COMPARISON DIFFERENT SOIL SERIES AFFECTING ON SACHA INCHI (PLUKENETIA VOLUBILIS) GROWTH PERFORMANCE IN UNIVERSITY COLLEGE OF AGROSCIENCE MALAYSIA

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ABSTRACT

Sacha inchi plants (Plukenetia volubilis L.) is recognised as an herbal plant that originated from the Amazon Forest in Peru which is region of South America. In recent years, it was used as a source of medicine and health by the Inca community in Peru. The objective of this research is focusing on the comparison between different soil series which effecting the sacha inchi growth performance. This study was conducted at University College Agroscience Malaysia (UCAM) in Alor Gajah, Melaka. All the sacha inchi seeds were planted into polybags with different soils series with same rate as treatments. The basic elements for all plants to growth were given with the rate such as water, fertilizer and light. Thus, 14 days are required for germination of sacha seeds before transferring into the polybags. This is because the sacha inchi plants are off-types variety of seeds. The Completely Randomized Design (CRD) is applied as an experimental designed. It consists of six (6) treatments and seven (7) replications in each treatment. The data then was collected for 8 weeks and had been analysed in a one-way ANOVA at 5% significant level with using Statistical Package for the Social Sciences (SPSS) software. The results showed that significant difference at all treatment with all the growth and physiological performance parameter for sacha inchi plants (Plukenetia volubilis L.). The results are also recorded that the T4 treatments (Padang Besar series (PBR_2) can be used as potential media soil series for commercial sacha inchi planting with proper management.

Keywords: *Sacha inchi, soil series, growth performance.*

INTRODUCTION

Sacha inchi (Plukenetia volubilis) is a member of the Euphorbiaceae plant family, originally found in Central and South America. It is cultivated for commercial purposes in the Peruvian Amazon, and there is the potential for its cultivation in Brazil as well. The seeds of this plant contain approximately 24 to 29% protein and a substantial 41.4% oil content. (Araújo-Dairiki et. al, 2018). It is now commercially growing in Southeast Asia, especially in Thailand. Sacha inchi is a new and promising crop, originating in the Amazon region. Sacha inchi (SI) or Plukenetia volubilis is an important climbing shrub plant from the Euphorbiaceae that grows mostly in the Amazon region of Ecuador, Peru, Brazil (del-Castillo, Á.M.R., Gonzalez-Aspajo, G., de Fátima Sánchez-Márquez, M. et al, 2019). The chemical composition of various parts of the sacha inchi plant varies. For instance, the seeds contain lipids ranging from 35% to 60%, including omega-3, 6, and 9 fatty acids, as well as proteins at levels of 25% to 30%, which include essential amino acids like cysteine, tyrosine, threonine, and tryptophan. Additionally, the seeds also contain vitamin E, polyphenols, minerals, and other compounds. (Sunan Wang, Fan Zhu and Yukio Kakuda, et. al, 2018).

Essential fatty acids, particularly those from the n-3 and n-6 families, have garnered significant attention as functional ingredients. They are recognized for their diverse array of health benefits, which include supporting brain development and reducing the risk of various health conditions such as cardiovascular diseases, certain types of cancer, and inflammatory diseases. These essential fatty acids play a crucial role in promoting overall health and well-being (Ana-Milena, et. al, 2018). Sacha Inchi oil (SIO), extracted from the seeds of the Sacha Inchi plant, is a versatile ingredient used in the preparation of various meals. In traditional culinary practices, the Sacha Inchi seeds are often roasted to enhance their flavor, while the leaves are cooked and incorporated into regular diets. Additionally, in the Amazon region, Sacha Inchi seeds have been used as a traditional remedy for addressing issues such as rheumatic problems and muscle aches.

This historical use highlights the potential medicinal properties associated with Sacha Inchi in addition to its culinary uses (Anis N. et al., 2022). In recent years, the production of Inca peanuts, also known as sacha inchi, has seen expansion in several Asian countries, with Thailand being one of the notable regions where cultivation has increased. This growth in production reflects the growing interest in sacha inchi as a valuable crop for its nutritional and commercial potential (Wongpattananukul S. et al, 2022). The shell of Sacha Inchi (SI) seeds, which is a significant byproduct of the oil extraction process, makes up approximately 30-35% of the total weight of the seeds. It constitutes crude fiber (77.84%), protein (2.75%), fat (0.39%), ash (1.75%) and nonnitrogenous components (17.27%) This shell, although not used for oil production, may have other potential uses or applications in various industries (Goyal A. et. al, 2022).

Soil is a natural entity characterized by distinct morphological features and varying parent materials, shaped over time through interactions among different climatic conditions, biological influences, underlying parent materials, and the age of landforms. The morphology of each soil, as visualized in a vertical cross-section through its various horizons, represents the cumulative impact of the specific combination of genetic factors that have contributed to its formation and development (Sulaiman S. et al., 2019). A well-structured soil series classification system is crucial for facilitating clear and effective communication regarding soils. It plays a vital role in enabling and enhancing various aspects of soil management, including land suitability evaluation, land use planning, technology transfer, and the promotion of sustainable land use practices. Such a classification system provides a common language and framework for professionals and stakeholders to better understand, utilize, and manage soils for a variety of purposes. (MC Laker, GP Nortjé, et. al, 2022).

The utilization of yield production from sacha inchi has a longstanding history in Peru, where the plant is native. However, sacha inchi is a relatively new introduction to Malaysia, coming from outside the country. This suggests that the cultivation and utilization of sacha inchi in Malaysia is a recent development compared to its long-established use in Peru. Hence, RISDA has identified this new plant as a candidate for commercialization, but it's worth noting that sacha inchi is a relatively new introduction to Malaysia. This study aims to assess the impact of sacha inchi growth using different soil types in Malaysia and to determine which soil medium is the most effective for achieving high sacha inchi productivity. The study's primary objective is to evaluate the growth and productivity of sacha inchi under various soil conditions in the Malaysian context.

The research aims to establish suitable and optimal plant distance sizes and understand the reciprocal influence between these distances and the plant itself. The first goal of this investigation is to assess how sacha inchi growth is impacted by various soil series in Malaysia, with a specific focus on the UCAM area. The second objective is to determine the most effective treatment for enhancing sacha inchi's physiological performance across different soil series. Plukenetia volubilis, commonly known as sacha inchi, is a relatively new plant in Malaysia. This plant originates from other countries, and as of now, there have been no comprehensive studies on sacha inchi conducted in Malaysia. The introduction of sacha inchi to Malaysia is relatively recent.

In addition, there is notable international demand for sacha inchi due to its potential health, beauty, and oil-related products. This demand has the potential to generate increased income for stakeholders. This information was reported in a news article featuring a statement from Datuk Zahidi Zainul Abidin, the chairman of RISDA, on May 3, 2017. In this research focused on comparison between soil series. This is because, soil series is an essential element of a plant to survive and produce a result. Hence, soil plays a significant role in the establishment and production of sacha inchi.

In this study, there are five (5) distinct soil series in UCAM, as identified by Mr. Mohammad Faizal Bin Rosly in August 2010, from the Land Management and Conservation Division of the Agriculture Department in Pulau Gadong, Melaka. These soil series are referenced by the following map numbers: JP TNH(MLK)207/7/880/7(27). The five (5) types of soil series are Batu Lapan series (BLN/3), Batu Lapan series (BLN/4), Gajah Mati series (GMI/2), Padang Besar series (PBR_2), and Disturbed land (DLD/1). These distinctions are essential for the study's soil analysis and its impact on sacha inchi cultivation.

MORPHOLOGY OF SACHA INCHI (*Plukenetia volubilis*)

Environmental factors such as light, temperature, water availability, and others, have a significant impact on the rate of photosynthesis in plants. Abiotic stresses, which are non-living environmental factors, can decrease the photosynthesis capacity of plants by affecting various critical processes. These include the inhibition of chlorophyll biosynthesis, the functioning of photosystems, electron transport mechanisms, stomatal conductance (the opening and closing of stomata), and the rate of transpiration. These stress-induced effects can have several negative consequences on the overall photosynthetic performance of plants (Chyi Chuann Chenn, et. al 2022).

Underutilized crops, often referred to as orphan crops, have the potential to offer valuable characteristics for various purposes. These include traits such as resilience to climate change, nutritional benefits, suitability for cultivation on marginal lands, and the ability to enhance income opportunities for small-scale farmers. Plukenetia volubilis L., commonly known as sacha inchi and belonging to the Euphorbiaceae family, is one such "lost crop" originally cultivated by the Incas in the Amazon basin. Sacha inchi is recognized for its oleaginous seeds, which are relatively large and contain high levels of omega-3 and omega-6 fatty acids, accounting for approximately 50.5% and 34.1% of the lipid fraction, respectively. Additionally, sacha inchi seeds are a source of protein and antioxidants. These characteristics make it a promising underutilized crop with significant potential (Kodahl, N et.al, 2020). While the dried leaves can be made into a kind of tea. Fresh and roasted (tea) leaves contained lots total alkaloids, saponins, and lectins (Warangkana Srichamnong, Pisamai Ting et al. 2018).

In recent years, as awareness and demand for P. volubilis (Sacha Inchi) have grown in international markets, there has been an influx of new and differently branded products. These products include gourmet oil, protein powder, and encapsulated oil, often marketed as dietary supplements. Additionally, you can find roasted and salted or candied Sacha Inchi seeds available for purchase, catering to various tastes and preferences (Kodahl N. et. al, 2021).

DIFFERENT SOIL GROWTH ON SACHA INCHI

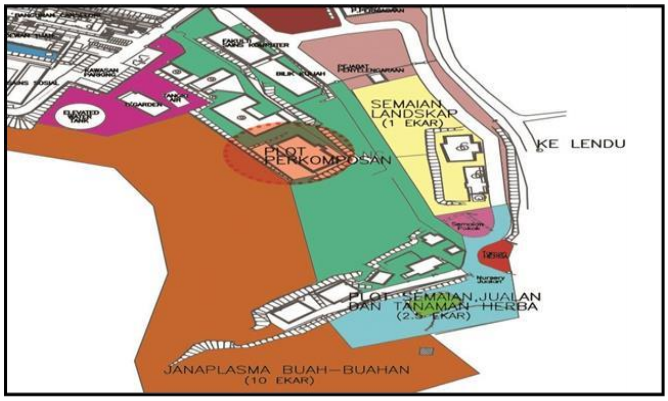
Soil classification is a valuable tool for geotechnical engineers as it allows them to predict the properties and behavior of soils more effectively. It involves categorizing soils into groups with similar response characteristics based on their index properties. This classification system helps engineers make informed decisions and assessments related to construction, foundations, and other

geotechnical projects by providing a structured way to understand and work with different types of soils (J Park, JC Santamarina et. al, 2017).

DESCRIPTION AREA OF STUDY

This study was carried out at the University College of Agroscience Malaysia (UCAM), situated in Ayer Pa'abas, Alor Gajah, Melaka. The research also involved laboratory work to assess the growth performance and productivity of sacha inchi. To be more precise, this experiment was conducted in close proximity to the hatchery site, with coordinates at Latitude 2.394493 and Longitude 102.167445.

Figure 1: Study Area, University College of Agroscience Malaysia (UCAM)



METHODOLOGY AND DATA COLLECTION

A method refers to a manner or mode of procedure, particularly an organized, logical, or systematic approach to instructing, investigating, inquiring, experimenting, or presenting information. In this study, multiple methods were employed to ensure that the experiment followed the prescribed procedures and achieved its objectives. Research methodology is the systematic and scientific approach to studying how research is conducted. It provides a structured way to methodically address research problems by logically following a series of steps. This process ensures that research is carried out in a rigorous and organized manner, enabling the collection of reliable data and the generation of meaningful results. (Mimansha Patel, Nitin Patel et. al. 2019).

The seedlings were transplanted one week after germination, which is equivalent to seven (7) days in the seedling tray. The decision to transplant was based on the seedlings reaching a height of five (5) to ten (10) centimeters and developing two (2) or three (3) leaves. Therefore, the process was carried out with great care to avoid damaging the roots. The seedlings were transplanted either in the early morning or late evening to avoid exposure to strong sunlight or excessive heat, as this could potentially disrupt the newly planted seedlings. This technique was employed to minimize any shock to the plants and ensure their successful transition to their new environment. Only the healthy plants were chosen for transplantation, ensuring that they could adapt well to the new growing medium. All the plants received watering twice a day throughout the data collection period. This frequent watering schedule was employed because sacha inchi is known for its heat resistance and has a high-water requirement. Conventional irrigation methods were utilized to ensure that an ample water supply was maintained for the plants. In this study, no fertilizers, whether chemical or bio-chemical, were applied to the plants as it could potentially interfere with the data collection process.

Sampling design plays a crucial role in statistics, as it helps in obtaining a representative understanding of the treatments being studied. In this research, several sampling design methods were employed to ensure data collection, experiment layout design, and the proper utilization of parameters. These methods were carefully selected and followed to achieve the research objectives systematically. In this experiment, six (6) different treatments were employed to identify the most suitable soil series for the growth of the plant. The six (6) treatments used in the study to assess the suitability of different soil series for the plant are are Batu Lapan series (BLN/3), Batu Lapan series (BLN/4), Gajah Mati series (GMI/2), Padang Besar series (PBR_2), Disturbed land (DLD/1), and coco Peat.

Experimental design is the process of planning a study to meet specified objectives. Indeed, a welldesigned experiment generates an empirical model of a process, enabling a better understanding and the ability to predict its behavior (Stewart Greenhill, et. al, 2021). Planning an experiment thoroughly is crucial to ensure that the research questions are addressed with the right type of data, an adequate sample size, and statistical power. This approach helps in achieving clear and efficient results, contributing to the success and validity of the research. In the experimental layout, there are a total of six (6) treatments, with five (5) experimental treatments and one (1) control treatment. Each of these treatments is replicated seven (7) times, including the control treatment. This replication helps ensure the reliability and robustness of the study's results.

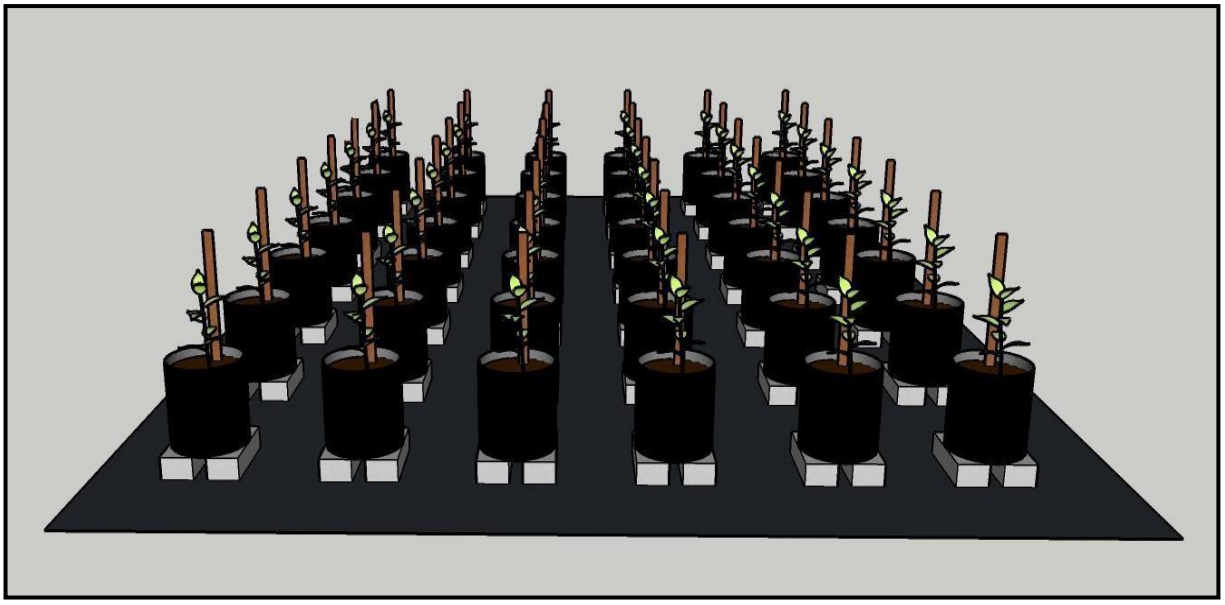


Figure 2: Front view site plan layout

The collected data was statistically analyzed by measuring various parameters, including the height of the plants, the number of leaves, the length of roots, the dry mass, and the number of sacha inchi fruits. These measurements were used to assess the overall performance and characteristics of the plants in the study. The growth performance parameter involves measuring the height of the sacha inchi plants using a measuring tape. Plant height measurements will be conducted weekly to monitor their growth progress. Additionally, the number of leaves on the sacha inchi plants will be counted every week to gather data on leaf growth.

Regarding physiological performance, data related to soil pH and soil moisture will be collected. Soil pH measurements for each treatment will be taken on a weekly basis. Monitoring these parameters is essential for assessing the overall health and physiological well-being of the sacha inchi plants in response to different soil series and conditions. For soil analysis, soil samples from each treatment are collected and diluted with distilled water at a ratio of 10 grams of soil to 10 milliliters of distilled water. These diluted samples are then left undisturbed for 24 hours before data collection. This process is essential to prepare the soil samples for subsequent analysis.

In the case of soil moisture measurements, data for each soil treatment is collected once a week using a soil moisture meter called "Extech MO750 with Heavy-Duty 8". This instrument helps in assessing and monitoring the moisture content of the soil over time, providing valuable information for the study's objectives.

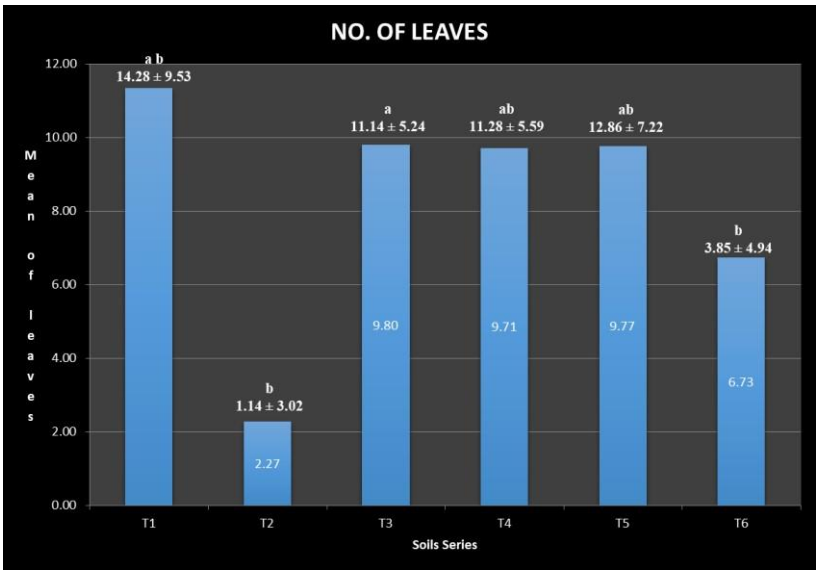
The data collected were analyzed using the Statistical Package for the Social Sciences (SPSS) software, specifically employing One-way Analysis of Variance (ANOVA). To ascertain significant differences between the treatments, the analysis utilized the Latin Square Design (LSD) multiple range tests. SPSS is commonly recognized by its full name, which is Statistical Package for the Social Sciences, or alternatively, Statistical Product and Service Solutions. It is extensively utilized as statistical software for analyzing data in the fields of social science and market analysis (Hilary I. Okagbue et. al, 2021). Completely Randomized Design (CRD) is used as an experimental designed. This approach is particularly well-suited for examining the impact of a single factor while also accounting for other potentially influential factors (Zahid Hussain et. al, 2019). The completely randomized design is commonly employed when environmental conditions are relatively consistent across the study area. It adheres to the principles of replication and randomization. In this design, each treatment is randomly assigned to experimental units, which can include plots, pots, or individual plants. The random allocation of treatments is done independently in each reservoir or experimental unit, ensuring unbiased and robust statistical analysis.

RESULT AND DISCUSSION

NUMBER OF LEAVES

A one-way ANOVA analysis was performed to assess the impact of various soil series on the number of leaves. The results showed a statistically significant effect of different soil series on the number of leaves.

Figure 3: The mean values (MEAN ± STD), and groups with different alphabetic letters are statistically significant (P = 0.05)



The number of leaves is a crucial parameter for assessing the overall performance of sacha inchi plants. The study revealed that the choice of different soil series as the primary treatment had a significant impact on the number of leaves throughout all growth stages of sacha inchi. This highlights the importance of soil selection in achieving the highest number of leaves in sacha inchi plants.

The number of leaves was assessed based on the application of different soil series treatments. The study found that the highest number of leaves was consistently observed in the T1 treatment, which corresponds to the Batu Lapan series (BLN/3) of soil series, across all growth stages of sacha inchi. In contrast, the lowest number of leaves was recorded in the T2 treatment, associated with the Batu Lapan series (BLN/4) of soil series. Specifically, the treatments ranked in terms of the number of leaves were T1 treatment (Batu Lapan series BLN/3): 11.33, T3 treatment (Gajah Mati series GMI/2): 9.80, T5 treatment (Disturbed land DLD/1): 9.73, T4 treatment (Padang Besar series PBR_2): 9.71, T6 treatment (Cocopeat medium): 6.73 and T2 treatment (Batu Lapan series BLN/4): 2.27.

Based on Figure 3, it is evident that the application of different soil series significantly affects the outcome, particularly in terms of the number of leaves in sacha inchi plants. These results indicate that the choice of T1 treatment (Batu Lapan series BLN/3) consistently led to the highest number of leaves in sacha inchi plants, while T2 treatment (Batu Lapan series BLN/4) resulted in the lowest number of leaves. Achieving an optimum plant density is a critical factor in maximizing the yield of maize crops. The spacing and arrangement of maize plants in the field can significantly impact their growth, development, and overall productivity. (Nishat S Islam et. al, 2023).

Therefore, the results of the ANOVA test indicated that the variation in soil series had a significant impact on the number of leaves (P = 0.001). Referring to Figure 3, the LSD at a 5% significance level for the number of leaves highlighted that the most significant differences were observed in the T2 treatment (Batu Lapan series BLN/4) and the T6 treatment (Cocopeat medium). In contrast, the remaining treatments, namely T1 treatment (Batu Lapan series BLN/3), T3 treatment (Gajah Mati series GMI/2), T4 treatment (Padang Besar series PBR_2), and T5 treatment (Disturbed land DLD/1), were not found to be as statistically significant as T2 (Batu Lapan series BLN/4) and T6 (Cocopeat medium) when considering the number of leaves.

PLANT HEIGHT

The application of various soil series resulted in uneven plant heights, and the ANOVA test confirmed a significant effect of different soil series applications on plant height (p-value = 0.050). This suggests that the choice of soil series had a notable impact on the height of the plants in the study.

Figure 4: The effect of different soils series on plant height on sacha inchi plants. Bars indicate (MEAN ± STD) and presented with different alphabetic letters are significantly different (P = 0.050)

In general, plant height serves as a valuable indicator of a plant's overall size and growth rate. It is an essential growth attribute that is directly associated with a plant's potential for productivity, including the yield of fodder, grains, or fruits. Optimal plant height is believed to have a positive correlation with a plant's productivity, indicating that taller plants often have the potential for higher yields. A one-way ANOVA was performed to investigate the impact of soil series on plant height. The analysis revealed a statistically significant interaction between sacha inchi plants and the frequency of soil application on plant height, with a p-value of 0.015.

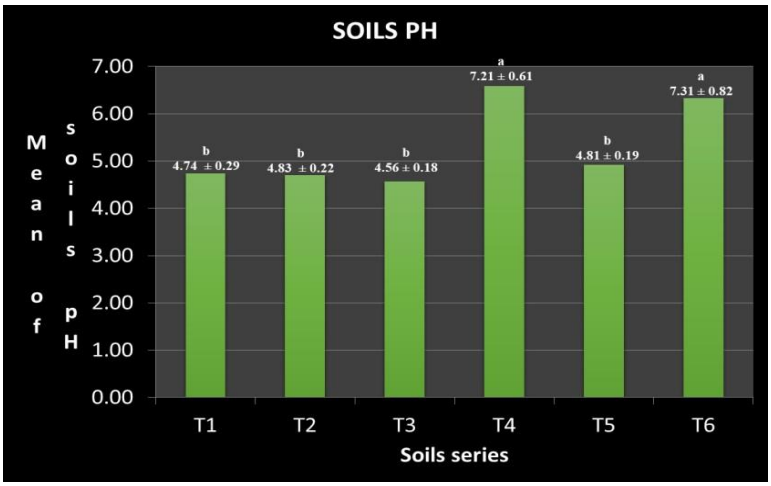
As shown in Figure 4, the mean values for plant height displayed statistically significant differences among the different treatments. This suggests that the choice of soil series had a notable effect on the plant height of sacha inchi plants in the study. The analysis revealed that the highest plant height was observed in treatment T1 (Batu Lapan series BLN/3), followed by T5 (Disturbed land DLD/1), which had the second-highest plant height. The results also showed that the third-highest plant height was recorded in treatment T3 (Gajah Mati series GMI/2), followed by treatment T4 (Padang Besar series PBR_2).

On the other hand, treatment T2 (Batu Lapan series BLN/4) of the soil series exhibited the lowest plant height compared to treatment T6 (Cocopeat medium). These findings demonstrate the variations in plant height associated with different soil series treatments, with some treatments resulting in taller plants than others. From the experiment, it was observed that the highest number of leaves, measured in centimeters (cm), was recorded in T1 treatment (33.48 cm), followed by T5 treatment (31.50 cm), T3 treatment (30.76 cm), and T4 treatment (27.59 cm). T6 treatment had a slightly lower number of leaves at 24.39 cm, while the lowest number of leaves was found in T2 treatment, measuring 15.81 cm. These results clearly indicate variations in the number of leaves among the different treatments.

SOILS PH

A one-way ANOVA was conducted to investigate the impact of different soil series on soil pH. The analysis revealed a statistically significant effect of different soil series on soil pH, with a p-value of 0.05. This indicates that the choice of soil series had a significant influence on the pH levels of the soil.

Figure 5: The effect of different soils series was application on soils ph on sacha inchi plant. Bars indicate (MEAN ± STD) and presented with different alphabetic letters are significantly (P = 0.05) In Figure 5, it is evident that there were statistically significant differences in the mean soil pH values among treatment groups, including treatment T1, T2, T3, T4, T5, and T6 (p = 0.000). Additionally, significant differences were observed between groups related to the application of different soil series on soil pH (p = 0.000). These findings highlight the considerable influence of soil series on the pH levels in the study.

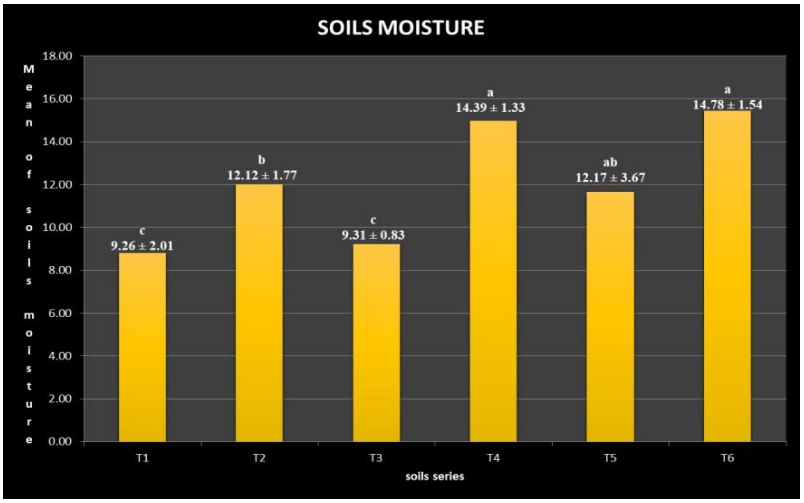


Multiple comparisons were conducted using the LSD test to identify significant differences in soil pH rates among the different soil series treatments. Figure 5 provides information on the mean soil pH values and standard deviations for this parameter. The significant differences observed in the pH levels of the soils indicate that there are indeed variations in soil pH among all the treatment groups with different soil series applications. This suggests that the choice of soil series had a notable impact on the pH levels of the soil in the study.

The analysis revealed that the highest soil pH value was recorded in T4 treatment (6.59) among the different soil series treatments. Following closely, the second-highest soil pH value was observed in T6 treatment (6.33). In contrast, T3 treatment, which corresponds to the Gajah Mati series, had the lowest soil pH value at 4.57. Comparatively, T2 (4.70), T1 (4.73), and T5 (4.93) treatments had slightly higher soil pH values than T3. These results illustrate variations in soil pH among the different soil series treatments, with T4 and T6 having the highest pH values and T3 having the lowest. The UCAM farm area development master plan for 2019, as reported by the Land Resource Management and Conservation Division of the Agriculture Department of Pulau Gadong, Malacca, indicates that the soil series (Gajah Mati series) is characterized by its shallowness, with a layer of laterite gravel present. This information provides insights into the soil characteristics of the specific area mentioned in the report.

SOILS MOISTURE

Figure 6: The effect of different soils series was application on soils moisture on sacha inchi plant. Bars indicate (MEAN ± STD) and presented with different alphabetic letters are significantly (P = 0.05)



The study revealed a significant difference in soil moisture levels among sacha inchi plants with different soil series applications. Interestingly, treatment T1 (Batu Lapan series BLN/3) exhibited the lowest soil moisture levels among all the treatments in the study. This finding highlights the variations in soil moisture depending on the choice of soil series for sacha inchi cultivation. The ANOVA test results indicate that the choice of different soil series had a significant effect on soil moisture (P = 0.000). Referring to Figure 6, the LSD test at a 5% significance level for soil moisture revealed that the most significant differences were observed in T1 treatment (Batu Lapan series BLN/3) and T3 treatment (Gajah Mati series GMI/2). These treatments exhibited the most notable variations in soil moisture levels among the studied treatments. Conversely, the remaining treatments, namely T2 treatment (Batu Lapan series BLN/4), T4 treatment (Padang Besar series PBR_2), T5 treatment (Disturbed land DLD/1), and T6 treatment (Cocopeat medium), were found to be less statistically significant in terms of soil moisture levels compared to T1 and T3 treatments. These results suggest that T1 and T3 treatments had the most pronounced impact on soil moisture, while the others had relatively less significant effects.

OVERALL SCORE OF TREATMENT PARAMETER

Figure 7: Overall ranking of all treatment parameter different soils series affect on growth performance of sacha inchi plants.

OVERALL SCORE TREATMENT						
PARAMETER	T1	T2	T3	T4	T5	T6
NUMBER OF LEAVES	1	2	1	1.5	1.5	2
PLANT HEIGHT	1	1.5	1	1	1	1
SOILS PH	2	2	2	1	2	1
SOILS MOISTURE	3	2	3	1	1.5	1
TOTAL	6	7.5	7	4.5	6	5
SCORE	4	5	4	1	3	2

The evaluation of the best treatment should primarily consider the effects of different soil series applications on the growth performance of sacha inchi plants. Assessing how well each treatment supports the growth, development, and overall health of the plants is crucial in determining the most suitable soil series for cultivating sacha inchi. Figure 7 displays the scoring of each treatment based on parameters related to growth performance, including the number of leaves and plant height, as well as parameters related to physiological performance, such as soil pH and soil moisture. The scoring allows for the identification of the best treatment among the different soil series applications based on their overall performance and merit. This comprehensive evaluation helps in determining which treatment outperformed others across various performance indicators.

The total score, obtained through a ranking of the treatments, is a key factor in identifying the best treatment among the different soil series applications. Comparing both growth performance and physiological performance across all treatments provides an accurate indicator for selection. Latin square designs are indeed valuable in agricultural settings, especially when dealing with multiple factors or gradients. The key characteristic of a Latin square design is that the number of treatments must be equal to the number of rows and columns. Therefore, experiments with a relatively small number of treatments, typically ranging from four to eight, are well-suited for Latin square designs. This design approach helps efficiently control for and assess the effects of multiple variables or treatments in agricultural research (Marcus Jones et. Al, 2015). The scores for each treatment are determined using the Latin Square Design (LSD). In this context, the treatment with the lowest total score is considered the best among the soil series applications, while the treatment with the highest total score is considered the least favorable. This scoring approach helps in objectively assessing and ranking the treatments based on their overall performance.

According to Figure 7, the results suggest that the best-performing treatment is T4 (Padang Besar series PBR_2). The total score for T4 (Padang Besar series PBR_2) is the lowest, at 4.00, indicating its superior performance. In contrast, T2 treatment (Batu Lapan series BLN/4) has the highest total score, at 7.50, implying it is not as effective as T4 (Padang Besar series PBR_2). Therefore, based on the total scores and overall performance, T4 (Padang Besar series PBR_2) is identified as the best soil series application for sacha inchi plants compared to T2 (Batu Lapan series BLN/4). The results obtained from the fieldwork suggest that these soil series could offer significant benefits to farmers or researchers cultivating sacha inchi in UCAM. By selecting the appropriate soil series, farmers and researchers may be able to reduce the costs associated with crop management. This strategic choice can help minimize unnecessary efforts and resources that do not contribute to agricultural productivity, particularly in the cultivation of sacha inchi plants. In the long term, such informed decisions can lead to more efficient and cost-effective farming practices.

CONCLUSION

This study's primary focus was to compare the impact of different soil series as growing mediums on the growth performance and physiological performance of sacha inchi plants (Plukenetia volubilis). The assessment was based on four (4) key parameters, namely the number of leaves, plant height, soil pH, and soil moisture. The study employed six different treatments representing various soil series which are T1 treatment: Batu Lapan series (BLN/3), T2 treatment: Batu Lapan series (BLN/4), T3 treatment: Gajah Mati series (GMI/2), T4 treatment: Padang Besar series (PBR_2), T5 treatment: Disturbed land (DLD/1) and T6 treatment: Cocopeat medium (control). These treatments were used to assess the sacha inchi plants' performance when grown in different soil series, with cocopeat medium as the control media. The evaluation focused on the specified parameters to understand how different soil conditions affected the plants.

The results obtained from the study indicate that there were distinct variations in both growth performance and physiological performance among the different soil series used as growing mediums. Specifically, the analysis revealed that all treatments exhibited significant differences in terms of the number of leaves, plant height, soil pH, and soil moisture. These findings underscore the importance of soil selection and its impact on sacha inchi plant growth and physiological responses.

Based on the comparison of the four (4) parameters for the different soil series treatments, it has been observed that T4 treatment (Padang Besar series PBR_2) consistently yielded the highest results for both growth performance and physiological performance. It obtained the best scores across all treatments. Therefore, based on the study's findings, it is recommended that T4 treatment (Padang Besar series PBR_2) be considered the most suitable soil series for sacha inchi plants, outperforming the other soil series in terms of supporting their growth and physiological wellbeing.

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