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The Effect of Cow Manure and Cow Dung Biochar Application on P Available and Growth of Corn Plants in Ultisol

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ABSTRACT

Cow manure and cow dung biochar have great potential in increasing P available in Ultisol soil.The application of cow manure and cow dung biochar on P available and the growth of corn plants in Ultisol soil was done to compare the effect between the two treatments.This research used a non-factorial randomized block design with 7 treatments, namely:control, 3 levels of cow manure with a dose of 5, 10 and 15 tons / ha and 3 levels of cow dung biochar with a dose of 5, 10, 15 tons / ha and 4 blocks.The parameters measured were H_2O pH, P available, P total, Al-dd, C organic, plant height, canopy dry weight and plant P uptake.The research results showed that the application of cow manure and cow dung biochar was able to increase H_2O pH, P available, P total, C organic, plant height, canopy dry weight, plant P uptake and was able to reduce the Al-dd in Ultisol soil.Cow dung biochar was better in increasing H_2O pH, P available and P total of Ultisol compared to cow manure.
Keywords: Cow manure, Cow dung biochar, Ultisol

INTRODUCTION

Ultisol soil is classified as acidic soil.Acidic soil is a soil where the concentration of H^+ ions is more dominant than OH^- ions.This condition is measured by the <5.5 soil pH.Many plants are unable to adapt growing and developing well in this soil, resulting in the decreased supply of P, K, Ca, and Mg, Al elements and some micronutrients dissolve and become toxic to plants (Mukhlis et al. 2017).

The availability of phosphorus is one of the obstacles that are widespread in Ultisol soil in Indonesia.Low soil phosphate content and high phosphate fixation by Al and Fe in the soil are obstacles that must be addressed first.Ultisol soil has a low pH, low organic matter content, low cation exchange capacity and a very low percentage of base saturation, but has high aluminum saturation resulting in very low soil productivity (Foth, 1998).

The availability of phosphorus in the soil is influenced by the following factors, namely: 1) soil pH 2) dissolved Fe, Al and Mn, 3) the presence of minerals containing Fe, Al, Mn, 4) Ca available, 5) the amount and level of decomposition of organic matter and 6) microorganism activities.The first four factors relate to each other because everything depends on the soil acidity (Barchia, 2009).

Until now various efforts have been made to overcome the problem of Ultisol soil.Cow manure is one of organic matter that has the potential as a soil conditioner which can overcome P available and improve other chemical properties in Ultisol soil.Cow dung has been widely used as manure that can increase soil and plant productivity.On the other hand, technology is currently developing biochar with various biomass sources, such as wood, leaves and even waste from livestock dung.Hence, cow dung also has another potential besides manure, cow dung also has the potential to be made into biochar which is also able to increase the productivity of Ultisol soil.

Cow manure is one of the animal waste products that can be used to improve the chemical, biological and physical properties of the soil.Nutrients in manure are not easily available to plants.Nutrient availability is strongly influenced by the level of decomposition / mineralization of these ingredients. Cow manure contains 2.34% N, 1.08% P, and 0.69% K. Among the types of manure, cow manure has a high fiber content such as cellulose, this can be seen from C / N

which is quite high.Therefore, composting needs to be done hence the C / N is below 20 (Hartatik and Widowati, 2011). According to the research results of Zaman et al. (2017), the application of cow manure at a dose of 10 tons/ha can increase P available, N total, and also K, Ca, and Mg exchange significantly.

On the other hand, cow dung biochar also has the potential to improve the productivity in Ultisol soil. Biochar is classified as alkaline material which is able to provide new solutions in improving polluted soils (Hidayat, 2015). Sukartono et al. (2011) research showed that cow dung biochar has high nutrient content such as N, P, Ca, and Mg but has lower C organic than coconut fiber biochar.In addition, according to Major et al. (2009) the porosity possessed by biochar contributes to nutrient adsorption due to its large surface area.

Biochar application is far more effective than other organic ingredients.Some of the advantages are that biochar stays in the soil for a long period of time, whereas the application of manure will experience mineralization into CO2 (and other greenhouse gases) in the next few months or several yearsdue to the rapid decomposition of organic matter in the ecosystem of tropical soils and biochar is also more effective in retaining nutrients for its availability to plants than other organic matters (Gani, 2009).

Based on the description above, it was necessary to examine the effect of cow manure and cow dung biochar as well as the best cow manure and cow dung biochar on P available and growth of corn plant in Ultisol soil.

MATERIALS AND METHODS

The research was conducted at the Screen House and the Research and Technology Laboratory of the Faculty of Agriculture, University of Sumatera Utara, and at Socfindo Indonesia Ltd., in April 2018 to August 2018.

The materials used in this research were Tanah Abang Galang Ultisol as observed soil, cow manure and cow dung biochar as the treatment materials, EM-4 bacteria as decomposers, SP36 fertilizer, urea and KCl as basic fertilizers, 5 kg polybags as soil containers, labels for marking the treatment and other materials needed for analysis. The tools used were hoes and sacks to pick up soil materials, sieves to sift the soil, scales to weigh the soil, pyrolysis tubes to make biochar, pH meters and other laboratory equipment for analysis purposes.

This research was conducted using a non-factorial completely randomized design with a dose level of cow manure and cow dung biochar, namely; P0: control, K1: cow manure 12.5 g / polybag (equivalent to 5 tons of cow manure / ha), K2: cow manure 25 g / polybag (equivalent to 10 tons of cow manure / ha), K3: cow manure 37.5 g / polybag (equivalent to 15 tons of cow manure / ha), B1: cow dung biochar 12.5 g / polybag (equivalent to 5 tons of cow manure / ha), B2: cow dung biochar 25 g / polybag (equivalent to 10 tons of cow manure / ha), B3: cow dung biochar 37.5 g / polybag (equivalent to 15 tons of cow manure / ha).

There were 7 treatments with 4 replications hence 28 units were obtained.The data obtained will be tested statistically based on the analysis of variance at the level of 5%, then orthogonal contrast testing.

The parameters observed were H2O pH (electrometry method), P available (Bray II), P total, Al-dd, soil C organic (walkley and black), plant height, canopy dry weight and P uptake of corn plants.

RESULTS AND DISCUSSION

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Table 1. Contrast test results for each treatment of observed parameters.

Contrast Test	pH H_2O	P Available	P Total	Al-dd	C Organic	Plant Height	Canopy Dry Weight	Plant P Uptake
P0 Vs K1K2K3B1B2B3	*	**	**	**	**	*	*	*
K1K2K3 vs B1B2B3	**	**	**	tn	tn	tn	tn	tn
K1 vs K2K3	**	tn	tn	*	**	tn	tn	tn
K2 vs K3	**	tn	tn	*	**	tn	tn	tn
B1 vs B2B3	**	*	**	tn	**	tn	tn	tn
B2 vs B3	**	**	tn	tn	tn	tn	tn	tn

Effect of cow manure and cow dung biochar application on pH H_2O of Ultisol Soi

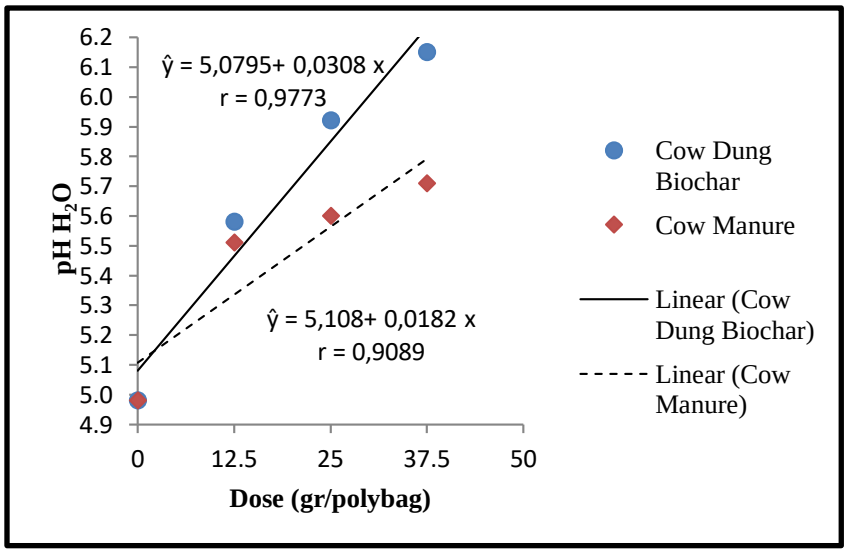

Figure 1: The Ability Comparison of cow manure and cow dung biochar inincreasing soil H_2O pH.

The application of cow dung biochar has a significant effect in increasing the H2O pH in Ultisol soil. The highest dose (37.5 g / polybag) was able to increase the H2O pH in Ultisol from 4.98 (acid) to 6.15 (slightly acidic).

The increases in pH is due to the presence of functional groups found in biochar which can bind H^+ in soil solution hence pH tends to increase. This was in accordance with Cha et al. (2016), which stated that biochar has a phenolic, carboxyl, and hydroxyl functional group that react with H^+ ions in the soil thereby reducing the concentration of H^+ in soil solutions and increasing soil pH. Meanwhile, in cow manure application can increase the H_2O pH from 4.98 (acid) to 5.71 (slightly acidic) at a dose of 37.5 g / polybag. The decomposition process that occurs in cow manure will produce organic acids that will bind Al to form complex compounds (chelate) with metal ions such as Fe and Al, hence it becomes a stable form in the soil and can be used as a buffer for changes in soil pH, hence soil pH

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increase (Nurida and Jubaedah, 2012).Cow dung biochar had higher result in increasing the H_2O pH in Ultisol soil compared to cow manure because cow dung biochar has higher pH value than cow manure, hence it has a faster effect on increasing soil pH. In addition, biochar that can last longer in the soil than cow manure (Benggu, et al. 2016) possibly resulting in faster changes effect in soil pH.

The effect of cow manure and cow dung biochar applications on P available of Ultisol soil

The application of cow dung biochar also affected the P available in Ultisol soil.The application of cow dung biochar has a very significant effect in increasing P available in Ultisol soil. P Available increasing occurred along with the increasing doses of cow dung biochar. The highest P available increasing was at a dose of 37.5 g/polybag, which was able to increase P available from 3.71 ppm to 25.79 ppm.This was due to the ability of biochar to contribute P to the soil hence it can increase the P available in soil. This can be seen from the increase in soil P total due to the contribution of P from cow dung biochar. Likewise with cow manure treatment, there was an increase in P available up to 4.86 pmm at a dose of 37.5 g/polybag. The increase in P available of Ultisol soil due to the application of cow manure also occurs along with the increase in the dose given. However, from Figure 2 it can be seen that the cow dung biochar had a higher effect on increasing the P available of Ultisol soil compared to cow manure. This was because the ability of cow dung biochar in contributing P is higher than cow manure due to the process of cow dung biochar making. This was in accordance with Chan and Xu (2009), who stated that biochar raw materials originating from livestock waste contribute higher P than other types of biochar. The ability comparison of cow manure and cow dung biochar in increasing soil P available can be seen in Figure 2.

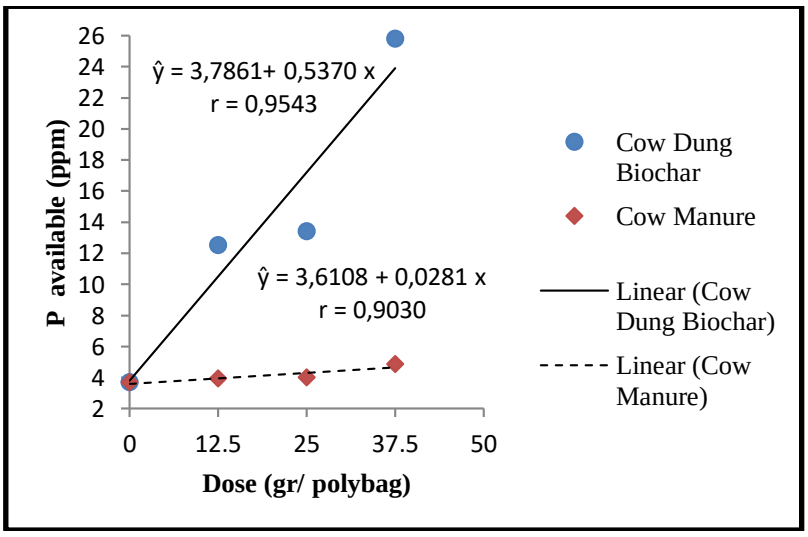

Figure 2: The ability comparison of cow manure and cow dung biochar in increasing P available of Ultisol soil

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The effect of cow manure and cow dung biochar application on P total in Ultisol soil

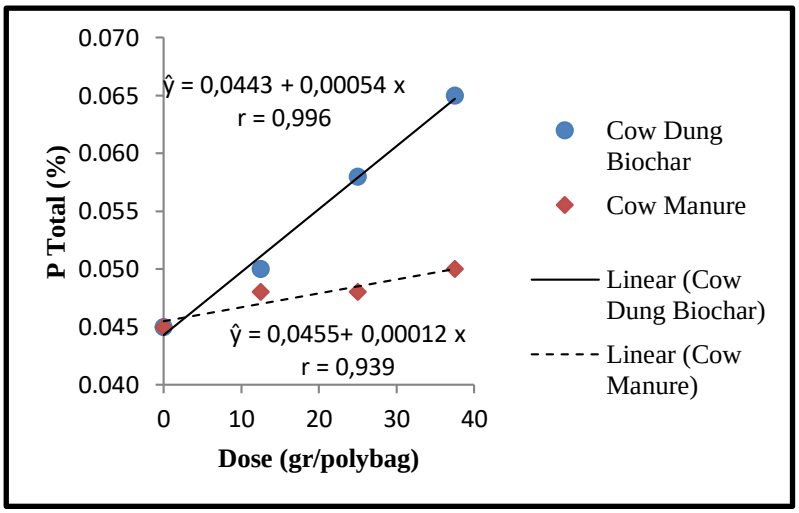

Figure 3: Ability comparison of cow manure and cow dung biochar in increasing P total of Ultisol soil.

The application of cow dung biochar was able to increase the P total of Ultisol soil from 0.045% (low) to 0.065% (medium).The highest P total increase was found at a dose of 37.5 g/polybag.The increase in P total of the soil occurred along with the increase in the dose of cow dung biochar.The increase in P total of the soil was related to the ability of cow dung biochar contributing P nutrients to Ultisol soil.This was supported by Guo et al. (2014) research, which stated that the application of cow dung biochar can increase the P total content in the soil.As well as cow dung biochar, cow manure was also able to increase the P total of Ultisol soil to 0.050% at a dose of 37.5 gr/polybag. However, cow dung biochar had a better effect in increasing the P total of Ultisol soil compared to cow manure.

The effect of cow manure and cow dung biochar application on Al-dd of Ultisol soil

The application of cow dung biochar also had a significant effect on decreasing the Al-dd of Ultisol soil.Cow dung biochar application can reduce soil Al-dd from 0.70/100g soil to 0.43 me/100g soil, i.e. at a dose of 37.5 g/polybag.This was because biochar has a functional group capable of adsorbing Al hence it was not hydrolyzed.This was in accordance with Gao and DeLuca (2016), which stated that biochar is able to chelate Al and Fe metals, thereby increasing the solubility of P in the soil.This was supported by Chan and Xu (2009) who stated that biochar has a carbonate group that is able to overcome the toxic effects of Al.Similarly, with cow manure, cow manure was also able to reduce Ultisol soil Al-dd up to 0.40 me/100g of soil.Organic acids in cow manure were able to chelate Al on soil hence Al-dd in the soil was decreased.This was in accordance with Setyorini et al. (2006) which stated that organic matter has the ability to interact with metal ions to form complex compounds hence metal ions that are toxic like Al can be reduced by chelating with organic matter.Both types of these treatments had the same effect in reducing Al-dd of Ultisol soil.Ability comparison of cow manure and cow dung biochar in decreasing Al dd of soil can be seen in Figure 4:

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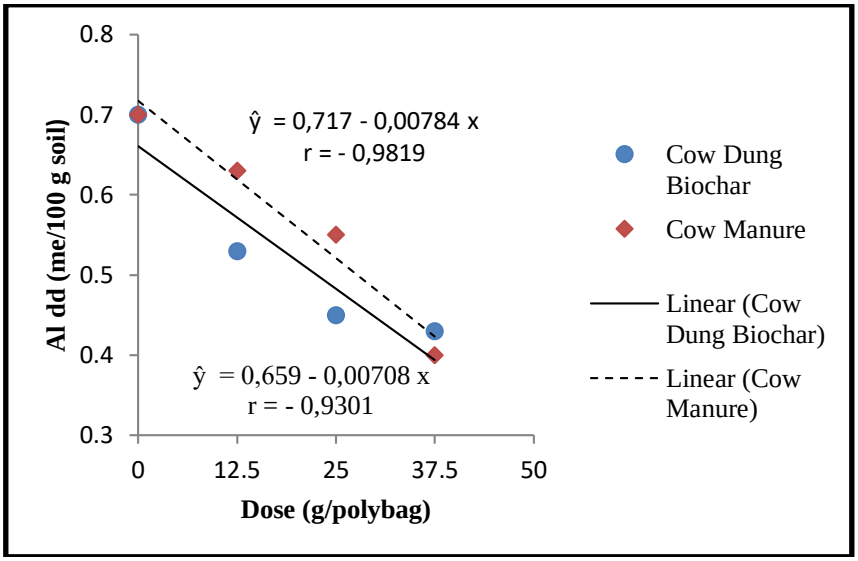

Figure 4: Ability comparison of cow manure and cow dung biochar in reducing Al dd of soil

The effect of cow manure and cow manure biochar application on C organic in Ultisol soil

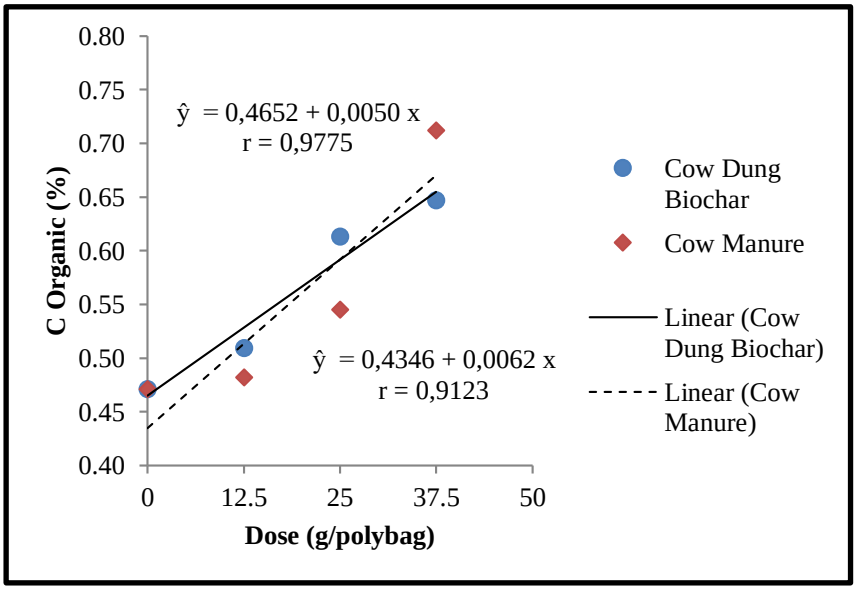

Figure 5: Ability comparison of cow manure and cow dung biochar in increasing C organic of Ultisol soil.

Biochar is an amendment material that contributes C organic to the soil. Cow dung biochar application can increase C organic in Ultisol soil. Cow dung biochar application increased soil C organic from 0.471 to 0.647 at a dose of 37.5g/polybag, in which an increase in soil C organic occurred along with the increasing doses of cow dung biochar. Cow dung biochar application can improve soil quality by contributing C organic to the soil. This was in accordance with Gani (2009) which stated that the pyrolysis process in biochar making produces aromatic carbon which is resistant to decomposition and is persistent in the soil. Cow manure application also significantly increased the C organic in Ultisol soil. Cow manure can increase C

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organic in Ultisol soil from 0.471% to 0.712% at a dose of 37.5g/polybag.The increase in soil C organic was due to the contribution of C organic from cow manure to Ultisol soil. This was in accordance with Hanafiah et al. (2009) which stated that the decomposition process of organic matter will produce CO2, H2O, $NO3^-$, and SO_4^{2-} organic acids. Organic compounds which released into the soil will contribute organic C to the soil. Ability comparison of cow manure and cow dung biochar in increasing soil C organic can be seen in Figure 5.

The effect of cow manure and cow dung biochar application on corn plants height

Cow dung biochar application was also able to increase the growth of corn plants, but not statistically significant. Cow dung biochar application can increase the corn plants height up to 137.78 cm at a dose of 37.5g/polybag. Likewise with the canopy dry weight of corn plants, there was an increase in canopy dry weight up to 22.54 g, at a dose of 37.5g/polybag. The increase in plant height and canopy dry weight occurred because biochar has the ability to retain nutrients and increase its availability for plants. This was in accordance with Gani (2009), which stated that biochar is able to increase productivity and nutrient retention and increase nutrient availability for plants hence it will provide benefits through increasing crop production. In addition, the application of cow manure was also able to increase the corn plants height and canopy dry weight, although the effect was not significant statistically. Cow manure application can increase the corn plants height up to 138.35 cm, at a dose of 37.5g/polybag. Likewise, with canopy dry weight, there was an increase in canopy dry weight up to 16.35g (37.5g/polybag), an increase in corn plant growth occurred along with an increase in the doses of cow manure application. The increase in corn plants growth was due to the contribution of nutrients from cow manure which has a positive impact on plant growth.

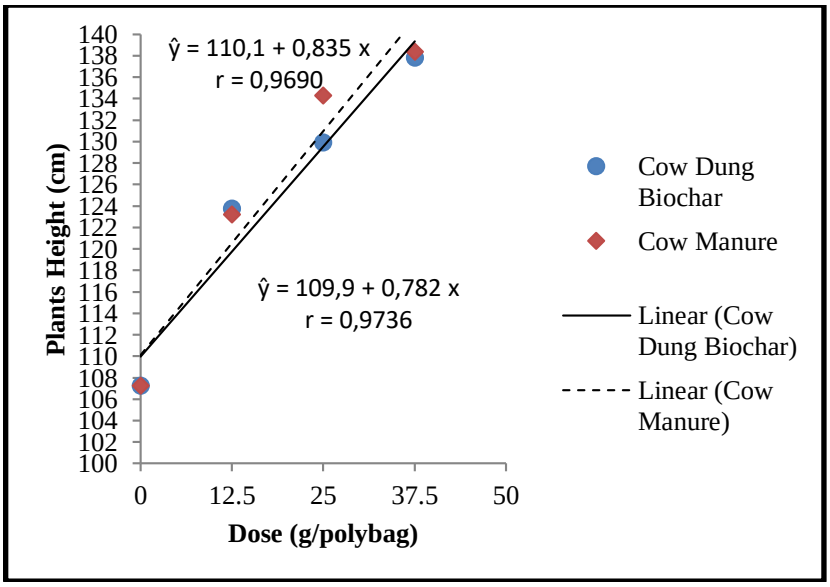

Figure 6: Ability comparison of cow manure and cow dung biochar in increasing corn plants height

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The effect of cow manure and cow dung biochar application on canopy dry weight of corn plants

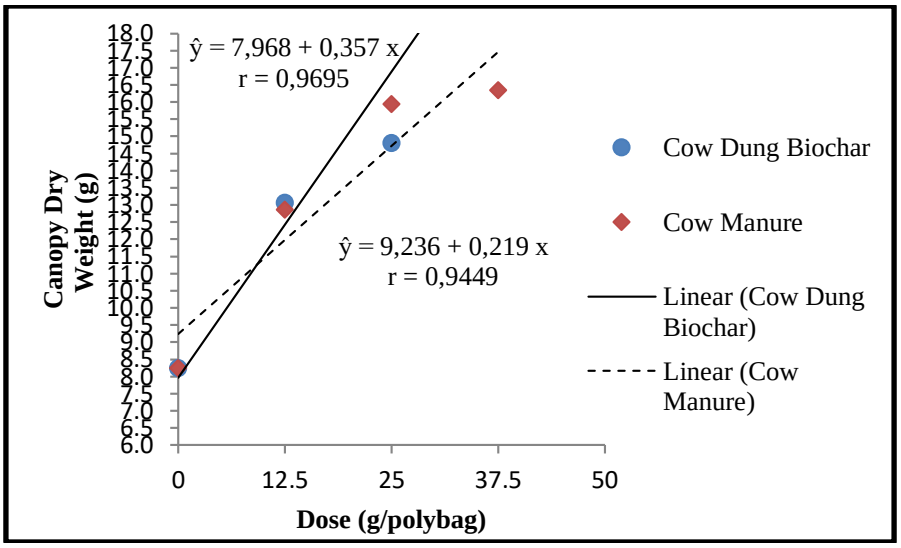

Figure 7: Ability comparison of cow manure and cow dung biochar in increasing canopy dry weight of corn plants

- **The effect of cow manure and cow dung biochar application on P uptake of corn plants**

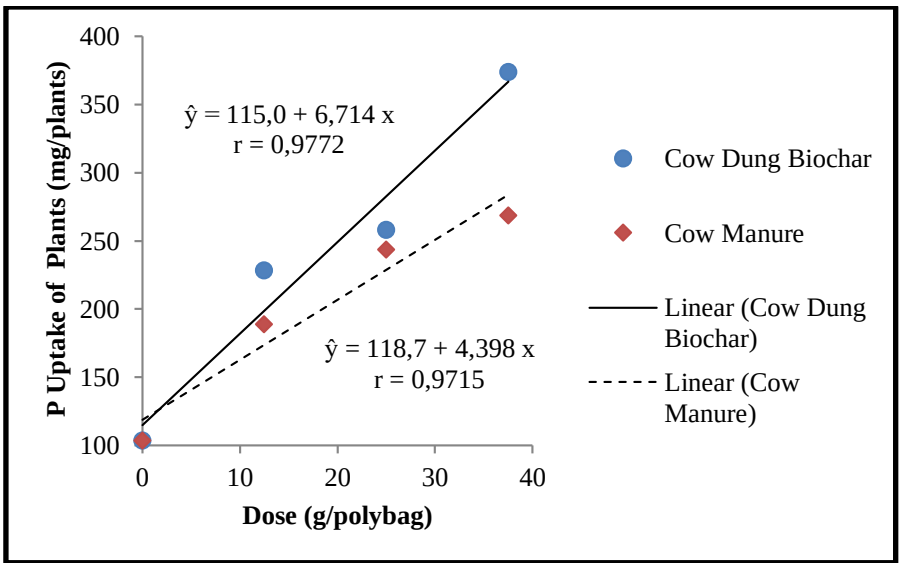

Figure 8: Ability comparison of cow manure and cow dung biochar in increasing P uptake of corn plants

In line with the increase in plant height and canopy dry weight, there was also an increase in P uptake of corn plants even though the effect was not statistically significant.The Increase in P uptake of corn plants reached 373.64mg/plant at a dose of 37.5g/polybag.Cow dung biochar application can improve the nature of Ultisol soil and also was able to contribute nutrients to the Ultisol soil, hence this has an effect on increasing P uptake of corn plants.Availability and solubility of nutrients in the soil due to biochar

application will affect plant nutrient uptake.In addition, the application of cow manure also had an effect on increasing P uptake of corn plants although statistically did not show a significant effect.There was an increase in P uptake of corn plants up to 268.72 mg/plant at a dose of 37.5g/polybag. The increase in P uptake occurred along with an increase in cow manure doses.The increase in P uptake of corn plants was due to the nature of manure which is able to improve the chemical properties of Ultisol soil and is able to contribute nutrients to the soil hence it has an impact on increasing P uptake of plants.

CONCLUSIONS AND SUGGESTIONS

Conclusion

The application of cow manure and cow dung biochar can increase H2O pH, P available, P total, C organic, plant height, canopy dry weight, plant P uptake and was able to reduce Al-dd in Ultisol soil.The best effect of cow dung biochar and cow manure in this research was at a dose of 15 tons/ha (37.5g/polybag).The application of cow dung biochar was higher in increasing H2O pH, P available and P total in Ultisol soil compared to cow manure application.Cow dung biochar and cow manure had the same effect in increasing soil C organic and decreasing Al-dd in Ultisol soil.

Suggestion

It was recommended to give cow dung in the form of biochar if you want to increase P available in the soil.

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