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Potential of 10 types of eucalyptus clones in the concession area PT TPL TBK Simalungun Indonesia

Benteng H. Sihombing

Program Studi Kehutanan Fakultas Pertanian Universitas Simalungun, Indonesia

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ABSTRACT

A researched 10 clones of Eucalypts were done in Toba Pulp Forest in 2 sectors of Aek Nauli and Tele as the representative plots. The main objective of the study was to determine the relationship between the number of trees and the average diameter, average branch-free height and average volume of 10 IND clones currently cultivated. in the plantation forest area of PT Toba Pulp Lestari Tbk and compared the volume of wood from 10 IND clones and determined the 3 candidate species recommended for cultivation in the next period. Research method of inventory of stand by circle radius plot of 11.28 m (0.04 ha) with 3 replications summarized plot broaded about 1.2 ha. Based on the wood analysis volume analysis can be resumed that 3 IND eucalypts clones are recommended for planting the next period, namely IND 61, IND 60 and IND 11.



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Corresponding Author:

Benteng H. Sihombing
Universitas Simalungun,
Email: bentenghsihombing@gmail.com

Introduction

The development of Industrial Plantation Forest (HTI) aims to produce wood quickly and sustainably to meet the raw material needs of the forestry industry. The exploitation of plantation forests is influenced by various factors that can determine economic output as indicated by the potential for timber produced (Poore, 2013). Plantation forest development generally develops fast-growing species of the Eucalyptus genus which have proven to be economically successful (Liu et al., 2018). Recently, the development of fast-growing species has focused on breeding eucalyptus species (Tomé et al., 2021). The recent increase in demand for wood as raw material for pulp and paper has forced forest plantation companies to carry out research on plant breeding in order to produce plants that are healthy, have high potential and have a short cycle. Plant breeding by crossing techniques (pollination) has been carried out for decades and several new plant clones have been obtained which are the result of crossing older trees with other superior plants (Acquaah, 2015).

The type of eucalyptus (*Eucalyptus* sp) as a type of plant that has been used on a business scale has been the result of crossbreeding and has been able to optimize the potential of wood in a real way (Rezende et al., 2013). Several clones that are considered superior compared to their parents have been planted on an economic scale for several periods. The advantages of this cross-breeding plant are the speed of plant growth and high wood production (Ahmar et al., 2020). With the existence of superior new clones, wood production can compensate for the shorter cycles (Guidi et al., 2013). The development of cross-breeding plants is proven to increase time and financial efficiency by shortening the specified cycle. With a superior new clone, the cycle life which was previously 7 years can be reduced to 3 years.

The mixture of clones of Eucalyptus spp wood seems to be an excellent alternative for producing OSB panels of Eucalyptus clones wood. The development of plants in industrial forest plantations currently requires the development of plants from crosses through a process of plant breeding (Jonas & de Koning, 2013). In the end, it is plants that have advantages that will be developed because these types of plants can be accounted for for their results because they have been tested so that the potential results obtained can be known in a measurable way. To develop clones of hybrid plants produced through research activities at the company, it is necessary to know the actual wood potential through inventory and measurement of stand variables (Nambiar et al., 2018).

The eucalypt clones are less moist and denser and contain fewer minerals and extraneous materials than the elephant grass species, which make them more attractive for utilization in deconstruction studies aiming at production of bioproducts (Gomes et al., 2015). Eucalyptus clone refers to a genetically identical copy of a eucalyptus tree that is produced through a process called cloning (Resende et al., 2016). The potential of different types of Eucalyptus clones in a concession area will depend on a variety of factors such as climate, soil type, and the specific objectives of the plantation (Pawson et al., 2013). The potential of these Eucalyptus clones will depend on various factors and the specific needs of the concession area (Wirabuana et al., 2022). A thorough analysis of the local growing conditions and market demand can help to determine which clones will be most suitable for a particular plantation.

In order to obtain data and information about the potential of the clones being developed (Drew et al., 2009), the figures from plant biometric measurements can serve as an indication of the potential for timber produced and with this data it is possible to identify the potential economic benefits that may be achieved (Vihervaara et al., 2013). Furthermore, data on production potential and quality of wood produced is used as a basis for evaluation to make a decision whether this type will be planted again in period 2 or discontinued. For that we need a correct inventory that can be accounted for statistically so that decision making does not experience errors.

In this study, the main research objectives were determined to determine the relationship between the number of trees (N) and the average diameter (D), the average branch-free height (H) and the average volume of wood (V) of 10 currently cultivated IND clones. economically in the plantation forest area of PT Toba Pulp Lestari Tbk and to compare the volume of wood (V) from 10 IND clones and determine the 3 prospective species that are recommended for cultivation in the next period. This research can provide information on the relationship between the number of trees and the average diameter, average branch-free height, and average volume of wood of 10 IND clones being cultivated. In addition, this study also provides recommendations for prospective species to be cultivated in the next period.

Method

This research was carried out in the HTI area of PT Toba Pulp Lestari Tbk in 2 plant cultivation sectors, namely the Tele sector and the Aek Nauli sector, North Sumatra Province which was carried out from July 2020 to November 2020. The materials needed in this study were clones of IND 61, IND 66, IND 47, IND 52, IND 60, IND 11, IND 73, IND 32, IND 72 and IND 82. The tools involved in this study included micro calipers to measure the diameter of 1 year old plants, phi bands to measure plants over 2 years old, tally sheets, vertex, camera, labels/etiquettes, markers, computers and others. .

In order to obtain data on the potential of eucalyptus clones, inventory plots were constructed which were placed only in the standing area to be harvested (end of cycle) (dos Reis et al., 2018). For each clone measured, the number of each plot was determined by 3 inventory plots in the form of a circle with a radius of 11.28 m (0.04 m²) in each clone so that the plot area of each IND clone was 0.012 ha and the total plot area of the 10 plant species to 1.2 ha. Tree dimensions were measured on stem diameter at breast height (1.3 m) using a phiband, while first branch plant height and total plant height were measured using a vertex.

Data processing in this study aimed to determine the average number of trees at the end of the cycle (NP), the average diameter of production wood (DP), the average height of production wood (HP), the average basal area of production wood (BDP). and average potential wood production (VP). Furthermore, the calculation formulas used are presented as follows.

To find out the basic area of timber production (BDp) the formula is used:

$$BD \text{ (m}^2\text{)} = 0.25 \pi (Dp)^2. \text{ where:}$$

BD	: Area of production timber base (m ²)
π	: 3.14 (mathematical constants)
Dp	: stem diameter at a height of 1.30 m

To find out the volume of wood production (Vp) is calculated by the formula:

$$V_p = BD_p \times fb \times H_p$$

Vp	: Wood potential (m ³)
BDp	: Base area (m ²)
Mobile phone	: Branch-free height (m)
Facebook	: Form factor (0.5).

Note: fb = 0.5 is determined according to what has been applied so far at PT Toba Pulp Lestari Tbk.

An analysis of the relationship between the number of trees and their diameter and free-branching height was carried out to determine the relationship between changes in the number of trees (Np) to the size of the average stem diameter (Dp) and the average height of trees (Hp) which are categorized as production trees harvested in end of cycle set by the company, in this case at the age of 3 years (Fadhilah et al., 2018). The relationship to be known is whether there is a tendency that the increasing number of trees affects the dimensions of stem diameter (Dp) and tree height without branches (Hp).

Analysis of the relationship between the number of trees and the basal area (BDp) and the volume of wood (Vp) is calculated to find out how the relationship between changes in the number of trees (Np) to the magnitude of the basal area size (BDp) and the volume of wood (Vp) that might be produced if at the end harvesting cycle is carried out. The relationship to be known is whether there is a tendency that an increasing number of trees (Np) can lead to a higher basal area (BDp) and an increase in the number of trees (Np) causes an increase in wood volume (Vp).

Prospectus analysis of IND eucalyptus clones was carried out by comparing the volume of wood (Vp) species per type of IND clone that could be produced when harvesting was carried out. The prospect of clone types in producing wood on a species-by-type basis needs to be studied so that accurate information can be obtained which plants have the best prospects to be planted in period 2 which are considered to provide the highest economic benefits.

Results and Discussion

Based on the results of biometric data processing from the 10 IND clones studied, a relationship was obtained between the clones and the number of Np trees (trunks) as presented in Table 1 below.

Table 1. Clone Relationship with Np (btg)

Clone	Np (btg)
ENG 52	1,375
ENG 47	1,475
ENG 60	1,500
ENG 61	1,575
ENG 32	1,583
ENG 72	1,600
ENG 82	1617
ENG 66	1675
ENG 73	1,700
ENG 11	1,708
Amount	15,898
Average	1,581

Source: Processed from primary data

Based on the data in Table 1 above, it can be seen that the order of the number of trees is sorted from the least number of trees to the most number of trees, IND 52 is the type of plant with the least number of trees (1,375 stems) and IND11 is the type of plant with the highest number of trees. lots (1,708 sticks). While the average number of trees from the 10 IND clones is 1,581 stems.

Based on the results of biometric data processing from the 10 IND clones studied, the relationship between the clones and the average stem diameter Dp (cm) was obtained as presented in Table 2. Based on the data in Table 2 above, it can be seen that the order of stem diameters is sorted from the smallest average stem diameter to the largest average stem diameter, IND 11 is the type of plant with the smallest average stem diameter (12.01

cm) and IND61 are the types of plants with the largest average stem diameter (14.90 cm). Meanwhile, the average stem diameter of the 10 IND clones is 12.81 cm.

Table 2. Relationship Between Clones and The Average Diameter (Dp)

Clone	dp(cm)
ENG 52	12.40
ENG 47	12.90
ENG 60	14,10
ENG 61	14.90
ENG 32	12,21
ENG 72	12,26
ENG 82	12.70
ENG 66	12.50
ENG 73	12.07
ENG 11	12.01
Amount	128.05
Average	12.81

Source: Processed from primary data

Based on the results of biometric data processing from the 10 IND clones studied, a relationship was obtained between the clones and the Hp branch-free height (m) as presented in Table 3 below.

Table 3. Relationship between Clones and branch-free height (Hp)

Clone	HP(m)
ENG 52	16.80
ENG 47	14.80
ENG 60	13.70
ENG 61	12.90
ENG 32	16.30
ENG 72	16,72
ENG 82	15.91
ENG 66	15.02
ENG 73	16.56
ENG 11	16,38
Amount	155.09
Average	15,51

Source: Processed from primary data

Based on the data in Table 3 above, it can be seen that the order of tree heights is sorted from the smallest free tree height to the largest free tree height, IND 61 is the smallest free tree height (12.90 m) and IND52 is the type of plant has the highest branch-free tree height (16.80 m). While the average branch-free tree height of the 10 IND clones is 15.51 m. Based on the results of biometric data processing from the 10 IND clones studied, a relationship was obtained between the clones and the Hp branch-free height (m) as presented in Table 4 below.

Table 4. Relationship between Dp (cm), Hp (m) to Np (btg)

Clone	dp(cm)	HP(m)	Np (btg)
ENG 52	12.40	16.80	1,375
ENG 47	12.90	14.80	1,475
ENG 60	14,10	13.70	1,500
ENG 61	14.90	12.90	1,575
ENG 32	12,21	16.30	1,583
ENG 72	12,26	16,72	1,600
ENG 82	12.70	15.91	1617
ENG 66	12.50	15.02	1675
ENG 73	12.07	16.56	1,700
ENG 11	12.01	16,38	1,708
Amount	128.05	155.09	15,898
Average	12.81	15,51	1,581

Source: Processed from primary data

Based on the data in Table 4 above, after carrying out multiple regression analysis between Dp (cm) and Hp (m) to Np (stem) with a linear relationship $Np (\text{stem}) = 4641.997 - 141.382 Dp - 80.650 Hp$ with a correlation coefficient of 0.227154 and a coefficient of determination of 0.006341. Based on the results of biometric data processing from the 10 IND clones studied, a relationship was obtained between the clones and the Hp branch-free height (m) as presented in Table 5 below.

Table 5. The relationship between Np (cm), Hp (m) to Vp (m3)

Clone	dp(cm)	HP(m)	Vp(m3)
ENG 52	12.40	16.80	135.51
ENG 47	12.90	14.80	163.55
ENG 60	14,10	13.70	211.85
ENG 61	14.90	12.90	250,27
ENG 32	12,21	16.30	127.56
ENG 72	12,26	16,72	181.48
ENG 82	12.70	15.91	187,77
ENG 66	12.50	15.02	178,37
ENG 73	12.07	16.56	174.31
ENG 11	12.01	16,38	197.77
Amount	128.05	155.09	1,808
Average	12.81	15,51	180.84

Source: Processed from primary data

Based on the data in Table 5 above, after carrying out a multiple regression analysis between Dp (cm) and Hp (m) on Vp (m3) with a linear relationship $Vp (\text{m3}) = 30.15477 + 19.2841 Dp - 6.2056 Hp$ with a correlation coefficient of 0.553118 and a coefficient of determination of 0.425438. Based on the results of biometric data processing from the 10 IND clones studied, the relationship between Clones, Np, Dp, Hp and Vp was obtained as presented in Table 6 below.

Table 6. Clone Relationship, Np, Dp, Hp to Vp

Clone	N.p.(cm)	dp(cm)	HP(m)	Vp(m3)
ENG 52	1,375	12.40	16.80	135.51
ENG 47	1,475	12.90	14.80	163.55
ENG 60	1,500	14,10	13.70	211.85
ENG 61	1,575	14.90	12.90	250,27
ENG 32	1,583	12,21	16.30	127.56
ENG 72	1,600	12,26	16,72	181.48
ENG 82	1617	12.70	15.91	187,77
ENG 66	1675	12.50	15.02	178,37
ENG 73	1,700	12.07	16.56	174.31
ENG 11	1,708	12.01	16,38	197.77
Amount	15,808	128.05	155.09	1,808
Average	1,581	12.81	15,51	180.84

Source: Processed from primary data

Based on the data in Table 6 above, after carrying out multiple regression analysis between Np (stem), Dp (cm) and Hp (m) to Vp (m3) with a linear relationship $Vp (\text{m3}) = -927.413 + 0.206283 Np + 48,44884 Dp + 10.43119 Hp$ with a correlation coefficient of 0.845734 and a determination coefficient of 0.768601. Based on the results of the analysis of the volume of wood that can be reached by the 10 IND clones, it can be seen that the sequence of potentials can be presented in Table 7.

Based on data on the dominance of wood volume from 10 types of IND Eucalyptus sp clones, it can be seen that the 3 prospective IND clones that are recommended for planting in the following period are IND 61 clones, IND 60 clones and IND 11 clones. In the second choice, 3 IND clones which can also be recommended for planting in the next period with relatively the same wood production are IND 82 clones, IND 72 clones and, IND 73 clones with the note that the 3 IND clones are resistant to pests and diseases.

The order of the number of trees is sorted from the least number of trees to the most number of trees, IND 52 is the type of plant with the least number of trees (1,375 stems) and IND11 is the type of plant with the highest number of trees. lots (1,708 sticks). While the average number of trees from the 10 IND clones is 1,581 stems. The order of stem diameters is sorted from the smallest average stem diameter to the largest average stem

diameter, IND 11 is the type of plant with the smallest average stem diameter (12.01 cm) and IND61 are the types of plants with the largest average stem diameter (14.90 cm). Meanwhile, the average stem diameter of the 10 IND clones is 12.81 cm.

Table 5. Timber Volume Domination of 10 Types of Clones IND

Clone	Vp(m3)
ENG 61	250,27
ENG 60	211.85
ENG 11	197.77
ENG 82	187,77
ENG 72	181.48
ENG 73	178.33
ENG 47	174.31
ENG 66	163.55
ENG 73	135.51
ENG 11	127.56
Amount	1,808
Average	180.84

Source: Processed from primary data

The order of tree heights is sorted from the smallest free tree height to the largest free tree height, IND 61 is the smallest free tree height (12.90 m) and IND52 is the type of plant has the highest branch-free tree height (16.80 m). While the average branch-free tree height of the 10 IND clones is 15.51 m. Based on the data in Table 4 above, after carrying out multiple regression analysis between Dp (cm) and Hp (m) to Np (stem) with a linear relationship $Np(\text{stem}) = 4641.997 - 141.382 Dp - 80.650 Hp$ with a correlation coefficient of 0.227154 and a coefficient of determination of 0.006341.

After carrying out a multiple regression analysis between Dp (cm) and Hp (m) on Vp (m³) with a linear relationship $Vp(\text{m}^3) = 30.15477 + 19.2841 Dp - 6.2056 Hp$ with a correlation coefficient of 0.553118 and a coefficient of determination of 0.425438. Based on the data in Table 6 above, after carrying out multiple regression analysis between Np (stem), Dp (cm) and Hp (m) to Vp (m³) with a linear relationship $Vp(\text{m}^3) = -927.413 + 0.206283 Np + 48.44884 Dp + 10.43119 Hp$ with a correlation coefficient of 0.845734 and a determination coefficient of 0.768601.

Based on data on the dominance of wood volume from 10 types of IND Eucalyptus sp clones, it can be seen that the 3 prospective IND clones that are recommended for planting in the following period are IND 61 clones, IND 60 clones and IND 11 clones. In the second choice, 3 IND clones which can also be recommended for planting in the next period with relatively the same wood production are IND 82 clones, IND 72 clones and, IND 73 clones with the note that the 3 IND clones are resistant to pests and diseases.

Conclusion

Based on the results of processing and data analysis of the 10 types of IND clones studied, it can be concluded that of the 10 IND clones studied, IND 11 clone had the highest number of trees (1,706 stems/ha). IND clone. is the type of plant with the fewest number of trees (1,375 stems), Clone IND 11 is the type of plant with the smallest average stem diameter (12.01 cm) and IND61 is the type of plant with the largest average stem diameter (14.90 cm) and clone IND 61 is the type of plant that has the smallest free tree height (12.90 m) and IND52 is the type of plant that has the largest free tree height (16.80 m). The linear relationship between Dp (cm) and Hp (m) to Np (stem) is $Np(\text{stem}) = 4641.997 - 141.382 Dp - 80.650 Hp$ with a correlation coefficient of 0.227154 and a determination coefficient of 0.006341. The linear relationship between Dp (cm) and Hp (m) to Vp (m³) is $Np(\text{trunk}) = 4641.997 - 141.382 Dp - 80.650 Hp$ with a correlation coefficient of 0.227154 and a determination coefficient of 0.006341 and the linear relationship between Np (stem), Dp (cm) and Hp (m) to Vp (m³) is $Vp(\text{m}^3) = -927.413 + 0.206283 Np + 48.44884 Dp + 10.43119 Hp$ with a correlation coefficient of 0.845734 and a coefficient of determination of 0.768601.

Meanwhile, the 3 prospective IND clones that are recommended for planting in the next period are IND 61 clone, IND 60 clone and IND 11 clone respectively. $382 Dp - 80.650 Hp$ with a correlation coefficient of 0.227154 and a determination coefficient of 0.006341 and the linear relationship between Np (bars), Dp (cm) and Hp (m) to Vp (m³) is linearly $Vp(\text{m}^3) = -927.413 + 0.206283 Np + 48.44884 Dp + 10.43119 Hp$ with a correlation coefficient of 0.845734 and a coefficient of determination of 0.768601. Meanwhile, the 3 prospective IND clones that are recommended for planting in the next period are IND 61 clone, IND 60 clone and IND 11

clone respectively. $382 D_p - 80.650 H_p$ with a correlation coefficient of 0.227154 and a determination coefficient of 0.006341 and the linear relationship between N_p (bars), D_p (cm) and H_p (m) to V_p (m^3) is linearly V_p (m^3) = $- 927.413 + 0.206283 N_p + 48.44884 D_p + 10.43119 H_p$ with a correlation coefficient of 0.845734 and a coefficient of determination of 0.768601. Meanwhile, the 3 prospective IND clones that are recommended for planting in the next period are IND 61 clone, IND 60 clone and IND 11 clone respectively.

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