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Effect of Combination of Biochar Tankos and Urea-enriched Chicken Manure (BIOCHIKE+) on Growth Oil Palm Seedling

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ABSTRACT

Background: Peatlands are marginal lands that have low soil pH, easy to experience nutrient retention and leaching. If this land is used for oil palm cultivation, it will affect its growth and production. These obstacles can be overcome by using fertilizer technology (Biochike+). Biochar Tankos is an organic fertilizer made from agricultural waste, which when combined with biochar chicken manure can be a highly nutritious organic fertilizer, plus Urea which can increase the total N of the soil. This study aims to examine the application of biochike+ fertilizer technology in peatlands to the growth of oil palm seedlings and the availability of N, P and K nutrients in peat soils.

Methods: The research was conducted in polybags with 6 levels of Biochike+ (B1, B2, B3, B4, B5 and B6) and 5 replications so that there were 30 polybags. The parameters observed were the height and number of leaves every month for 3 months and the chemical properties of the soil after an incubation period of 1 month including pH, N, P and K of available soil. The design was completely randomized design (CRD).

Result: The data obtained were analyzed statistically by analysis of variance (ANOVA) with a 5% significant difference test. showed that the application of Biochike 1 fertilizer (25% biochar Tankos: 75% biochar chicken manure: 100% Urea) gave the highest value to height growth and the availability of N, P, K nutrients in the soil. From an economic analysis, sales of Biochike+ at a price of 1.6 USD per kilogram at the biochar producer level, have provided a profitable value. There are 2 things that benefit from applying Biochike+ fertilizer, namely increasing crop yields and reducing the need for chemical fertilizers.

Key words: Biochar chicken manure, Biochar tankos, Leaching, Peat soil.

INTRODUCTION

Peat soils have low fertility due to the thickness of the peat, nutrient retention and toxic organic acids. Nutrient retention means that nutrients become unavailable to plants because they are bound by organic acids. Leaching is a nutrient that is easily lost due to leaching by water so that it becomes unavailable. However, this does not mean that peat lands cannot be developed for plantation cultivation oil palm.

One effort to increase the fertility of peat lands is fertilization by paying attention to the balance between inorganic and organic fertilizers (Hakim *et al*., 1986). Application of organic fertilizer biochar Tankos-chicken manure enriched with Urea is expected to increase soil fertility and peat land quality, is effective, environmentally friendly and sustainable to increase the growth of oil palm seedlings.

Preliminary studies have been carried out to get the right formulation between Tankos biochar and biochar chicken manure. Indrawati *et al*. (2022) stated that from the incubation experiment between Tankos biochar, chicken manure, for 4 weeks the C/N ratio was <20%, besides that base saturation and CEC were higher than 2 weeks incubation, showing that the use of Tankos biochar + Chicken manure with a ratio of 25:75 and 50:50 can increase the fertility of paddy fields.

Biochar Tankos contains nutrients which can be seen in Table 1.

From Table 1, it is found that the pH of biochar is close to neutral and has a nutrient content eventhough the value is low. The C/N ratio of Tankos biochar is 30%, showing that Tankos biochar has a fairly good maturity level. This also shows that biochar is a very good ameliorant to apply to soil because the C/N biochar of Tankos is easily decomposed to release nutrients. Biochar has a function for soil amendment and leaching loss for nitrogen fertilizer. (Nurmalasari *et al*., 2020).

The nitrogen content of Tankos biochar is 0.80% which is in the low category. According to Hidayati (2018), when the pyrolysis process occurs, the N contained in biochar is lost during the evaporation process, this causes the N

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content in biochar to be reduced or low in nitrogen. Thus the ability capacity of Tankos biochar in its application still has to consider fertilization with other sources of nitrogen fertilizers such as urea or ZA.

The level of P in Tankos biochar is 0.08% including in the low category. According to Darmosarkoro *et al.* (2008), 1 ton of Tankos contains several nutrients equivalent to 3 kg of urea, 0.6 kg of rock phosphate, 12 kg of KCl and 2 kg of kieserite. The P element in Tankos biochar is the lowest element compared to the N, K and Mg elements probably because it is lost because of the pyrolysis process.

The level of potassium (K) contained in Tankos is 3.65% which is included in the high category, this is in line with Indrawati, 2018, the element K is a constituent of plant organic matter, one of which is Tankos.

Biochar chicken manure is one of the organic materials that affect the physical, chemical and plant growth properties. Chicken manure has high levels of nutrients and organic matter (Taiganides, 1978). Chicken manure contains nutrients N 1%, P 0.80%, K 0.40% and water content 55% (Lingga, 1986). At the end of the research an analysis of production costs will be carried out, for the use of Biochike fertilizer.

MATERIALS AND METHODS

The research was carried out in an oil palm nursery on Kebangkitan Nasional Street, Siantan District, Pontianak. This material and research tool used is oil palm empty fruit bunches (Tankos), chicken manure, peat soil, *etc*.

Research implementation consists of Chemical characterization of fresh organic matter and peat soil followed by preparation of materials and production of biochar at the Laboratory of Chemistry and Soil Fertility, Faculty of Agriculture, University of Tanjungpura, Organic carbon (%) with dry destruction method, pH H_2O measurement using a pH meter, Total P (ppm) with Bray I /Spectrophotometer, Total K (%) with Flamephotometer/1N , Total Ca and total Mg with NH_4Cl Extract. Pore Analysis using Quanta Chrome/Nitrogen Gas: Quantachrome NovaWin2 Instruments Version 2.2. The study used a RAL design pattern consisting of 6 treatment factors, namely Urea with various doses and was repeated 5 times so that there were 30 polybags. The treatment can be seen in Table 2.

Each polybag was given a combination of treatments and incubated for 1 month. After that, the soil samples were taken according to the treatment to analyze the chemical properties of the soil (pH, N, P, K). Each polybag is then planted with oil palm seedlings aged 2 months, measurement of growth parameters, namely plant height, number of leaves and stem diameter is carried out once every 1 month until the seeds are 5 months old. At the end of the study, soil samples were taken to be analyzed in the laboratory according to the research parameters. (pH, soil N, P, K). Data analysis was carried out using the F test and DMRT at a 5% confidence level (Gomez and Gomez, 2007).

Calculations for Cost Analysis using the Formula:

HPP= Cost of production per year: Total production per year

Where,

Selling price= HPP + (mark - up × HPP) (Suratman, 2002).

RESULTS AND DISCUSSION

Chemical and physical properties of peat

Peat soil has been analyzed at the Laboratory, as shown in Table 3.

Peat soil has an acidic pH and high CEC but low base saturation. The high CEC is due to a large number of organic acids due to peat decomposition. High C content and low N content are categorized as nutrient-poor soils.

Observation of plant height in months I, II and III

Observation of plant height in months I, II and III can be seen in Table 4.

The effect of giving Biochike+ on plant height in month I was significantly different in treatment B6, as well as in month III. And the increase in plant height is seen every month, as well as in month III. And an increase in plant height was seen every month. The Biochike I treatment gave the highest plants compared to other treatments. Based on Table 4, the growth of seedling height in each month varied from 0.86 cm at 2 months and the highest increase was found at 3 months, namely 10.56 cm. Better root development can cause this increased growth so that the seeds can absorb nutrients and impact the growth of oil palm seedlings.

With the application of Biochike I, which was also given at a dose according to the PPKS (Palm Oil Research Center) recommendation, it turned out to provide excellent growth exceeding the PPKS standard. At the end of the

Table 1: Chemical properties of biochar Tankos.

Analysis parameters		Biochar tankos
pH	-	7.74
P available	(cmol (+) kg^{-1})	0,08
K available	(cmol (+) kg^{-1})	3.65
Total Ca	(cmol (+) kg^{-1})	1.37
Total Mg	(cmol (+) kg^{-1})	0,48
CEC		17.0
Na available	(cmol (+) kg^{-1})	6.78

Table 2: Research treatment.

Treatment	Dose (%)		
	Biochar Tankos (BT)	Biochar chicken manure (BCM)	Urea (U)
B_1	25	75	100
B_2	25	75	75
B_3	50	50	50
B_4	50	50	25
B5	75	25	100
B6	75	25	75

study, namely at 5 months, the PPKS standard was 26 cm and the height of the seeds in this study was 38.90 cm, an increase of 13.8% compared to the PPKS standard. Biochar has a high water holding capacity, so it can keep the N nutrient from being washed away and make it more available to plants.

This is in line with Putri *et al*. (2017), which stated that the application of biochar had a significant effect on plant height. The increase in plant height was influenced by the increase in nitrogen elements with the application of biochar Tankos and Urea. Biochar Tankos has a high water-holding capacity, so it can keep N nutrients from being easily washed out and make them more available to plants. Biochike I fertilizer can increase inorganic N needed for plant assimilation by increasing retention and reducing the impact of leaching N.

Observation of the number of leaves in months I, II and III

Observation of the number of plant leaves in months I, II and III can be seen in Table 5.

Based on Table 5, the increase in the number of leaves each month varies from two strands in the second month and the highest increase was found at 5 months of seedlings 6.7 strands. This greatly increased growth can be caused by better root development, so that the seeds can absorb nutrients and have an impact on the growth of oil palm seedlings. Biochar chicken manure is better in increasing soil fertility because it decomposes quickly and contains more nutrients complete (macro and micro) as well as Microorganisms in it able to decompose the soil into more good, so that some of the nutrients in soils such as P are easily available and absorbed plant. Nutrients P and K a lot needed for stem growth and branch and also works for formation of carbohydrates so that produce a large number of leaves (Sucipto, 2010).

The treatment of BI application had a significant effect on the number of leaves during the observations of 3 month and 4 month. According to Wahyuni *et al*. (2021), in the formation of leaves, sufficient nutrients are needed so that the number of leaves produced is large. With the provision of biochar can increase the number of leaves. In addition to nutrients N and K, EFB biochar also contains Mg. The presence of Mg nutrient content can further increase the number of leaves. Moreover, in this study, urea was also given whose function was also for leaf growth.

The application of Tankos biochar and fertilizers given at a dose according to PPKS recommendations could provide excellent growth exceeding PPKS standards. At the end of the study at 5 months, the number of seedling leaves according to the PPKS standard was 10.5 strands and the number of leaf seedlings from the research was 11.1 strands, an increase of 5.7% compared to the PPKS standard.

Observation of pH, availability of N, P, K soil elements

Observation of pH and availability of N, P and K can be seen in Table 6.

Table 3: Results of peat soil chemical analysis.

Analysis parameters		Value	Criteria
pH H_2O	-	3.48	Low
pH KCl	-	3.25	Low
C Organic	%	58.5	High
Nitrogen total	%	1.90	Low
Extraction of bray I			
P_2O_5	ppm	24.12	Low
Extraction of NH_4OAC			
Calsium	cmol (+) kg^{-1}	2.71	Low
Magnesium	cmol (+) kg^{-1}	1.31	Low
Kalium	cmol (+) kg^{-1}	0.47	Low
Natrium	cmol (+) kg^{-1}	0.78	Low
KTK	cmol (+) kg^{-1}	120.56	High
KB	cmol (+) kg^{-1}	5.27	Low
Extraction of KCl 1N			
Alumunium	cmol (+) kg^{-1}	1.77	Low
Hidrogen			

Source= Data analysis, 2022.

Table 4: Effect of treatment on oil palm plant height in soil peat up to 3 months.

	Observation variable		
	Plant height		
Treatment (BT : BCM : Urea) (%)	Month I	Month II	Month III
B1 (25 : 75 : 100)	27.34b	32.90b	38.90b
B2 (25 : 75 : 75)	23.40a	29.76aab	35.50a
B3 (50 : 50 : 50)	27.00a	28.95ab	38.80a
B4 (50 : 50 : 25)	23.80a	28.56ab	32.20a
B5 (75 : 25 : 100)	23.90a	24.76a	31.30a
B6 (75 : 25 : 75)	23.60a	28.75ab	22.90a
F table	0.16	1.55	3.59
F count	0.24 tn	0.194 tn	0.073*

Source= Data analysis, 2022.

Description:*= Significant effect.

T: Biochar tankos, BCM: Biochar chicken manure, U: Urea.

Table 5: Effect of treatment on number of leaves of oil palm plants in soil peat up to 3 months.

	Observation variable		
	Number of leaves (strands)		
Treatment (BT : BCM : Urea) (%)	Month I	Month II	Month III
B1 (25 : 75 : 100)	2a	4.6b	6.7b
B2 (25 : 75 : 75)	2a	4a	6a
B3 (50 : 50 : 50)	2a	4a	6.4a
B4 (50 : 50 : 25)	2a	4.3a	6.6a
B5 (75 : 25 : 100)	2a	3.9a	5.9a
B6 (75 : 25 : 75)	2a	3.8a	5.6a
F table	-	1.11	1.15
F count	-	0.37	0.35

Source= Data analysis, 2022.

Description:*= Significant effect.

T: Biochar tankos, BCM: Biochar chicken manure, U: Urea.

The effect of Biochike+ fertilizer on N,P,K showed that treatment B1 gave the highest value of N, P and K compared to other treatments and was significantly different, while the pH was not significantly different. Provision of Urea as recommended (100%) gave the highest total soil N because Urea as a source of N was added to biochar chicken manure which was rich in N, P and K nutrients.

The increase in total N comes from the mineralization of organic matter provided (chicken manure and urea). Chicken manure has a high nitrogen content, so it can act as a supplier of nutrients in the soil. Organic N, which is mineralized by bacteria, produces the availability of nitrogen in peat soil.

In peat soils, the P content is less available because P is bound so that phosphorus compounds are not soluble in the soil. Peat soil absorbs low P fertilizer because it contains functional groups in the form of nitric and humic acids which are negatively charged so chicken manure which has a high P content is needed as a cation bridge so that the P element survives.

In the available P parameter, treatment B1 differed significantly from all treatments and also gave the highest available P value, this could be because of the increased availability of available P in the soil sourced from chicken manure. With the higher dose of chicken manure given, the availability of phosphorus will increase this is because chicken manure will undergo a mineralization process assisted by microorganisms so that it releases nutrients including phosphorus into the soil and explained Hakim *et al*. (1986) that chicken manure has a residual effect, namely the nutrients can gradually become available to plants. Chicken manure also contains the highest amount of P_2O_5 compared with other organic fertilizers. Guo *et al*., (2014) stated that biochar can increase the concentration of N-total and P in the soil because it can reduce leaching and can absorb nutrients in the soil. Treatment B1 gave a significantly different effect on all treatments and also gave the highest available K value. Potassium is a mobile element in plants, both in cells, in plant tissues, as well as in xylem and phloem. The provision of biochar chicken manure and tankos contributes to K and this can have a positive influence on increasing soil support for leaching or protecting K nutrients (Indrawati, 2018).

SEM of biochike +

SEM test was conducted to see the pore size in Biochike+ (I) fertilizer and can be seen in Fig 1:

The appearance of the surface pores of Biochike I which was pyrolyzed at 500°C for 4 hours, were sturdy and regular in structure, with large macro and micro pore sizes. The arrangement and shape of the large and neatly arranged pores will increase the role of biochar as an ameliorant in the soil. This intact pore formation makes biochar better in terms of biochar density, particle density and aeration. The water retention ability of biochar is influenced by the high surface area, volume and pore size biochar (Indrawati *et al*., 2020).

Biochar Tankos has macro and micropores, which function as a place for nutrients, a place for microbes to decompose and store water and all of them aim to increase the availability of N, P and K in peat soil so that vegetative growth of oil palm plants can be optimal.

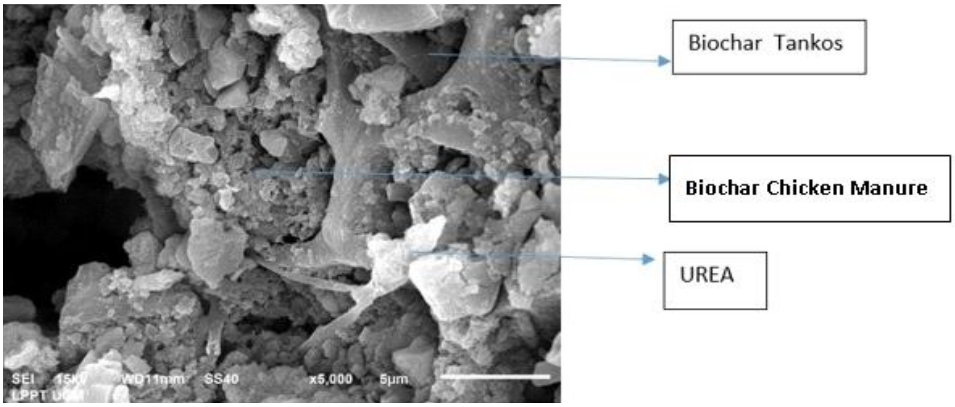
Biochike+ fertilizer profit analysis

We calculate in units per month:
The total value of production costs per month = IDR 17,466,501.
Production costs consist of: Fixed Costs (Equipment Costs, Laboratory Test Costs, Tankos. Waste Costs, Chicken Manure Costs, Urea Costs, Starch Costs, Labor Costs).
Amount of total production per month = 765 kg.
Mark-up value = 10%.
Mark up pricing is an increase in price or total rupiah that has been added up with the cost of a product to produce a selling product value.
Obtained selling price = IDR 25,115/kg or 1.65 USD.

Table 6: Effect of treatment on nutrient availability N, P, K on peat soil after 1-month incubation.

	Observation variable			
	Parameter			
Treatment (BT : BCM : Urea)(%)	pH	N total	P available	K available
B1 (25 : 75 : 100)	6.03a	2.7a	434.23a	8.23a
B2 (25 : 75 : 75)	6.02a	2.5b	418.70b	7.41b
B3 (50 : 50 : 50)	6.06a	2.05b	360.61ab	5.97c
B4 (50 : 50 : 25)	6.05a	1.81c	260.09c	5.98c
B5 (75 : 25 : 100)	6.01a	2.32c	243.72d	5.14c
B6 (75 : 25 : 75)	6.03a	2.26cd	248.43d	4.90d
F table	<0.01	<0.01	<0.01	<0.01
F count	0.001 ns	29.89*	895.86*	182 .83*

Source= Data analysis, 2022.
Description*= Significant effect.



Source: LPPT UGM (2022).

Fig 1: Pore shape of Biochieke+ (I).

CONCLUSION

1. Application of Biochike I (25% biochar Tankos: 75% biochar Chicken Manure: 100% Urea) gave the highest value of N, P, K nutrients in the soil followed by Biochike II and Biochike III fertilizers, because Urea as a source of N plus chicken manure which is rich in N, P and K nutrients.
2. The application of Biochike I fertilizer gave the highest growth in plant height and number of leaves of the oil palm seedlings.
3. From the analysis of the cost of goods sold, sales of Biochike+ fertilizer at a price of 1.6 USD per kilogram at the biochar producer level, have provided a profitable value.

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Conflict of interest

The authors declare that they have no conflict of interest.

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