Nickel Post-Mining Land Reclamation Through Provision Of The Organic Matter And Selection Of Local Crops

by Imam Taukhid

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abstract

The handling of topsoil soil at the beginning of mining is often neglected, so soil conditions in reclamation activities decrease soil fertility and cause the growth of reclaimed plants to be hampered. This study aims to increase soil fertility through the addition of organic matter and the growth of reclaimed plants. This study used experimental methods in the field. The provision of organic matter derived from modified komba-komba plants and given 7 kg per planting hole and reclamation plants tested as many as 12 local plants, namely Johar (*Senna siamea*), Cemara Angin (*Gymnostoma rumphianum*), Mango–Mango (*Mangifera sp*), Kusambi (*Schleichera oleosa*), Tumbeua (*Kjellbergiodendron celebicum*), Kamoni-Moni (*Syzygium acuminatissimum*), Angsana (*Pterocarpus indicus*), Waru (*Hibiscus tiliaceus*), Damar (*Agathis dammara*), Red Bintangor (*Calophyllum inophyllum*), Wola (*Vitex cofassus*), and Cholama Wood (*Parinary corimbosa*). Soil observations were carried out at the beginning and end of the study, and plant growth was observed every six months for 3.5 years (2019-2022), including the plant canopy's height, diameter, and width. The results showed that the initial soil conditions had very low fertility. Plant growth variables showed varying responses to the application of organic matter from the time of observation. The speed and acceleration of growth of reclaimed plants also vary. However, if it is connected with the growth of reclaimed plants with pH, C-organic, and soil moisture, adaptive and fast-growing reclamation plants are Kusambi (Schleichera oleosa), Angsana (Pterocarpus indicus), and Wola (Vitex cofassus) plants.

Keywords: organic matter, plant growth, reclaimed plants, post-mining nickel, pH, soil moisture

INTRODUCTION

Nickel ore extraction activities begin with removing ground-level cover vegetation, peeling the top soil layer, and stockpiling it will degrade the horizon and soil structure, eliminating biodiversity above and below the soil surface and the biological process of nutrient recycling, which in turn decreases land productivity, atmospheric and aquatic quality (Sugden, Stone, and Ash 2004). Mining companies are required to revegetate post-mining land to prevent erosion, convert heavy metals into insoluble forms into plant biomass, and restore the function of soil ecosystems. The problem is that the availability of topsoil as a suitable planting medium for plant growth around the mining area is minimal. Landfilling in nickel ore mining areas (including in Southeast Sulawesi) has a laterite behaviour characterized by a low number of paramagnetic particles, low hydraulic conductivity, high plasticity, low organic matter content and fertility, and low abundance and activity of soil organisms (Minasny and Hartemink 2011; Safiuddin et al. l 2011). Akibatnya, karakteristik fisik, kimia dan biologi tanah kurang sesuai dengan kebutuhan pertumbuha n optimal tanaman (Sobati-Nasab, Alirezalu, and Noruzi 2021).

Other impacts of this mining activity are changes in landforms, changes in the physical and chemical conditions of the soil, loss of natural vegetation in the environment, and fertile *topsoil* layers of organic matter and nutrients (Setyowati, Amala, and Aini 2018). Other impacts of soil physical properties include changes in soil structure, decreased environmental aesthetics, soil compaction, decreased permeability and soil infiltration, and a high degree of erosion hazard(Ikbal, Iskandar, and Budi 2016). The chemical properties of the soil occur changes in the elements in the soil, the high content of ni soil minerals, and their accompanying minerals (Dan et al. 2008). To restore the minimum possible function of the land, it is necessary to reclaim or revegetate it.

This land reclamation is the final activity of the nickel mining stage. This activity requires land handling and selection of crops per the land conditions to be reclaimed. The land to be reclaimed already has sufficient soil characteristics to be adapted to the proper plant selection. Reclamation is considered successful if it has met the established reclamation success criteria. In this case, for revegetation activities, it is necessary to pay attention to the type of plant chosen and the conditions for growing plants with land conditions so that the criteria for successful reclamation can be achieved (Setyowati, Amala, and Aini 2018).

On the other hand, post-mining land reclamation often experiences obstacles in choosing the right plants from a particular location, pretreatment of the soil for crop sustainability, and provision of topsoil. The provision of topsoil generally in post-nickel mining land is complicated to obtain, considering that there has been no effort to store topsoil soil in a particular place, and the price of this stacking and removal operation is relatively high, so it is often overlooked. This condition requires technological innovation to present adequate soil conditions for growing and developing reclaimed plants.

The soil's good physical and chemical characteristics and the choice of reclaimed plants that correspond to local conditions are in demand. Similarly, the placement of site-specific plants, commonly called local plants, is the leading choice considering that the plants have adapted to the local environment. The provision of local organic matter and inorganic fertilizers as an initial food provider for plants is needed for the sustainability of reclaimed plants. This study aims to increase soil fertility through the provision of organic matter, the growth of reclaimed plants, and the selection of reclaimed plants that have good speed and growth.

RESEARCH METHODS

This research was carried out in the mining site area of PT. Anugerah Harisma Barakah (AHB) in South Kabaena District with Planting Location Code A2-S3 and soil analysis was carried out at the Soil Department Laboratory, Faculty of Agriculture, UHO. This research lasted for three years, from June 2019 to July 2022. The location of the study is presented in Figure 1.

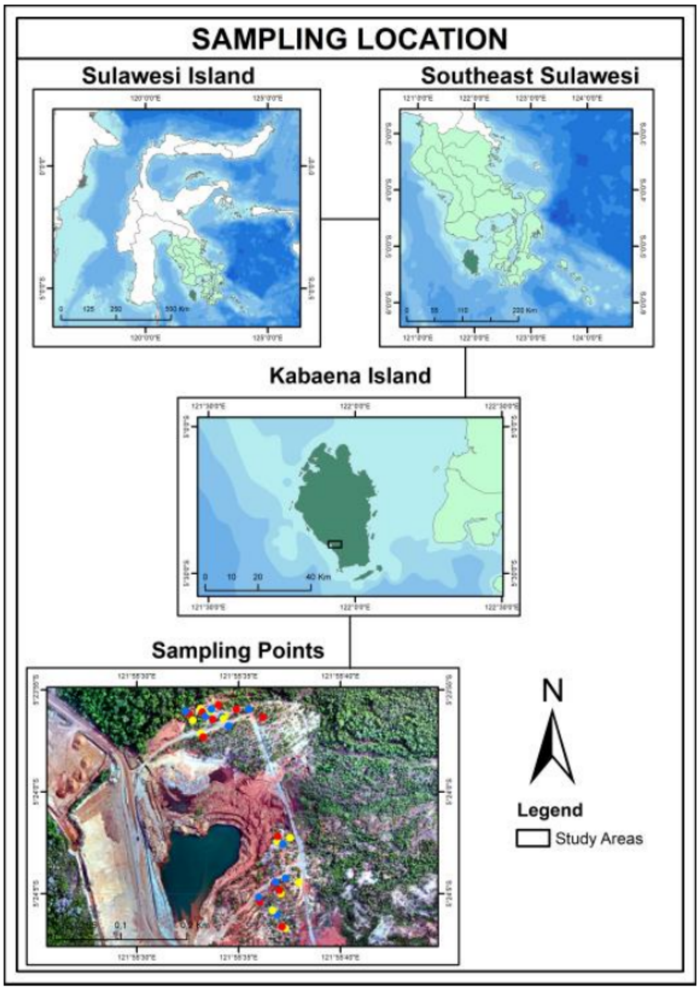


Figure 1. Research and sampling Locations

The materials used in this study are mining block maps, organic fertilizers, plastic bags, label paper, the company'smicroclimate, rainfall data for the Bombana Regency area, and chemicals for laboratory analysis purposes. The tools used in this study were GPS (*Global Positioning System*), roll meter, paul, shovel, field knife, machete, earth drill, *sample ring*, raffia rope, stationery, and equipment for laboratory analysis.

1. Field Testing Phase

The field implementation stage is divided into four, including:

a. Land Determination and Research Area

This research was carried out using experimental methods in the area of the mine reclamation site. The land and area of an experiment are based on the location that has been mined and declared to have been completed covering an area of 2 ha. The height of the location is above 27 m above sea level and is more than 30 m from the beach, with the highest tides and lowest tides. The experimental land has been carried out with a fireplace for the test site. The fireplace in question is the creation of stepped shoulder land according to the slope of the slope,

b. Profile Observation and Early Soil Sampling

Soil profile drawing is carried out directly through the appearance of the surface of the soil excavation around it up to the layer of the parent material. Initial soil sampling prior to the experiment was carried out at 36 following observation points in the composite. For soil fertility assessment, soil observations include texture, pH, C-organic, N-total, P2O5, K2O, Ca, Mg, and KTK.

c. Spacing and Planting Holes

Planting distances are set with a size of 3 m x 3 m. The testing area of 2 ha was obtained from around 2,222 planting holes. Planting pits are made in the dry season with a size equivalent to 1 pc 200 excavator bucket.

d. Regulation of Plant Nutrition

The planting pits that have been prepared are then given nutrients for plants in the form of organic matter (compost fertilizer) derived from cow dung and komba-komba leaves, as much as 7 kg. In addition, to speed up the process of providing nutrients in the soil at the beginning, NPK fertilizer of 50 gr per hole is applied. The results of the initial testing of soil conditions with a low pH then dolomite lime of 100 gr per hole were also given. Organic fertilizers, NPK, and lime are applied simultaneously, then stirred evenly and covered with soil that has been smoothed on top of 7-10 m thick until waiting for the rainy season.

e. Reclaimed Crop Arrangements

The plants used are local plants that grow and develop before mining. The age of the plant seeds that are tested will be transferred when they are 3 to 8 months old or have been eligible for transplant. The plants used are Johar (*Senna* *siamea*), Cemara Angin (Gymnostoma rumphianum), Mangga–Mangga (Mangifera sp), Kusambi (Schleichera oleosa), Tumbeua (Kjellbergiodendron celebicum), Kamoni-Moni (Syzygium acuminatissimum), Angsana (Pterocarpus indicus), Waru (Hibiscus tiliaceus), Damar (Agathis dammara), Bintangor Merah (Calophyllum inophyllum), Wola (Vitex cofassus), Kayu Kolasa (Parinari corimbosa). The position and condition of the plant repeat are presented in Table 1.

Table 1. Location of Observation Coordinates of Soil and Plant Samples

No.	**Plant Type**	**Deuteronomy**	**Koordinat**	**No.**	**Plant Type**	**Deuteronomy**	**Coordinates**
1	Johar (Senna siamea)	1	S = 05°23'56,25" E = 121°55'34,30"	7	Waru (Hibiscus tiliaceus)	1	S = 05°24'2,26" E = 121°55'37,52"
		2	S = 05°23'55,95" E = 121°55'34,89"			2	S = 05°23'56,35" E = 121°55'36,19"
		3	S = 05°23'55,96" E = 121°55'35,51"			3	S = 05°24'02,44" E = 121°55'36,92"
2	Cemara Angin (Gymnostoma rumphianum)	1	S = 05°23' 57,13" E = 121°55'133,16"	8	Damar (Agathis dammara),	1	S = 05°24'6,71" E = 121°55'37,30"
		2	S = 05°23'57,33" E = 121°55'33,26"			2	S = 05°24'06,64" E = 121°55'37,13"
		3	S = 05°23'56,33" E = 121°55'34,19"			3	S = 05°24'06,03" E = 121°55'36,89"
3	Mangga–Mangga (Mangifera sp)	1	S = 05°23'55,92" E = 121°55'33,13"	9	Bintangor Merah (Calophyllum inophyllum),	1	S = 05°24'5,84" E = 121°55'36,68"
		2	S = 05°23'56,09" E = 121°55'33,22"			2	S = 05°24'05,40" E = 121°55'36,03"
		3	S = 05°23'56,29" E = 121°55'33,39"			3	S = 05°24'05,18" E = 121°55'35,99"
4	Kusambi (Schleichera oleosa)	1	S = 05°23'56,42" E = 121°55'34,25"	10	Wola (Vitex cofassus),	1	S = 05°24'2,45" E = 121°55'36,88"
		2	S = 05°23'56,45" E = 121°55'33,73"			2	S = 05°24'02,19" E = 121°55'36,91"
		3	S = 05°23'56,78" E = 121°55'34,50"			3	S = 05°24'02,58" E = 121°55'37,16"
5	Kamoni-Moni (Syzygium acuminatissimum),	1	S = 05 23'56,06" E = 121°55'33,59"	11	Tumbeua (Kjellbergiodendron celebicum)	1	S = 05°24'05,01" E = 121°55'37,08"
		2	S = 05°23'55,75" E = 121°55'34,02"			2	S = 05°24'4,84" E = 121°55'37,01"
		3	S = 05°23'55,95" E = 121°55'33,66"			3	S = 05°24'04,252" E = 121°55'37,31"
6	Angsana (Pterocarpus indicus)	1	S = 05°23'56,50" E = 121°55'32,75"	12	Kayu Kolasa (Parinari corimbosa)	1	S = 05°24'04,45" E = 121°55'37,96"
		2	S = 05°23'S56,17" E = 121°55'32,56"			2	S = 05°24'04,52" E = 121°55'36,75"
		3	S = 05°23'56,05" E = 121°55'32,41"			3	S = 05°24'04,43" E = 121°55'36,81"

Plant arrangements are adjusted to the growing plants' habits around PT's mining area. AHB. The number of plants planted is not carried out proportionally in the field, so the amount in 2 Ha for each type of plant is different. The tested plants are then put into a planting hole in the second rainy season by digging at the centre of the fertilizer distribution and are estimated to be as high as the blanket soil when in the nursery (not crushed or decomposed so that the roots of the plant are visible).

f. Maintenance of Reclaimed Plants

Given that the location of the study is far from the community, so livestock disturbances are considered to have little effect. To keep the test plants only from forest animals like monkeys and pigs. There is no weeding or alternation of plants nor disturbance of plant-bearing organisms because this study purely looked at plants' resistance to adapt to the surrounding environment.

g. Soil and Plant Observations

Soil observations and sampling were carried out in conjunction with plant observations in June 2019, January 2020, June 2020, January 2021, June 2021, November 2021, and July 2022. Samples of observational soil were taken as many as three samples as a test per plant and then composted so that 12 soil samples were obtained in each observation. Soil samples are taken using an earthen drill. Observations include pH, C-organic and soil moisture, pH using a pH meter, C-organic in the laboratory, and soil moisture determined using a soil potentiometer.

Plant observations were taken on selected plants proportionally and represented plants planted in reclaimed areas. The plants were selected to be the representative plants for each of the plants tested by three representatives. The measured plants are in the form of plant height, stem diameter, and canopy width. Plant height is measured from the soil surface to the tip of the stem in cm. Diameter rods use callipers and then use metered tape in cm. The width of the canopy is measured from the left, and suitable outermost leaves are symmetrically in cm.

2. Data analysis and Laboratory phase

Analysis of field test data using physical and chemical parameters of the soil before and after the study in a composite way. The physical analysis includes soil texture and soil moisture. Chemical analysis of the soil includes pH, C-organic, N-total, P_2O_5, K_2O, Ca, Mg, and KTK. Obtaining the data of the selected plant is carried out by analyzing it statistically simply. A correlation analysis was carried out to see the relationship between the growth of reclaimed plants and soil conditions.

RESULTS AND DISCUSSION

RESULT

Condition of Ex-Mining Land

The soil of the study site is a laterite type of soil. The development of the laterite profile is influenced by humid and hot climatic conditions with high rainfall (Ito et al., 2021; Paul et al., 2022). This soil has a reasonably hard surface derived from sedimentary material, resistant to erosion, red, brown to dark reddish brown

because it contains iron, aluminium, and magnesium, as well as a rusty red colour due to the high iron oxide content (Ito et al. 2021; Mustafa et al. 2022; Onyelowe et al. 2021; Rusdiansyah, Adriani, and Barkiah 2021; Zainuddin et al. 2021). The name knows the order of the land of Ultisol. These soils are relatively old and are characterized by (i) illuviation of clay with argillic and kandic epipedons and (ii) leaching of bases from the surface to a profile depth of <35% of the alkaline fertilization capacity (Candra et al., 2021; Lowe 2019).
The post-nickel mining soil at the study site has a relatively good thickness of the topsoil layer from the land fireplace so that the soil surface is met, but the planting pit has significant obstacles. The condition of the fireplace condition in the study's local field of the study is presented in Figure 1.

Figure 1. Land Fireplace Condition of the Research Site

Figure 1 shows that the soil depth condition is limited; the land fireplace has lower soil compaction and damage to the structure, texture, porosity, and bulk density. The soil surface condition is tidied up and added with a layer of topsoil that closes the soil surface, but the planting pit contains a small amount of topsoil soil. This causes the fertility of the soil for plant growth to be hindered. To see the initial condition of the soil, the study site is presented in Table 1.

Table 1. Results of Analysis of Physical and Chemical Properties of Soil Research Sites

No.	Variable	Unit	Value	Dignity
1	Texture			
	Sand	%	13	
	Dust	%	38	Clay
	Clay	%	49	
2	Soil pH (H_2O)		5.3	Sour
3	C-organic	%	1.08	Low
4	N-total	%	0.22	Medium
5	P_2O_5 (HCl 25%)	mg.100g^{-1}	7.02	Low
6	K_2O (HCl 25%)	mg.100g^{-1}	11.85	Very low
7	Ca^{2+}	cmol(+).kg^{-1}	1.03	Very low
8	Mg^{2+}	cmol(+).kg^{-1}	0.37	Very low
9	CEC	cmol(+).kg^{-1}	9.88	Low

Table 1 shows that the soil conditions after mining have a clay texture with a predominance of clay and dust, acidic soil pH, low C-organic, medium N-total, medium P_2O_5, interchangeable bases (K_2O, Ca^{2+}, and Mg^{2+}) very low, as well as low CEC.

Conditions of The Tested Plants

The plants that are tested are plants that have existed before mining activities. This plant grows and develops around the mining area. The condition of the plant is presented in Figure 2.

1=Johar (Senna siamea); 2=Cemara Angin (Gymnostoma rumphianum); 3=Mangga–Mangga (Mangifera sp); 4=Kusambi (Schleichera oleosa); 5=Tumbeua (Kjellbergiodendron celebicum); 6=Kamoni-Moni (Syzygium acuminatisicum); 7=Angsana (Pterocarpus indicus); 8=Waru (Hibiscus tiliaceus); 9=Damar (Agathis dammara); 10=Bintangor Merah (Calophyllum inophyllum); 11=Wola (Vitex pinnata); 12=Kayu Kolasa (Parinari corimbosa)

Figure 2. Conditions of the tested reclaimed plants

Figure 2 shows that the types of reclaimed plants piloted vary from the stem's height, diameter, and width of the plant canopy.

Plant Growth

The reclaimed plants piloted used indicators of the plant canopy's height, diameter, and width, presented in Figures 3, 4, and 5, respectively.

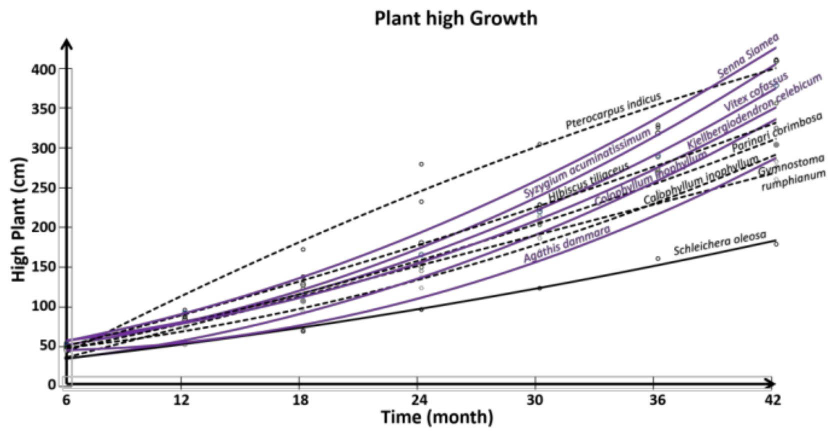
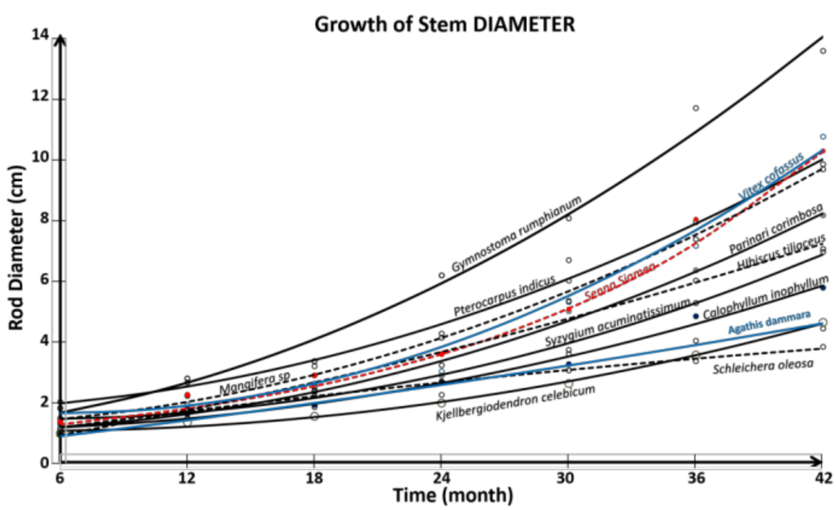


Figure 3. Height of Reclaimed Plants against Observation Time

Figure 3 shows that the reclaimed plants tested had the same high-rise tendency based on observation time. However, the plants *Senna siamea*, *Pterocarpus indicus*, *Syzygium acuminatissimum,* and *Vitex cofassus* rapidly increase in plant height compared to other plants. However, from Figure 3, it can be seen that the *plant Pterocarpus indicus* plant height gain slowed down in the 42nd month.



Gamber 4. Reclamation Plant Diamater to Observation Time

Figure 4 shows that the plants *Gymnostoma rumphianum*, *Pterocarpus indicus,* and Wola *Vitex cofassus* have a rapid increase in stem diameter compared to other reclaimed plants. At the same time, the *Schleichera oleosa* plant experiences a slowdown in the increase in stem diameter.

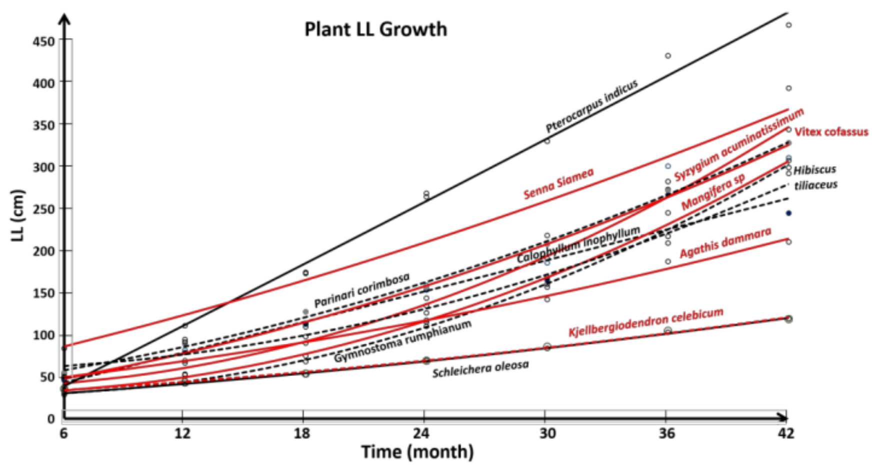


Figure 5. Canopy width of the Reclamation plant against the Time of Observation

The width of the canopy of reclaimed plants is the character of the plants owned. The highest heading width is obtained from *Pterocarpus indicus*, *Senna siamea,* and *Syzygium acuminatissimum*. At the same time, the plant *Kjellbergiodendron celebicum* has a slow wide development of the crown. If the plant growth is included in the resultant equation, then the analysis results will be obtained and presented in Figure 6. The analysis showed linear growth over time and had a very high correlation. The growth of reclaimed plants against time is presented in Figure 6.

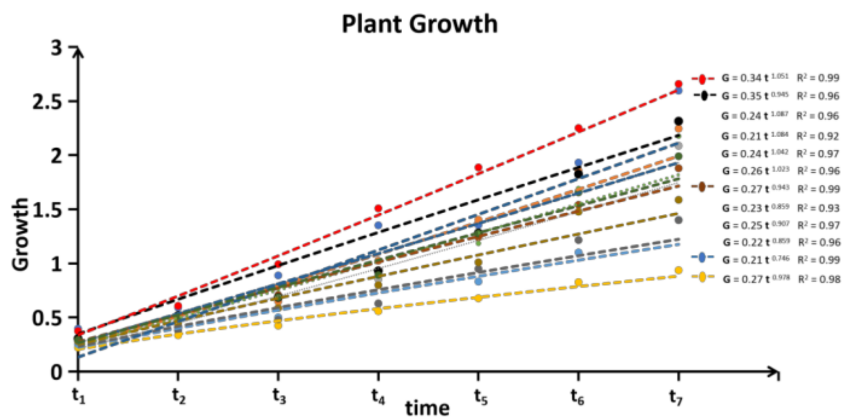


Figure 6. Reclaimed Plant Growth

Figure 6. shows that all reclaimed plants tested can grow well at the study site. *Pterocarpus indicus* plant has good growth results, followed by *Agathis dammara* and *Vitex cofassus*. However, when viewed from the growth speed of each plant, it shows a different pattern, as presented in Figure 7.

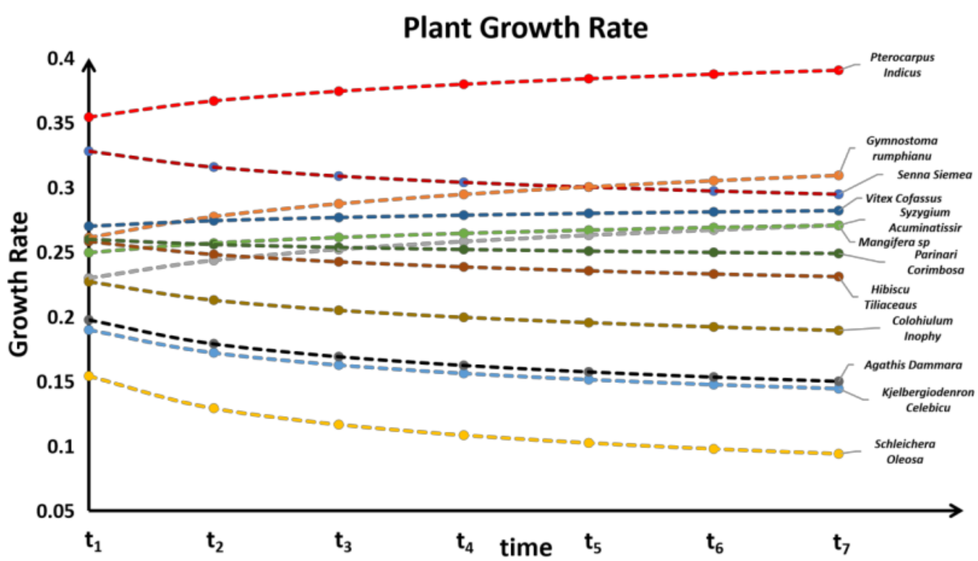


Figure 7. Growth Speed of Reclaimed Plants

Growth is a function of increasing plant height, diameter stem, and width of the canopy with observation time. Figure 7 shows that each plant has a different growth speed pattern towards the same organic matter treatment. *Pterocarpus indicus*, *Gymnostoma rumphianum*, *Syzygium acuminatissimum*, and *Mangifera sp* show an increased growth speed, while others show a decreasing speed. This indicates that the reclaimed plants tested have a different growth reaction to previous environmental conditions.

However, when viewed from the acceleration of growth, which is a change in speed to the change in time presented in Figure 8. There are two behaviours of growth acceleration, namely increased growth acceleration and decreased growth acceleration, but the whole plant is towards constant plant growth. Figure 8 shows an indication of the change and overhaul of the organic matter in the soil into nutrients absorbed by plants in the 1st to 12th months.

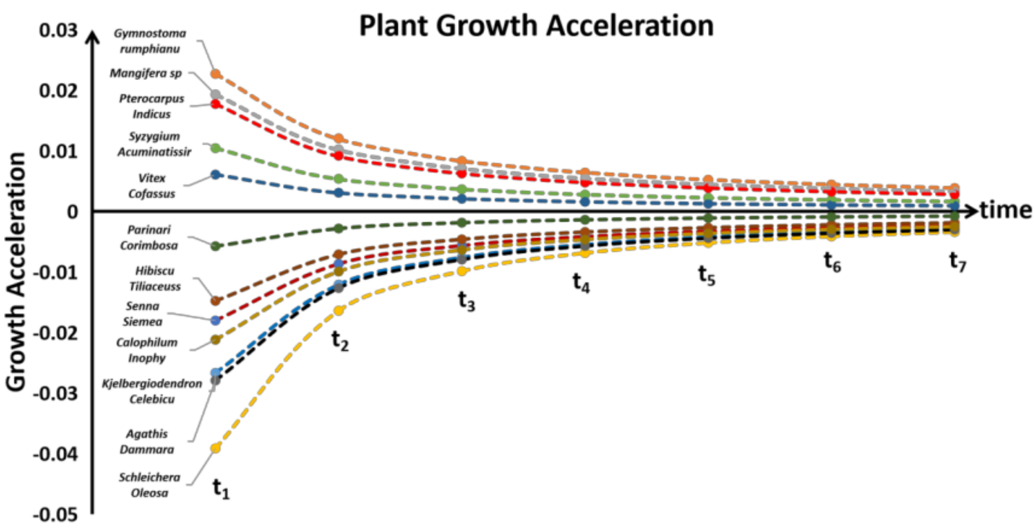


Figure 5. Accelerated Growth of Reclamation Plants

Schleichera oleosa, *Agathis dammara*, and *Kjellbergiodendron celebicum* plants showed increased acceleration compared to other reclaimed plants. *Gymnostoma rumphianum*, *Mangifera sp*, and *Pterocarpus indicus* show a decreased acceleration compared to other plants.

Relationship between Plant Growth and Soil Properties

The relationship between plant growth and soil properties was analyzed using correlation analysis, and the analysis results are presented in Table 2.

Table 2. Relationship between Plant Growth and Soil Properties

Plant Growth Vs. Soil Properties	Plant											
	1	2	3	4	5	6	7	8	9	10	11	12
	Coefisien of Cerrelation (R)											
Plant Growth Vs. pH	0,75	0,92	0,72	0,87	0,69	0,59	0,91	0,60	0,62	0,61	0,80	0,49
Plant Growth vs. C-Organic (%)	0,74	0,83	0,51	0,91	0,56	0,57	0,85	0,84	0,80	0,84	0,80	0,78
Plant Growth vs. Moisture (%)	0,00	0,12	0,65	-0,02	0,18	0,15	-0,34	-0,32	0,32	0,58	0,01	0,59
$y_1 = a_o + a_1 X_1 + a_2 X_2$	0,78	0,93	0,76	0,92	0,69	0,68	0,92	0,88	0,81	0,85	0,84	0,79
$y_2 = a_o + a_1 X_1 + a_2 X_2 + a_3 X_3$	0,95	0,93	0,80	1,00	0,76	0,88	0,97	0,95	0,92	0,94	0,96	0,78

Information: Y1, Y2 = Plant Growth; $\mathbf{X_1}$ = pH ; $\mathbf{X_2}$ = C- organic ; $\mathbf{X_3}$ = Humidity; a_o, a_1, a_2 are respectively constants that express the contribution of soil properties to the Plant Growth

1=Johar (*Senna siamea*), 2=Cemara Angin (Gymnostoma rumphianum), 3=Mangga–Mangga (Mangifera sp), 4=Kusambi (Schleichera oleosa), 5=Tumbeua (Kjellbergiodendron celebicum), 6=Kamoni-Moni (Syzygium acuminatissimum), 7=Angsana (Pterocarpus indicus), 8=Waru (Hibiscus tiliaceus), 9=Damar (Agathis dammara), 10=Bintangor Merah (Calophyllum inophyllum), 11=Wola (Vitex cofassus), 12=Kayu Kolasa (Parinari corimbosa)

Table 12 shows a real relationship between plant growth with pH and C-Organic and unreal with Soil moisture, but when linked between the three soil properties, it shows an honest and genuine relationship. The relationship of plant growth with the highest soil pH in plants *Gymnostoma rumphianum*, *Schleichera oleosa,* and *Vitex cofassus*. The relationship of plant growth with C-organic is highest in *schleichera oleosa* plants, *Pterocarpus indicus,* and *Calophyllum inophyllum*. Meanwhile, the relationship between plant growth and soil moisture is highest in *Mangifera sp*, *Calophyllum inophyllum,* and *Parinari corimbosa* plants. If plant growth is connected with pH and C-Organic, a noticeable relationship is obtained in *gymnostoma rumphianum* and *Pterocarpus indicus* plants. However, if it is connected with growth with all observation variables, a very close relationship is obtained in *schleichera oleosa*, *Pterocarpus indicus*, and Vitex cofassus plants.

Discussion

Preliminary soil conditions Table 1 shows that the soil conditions after mining have a clay texture with a predominance of clay and dust. The condition of this soil is because the topsoil layer has been mixed with the soil of the mining base, which has a sandy clay texture. According to (Anda et al. 2022), soil texture tends to change from sandy clay to sand throughout the post-mining profile. Soil acidification is one of the important chemical properties of soil in the growth process of reclaimed plants that reflects the availability of macro and micro elements and encourages the biogeochemical cycle in the soil (Zheng et al., 2022). Table 1 shows that the soil pH of the study site indicates the pH of acidic soils. This causes the condition of other soil chemical elements to be low in the form of organic carbon, and the exchange capacity of cations and bases is shallow. Other nutrients very low include potassium, calcium, and magnesium. At the same time, the total Nitrogen content is at a low state.

Reclaimed plants' growth tends to increase at the same planting height based on observation time. According to (Iskandar et al. 2022), plant growth at 0-2 and 2-4 years since recovery is dominated by the young growth rate and shows the same growth.

Furthermore, it can be said that growth is affected by pH, C-organic, and soil moisture. The pH value of the soil shows an increase, but it occurs per field every observation. This is in line with (2019), which revealed that the plants would increase significantly with increasing soil pH in each reclaimed acreage. Applying organic matter in mine reclamation soils can increase the growth of reclamation plants Sesbania rostrata and S. cannabina for reclamation of mine tailings /zinc (Pb / Zn) through the application of organic matter (Ye et al. 2001). Organic matter in the form of fertilizer can encourage plant growth in soils contaminated with heavy metals. Organic matter in the form of fertilizer can encourage plant growth in soils contaminated with heavy metals (Wang et al., 2022). Carbon accumulation at the reclamation site increases with plant growth (Xie et al., 2021). Soil moisture and soil pH largely determine the solubility of soil organic matter for plant growth (I. Ameh and J. Onuh 2020).

Kecepatan dan percepatan pertumbuhan tanaman reklamasi ditentukan oleh perombakan bahan organik, karakter tanaman dan kondisi tanah. Menurut (Turisová et al., 2020) said that the overhaul of organic matter in the soil increased the growth acceleration of reclaimed plants tested in greenhouses. Reclaimed plants' character can provide different environmental adaptations (Saijo and Loo 2020; Xie et al. 2021). According to (Agbeshie and Abugre 2021), adequate soil conditions can increase nutrient availability, speed up nutrient absorption, and accelerate plant growth.

CONCLUSION

The conclusions in this study are (1) the provision of organic matter can increase the actual growth of reclaimed plants, (2) there is a relationship between plant growth and pH, C-organic and soil moisture, (3) the speed and acceleration of growth of good reclaimed plants found in *Schleichera oleosa, Pterocarpus indicus*, and *Vitex cofassus* plants.

Reference

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