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EFFECTS OF BIOCHAR APPLICATION ON PHYTOREMEDIATION OF GOLD MINE TAILINGS BY VETIVER GRASS, *Chrysopogon zizanioides* (L.).

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BY

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A project report submitted to Faculty of Agriculture, Universiti Putra Malaysia, in fulfillment of the requirement of PRT4999 (Final Year Project) for the award of the Degree of Bachelor of Agricultural Science

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This project report entitled the **Effects of biochar application on phytoremediation of gold mine tailings by Vetiver grass (*Chrysopogon zizanioides*)** is prepared by Mohd Syafiq bin Wahab and submitted to the Faculty of Agriculture, Universiti Putra Malaysia, in fulfillment of the requirement of PRT4999 (Final Year Project) for the award of the degree of Bachelor of Agricultural Science.

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ABSTRACT

A study on the effects of biochar application on phytoremediation of gold mine tailings by using Vetiver grass, *Chrysopogon zizanioides* was conducted at Glass House Unit 2, Universiti Putra Malaysia. The objective of this study is to determine the effect of biochar on phytoremediation of tailings, to determine the most effective rate of rice husk biochar to be used, and to determine the capability of Vetiver grass, *C. zizanioides* in absorbing heavy metals. The treatment used for this study was at different rates of biochar (0, 25, 50, 75, and 100 grams) to be mix with the tailings and topsoil of Munchong series as the media for planting both of the plants. The mass of tailings were kept constant at 20 grams while the topsoil at 200 grams. The experimental unit had been designed with four replications and planted for 60 days. Maintenances like watering and weeding were manually done. After 60 days, plants were taken out from the plant and cut according to two parts, root and shoot. Then, dry ashing process was done to the parts and the samples are tested by Inductively Coupled Plasma (ICP) optical emission spectrometry to determine the amount of heavy metals that had been extracted. From the results, *C. zizanioides* showed potential in surviving on contaminated tailings and in uptaking heavy metals. In addition, rice husk biochar also showed its ability in immobilization of heavy metals, making it unavailable for uptakes. Soil management strategies should focus on these two methods for soil phytoremediation. The data was analysed by using Analysis of Variance (ANOVA) in Statistical Analyses System (SAS 9.2).

ABSTRAK

Satu kajian tentang kesan penggunaan biochar terhadap fitopemulihan sisa lombong emas menggunakan rumput Vetiver, *Chrysopogon zizanioides* telah dijalankan di Rumah Kaca Unit 2, Universiti Putra Malaysia. Tujuan kajian ini adalah untuk mengenal pasti kesan biochar terhadap fitopemulihan sisa lombong, kadar penggunaan biochar sekam padi yang paling berkesan, dan kebolehan rumput Vetiver, *C. zizanioides* menarik elemen logam. Rawatan yang telah diberikan berbeza dari segi kadar berat biochar (0, 25, 50, 70, dan 100 gram) untuk dicampurkan dengan sisa lombong dan tanah atas siri Mnchong sebagai media tanaman. Berat sisa lombong dan tanah atas masing-masing dimalarkan pada 20 dan 200 gram. Unit eksperimen mempunyai empat pengulangan dan telah ditanam selama 60 hari. Proses penjagaan seperti menyiram dan merumpai dilakukan secara manual. Selepas 60 hari, rumput dituai dari polibeg dan dipotong kepada dua bahagian iaitu akar dan pucuk. Kemudian, pengabuan kering telah dilakukan dan sampel dihantar ke ICP-MS dan jumlah elemen logam yang ditarik diketahui. Data telah dianalisis menggunakan Analisis Varian (ANOVA) dan Statistical Analyses System (SAS 9.2). Dari dapatan kajian, *C. zizanioides* menunjukkan potensi dalam kemandirian di sisa lombong tercemar dan pengambilan elemen logam. Sebagai tambahan, biochar sekam padi turut memperlihat potensi dalam menghentikan pergerakan elemen logam sekali gus tiada elemen logam untuk pengambilan. Strategi pengurusan tanah harus memberi fokus kepada kaedah ini untuk fitopemulihan tanah.

CHAPTER 1

INTRODUCTION

Back to the old days, mining industry had been one of the major contributors to the economic growth in Malaysia. Mining has been defined as the process or business of digging in mines to get metals, jewels, minerals, etc. It is usually involved digging in big areas. One of the examples of mine in Malaysia is Penjom gold mine in Pahang. This gold mine has produced nearly 80,000 ounces of gold per year (Avocet, 2010). There are several methods can be used in gold mining such as placer mining, panning, sluicing, dredging, rocker box and hard rock mining. These methods will produce wastes that are very harmful for the environment and mankind.

One of the wastes produced is tailings. Tailings are the materials left over after the process of separating the valuable fraction from the uneconomic fraction of an ore. Typically, the bulk quantity of a tailings product will be barren rock, crushed and ground to a fine size ranging from coarse sands down to a talcum powder consistency. Tailings may contain trace quantities of metals found in the host ore, and they may contain substantial amounts of added compounds used in the extraction process. The elements and compounds uncovered and liberated through mining and processing, which are not usually part of the ecological systems in such a form or concentration have the potential to alter the receiving environment to its detriment. Common minerals and elements found in tailings including arsenic, copper, fluorite,

lead, mercury, sulphur and cadmium. These can cause detrimental effect onto the soil and groundwater, thus affecting human, plants, and also animals.

There are many ways that can be used for soil remediation but one of the easiest methods is phytoremediation. Phytoremediation is the use of green plant-based systems to remediate contaminated soils, sediments, and water. Green plants will be planted at the targeted area and it will act like a sponge and absorb the heavy metals in the soil. Contaminated sites often support characteristic plant species, some of which are able to accumulate high concentrations of heavy metals in their tissue (Khan et al., 2000). The most common heavy metal contaminants are: cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), lead (Pb), nickel (Ni) and zinc (Zn) (Lasat et al., 2001; Chhotu et al., 2008). Examples of plants that can be used for phytoremediation are mustard plants, alpine pennycress, hemp, and pigweed.

Biochar can assist phytoremediation process but the suitable rate of biochar to be used has to be identified first. This to avoid waste usage of biochar as the cost of biochar is quite expensive and help plants to absorb maximum amount of heavy metals. It also helps to increase the survival rate of the Vetiver grass, *Chrysopogon zizanioides* when planted in mixture of tailings and Munchong topsoil.

Objective

The objectives of this study were:

1. To determine the effect of biochar in phytoremediation of tailings.
2. To determine the most effective rate of biochar to be used.
3. To determine the ability of Vetiver grass to extract heavy metals (arsenic, copper, lead)

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