Improvement of nutrient status in ex-gold mining land with the application of rice terra preta biochar technology

Gusmini\textsuperscript{1,3}, Adrinal\textsuperscript{1,3}, Yaherwandi\textsuperscript{2}, E L Putri\textsuperscript{3}, R Panji\textsuperscript{1}

\textsuperscript{1}Department of Soil Science, Agriculture Faculty, Andalas University, Padang, West Sumatera, 25163, Indonesia.
\textsuperscript{2}Department of Plant Protection, Agriculture Faculty, Andalas University, Padang, West Sumatera, 25163 Indonesia.
\textsuperscript{3}Post graduate of Soil Science, Agriculture Faculty, Andalas University, West Sumatera, 25163, Indonesia.

E-mail: gusminianis@gmail.com

Abstract. This research on the escalation of nutrient status aims to determine the effect of giving Terra Preta Biochar Padi (Tetadi) on ex-gold mining land to P-available land in Nagari Padang Sibusuk Sijunjung Regency, West Sumatra. Soil samples were taken from the former gold mining soil with a depth of 0-20 cm randomly. This research was conducted using a completely randomized design with 6 treatments and 4 replications consisting of control (A), Tetadi 10 tons / ha (B), Tetadi 15 tons / ha (C), Tetadi 20 tons / ha (D), Tetadi 25 tonnes / ha (E), and Tetadi 30 tonnes / ha. The results showed that giving Terra Preta Biochar Rice to ex-gold mining land could increase the highest available P of soil in the treatment of rice Terra Preta Biochar 30 tonnes / ha with the results of the 5% DMRT statistical test very significantly different from the control treatment and 10 tonnes / ha and 15 tonnes / ha. Soil pH also showed the highest increase in the treatment of 30 tonnes / ha with a pH value of H\textsubscript{2}O of 5.7 and followed by a pH of KCl with a value of 4.6 and statistical test results showed that the treatment of 30 tonnes / ha was also very significantly different from control and treatment.

Keywords: P nutrient status, Tetadi, P-available.

1. Introduction
West Sumatra is one of the provinces in Indonesia that has the potential for gold. One of the districts in West Sumatra that has a lot of gold mineral resources is Sijunjung Regency. According to data from the Forum for the Environment, the area of agricultural land that has been threatened with damage due to the gold mining process in Sijunjung Regency reaches 548 hectares. The form of land damage caused by gold mining activities is a decrease in the quality of soil chemical properties. Ex-mining soils have soil chemistry problems related to low soil acidity (pH), low organic matter content and low nutrient content. Improvement of P nutrient status is an increase in the available P content in the soil that has been incubated with the Terra Preta Biochar Rice treatment. Lack of P nutrient can cause: plant roots do not develop; in a state of severe P deficiency, leaves, and branches. The number of tillers is reduced [1]. Biochar has the ability to stabilize heavy metals in contaminated soil by significantly reducing the absorption of heavy metals by plants and can improve soil quality by improving soil physical, chemical and biological properties [2];[3];[4]. The main mechanism of absorption of heavy metals by biochar according to [5] is the exchange of heavy metals with Ca\textsuperscript{2+}, Mg\textsuperscript{2+} and other cations contained in biochar.
Terra preta is a combination of organic and biochar materials which is one of the renewable technologies for the improvement of this former gold mine land. The terra preta composition are organic waste, manure, and rice husk biochar which is renovated with the help of decomposer. This technique also helps eliminate dependence on rainfall and chemical fertilizers that potentially destroy the soil in the long period.

2. Materials and Methods

2.1. Time and Location of Research
This research was conducted from June to November 2020 in the greenhouse and laboratory of the Soil Department, Faculty of Agriculture, Andalas University, Padang, West Sumatra.

2.2. Tools and Materials
Tools that will be used during the research namely, a tool for making terra preta, hoe, beaker, erlenmeyer, pot, dropper, sample ring, and others. Meanwhile, the materials used are land from ex-gold mining taken in Nagari Padang Sibusuk, Sijunjung Regency, biochar rice husks that have undergone a pyrolysis process by heating 400 - 500 °C, composted manure, indicator crops used is the paddy, and the basic fertilizers used are Urea, SP-36, and KCl.

2.3. Research Methods and Implementation
The method used in this study was a completely randomized design (CRD) pot experiment method with 6 treatments and 4 replications, to obtain 24 experimental units. The treatments used consisted of treatment treatment A (control), B (10 tonnes/ha tetadi), C (15 tonnes/ha tetadi), D (20 tonnes/ha tetadi), E (25 tonnes/ha tetadi), dan F (30 tonnes/ha tetadi).

2.4. Soil Analysis
Soil analysis consists of pH (H₂O), organic matter, available P, water content, texture, bulk density, and permeabilitas.

2.5. Data analysis
The data obtained in the form of initial soil analysis, final soil analysis, and plant data will be processed based on statistical analysis, variety, and further test (DMRT) at 5% level.

3. Result and discussion

3.1 Preliminary Soil Analysis Results
The results of the preliminary soil analysis on ex-mining soils are presented in Table 1. Based on the results of the analysis of the chemical and physical properties of the initial soil in Table 1, it can be seen that the soil in the research area has a pH H₂O of 4.52, which is acidic, as well as the total N, exch-K, exch-Ca, exch-Mg, and exch-Na in this ex-mining area are very low status. In addition, the initial soil CEC value indicates a high status. Organic matter and available P content also experienced a low level for their respective soil properties. This condition indicates that the land use has a low fertility rate. It can also be seen that the physical properties of the former gold mine soil have a moisture content of 11.41%, and are having a loamy sand soil texture with bulk density of 1.01 g / cm³ and permeability of 139.65 cm/hr. If this condition is not improved, it will inhibit plant growth.

Mining activities have the potential to generate substantial regional income. However, these activities also have negative impacts on the environment[6]. The negative impacts are a decrease in the condition of ex-mining soil in the form of loss of soil layer profile, soil compaction (high level of bulk density), lack of essential nutrients, low pH, pollution by heavy metals on ex-mining land (tailings), and decrease in soil microbial population[7]. This condition will disrupt the ecosystem of an environment, causing environmental quality and productivity to decrease[8] so that the ecological system will suffer damage.
Table 1. Preliminary soil analysis

| Type of analysis | Score | Criteria |
|------------------|-------|----------|
| Chemistry        |       |          |
| pH H₂O           | 4.52  | Acid     |
| pH KCl           | 4.41  |          |
| Organic matter (%)| 1.50  | Low      |
| Available P (ppm)| 6.19  | Low      |
| Physics          |       |          |
| Water content    | 11.41 |          |
| Texture          |       |          |
| Sand (%)         | 77.07 | Loamy sand|
| Silt (%)         | 21.85 |          |
| Clay (%)         | 1.08  |          |
| Bulk density (g / cm³) | 1.01 |          |
| Permeability (cm / hr) | 139.65 | Fast    |

3.2 Soil properties After Incubation

Observation of several soil chemical properties after incubation with Tetadi (Terra Preta Biochar Rice Husk) includes: pH (H₂O) pH, pH (KCl), available P (ppm), and Organic C (%). The results of the analysis of soil chemical properties after incubation are presented as follows.

3.2.1 Soil pH. Ex-gold mining land has a low pH value which results in the soil dissolving easily with high concentrations of metals [9]. The soil pH value that has been applied with Rice Husk Terra Preta Biochar with several doses can be seen in Figure 1

![Figure 1. Soil pH following the application of Tetadi.](image)

The statistical results of the highest pH is in the F application, namely Terra Preta Biochar Rice Husk, a dose of 30 tonnes / ha, but at pH H₂O there is a significant difference in the D treatment dose, namely the dose of 20 tonnes / ha. This indicates that Rice Husk Terra Preta Biochar is capable of being an ameliorant in increasing the pH of the former gold mining soil which was previously acidic. Soil pH that is neutral in ex-gold mine soil which is given ameliorant can increase nutrient content in the soil[8].

3.2.2. Organic material. The results of the organic matter content in ex-mining soil that has been incubated with Rice Husk Terra Preta Biochar at several doses can be seen in Figure 2.

Terra preta serves as organic material for this former gold mine soil. The results of this analysis also show that the highest does of tetadi. Which is 30 tonnes/ha, can increase the criteria for organic matter content from low to moderate so that this condition can have a better impact on soil health and plant
growth on it. The increase in organic matter is able to increase the activity of microorganisms in the soil so that soil porosity is better and is followed by good nutrient conditions and water availability [10].

3.2.3. P-available. The results of the P value analysis available on ex-gold mine soil that has been incubated by Terra Preta Biochar Rice husk at several doses can be seen in Figure 3.

In Figure 3, it can be seen that giving tetadi can increase P in the soil. This is because there is an increase in the pH value of the soil, meaning that the closer to the neutral pH value of the soil, the higher P-available content. Increasing the pH value of the soil close to a neutral point causes the fixed P to be released and dissolved, so that its availability increases [11].
4. Conclusion
The application of Terra Preta statistical analysis showed a significant effect to available P and soil pH. Although the other parameters are not significantly different, it has shown a significant increase in soil fertility yield.

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