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Analysis of the Effect of Providing MNBs Organic Liquid Fertilizer on the Growth of *Pueraria Javanica* Plants in Coal Mining Areas

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Abstract: Apart from ex-mining land which requires management and rehabilitation using soil microbial communities, reclamation activities require time and technology with high costs and results that are not necessarily effective and efficient. One effective way is to provide organic fertilizer which contains lots of microbes and is able to neutralize soil acidity. This type of research is experimental research with a research design using a Completely Randomized Design (CRD) 4 x 6. The population of this research is all Ruji Nut Plants (*Pueraria Javanica*) that grow in the PT Mine Wire House area. The main natural coal sampled in this research were 24 Ruji Nut Plants (*Pueraria Javanica*). The results of this research were that administering NPK solution and Micro Nano Bubbles (MNBs) was proven to help accelerate stem growth, number of leaves, number of leaf branches, root length and increase the biomass of Ruji Nut (*Pueraria Javanica*) plants in planting media with minimal topsoil. The dosage of Organic NPK Solution and Micro Nano Bubbles (MNBs) for optimal growth of Pueraria javanica plants was in treatment 4 (90 ml), where in treatment 4 the average stem growth, number of leaves, number of leaf branches, root length and plant biomass reached optimal point. So the use of Organic NPK solution using Micro Nano-Bubbles (MNBs) is more effective and environmentally friendly because it is formed from organic materials.

Keywords: Micro nano bubble; NPK fertilizer; *Pueraria Javanica*

Introduction

Reclamation of ex-mining land is an aspect that cannot be separated from mining activities. Reclamation is the key to preserving the environment on ex-mining land. Reclamation of ex-mining land generally aims to replant ex-mining land with forestry plants (Nursaputra et al., 2021). This happens because the ex-mining land is generally around forest areas. This requires careful and detailed planning and refers to the Decree of the Minister of Energy and Mineral Resources No. 1827 K/30/MEM/Year 2018.

Ex-mining land does not contain nutrients so it is impossible to plant directly (Hirfan, 2018). The presence of soil microorganisms accelerates the decomposition process and supports the supply of organic substances. That's why a very important aspect to do before revegetation is improving soil conditions, namely pH (acidity level), availability of organic compounds, increasing the bacterial community, aeration, as well as soil physical and chemical factors. These are important aspects that are directly related to soil fertility. Soil fertility greatly determines the success of reclamation on ex-mining land (Hasan, 2018). Currently, liquid sodium, phosphorus and potassium (NPK) fertilizers on the market are used for plant reclamation or revegetation activities at a price of Rp. 100,000/liter.

An important problem of this research, besides post-mining land, is that it requires management and rehabilitation using soil microbial communities. Another

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problem is that carrying out reclamation requires time and technology with high costs and results that are not necessarily effective and efficient. Related to the problem above, before carrying out reclamation it is necessary to prepare ex-mining land that is able to support the life of the plants that will be planted on ex-mining land. One effective way is to provide organic fertilizer which contains lots of microbes and is able to neutralize soil acidity. Organic fertilizer containing nutrients and microbes contained in biological organic fertilizer can increase the efficiency of nutrient uptake (Antonius et al., 2018).

Reclamation activities for ex-mining land around the world currently tend to use soil microbes to accelerate nutrient availability and support plant growth. In this regard, research is needed to develop organic fertilizer that is effective and efficient and supported by the latest technology with the application of the concept of eco nano biotechnology. Preparation of organic liquid NPK solution for the growth of *Pueraria Javanica* plants in coal mining areas.

The use of nanotechnology is in the form of using water to make liquid fertilizer with a size of 200 micrometers (µm) – 10 nanometers (nm) which is called Micro Nano Bubbles (MNBs) which is produced by a nanopress tool. The advantage of nano-sized water is that it is able to speed up microbial processes or activities and is efficient in the absorption of nutrients by plant root fibers. This is able to accelerate plant growth by 30% from normal conditions.

Dari uraian diatas, maka peneliti tertarik untuk melakukan eksperimen mwngwnai pengaruh pemberian pupuk cair MNB organik terhadap pertumbuhan tanaman Pueraria Javanica di area pertambangan batubara PT. Bara Alam Utama, Kabupaten Lahat, Provinsi Sumatera Selatan.

Method

This type of research is experimental research with a research design using a Completely Randomized Design (CRD) 4 x 6. A Completely Randomized Design is a field design where all experimental units are homogeneous (Lentner et al., 1986). RAL is the simplest design when compared to other designs.

In this design the only sources of observed variation are treatment and error. Therefore, RAL is generally suitable for homogeneous environmental conditions, tools and media. The population of this research is all Ruji Bean Plants (*Pueraria Javanica*) that grow in the PT Mine Wire House area. Bara Alam Utama. The samples from this research were 24 stems from Ruji Nut Plants (*Pueraria Javanica*).

The factor used is the concentration of the liquid NPK solution. Each factor has 4 treatment levels with 6 repetitions (6 X 4). The concentration of the solution used was 10 ml (Control), 30 ml, 60 ml, 90 ml. Completely Randomized Design (CRD) Test Method as an analysis method and steps were prepared according to this method in carrying out the research.

Results and Discussion

Research Sites

The research schedule will be carried out in the period August–December 2022 located at PT. Bara Alam Utama, Lahat Regency, South Sumatra Province.

Figure 1. Regional achievement location research location PT. Bara Alam Utama (Source: PT Document. Bara Alam Utama, 2023)

Analysis of Pueraria Javanica Plant Growth Stem Growth

Growth in stem length of *Pueraria Javanica* plants when given NPK and Micro Nano Bubbles (MNBs) solutions with 4 treatments were observed for 8 weeks. The first week is the acclimation week where this process allows the plant to survive and function well in a different environment or unusual conditions and the plant is said to be in the process of adapting and adjusting to new conditions. The next week is development after being given an organic NPK solution and MNBs. The average growth rate of Pueraria Javanica plant stems with the addition of 90 ml of organic NPK solution and MNBs was 27 cm per week, longer compared to other concentrations of organic NPK solutions and MNBs. This can be seen in the plant stem growth rate graph in Figure 2.

Comparison of the average length of *Pueraria Javanica* plants 8 weeks after planting. The highest stem length of the Pueraria Javanica plant was seen when the organic NPK and MNBs solution was given at a dose of 90 ml, which had a length value of 192.98 cm and was longer compared to the growth of other treatments.

The shortest average value of the stem length of *Pueraria Javanica* plants was seen in the control treatment (P1, 0 ml) without adding organic NPK solution and

MNBs to the planting medium, the growth of *Pueraria Javanica* in the eighth week after planting only had a stem length growth of 142.57 cm. The control treatment in a completely randomized design study plays an important role in evaluating the effects of the treatment being studied, controlling confounding factors, maintaining the validity of the study, and providing an appropriate basis for statistical calculations. A more detailed comparison of the averages can be seen in Figure 3.

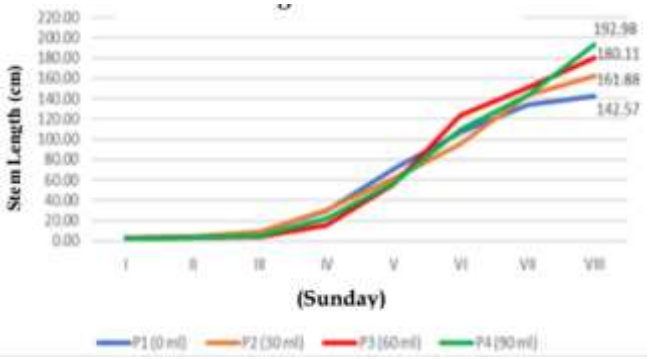


Figure 2. Growth rate of stem length of Pueraria Javanica plants when given NPK and MNBs solutions in each treatment (Source: Author's Analysis 2023)

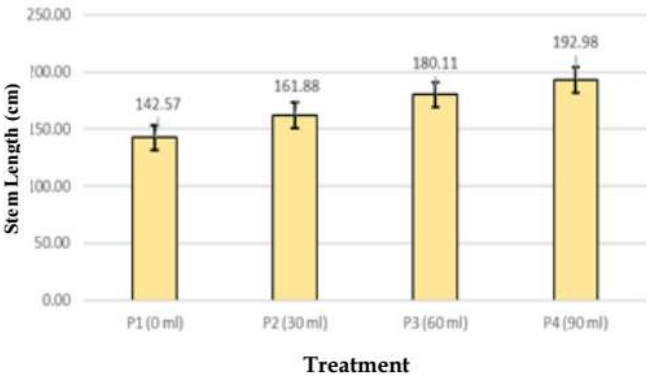


Figure 3. Comparison of the average growth rate of stem length of Pueraria Javanica plants when given NPK and MNBs solutions in each treatment (Source: Author's Analysis 2023)

Number of Leaves

In this study, at several concentrations of NPK and MNBs solutions which were monitored for 8 weeks, it was seen that the average growth in the number of *Pueraria Javanica* leaves by administering NPK and MNBs solutions at a concentration of 90 ml produced the highest number of leaves when compared to administration at other concentrations. Meanwhile, from observations, the least growth in the number of leaves was seen in the control concentration treatment (P1, 0 ml), where the average leaf growth was only 6 pieces per week. This can be seen in the growth rate of the number of leaves in Figure 4.

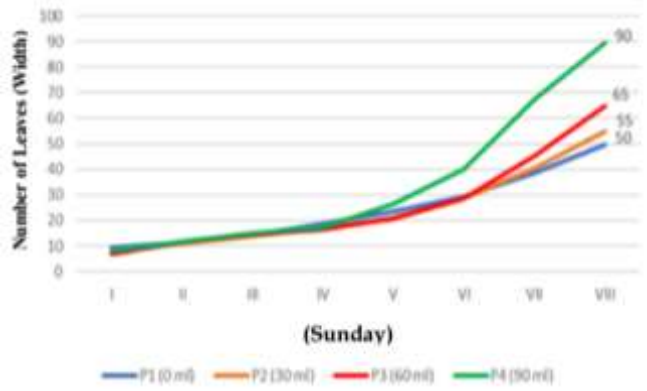


Figure 4. Growth rate of the number of leaves of Pueraria Javanica plants when given NPK and MNBs solutions in each treatment

The difference in the increase in the number of *Pueraria Javanica* leaves was greater when given a concentration of 90 ml (90 pieces), while when given at other concentrations. Meanwhile, when giving a concentration of organic NPK solution and MNBs of 30 ml, the average number of leaves increased by 55 sheets and a concentration of 60 ml resulted in an increase of 65 leaves. The lowest average value of the number of leaves of *Pueraria Javanica* plants was seen in the 0 ml control treatment which was treated without providing organic NPK solution and MNBs in the planting medium, where there was only an increase in the number of leaves by 50 pieces until the eighth week of the research period. A more detailed comparison of the averages can be seen in Figure 5.

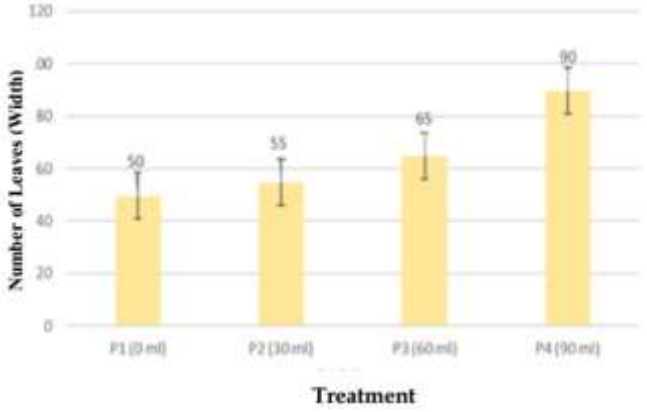


Figure 5. Comparison of the average growth in the number of leaves of *Pueraria Javanica* plants when given NPK and MNBs solutions in each treatment

Number of Leaf Branches

The difference in concentration of organic NPK solution and MNBs given to Pueraria Javanica plants has an effect on increasing the number of stem branches. The

main factors that influence soil cover are increasing the number of leaves and increasing the number of stem branches, this is because the *Pueraria Javanica* plant type is a type of vine that grows to cover the ground surface. The rate of addition of stem branches can be seen in Figure 6.

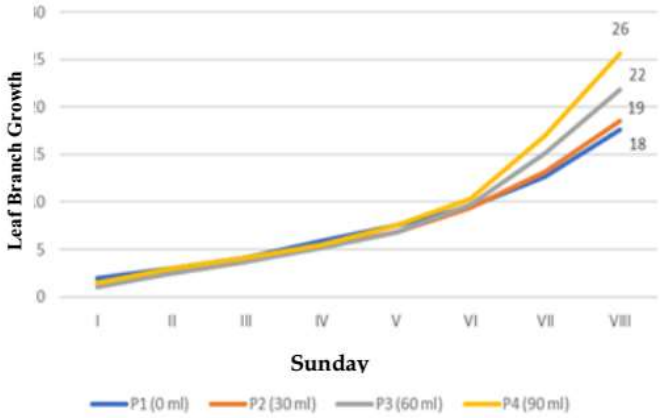


Figure 6. Growth in the Number of leaf branches of *Pueraria Javanica* Plants on the administration of NPK and MNBs solutions in each treatment (Source: Author's analysis 2023)

From the results of measuring the number of leaf branches of Pueraria Javanica plants at various levels of concentration of organic NPK solution and MNBs for 8 weeks, it can be seen that the average number of stem branches of *Pueraria Javanica* plants with the addition of 90 ml of organic NPK solution and MNBs produced more stem branches when compared with the concentration another. Based on the graph in Figure 7, it can be seen that the difference in the increase in the number of leaves was visible in the sixth week after the planting period.

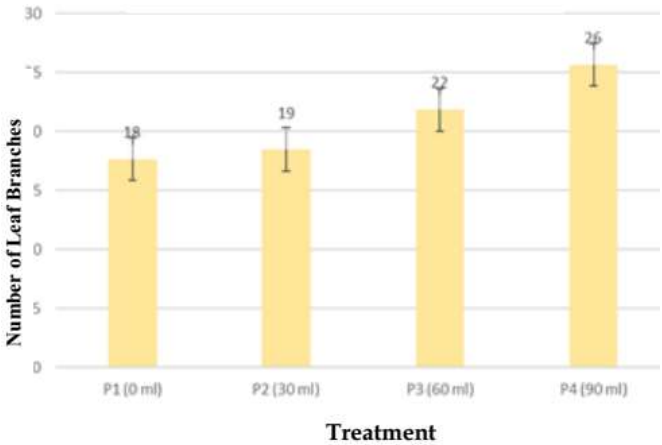


Figure 7. Comparison of the average number of leaf branches of *Pueraria Javanica* Plants on the administration of NPK and MNBs solutions in each treatment

The lowest average value of leaf branches of *Pueraria Javanica* plants was seen in the control treatment (P1, 0 ml). Without adding organic NPK solution and MNBs to the planting medium, Pueraria Javanica growth in the eighth week after planting only had 18 leaf branches. Meanwhile, in the treatment with a concentration of 30 ml, the number of leaf branches increased by 19 branches and at a concentration of 60 ml there were 22 leaf branches. The control treatment in a completely randomized design study plays an important role in evaluating the effects of the treatment being studied, controlling confounding factors, maintaining the validity of the study, and providing an appropriate basis for statistical calculations.

Root Length

The graph shows that administering organic NPK and MNBs solutions with concentrations of 30 ml, 60 ml and 90 ml can influence the growth rate of Pueraria Javanica roots. The longest root growth rate was seen in Pueraria Javanica plants given a solution of organic NPK and MNBs with a concentration of 90 ml. Normal root length response can be seen in the control treatment. The shortest average value of the root length of *Pueraria Javanica* plants was seen in the control treatment which can be seen in Figure 8. Without adding organic NPK solution and MNBs to the planting medium, the growth of Pueraria Javanica in the eighth week after planting only had an increase in root length of 57.31 cm.

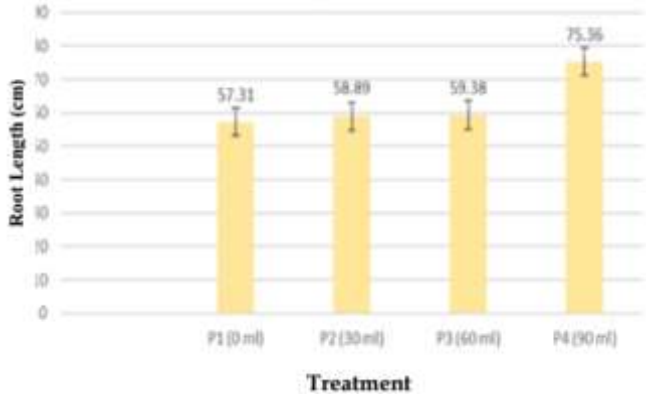


Figure 8. Comparison of the average root length of *Pueraria Javanica* Plants on the administration of NPK and MNBs solutions in each treatment

Root Nodules

Root nodules in the *Pueraria Javanica* species are special structures that form on the roots of the plant as a result of symbiotic interactions between plant roots and Rhizobia bacteria. Root nodules are an adaptation of plants to their environment and can have a variety of functions, including storage of food reserves, increased nutrient uptake, and support of the plant in a particular environment. This is an example of how plants can adapt to survive and grow well in a variety of environmental conditions. The results of measurements of *Pueraria*

Javanica plant nodules at various concentration levels of organic NPK solution and MNBs for 8 weeks showed that the average number of nodules on *Pueraria Javanica* plants with the addition of 60 ml and 90 ml of organic NPK solution and MNBs resulted in a larger nodule size when compared to the concentration. another. This can be seen in figure 9.

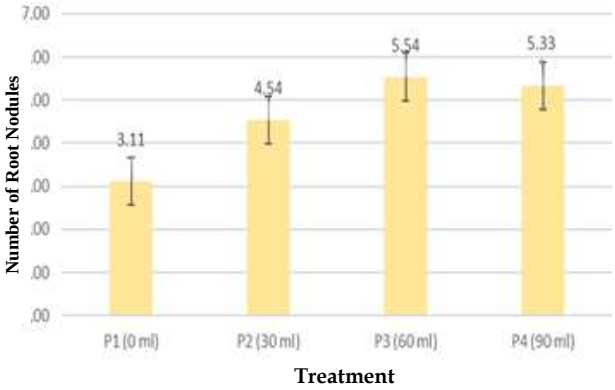


Figure 9. Comparison of the average number of root nodules of *Pueraria Javanica* Plants on the administration of NPK and MNBs solutions in each treatment

Plant Growth Analysis

In this study, there was an effect on the growth of *Pueraria Javanica* plants on the addition of organic NPK solution and MNBs, based on analysis of variance (ANOVA) carried out on stem length, number of leaves, number of stem branches, root length, number of root nodules, and biomass of *Pueraria Javanica* plants. Organic NPK and MNBs solutions contain microelements that are important for plant growth, such as iron (Fe), copper (Cu), zinc (Zn), nitrogen in organic form, such as amino compounds or natural urea. The nitrogen content in organic solutions can range from 1% to 5%. And. The content of these microelements also varies depending on the source of the organic material and solution formulation. Analysis of *Pueraria Javanica* plant variants can be seen in Table 1.

Table 1. Analysis of Variants (ANOVA) of *Pueraria Javanica* Plants Against All Treatments

Parameter	F test		Information
	F Count	F Table	
Stem Length	4.15	3.10	Influential
Number of Leaves	14.84	3.10	Influential
Number of Leaf Branches	5.55	3.10	Influential
Root Length	3.49	3.10	Influential
Root Nodules	8.33	3.10	Influential
Biomass	3.85	3.10	Influential

The growth in the number of leaves is the parameter of the *Pueraria Javanica* plant that has the most significant influence on the application of organic NPK solutions and MNBs. Organic NPK solutions and MNBs can potentially stimulate plant growth, including leaf growth. Organic substances in organic NPK solutions and MNBs can influence the process of cell division and cell elongation in stems, which can result in an increase in the number of leaves.

The application of organic NPK solutions and MNBs to the stem length of *Pueraria Javanica* plants can vary depending on various factors, including environmental conditions, plant genetics, and the dose or frequency of application of organic NPK solutions and MNBs. In addition, the complex interactions between these factors can also influence the overall plant growth response.

Analysis of significant differences between treatment groups after analysis of variance (ANOVA) is the Duncan test or DMRT. Duncan's test helps in identifying treatments that differ significantly in terms of *Pueraria Javanica* growth. After conducting analysis of variance to compare treatments as a whole, Duncan's test was used to compare all treatment pairs individually. This allows researchers to determine which treatment groups significantly differ from each other in terms of plant growth.

The Duncan test can also determine the treatment that produces the best growth in Pueraria Javanica plants. This test helps to identify treatments that produce significant differences in plant growth, and the treatment with the best results can be identified as the most effective in increasing the growth of the legume plant. The use of the Duncan Test in research on giving organic NPK solutions and MNBs to the growth of *Pueraria Javanica* is very important to gain a deeper understanding of the differences in treatment in terms of plant growth. Based on the Duncan test results, it can be seen that the best method is to increase root nodules, biomass, root length, number of stem branches, stem length.

Table 2. Duncan Test of *Pueraria Javanica* Plants on All Soil Parameters

Treatment	Duncan's test				
	Long Stem	Amount Leaf	Amount Branch Leaf	Long Root	Biomass
P 1 0 ml	a	a	a	a	a
P2 30 ml	ab	ab	ab	ab	ab
P3 60 ml	bc	bc	bc	a b c	a b c
P4 90 ml	d	d	d	d	d

Information: Based on DMRT at the a=5% level, numbers followed by the same letter in the same column are not significantly different.

Planting Media Analysis

Planting media analysis has an important role in research related to the administration of organic NPK

solutions and MNBs on the growth of Pueraria javanica plants. Laboratory-scale growing media analysis is an important step in plant research and development, whether to identify plant nutritional needs, test potential media for growing certain plants, or optimize growing media for experimental research, as well as assisting in evaluating the quality of soil used for research. This analysis involves measuring various parameters such as soil pH, organic matter content, nutrient availability, cation exchange capacity (CEC), and other physical soil properties.

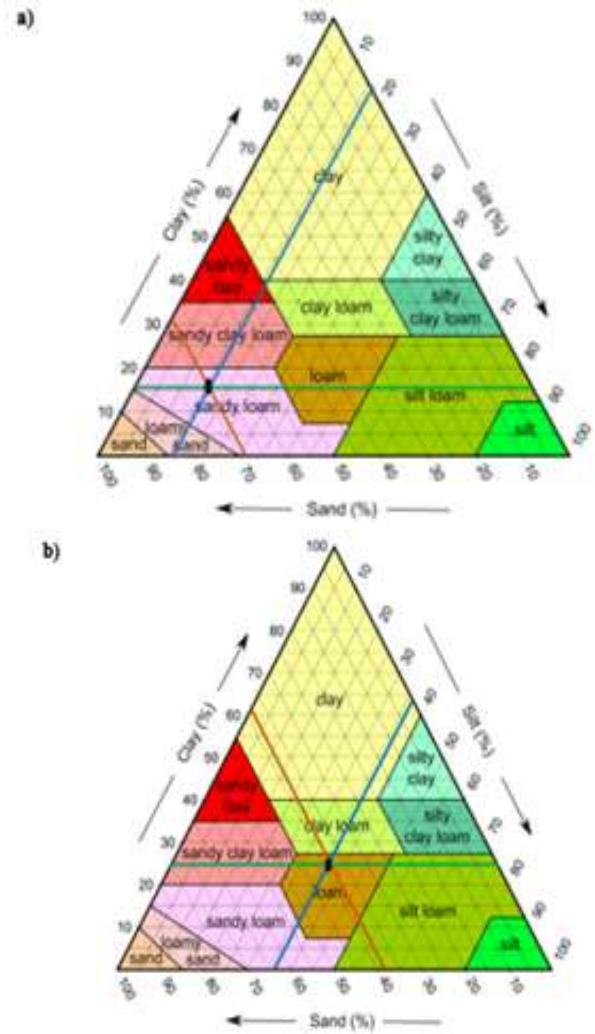


Figure 10. Soil fraction analysis in (a) Subsoil soil samples (b) Overburden soil samples (Source: Author's analysis, 2023)

The condition of the initial soil media fraction can be seen in Figures 11 and 12, where it can be seen that mixing 50% subsoil (clay) and 50% overburden (sandy loam) produces a soil media with a soil fraction that can be categorized as sandy loam. The condition of the soil media in the control (P1, 0 ml) was assumed to be the condition of the soil before treatment with organic NPK and MNBs solutions at several concentrations.

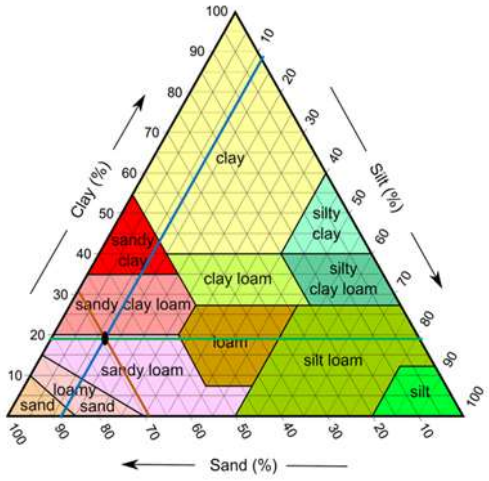
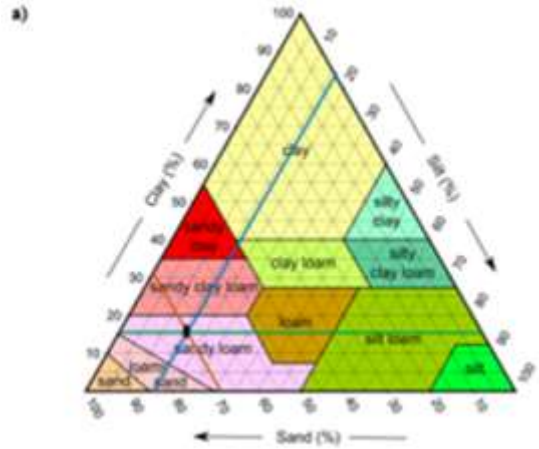


Figure 11. Control soil fraction analysis (0 ml)

The planting media in this study mixed materials from 50% subsoil and 50% overburden. In general, the soil texture in each final observation condition a, b and c in Figure 13 of all treatments is sandy loam and sandy clay loam. Soil media in the second treatment (30 ml) and third treatment (60 ml) can be seen that the soil fraction can be categorized as sandy clay, while the soil fraction in the fourth treatment (90 ml) can be categorized as sandy clay.

Providing organic NPK and MNBs solutions in doses of 30 ml, 60 ml, and 90 ml to create soil media with soil fractions that can be categorized as sandy loam in Figure 12 can be an interesting approach in reclamation of ex-coal mining land. Sandy loam planting media is a type of planting media that contains a mixture of clay and sand. This mixture creates a different soil texture than pure clay or pure sand. Sandy loam planting media can also be a good choice for various types of plants and has the ability to hold a certain amount of water, this can provide water reserves for plants during dry weather and allows good aeration for plant roots. Roots can get oxygen easily.



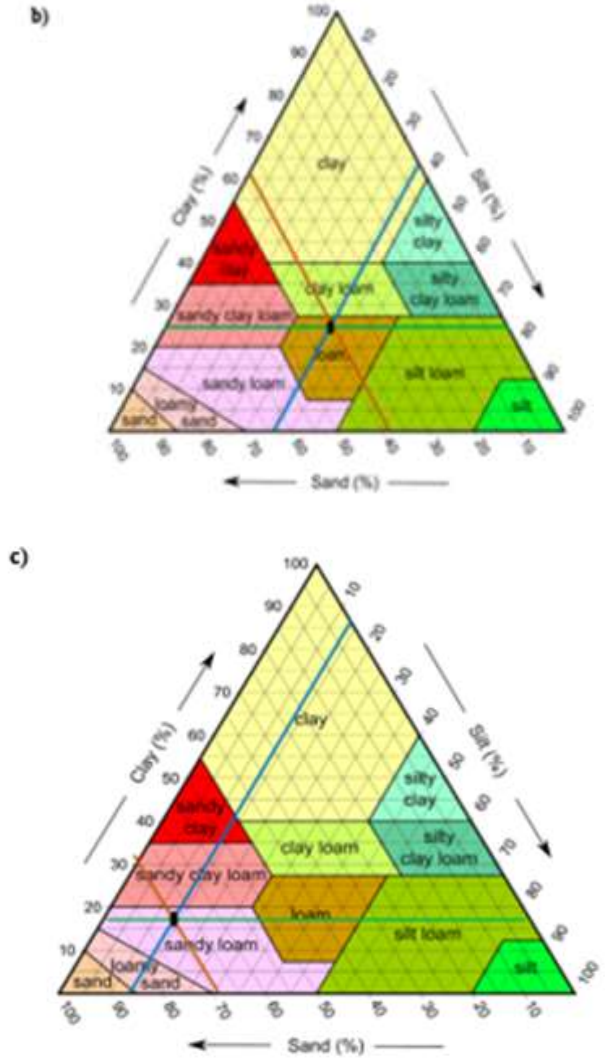


Figure 12. Soil Fraction Analysis (a) Treatment 2 (30 ml), (b) Treatment 3 (60 ml) and (c) Treatment 4 (90 ml) (Source: Author's analysis, 2023)

Soil Quality Analysis

Analysis of Soil pH Parameter Values

Soil acidity or soil reaction (pH) shows the concentration of H+ ions in the soil solution. The soil acidification process occurs when the production and use of H+ ions from reactions that occur in the soil. The soil acidification process occurs when the production of H+ ions exceeds the use of H+ ions and vice versa, the use of H+ ions in chemical reactions in the soil that exceeds the production of H+ ions causes an increase in soil pH (Saidy, 2018). Based on research that has been carried out, the pH value in the planting medium for each treatment can still be categorized as acidic, both soil pH using H2O and HCl solvents. There was no significant change in the acidity level of the planting medium between treatment 1 and other organic NPK solution concentration treatments. Parameter analysis can be seen in figures 13 and 14.

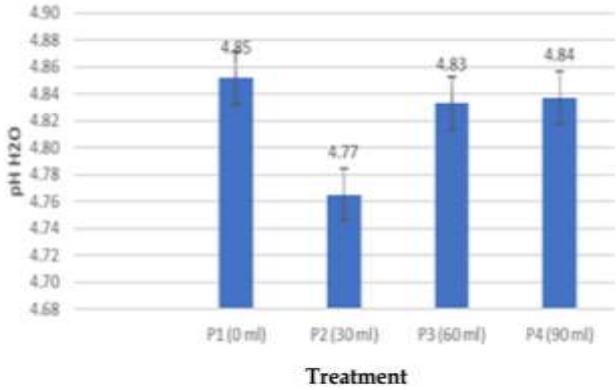


Figure 13. Analysis of average soil pH parameters against H2O in soil media

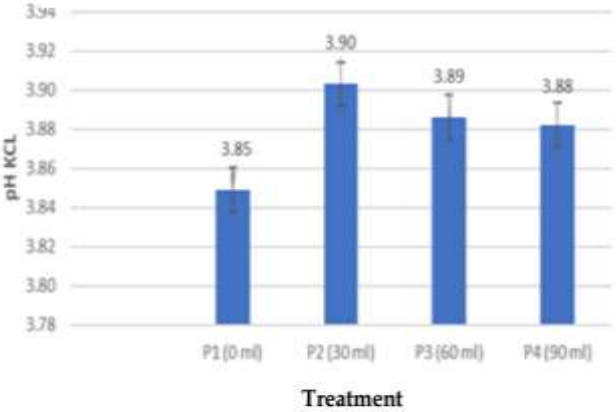


Figure 14. Analysis of average soil pH parameters against KCl in soil media

Analysis of Parameter Values for Macro Nutrient Elements

The component or part of soil organic matter that is considered important in providing macro nutrients is particulate organic matter. These nutrients are produced from the mineralization process of soil organic matter (nitrogen, phosphorus and organic sulfur) and will be converted into a form that can be absorbed by plants. Organic compounds are used as an energy source to liberate P and S into forms available to plants through the enzyme hydrolysis process (Harik et al., 2018).

C-Organic

In this study, the value of the C-Organic parameter in soil media based on laboratory tests showed an increase, although the value of the total Nitrogen parameter could still be categorized as low. The following is a graph of organic carbon values based on laboratory research for each treatment. With the highest value in the treatment concentration of organic NPK solution and MNBs 90 ml. The results of the C-Organic analysis can be seen in Figure 16.

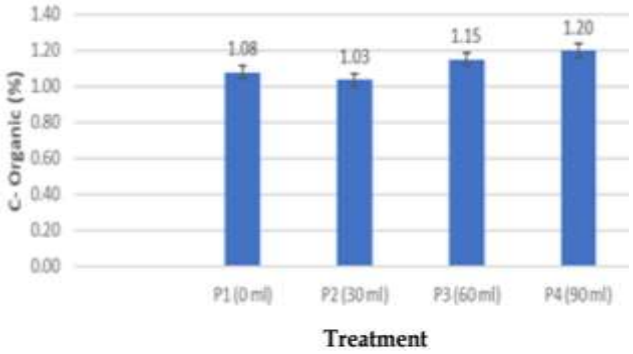


Figure 15. Analysis of average C-organic parameters in soil media

Total Nitrogen

The parameter value of Total Nitrogen in the soil media after being given the NPK and MNBs solution shows that there is a decrease when compared to the control concentration treatment (P1, 0 ml), this can be seen in Figure 16.

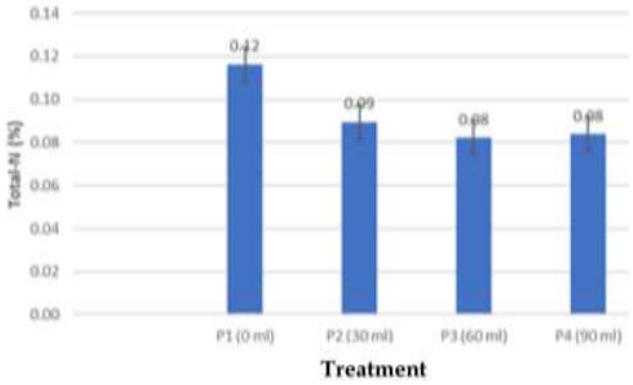


Figure 16. Analysis of average total nitrogen parameters in soil media

Potassium

Soil potassium is formed from the weathering of rocks and minerals that contain potassium. Plants' need for potassium is quite high and will show symptoms of deficiency if their needs are not met. Potassium has an important role in physiological processes such as carbohydrate metabolism, formation, breakdown and translocation of starch, nitrogen metabolism and protein synthesis, monitoring and regulating the activity of various mineral elements, neutralization of organic acids which are important for physiological processes, activating various enzymes, accelerates the growth of meristematic tissue and regulates the movement of stomata and things related to water (Wawan, 2017). The results of the analysis of potassium parameters in soil media in the treatment can increase the K value which can be categorized as high, seen in the treatment with a concentration of organic NPK solution and MNBs P4 of 90 ml. The average analysis of potassium parameters can be seen in Figure 17.

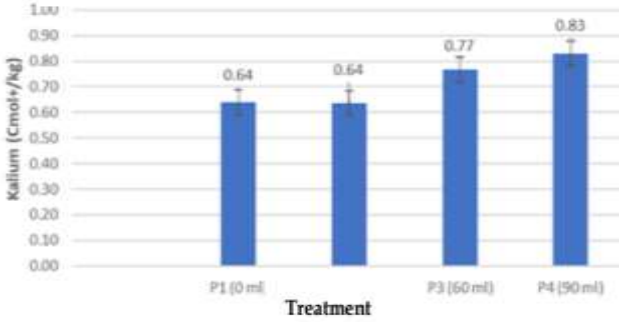


Figure 17. Analysis of average potassium parameters in soil media

Magnesium

Magnesium is in inorganic form in the soil, but in significant amounts it is also associated with organic matter in humus. Magnesium is an element that forms chlorophyll. Lack of magnesium causes characteristic color changes in the leaves. The analysis value of the Mg parameter in each planting media treatment can be categorized as moderate with the results in the treatment research of the concentration of organic NPK solution and MNBs P4 90 ml increasing by 1.38 Cmol+/kg. Analysis of the average value of the Magnesium parameter can be seen in Figure 18.

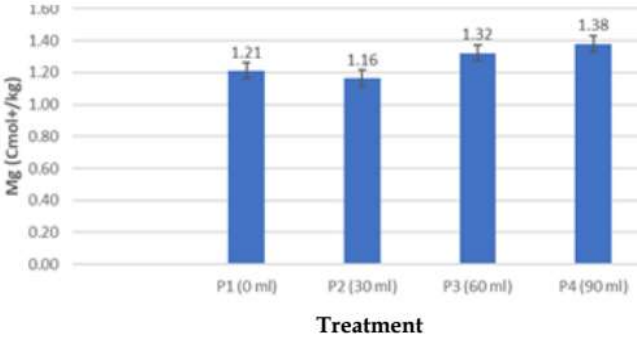


Figure 18. Analysis of average magnesium parameters in soil media

Calcium

Calcium is classified as a secondary essential element such as Magnesium and Sulfur. The benefits of calcium are that it activates the formation of root hairs and seeds and strengthens stems and helps pollination success, helps cell breakdown, helps the activity of several enzymes. Usually soil is acidic if it has a low Ca content (Wawan, 2017). The results of the research on the calcium parameter values in the soil media in each treatment had values that could be categorized as low, but there was an increase in the amount of calcium content in the treatment with a concentration of organic NPK solution and MNBs P4 of 90 ml. The average analysis of Calcium parameters can be seen in Figure 19.

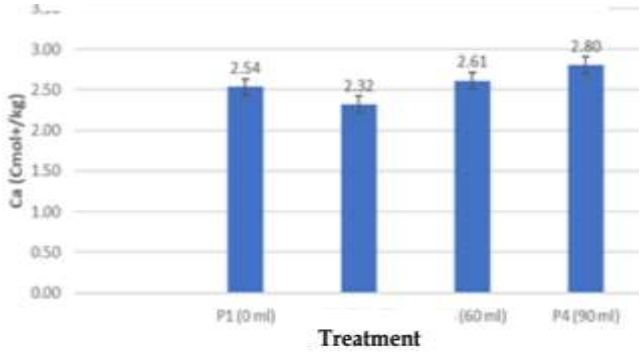


Figure 19. Analysis of average calcium parameters in soil media

Micro Nutrient Parameter Analysis
Sodium

Sodium is a micro nutrient that plants absorb in the form of Na+. Sodium in the soil can have a positive or negative effect on plant growth. Excess Na in the soil will cause the soil to disperse so it is easily eroded. The analysis value of the Na parameter in all treatments can be categorized as low to very low. In the graph there is a decrease in the sodium content of the planting medium when compared to the control planting medium P1 0 ml. Analysis of the average value of the Sodium parameter can be seen in Figure 20.

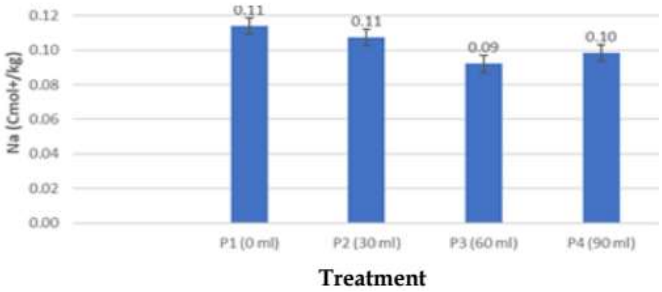


Figure 20. Analysis of average sodium parameters in soil media

Discussion

Indonesia is a country with very high potential for mineral reserves. This potential causes a lot of mining activities in Indonesia. Even though it can increase state income, mining activities are not free from negative impacts. Mining activities that use chemicals and land dredging activities have negative impacts on mining activities, namely environmental pollution and damage to soil structure. The Mining Advocacy Network (Jatam) noted that in 2020, there were at least 3,092 mining holes that had not been reclaimed in Indonesia. To prevent further damage, the government issued regulations requiring reclamation for all mining companies. Mining reclamation regulations are contained in Article 161 B paragraph (1) of Law no. 3 of 2020.

The Ministry of Energy and Mineral Resources (ESDM) noted that throughout 2021, 8,539 hectares of ex-mining land had been successfully reclaimed. The reclamation that has been carried out is expected to provide added value to the ex-mining environment which is usually unproductive land. According to the direction, most of the ex-mining land will be reclaimed as agricultural land or in accordance with the Regional Spatial Planning (RTRW). Apart from being used as agricultural land, ex-mining land can also be used as a means of education and tourism (APL).

The biggest problem in land management in mining areas is that the estimated volume of soil will not be enough to cover all open areas. Based on data from PT. The BAU of land clearing up to 2022 is 612.98 Ha, of which reclamation has been carried out starting from 2012-2022 amounting to 82.92 Ha, while the area that needs to be reforested is 417.76 Ha, therefore PT. BAU still lacks soil to cover 376 Ha or 2,254,260 m3.

Steps that need to be taken by PT. BAU is trying to carry out planting with minimal availability of topsoil, so an accelerated LCC (Legume Cover Crop) planting method is needed to create layers which will later be expected to become natural organic material in disposal areas with minimal topsoil.Soil organic matter generally comes from plant tissue. Plant residues contain 60-90% water and the remaining dry matter contains carbon (C), oxygen, hydrogen (H) and small amounts of sulfur (S), nitrogen (N), phosphorus (P), potassium (K), calcium (Ca) and magnesium (Mg). Even though the amount is very small, this nutrient is very important for soil fertility.

According to Ruhiyat (1999), Legume Cover Crop also lowers soil temperature and reduces soil compaction by decreasing soil volume weight followed by increasing space. total pores. Meanwhile, the decrease in pH of H_2O is thought to be caused by an increase in the concentration of organic material C in the soil, which in the decomposition process produces organic compounds that can reduce soil pH.

The type of LCC recommended in this research is the *Pueraria Javanica* plant. The reason this plant is used is because it grows easily in ex-mining land and is able to improve the quality of soil nutrients. The Pueraria Javanica plant originates from Thailand, another of the most well-known cover plants in the world, a powerful creeper. This plant can stand strongly in the sun and prevent the growth of Chromolena weeds. Level of use of *Puerraria Javanica* nuts.

Pueraria Javanica is a Land Cover Plant/LCC which is commonly used by rubber, oil palm and mining plantations as a pioneer plant which is able to increase soil fertility. the main crops (rubber or oil palm) are immature, and these nuts lower the soil temperature during dry times. Organic fertilizer plays an important role in increasing the physical, chemical and biological

fertility of the soil as well as making the use of inorganic fertilizer more efficient. The quality and composition of organic fertilizer varies depending on the basic compost material and the manufacturing process.

Effect of Giving Organic NPK Solution and MNBs on Pueraria Javanica Plant Growth.

The role of NPK and MNBs solutions in the physical properties of soil include improving soil structure because organic material can bind soil particles into stable aggregates, improving the distribution of soil pore sizes so that soil water holding capacity is better and air movement in the soil is also better and reduces soil temperature fluctuations.

Variations in the dose of Organic NPK solution and MNBs have been evaluated to see their effect on the growth of Pueraria Javanica plants. Based on the Duncan test results, a dose of 90 ml of Organic NPK solution and MNBs showed the best results in increasing all observed growth parameters.

From the research carried out, it can be seen that the long growth of a plant occurs due to cell division and elongation events which are dominated at the tip of the top of the plant. Determining the correct dosage of NPK and MNBs solutions can increase stem length growth, increase the number of leaves, increase the number of leaf branches, increase root length, increase the number of root nodules and increase plant biomass.

An increase in stem length is an indication of good vegetative growth in plants. A greater number of leaves indicates that the plant has a greater ability to photosynthesize, meaning the plant can produce more energy for growth. A greater number of stem branches can increase the plant's ability to absorb light and carry out photosynthesis. Longer root length can increase the plant's capacity to absorb water and nutrients from the soil. In addition, increasing plant biomass indicates an increase in overall crop production.

NPK solution andMNBsis an organic liquid fertilizer and the basic ingredients for making it can be ensured to contain few hazardous materials such as heavy metals such as Pb, Cd, Hg and As. Choosing fertilizer that is free from heavy metals is very necessary because fertilizers containing heavy metals are thought to contain many dangerous substances, heavy metals and phenolic acids which can pollute the environment and poison plants.

Based on observations that have been made, the use of organic NPK solutions and MNBs does not affect soil pH with H2O or HCl solvents. This is due to the nature of the NPK and MNBs solutions which have a slightly acidic pH (Janarthanan et al., 2020), therefore the NPK and MNBs solutions applied to soil media which initially already had an acidic soil pH, still make the soil become sour. According to Dr. Rosukon Poompanvong, a good pH value in the fermentation process of NPK and MNBs solutions is a pH value below 4 (Ronny & Ihsan, 2022). The NPK and MNBs solutions have a fresh sour fermented aroma and have an acidic pH of 4 and contain various nutrients such as organic c, nitrogen, phosphorus and potassium.

This study also has several limitations. First, the focus of the research is only on the Pueraria Javanica species and the effect of organic NPK solutions and MNBs on other plant species still needs to be studied further. In addition, this research was conducted in laboratory or greenhouse conditions, so the results need to be verified through field tests at actual post-coal mining locations. This research provides new understanding about the use of organic NPK solutions and MNBs to increase plant growth on post-coal mining land. By improving the growth of *Pueraria Javanica* plants, this research has the potential to make a significant contribution to post-mining land rehabilitation efforts and promote ecosystem sustainability. The Effect of Soil Media Conditions after Being Given Organic NPK and MNBs Solutions on the Growth of *Pueraria Javanica* Plants.

The research results showed that the use of organic NPK and MNBs solutions at a dose of 90 ml had a positive influence on the total content of organic carbon, magnesium, potassium and calcium in the soil media. This shows that this combination can be used as an effective method to improve soil quality in terms of essential nutrient content. This study also showed a significant increase in the total organic carbon content in soil media with the use of organic NPK solutions and MNBs. This shows that this method is effective in increasing organic matter levels in the soil. Organic matter in soil plays an important role in improving soil structure, water retention, and nutrient availability for plants. Increasing organic carbon can improve soil fertility and the quality of plant growth.

A dose of 90 ml of organic NPK solution and MNBs was the optimal dose to achieve maximum increase in total organic carbon content. This indicates that it is necessary to pay special attention to the doses used in agricultural practices, as too low a dose may not give the expected results, while too high a dose may result in wastage of material.

The use of organic NPK and MNBs solutions at a dose of 90 ml can be recommended as a method for increasing soil fertility and productivity of reclamation activities in post-mining reclamation areas. This can help companies increase revegetation crop yields in an environmentally friendly way, because this method utilizes natural soil microorganisms and does not require the use of harmful chemicals.

The results of the correlation analysis showed an interesting pattern of relationships between plant growth and soil parameters. There was a negative correlation with the development of total nitrogen in the observed soil media. This also of course requires further research as to why this could happen.

The low pH values of H2O, pH KCl, potassium, magnesium, calcium and sodium in the soil are thought to be caused by plants using water, nutrients and minerals from the soil for growth and development. Plants absorb many nutrients such as potassium, magnesium, calcium and sodium, the levels of these nutrients in the soil will naturally decrease. Plants with lots of leaves or root nodules tend to have increased microbial activity around their roots. These microbes play a role in the decomposition process of organic matter and release organic acids into the soil, which can cause a decrease in pH (Al-Busaidi et al., 2003).

The higher number of leaves and root nodules on *Pueraria Javanica* plants indicates more intensive photosynthetic activity and better nutrient absorption capacity. In this case, plants can take up nutrients available in the soil efficiently, which in turn can lead to a decrease in nutrient concentrations in the soil. The presence of more leaves and root nodules can reduce soil acidity levels (lower pH) due to high nutrient absorption activity (Mudhita et al., 2016).

Organic NPK and MNBs solutions contain microbes that can increase soil aggregation, improve soil structure, and increase organic matter content. The application of organic NPK and MNBs solutions to soil improves soil physical and chemical properties, such as water infiltration, porosity, cation exchange capacity (CEC), and water holding capacity (Nurdiansyah et al., 2023). This has a positive impact on the growth of *Pueraria Javanica* plants.

Other plant growth parameters such as stem length, number of branches, root length, and biomass show a positive correlation with pH Kcl, CEC, Potassium, Magnesium, Calcium. This shows that the higher the value of the plant growth parameters, the observed soil parameter values tend to increase.

This positive correlation can be explained as follows. Better growth of Pueraria Javanica plants, such as an increase in stem length, number of branches, root length, number of root nodules and biomass, indicates higher photosynthetic activity and the plant's ability to take up nutrients from the soil effectively. As a result, increased plant activity can increase the availability of nutrients in the soil and positively influence the pH balance and nutrient content of the soil (Hartati, 2023).

This research has important implications in the context of post-coal mining land rehabilitation. In an effort to restore the quality of degraded soil, the use of *Pueraria Javanica* plants can provide significant benefits. This plant is able to increase important soil parameters, such as pH, cation exchange capacity, and essential nutrient content. Thus, the use of *Pueraria Javanica* as a ground cover plant on post-coal mining land can increase the success of land rehabilitation.

The identified correlations only reflect statistical relationships between observed variables, and do not provide direct causal explanations. In addition, this research was limited to the *Pueraria Javanica* plant species and soil parameters were limited to pH H_2O, pH KCL, CEC, Potassium, Magnesium, Calcium and Sodium. Further research is needed to expand understanding of the correlation between plant growth and soil parameters by involving other plant species and other relevant soil parameters. This research provides a new understanding of the relationship between *Pueraria Javanica* plant growth and soil parameters on post-coal mining land. These findings provide a strong basis for using Pueraria Javanica as an effective rehabilitation plant in improving soil quality.

Conclusion

Based on research that has been carried out, the results show that administering NPK and MNBs solutions has been proven to help accelerate stem growth, number of leaves, number of leaf branches, root length, number of root nodules and increase the biomass of *Pueraria javanica* plants in planting media with minimal topsoil.

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Auhor Contribution

Y. A: preparation of original draft, results, discussion, methodology, conclusions; I. U, M. G and A. R: analysis, review, proofreading and editing. Y. A, I. U, M. G and A. R: All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interst

The authors declare that there is no conflict of interest regarding the publication of this paper.

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