



RESEARCH PAPER

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Diverse influential factors for the growth and juice sugar production of *Arenga pinnata* plantation

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Abstract

This paper reported the environment study that influenced the growth of the *arenga pinnata* plantation in Tapanuli Selatan Regency of Indonesia. Three reasons that made this research play an important; it revealed the factors that affect the growth of *Arenga pinnata*; gave the calculation of production of this plant; and contributed to farmers, local government, and researcher. Its methodology applied two ways; one was an observation in the field work for the growth based on the altitude position of plantation sites; second included a chemical analysis and calculation of juice production of *Arenga pinnata*. Data found showed that the plantation sites affect the production of *Arenga pinnata* juice and sugar. If the site was on the 0-400 m above the sea level it made the low growth and less juice production of *Arenga pinnata*. In contrast, the highest growth and best juice production were found in the plantation site above 800 m from the sea level. Analysis reported that the higher the pH the production of juice and the higher amount of sugar produced and the decreasing of C-organic soil was decreased C or N ratio which was made N easy to decompose and was accelerated N usage. the range of K at the study sites is between 0.11-2.35 and it can be seen that the relationship between K and the production of juice and the amount of sugar produced generally has a positive relationship. It concluded that the influential factors for the growth and juice and sugar production of *Arenga pinnata* plantation included the position of sites, pH, c-organic soil, the elements of N and K of soil.

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Introduction

The *Arenga pinnata* is one of the plants that do not require special climatic conditions and soil to support its growth. Central Java Forestry Service (2011) said that the *Arenga pinnata* might flourish in the midst of other trees and shrubs, in the plains, hillsides, valleys and mountains up to 1,400 meters altitude. Plant roots that can reach a depth of 6-8 meters can withstand erosion, as well as very effectively attract and hold water. Furthermore, Hidayati (2009) said that this tree does not need the fertile soil, *Arenga pinnata* can live in all soil conditions (clay, calcareous soil and sandy soil). *Arenga pinnata* that grows wild in the South Tapanuli Regency of Indonesia helps farmers in the plantation. Although palm trees are also a source of income farmers, but research is still paid attention less from the local government. As a consequence, the *Arenga pinnata* plant is only managed by the small communities by relying on tradition cultivation. Therefore, the majority of livelihoods of the people of South Tapanuli are farmers and gardeners. The forest grows a lot of wild *Arenga pinnata*. For example, it was found that in Pasar Minggu Village of South Tapanuli Regency with a height of 500 above sea level, the *Arenga pinnata* of the farmers produce as much as 25 liters/day; the morning harvest yield 15 liters and the afternoon 10 liters / stem.

Based on the problem above, it is necessary to study about the *Arenga pinnata* plant in relation with soil nutrient status of pH, C-organic, N, P, K and Mg.

This experiment was carried in South Tapanuli Regency where we found many farmers cultivate the *Arenga pinnata*.

Materials and method

The materials that used in this research were such as:

1. Measuring instrument of *Arenga pinnata* (Refractometer)
2. A milled tube for counting juice production
3. Scale for counting sugar production of *Arenga pinnata*
4. Software SPSS Windows 2000.

Two methods were applied in this study; one was an observation in the field work for the growth based on the altitude position of plantation sites; second included a chemical analysis and calculation of juice production of *Arenga pinnata*.

This study was conducted in many villages; Situmba and Panabari Tano Tombangan Angkola District with altitude 0 - 400 m, Pasar Sampurna, Gunungtua, Aek Nabara Marancar Sub District with 400 - 800 m altitude and Sialaman, Sialaman Jae Sipirok with altitude > 800 m and each altitude was taken 10 sample. Thus, sample was collected from each plant that already used to measure the juice of *Arenga Pinnata* production.

For each type of altitude the place was taken as many as 10 soil samples and samples of the juice of *Arenga pinnata*. For the calculation of the average production of the juice of *Arenga pinnata*, the calculation of the result of the juice of *Arenga pinnata* produced/tree for 1 (one) week. While the the juice of *Arenga pinnata* is taken from each plant that is sampled to be analyzed sugar content.

The data were processed by using multiple linear regression analysis with linear model as follows:

$$Y = a + b_1X_1 + b_2X_2 + \dots + b_nX_n$$

Processing of the juice of *Arenga pinnata* is done by cooking the tapped stems of *Arenga pinnata* by using a cauldron. The fuel used for such cooking is firewood.

The juice of *Arenga pinnata* as much as 3 liters heated for 1 hour and 30 minutes where the the juice of *Arenga pinnata* was become thick and brownish brown then the thick the juice of *Arenga Pinnata* is inserted into the mold that has been prepared.

After the *Arenga pinnata* is dry and cold then weighing the *Arenga pinnata*.

Results

The results of the study discussed the study of the productivity of palm trees based on nutrient status in high-sequence place in South Tapanuli Regency which was observed from several observed variables namely soil nutrients (pH, Organic C, N, P, K and Mg. The amount of sugar produced by the highest sugar is found in T2 (400 - 800 m asl) with the amount of sugar of 2.09 kg, followed by T1 (0 - 400 m asl) of 1.09 kg and the lowest in T3 (> 800 m asl) with a sugar amount of 1.07 kg.

From the data, it can be seen that the highest the juice of *Arenga pinnata* production is found in sample 4 plants in Marancar Village area with the production

of the juice of *Arenga pinnata* about 25.8 l/tree/day at altitude of 600 m, while the lowest is found in sample 6 plants in Tano Tombangan Village area with production of 3.93 l/tree/day at an altitude of 290 m. The highest sugar content was found in sample 4 plants in Tano Tombangan Village with sugar content of 17.33% and the lowest was found in the 1st sample plant in Sialaman Village with 10% sugar content.

While the highest sugar production was also found in sample 4 plants in Marancar Village area with sugar production of 3.53 kg /tree/day, and the lowest in sample 3 plants in Tano Tombangan Village with 0.59 kg/tree/day sugar production.

Table 1. Soil Analysis Results.

No. Lab	No. Lap	Parameter					
		pH (H2)	C-Organik (%)	N- Total (%J)	P - Bray II (PP)	K- exchange (me/100)	Mg. exchange (me/100)
12358	TA (1)	6.73	K63	0.16	14.70	1.54	1034
12359	TA (2)	6.16	1.61	0.16	9.65	1.33	0954
12360	TI (3)	6.44	2.40	0.21	26.18	2.83	1097
12361	TA (4)	7.11	1.87	0.15	21.41	1.66	1038
12362	TA (5)	5.16	1.31	0.13	30.78	0.83	0.560
12363	TA (6)	5.94	1.13	0.13	J6.64	0.90	0.909
12364	TI (7)	6.62	2.63	0.24	27.42	1.73	1.127
12365	TI (8)	6.42	2.89	0.16	25.12	1.08	1.005
12366	TA (9)	5.80	2.36	0.17	23.89	0.98	1.109
12367	TI (10)	7.06	2.10	0.17	39.79	2.16	1.128
12368	TA (1)	5.54	2.18	0.24	9.22	1.22	0.529
12369	TA (2)	5.25	2.51	0.22	7.81	1.24	0.163
12370	TA (3)	5.37	0.60	0.36	5.87	1.16	0.687
12371	TA (4)	4.73	3.04	0.28	7.10	0.30	0.240

It shows the relationship of sugar production to the status of nutrients and plant morphology at high place scale.

Magnesium (Mg) is no less important element in supporting the growth and production of the *Arenga pinnata* From the results of soil analysis conducted obtained Magnesium range (Mg) at the study site is between 0.108 - 1.153 (me/100). From the regression equation shown in Figures 13 and 14, it can be seen that in general has a positive relationship to the production of the juice of *Arenga pinnata* and the

sugar production in general has a negative relationship. The overall effect of Magnesium (Mg) on the production of the juice of *Arenga pinnata* and the amount of sugar produced is not significantly different.

This is due to the amount of Magnesium (Mg) encountered in the research location belonging to the

low category, so Magnesium (Mg) which is one component of chlorophyll molecule cannot play a role in plant metabolism. Magnesium (Mg) inside of the plant is a component of chlorophyll molecule in all green plants, and play an important role in almost all plant metabolism and protein cystesis. The Mg element also acts as a co-factor in almost all enzymes

that activate phosphorylation (ATP) processes or enzymes that use other nucleotides for DNA and RNA synthesis.

In addition, magnesium also has an essential function as a bridge element of aggregation of ribosomal units in protein synthesis (Munawar, 2011).

Table 2. Lab Analysis.

No Lab	No LaB	Parameter					
		pH (HCO)	C - Organic (%)	N –Total (%)	P - Bray II (ppm)	K – exchange (me/100)	Mg –exchange (me/100)
12372	T2 (5)	5.18	2.74	0.22	12.93	0.21	0.404
12373	T2 (6)	6.10	2.40	0.48	7.46	1.87	0.937
12374	T2 1)	5.30	3.41	0.29	7.10	0.93	0.367
12375	T2 (8)	4.73	3.19	0.24	7.46	0.31	0.108
12376	T2 (9)	4.82	2.66	0.23	11.34	0.38	0.372
12377	T2 (10)	4.62	2.29	0.23	13.64	0.61	0.206
12378	T3(1)	5.26	3.71	0.30	6.75	0.97	1.153
12379	T3(2)	4.92	2.25	0.42	9.75	0.90	0.416
12380	T3 (3)	5.68	2.77	0.22	9.40	1.57	1.097
12381	T3(4)	5.82	3.75	0.36	9.05	1.62	0.455
12382	T3 (5)	4.93	3.64	0.33	7.63	1.71	0.440
12383	T3 (6)	5.95	3.64	0.34	7.49	0.52	0.599
12384	T3 (7)	5.90	2.47	0.50	11.70	2.01	1087
12385	T3 (8)	5.61	3.64	0.41	9.93	1.86	0.643
12386	T3 (9)	5.99	3.67	0.58	9.58	0.11	0.862
12387	T3(10)	5.89	0.53	0.50	10.28	2.35	0.494

In all of the three attitude locations, the highest average production of the juice of *Arenga pinnata* was found in T2 (400 - 800 m asl) with the juice of *Arenga pinnata* production of 15.04 l/day followed by T3 (> 800 m asl) with the production of the juice of *Arenga pinnata* at 8.54 l/day and the lowest in the T1 area (0 - 400 m asl) with the production of juice of 7.56 l/day.

Discussion

The research results showed the soil nutrient status and the characteristics of plant growth and altitude of place contributed to the production of the juice of *Arenga pinnata* and the amount of sugar produced. The soil pH values encountered in the study sites were in the range of 4.65 to 6.90, at high acid levels to very low (Hanafiah, 2004).

Judging from the relationship between the soil pH and the production of the juice *Arenga pinnata* and

sugar production, it generally has a positive relationship which means that the higher the pH the production of juice and the higher amount of sugar produced. This is because increasing soil pH was increase the availability of nutrients needed by plants, because soil pH is an important factor that determines the solubility of elements in the soil. As explained by Tan (1992) that the soil pH effect on the growth of plants either directly or indirectly. The indirect effect on the plant is through its effect on the solubility of plant nutrients.

Table 3. Data Analysis of Parameter.

No Lab	No Lap	Parameter					
		pH (HCO)	C – Organic (%)	N – Total (%)	P - Bray II (ppm)	K –exchange (me/100)	Mg – exchange (me/100)
12607	T1 – S3	6.90	1.36	0.32	7.10	1.645	0.482
12608	T1 – S4	6.56	2.20	0.49	8.08	0.635	0.501
12609	T1 – S7	6.35	1.29	0.32	6.23	0.737	0.463
12610	T1 – S10	5.71	1.24	0.33	6.07	0.717	0.530
12611	T2 – S2	5.91	0.89	0.82	10.63	1.247	0.486
12612	T2 – S4	4.65	2.20	0.49	8.51	1.610	0.564
12613	T3 – S3	5.31	2.20	0.54	8.16	0.829	0.535
12614	T3 – S5	5.40	3.56	0.62	10.28	1.705	0.501

The *Arenga pinnata* growth was observed based on various environments such as land positions, the soil chemistry and the altitude of the site of *Arenga pinnata*. It was found that the highest production of *Arenga pinnata* in T2 area (400 – 800 m above sea level) with the juice production about 15.04 liters/day, followed by T3 area (> 800 m above sea level) with production around 8.54 liters/day, and the lowest production of the *Arenga pinnata* was found in T1 area (0 – 400 m above sea level) with *Arenga pinnata* production reaches 7.56 liters/day. Therefore, the highest production of sugar was found in T2 area (400 – 800 m above sea level) with sugar production approximately 2.09 kg, followed by T1 area (0 - 400 m above sea level) with sugar production around 1.09 kg, and the lowest production of sugar was found in T3 area (> 800 m above sea level) with sugar production at least 1.07 kg/day.

From soil analysis results showed that the C-organic content encountered at the study sites was in the range of 0.53 - 3.75. From the regression equation it turns out that C-organic in general has a negative relationship to the production of the juice of *Arenga Pinnata* and the amount of sugar produced.

It is known that one of the most important organic matter for the increase of soil organic matter content is organic carbon content (C), so with decreasing of C-organic soil was decreased C or N ratio which was made N easy to decompose and was accelerated N usage.

This is in accordance with Munawar's (2011) opinion, that the importance of the C/N ratio of an ingredient is related to the effect of the material on the availability of N to the plant, and the rate of decomposition of the material in the soil. The low C/N ratio means the material contains lots of N and was easy to decompose. Conversely, high C/N was be difficult to decompose and was cause N cultivation in Plants.

The nitrogen that is part of all living cells, which results in soil characteristics that were analyzed throughout the study of sites. It showed that N content was between 0.13 - 0.82. From the regression equation, it is seen that in general the relationship between N with the production of the juice of *Arenga pinnata* and the amount of sugar produced has a positive relationship, which means the production was increased along with the increase of N.

The *Arenga pinnata* plants may have good roots so that the ability to absorb N was possibility higher. Thus the plant was growing well and produced the juice of *Arenga pinnata* and the amount of sugar produced higher. Munawar (2011) found that the N in plants serves as a major component of proteins, hormones, vitamins and enzymes for plant life. Similarly, Sanchez (1993) mentioned that N elements play an important role as chlorophyll contributors in the process of photosynthesis, increasing the growth of leaves and stems, making plants better. Metabolism N is a major factor of vegetative growth,

stems and leaves. Plants that get enough N supply, then vegetative growth was positively good. In line with the finding, Lingga (1998) stated that the N elements for plants can stimulate overall plant growth, especially stems and leaves.

In addition to element N, the presence of P elements is not less important in the process of plant growth. Based on soil analysis data, it is known that the range of Pat the study sites is between 6.07 - 30.78. From the regression equation, it is seen that the close relationship between P to the production of the juice of *Arenga pinnata* and the amount of sugar produced has a positive relationship, where production was increased with high Ph in soil.

This condition occurs because the nutrient P at the beginning of growth can support the growth of roots, flowering and cooking which causes can increase crop production. Sufficient P availability was strengthen the stem, as well as improve the flowering and maturation process of the fruit. In addition, Setyati (1992) stated that the element P plays a role in the process of photosynthesis of plants that produce energy in the form of ADP and ATP that plants need in metabolic processes such as the formation of amino acids, fats, proteins, flour and other organioik compounds. Furthermore, Hanafiah (2012) argued that ATP is a compound involved in various energy transfer reactions in almost all metabolic processes of plants, so that P elements play a vital role in supplying the chemical energy involved in the production of heat, light and motion. The response of plant crops to this element is mainly seen in the root system, growth in general, quality and total production.

Potassium is a primary essential nutrient for plants that is absorbed by plants in large quantities compared to other nutrients, except N. In this study, the range of K at the study sites is between 0.11-2.35 and it can be seen that the relationship between K and the production of juice and the amount of sugar produced generally has a positive relationship.

Furthermore, Sutedjo (2010), said that one of the functions of K for plants is to regulate the movement of stomata and matters relating to water or to maintain the necessary plant turgor in the process of photosynthesis and other processes in order to run well, and can accelerate the growth of tissue meristimatik . In addition, according to Taslim *et al.* (1993) stated that K is also necessary for cell growth, sugar formation, starch and protein.

Conclusion

The production of juice or the amount of sugar produced depend on sites of plantation area. The highest production of the juice of *Arenga pinnata* was found in T2 area (400 - 800 m asl) with the juice of *Arenga pinnata* production 15, 04 l/day followed by T3 (> 800 m asl) with the juice of *Arenga Pinnata* production of 8,54 day and the lowest in area T1 (0 - 400 m asl) with the production of juice sebesar 7,56 l/day. The highest sugar production was found in T2 (400 - 800 m above sea level) with 2.09 kg of sugar, followed by T1 (0 - 400 m asl) of 1.09 kg and the lowest in T3 (> 800 m asl) with the amount of sugar of 1.07 kg.

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