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The role of ground cover plant in soil improvement after mining activity in South Kalimantan

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Abstract: *The aim of the research is to identify the potentiality of vegetation to improve chemical soils element in the disposal soil after mining activity in South Kalimantan, Indonesia. The experiment was done by establishing plots observation by 4 x 10 m which are set up at disposal land with the length slopes 35 meter and the high of slope was 12 meter. Four plant species namely Desmodium adscendens, Pueraria phaseloides, Centrosema pubescens and Alopogonium mucunoides was planted in the experimental plots The observation was done systematically in order to identify the chemical characteristic of soils. Result of the study shows that ground cover in disposal soils in post mining area contribute to increase C organic of soil. The plots with vegetation cover Pueraria phaseloides, Centrosema pubescens, and Calopogonium mucunoides provides significant carbon stock in soils. These plants also contribute significantly to increase Nitrogen content in soil system. In this experiment, soil with Desmodium adscendens has highest contribution in increasing P_2O_5 in soil system. Calopogonium mucunoides has highest contribution in increasing Potassium element in soil system, following by Centrosema pubescens and Desmodium adscendens. Three vegetation covers, namely Desmodium adscendens, Pueraria phaseloides, and Centrosema pubescens able to increase pH in disposal soil in post mining area. The contrubution of Desmodium adscendens as a ground cover in Calcium improvement in disposal land in post mining land higher than soil with Pueraria phaseloides. In this experiment, plot with Desmodium adscendens, Pueraria phaseloides, Centrosema pubescens and Calopogonium mucunoides able to increase Magnesium in soil. The highest base saturation was found at soil with ground cover Calopogonium mucunoides, followed by Centrosema pubescens and Desmodium adscendens. The Pueraria phaseloides seems to be no contribution in base saturation, in which statistically it is no significant different with control. These research reveals that vegetation covers contributes significantly in disposal soil improvement in post mining area.*

Keywords: *erosion, soil management, post mining, chemical soil improvement*

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I. Introduction

Coal mining is one of the human activities which are widely recognized changes the landscape and produce numerous negative impact to environment. Changes of landscape influence changes of land suitability for agriculture, reduce land availability to support hydrological process, and lead to the extinction of biodiversity. Change of landscape potentially reduce chemical element of soils, in which it is crucial in plant and crops productivity [1] [2].

The open mining especially is important issues in Indonesia. An intensive and massive open mining often employ numerous machine which area able to change large habitat in a short time. These influence the rapid loss of vegetation in short time. There are also changes in soil viability and ability to support living system, both in soil and the surface of soil. Rehabilitation of land in post mining area through revegetation often become the important step to increase the viability of soils. In rehabilitation program, the selection of proper plant species becomes key for success[3][4].

Plant is important instrument in soil conservation and rehabilitation especially in degraded soils land. Recent survey shows that numerous plant has ability to improve soil condition and decrease threats of lands. The types of plant chosen depend on the soil and plant potential viability to reduce negative impact of mining. The use and integration of vegetation in soil rehabilitation in post mining area can only be achieved through scientific studies in plant and vegetation contribution to countermeasure land degradation. There is also numerous indigenous agricultural practices which is important for post mining area rehabilitation. There are also

simple methods to improve land status using planting shrubs as vegetation cover. It is therefore useful and perhaps important to perform plant ability regarding its role in soil conservation [4][5][6] [7].

As far, there are few studies on the implementation of ground cover application to improve soils quality in post mining lands. Kalimantan has huge biodiversity and offer numerous plant species to involve in land rehabilitation program [8]. The aim of the research is to identify the potentiality of vegetation to improve chemical soils element in the disposal soil after mining activity in South Kalimantan, Indonesia.

II. Methods

The experiment was done in post mining area in South Kalimantan, Indonesia. It is located at the geographic position of S 02°11'12"and E 115°30'33.3", with altitude 104 meter asl [9] (Fig. 1). The experiment plots are set up at the disposal area of post mining land. An experimental plot by 4 x 10 meter was set up at the area with the length of slopes 35 meter and high 12 meter. The experimental plot as established and experiments was done by setting plot as (1) plot without vegetation as control P0, (2) plot with *Desmodium adscendens* P1, (3) plot with *Pueraria phaseloides* P2, (4) plot with *Centrosema pubescens* P3, and (5) plot with *Calopogonium mucunoides* P4. In each plot, there are three plots observation were established.

The physical and chemical analysis of soils in each plot was done following standard methods. Soil sample was collected from each plot experiment after one period of plant growth. Soils was take at 5-10 cm in depth. About 500 gr soil was collected for further chemical analysis in laboratory. Data were analyzed descriptively.

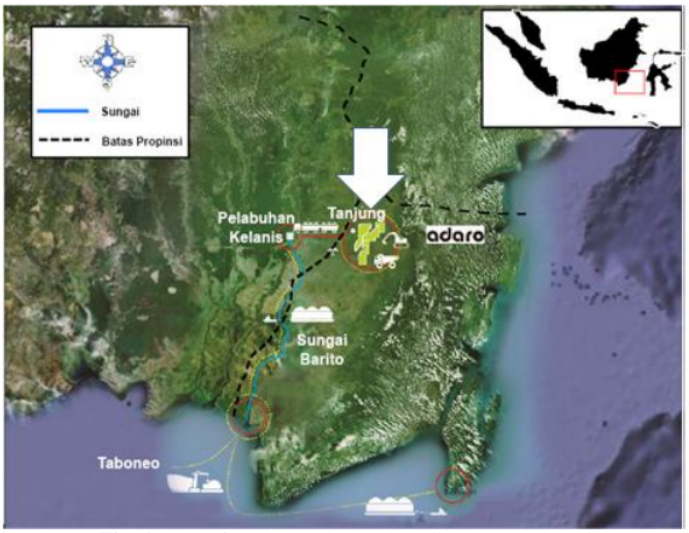

Fig. 1. Map of study area in South Kalimantan, Indonesia

III. Result and Discussion

Vegetation contributes significantly in soil improvement. Among the benefits of vegetation, area reducing potential land slide and contributes in hydrological cycle of the area [10]. Carbon as one of the main element of soil, and the existence of carbon in soil can be in organic and inorganic form. The organic carbon often composed from residues of animals and plant, in which it is contribute to positive impact to soil chemical and physical aspect [11]. In this research, the planting some plant in disposal soils in post mining area contributes to increase C organic of soil (Fig. 2).The plots with vegetation cover *Pueraria phaseloides* P2, *Centrosema pubescens* P3, and *Calopogonium mucunoides* (P4) provides significant carbon stock in soils. It is higher than the contribution of *Desmodium adscendens*. There are, however, contribution of vegetation cover in carbon organic improvement in soil compared to the control. The contribution of vegetation to improve organic carbon not only significant to improve soil fertility to support plant grows, but it is also significantly contributes in global warming mitigation. Organic carbon in soil is major sink, in which it is important in global carbon balance. Organic carbon also provides benefits impact to support plant and crop growth [11].

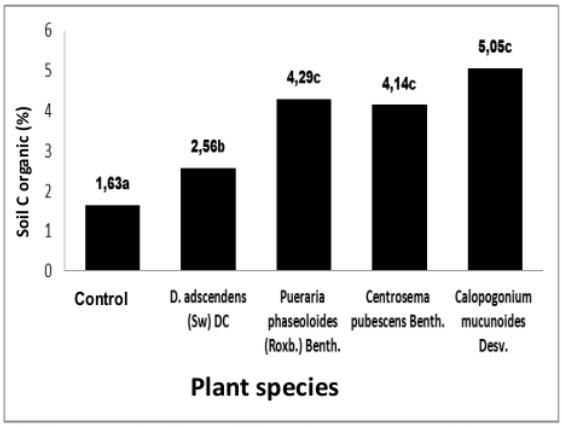

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Fig. 2. The ability of plant to increase organic carbon in disposal soils in post mining area

Nitrogen is the crucial element in soil. In soil system and environment, Nitrogen exists in many forms. In soil system, Nitrogen able to changes and transforms easily form one form to another. While nitrogen is important element in soil to support plant and crop productivity, some human activity potentially decrease Nitrogen content through denitrification, leaching, volatilization and soil erosion. Plant and crop removal also contributes to the Nitrogen loss from soil system. Therefore, planting vegetation in the surface of degraded plant is important to enhance the Nitrogen balance in soil system [12]. The nitrogen content of soils in each observation lot was given in Fig. 3. From Fig. 3, it is clear that planting vegetation cover able to increase Nitrogen compared to the land without vegetation cover. Thre vegetation covers, namely soil with vegetation cover of *Desmodium adscendens* P1, *Pueraria phaseloides* P2, *Centrosema pubescens* P3, and *Calopogonium mucunoides* shows no significant different to increase Nitrogen in soil system. These experiment shows that establishment ground cover using such plant is important strategy to improve chemical characteristics of soils [13][14].

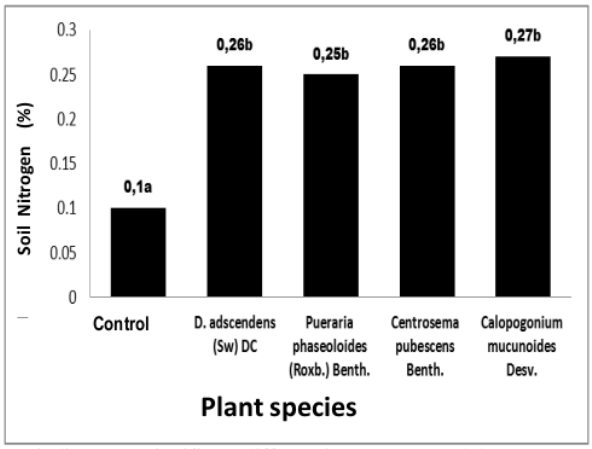

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Fig. 3. The ability of plant to increase nitrogen content in disposal soils in post mining area

P_2O_5 -the phosphate oxide- is sources of phosphor in soil in which this element is crucial for plant growing. Soil vegetation contributes to the increase of P_2O_5 (Fig. 4). In this experiment, soil with *Desmodium adscendens* has highest contribution in increasing P2O5 in soil system. Phosphates is important element, in which the abundance phosphate in water environment led to the rapid growth of algae and stimulates weeds. Scholar point out that phosphorus is easy to fix in the soil system, in which plant can absorb only in a small amount [15][16].

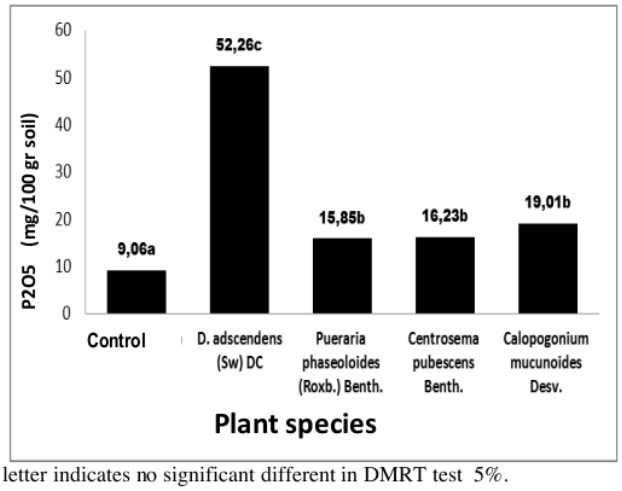

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Fig. 4. The ability of plant to improve P_2O_5 contentin disposal soils in post mining area

Potassium is crucial element in soil system, and especially it is important in crops productivity. There are significant role of vegetation in K_2O in soil system. Theoretically, K_2O found in sub soil land about 2.02 and top soil was about 1.92%. These is become the crucial element in soils, especially for plant growth [17] [18]. In this research, *Calopogonium mucunoides* has highest contribution in increasing Potassium element in soil system, following by *Centrosema pubescens* and *Desmodium adscendens*. The lowest contribution was given by *Pueraria phaseloides*. However, compared to the control, these plant contributes to the potassium element improvement, in which it is benefits to enhance soil quality.

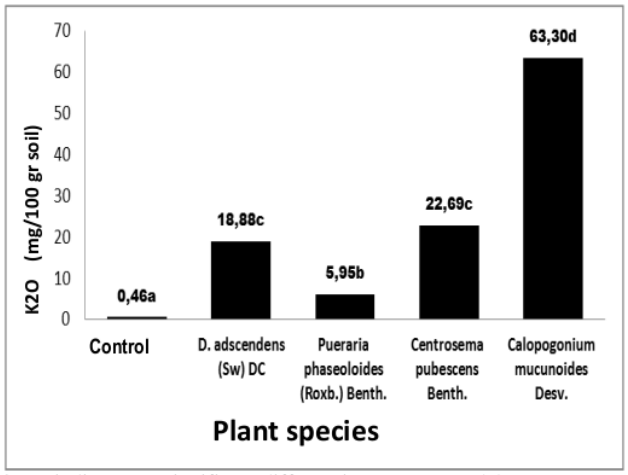

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Fig. 5. The ability of plant to improve K_2Ocontentin disposal soils in post mining area

Vegetation cover able to increase soil pH. Three vegetation covers, namely *Desmodium adscendens* P1, *Pueraria phaseloides* P2, and *Centrosema pubescens* P3. *Calopogonium mucunoides* able to increase pH, but compared to the previous vegetation it is quite low (Fig. 6). pH is important becuse pH dtermine the success of important soil element by plant, such as Magnesium [19].

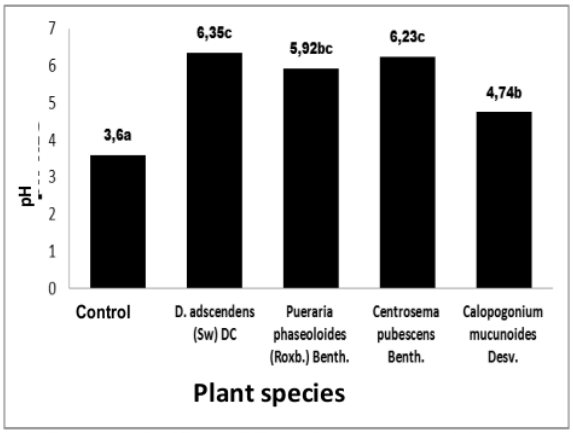

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Fig. 6. The impact of vegetation in soil pH in disposal soils in post mining area

Calcium is an important metal in soil sistem, in which it is important to create goot soil structure for agricultural activiity and to support plant growth. Principally, plant cover contribute in calcium content in soil system [20]. The contrubution of *Desmodium adscendens* P1 as a ground cover in disposal land in post mining land higher than soil with with *Pueraria phaseloides*. The high contribution was provided by *Centrosema pubescens* and *Calopogonium mucunoides*

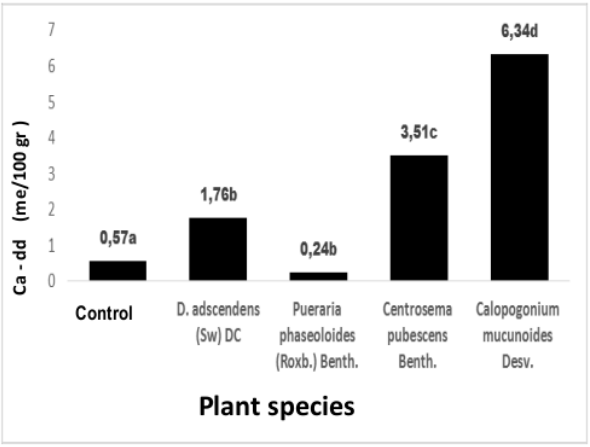

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Fig. 7. The impact of vegetation in Ca-dd in disposal soils in post mining area

Magnesium is importan element in soil system. In lant physiology, Magnesium important as a buiding block of plant cell organel called Chlorophyl, in which it is important in plant photosysntehsis. In soil system, there are three fractios of magnesium, namely Magnesium in soil solution, exchangeable magnesium and non-exchangeable magnesium. There are two important mechanism of Magnesium up take, namely passive active and diffusion [21]. In this experiment, plot with *Desmodium adscendens*, *Pueraria phaseloides*, *Centrosemapubescens* and *Calopogonium mucunoides* able to increase Magnesium.

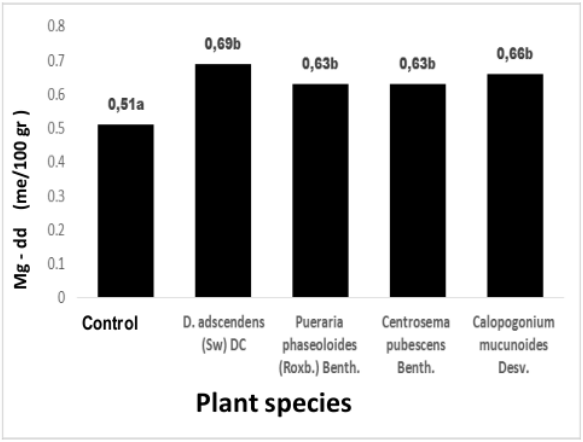

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Fig. 8. The impact of vegetation in Mg-dd in disposal soils in post mining area

In soil system, Base saturation is important since it is indicates the balance between base and acid cations which area adsorbed by CEC. The highest base saturation was found at *Calopogonium mucunoides*, followed by *Centrosema pubescens* and *Desmodium adscendens*. The *Pueraria phaseloides* seems to be no contribution in base saturation, in which statistically it is no significant different with control (Fig. 9).

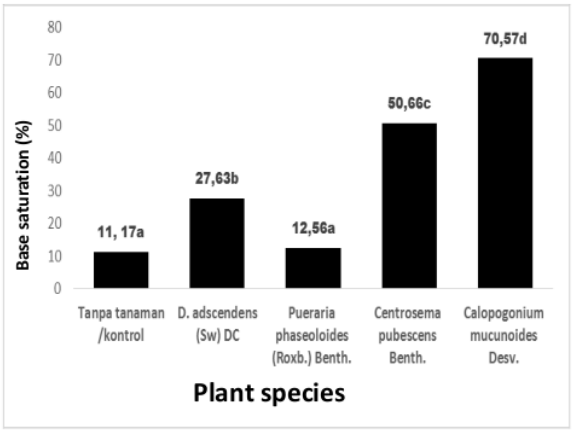

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Fig. 9. The impact of vegetation in base saturation in disposal soils in post mining area

IV. Conclusion

Pueraria phaseloides, *Centrosema pubescens*, and *Calopogonium mucunoides* able to increase carbon stock and nitrogen content in soil system. In this experiment, soil with *Desmodium adscendens* has highest contribution in increasing P_2O_5 in soil system. *Calopogonium mucunoides* has highest contribution in increasing Potassium element in soil system. Three vegetation covers, namely *Desmodium adscendens*, *Pueraria phaseloides*, and *Centrosema pubescens* able to increase pH in disposal soil in post mining area. The contrubution of *Desmodium adscendens* as a ground cover in Calcium improvement in disposal land in post mining land higher than soil with *Pueraria phaseloides*. Plot with *Desmodium adscendens*, *Pueraria phaseloides*, *Centrosema pubescens* and *Calopogonium mucunoides* able to increase Magnesium in soil. The highest base saturation was found at soil with ground cover *Calopogonium mucunoides*, followed by *Centrosema pubescens* and *Desmodium adscendens*.

Acknowledgements

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