces for water infiltration and drainage (Olubanjo & Yessoufou, 2019). The decrease in bulk density at the 0-15 cm level, as opposed to the 15-30 cm

depth, may be attributed to the breakdown of organic materials (Waslam et al., 2016). Furthermore, compaction was also a result of deforestation and logging activities carried out to build a plantation orchard. This action also reduces the organic content in the topmost layer of the soil. (Amlin et al., 2014). A soil with a lower bulk density was regarded to be well-structured because it has more pore spaces, which allow for better aeration, water infiltration, drainage, irrigation, and ease of plant root penetration.

2.6 The Chemical Properties of Soil

2.6.1 Soil pH

The durian plant thrives in soil conditions with a pH level that falls within the range of 5.5 to 6.5. Approximately 72% of Malaysia's soil was weathered, mostly in upland regions (Shamshuddin & Wan, 2011). This was a frequent characteristic of tropical countries like Malaysia (Kostov, 2017). The humid tropical climate, characterized by abundant rainfall and high temperatures, facilitates the quick dissolving and leaching of weatherable minerals. For example, the soils that are formed as a result contain abundant kaolinitic clays and sesquioxide, which have charges that depend on the pH. The degree of weathering was determined by the principal sources of hydrogen ions (H^+). It causes the separation of carbonic acid, which is produced when carbon dioxide dissolves in water, or the conversion of pyrites into sulphuric acid. Prolonged exposure to a humid climate typically leads to a higher buildup of soil acidity. To increase the soil's alkalinity and establish a pH level that promotes the thriving of durian trees, the utilization of liming agents and organic fertilizers may prove advantageous. (Anderson, et al., 2013). These amendments can enhance crop performance by

increasing nutrient availability for uptake by the roots, since they provide a proper soil pH for nutrient absorption.

2.7 Importance of *Durio zibethinus* Plantation

2.7.1 Economic Demand

Malaysia ranks as the second most significant global exporter of durian. The export market of Malaysian durians in the year 2015 was illustrated in Figure 2.3. Malaysia has been exporting durians to 18 different destinations, both within Asia and outside of the region, including New Zealand, the United States, Canada, and Australia. The main export markets were Singapore (49%), Hong Kong (12%), China (36%), and various other countries. Malaysia has secured unlimited access to the Singaporean and Hong Kong markets for its fresh and processed durian products. The Chinese market, however, only allows the sale of frozen durian pulp and paste. Malaysia has been engaged in negotiations with China to get authorization for exporting fresh durian, although approval has not been given yet. In 2015, the entire export value of Malaysian durians reached US\$ 16.5 million, representing a significant 61% growth compared to the previous year's export value of US\$ 10.3 million. The Malaysian National Agro-food Policy (2011-2020) has designated durian as one of the elite fruits, alongside nine other premium varieties. It exhibits significant potential and was projected to have strong demand in the future. The 2018 Budget has recognized durian, pineapple, and coconut as the fruits that have the highest potential to contribute significantly to the country's economy. The Malaysian government's objective was to establish durian as a burgeoning business, with the purpose of generating revenue for both growers and the nation. The Ministry of Agriculture and Agro-based Industry has

been tasked with developing a strategic action plan to ensure that all initiatives are focused on the growth and development of the sector.

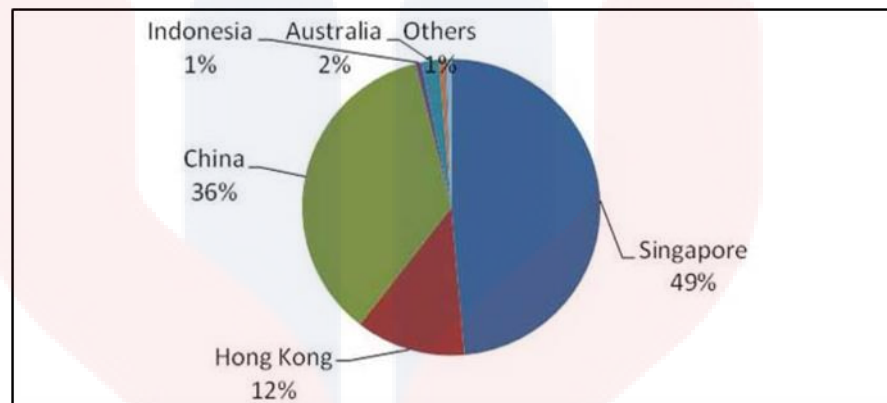


Figure 2.1: Malaysia Durian Export (Suntharalingam, 2020)

2.7.2 Industry

In Malaysia, durian trees have traditionally been grown in private residential areas. It was customary for each village home to have one to three trees that would produce fruit during specific seasons. This fruit had significant value for the communities over generations. The popularity of durian in the region has significantly increased, leading to a huge surge in demand for the fruit in recent years. A number of Malaysian businesses are expanding into new markets to cater to the strong demand for durian-related products, indicating a significant interest among durian enthusiasts. Hernan Corporation Sdn Bhd, a leading Malaysian exporter of durian and durian-based products, has expanded its operations to the Japanese market by dispatching its inaugural shipment of Musang King and D101 frozen durian varieties. Durian products are distributed and can be purchased at local grocery stores, specialty food retailers, and dining establishments. The Ministry of Agriculture and Food Industries (MAFI) was currently developing a 'Durian Strategy' to capitalize on the growing popularity of the fruit among international tourists, especially those from China. Despite the yearly increase in Chinese demand for durian, it was predominantly available in frozen, chilled, or pulp forms. (Neo, 2019). If cultivation spreads, the growing worldwide

demand and earnings might potentially lead to habitat degradation. Without a doubt, durian has emerged as one of the most profitable fruits for producers and exporters in Malaysia. Due to the increasing demand for the fruit, there has been a substantial expansion in the production of durians. This includes shifting from gardens and small parcels of land, where durian trees are cultivated alongside other fruit trees, to expansive plantations referred to as 'Durian Farms'. The durian fruit currently occupies approximately 41% of cultivated land in Malaysia.

The popularity of this product was on the rise, coinciding with a decrease in the prices of oil palm, cocoa, and rubber. Furthermore, the durian market has demonstrated its ability to withstand the challenges posed by the Covid-19 pandemic and was still experiencing growth. The substantial financial gains obtained from cultivating durian are leading to a concerning trend of forest destruction in Southeast Asia. (Baqi et al., 2022). Farmers are progressively expanding the cultivation of durian trees from the boundaries of forests into protected regions, integrating the trees into the existing natural vegetation. There was a scarcity of research on this topic, hence the degree of durian-induced habitat degradation in Malaysia, or any other location, has not been measured.

The authors (Siti-Munirah) have directly seen significant harm to ecosystems in Malaysia. Environmental groups in Malaysia are pushing for the restriction of new durian cultivation areas to exist wasting oil palm plantations, to prevent the further deterioration of deforestation. (Airriess, 2020). Nevertheless, there was a lack of comprehensive documentation about the impact of durian farming on biodiversity loss and extinction. Therefore, we propose that further study should be dedicated to investigating this issue.

Over the years, the MARDI has actively supported and enhanced durian production through its research and development efforts, leading to the creation of new durian types that meet the needs of consumers. The work was noteworthy as Malaysia's Ministry of Agriculture and Food Industries (MAFI) expects the country's durian production to increase and reach 443,000 tonnes by the year 2030. MARDI was also actively encouraging tour was activities that are linked to the growth and discovery of durian, commonly referred to as Durio-tourism. In 2017, MARDI launched its first Durio-tourism site, situated in Kuala Kangsar, Perak.

The National Policy on Biological Variety 2016-2025 has been implemented in Malaysia to protect important ecosystems, species, and genetic variety. By 2025, it was necessary to establish a precise objective to effectively preserve the genetic variability of produced plants, farmed and domesticated animals, as well as their wild counterparts. MARDI has improved the safeguarding of plant genetic diversity by creating the genebank MyGeneBank™ in 2014. MyGeneBank™ concentrates on the preservation and storage of agriculturally important species and wild relatives of crops through field and seed conservation, in vitro techniques, cryopreservation, and herbarium cataloging. This measure will aid in the protection of valuable genetic resources, such as the cultivated collection of *Durio* and other scarce indigenous fruit species in Malaysia, which has been maintained since the 1980s (Mohd Shukor et al., 2015).

CHAPTER 3

MATERIAL AND METHOD

3.1 Study Area

The study area for this study was Ayer Lanas, Jeli and Kg To'Uban, Pasir mas, Kelantan. The study site was chosen because of the differences in the attitude and soil type. Pasir mas plot with coordinates $5^{\circ}58'36''\text{N}$ $102^{\circ}8'39''\text{E}$ and 30 meters above sea level with a distance to the near river almost 200 meters. The durian orchard in Jeli (plot coordinates $5^{\circ}46'45''\text{N}$ $101^{\circ}52'10''\text{E}$) was the 40-meter elevation above sea level and was located approximately 10 meters from the river stream

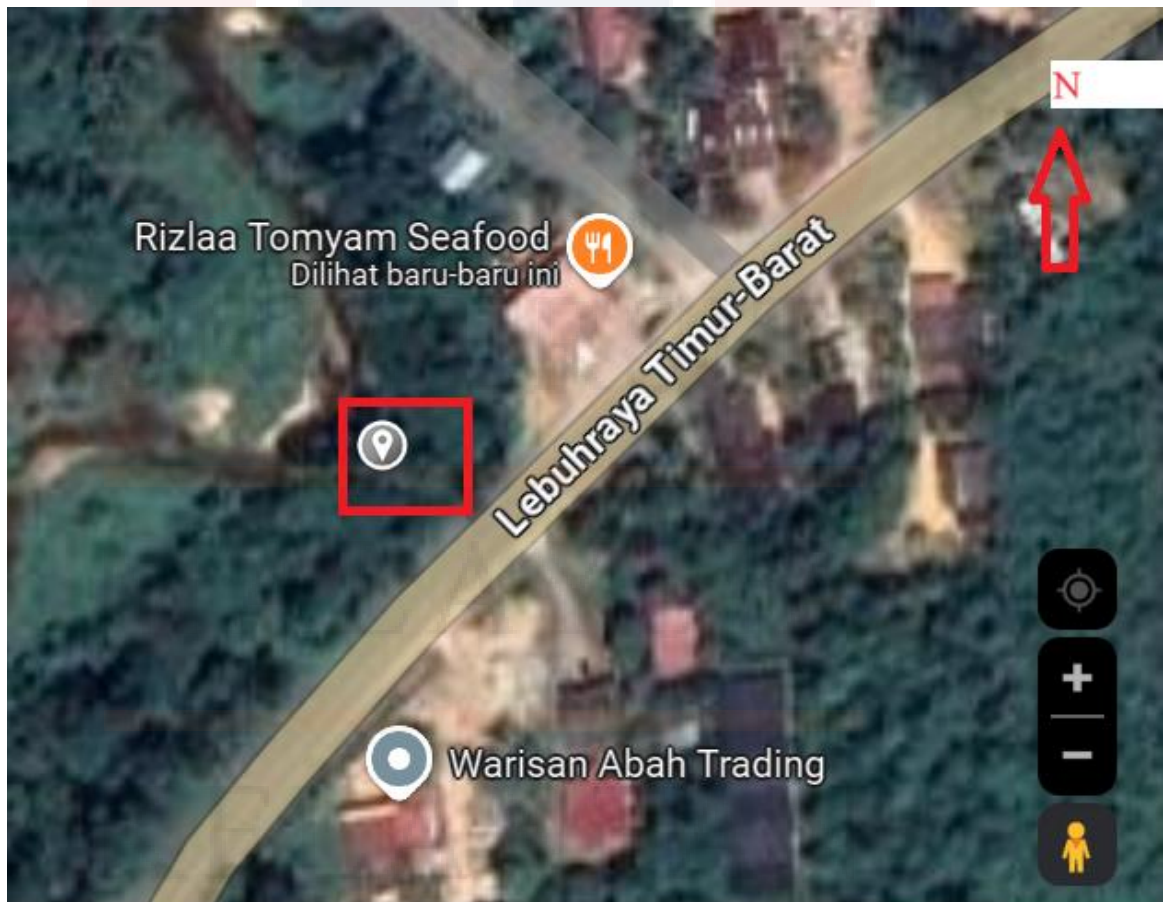


Figure 3.1: Sampling site at Ayer Lanas Jeli, Kelantan map.

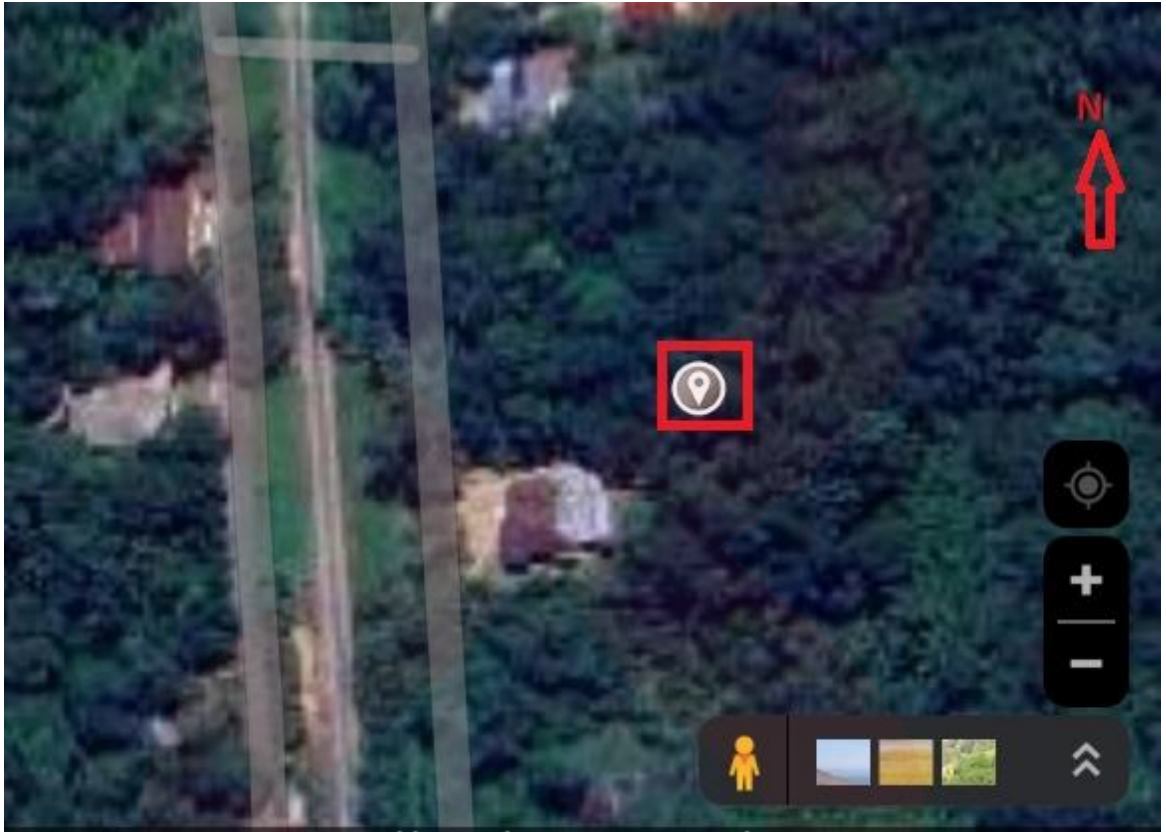


Figure 3.2: Sampling site at Pasir Mas, Kelantan map.

3.2 Material

Table 3.1: shows the function of materials:

MATERIAL	FUNCTION
An auger	To collect the soil sample.
PH meter	To obtain a more accurate PH measurement of soil.
Soil thermometer	To obtain a more accurate temperature of the soil.
Soil Moisture Meter	To obtain the moisture in the soil.
Sieves	To clean the unwanted elements from the soil element.
Icebox	To store and preserve the soil samples.
Aluminum foil	To put the soil sample to be dried.
Oven	To drying process of soil sample.
Pen	To write the important information.
Notebook	To note taking about all the important information.
Sampling bag	To collect samples of soil.
Glove	To remove unwanted elements from a sample.
Measuring tape	To measure the distance of the sampling site.

Diameter tape	To measure the diameter of trees.
Leser distance meter	To measure the height of the trees.

3.3 Method

3.3.1 Sampling design

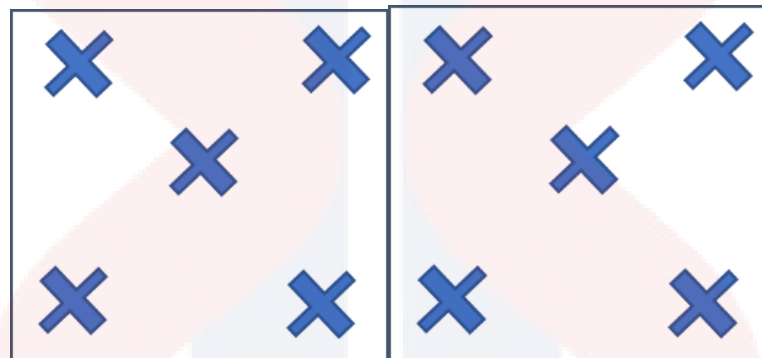


Figure 3.1: Illustration of soil sampling design site.

Sampling plots measuring 20 meters by 20 meters, which was equivalent to an area of 400 square meters, were set up at both Pasir Mas and Jeli study sites. Our objective in these plots was to locate and quantify approximately 10 to 12 durian trees. The chosen plots were indicative of the usual cultivation conditions in Ayer Lanas and Pasir Mas, guaranteeing that the gathered data would be pertinent for wider applications. For soil sampling, the illustration in Figure 3.1 shows the area where soil samples will be taken in parallel between the two plots to ensure parallel data.

Soil samples are collected to examine the pH, temperature, and organic content of the soil. Using an auger, five holes are drilled within the designated quadrat area, making sure that each hole reaches a depth between five and fifteen centimeters. Therefore, a total of five samples are acquired from a solitary spot. A total of 10 samples are obtained from both sampling sites. Every sample was placed in an airtight

bag to ensure a completely sealed environment and then stored in the icebox to avoid the sample from becoming undesirable. Afterward, we returned to the laboratory to subject the soil to baking to determine its water content and organic matter.

3.3.2 Organic Matter Analysis

Utilize a soil auger to excavate a hole with a depth ranging from 5 to 15 centimeters. Ensure that the sample was collected within the designated quadratic sampling area. To obtain a comprehensive analysis of the soil, it was necessary to collect samples from both the surface and sub-surface layers at five different places inside the site. The specimen should be placed in a plastic bag and marked with the relevant details. For this study, it was necessary to collect 5 soil samples from each quadratic sampling plot, as well as 10 soil samples from two distinct locations: Ayer Lanas, Jeli, and Kg To' Uban, Pasir Mas Kelantan. To accurately document the information in the recording data, it was necessary to include the precise coordinates of each sampling location. Afterward, we returned to the laboratory at University Malaysia Kelantan to analyze the soil samples. Begin by placing the soil within aluminum foil and weighing it without removing any organic material from the sample. Next, place the foil-wrapped soil in an oven and heat it at a temperature of 500 degrees Celsius for 16 hours. Once the oven has finished, extract the sample and weigh it using a scale. It was necessary to record the result data for Analysis.

Equation 3.1: Organic matter formula.

$$= \left(\frac{(\text{Wet Weight} - \text{Dry Weight})}{\text{Dry Weight}} \right) \times 100$$

3.3.3 Water content in soil

Utilize a soil auger to excavate a hole with a depth ranging from 5 to 15cm. Ensure that the sample was collected within the quadratic sampling plot. To obtain comprehensive soil data, it was necessary to collect samples from both the surface layer and the underlying layers at five different places inside the site. The specimen must be stored in a plastic bag and clearly labeled with the relevant information. For this study, it was necessary to collect 5 soil samples from each quadratic sampling plot, as well as 10 soil samples from two district locations: Ayer Lanas, Jeli, and Kg To' Uban, Pasir Mas Kelantan. To include the coordinates of each sampling site, it was necessary to append the location data to the recording information. The collected soil samples were subsequently transported back to the laboratory located at the University of Malaysia Kelantan, where they were then subjected to further analysis. Begin by measuring the soil sample that still contains the organic content and document the collected information. First, eliminate the scale of organic matter and save the recorded data. Next, subject the soil sample to a temperature of 155 degrees Celsius in an oven for 24 hours. Finally, scale the sample after it has been removed from the oven. It was necessary to record the result data for correlation analysis.

Equation 3.2: water content formula

$$\text{Water Content (\%)} = \left(\frac{\text{Wet Weight} - \text{Dry Weight}}{\text{Dry Weight}} \right) \times 100$$

3.4 Data Analysis

3.4.1. Soil Analysis

In data Analysis of organic matter and water content in soil samples, the mean, median, and standard deviation are essential metrics for summarizing and comprehending the data.

The mean provides the average value of organic matter or water content across all samples. It was calculated by aggregating all values and dividing by the number of samples. The mean was useful for identifying the central tendency of the data, giving a general notion of the typical amount of organic matter or water content present.

The median was the middle value when the data was ordered from smallest to greatest. It was less sensitive to extreme values or outliers compared to the mean, making it a robust measure of central tendency. The median offers insight into the data's distribution, demonstrating the point at which half the values are above and half are below.

The standard deviation assesses the dispersion or spread of the data around the mean. A high standard deviation indicates a broad range of values and greater variability in organic matter or water content. Conversely, a low standard deviation suggests that values are concentrated close to the mean. This metric was crucial for understanding the consistency of the data and the extent of variability within the soil samples.

RESULTS AND DISCUSSION

4.1 Overall Soil Properties for *Durio zibethinus*

4.1.1 Soil pH

The soil properties for the *Durio zibethinus* orchard in the study area are summarized in Table 4.1 below. The overall soil pH at Pasir Mas was 6.725, which was marginally more neutral in comparison to Jeli's average pH of 6.4167. The soil's pH level was a critical determinant of nutrient accessibility and microbial function. An almost neutral pH, such as the one found in Pasir Mas, typically signifies ideal circumstances for a diverse range of crops, as it promotes maximum absorption of nutrients. Conversely, the marginally more acidic soil in Jeli may restrict the accessibility of specific nutrients, while simultaneously augmenting the accessibility of others, such as iron and manganese. The slight variation in pH levels can have an impact on the optimal crop selection for different regions and their overall well-being and productivity

Table 4.1: Mean of soil properties for *Durio zibethinus* orchard at study area in Ayer Lanas, Jeli and Pasir Mas, Kelantan.

Soil Properties	Study Area		
	Ayer Lanas, Jeli	Pasir Mas	Total mean
pH level (PH)	6.416	6.72	10
Temperature (°c)	27.33	29.87	10
Organic Matter (%)	33.2	24.9	10
Water content (%)	28.4	15.4	10

4.1.2 Temperature of the soil

The temperature of the soil has a significant influence on the growth of plants as well as the activity of microorganisms within the soil. The average soil temperature of Pasir Mas was 29.87°C, which was much higher than Jeli's temperature of 27.33°C. Elevated soil temperatures can expedite biological and chemical processes, hence promoting plant development. Nevertheless, exceedingly elevated temperatures can also augment evaporation rates and impose water stress on plants. The lower soil temperature in Jeli indicates a moderate microclimate, which can benefit crops that are sensitive to heat stress. This can result in more consistent growth conditions throughout the year.

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4.1.3 Soil Water Content

The presence of water was crucial for the hydration of plants and the transportation of nutrients. In Jeli, the average water content of the soil was higher at 28.4% of water, whereas in Pasir Mas it was lower at 15.45% of water. These findings indicate that the soil in Jeli has superior water retention properties, which might be advantageous in arid conditions by guaranteeing adequate moisture availability for plants. Conversely, the reduced amount of water in Pasir Mas may require more frequent irrigation to sustain ideal soil moisture levels, potentially heightening the dependence on water resources and the expenses associated with farming.

4.1.4 Soil Organic Matter

Soil organic matter has a vital role in preserving soil structure, fertility, and microbial activity. Jeli's soil exhibits a greater average organic matter concentration (3.3232 g/10g of soil) in comparison to Pasir Mas (2.4952 g/10g of soil). Elevated levels of organic substances in the soil enhance its physical structure, water retention capabilities, and accessibility of nutrients. This results in improved overall plant health and increased agricultural productivity. This suggests that the soil in Jeli was probably more fertile and more suitable for sustainable agriculture. On the other hand, the lower amount of organic matter in Pasir Mas indicates a requirement for techniques that can boost soil organic matter, such as adding organic amendments or using cover cropping, to optimize soil health and production in the long run.

To summarise, the soil in Jeli was more suitable for sustainable agriculture since it has a larger water content and organic matter, despite having a little lower pH and cooler temperature. Pasir Mas, characterized by its relatively neutral pH and

elevated temperature, may be well-suited for cultivating crops that flourish in hotter environments. However, meticulous attention to soil moisture and organic matter was necessary to maintain sustainable productivity over the long run. These disparities emphasize the significance of customized soil management techniques to maximize crop development and soil well-being in every locality.

4.2 Discussion on the Standard Deviation of Soil Properties in Pasir Mas and Jeli.

Table 4.2: Standard Deviation soil properties for *Durio zibethinus* orchard at Ayer Lanas, Jeli and Pasir Mas, Kelantan.

Study area	Ayer Lanas, Jeli	Pasir Mas	Total mean
pH	0.219	0.164	10
Temperature (°c)	0.471	1.165	10
Organic Matter (%)	0.576	0.278	10
Water content (%)	0.884	0.323	10

4.2.1 Soil pH level

Soil pH refers to the measurement of the acidity or alkalinity of soil. The soil pH at Pasir Mas exhibits a standard deviation of 0.1639, suggesting consistent pH levels among the studied plots. The continuous acidity of the soils in Pasir Mas indicates a stable condition, which can be beneficial for agricultural activities. This stability ensures a predictable supply of nutrients and facilitates better soil management. Conversely, Jeli exhibits a marginally greater standard deviation of 0.2192 for soil pH, suggesting a greater degree of variation in soil acidity. Ensuring

ideal growing conditions for plants may necessitate meticulous monitoring and control, as fluctuations in pH can impact nutrient absorption.

4.2.2 Temperature of the soil

There was a significant disparity in soil temperature between the two regions. Pasir Mas exhibits a greater standard deviation of 1.1659, suggesting that there was a substantial variation in soil temperatures among different plots. This variance can have an impact on the growth of plants and the activity of soil microbes, which could potentially result in the inconsistent performance of crops. On the other hand, Jeli exhibits a lower standard deviation of 0.4714, indicating a greater consistency in soil temperatures. The constancy of environmental conditions can have a positive impact on plant development and microbial activity, hence simplifying agricultural management to some extent.

4.2.3 Soil Moisture Content

The soil water content in Pasir Mas has a standard deviation of 0.3237, but in Jeli it has a standard deviation of 0.8842. This suggests that the soil water content in Jeli was more prone to variation, which can provide difficulties in maintaining a regular amount of soil moisture required for optimal plant growth. Increased fluctuation in soil moisture might result in uneven plant growth and need more accurate irrigation procedures. On the other hand, the reduced variability in Pasir Mas indicates a more constant distribution of soil moisture, which can facilitate irrigation and promote stable plant health and productivity.

4.2.4 Soil Organic Matter

Pasir Mas exhibits a standard deviation of 0.2789 for soil organic matter, suggesting a high degree of consistency in the levels of organic matter seen in the sampled plots. Maintaining a consistent level of organic matter in the soil was advantageous for soil fertility because it guarantees a continuous provision of nutrients and promotes a robust soil structure and microbial activity. On the other hand, Jeli exhibits greater variability, as indicated by a standard deviation of 0.5760. These findings indicate that the distribution of soil organic matter in Jeli was not uniform, resulting in variations in soil fertility across different areas. This uneven distribution may have an impact on plant growth. To effectively handle such variability, it would be necessary to apply specific soil amendments in different locations to guarantee adequate levels of organic matter.

To summarise, Pasir Mas generally demonstrates greater soil stability in comparison to Jeli. Pasir Mas exhibits a reduced range of fluctuations in soil pH, temperature, water content, and organic matter. This indicates a more homogeneous environment, which can streamline agricultural practices and potentially result in more stable crop production. In contrast, the greater variety in Jeli's soil qualities suggests that specific and extensive soil management approaches are required to handle the diverse circumstances throughout the region. Gaining insight into these distinctions was essential for formulating efficient agricultural tactics customized to the circumstances of each locality.

4.3 T-Test of Soil Properties

4.3.1 Discussion of Soil Properties Using Paired T-tests

Table 4.3: T-test of the soil properties on the orchard in Ayer Lanas, Jeli, and Pasir Mas, Kelantan.

T-test	Soil Ph	Soil temperature	Soil water content per 10 grams	Soil organic matter per 10 grams
Mean	6.59	28.75	2.19	2.91
Variance	0.063	2.642	0.963	0.418
Observation	10	10	10	10
Pearson Correlation	0.539		0.270	
Hypothesized mean	1		0	
Df	13		9	
t-stat	-57.677		-2.212	
P(T<=t) one tail	2.360		0.027	
T critical one-tail	1.770		1.833	
P(T<=t) two-tail	4.720		0.054	
T critical two-tail	2.160		2.262	

4.3.2 Soil pH and Soil Temperature

For our investigation into soil attributes, we employed a paired t-test to assess the differences in the averages of soil pH and soil temperature. The findings indicate that the average soil pH was 6.59 and the average soil temperature was 28.79°C. The soil pH has a variance of 0.064, but the soil temperature has a variance of 2.643. The Pearson correlation coefficient between soil pH and soil temperature was 0.54, which

suggests a moderate positive link. This calculation was based on 14 observations for each variable.

A paired t-test was performed with a hypothesized mean difference of the computed t-statistic was -57.68, which was markedly below the threshold values for both one-tail (1.77) and two-tail (2.16) tests, indicating statistical significance. The p-values for one-tail ($2.36E-17$) and two-tail ($4.72E-17$) tests are extremely small, significantly lower than the standard alpha limits of 0.05 or 0.01. Consequently, we can conclude that the null hypothesis was rejected, indicating a substantial disparity between the average values of soil pH and soil temperature.

4.3.3 Soil Water Content and Soil Organic Matter

A paired t-test was conducted to analyze the soil water content (per 10 grams) and soil organic matter (per 10 grams). The average soil water content was 2.20, whereas the average soil organic matter was 2.91. The variances for each attribute are 0.964 and 0.418, respectively, based on 10 observations for each. The Pearson correlation coefficient was 0.27, suggesting a weak positive association. The t-statistic was -2.21, assuming a mean difference of 0. The one-tail test has a critical value of 1.83, whereas the two-tail test has a critical value of 2.26. The p-value for the one-tail test was 0.027, which was below the threshold of 0.05, suggesting that the result was statistically significant. The p-value for the two-tail test was 0.054, just beyond the threshold of 0.05, indicating marginal significance.

4.3.4 Interpretation and Implications

The t-test results indicate a considerable disparity between soil pH and temperature, emphasizing the substantial variation in these two soil characteristics. This implies that the factors that influence soil pH are different from the factors that impact soil temperature. Comprehending these elements was essential for agricultural practices, as pH can impact the availability of nutrients, while temperature affects microbial activity and plant growth.

The findings for soil water content and soil organic matter indicate a notable disparity with the one-tail test but show only a slight lack of significance with the two-tail test. This implies that although there was some indication of a distinction, it was not as prominent. The low correlation suggests that variations in soil water content have limited predictive power for changes in soil organic matter. This observation was crucial for the management of soil, as both characteristics are essential for the well-being and productivity of the soil.

Ultimately, the paired t-tests offer valuable insights into the correlations and discrepancies among crucial soil parameters. These findings can provide guidance for soil management strategies to maximize agricultural productivity and ensure long-term sustainability.

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CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

Finally, but just as importantly, future studies must clarify *Durioo zibethinus'* genetic variability as well as how particular cultivar types react to variations in the kind and circumstances of the so Understanding the genetic variations may make it possible to choose the appropriate cultivars for a given area, increasing fruit yield and quality.

Growing durian, or *Durio zibethinus*, was one of Malaysia's most important agricultural products. The planting area's soil characteristics have a significant impact on the health of the plants overall, fruit yield, and tree growth, all of which are critical to the success of durian farming. The purpose of this study was to assess and contrast the soil characteristics of Jeli and Pasir Mas, two important durian-producing regions in Kelantan. Finding out the unique characteristics of the soil in these districts and evaluating its potential for durian farming were the goals.

The primary aim of the research was to ascertain the characteristics of the soil in Jeli and Pasir Mas. Samples of soil were taken from different durian orchards in both districts, and important factors including pH, organic matter content, soil texture, and drainage capacity were examined.

According to the investigation, Jeli's soil has a slightly more acidic pH, greater drainage, and a higher organic matter concentration. Due to their preference for well-drained soils with a high organic matter content and a pH range of 5.5 to 6.5, durian trees thrive best in these conditions.

On the other hand, it was discovered that the soil in Pasir Mas had a pH that was more neutral to slightly alkaline, a larger clay content, and less organic matter. Pasir Mas's heavy soil texture may cause compaction and poor drainage, all of which are detrimental to the growth of durian. There are notable variations in the soil qualities between the two districts, which could affect how well durian farming does in each place.

Comparing the soil characteristics of Jeli and Pasir Mas allowed us to establish whether the district provides a better environment for durian farming, which was the second goal. The study brought to light several significant variations that may have an impact on durian yield.

Jeli's soil was more suited for durian cultivation due to its increased organic content and improved drainage. These characteristics of the soil promote the tree's nutrient uptake and aid in maintaining a robust root system, which improves fruit quality and productivity. Furthermore, Jeli's soil's slightly acidic pH falls within the durian's ideal pH range.

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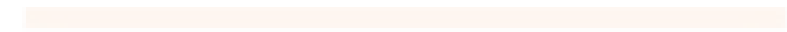
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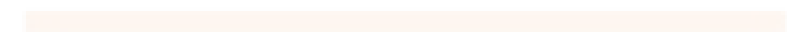
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APPENDIX
APPENDIX I



