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# Application of coconut biochar and organic materials to improve soil environmental

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**Abstract.** Inceptisol is a land which suitable for brick making, where the industry will take several meters of topsoil for raw material of brick industry. The loss of topsoil causes soil damage, while the topsoil is a source of nutrition for plant growth. The purpose of this study is to improve the soil environment because damage is caused by the brick industry. The application of the material used is biochar from coconut shell and cow manure with a dose of 0 tons per hectare, 10 tons per hectare, 15 tons per hectare, and 20 tons per hectare which is incubated in the topsoil for 0 months, 1 month, 2 month and 3 months. The best content of organic matter in the soil environment is around 2%. If it is lacking, then there must be added ingredients that contain enough C-organic and nutrients for good soil environmental conditions. The treatment of biochar and organic matter can improve the soil environment because it is a source of C and nutrients. Both of these materials function improve the physical and chemical properties of the soil such as cation exchange capacity (CEC) and soil pH. Changing characteristics will create a better soil environment so that soil nutrients will become more available for growth.

## 1. Introduction

The effect of environmental will determine changes in the characteristic of soil, especially in the topsoil. Topsoil damage due to mining or erosion is a significant factor in soil fertility. Soil loss causes several changes, such as changes in the physical properties of the soil which make the soil become compaction and changes in soil chemical properties which will limit the ability to grow and the types of plants cultivated [1]. Loss of nutrients and carbon content in the topsoil causes a decrease in fertility and soil quality. The addition of organic matter and carbon will recover a damaged soil condition [2]. The sources of organic material came from organic, animal, residual household, municipal, industrial waste, and compost. The C-organic content in cow manure about 31.34% are the source of increasing soil organic carbon, and it can improve soil cation exchange capacity [3].

The source of organic matter for tillage improve physical, chemical, and biological properties of soil so that it can provide nutrients for plants. The decomposition of organic matter changes the chemical composition of complex compounds into simple compounds. Improvement of soil properties will also affect the availability of nutrients. The soil repairing process that has been damaged was an effort to



improve soil environmental conditions by reactivating bacteria which decompose organic matter in the soil [1].

The decomposition process of organic matter in the soil is one indicator of the materials quality. Biochar as a soil amendment has a positive correlation to the carbon content of the material contained. A good pyrolysis process will produce more carbon content a lot of carbon content will last a long time to stay and stable in the soil. Besides, the stability of the soil carbon content will improve the soil environmental factors. Decomposition rates of organic residues in the soil and stabilization of C in humus are influenced by climatic and ecological factors such as temperature, humidity, soil pH, soil nitrogen availability, and soil texture. Almost 55–75% of organic C content in plants was released in the form of CO<sub>2</sub>, a small portion of C residue in biomass will be decay [5]. The coconut biochar contains carbon about 42.01% can be used as soil carbon stabilization. The functions of biochar is not similar with cow manure. The functions of biochar were charcoal to improved soil environmental.

## 2. Methodology

The Effect of land damage due to mining and the continuous use of land without being prepared by replacing nutrients absorbed by plants in the soil will result in poor soil nutrients and low soil C levels. In fact, C organic contains was important ameliorant in the soil. It functions as a framework for soil nutrient bonding structure that serves to slow down the loss of soil nutrients caused by leaching or erosion. Some efforts can be made to improve the soil quality, such as providing soil organic matter and biochar in the soil. Making biochar material can be done by pyrolysis combustion process with minimal oxygen or not. Less or no oxygen in the combustion process will get the best quality product. In this research the combustion of materials by pyrolysis at a temperature about 600°C with a rotary drum method to make biochar to obtains a perfect combustion system.

The research used by cow manure and biochar from coconut shell material with an incubation process based on periods. The research was used survey methods and descriptive method, that was by taken the soil sampling of paddy soil. The paddy soil was used Inceptisols in the brick industry mining area. The design of the research was used a completely randomized design (CRD) with three treatments, namely Bagasse Waste, Cow Manure Waste, and Coconut Shell Biochar. Each treatment with a dosage of 0 tons per hectare, 10 tons per hectare, 15 tons per hectare, and 20 tons per hectare. There was observed incubation at 0 months, 1 month, 2 months and 3 months. It is repeated three times. So there are 108 pots. The coconut biochar and organic matter were mixed with minerals in Inceptisol without composted process.

The purpose of mixing of both materials is to accelerate the decomposition process in soil minerals. The decomposition process both coconut shell biochar and organic matter were carried out at periodic times about 0, 1, 2 and 3 months. During the incubation process, water content was done always maintained at field capacity. The correlation between material and incubation time shows that the better decomposition process was sufficient than soil nutrients. The Addition of soil moisture due to evaporation greatly determines the quickly of the soil decomposition process. The Soil analysis was carried out after the incubation process has expired — soil analysis of C-Organic, cation exchange capacity, and soil reaction. Data analysis was used Duncan's Multiple Range Test on the 5%.

## 3. Result and Discussion

The Amelioration is activities of adding external material to repair soil damage due to man disturbances and natural factors. The continuous land use without providing balanced additional nutritional input causes the degradation of land production [6]. Decrease in soil quality was caused by losses in the top soil were the most dangerous for factor soil damage [7]. The top soil loss is resulted from weathering of rocks and loss of soil organic matter results in damage to soil physical and chemical properties. The return of soil functions with amelioration was taken the long time [8]. The use of coconut biochar and organic matter was one alternative to problem solved in soil damage. The coconut biochar ameliorant application as a carbon-rich as charcoal will improve soil damage conditions [9]. The coconut Biochar can increase cation exchange capacity and soil C content in the soil (Table 1). While the provision of organic ingredients can improve soil fertility. The use of coconut biochar at dosage about 15 and 20 tons per ha of soil C content showed significant effect compared than controls. It was increase carbon

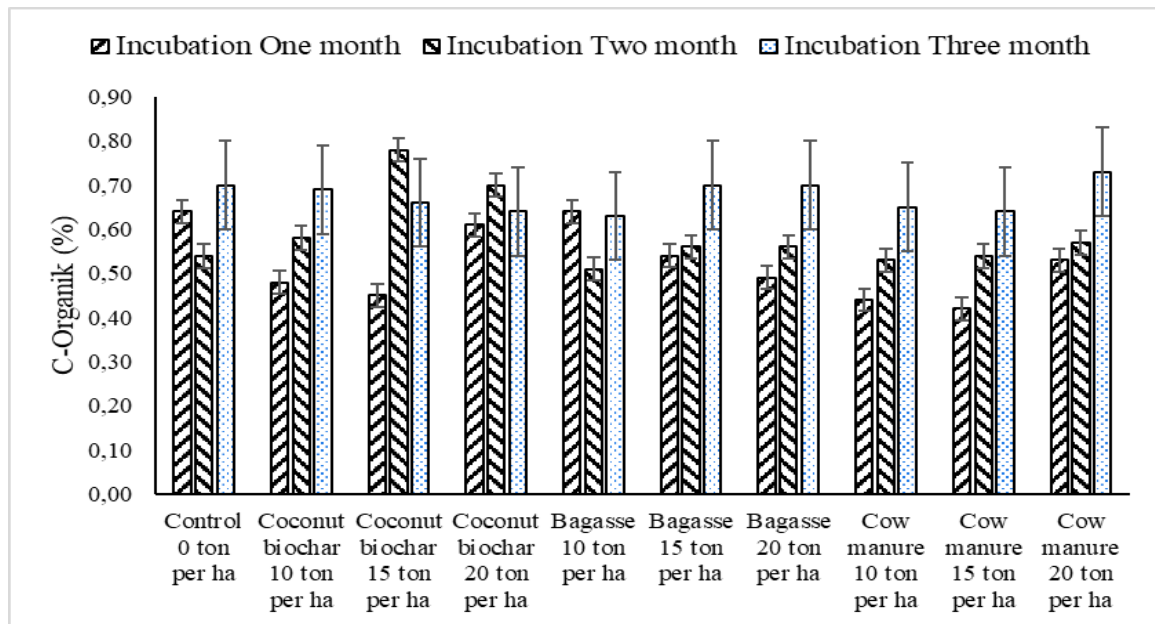
content to 0.78% in the treatment with coconut biochar incubated for 2 months. While the coconut biochar treatment which is incubated for 3 months did not show significant differences (Table 1). The increase on organic C levels at 2 months incubation was showed the peak process of decomposition of organic matter with biochar, while in incubation about 3-months can processes the decomposition at stable. It was proven to be a constant relative carbon content of 0.6% (Table 1).

**Table 1.** C-organic in the soil after treatment on the biochar and organic waste for incubation in the soil.

<b>Treatment</b> <b>Incubation</b>	Bagass (ton/ha)				Coconut Biochar (tone/ha)				Cow manure (tone/ha)			
	0	10	15	20	0	10	15	20	0	10	15	20
One month	0.63 ab	0.64 ab	0.54 bc	0.49 c	0.64 abcd	0.48 cd	0.45 d	0.61 abcd	0.63 abc	0.44 d	0.42 d	0.53 a
Two month	0.54 bc	0.51 c	0.56 c	0.56 c	0.54 bcd	0.58 abcd	0.78 a	0.70 ab	0.53 cd	0.53 cd	0.54 cd	0.57 bc
Three month	0.69 a	0.63 ab	0.70 a	0.72 a	0.70 a	0.69 ab	0.66 abc	0.64 abcd	0.69 a	0.65 ab	0.64 abc	0.73 a

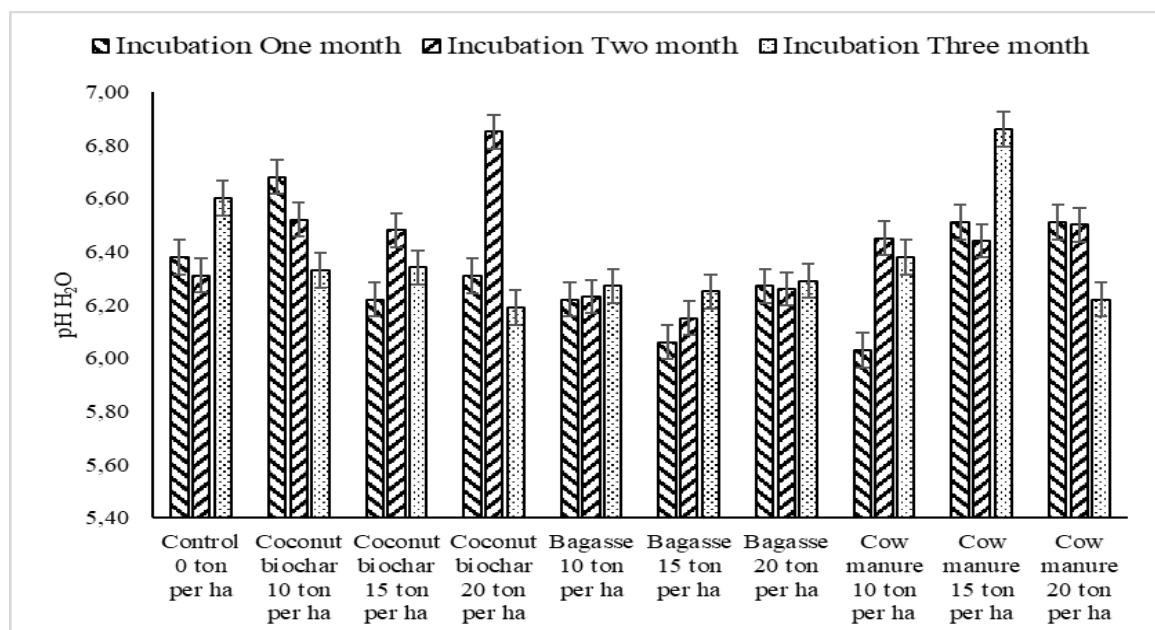
Numbers in the same column followed by similar letters are not significantly different according to Duncan's New Multiple Range Test ( $P>0.05$ ).

The treatment with organic matter of cow manure at 2 and 3 months incubation was not significantly different at the level of 5%. This shows that the organic matter content of cow manure was susceptibility to decomposition and carbon content does not show a relevant increase and it is easy to leaching. The organic matter of cow manure was different from the treatment on bagasse even though they did not show significant differences, but in bagasse treatment can increase soil carbon in incubation for 3 months by 0.72% in incubation for 3 months. The organic matter of cow manure is different from the treatment on bagasse even though they did not show significant differences, but in bagasse treatment can increase soil carbon at incubation for 3 months about 0.72% in incubation for 3 months. This shows was used of bagasse in the soil can experience a slowly decomposition process so that it can release carbon in the material even in small effect. The highest increase in soil carbon in bagasse and cow manure treatment was dosage about 20 tons per hectare to increased 0.72-0.73% (Table 1). The best of soil carbon availability was taken the coconut biochar treatment with dosage about 15 tons per hectare which is incubated for 2 months, while the lowest soil carbon supply was treatments with cow manure was dosage about 15 tons per hectare with incubation for 1 months (Figure 1).



**Figure 1.** The C-Organik content after treatment on the biochar coconut, waste organic bagasse, and cow manure.

This shows the use of bagasse into the soil can experience a slow decomposition process so that it can release carbon in the material even in small amounts. The highest increase in soil carbon in bagasse and cow manure treatment is at a dose of 20 tons per hectare of 0.72 -0.73% (Table 1). The best soil carbon availability is in the coconut shell biochar treatment with a dose of 15 tons per hectare which was incubated for 2 months, while the lowest soil carbon supply was treated with cow manure at a dose of 15 tons per hectare with incubation for 1 month (figure 1). The treatment of coconut biochar variously dosage of 10, 15 and 20 tons per hectare does not show an increase in soil reaction [10]. The pH H<sub>2</sub>O on the all treatment dosage showed a range about 6.0 and it did not increase the pH value of the soil at various levels of coconut shell biochar treatment (Figure 2).



**Figure 2.** pH H<sub>2</sub>O content after treatment on the biochar coconut, waste organic bagasse, and cow manure.

The Coconut shell biochar with pyrolysis system at a temperature about 600°C to describe the all volatile elements and mobile elements they are easily lossess. The functions of Coconut shell biochar was biological charcoal to increased the stable of carbon in the soil and presence in the long periods [6], [11]. The side effects of biochar use into the soil will be improved to cation exchange capacity [6].

The treatment of coconut biochar did not show significant differences in soil cation exchange capacity in incubation about 1 and 2 months, but the coconut shell biochar treatment would be significantly different at 3 months incubation with dosage 10 tons per hectare (Table 2). It was increased to cation exchange capacity (no treatment) about 7.78 cmol (+) kg<sup>-1</sup> to 10.86 cmol (+) kg<sup>-1</sup> at dosage about 10 tons per hectare. It showed that carbon-rich biological charcoal was obtained by pyrolysis process improve the cation exchange complex on the soil. The used of coconut shell biochar with a perfect pyrolysis process will provide more than carbon for best soil ameliorants [12], [8], [10].

The treatment of organic matter on the cow manure can increased cation exchange capacity in 2 months incubation, but it was not as high as in coconut shell biochar. It was caused the treatment by the cow manure is easily to decomposition and it contains more than cations as well.

**Table 2.** Cation exchange capacity in the soil after treatment on the biochar and organic waste for incubation in the soil.

Treatment	Bagasse (ton/ha)				Coconut Biochar (tone/ha)				Cow manure (tone/ha)			
Incubation	0	10	15	20	0	10	15	20	0	10	15	20
One month	6.28 c	4.81 c	4.40 c	6.64 c	6.28 c	7.53 bc	5.74 c	8.26 bc	6.28 ab	5.14 b	4.68 b	7.70 a
Two month	4.72 c	7.42 bc	7.05 bc	4.72 c	6.75 c	5.90 c	6.36 c	7.45 bc	6.75 ab	8.29 a	8.51 a	7.56 a
Three month	7.78 abc	10.43 ab	10.85 a	7.17 bc	7.78 bc	10.86 a	6.92 c	9.50 ab	7.78 a	6.28 ab	8.61 a	8.40 a

Numbers in the same column followed by similar letters are not significantly different according to Duncan's New Multiple Range Test ( $P > 0.05$ ).

The increase of cation exchange capacity in the treatment of cow manure did not higher than that of coconut biochar. Whereas in the decomposition process was the bagasse treatment showed an increase in the soil cation exchange capacity at 3 months incubation, it is still lower than the use of coconut shell biochar. Thus, the treatment of coconut shell biochar was the best treatment to improve the soil for carbon supply and increase the cation exchange capacity on the soil.

#### 4. Conclusions

The soil environmental conditions can be improved by using materials rich in C-contents. Rich carbon is produced by pyrolysis system in the temperature about 600°C. The use of coconut shell biochar dosage about 15 tons per hectare can increase C-organic contents in incubation for 2 months. Meanwhile, the improvement of soil cation exchange capacity can use coconut shell biochar at a dosage of 10 tons per hectare with incubation in the soil about 3 months.

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