LIFE FORCE AND GROWTH QUALITY OF WHITE JABON (*Anthocephaluscadamba*) ON VARIOUS OF SOIL TYPES IN POST-MINING CEMENT AREAS

Kekuatan Hidup dan Pertumbuhan Kualitas Jabon Putih Anthocephaluscadamba) pada Berbagai Tanah Jenis-Jenis Di Wilayah Semen Pasir

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ABSTRAK: Lahan kegiatan semen pasca penambangan harus direhabilitasi dan direvegetasi sesuai dengan peraturan yang berlaku di Indonesia. Jabon putih (Anthocephaluscadamba) adalah salah satu spesies alternatif yang ditanam di lahan semen pascatambang, karena spesies ini mampu hidup di tanah terbuka dan tidak subur. Penelitian ini dilakukan untuk mengetahui kemampuan hidup dan pertumbuhan jabon putih di lahan bekas tambang semen yang memiliki berbagai jenis tanah, yaitu laterit, tanah liat dan batu kapur. Metode yang digunakan adalah melakukan inventarisasi dan pengukuran tanaman Jabon putih yang ditanam di berbagai jenis tanah (laterit, tanah liat dan batu kapur). Penelitian dilakukan selama tiga bulan dengan durasi pengukuran setiap bulan untuk 300 tanaman dengan masing-masing jenis tanah terdiri dari 100 tanaman. Hasil penelitian menunjukkan persentase kelangsungan hidup tanaman jabon putih di laterit, tanah liat, dan batu kapur masing-masing adalah 91%, 87% dan 93%. Kualitas tanaman sehat di tanah laterit adalah 50%, tanaman tidak sehat 37%, tanaman mendekam 4% dan tanaman mati 9%, di tanah liat jumlah tanaman sehat 46%, tanaman tidak sehat 32%, mendekam tanaman 9% dan tanaman mati 13%, sedangkan di tanah kapur jumlah tanaman sehat adalah 67%, tanaman tidak sehat 24%, tanaman merana 2% dan tanaman mati 7%. Tingkat pertumbuhan rata-rata pada tanaman Jabon putih terjadi di laterit, tanah liat dan batugamping masing-masing 1,51 cm, 1,61 cm, dan 1,81. Pertumbuhan jumlah daun jabon di tanah laterit, tanah liat, dan kapur masing-masing adalah 0,59, 0,61 dan 0,67. Pertumbuhan tanaman jabon putih terbaik dari ketiga jenis tanah tersebut adalah tanah kapur

Kata kunci: jenis tanah; kekuatan hidup; kualitas hidup; pertumbuhan

ABSTRACT: *Land of post-mining cement activities must be rehabilitated and revegetated in accordance with applicable regulations in Indonesia. White jabon (Anthocephaluscadamba) is one of alternative species which are planted in post-mining cement land, because this species is able to live on open and infertile soil. This study was conducted to determine the ability of life and growth of white jabon in post-cement mine land which has a variety of soil types, namely laterite, clay and limestone. The method used is conducting an inventory and measurement of white Jabon plants grown on various types of soil (laterite, clay and limestone). The study was conducted for three months with the duration of measurements every month for 300 plants with each type of soil consisting of 100 plants. The results showed the percentage of the survival of white jabon plants on laterite, clay, and limestone were 91%, 87% and 93%, respectively. The quality of healthy plants in laterite soil is 50%, unhealthy plants 37%, 4% languishing plants of 4% and dead plants of 9%, in clay soil the number of healthy plants is 46%, unhealthy plants of 32%, languishing plants of 9%and dead plants of 13%, while in limestone soil the number of healthy plants is 67%, unhealthy plants of 24%, languish plants of 2% and dead plants of 7%. The average growth rate in white Jabon plants occurs in laterite, clay and limestonesoilswere 1.51 cm, 1.61 cm, and 1.81 respectively. The growth in the number of jabon leaves in the laterite, clay, and limestone soils was 0.59, 0.61 and 0.67 respectively. The best white jabon plant growth from the three types of soil is the limestone soil.*

Keywords: soil type; life force; quality of life; growth

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INTRODUCTION

White Jabon (*A. cadamba*) plants include industrial trees from the Rubiaceae family which are fast growing and have many uses. White jabonis one of the potential species of Indonesia that is fast-growing and multipurpose, so it is widely used for raw materials for making plywood, construction, pilp, fiberboard and particle board (Seorianegara*et al*, 1993)Kartawinata (1994) This species also has a short life cycle, making it profitable in terms of production and classified as light-demanding species. In natural forestwhitejabon high reaches 45 m, free of branches 30 m in diameter 160 cm. This species trees has straight and cylindrical stems, are easily planted, and are easy to get seeds in large quantities (Martawidjaya*et al*., 2005) It grows in newly opened areas, so it is pioneer (Martawidjaya*et al*., 2005). It also grows in moist areas on the banks of rivers, swamps and sometimes submerged in water. Jabon spread from the coastal area to a height of 1000 m asl(Heyne, 1978).

One type of plant that is widely cultivated in community forests today is jabon (*A.cadamba*). Jabon stands are mostly cultivated on farmers' land because they are fast-growing with relatively the same quality as sengon. Some advantages of jabon included fast growth, adaptability to various growing places and relatively easy silvicultural treatment. It included light wood to be able to be used as a variety of products including, matches, pencils, toys, pulp and paper (Krinawati*et al*., 2011). It is now one of the leading wood industries and is superior to other wood. Cultivating jabonputih plants is more profitable at a price of USD 80/m^3(Mulyana*et al*., 2010).

White jabon is a plant that is capable of living in various types of soil and jabon is a damaged land-management plant, such as in post-mining cement land. Mining of cement raw materials is carried out with an open pit mining system so that it tends to damage land surface conditions including loss of vegetation, reversal or changes in soil structure, erosion, water pollution, changes in soil density, air pollution, and increased toxic or toxic substances on the ground (Fox, 1984)The types of soil needed in cement manufacturing include: laterite, clay and limestone. These three types of soil during the land rehabilitation period have changed physical and chemical properties due to the opening of the area. In these three types of soil planting white jabon as an alternative plant species and post-mining revegetation.

Laterite is a product of chemical weathering of rocks which lasts for a long time in wet or humid climatic conditions. It can be processed to produce nickel. Basically laterite rocks can be divided into two layers, namely the limonite and saprolite layers (Yildrim, *et al.,* 2012).

Clay is a product that is the result of weathering from hard rock, such as basalt, andesite, granite, etc., so that clay is very dependent on the original rock. Generally hard basalt/andesite rocks will give red clay, while granite will give white clay (Hartono, 1993)

The type of soil Limestone or limestone is rock solid that contains a lot of calcium carbonate (Lukman*et al*., 2012). Mineral carbonate commonly found associated with limestone is aragonite (CaCO3) which is a metastable mineral because at certain times it can turn into calcite (CaCO3) (Sucipto, 2007)

This research is based on research in ULM cooperation with the company PT. ITP. This research was conducted to analyze the survival and quality of growth of white Jabon plants on various soil media. Thus, it can be seen how much the ability of white Jabon plants to live on a variety of different soil media, such as types of soil limestone, clay and laterite.

The purpose of this study is to analyze the life force of white jabon plants in various soil media. (Limestone, clay and laterite), analyze the quality of life of white jabon plants in various soil media and analyze the growth of white jabon plants on various soil media. The expected benefits of this study are as reference material in the development of the type of white jabon in post-cement reclamation land in South Kalimantan in particular, and in Indonesia in general.

RESEARCH METHODS

Time and Place of Research

This research was conducted in the area of PT ITP Tbk Kotabaru Regency, South

Kalimantan Province. The time needed for this study is ± 3 months from January to March 2018 including preparation, data collection and report preparation activities.

Figure 1. Location of research

Research procedure

Planting activities begin with land preparation and cleaning of weeds, to facilitate the process of observation and maintenance. Then the process of making a planting hole with a size of 40x40x 40cm, as well as giving manure as much as 5kg for each hole as basic fertilizer and spacing of sizes of 3x3m.

The planting process is carried out when the land is ready and the white jabon plants that are still in a polybag must be removed first. Then the plants are planted in holes that have been prepared and labeled as well as stakes, to facilitate observation. Observations are carried out every day by measuring height and counting the number of leaves every 1 month for 3 months.

Maintenance activities carried out include watering and cleaning. Watering is done twice a day, that is, in the morning and evening while cleaning is carried out on the nuisance weeds around the plant.

Observation Parameters

Life Power (%)

At the end of the observation for the whole plant the life force is calculated using the formula:

Life force (%) = (Number of plants that live) / (Number of all plants) x 100%

Quality of life

Observation of plant life quality observed from its growth, namely healthy, unhealthy, languishing and dying. According to Minister of Forestry Regulation, (2009) plant growth is classified into 3 categories, namely healthy, unhealthy and languishing plants.

Healthy plants

Healthy plants are plants that grow fresh and the stems are relatively straight, thick with a minimum height according to standards and free of pests and diseases / weeds. Usually plants will grow healthy when carried out care and maintenance such as weeding, sowing, fertilizing and eradicating pests and diseases and weeds.

Healthy plants = (Number of healthy plants) / (Number of all plants) x 100

Unhealthy plants

Unhealthy plants are plants that grow abnormally or are attacked by pests, leaves are yellow or colorless and are bent stems.

Unhealthy plants = (Number of unhealthy plants) / (Number of all plants) x 100%

Plants languish

The languishing plants are plants that grow abnormally or are attacked by pests

and diseases so that if they are kept small they will probably grow well.
Plant languish = (Number of plants that languish) / (Number of plants) x 100%

Dead Plants

Dead plants are plants that cannot grow again and are characterized by stems, leaves and twigs that dry until they finally die.
Dead plants = (Number of dead plants) / (Number of all plants) x 100%

Growth

Observation of growth is only measuring the height and number of leaves, observations are made once every 1 month for a period of ± 3 months. The way to measure plant height is labeled on the part of the stem that is 5 cm high from the ground.

Data analysis

This study used a Completely Randomized Design (CRD), with 3 treatments repeated 100 times, to obtain 300 experimental units.
The treatment used consists of:
wj1 = white jabon planted on Limestone
wj2 = white jabon planted on Clay soil
wj3 = white Jabon planted on Laterite soil

The general form of RAL, as follows:
$Yij = \mu + ti + \varepsilon ij$

Information:
I = the second treatment (i = 1,2,3, ... r)
J = j-th test (j = 1,2,3, ... r)
Yij = observation on the first treatment on the j-th test
μ= general average
ti= the effect of the second treatment
εij= random effect of experimental error from the first treatment on the j-th test

RESULTS AND DISCUSSION

Results

Life force of plants

Based on the results of the study it can be seen that white jabon has a percentage of life force in various places such as laterite soil, clay soil and limestone soil. Percentage of plant life is a characteristic of success in assessing the ability of plants to adapt to the environment and can grow well. White jabonhas a different percentage of life force for each type of soil, at the end of the observation the number of plants that live compared to the number of all plants planted in each treatment. Percentage of life force of white jabon planted in each type of soil can be seen in Figure 2.

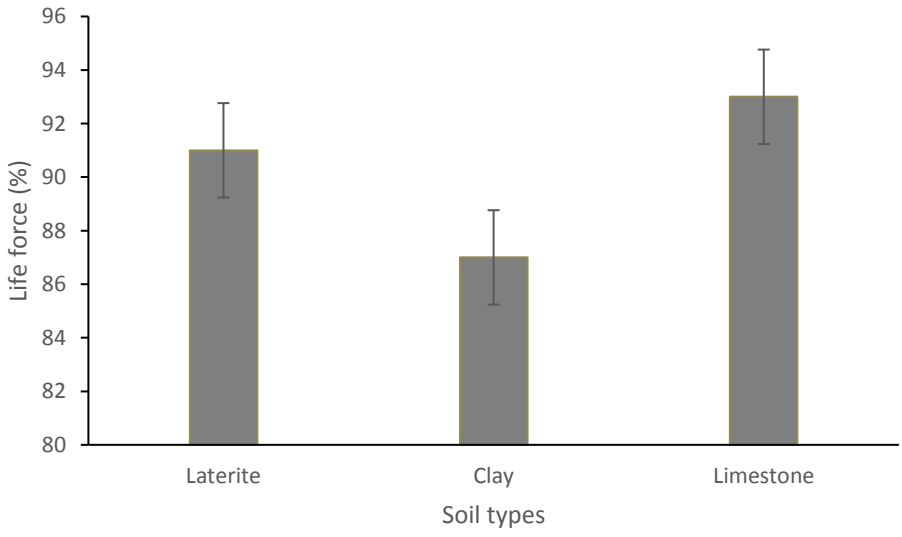

Figure 2. Percentage of life force of white jabon

Based on the results in figure 2, the highest percentage of the life force of the white Jabon plant is located on the limestone soil of 93%. Acidity in limestone soils or calcareous soils is close to neutral pH 8.06 and limestone soils contain alkaline calcium ($CaCO_3$) minerals, so that the soil becomes quite fertile. The survival rate of white jabon in laterite soils is also high at 91%, the acidity of laterite soil around pH 5.84. If compared with white jabon planted on limestone soil the condition is not too different. this shows that white jabon can grow well in both types of soil. While the lowest percentage of white jabon occurs in clay soil which is 87% with clay soil pH which is 3.23, meaning this type can live on soils with acidic conditions.

Quality of white jabon life

Based on the results of observations obtained the quality of life of white jabon on different soil media, such as laterite, clay, and limestone soil types. The quality of life in white jabon such as healthy plants, unhealthy, languishing and deadcan be seen in Figure 3-5.

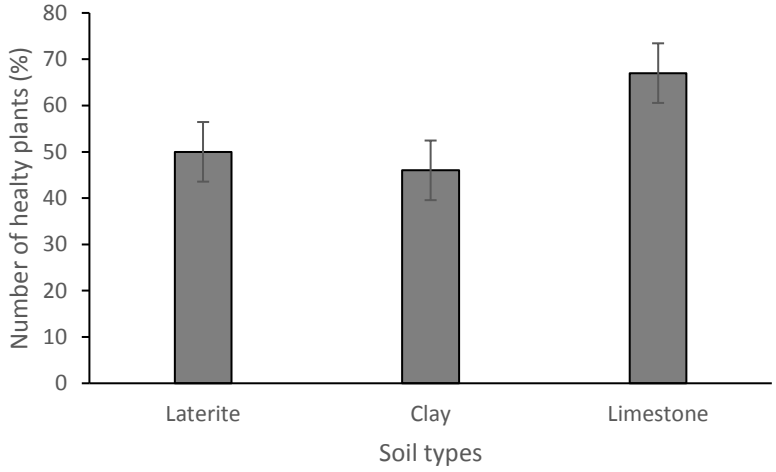

Figure 3. Average healthy plants on various types of soil

Figure 3 shows that the highest average number of healthy plants of white jabon occurs in limestone soil types, at 67%, while the lowest is found in clay soil at 46%. The number of healthy plants on laterite soil is 50%. This condition is caused by differences in the pH of the soil in each place to grow. A low pH of 3.23 in clay soil can inhibit plant growth and the ability of soil to bind nutrients to be small. Besides the dependence of white Jabon live on soils with high water content, generally white jaboncan not live optimally on land with low soil water content (Soetrisno, 1996)There are several provenances of white jabon which are able to grow well in marginal conditions such as dry or waterlogged land Martawidjaya*et al*., 2005),Seorianegara*et al*, 1993)

The difference in the percentage of healthy plants of white jabon is the ability of plants to adapt to each growing place, where the average value of the percentages varies in each treatment of land owned by the white jabon plant. In general, white jabon is able to adapt to marginal and fertile lands. The selection of potential provenances for specific sites is one of the strategies for adapting to climate change (Rehfledt, *et al*., 2006), (Millar, *et al*., 2007).

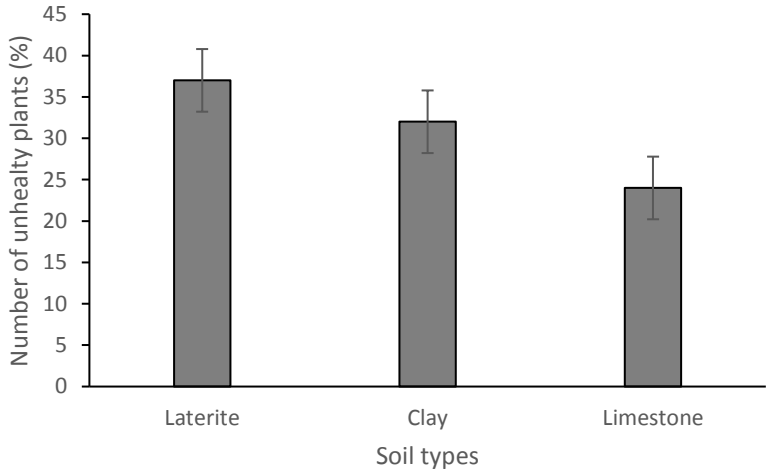

Figure 4. Average unhealthy plants in each type of soil

Figure 4 shows the highest average of unhealthy plants occurring in laterite soil treatment at 37%, because the soil type has a lack of nutrients and high acid content with a low pH of 5.84 which causes the plant to be unhealthy in stunted growth. Subsequent unhealthy plants in clay soils are 32% with a pH of 3.23, the condition of soil pH like this is very risky to inhibit plant growth and the lowest percentage of unhealthy plants on limestone soils is 24%. Because the soil pH is 8.06 which close to neutral so that the ability to bind nutrients to the soil is greater in plants.

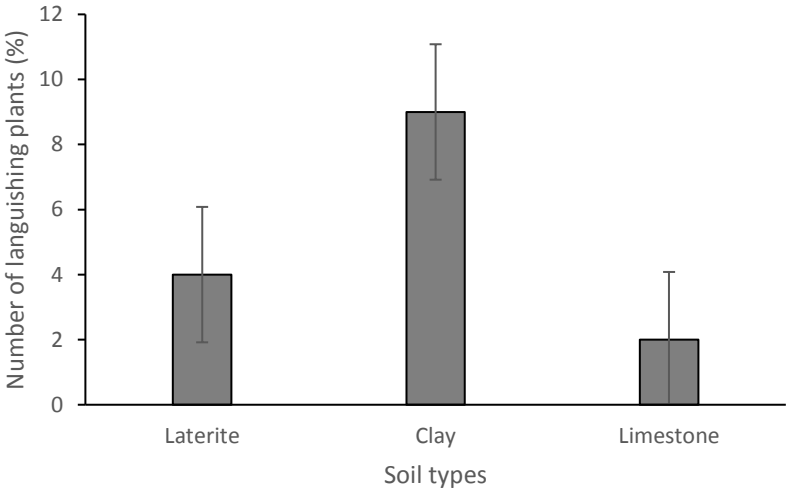

Figure 5. Average oflanguishingplants

Figure 5 shows the highest languishing plants in white jabon in clay soil types of 9%. Number of Plants languish on laterite soil is 4%. The lowest plant in the limestone soil type is 2%. The low rate of miserable plants on post-cement mining land is due to the ability of white jabon which is high on marginal lands such as dry land with low water content (Martawijaya,*et al*.,1989), (Seorianegara*et al*, 1993)

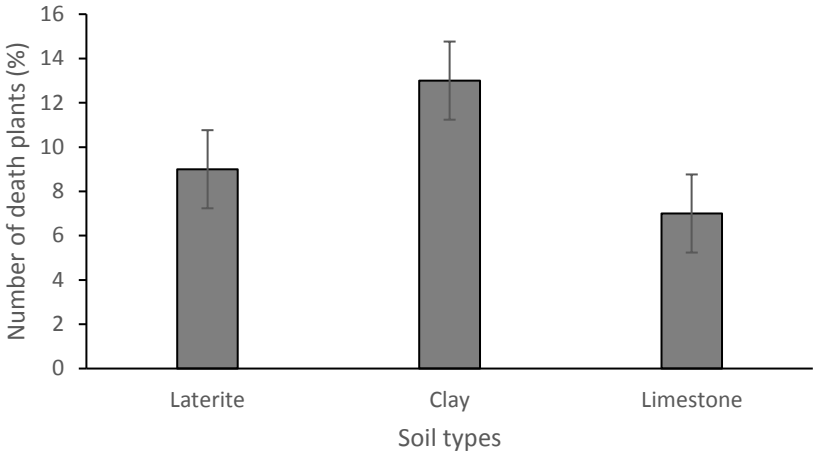

Figure 6. Average of dead plants

Figure 6shows the dead plants in white jabon which are the highest owned by clay soil which is 13%. The next dead plants occur on laterite soil by 9% and while the lowest dead plants are on limestone soils of 7%. Soils with a high degree of acidity or low pH tend to be higher in the number of dead plants than those with low or neutral acidity.

Growth in height and number of leaves

The average high growth of white Jabon in each type of soil has different growth data. This can be seen in Figure 7.

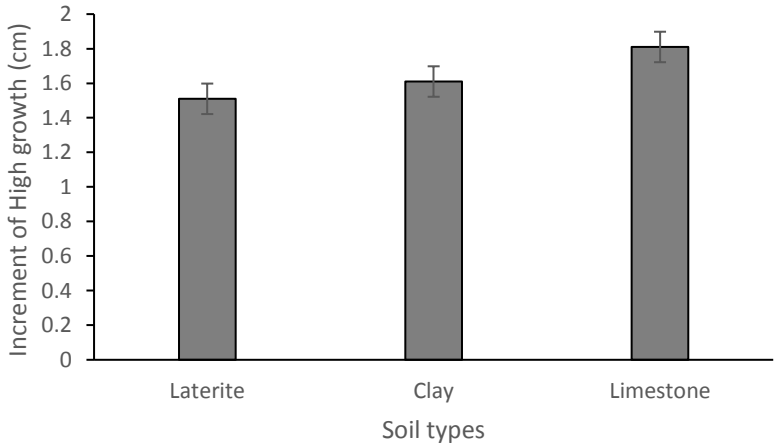

Figure 7. Increment of height of white jabon in each type of soil

Figure 7 shows the highest growth of white jabon plant occurs in the type of limestone soil of 1.81cm, in clay soil is 1.61cm and the lowest is in laterite soil of 1.51cm. Under normal conditions or not the former 5-year old whitejabon mine plant area has a high increment of 0.8-7.9m per year. Compared to the different areas of the former cement mine, it is very large. This condition is caused by a very low level of soil fertility in the post-mining area and is not well aerated.

Table 1. Analysis of high diversity of white jabon plants

Source of Diversity	Free Degree	Number of Square	Squares	F count		F table 5%	F table 1%
Treatment	2	4.26	2.13	9.44	**	3.03	4.69
Error	268	60.39	0.23				
Total	270	64.64					

Based on the results of the analysis of diversity shows that the value of $F_{count} > F_{table}$ at the level of 5% and 1% thus the results of the high variance show a very significant effect on the increase in height of white jabon. To find out the difference in influence on the high value of white jabon then a further test of the average value is carried out.

Table 2. Duncan's continued test on the increase in height of the white jabon plant

Treatment	Average	Different Values	
		Limestone	Clay
Limestone	1.81		
Clay	1.67	0.15^{tb}	
Laterit	1.51	0.30^{tb}	
D	5%	0.59	0.62
	1%	0.78	0.82

Information:
* = significantly different
** = very different
Tb = not significantly different

Based on Table 5, the results of the DMRT follow-up test showed that high patches of the average value of white jabon increase showed no significant difference between the 3 soil types, namely 1.81cm limestone type, 1.67cm clay soil type and laterite soil type 1.51cm.

Growth of the number of leaves

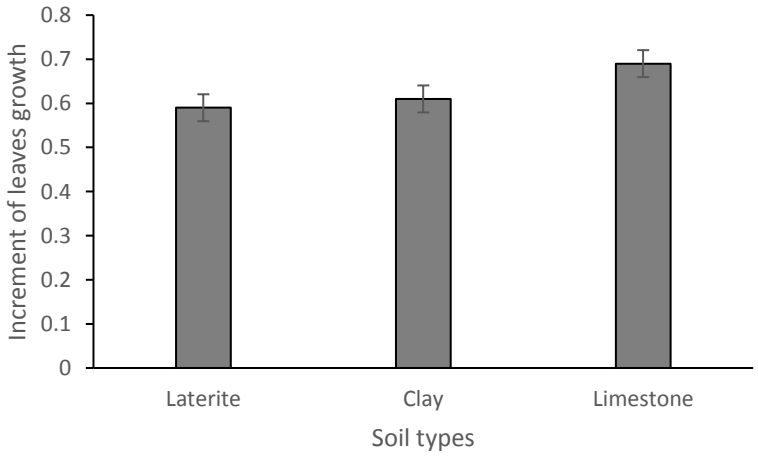

Figure 8. Growth of the number of white jabon leaves

Based on Figure 8 shows that the number of leaves has an average value in white Jabon plants with different treatments, the highest number of leaves occur in the limestone soil is 0.69cm. The next number of leaf growth is owned by clay soil which is 0.61cm and also the lowest increase in laterite soil which is 0.59cm.

Table 3.Analysis of the diversityofnumber of leaves

Source of Diversity	Degree of Freedoms	Number of Square	Squares	F count		F table	
						5%	1%
Treatment	2	0.48	0.24	11.66	**	3.03	4.69
Error	268	5.51	0.02				
Total	270	5.98					

Information:
** =: very significant

Table 3 shows that the value of $F_{count} > F_{table}$ in the analysis of the number of leaves that have a very significant effect on the number of white jabon leaves, both at the level of 5% and level 1%, this is evidenced from the calculated $F_{count}(11.66) > F_{table}$ value level 5% (3.03) and F 1% (4.69). Because the treatment has a very real effect, then based on the value, Duncan's different test needs to be done to find out which treatment has the best results can be seen in Table 4.

Table 4. Duncan's continued test on the number of leaves

Treatment	Middle Value	Different Value	
		Limestone	Clay
Limestone	0.69		
Clay	0.61	0.07^{tb}	
Laterit	0.59	0.10^{tb}	0.02^{tb}
D	5%	0.18	0.19
	1%	0.24	0.25

Information:
* = significantly different
** = very different
Tb = not significantly different

Based on the data in Table 4, the results of further tests show that from the three treatments the soil type states that it is not significantly difference, this is evidenced by the value of the three treatments. Because the limestone soil type increases the number of leaves with a middle value which is 0.69, then the number of leaves increases in clay soil type is 0.61 and laterite soil types are 0.59. This shows that the growth of white Jabon plants does not have a significant difference in the three types of soil.

Discussion

The success of forest cultivation is largely determined by the suitability of species planted with planting sites or growth sites, including appropriate silvicultural techniques (Mindawati, *et al*. ,2015). Jabon is a species of pioneer that can grow on various types of soil, including moist alluvial soil and generally in secondary forest degraded along river banks, transition areas between swampy areas, periodically or permanently waterlogged areas (Phillips, *et al*., 2002), (Sudrajat, 2015). From the results of this study also showed that white jaboncan grow well with life force above 80% on laterite soil, clay, and limestone in post-mining areas of cement which are nutrient-poor and acidity from the lowest pH 3.23 to the highest in limestone pH 8.06, with a life force of 87-93%. White Jabon can

grow at very low to low soil pH (Mindawati, *et al*., 2015)

White jabon is a species of plant that grows in early successive tree species (Shukla and Ramakrishnan., 1986)The light factor is an important factor for the growth of white jabon, so that this species is not able to grow optimally in shaded conditions. In its natural habitat the temperature for growth of white Jabon ranges from 32-42^{o}C with a minimum temperature of 3-15.5^{o}C. Annual average rainfall in its natural habitat ranges from 1,500-5,000mm. This type generally grows at an altitude of 300-800m above sea level. In the equator the white Jabon grows at an altitude of 1-1,000m asl. **(**Martawidjaya, *et al*.,2005)

White jabon can live on fertile soils to infertile soils such as lands on post-mining of cement land. White jabon can grow on soils with low to very high organic C content, low to high total N, low to high C/N, P available low to high, low to medium K, very low to very high Ca and very low to very high. These elements are macro elements that are very necessary for plant growth (Soepardi, 1983)

CONCLUSION

White jabon is able to adapt to marginal land post-mining cement area with the percentage of life force on laterite soils, clay and limestone is 91%, 87% and 93% respectively.

The quality of life of the white jabon planted in the post mining cement areas is also quite good with a percentage of healthy life on 50% laterite, 46% clay and 67% limestone. Soil pH is very significant influence on the quality of life of plants.

The best growth on the three types of soil is on the type of limestone soil with high growth per month at an average of 1.81cm and the addition of leaves of 0.69, while the other types of soil each clay 1.67cm with added leaves of 0.61 and laterite 1.51cm, with leaf number increase of 0.59. The best growth for white Jabon plants occurs in the type of limestone soil.

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