Compost of oil palm empty fruit bunches with coastal mud and rice husk biochar to improve the acid sulphate soil fertility

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Abstract. The research purposes: (1) Producing enriched compost of oil palm Empty Fruit Bunches (EFB) with coastal mud and rice husk biochar that is suitable for application to acid sulphate soils, (2) Getting the best dosage to increase acid sulphate soil fertility. The method used: complete random design (CRD) factorial pattern, the first factor composition of enriched oil palm EFB compost, second factor: doses of compost enriched. Data analysis using analysis of Variance (ANOVA), significant differences continued with Honestly Signiant Difference Test (HSD). The variables observed were: soil pH H2O, Each-Al, Total-N, Bray-P and each-K. The results showed: compost oil palm EFB treatment significantly affected the each-K, whilst did not significantly affect the pH H2O, Total-N, Bray-P and each-Al. Although enriched compost treatment did not significantly, and the finding is the treatment enriched compost trend to increased pH H2O, Total-N and Bray-P.

1. Introduction
Sub optimal land use for expansion of rice fields faces serious problems. Currently the existing rice fields in Indonesia, around 8.1 million ha, tend to decrease due to conversion to non-rice fields, while the government's ability to expand rice fields is only around 30-40 thousand hectares every year [1]. Therefore, in order to realize national food security, it can utilize acid sulphate land. Agricultural development in acid sulphate fields often faces several problems such as low soil pH and available phosphate, and high Fe content. The use of Oil Palm Empty Fruit Bunches (EFB) compost enriched with coastal mud and rice husk biochar is the right technology choice to overcome these obstacles, so research is needed to make enriched compost enrichment compost formulations for acid sulphate fields and see the effect of muddy compost enrichment applications sea and rice husk biochar to improve soil chemical properties, so that it will increase the fertility of acid sulphate soils.
The recommended general use of compost is the use of single compost with a dosage range of 5-15 tons per ha. From the results of preliminary research that has been carried out, the application of 5 tons / ha of oil palm empty fruit bunch (EFB) compost combined with 10 tons / ha of Chromolaena odorata biomass on Sulfaquent soil (acid sulphate) can increase pH from 5.26 to 6.22 [2]. Therefore, efforts are needed to improve the quality of compost through the method of compost enrichment (compost enrichment) with the addition of many other ameliorants available locally. The compost additives that can be utilized include coastal mud and rice husk biochar.

Utilization of rice husk biochar combined with Chromolaena odorata and rice straw at 6 weeks after incubation, can increase pH, organic C, available P and cation exchange capacity (CEC) and reduce exch-Al and Fe-soluble [3]. Furthermore, for the utilization of coastal mud as ameliorant, this is consistent with the results of research that coastal mud can increase base saturation (KB), thereby increasing soil fertility [4].

Oil palm EFB can be used as a source of organic fertilizer / compost which has the nutrient content needed by soil and plants. Nutrient content of oil palm EFB compost contains total N (1.91%), K (1.51%), Ca (0.85%), P (0.54%), Mg (0.09%), C-organic (51.23%), C / N ratio 26.82%, and pH 7.13 [5]. The application of oil palm EFB had a significant effect on soil chemical properties (soil pH, C-organic, Ca-exchange, exchangeable Mg, and CEC), N and P levels in leaves and the total and cumulative average of fresh fruit bunches [6].

To improve the quality and quantity of nutrients from Oil Palm EFB compost, enrichment is carried out by adding other ingredients. The enrichment of Oil Palm EFB compost with spent earth, showed that the higher doses of spent earth (0.5-1.5 tons / ha) tended to be better growth of soybean plants [7]. Furthermore, enrichment of compost with additives such as urea, single super phosphate, obtained a reduction in C: N ratio, a decrease in lignin levels and the amount of phenol during the composting period compared to original raw materials and an increase in other nutrients during the composting period [8].

Coastal mud is a large natural resource and has the potential to improve soil fertility. The treatment of coastal sludge has a significant effect on increasing peat soil pH from 3.95 to 4.82 and 8.23, influencing the available K soil, having a significant effect on increasing Ca, Mg and Na, increasing Base Saturation peat soils are above 50% on average, so it can be said that the application of coastal mud can increase the fertility of peat soil.

Rice husk contains 0.32% N, 0.07% P, 0.12% K, 0.27% Ca, and 0.16% Mg. From this content it is possible to use rice husk as a nutrient contributor in the soil. His results showed that rice husk charcoal gave increased pH from 3.75 to 4.40, increasing soil organic matter from 0.78% to 4.49%, increasing K from 0.19 cmol / kg to 0.44 cmol / kg, increase Ca from 0.34 cmol / kg to 0.44 cmol / kg, and can reduce Al-dd from 2.31% to 2.96% in Sulfaquent soil, and give a significant influence on the height of rice plants with a value of 86.17 cm compared to with control 75.17 cm [9]. Biochar application can increase rice yield up to 20-30% [10], furthermore giving rice husk charcoal 3 kg / m2 can increase pH to 5.5 and increase grain and straw yield by 30% and 40% [11].

In connection with the foregoing, the use of materials that are available in large quantities and are local in nature such as sea mud and rice husk biochar, is the best choice to overcome the limitations of acid sulphate soils.

2. Method
The research was carried out in the greenhouse of the Faculty of Agriculture, Panca Bhakti University, Pontianak, starting April 2017 to October 2017. Materials used: acid sulphate soil taken from locations in Sungai Kakap Subdistrict, Kubu Raya Regency, oil palm Empty Fruit Bunches (EFB), coastal mud, biochar rice husk, chemicals for soil and compost analysis. The tools used: tools for composting, hoes, machetes, pH meters, scales, soil drills, buckets, plastic tubs, cameras, other analytical tools in the laboratory, and writing instruments.

The study began with the preparation of acidic sulphate soil. Acid sulphate soil is taken from the location in Sungai Kakap Subdistrict, Kubu Raya Regency, at a depth of about 20 cm from the ground.
The soil is cleaned of gravel and roots and then dried. Furthermore, the soil is sieved with a wire sieve measuring 2 mm x 2 mm to obtain a uniform size. The 3 kg of soil is put into a 20 x 30 polybag. The prepared media is then applied with oil palm EFB compost which has been enriched with coastal mud and rice husk biochar, according to the treatment, mixing is carried out evenly in the media. The media is ready to be stored in the Faculty of Agriculture’s greenhouse.

The oil palm EFB used came from the farmer’s farm. Compost is made by cutting small pieces of oil palm EFB, then decomposer solution (Trichoderma sp) is added as recommended, put in plastic sheeting for 4 weeks. The coastal mud used came from the coast in the Mempawah area of Pontianak Regency. Coastal mud is dry and then smoothed. Biochar of rice husk is made from rice husks around the rice mill location. Furthermore, the coastal mud and finished biochar are mixed into the oil palm EFB compost according to the treatment level.

Enriched compost is then applied to the planting media, watering until field capacity conditions. Observations of variable acid sulfate soil fertility at the end of the study included: exch-K, pH H2O, N-total, P-Bray and exch-Al.

The study used a Completely Randomized Design (CRD) with a factorial pattern consisting of 2 factors. The first factor is the composition of oil palm EFB compost enrichment with code t (ratio 1: 1 and 1: 1: 1), which consists of 3 levels, namely:
- t1 = oil palm EFB + coastal mud
- t2 = oil palm EFB + rice husk biochar
- t3 = oil palm + coastal mud + biochar rice husk.

The second factor is the weight of compost and enrichment ingredients with code b which consists of 3 levels, namely:
- b1 = dose of 5 tons / ha
- b2 = dose of 10 tons / ha
- b3 = dose of 15 tons / ha.

So that the two treatment factors produced nine treatment combinations, each treatment combination was repeated 3 times to obtain 27 experimental units. To find out the effect of treatment on the observation variable, data analysis used an analysis of variance (ANOVA), and if there were significant differences, it was followed by an Honestly Significant Difference test (HSD) at the level of 5%.

3. Results and discussion

3.1. Characteristics of compost oil palm empty fruit bunches enriched

The analysis results presented in Table 1 show that oil palm EFB compost enriched with coastal mud and rice husk biochar has a pH value of 7,45 higher than un enriched oil palm EFB compost which is equal to 5,0. This shows that the ameliorant material used to enrich the oil palm EFB compost namely coastal mud and rice husk biochar, is effective for increasing soil pH, from several studies carried out stating that the addition of 10 tons / ha of biochar rice husk can significantly increase the acidic soil pH of Sulfate. As well as the main macro nutrient content, namely elements N, P and K, where on enriched oil Palm EFB compost shows a higher value of 3.12%, 4.62% and 0.54%, compared to un enriched oil palm EFB compost by 0.66%, 0.19%, and 0.13%.

Table 1. Comparison of oil palm EFB compost before and after enrichment.

| Analysis parameters | Oil palm EFB Compost before enrichment | Oil palm EFB Compost after enrichment |
|---------------------|----------------------------------------|---------------------------------------|
| pH                  | 5.00                                   | 7.45                                  |
| C-organik (%)       | 40.34                                  | 32.19                                 |
| N-total (%)         | 2.66                                   | 3.12                                  |
| C/N Ratio           | 15.17                                  | 10.32                                 |
| Fosfor (%)          | 0.19                                   | 4.62                                  |
| Kalium (%)          | 0.13                                   | 0.54                                  |
| Kalsium (%)         | 1.3                                    | 0.07                                  |
| Magnesium (%)       | 0.19                                   | 0.17                                  |
The use of enriched oil palm EFB compost in acidic sulfur soil is expected to increase the pH of the soil, so that the availability of nutrients at pH close to neutral will be higher. The high nutrient content in oil palm EFB compost is thought to be due to improved soil pH so that it will increase the activity of decomposing microorganisms (seen from the lower C/N Ratio of 10.32% on enriched oil palm EFB compost) which shows that the compost is fully cooked, thus releasing minerals-minerals that are beneficial to plants (including N, P and K).

3.2. Properties of soil
The application of oil palm EFB compost enriched with local amendments such as coastal mud and rice husk biochar can actually improve some chemical properties of acid sulphate soil, and the application of biochar in acid soils in South US could increase soil pH, soil organic matter, Mn, and Ca and decrease S and Zn. From the results of this study, as shown in Table 2, it can be seen that the application of oil palm EFB compost enriched significantly can increase exchangeable Potassium (exch-K), where treatment is b3 (oil palm EFB 15 tons / ha + coastal mud 15 tons/ha + rice husk biochar 15 tons / ha) can increase exch-K to 0.30 cmol (+) kg⁻¹. Exch-K is an easily available form for plants, which amounts to about 1% - 2% K of total land. This increase in exch-K is due to increasing soil pH due to the addition of enriched oil palm EFB (from 5.0 to 7.45). As it is known that in acid sulphate soils, many ions which cause acidity occupy the soil sorption complex. If the soil pH increases, due to the addition of enriched oil palm EFB compost, there will be deposition of compounds that cause acidity of the soil in the space between the mineral layers, which can inhibit K fixation by the soil. As a cation, K is absorbed by negatively charged soil colloids, both inorganic and organic [12].

Table 2. Summary of analysis of varian for soil properties due to additions enriched compost oil palm EFB.

| soil properties | pH H₂O | Al-dd (cmol(+)kg⁻¹) | N-Total (%) | P-Bray (ppm) | K-dd (cmol(+)kg⁻¹) |
|----------------|--------|---------------------|-------------|--------------|--------------------|
| Before treatment | 4.66   | 0.26                | 0.96        | 18.93        | 0.26               |
| After treatment  | 4.78   | 0.17                | 0.84        | 11.15        | 0.30*              |

Description: * = significant results, but no interaction occurred
Source: Results of data analysis, 2017

The application of enriched oil palm EFB compost also influences the increase in soil pH, it can be seen that the enrichment of oil palm EFB compost can increase the pH of acid sulphate soil from 4.66 to 4.78 (already fulfilling the requirements for growing rice). Increasing soil pH can increase the availability of macro nutrients, and increase soil microorganism activity [13].

The application of enriched oil palm EFB compost can also reduce exch-Al, from 0.26 to 0.17 cmol (+) kg⁻¹. Al solubility is related to the acidity of the soil, the higher the solubility of Al, the soil will also be more acidic. In these soils, concentrations of basic cations such as Ca, Mg, and K in the sorption complex are usually low, whereas acid cations are like Al dominant. In such conditions, Al and other cations will be hydrolyzed to produce H⁺ ions in the soil solution, with the following reaction:

\[ \text{Al}^{3+} + 2 \text{H}_2\text{O} \rightarrow \text{Al(OH)}_3 + 3\text{H}^+ \]

From this reaction, the release of H⁺ ions can increase soil acidity. So that on acidic soils that are rich in Al, they are a source of acidity as well as toxic for plants [14]. For this reason, with the addition of oil palm EFB compost enriched with ameliorants (coastal mud and rice husk biochar), Al will be bound so that it settles, and its solubility will decrease, thereby increasing nutrient availability.

4. Conclusions
The results showed that the treatment of enriched oil palm EFB compost had the potential to increase acid sulphate soil fertility, with details having a significant effect on exch-K, having no significant effect on pH H₂O, N-total, Bray-P, exch-Al. Although the treatment of enriched compost did not significantly
affect the pH H2O, N-total and P-Bray, but the treatment of enriched oil palm EFB compost in acid sulphate soils tended to increase the pH H2O, N-total and P-Bray.

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