Growth Analysis of Balangeran (*Shorea balangeran*), Red Meranti (*Shorea albida*), and Jelutung Rawa (*Dyera polyphylla*) In The Campus Forest of University of Palangka Raya

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ABSTRACT

Sustainable peatland management can be determined by selecting the right species from technical, social, economic, and environmental aspects. Forest sustainability becomes increasingly important when the need for wood continues to increase, while the sustainability of raw materials both in quantity and quality is declining as illustrated by the current condition of forests in Indonesia. Theresearch aims to determine the diameter riap, high riap and volume riap *of Balangeran*, Jelutung Rawa *Miq and* Meranti Merah, conducted in the Campus Forest of Palangka Raya University. The data collection method is carried out by making measuring plots in each plant plot and determining samples intentionally the results of the study riap annual average diameter, height and volume for Balangeran plants (1.22 cm; 0.99 m; 0.007 m³), Maranti Merah (1.27 cm; 0.77 m; 0.004 m³) and Jelutung Rawa (1.45 cm; 0.62 m; 0.000 m³). Balangeran and Meranti Merah are higher in growth than Jelutung Rawa, due to planting spacing, and lack of maintenance measures. From this study, it was concluded that the annual average diameter and height for plant species in the UPR Campus Forest was quite optimal, so it was necessary to continue measuring until it reached the optimal production cycle.

Keywords: Balangeran, Jelutung rawa, Meranti merah, Riap Growth, UPR

1. Introduction

   Peat swamp forests have natural wealth in the form of trees with a relatively high diversity of plant species. The distribution of species diversity in peat swamp forests can reach a very wide area and some of them are endemic. The success of sustainable peatland management can be determined by the selection of the right species from technical, social, economic, and environmental aspects. Types that meet these criteria include Balangeran (*Shorea balangeran*) and Jelutung Rawa (*Dyera polyphylla* Miq). Both types include tree species that have high economic value and are peatland endemic tree species that are only found in two countries in the world: Indonesia and Malaysia. In addition to these two types, red Meranti can be developed in the development of plantation forests in forest and land rehabilitation activities. Meranti plants can contribute to carbon storage, reduce atmospheric CO_2 concentrations, and still provide high-quality wood. Therefore, this meranti species can be grown for reforestation/reforestation projects or plantation forests for wood products, to reduce deforestation and forest degradation. Knowledge of the nature of the growth of Balangeran, Meranti Merah and Jelutung Rawa plants is an important stage to obtain clearer information about its growth, as part of the analysis of wood utilization Plant productivity can be measured, one of which is through diameter growth, besides because it is easy to implement it also has high accuracy and consistency, so that diameter growth can be used for explain the productivity of plants (trees), (Pamoengkas, 2006).

2. Materials and Methods

Materials

Location map, camera, Ribbon meter / Phi Band, Measuring Stick, rapia rope, wooden stake, GPS, Long Meter, Compass, Computer and Stationery. Balangeran Plant (age: 7 years): 300 trees, Red Meranti (age: 6 years): 300 trees and Jelutung (age: 6 years): 110 trees.

Methods

Data Collection and Processing

Data collected in this study: diameter and height of Balangeran and Maranti Merah stands each 300 plant samples and Jelutung Rawa 110 plant samples and selected intentionally (purposive sampling). Calculation of individual data:

- **Riap diameter** is calculated using the formula (Ruchaemi, 1994)

  $$Id = dt : t$$

  Information:
  Id = Riap annual mean diameter (cm/plant/yr)
  Dt = Plant diameter at measurement time (cm)
  t = Age of plants at time of measurement (years)

- **Riap Height**, calculated by the formula:

  $$ih = ht : t$$

  Information:
  ih = Annual average riser height (m/crop/year)
  Ht = Plant height at measurement time (m)
  t = Age of plant at time of measurement (years)

- **Riap Volume**, calculated by the formula:

  $$iv = vt : t$$

  Information:
  Iv = Average annual volume riap (m³ /plant/year/)
  Vt = Volume of plant at time of measurement (m³)
  t = Age of the plant at the time of measurement (year).

3. Results and Discussion

Riap annual average Balangeran, Meranti Merah and Jelutung Rawa

Plant Growth measured is the total diameter and height of Balangeran plants aged around 7 (seven) years, Meranti Merah and Jelutung Rawa aged 6 (six) years planted in the Campus Forest of Palangka Raya University.

The results of measuring and calculating the diameter, height and volume of plants as presented in Table 1.

Table 1. Average Growth Plant Height, Diameter and Volume

NO	TYPES OF PLANTS	DIAMETER (cm)	HEIGHT (m)	VOLUME (m3)
1	Balangeran	8,553	6,930	0,051
2	Red meranti	7,670	4,656	0,027
3	Swamp langur	3,709	2,703	0,005

Source: processed from primary data, 2023

From Table 1 above, it can be seen that the growth of the average height of Balangeran plants: 6.93 m, red Meranti: 4.66 m and swamp Jelutung plants: 2,703 m. Average Diameter of Balangeran 8.55 cm, Red Meranti

Annual Average Riap Height

The height of Balangeran, Meranti Merah and Jelutung plants is each calculated based on the results of plant height measurements divided by the age of the plant at the time the measurement is carried out so that the average annual height riap is obtained. The results of observations and measurements for Plant height Riap as presented in Table 2.

Table 2. Descriptive Plant Height Riap Statistics

Types of plants	Min	Max	Average	Standard deviation
Balangeran	0.373	1.643	0.990	0.266
Meranti	0.375	1.382	0.776	0.195
Jeluntung	0.145	1.528	0.450	0.193

Source : processed from primary data, 2023

In balangeran plants, the average annual riap plant height ranges from 0.373 – 1,643 m/yr, with an average of 0.990 m/th and a standard deviation of 0.267. In meranti plants, plant height ranges from 0.375 – 1.382 m/yr, with an average of 0.776 m/th and a standard deviation of 0.195. While in jeluntung plants, plant height was obtained ranging from 0.145 – 1,528 m / year, with an average of 0.450 m / year and a standard deviation of 0.193. Riap annual height and standard deviation of Balangeran, Meranti and Jelutung plants as shown in Figure 4.
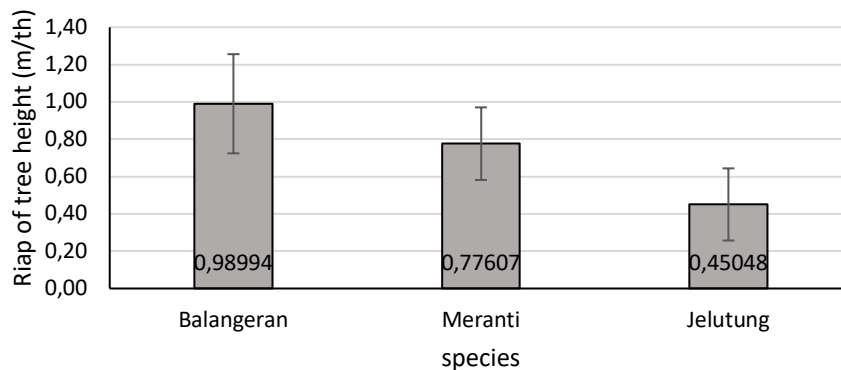

Figure 4. Meranti and Jelutung plants as shown

The results of the calculation of the highest riap growth of Balangeran plants, this condition is estimated because the Balangeran growing place is quite appropriate, although maintenance measures are still needed in the form of thinning, so as to provide optimal growing space for Balangeran growth. In contrast to the Jelutung Rawa plant which is a more open shade condition. Less than optimal growth can also be caused by the exponential phase of growth not running perfectly due to competition for space, substrate or nutrients (Gardner et al., 1991). Light intensity has a significant effect on increasing plant height. Plants in places with low light intensity have significantly smaller growth rates compared to places with higher light intensity. The response to a decrease in light intensity is a decrease in increased growth height, a decrease in leaf production as well as leaf area (Court and Mitchell, 1989).

Average Riap Annual Diameter

The diameter of the balangeran, red meranti, jelutong plants is calculated based on the results of measuring plant diameter divided by the age of the plant at the time the measurement is made so that the average annual diameter riap is obtained.

Table 3. Descriptive Statistics Riap Annual Average Plant Diamater

Species	Min	Max	Average	Standard deviation
Balangeran	0.271	3.143	1.222	0.460
Meranti	0.317	2.750	1.278	0.410
Jeluntung	0.283	2.117	0.618	0.273

Source : processed from primary data, 2023

The largest average diameter riap is found in meranti plants, which is 1,278 m / year. The average riap diameter of balangeran was obtained at 1,222 m / th and in jelutung plants obtained at 0,618 m / year. Riap annual diameter and standard deviation of Balangeran, Meranti and Jelutung plants as shown in Figure 5.
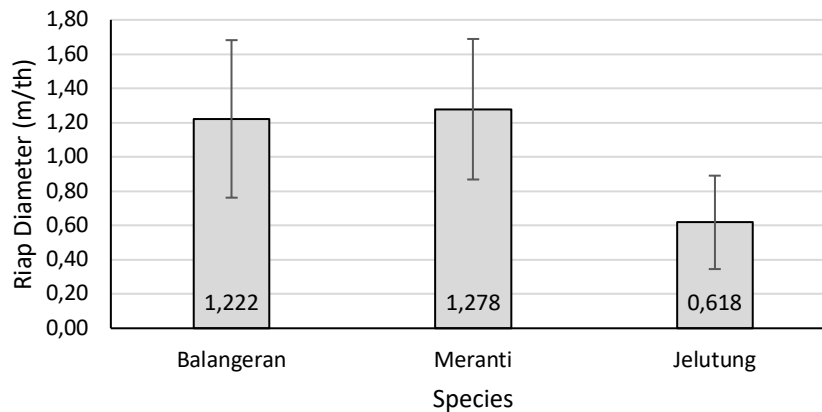

Figure 5. Riap Annual Average Plant Diameter

Diameter is the primary (base) measure of a tree that has a relationship with the volume of the tree (Spurr, 1952). The diameter riap shows that the highest riap reaches 3.14 cm/year while the lowest riap reaches 0.27 cm/year (Table 3). The average diameter of the Red Meranti Plant is larger than that of the Jelutung Rawa plant. This condition is thought to be influenced by higher light intensity due to open location conditions or without shade trees. The high diameter of the Meranti plant is due to this location, most of the Red Meranti is quite well maintained and its growth is optimal. Referring to Meijer *in* Mindawati and Tiryana (2002) which classifies the growing speed of a tree species into five classes based on the riap of the trunk diameter, the five classes are very fast (riap > 1.4 cm / year), fast (riap = 1.19 - 1.4 cm / year), normal (riap = 0.79 - 1.19 cm / year), rather slow (riap = 0.36 - 0.79 cm / year), and slow (riap < 0.36 cm / year). From this information, it can be concluded that Balangeran and red Meranti plants are included in the category of fast growth, while Jelutung Rawa includes rather slow growth.

Average Riap Annual Volume

The annual average riap of the volume of balangeran, red meranti and jelutung plants is respectively calculated based on the results of plant height measurements divided by the age of the plant at the time the measurement is carried out so that an average annual height riap is obtained. The description of Riap Volume Statistics is as presented in Table 4 below.

Table 4. Descriptive Statistics Riap Volume

Species	Min	Max	Average	Standard deviation
Balangeran	0.00016	0.05593	0.00732	0.00703
Meranti	0.00011	0.02855	0.00447	0.00404
Jeluntung	0.00003	0.01936	0.00083	0.00200

Measurement of plant volume riap obtained based on plant height value and diameter per year. Riap The average volume of balarengan reaches 0.00732 m³/yr. Meanwhile, the meranti species has an average plant volume of 0.00447 m³ / year. In the type of jeluntung, it has the smallest average plant volume compared to balarengan and meranti which only reaches 0.00083 m³ / year. Riap the annual volume and standard deviation of the crop as shown in Figure 6.
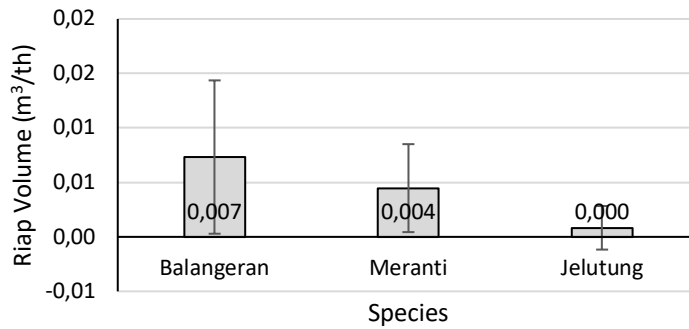
Figure 6. Riap average annual volume of Plants

The volume of a tree can be seen from the speed of growing diameter, which each type has a different rate. For all types, when young generally has a high diameter growth rate, then getting older decreases until finally stops (Simon, 2007).

The Relationship between Diameter, Height and Volume of Balangeran, Red Meranti and Jelutung Rawa Balangeran

The relationship between the diameter, height and volume of Balangeran plants according to diameter and height measurement data obtained results as presented in Table 8 follows.

Table 8. R and R2 Values Relationship Between Plant Diameter, Height and Volume Balangeran trees

	Diameter	Tall
Tall	R = 0.692 R2 = 0.479 = 47.9%	
Volume	R = 0.916 R2 = 0.839 = 83.9%	R = 0.737 R2 = 0.542 = 54.2%

In Table 8, showing the testing of the relationship between the diameter, height and volume of balangeran plants, the value of the correlation coefficient is greater than 0.6 so that it is concluded that the relationship between the three variables is very strong. The relationship between diameter, height and volume in graphic form as presented in Figure 7, Figure 8 and Figure 9 below.
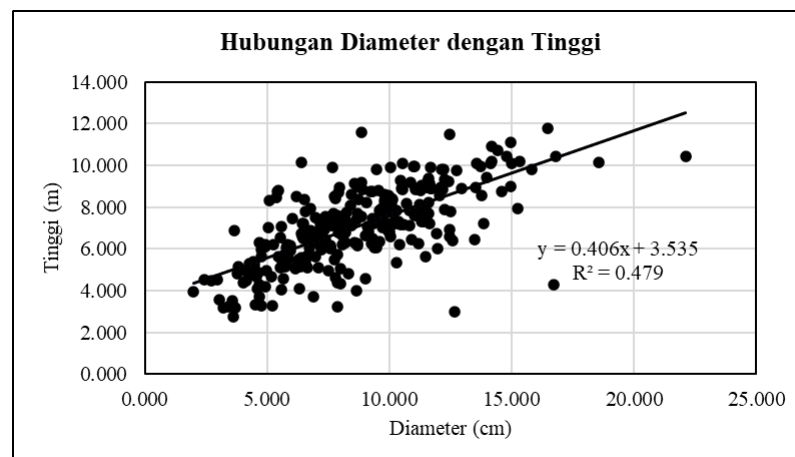

Figure 7. The Relationship of Diameter with the Height of Balangeran Plant
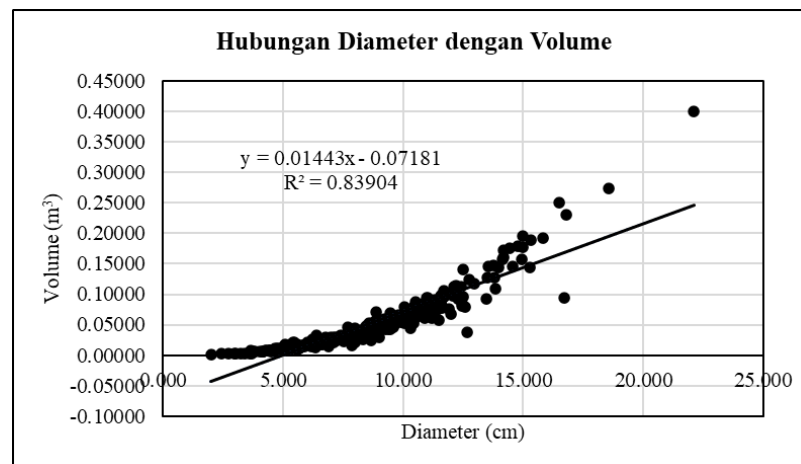
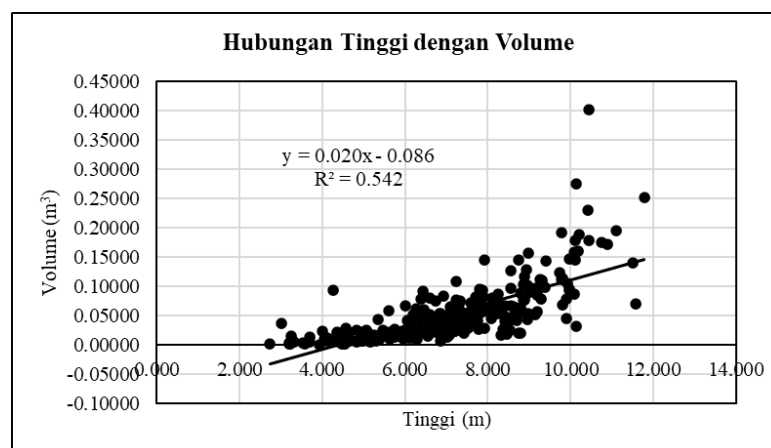Figure 8. Relationship of Diameter with Volume of Balangeran Plant

Figure 9. The relationship between height and volume of Balangeran Plant

Of the 300 balangeran plants, most have a diameter between 5.97cm – 10.03 cm. The smallest diameter is 1.90 cm with the largest diameter reaching 22.2 cm. Most have a height between 4.61 m to 6.60 m. The smallest plant height is 2.61 m with the largest height reaching 12.6 m. The volume of the bar is between 0.0011 m 3 to 0.0831 m³. The smallest plant volume is 0.0011m ³ with the largest volume reaching 0.4111 m³.

Red Meranti

The relationship between the diameter, height and volume of the Red Meranti plant according to the diameter and height measurement data obtained results as presented in Table 9 below.

Table 9. R and R2 Values The Relationship Between Diameter, Height and Volume of Red Meranti tree

	Diameter	Tall
Tall	R = 0.820 R2 = 0.672 = 67.2%	
Volume	R = 0.921 R2 = 0.848 = 84.8%	R = 0.858 R2 = 0.736 = 73.6%

Testing the relationship between the diameter, height and volume of red meranti plants obtained a correlation coefficient value greater than 0.6 so that it was concluded that the relationship between the

three variables was very strong. The relationship between diameter, height and volume is graphically presented in Figure 10, Figure 11 and Figure 12.
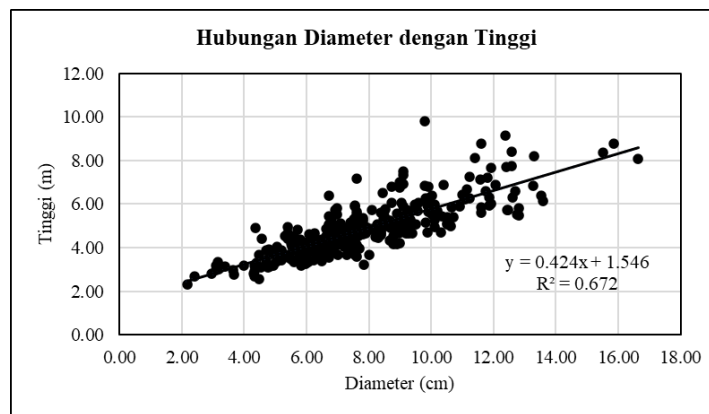

Figure 10. The Relationship of Diameter with the Height of the Red Meranti Plant
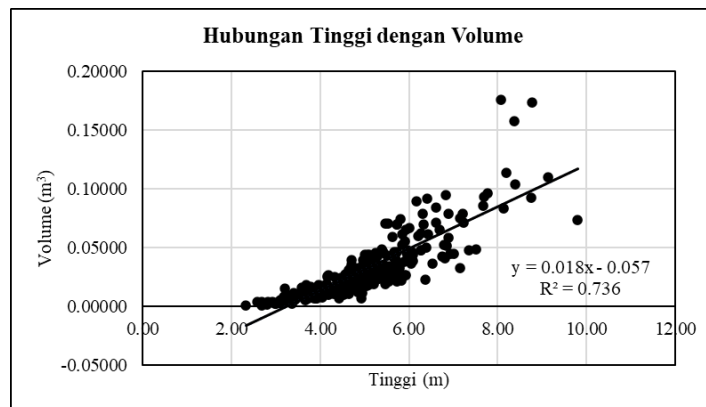
4.

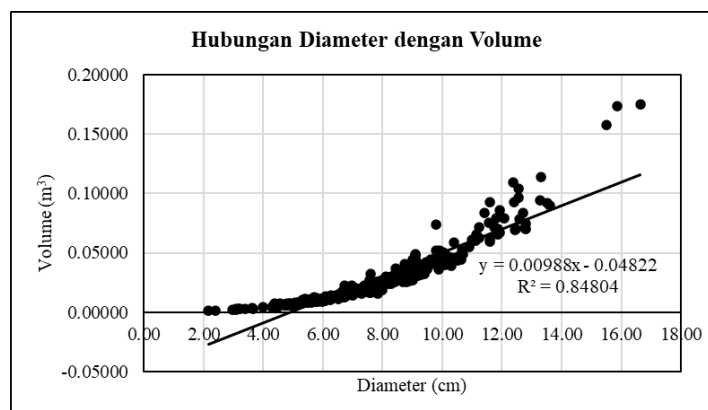**Figure 11.** High Relationship with Red Meranti Plant Volume

Figure 12. Relationship of Diameter with Volume of Red Meranti Plant

Of the 300 red meranti plants sampled, most have a diameter between 4.89 cm – 7.87 cm. The smallest diameter is 1.90 cm with the largest diameter reaching 16.80 cm. Most have a height between 3.81 m to 5.36 m. The smallest plant height is 2.25 m with the largest height reaching 10 m, while the volume of the stem is between 0.0006 m3 to 0.0401 m^3. The smallest plant volume amounted to 0.0006 m ^{3} with the largest volume reaching 0.1981m^3.

The results showed that *S. leprosula* plants planted in the Campus Forest (KBS) showed good development. The average diameter of plants aged 6 years has reached 7.67 cm with the largest diameter plants reaching 16.80 cm.

Jelutung Rawa

The average diameter and height measurements taken were then used to test the magnitude of the relationship between diameter, height and volume (Table 10).

Table 10. The Relationship Between the Diameter, Height and Volume of the Swamp Jelutung trees

	Diameter	Tall
Tall	R = 0.923 R2 = 0.852 = 85.2%	
Volume	R = 0.826 R2 = 0.682 = 68.3%	R = 0.795 R2 = 0.631 = 63.1%

Testing the relationship between the diameter, height and volume of jelutung plants obtained a correlation coefficient value greater than 0.6 so that it was concluded that the relationship between the three variables was very strong. The relationship between diameter, height and volume is graphically presented in Figure 13, Figure 14 and Figure 15.
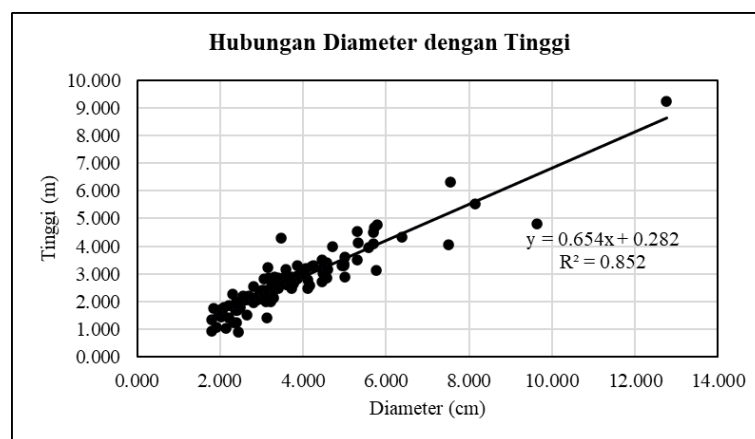

Figure 13. The Relationship of Diameter with the Height of the Swamp Jelutung trees
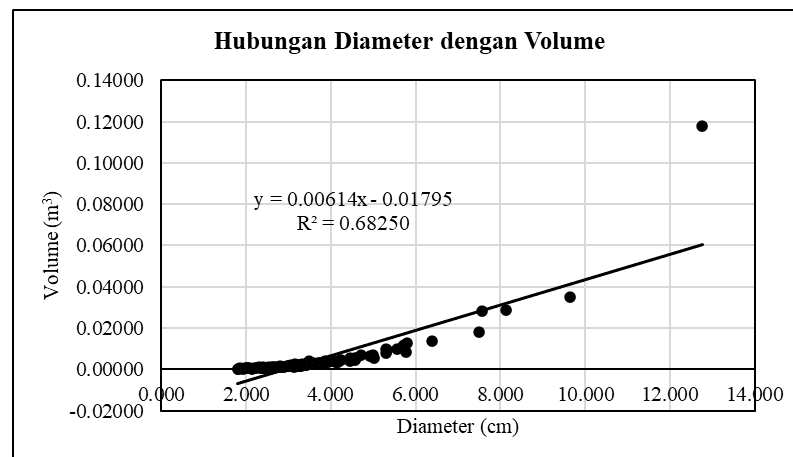

Figure 14. The Relationship of Diameter with the Volume of Swamp Jelutung trees
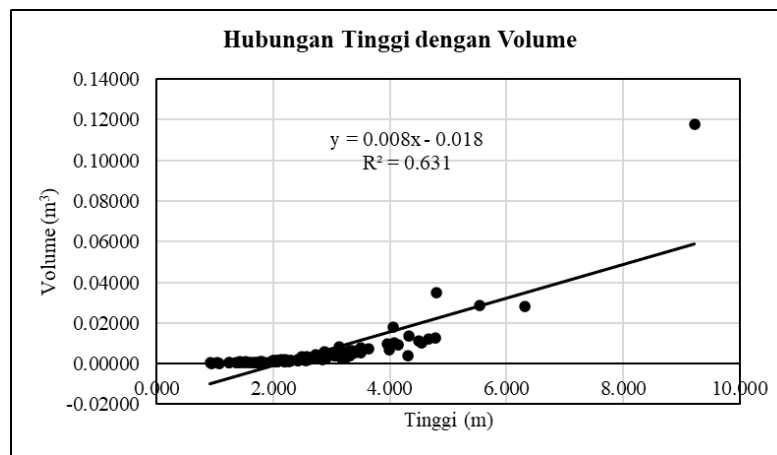
Figure 15. High Relationship with Swamp Jelutung Plant Volume

The growth of Jelutung Rawa plants in the UPR Campus Forest based on observations and measurements of diameter and height shows suboptimal growth, this is due to limited environmental components. Soil fertility and low pH are limiting factors in peatlands (Kissenger, 2020). Jelutung plants planted in 2017 (6 years) with an average diameter of 3.92 cm – 6.13 cm and a height between 2.57 m to 4.25 m, while plants in Jabiren from Siahaan's research, 2023 for 6 years old: average diameter 12.62 cm and height 6.24 m. In addition to the level of soil fertility, which is an obstacle to the growth of diameter and height of Swamp Jelutung plants, namely lack of maintenance and planting distances that are too wide (6m x 3m), and when planting seedlings do not get shade because the planting location is more dominated by reeds and ferns.

Conclusions

1. The annual average riap height of Balangeran is 0.99 m ± 0.27; Meranti: 0.78m ±0.19 and Jelutung: 0.45m ± 0.19, Riap annual average diameter of balangeran: 1.22cm ± 0.46, Meranti: 1.28±0.41 and Jelutung: 0.62±0.27, while Riap annual average volume of Balangeran: 0.0073m 3± 0.00, Meranti: 0.0044m3±0.00 and Jelutung 0.0008 m 3±0.00.
2. Belangeran and Meranti plants grow in diameter and height is quite optimal, while Jelutung Rawa is very low, due to planting distance, maintenance and soil fertility conditions
3. Three variables namely the height, diameter and volume of Balangeran, Meranti Merah and Jelutung rawa plants have a very strong correlation ($R^2 > 0.6$).

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Conflict of Interest

All authors are requested to disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations

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