ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

Increasing the Potential of the Quality of Ex-Mining Land for Oil Palm Plants with Composting and Humic Acid Methods as Soil Remedies

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Abstract:- Coal mining has the potential to cause land damage because it can have an impact on the destruction of the ecosystem so that it can no longer carry out its functions optimally. For this reason, technology is needed to improve the condition of post-mining land, one of which is by adding soil improvers. In this study, the potential quality of damaged ex-mining land was improved by adding compost and humic acid as soil improvement with the hope that the soil would become good again so that it could increase land productivity for oil palm growth.

The objectives of this study are: 1) to evaluate the suitability of ex-mining land for oil palm plants, 2) to know the inhibiting or limiting factors of land and how to overcome them, and 3) to find out the best soil amendment treatment for the vegetative growth of oil palm plants.

The results of the study showed that: 1) the land of the former coal mine based on the results of the land evaluation was suitable or suitable for planting oil palm plants, 2) the factor that became an obstacle or limiting the potential of the land was soil fertility and how to overcome it by applying or adding compost and humic acid as soil amendments, and 3) the treatment of soil amendments both P0, P1 and P2 showed no significant difference in the results for the vegetative growth of oil palm plants both the increase height, number of leaves and stem diameter at the observation of months 1, 2, 3, 4 and during the 4 months of observation.

I. INTRODUCTION

Environmentally friendly development is an important need for every nation and country that wants the preservation of natural resources, for this reason natural resources need to be maintained and maintained for the survival of humans now and future generations (Hirfan, 2016).

Coal mining has the potential to cause land damage, mining activities can have an impact on the destruction of the ecosystem, so that it can no longer carry out its functions optimally, such as soil protection, water management, weather control, and other functions in regulating environmental protection. In 2015 for the East Kalimantan region there were no less than 1302 coal mining permits, so that the total coal production last year was 180 million tons and will continue to increase every year. For the Samarinda area, 72% of the area with a total of 718 square km or 718,000 hectares is coal mining permit land and of the 72%, 40% has been and is being mined (Kurniawan and Pranomo, 2016).

According to Antara News on October 17, 2023, the Ministry of Environment (MoEF) reminded mining companies to take responsibility for gaping excavated holes by reclaiming them so that damaged land does not have a bad impact on the environment and health. This mining activity also contributes to narrowing the land for food production due to mining business permits, so that agricultural land becomes narrow. The impact of the mining permit in 2012 in East Kalimantan had an area of 68,120 hectares of agricultural land, the area of land decreased by around 4,000 hectares in 2022 to 64,030 hectares (Anonymous, 2023).

Mining activities have an impact on the damage to the ecosystem that occurs so that it has an impact, including poor physical, chemical and biological conditions of the soil, such as unprofiled soil layers, compaction, lack of important nutrients, low pH, pollution by heavy metals on former mining land, and a decrease in soil microbial populations. Environmental conservation efforts need to be made so that further damage does not occur.

Over time, land damage due to mining activities is getting wider, so that forests with potential for agricultural cultivation are decreasing. This is closely related to sustainable development, namely ex-mining areas must be able to maintain economic, social and environmental sustainability for the community. However, until now there have been no real economic benefits felt by the community from the reclamation. This shows that the spread of post-mining land has not been widely used for agriculture, for this reason the use of post-mining land for plant cultivation needs to be supported (Lawing, 2021).

One of the plants that has the potential to be developed on ex-mining land with damaged physical and chemical properties and climatic conditions in East Kalimantan is oil palm plants, where this plant is a mainstay commodity of East Kalimantan because it is tolerant of poor environmental conditions, but to achieve an optimal growth rate requires a certain range of environmental conditions. Climate conditions are one of the main environmental factors that

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

affect the success of oil palm development (Madani, et al., 2021).

Nurbaity, et al. (2017) argue that the use of ex-mining land for agriculture is expected to provide wider employment opportunities and increase community income. The rapid development of oil palm plants in the community has resulted in the area of land with a high level of fertility becoming increasingly limited. This forces smallholders to take advantage of marginal lands that have several limiting factors for oil palm cultivation (Mandala, et al., 2021). Based on the description above, it is necessary to carry out activities to improve the potential quality of ex-mining land with the addition of compost and humic acid as soil improvement so that it is hoped that the quality of the land will be good and can be used for plant growth.

A. Problems

- Overcoming the declining availability of land by improving the quality of critical land (ex. mines) so that it can function again as agricultural land.
- Improve the potential quality of damaged and nutrient-poor ex-mining land by adding compost and humic acid as soil amendments.
- Can oil palm plants grow well in unstable environmental conditions so that they can help in the restoration of the ecosystem in the area.

B. Special Purpose

- Evaluating the suitability of ex-mining land for oil palm plants
- Knowing the inhibiting factors or land boundaries and how to overcome them
- Determine the best soil amendment treatment for vegetative growth of oil palm plants.

C. Urgency of Research

Providing understanding to the community about the potential of oil palm plants as plantation crops that are expected to grow on ex-mining land with the addition of soil amendments to improve soil quality in degraded environments. In addition, it is hoped that oil palm plants can grow in unstable environmental conditions so that they can help in the restoration of the ecosystem in the area.

D. Special Specifications

Providing insight on how to improve the quality of soil in ex-mining land so that it can support the growth and development of plants, assisting in the reclamation process by using oil palm plants as a research trial so that it is hoped that ex-mining land can be used as oil palm plantation land

II. RESEARCH METHODOLOGY

A. Time and Place

This research lasted for 4 months, from July to October 2024, including land surveys, soil sampling, making research demonstration plots, soil amendment treatments, plant applications and data collection. The research site was carried out on land near the Samarinda Politani Campus (research demonstration plot).

B. Tools and Materials

Tools used in the study: crowbar/pincer, knife, scale, machete, hoe, shovel, padlock, hose, water reservoir, *sprayer*, microcaliper, meter, office stationery, bucket, arco, black plastic bag, raffia rope and camera. The materials used are 80 seeds of the Tenera Lonsum variety of palm oil, compost, and water.

C. Research Procedure

➢ *Research Stage 1*

- *Land survey to the location of the former mining land*

The land survey activity to the location of the former mine aims to find out the location where the research takes place and observe the natural conditions and the environment so as to facilitate research implementation activities.

- *Survey of former mining land to determine the characteristics of the land*

The research was carried out using an analytical descriptive method on former coal mine land by observing land characteristics and taking samples of intact soil randomly and representing land conditions.

- Soil sampling was carried out by taking soil at a depth of 0 – 30 cm using a sampling ring with 20 sampling points to measure the weight of soil content. Next, soil samples are taken again using a hoe with the same depth of 0 – 30 cm. The soil taken is then put into a bucket to be composted. The number of samples for soil chemistry to be analyzed in the laboratory is 4 soil samples.
- Sampling was carried out on 4 observation objects with each point representing 5 random sub-sample points using the Stratified Random Sampling method.
- The parameters studied were the physical and chemical properties of the soil, namely soil reaction (pH), Total Nitrogen (N), Available Phosphorus, Potassium, organic matter, volume weight, texture, structure, total porosity, and soil moisture content under field conditions.

➢ *Research Phase Ii*

- Evaluation of the suitability of ex-mining land for oil palm plants
- Physical and chemical observations of the land are carried out to determine the characteristics and quality of the land, then an evaluation is carried out for oil palm cultivation.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

- The variable interval of the quality of the land of the former coal mine is then compared to the needs of oil palm plants. Based on this comparison, it is assessed whether the quality of the land of the former coal mine is appropriate or not suitable for oil palm commodity crops.

➢ *Research Phase Iii*

- *Inhibiting factors and improving land quality*

The results of the land evaluation will then find inhibiting factors and improvements must be made. One of the inhibiting factors is the composting and humic acid methods as soil amendments to improve land quality.

- *The treatment of improving inhibiting factors by using soil improvement treatment consists of 3 treatments, namely: P0 (control), P1 (compost) and P2 (humic acid). The data from the research results were then processed using SPSS.*

➢ *Research Phase IV*

- *Making A Research Demonstration Plot*

The research demonstration plot was used as a research site for observation of oil palm plant growth with the following treatments: (P0) control, (P1) compost, and (P2) humic acid. The demonstration plot was prepared in advance to facilitate the provision of treatment.

- *Preparation of Treatment*

Prepare the dosage for compost according to the treatment, namely: P0 = control, P1 = 50% compost: 50% of the former coal mine soil, and P2 = humic acid as much as 50%: 50% of the former coal mine soil) and then applied to oil palm plants.

- *Preparation of Planting Media*

The study used soil that was first treated and left for 1 week so that the treatment was mixed with the soil.

- *Observation*

The parameters observed in this research are vegetative growth of oil palm plants such as: increase in plant height, number of leaves, and stem diameter which is carried out once every 1 month with an observation period of 4 months.

- *Data Analysis*

The data obtained was analyzed using a Complete Random Design with correlation using the SPSS program with Test F and Advanced Test at the level of 5%. This study consisted of 3 treatments and 25 replicates.

III. RESULTS AND DISCUSSION

A. Evaluation of Land Suitability for Oil Palm Plants.

Oil palm plants for good growth require growing conditions or the condition of the land/area as in Table 1 below.

Table 1. Conditions for Growing Oil Palm Plants.

It	Growing Conditions	What To Want
1.	Climate:	
	Air temperature	22-33ºC (27ºC optimal)
	Rainfall	1,250 – 3,000 mm/yr (optimum 1,750 – 2,500 mm/yr)
	Dry moon	(Rainfall < 100 mm/month) < 3 months (optimum 0-1 month)
	Air humidity	50 – 90 % (optimum 80 %)
	Duration of sun exposure	5 – 7 hours/day
	Place height	< 400 m above sea level (optimum < 200 m above sea level)
2.	Topography	Flat – choppy slope 0 – 8 % (suitable) Undulating – hilly slope 8 – 30 % (need a terrace to prevent erosion).
3.	Soil	Oil palm grows on both Podsolic (*Ultisol*), Latosol (*Oxisol*), Resosol (*Entisol*), Aluvial and Hydromorphic (*Inceptisol*), Andosol (*Andisol*) and peat (*Histosol*) soils
4.	Drainage	Good drainage is needed to support the growth and high productivity of oil palm.
5.	Soil texture	The ideal soil texture is sandy clay loam containing a sand fraction of ± 45% and a clay fraction of 20 – 35%.
6.	Soil pH	The optimum soil pH conditions for oil palm plants ranged from 5.0 to 6.0.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

Table 2. Quality of Research Land

It	Growing Conditions	What to want
1.	Climate:	
	Air temperature	26.7-27.8°C, with a minimum air temperature of 25.0°C and a maximum air temperature of 28.2°C
	Rainfall	Lowest (50-100mm) to high (300-400 mm) 11-20 rainy days/month
	Dry moon	(Rainfall < 100 mm/month) < 3 months (optimum 0-1 month)
	Air humidity	87%.
	Duration of sun exposure	± 6.8hrs/day
	Place height	10-200 m above sea level (generally 100-1,000 meters above sea level)
2.	Topography	<30%
3.	Soil	Podsolic red yellow (*Ultisol*)
4.	Drainage	Somewhat hampered
5.	Soil texture	Sandy loam
6.	Soil pH	5,26

Source : Research data

Table 3. Class Suitability of Former Mining Land for Oil Palm Plants

It	Land Characteristics	Symbol	Intensity of Limiting Factors			
			Without (S1)	Light (S2)	Keep (S3)	Heavy (N1)
1.	Rainfall (mm)	H	1.750-3.000	1.500-<1.750 > 3,000	1.250-<1.500	<1.250
	Temperature	T	22-33	<22->33	18-20 >35	<18 > 40
2.	Dry Moon (mo)	K	<1	1-2	>2-3	>3
3.	Altitude above sea level (masl)	I	0-200	>200-300	>300-400	>400
4.	Shape of area/slope slope (%)	W	Flat-choppy < 8	Wavy 8-15	Undulating hills >15-30	Mountainous >30
5.	Rocks on the surface and in the soil (% by volume)	B	< 3	3-15	> 15-40	>40
6.	Effective depth (cm)	S	>100	75-100	50-<75	<50
7.	Soil texture	T	Dusty clay; sandy clay clay; dusty clay clay; clay clay	Clay; sandy clay; sandy loam; Sand	Loamy sand; dust	Heavy weight; sand
8.	Drainage class	D	Good; keep	Somewhat hampered; rather fast	Fast; Hampered	Very fast; highly flooded; Hampered
9.	Soil salinity (pH)	A	5,0-6,0	4.0-<5.0 >6.0-6.5	3.5-<4.0 >6.5-7.0	<3.5 >7.0

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

Table 4. Analysis of Chemical and Physical Content of Former Coal Mine Soil

It	Observed Elements	Unit	Value	Standard Provisions SNI 2803:2012	Information	Corrective Actions
1.	N Total	%	0,0700	Min 6 %	Very low	Need fertilization action
2.	P Total	%	0,0106	Min 6%	Very low	Need fertilization action
3.	K Total	%	0,0154	Min 6%	Very low	Need fertilization action
4.	pH H2O	-	5,26	6,5-7,8	Sour	Need for calcification action
5.	C-Organic	%	0,1844	3,05-5,00	Very low	Need to take action to add organic fertilizer
6.	C/N Ratio	-	2,634	16-25	Very low	Organic fertilizer fertilization action is needed
7.	Porosity	%	50,08		Not good	Need to add organic matter
8.	Structure	-	Prismatic pole		Not good	Need to add organic matter
9.	Texture		Sandy loam		Not good	Need to add organic matter

The characteristics of former coal mine land as a planting medium observed through the results of field observation, secondary data collection and laboratory tests which can be seen in Tables 1 and 2 are as follows:

- *Temperature (t)*

The average annual temperature suitable for oil palm plants is 22-330C and not suitable at >35-<180C. The average temperature data at the research site was 26.7-27.80C. So that the temperature at the research location is suitable for the growth of oil palm plants because at these temperature conditions Sswit coconut plants can grow and develop well. According to Rifki, et al. (2023) that oil palm plants can grow well at an air temperature of 27ºC with a maximum temperature of 33ºC and a minimum temperature of 22ºC throughout the year. In addition, it is also supported by the climatic conditions of the East Kalimantan region which is below the equator so that it has a tropical climate so that the dry season and rainy season are not decisive so that the sun is long and rainfall is high.

- *Rooting Media (r)*

The rooting medium is affected by the texture, structure and drainage of the soil. Oil palm plants can grow and develop well in areas with moderate drainage classes, good and not suitable in areas with very fast drainage classes. Soil drainage is a soil condition that can indicate the speed of water loss from the soil, either through soil runoff/soil percolation, or a soil condition that can indicate the duration and frequency of water saturation (Saputra, et al., 2024).

The results of observations on the research sample have a drainage class of S2, which is a somewhat hampered class. So that to be suitable, it must be done to improve the drainage inhibiting factors by adding organic matter to improve the physical condition of the former coal mine soil so that the soil can be used for plant growth.

According to Bolly and Apelabi (2022), organic matter if given or applied to the soil will make more air cavities and soil structures more stable so that soil particles do not easily escape when exposed to water splashes. In addition, the properties of organic matter are looseness, high soil moisture, and stable soil temperature so that it is able to increase the activity of microorganisms in the soil. This condition can cause the soil structure to become loose and crumbly and easy to process.

- *Soil texture*

Oil palm plants can grow and develop well on soils with sandy clay textures, clay clays, dusty clays, and dusty clay soils and are not suitable for soils with gravel and sand textures. Soil texture is a relative comparison of clay, dust and sand fractions, soil texture will affect the development of plant roots. Based on the results of the soil laboratory, it shows that the texture of sandy clay soil belongs to the S2 class with light barriers. The improvement efforts carried out are the addition of organic matter to improve the texture of the soil.

- *Effective Depth*

Oil palm plants can grow and develop well in areas with a depth of ≥100 cm and are not suitable in areas with a depth of < 50 cm. Effective depth will affect root growth and development, drainage and physical characteristics of the soil. The effective depth based on the data from field observations in the research sample showed that the effective depth was >100 cm, which was class S1 without any factors inhibiting the effective depth, so that the land was suitable for oil palm growth.

- *Available Calories (n)*

The content of N, P and K based on soil laboratory data shows very low values, namely class N1, which is not suitable for now, but if the inhibiting factors are improved, it will increase to a suitable level. Efforts to improve the

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

inhibitory factors N, P and K can be done by applying N, P and K fertilizers.

The nutrient resistance parameters in this study are seen from the content of elements N, P and K. The results of laboratory analysis show that the soil of the former coal mine has a very low nutrient content for N, P and K. So it is necessary to make improvements by adding soil amendments in the form of compost or humic acid to improve the physical, cyclic and biological properties of the soil.

Oil palm plants can grow and develop well in areas with good soil fertility, so it is necessary to improve nutrient conditions by adding fertilizer to increase soil fertility. Efforts to improve the factors that inhibit nutrient retention can be carried out by liming or adding organic matter.

➢ *Soil Hydrogen Potential (pH)*

Oil palm plants can grow and develop well in areas with soil pH of 5.0-6.5 and not suitable for soils with pH >8.5-.4.2. The pH value needs to be known because each plant has certain pH criteria in order to grow properly. The soil pH based on the measurement results on the soil sample has a soil pH of 5.26, which is somewhat acidic and is included in the S1 class. Efforts to improve the mild inhibiting factor, namely the pH of the soil is slightly acidic, so it can be done by liming or applying organic matter.

➢ *Erosion Hazard Level (e)*

The level of erosion danger can be estimated depending on the conditions in the field, more specifically by focusing on the presence of wide erosion on the surface, trench erosion, and trench erosion (Saputra, et al., 2024). To find out the level of erosion hazard, it can also be done by looking at the eroded or lost soil surface against the uneroded soil depicted by the presence of horizon A. Slope is the most influential topographic feature of erosion, where erosion causes the loss of fertile soil for plant growth (Arsyad, 2010).

According to Muhaimin, et al. (2022) the erosion hazard level has 4 classes of erosion hazard levels, namely very light with a slope slope of <8% is very suitable (S1), light with a slope slope of 8-15% is quite suitable (S2), while the slope slope is 15-25% according to the marginal (S3) and the slope weight of 25-45% is not suitable for now. In field observations, the slope of the slope is included in the S3 class, so it is necessary to improve the inhibiting factors by making terasirings.

B. Land Suitability Class for Oil Palm Plants and Inhibiting Factors

The land of the former coal mine after soil observation and analysis and obtained land quality is then matched with the condition of growing for oil palm plants so that the land suitability class for oil palm plants presented in Tables 3 and 4 is obtained. There are classes of actual land suitability for oil palm plants, namely S3 and S2 classes.

The potential conformity class is the condition that is expected after being given in accordance with the established management level. The level of management in the land suitability evaluation research for oil palm plants focuses on low to medium management levels, because at this level of management efforts can be carried out with relatively affordable cost capital. Efforts to improve the actual land quality have become potential land for oil palm plants with low to medium management levels so that it has resulted in a one-level increase.

The level of management or improvement of inhibiting factors on land quality is carried out by adding soil amendments, namely in the form of organic matter, which can be in the form of compost or organic matter so that it can improve soil fertility and soil physicality, namely texture, structure, soil roots, porosity and soil drainage. So that the quality of the soil becomes improved and in accordance with the conditions for growing oil palm plants.

According to Bolly and Apelabi (2022), the humus properties of this material are looseness, high soil moisture, and stable soil temperature so that it is able to increase the activity of microorganisms in the soil, these conditions can cause the soil structure to become loose and crumbly and easy to process. In addition to the soil structure becoming good, the temperature in the soil also becomes more stable even though the soil surface feels hot due to sunlight, the soil layer in it remains unaffected. The level of soil moisture is also well maintained because organic matter is able to absorb water 2 to 4 times its weight so that the water supply in the soil is sufficient.

In terms of actual land suitability, there are two classes of land suitability, namely classes S2, S3 and N1. Improvement efforts with low to medium management levels resulted in a higher level of class one, the results of the potential land suitability class showed an increase in class one level from class N1 to class S3 (for nutrient retention) and class S3 to class S2 (topography with terraser making) and class S2 to class S1 (texture, structure and porosity with the addition of soil improvement) after improvements were made to inhibiting factors.

C. Application of Compost and Humic Acid Treatment as Soil Amendment

➢ *High Growth of Oil Palm Plants*

Table 5. Increase in Height of Oil Palm Plants After Transplanting (cm)

Treatment	Plant Height Increase (Months)				
	1	2	3	4	For 4 Months
P0 (control)	4.26tn	3.72 tn	3.19 tn	4.04 tn	15.21 tn
P1 (compost)	4.79 tn	3.59 tn	6.52 tn	9.04 tn	23.94 tn
P2 (humic acid)	2.60 tn	4.44 tn	5.85 tn	6.68 tn	19.57 tn

Information:

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

tn = Not siqnifikan or not real difference

Table 6. Tests of Between-Subjects Effects

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	38.877a	2	19.439	.679	.526
Intercept	745.679	1	745.679	26.044	.000
Treatment	38.877	2	19.439	.679	.526
Error	343.577	12	28.631		
Total	1128.133	15			
Corrected Total	382.454	14			

R Squared = .102 (Adjusted R Squared = -.048), F calculated treatment : 0.679 and F table : 3.89

Based on the results of statistical tests, it can be seen that the increase in the height of oil palm seedlings (tables 5 and 6) at the age of 1, 2, 3, 4 and for 4 months after transplanting showed no real effect or no significant difference in the treatments of P0 (control), P1 (compost + soil) and P2 (humic acid + soil). Although there is no obvious difference, but when viewed from the average increase in plant height, the highest is P2 treatment (compost + soil), then P3 ((humic acid + soil), and finally P0 (control).

There is no real difference between these treatments because in this oil palm plant the vegetative growth is rather slow because it is planted in the soil of a former coal mine which has damaged physical properties and low nutrient content, so that the application of soil improvement treatment, namely compost and humic acid, is rather slowly absorbed by the roots of the plant so that it affects the high growth process of the plant. This is because organic matter (compost and humic acid) has a complete nutrient content but the amount is small and the absorption process by plant roots is slower because it undergoes a further decomposition process in the soil so it takes longer to see the growth results. But these organic matter (compost and humic acid) if applied to the soil can improve the physical, chemical and biological properties of the soil. When viewed from the physical soil of the planting medium used, there are changes, namely the planting medium that is treated with P1 and P2, the physical condition is that the soil texture is looser and the soil pores are better. As for the physical oil palm plant, the color of the leaves of the plant is greener.

According to Liah, et al. (2024) that organic matter or compost fertilizer applied to the soil undergoes a decomposition process first, the nutrients absorbed by the roots are relatively few, so the existing nutrients are not enough to increase the height growth of plants.

In accordance with the opinion of Musnawar (2003) that compost, also the same as manure and green manure, is slow release, meaning that the nutrients in the fertilizer are released gradually and continuously for a certain period of time, so that the nutrients are not fully available to plants.

- *Increase in the Number of Leaves of Oil Palm Plants (Leaves)*

Table 7. Increase in the Number of Palm Leaves after Transplanting (Leaves)

Treatment	Increase in Plant Leaf Count (Month)				
	1	2	3	4	For 4 Months
P0 (control)	1.05 tn	0.45 tn	1.00 tn	1.45 tn	3.95 tn
P1 (compost)	1.75 tn	0.90 tn	2.05 tn	0.90 tn	5.60 tn
P2 (humic acid)	1.90 tn	0.75 tn	0.90 tn	1.60 tn	5.15 tn

Information:
tn = Not siqnifikan or not real difference

Table 8. Tests of Between-Subjects Effects

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	.271a	2	.135	.088	.917
Intercept	45.414	1	45.414	29.378	.000
Treatment	.271	2	.136	.088	.917
Error	18.550	12	1.546		
Total	64.235	15			
Corrected Total	18.821	14			

R Squared = .014(Adjusted R Squared = -.150), F calculated treatment : 0.088 and F table : 3.89

Based on the results of the statistical test, it can be seen that the increase in the number of leaves of oil palm seedlings (tables 7 and 8) at the age of 1, 2, 3, 4 and for 4 months after transplanting showed no real effect or no significant difference in the treatments of P0 (control), P1 (compost + soil) and P2 (humic acid + soil). Although there is no obvious difference, but when viewed from the average increase in

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

plant height, the highest is P2 treatment (compost + soil), then P3 ((humic acid + soil), and finally P0 (control).

The planting media of former coal mine land is given treatment that does not differ significantly between these treatments due to the poor condition of the former mining soil for damaged physical elements and properties, so it needs treatment to restore these conditions. Meanwhile, the soil amendment treatment (compost and humic acid) applied showed no significant difference from the P0, P1 and P2 treatments. It is suspected that the soil amendment treatment applied has not been completely decomposed and is still undergoing a further decomposition process and cannot be absorbed by the roots optimally and the N nutrients contained in the compost are relatively small/small so that they are not able to meet the needs of plant vegetative growth, especially the number of leaves, plant height and stem diameter so that it has an unreal effect.

As stated by Dwidjoseputro (1998), plants will thrive and give good results if the nutrients they need are available in sufficient and balanced amounts. In addition, it is also due to the relatively small nutrient content in soil improvers, resulting in a relatively small supply of nutrients, so that the growth and development of oil palm plants is not optimal (Liah, et al., 2024). In line with Karim's opinion, et al. (2019) stated that organic fertilizers are not only able to improve the physical, chemical and biological properties of the soil but also add macro and micro nutrients in the soil but in small amounts.

➢ *Increase in Stem Diameter of Oil Palm Plants*

Table 9. Increase in Stem Diameter After Transplanting (mm)

Treatment	Increase in Plant Stem Diameter (Months)				
	1	2	3	4	For 4 Months
P0 (control)	5.42 tn	2.06 tn	2.05 tn	1.78 tn	11.29 tn
P1 (compost)	5.61 tn	2.35 tn	2.53 tn	4.16 tn	14.6 tn
P2 (humic acid)	6.06 tn	3.70 tn	2.25 tn	2.42 tn	14.43 tn

Information:
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Table 10. Tests of Between-Subjects Effects (Variable Diameter of Stem)

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	4.823a	2	2.411	.114	.893
Intercept	422.942	1	422.942	19.963	.001
Treatment	4.823	2	2.411	.114	.893
Error	254.240	12	21.187		
Total	682.004	15			
Corrected Total	259.063	14			

R Squared = .019(Adjusted R Squared = -.145), F calculated treatment : 0.114and F table : 3.89

Based on the results of statistical tests, it can be seen that the increase in the height of oil palm seedlings (tables 9 and 10) at the age of 1, 2, 3, 4 and for 4 months after transplanting showed no real effect or no significant difference in the treatments of P0 (control), P1 (compost + soil) and P2 (humic acid + soil). Although there is no obvious difference, but when viewed from the average diameter of the plant stem, the highest is P2 treatment (compost + soil), then P3 (humic acid + soil), and finally P0 (control).

There is no obvious difference between these treatments because in oil palm plants for vegetative growth is rather slow because the treatment of refiners (compost and humic acid) has a complete nutrient content but the amount is small and the absorption process by plant roots is slower because it undergoes a further decomposition process, so it is not able to spur the growth of the diameter of the stem of oil palm plants. There is no real difference between these treatments , it is suspected that the dose of soil amendment (compost and humic acid) has not been able to provide nutrients optimally for plant growth. This is in accordance with the statement of Hawayanti et al. (2020) which stated that if nutrients are less than optimal needs, plant growth is also not optimal. In accordance with the opinion of Jurhana et al. (2017) who stated that if the nutrient needs are met, plant growth will increase.

The low increase in the stem diameter of oil palm plants is suspected to be due to the nitrogen content contained in compost and humic acid that is not yet available to plants so that vegetative growth is not optimal. Herlinawati et al. (2022) stated that the availability of nutrient N is able to accelerate plant vegetative growth.

In addition, for stem growth, a high K element is needed so that the palm stem grows firmly and affects the increase in stem diameter. The compost results from the study have a low content of K nutrients so that they are not able to spur the growth of stem diameter. This is in accordance with the statement of Hawayanti et al. (2020) which stated that if nutrients are less than optimal needs, plant growth is also not optimal.

According to Roli (2013) compost fertilizer contains complete nutrients both macro and micro nutrients but the portion is small such as nutrients N, P, K and others so that it

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24NOV1090

is not enough to help the growth of oil palm plants such as forming sturdy and large stems, potassium nutrients can also increase carbohydrate synthesis and translocation. Furthermore, Utomo et al. (2015), said that the application of fertilizers containing potassium is able to increase plant growth, especially through increasing the size of the stem diameter and plant height.

Fig 1. Oil Palm Plants after Treatment

IV. CONCLUSION

- The land of the former coal mine is based on the results of the land evaluation according to or suitable for planting oil palm plants.
- Factors that are inhibiting or limiting land potential are soil fertility and how to improve it by applying or adding compost and humic acid as soil amendments.
- Soil improvement treatments for both P0, P1 and P2 showed no significant difference in the vegetative growth of oil palm plants, both in height, number of leaves and stem diameter in the observation months 1, 2, 3, 4 and during 4 months of observation.

SUGGESTION

Further research is needed related to planting oil palm plants directly on ex-mining land to determine the growth and yield after being on the land.

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