The Effect of Biochar Application on Nutrient Availability of Soil Planted with MR219

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Abstract
This study aims to determine the effect of biochars on the soil pH, nutrient content in soil and the growth performance in terms of height of paddy and number of tiller in a field experiment. Biochars as a new soil amendment has a potential in controlling the fate of trace elements in the soil system. However, the production of biochar from different types of biomass resulted in variable biochars properties which have an influence on trace elements availability in soil. Both biochars type was tested at equal rates respectively. The results detailing the nutrient content and growth performance of paddy showed that the application of both RH and EFB improve biomass production. The results show that the addition of EFB biochar to soil has a positive effect in growth performance and nutrient content. However, after running the statistical analysis on data, it shows that there is no significant difference between the treatments either in soil pH, nutrient content, plant height and the number of tiller on paddy (P>0.05).

Introduction
Biochar is plant based materials that has been charred by a process called pyrolysis, where there is no or less oxygen. It is rich in carbon elements. Biochar is referred to the plant biomass derived materials that includes chars and charcoal while excluding fossil fuel products [1]. The function of biochars are used as a soil amendment which enhances plant growth and nutrient use efficiency, improved holding capacity of nutrients such as nitrogen, calcium, phosphorus and has higher pH and higher moisture-holding capacity to the soils. Biochar is usually produced from plant residue such as paddy husk, corn stalk, rubber pod and oil palm's empty fruit bunches (EFB). Different types of plant residues require different temperature in order to turn into biochar. MR219 is a variety of rice that is widely planted in Malaysia due to its high yield potential (10.75 tonne/ha), shorter life cycle (105 to 111 days) and is good for consumption [2].

Types of soil
Soil of silty clay loam can be classified as one properties of soil organic matter. Some of the physical properties of silty clay loam have been proposed as indicators of soil quality. Long term sustainable agriculture based on the maintenance since its level generally lead to decreased crop productivity. The continuous cultivation in soil silty clay loam in most irrigated lands has resulted in the decline of soil physical condition. There are some of the properties of these soil which are the soil structure is strongly related to organic matter because it’s binds mineral particles into aggregates and reduces the susceptibility of soil to erosion. However in terms of the quality of soil, silty clay loam based on its soil structure on water sized stable shows that the soil is highly enriched and most labile fraction [3]. Usually in extremely low pH condition, the soil is subject to drought and with limited nutrients and poor drainage.

Application of fertilizers and biochars, however, can increase soil pH and also increased nutrient availability to plants with biomass of carbon (C) increase especially in low pH soil [4]. Application of biochars can improve soil’s physiochemical properties in terms of water holding capacity (WHC), increase the activity of microbes and available nutrient. Suggested that with the addition of biochars to the silty clay loam, it can alter the soil’s properties such as pH, WHC, CEC and plant nutrient [5].

Objectives
- To determine the content of biochars in term of nutrient.
- To determine the effect of difference biochars used on MR219 rice growth.

Methodology
There are three treatments applied to the MR219 paddy – EFB biochar, rice husk biochar and conventional NPK fertiliser as control planted in silty clay loam soil. Treatment was applied on 3rd, 7th and 10th weeks. Data on paddy growth were collected on weekly basis and nutrient content in soil was tested the week following application of treatment. The nutrient content of biochar was tested using dry ashing method while nutrient content was tested using acid digestion method. Samples from both tests was analysed using the Perkin Elmer's Inductively Coupled Plasma – Optical Emission Spectrometer (ICP-OES). All data and ICP’s result are further analysed using Minitab software (Figure 1).

Results and Discussion
Figure 1 above presents the nutrient content in Empty fruit bunch biochars (EFBB) and rice husk biochars (RHB) used for the experiment. The EFBB were high in every element compared to the RHB which are lower. The EFBB are quite high in K and had more C than P and Mg. Figure above shows Ca and Mg in RH is low compared to in EFB biochar. However the availability nutrient on that element is related to the pH value. Since somehow the pH of RH is 4.8 something it affects biochar. However the availability nutrient on that element is related to the pH value. Since somehow the pH of RH is 4.8 something it affects the amount of Ca and Mg because pH of RH is less than 5, Ca and Mg

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is generally low amount. However, the high content of K and Ca is expected to benefit from application of EFBB with a good temperature of biochars the application for both treatment to MR219 was applied with 18 g of biochars for total application of 3 times within week 3 to week 9, and the timeline of application are referred from manuring programme schedule for participating farmers [6,7]. In terms of plant height, application of EFBB and RHB to the plant were not significant (P=0.432) and the effect of plant growth also not significant even though the height and number of tiller plant showed an improvement from week 3 to week 10. The increase in soil nutrients and an improvement in plant due to the biochars application are consistent with the work of where the application of biochars had increased the content of nitrate (NO$_3^-$) especially at tillering stage [8]. Plus, the increased in nutrients of biochars can be directly relate to the increases in soil pH recorded for the treatment (Table 1).

In fact every parameter’s reading increased with the addition of biochars. Based on the physical properties of biochars, Table 1 shows the different pyrolysis temperatures. The biochars that were applied on plants with 550°C, The temperature were choose because it is shows the best result were on 500°C for EFB and RH in terms of nutrients content as shown in table below. The variability of the nutrients in the biochars with increasing temperature is due to their volatility and effect of pyrolysis temperature on both composition and chemical structure of biochars. Besides the concentration of the nutrients in the biochar also depend on the process of partial devolatilization of the nutrients at elevated temperatures [9].

There is no significant difference between application of EFB and rice husk biochar in terms of plants height as well as number of tiller. According to usage of biochar alone without the combination of urea fertilizer cannot gave much effect to growth performance of paddy (Figure 2).

In terms of crop production, the application of biochars generally, should be beneficial to the plant height on the Figure 2. The effects of biochars amendments on rice growth are shown in figure above. Overall, biochars application had positive effects on the paddy growth. EFB biochars application significantly increased height and number of tillers in few successive weeks. In weeks 5 the paddy treated with EFB amendments increased from 52.25 cm and 5.25 numbers of tillers to 94.75 cm in height and 46 tillers, respectively. In particular, in comparison with the corresponding controls, chemical fertilizer (NPK) showed a smaller gap between EFB either in height or number of tillers.

However, same goes to the rice husk that showed a poor response on effect of biochars which are from 37.25 cm and 4 to 93 cm and

<table>
<thead>
<tr>
<th>Chemical property</th>
<th>Rice husk</th>
<th>Empty fruit bunch</th>
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<tbody>
<tr>
<td>pH</td>
<td>4.42</td>
<td>5.62</td>
</tr>
<tr>
<td>EC (mS cm$^{-1}$)</td>
<td>0.52</td>
<td>0.92</td>
</tr>
<tr>
<td>CEC (cmol.kg$^{-1}$)</td>
<td>1.80</td>
<td>3.93</td>
</tr>
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Table 1: The chemical properties of rice husk and empty fruit bunch biochars produced different pyrolysis temperatures.

Based on the three treatments, EFB give the result in terms of the plant height compared to the other two treatments. The amount of treatments are applied with the same amount per pail are based on journal which are 0.9 gram for NPK and 18 gram for both biochars. A statistically notable rise in the rice productivity are compared with its control treatment shown that the height of paddy and the number of tillers has no significance difference (P=0.432) on the application of the treatments but it had a significantly positive effect on the height and number of tiller. The positive growth responses were partly attributed to the nutrients directly supplied by the biochars and NPK.

However, the growth performance differed with biochars types. Rice husk usually had a high pH, therefore it is reasonable that the soil treated with rice husk biochars also had a high pH since it has high CEC value, P and K content. This result indicated that acidic soil can be treated with rice husk biochars can used as substitute application for lime materials in order to improve the pH soil (Figure 3).

The Figure 3 above shows the average of nutrient content before and after treatment of biochars. It indicates the amount of every element which is P, K, Ca and Mg before treatment is lower than after treatment.
For Mg the amount of Mg before treatment is lower compared to the value of NPK, EFB and RH after treatment. However from test statistical analysis shows that there is no significant difference between both treatment (P=0.765). Mg is a major constituent of the chlorophyll molecule; therefore K is actively involved in the photosynthesis activity and also helps in stabilizing the structure of nucleic acids. According to when biochars is added along with compost, the exchangeable Mg was increases.

**Conclusion and Recommendation**

From the result we can estimate that biochars from EFB is better than RH in term of its nutrient content. But from the ANOVA test, it showed that there is no significant difference between both treatment in term of its nutrient content and plant growth (plant height and tiller). So we can choose to apply NPK fertilizer, EFB or RH biochars to the field since it end up with the same results. For future study, rate of biochars and NPK fertilizer application need to be increased and varied so that a more significant result can be achieved from the treatments. To the farmers that are concerned towards the environment, the use EFB or RH biochars are recommended. In term of cost, both EFB and RH biochars come as cheaper alternatives to the conventional practices of using the chemical fertilizer. Plus the use of biochars can also reduce toxicity to the soil.

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**References**

