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Study of Land Characteristics in West Angkola and Marancar in Relation to the Fruit Quality of Salak Sidimpuan (*Salacca sumatrana* Becc.)

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Abstract

Salak Sidimpuan is one of the leading crops and is favored by the people of South Tapanuli due to its unique taste and fruit appearance compared to salak grown outside the region. This type of salak primarily grows in the central salak production areas, particularly in Angkola Barat and Marancar sub-districts. This study aims to identify the differences in land characteristics for salak cultivation in Angkola Barat and Marancar, and to determine the relationship between land characteristics and the fruit quality of Salak Sidimpuan. The research method employed a field survey and purposive sampling, a sampling technique based on specific criteria. Statistical analysis was performed using an independent samples t-test and linear regression with SPSS software. The results of the t-test showed that land characteristics such as organic carbon (C-organic), phosphorus (P), and total dissolved solids (TDS) of the fruit in Angkola Barat and Marancar did not differ significantly. However, cation exchange capacity (CEC), nitrogen (N), and fruit weight showed significant differences. Regression analysis revealed that C-organic, CEC, N, P, and potassium (K) had a positive correlation with fruit quality in Angkola Barat, with correlation coefficients of 0.079, 0.670, 0.041, 0.651, and 0.412, respectively.

Keywords: *Land Characteristics, Fruit Quality, Salak Sidimpuan*.

1. INTRODUCTION

Salak (snake fruit) is an indigenous Indonesian commodity that can grow in lowland areas up to elevations exceeding 800 meters above sea level (Sutoyo and Suprapto, 2010). Salak Sidimpuan (*Salacca sumatrana* Becc.) is a local variety with strong development potential in South Tapanuli. It is one of the region's main agricultural commodities and has become an icon of South Tapanuli Regency. The cultivation of Salak Sidimpuan dates back to around the 1930s.

According to Nasution (2013), salak production in Marancar is lower than in Angkola Barat. Production data from three research sites in Marancar show an average yield of 6–8 tons/ha/year, whereas in Angkola Barat, the average yield ranges from 3–20 tons/ha/year. Given these disparities and the fact that current yields do not consistently

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meet the annual production standard, it is necessary to investigate the relationship between soil physical properties and salak production in Marancar.

Land characteristics refer to measurable or estimable attributes of the land. These characteristics are closely related to land quality in terms of its capacity to support optimal land use or to ensure successful crop cultivation, ultimately leading to optimal production. Various sources indicate that the application of land characteristics in land evaluation varies depending on the purpose. The key land characteristics commonly used in land assessment include mean annual temperature, rainfall, air humidity, drainage, soil texture, coarse material content, effective soil depth, soil maturity, cation exchange capacity (CEC), base saturation, soil pH, organic carbon (C-organic), slope, and erosion hazard.

One effort to sustain the cultivation of Salak Sidimpuan — a fruit with high commercial potential — is to identify the specific land characteristics associated with its cultivation. This is essential for evaluating soil properties and their relationship to fruit quality. Based on the aforementioned background, this study aims to assess and compare the land characteristics in Angkola Barat and Marancar and analyze their relationship to the fruit quality of Salak Sidimpuan (*Salacca sumatrana* Becc.).

2. RESEARCH METHOD

The research was conducted at two locations: Angkola Barat and Marancar Subdistricts, South Tapanuli Regency, within productive salak (snake fruit) cultivation areas. The study took place from June to July 2024. Soil nutrient analysis was carried out at the Laboratory of the Faculty of Agriculture, Andalas University, Padang.

This research employed a field survey method with purposive sampling for selecting sample plants. Purposive sampling is a technique in which samples are selected based on specific criteria and careful consideration to ensure appropriate observation and sample collection for subsequent analysis. The sampling criteria in this study focused on Sidimpuan salak plants that were in the productive (fruit-bearing) stage. Data analysis was conducted manually using the Independent t-test formula for comparing separate samples, as well as linear regression analysis using SPSS software.

Research Analysis

To examine the relationship between land characteristics and the fruit quality of Sidimpuan salak, a simple linear regression analysis was conducted using a systematic equation model, along with an Independent t-test for unpaired samples. The analyses included:

1. Independent t-test Formula for Unpaired Samples

The Independent t-test (for unpaired samples) is applied when one group of data is not dependent on—or does not influence—the other group. This test is used to determine whether there is a statistically significant difference between the means of two unrelated samples. The formula used is as follows :

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1{}^2}{n_1} + \frac{s_2{}^2}{n_2} - 2r\left(\frac{s_1}{\sqrt{n_1}}\right)\left(\frac{s_2}{\sqrt{n_2}}\right)}}$$

Description :

X_1 : the mean of sample 1
X_2 : the mean of sample 2
S_1 : the standard deviation of sample 1
S_2 : the standard deviation of sample 2
S_1^2 : the variance of sample 1
S_2^2 : the variance of sample 2
r : the correlation between the two samples

The t-test statistic for independent samples with unequal variances is calculated as:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}} \quad \text{with} \quad t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2} - 2r\left(\frac{S_1}{\sqrt{n_1}}\right)\left(\frac{S_2}{\sqrt{n_2}}\right)}}$$

Description :

S_1^2 : the sample size of Angkola Barat
S_2^2 : the sample size of Marancar
n_1 : the variance of the Angkola Barat sample
n_2 : the variance of the marancar sample
X_1 : Average of the Angkola Barat sample
X_2 : Average of the marancar sample

2. Simple Linear Regression

To determine the relationship between land characteristics and dissolved solids, it is analyzed using simple linear regression with the general formula :

$Y = a + b X$

Where :
Y : Dependent variable (Salak)
b : Intercept of the Y-axis
x : Linear regression coefficient

3. RESULTS AND DISCUSSION

A. Soil Analysis Results

The results of soil analysis from samples collected in each sub-district are presented in Table 1. Field observations were conducted through soil sampling in salak plantations in each village within the respective sub-districts. These results represent soil properties considered to reflect the characteristics influencing nutrient availability in the salak-growing areas.

Table 1. Soil nutrient analysis of salak plantations in Angkola Barat and Marancar Sub districts.

Site Location	Nutrients					Fruit Quality	
Angkola Barat	Organic Carbon (C) (%)	CEC (meq/100 g)	Nitrogen (N) (%)	Phosphorus (P) (%)	Potassium K (%)	(TSS) (Brix)	Fruit Weight (g)
Tobotan	2.05	46.716	0.47	3.028	1.486	20.00	78.26
Simatorkis	2.32	92.62	0.34	1.956	0.24	21.00	142.18
L.Layan (1)	4.22	2.81	0.46	1.606	0.126	20.00	87.60
L.Layan (2)	2.66	35.117	0.45	17.047	0.832	22.00	60.45
Sitaratoit	2.89	49.66	0.62	2.086	0.802	22.00	130.61
Total	**14.14**	**226.923**	**2.34**	**25.723**	**3.486**	**105**	**499.1**
Average	**2.828**	**45.3846**	**0.468**	**5.1446**	**0.6972**	**21**	**99.82**
Marancar	Organic Carbon (C) (%)	CEC (meq/100 g)	Nitrogen (N) (%)	Phosphorus (P) (%)	Potassium K (%)	(TSS) (Brix)	Fruit Weight (g)
Momb. Boru	2.32	29.13	0.41	2.177	0.107	20.00	73.69
G. Manaon	2.81	33.89	0.62	1.847	0.19	21.00	58.71
M. Godang	1.36	6.02	0.38	1.92	0.21	22.00	107.76
Sigordang	1.8	57.0	0.39	1.79	0.14	20.00	65.66
P. Sempurna	2.61	69.64	0.43	2.158	0.074	19.00	70.75
Total	**10.9**	**195.68**	**2.23**	**9.892**	**0.721**	**102**	**376.57**
Average	**2.18**	**39.136**	**0.446**	**1.9784**	**0.1442**	**20.4**	**75.314**

Ket : Cation Exchange Capacity (CEC)
Total Dissolved Solids (TSS) (Brix)

In Table 1, the soil nutrient contents (Organic Carbon, CEC, N, P, K), soluble solids, and fruit weight in the salak plantations of Angkola Barat are higher than those in the salak plantations of Marancar. The higher nutrient content in the salak plantations of Angkola Barat influences the metabolic processes of the salak plants, including the role of nutrients in the photosynthate formation in the fruit, which affects the soluble solids content, particularly glucose, in the salak fruit from Angkola Barat.

The results of the T-test analysis for soil nutrient data from salak plantations in both sub-districts are presented in the table below. The independent t-test results show that Organic Carbon does not differ significantly between Angkola Barat and Marancar, as shown in Table 2.

Table 2. Results of Independent T-Test Analysis Comparing Organic Carbon, Phosphorus (P), and Fruit Soluble Solids Content (Brix) in Angkola Barat and Marancar.

Discussion	Organic Carbon (C) (%)	Phosphorus (P) (%)	Total Dissolved Solids (TSS) (Brix)
Significant	0.197	0.320	0.402
F-value	0.147	6.551	0.060
t-value	1.405	1.060	0.885
Note:	NS (Not significantly different)		

Note: *Significant if $p < 0.05$, indicating a statistically significant difference (*)*
Not significant if $p > 0.05$, indicating no statistically significant difference (ns)

Based on the results in the table above, the values for Organic Carbon, Phosphorus (P), and Fruit Soluble Solids Content (Brix) were not statistically significant, with p-values of 0.197 for Organic Carbon, 0.320 for Phosphorus, and 0.402 for Brix. Since all values are greater than 0.05, it indicates that there are no significant differences between Angkola Barat and Marancar. This suggests that the soluble solids content in Salak Sidimpuan fruit is not determined by the sweetness or acidity of the fruit, and is therefore not influenced by the fruit's flavor profile. This finding contrasts with existing theories which suggest that sweeter fruits tend to contain higher amounts of sugars in the form of monosaccharides (fructose and glucose) and disaccharides (sucrose) compared to other compounds. This differs from the opinion of Sudjijo (2008), who stated that the level of total soluble solids significantly influences the sweet taste of salak fruit, as total soluble solids consist of dominant compounds that determine sweetness—primarily sucrose, glucose, and fructose. Meanwhile, Siregar (2023) stated that as fruits ripen, their sugar content increases, although both sugar and acid levels undergo drastic changes.

The differences in Organic Carbon and Phosphorus (P) content in Salak Sidimpuan between Angkola Barat and Marancar were also not statistically significant. This may be attributed to variations in environmental conditions and soil nutrient status between the two sub-districts, particularly differences in elevation, which influence nutrient dynamics. Therefore, the addition of organic matter to the soil is necessary, as it enhances nutrient availability through the mineralization process—the final stage of organic matter decomposition. Organic matter plays a crucial chemical role in supplying essential nutrients such as nitrogen (N), phosphorus (P), and potassium (K), particularly for Salak Sidimpuan cultivation, thereby improving the availability of organic carbon and phosphorus in the soil. According to Aziz et al. (2012), the mechanism by which available phosphorus increases is through the mineralization process triggered by the addition of organic matter, which also contributes to the release of organic carbon into the soil.

B. Comparison of Cation Exchange Capacity (CEC), Nitrogen (N), Potassium (K), and Fruit Weight between Angkola Barat and Marancar Based on Independent T-Test

The results of the independent t-test analysis show that CEC, N, K, and fruit weight differ significantly. These statistically significant differences are presented in the independent t-test results in Table 3 below:

Table 3. Results of Independent T-Test Analysis Comparing CEC, Nitrogen (N), Potassium (K), and Fruit Weight between Angkola Barat and Marancar

Discussion	Cation Exchange Capacity (CEC) (meq/100g)	Nitrogen (N) (%)	Potassium K (%)	Fruit Weight (g)
Significant	0.045	0.039	0.048	0.049
F-value	0.460	0.002	8.126	1.956
t-value	2.377	2.464	2.326	2.315
Note:	* **Significantly different**			

Note: Significant if $p < 0.05$, indicating a statistically significant difference. If $p > 0.05$, the difference is not statistically significant (NS).

To compare CEC, nitrogen (N), potassium (K), and fruit weight between Angkola Barat and Marancar, an independent t-test was used. The results, as shown in Table 3 above, indicate statistically significant differences between the two locations: CEC ($p = 0.045$), nitrogen ($p = 0.039$), potassium ($p = 0.048$), and fruit weight ($p = 0.049$). Since all p-values are less than 0.05, the differences are considered statistically significant. These results suggest that environmental factors may influence land characteristics, including climate, altitude, humidity, temperature, and others. The variation in altitude between Angkola Barat and Marancar may contribute to the observed differences, particularly in fertilization practices, such as the type and dosage of fertilizers applied in each district. In addition, differences in crop varieties, soil types, and nutrient availability also contribute to the significant variations in CEC, N, K, and fruit weightDifferences in nutrient content between the two districts may be a key factor influencing these significant results, where increased nutrient levels can enhance the quality of the crop.

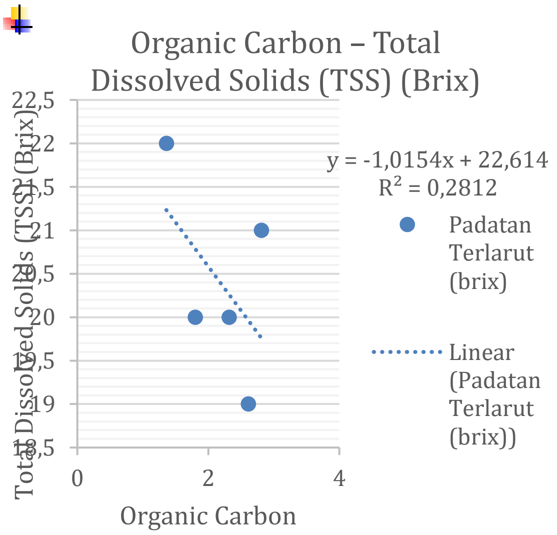
The application of potassium (K) to soil can accelerate fruit development, including both fruit size (fruit weight) and taste. Larger fruit weight is considered a key indicator of quality, as it generally reflects heavier individual fruit mass. To prevent potassium from being easily leached from the soil, an increase in the cation exchange capacity (CEC) is recommended. A higher CEC enhances the soil's ability to retain potassium, thereby reducing leaching losses.

According to Farhad et al. (2010), potassium plays a crucial role in the development of *salak sidimpuan* fruit by promoting fruit growth. Potassium is essential in plant metabolism and is directly involved in several physiological processes. Adekiya et al. (2016) also emphasized that improvements in both fruit quantity and quality depend on the availability of both macro- and micronutrients. The productivity of *salak* is not solely determined by the presence of nitrogen (N), phosphorus (P), and potassium (K), but also by the overall sufficiency and balance of macro- and micronutrients (Rai et al., 2010). Ginting (2010) further noted that potassium improves fruit size and quality during the generative phase and contributes to enhanced fruit sweetness.

C. Comparison of Land Characteristics in Angkola Barat on the Fruit Quality of *Salak Sidimpuan* (*Salacca sumatrana* Becc.) Based on Simple Linear Regression Analysis

The results of the study indicate that land characteristics significantly influence the fruit quality of *Salak Sidimpuan*, as demonstrated through simple linear regression analysis. The analysis shows a strong relationship between land characteristics and the quality of *Salak Sidimpuan* fruit in Angkola Barat. The relationship with Brix (sugar content) can be observed in Figures 1a, 1b, 1c, 1d, and 1e, while the relationship with fruit weight is presented in the simple linear regression equation shown in Table 5.

Based on Figures 1a to 1e, the results of the simple linear regression analysis show that soil organic carbon (C-organic) has a coefficient of determination (R^2) of 0.281, indicating a low correlation. Potassium (K) shows a high correlation with an R^2 value of 0.924. However, despite this high R^2 value, the coefficient of determination for K with respect to Brix (soluble solids content) is only 0.021, indicating that only 2.1% of the variation in salak fruit quality (Brix) can be explained by potassium levels in the soil, while the remaining variation is influenced by other factors. The R^2 values for nitrogen (N), phosphorus (P), and cation exchange capacity (CEC) are 0.016, 0.275, and 0.808, respectively. The Brix value in *Salak Sidimpuan* fruit reflects the percentage of dissolved sugars, indicating a high sugar content and a sweet taste.



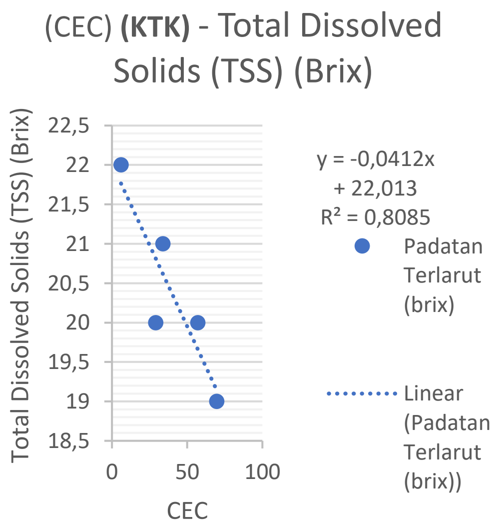
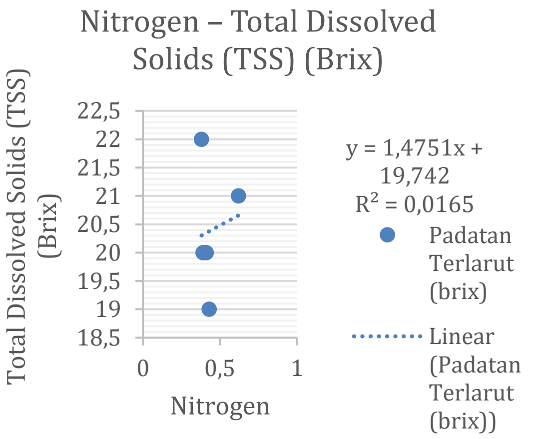


Figure a. Relationship between organic carbon (C-org) and Total dissolved solids.
Figure b. Relationship between Cation Exchange Capacity (CEC) and Total Dissolved Solids (TDS)



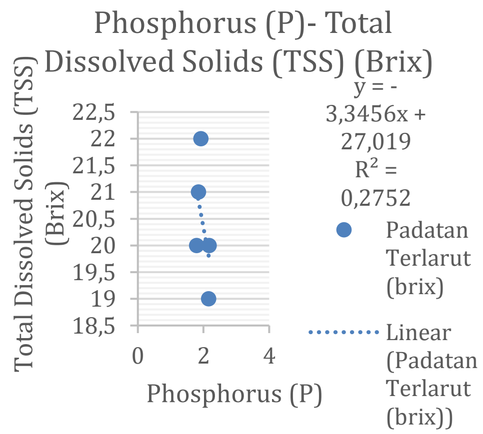


Figure C. Relationship between nitrogen and dissolved solids. Figure D. Relationship between phosphorus (P) and dissolved solids

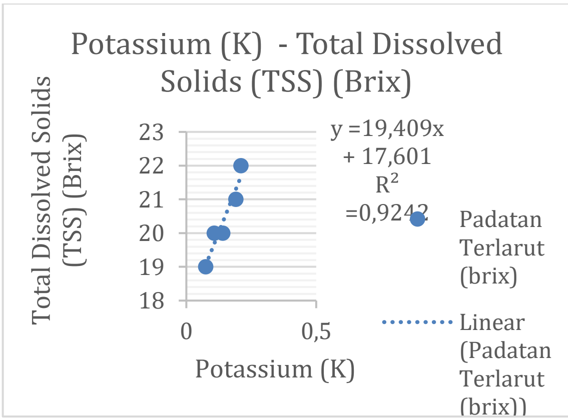


Figure D. Correlation between soil potassium levels and total soluble solids (TSS) in *Salak Sidimpuan* fruit, expressed in °Brix.

This indicates a similarity in several factors that influence soil organic carbon (C-organic), cation exchange capacity (CEC), nitrogen (N), phosphorus (P), and potassium (K), such as climate (rainfall and temperature), drainage, soil texture, and pH. Each of these soil nutrients exhibits a positive regression relationship, meaning that as the levels of C-organic, CEC, N, P, and K increase, the Brix (soluble solids content) of *Salak Sidimpuan* fruit also increases.

According to Bachtiar and Ura (2017), relatively low CEC values result in easier leaching of nutrients due to water movement through the soil, thereby reducing nutrient availability for plants. Novizan (2005) stated that low soil CEC can be improved by adding organic materials such as compost or manure; additionally, the application of ground zeolite rocks can significantly enhance soil CEC. Sari and Prayudyaningsih (2015) also noted that nitrogen is highly beneficial for plant growth. Nitrogen contributes to increased chlorophyll content in leaves, thereby enhancing the photosynthesis process and resulting in greater assimilate production, which ultimately promotes better plant growth.

Table 5. Mean Values of Simple Linear Regression Analysis of Land Characteristics in Angkola Barat in Relation to the Fruit Weight of *Salak Sidimpuan* (*Salacca sumatrana* Becc.)

Soil Nutrient Content	Linear Regression Equation	R	R^2
Organic Carbon	Y = 97.308 + 4.913	0.079	0.006
CEC (KTK)	Y = 66.855 + 0.726	0.670	0.448
Nitrogen (N)	Y = 104.642 + 11.918	0.041	0.002
Phosphorus (P)	Y = 177.402 – 3.417	0.651	0.424
Potassium (K)	Y = 118.312 – 26.523	0.412	0.170

Based on Table 10, the results of the simple linear regression analysis indicate that soil organic carbon (C-organic) has a correlation coefficient (r) of 0.079, and nitrogen (N) has a correlation coefficient (r) of 0.041. These low values suggest that both C-organic and N have a very weak relationship with salak fruit quality (fruit weight) in Angkola Barat. The coefficient of determination (R^2) for C-organic is 0.006, meaning that only 0.6% of the variation in fruit weight is explained by C-organic, while the R^2 for N is 0.002 (0.2%). In contrast, the regression analysis shows that cation exchange capacity (CEC) has a correlation coefficient (r) of 0.670, and phosphorus (P) has a correlation coefficient of 0.651, indicating a strong relationship with salak fruit quality. The R^2 values for CEC and P are 0.448 (44.8%) and 0.424 (42.4%), respectively, suggesting that these soil characteristics significantly influence fruit weight.

Potassium (K) shows a moderate correlation with fruit weight, with an r value of 0.412 and an R^2 of 0.170 (17.0%), indicating that land characteristics related to potassium moderately affect salak fruit quality. The regression equations indicate that C-organic, CEC, and N have positive regression coefficients, meaning that increases in these variables are associated with an increase in fruit weight. Conversely, P and K exhibit negative regression coefficients, suggesting that higher levels of P and K are associated with a decrease in fruit weight.

According to Hairiah (2007), each land area stores a different amount of carbon depending on vegetation diversity, plant density, and land management practices. Higher soil fertility conditions tend to result in greater carbon storage in the soil. In other words, the amount of carbon stored in the soil (as soil organic matter) is influenced by the amount of carbon stored in the aboveground biomass. Mukhlis (2007) stated that the higher the soil organic matter content, the higher the soil's cation exchange capacity (CEC).

4. CONCLUSION

The conclusions drawn from this study are as follows:

1. The land characteristics of salak plantations in Angkola Barat and Marancar show significant differences in cation exchange capacity (CEC), nitrogen (N), potassium (K), and fruit weight.
2. The regression relationships between soil organic carbon (C-organic), CEC, N, phosphorus (P), and K and salak fruit quality in Angkola Barat show positive correlations, with correlation coefficients of 0.079, 0.670, 0.041, 0.651, and 0.412, respectively.

5. REFERENCES

Adekiya, A. O., & Agbede, T. M. (2016). Effect of methods and time of poultry manure application on soil and leaf nutrient concentrations, growth, and fruit yield of tomato (*Lycopersicon esculentum* Mill.). *Journal of the Saudi Society of Agricultural Sciences*, **16**, 383–388.

Aziz, A., Muyassir, & Bakhtiar. (2012). Effects of planting distance and manure dosage on soil chemical properties and rice yield (*Oryza sativa* L.). *Journal of Land Resource Management*, **1**(2), 120–125.

Bachtiar, Budiman, & Ura, R. (2017). The effect of *Leucaena leucocephala* stands on soil fertility in the Ko'mara forest area, Takalar Regency. *Journal of Natural and Environmental Sciences*, **8**(15), 1–6.

Farhad, I.S.M., M.N. Islam, S. Hoque, and M.S.I. Bhuiyan. 2010. Role of potassium and sulphur on the growth, yield, and oil content of soybean (Glycine max L.). Ac. J. Plant Sci. 3 (2): 99-103.

Ginting, R. (2010). Product Design. Yogyakarta: Graha Ilmu, 2(1), 102–109.

Hairiah, K. (2007). Soil Biology: The Foundation for Healthy Soil Management. Yogyakarta: Pustaka Adipura, pp. 97–98.

Mukhlis. (2007). Soil and Plant Analysis. Medan: USU Press.

Nasution, Y. (2013). Land Suitability Evaluation of Salak Sidimpuan in South Tapanuli (Tapsel). Master's Thesis, Graduate Program, Department of Agrotechnology, Faculty of Agriculture, University of North Sumatra.

Novizan. (2005). Effective Fertilization Guidelines. Tangerang: PT Agro Media Pustaka.

Rai, I. N., Semarajaya, C. G. A., & Wiraatmaja, I. W. (2010). Phenophysiological Study of Flowering in Salak Gula Pasir to Overcome Fruit Set Failure. *Journal of Horticulture*, 20(3), 216–222.

Sari, R., & Prayudyaningsih, R. (2015). Rhizobium: Utilization as Nitrogen-Fixing Bacteria. *InfoTeknis EBONI Journal*, 12(1), 51–64.

Siregar, M. A. R. (2023). Increasing rice crop productivity through the application of modern agricultural technology. *Jurnal Padi*, 22(1), 33–40.

Sudjijo, S. (2008). Characterization and Evaluation of Several Salak Accessions. *Journal of Horticulture*, 18(4), 85–143.

Sutoyo, Suprapto. (2010). Salak Cultivation. Ungaran: Central Java Agricultural Technology Assessment Institute.