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The Effect of Applying Biochike+ Fertilizer to Big Chili (*Capsicum annum* L.) Production in Alluvial Soil and Financial Analysis

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ABSTRACT

Background: Alluvial soil has poor chemical properties for the growth of large chili plants, due to high soil acidity, low organic matter and nutrient content and poor soil structure, which will directly cause the growth and production of large chilies to be suboptimal. Efforts that can be made to increase plant growth are by using a combination of biochar tankos and chicken manure biochar (Biochike+). This study aims to determine the effect of Biochike+ fertilizer on the absorption of N, P, K nutrients, growth and yield of large chili plants in alluvial soil and to determine the financial aspects of Biochike+ fertilizer production.

Methods: Cultivation using polybags. The research design used a completely randomized design (CRD) consisting of a combination of biochar doses B0= Control, B1= 10 t.ha^{-1}, B2= 20 t.ha^{-1}, B3= 30 t.ha^{-1} and B4= 40 t.ha^{-1} and analysis of the costs and benefits of Biochike+fertilizer. The treatment was repeated 5 times so that there were 25 polybags.

Result: The administration of Biochike+had a significant effect on all parameters. In the B4 treatment, the production of large chilies reached 300%, N uptake was 352%, P uptake was 200% and K uptake was 120% compared to the control. Financial analysis shows that large chili production using Biochike+ fertilizer is profitable, which is IDR 62,649,420.3 per harvest.

Key words: Alluvial, Big chillies, Biochike+, Financial analysis.

INTRODUCTION

The existence of Alluvial land is very extensive, (2 million ha of 14.7 million ha of land area of West Kalimantan according to the Central Statistics Agency, (2021), but in its use as agricultural land there are many obstacles such as pH, base saturation (BS), low N, P, K nutrient content and has varying C/N. Soil productivity varies from low to high, soil permeability is slow and sensitive to erosion (Yulies *et al*., 2022).

Biochar is charcoal that is given to the soil system and plants as a soil amendment. Biochar is produced from the pyrolysis process or burning of organic materials in limited oxygen conditions. Unlike organic materials, biochar is composed of aromatic carbon rings so it is more stable and long-lasting in the soil. (Indrawati *et al*., 2017). Biochar can be an alternative as a biofertilizer in an effort to increase the production of large chili plants on alluvial soil. Application of biochar can increase pH in acid soil (Abbasi and Anwar, 2015), increase soil CEC (Tambunan *et al*., 2014) and provide nutrients N, P and K (Ippolito *et al*., 2019). Biochar maintains soil moisture so that its water-holding capacity is high (Ojeda *et al*., 2015). Apart from that, applying biochar to the soil can increase growth and nutrient uptake in plants (Syuhada *et al*., 2016).

Tanks can be used as biochar because they have a fairly high mineral composition, such as Ca, Fe, Na, K and P, so they have the potential to be used as biochar as a soil conditioner (Nuryani and Indrawati, 2023). The biochar used in this research is tank's biochar and chicken manure biochar, with a dosage ratio of 50:50% and here in after referred to as Biochike+. The chemical properties of tank's biochar according to (Yulies *et al*., 2022), are pH H_2O 6.74, DHL 0.43 mS, Ca, Mg, K average 1.26: 0.43; 3.65 [cmol(+)kg^{-1}], CEC 10.00 [cmol(+)kg^{-1}], while the chemical properties of chicken manure biochar are pH 6.75, C 21.85%, N 0.95%, P 4.54%, K 0.27%. This data shows that once it has become biochar, chicken manure still has N,P,K nutrients, although not as much. Economically, there is an increase in added value from the use of tank's and chicken manure in Biochike+ fertilizer so that it can provide financial benefits.

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According to the WKCS (2021), the production of fresh large chili in 2013 was 2,848 tons/ha and in 2014 it was 2,199 tons/ha for 706 hectares of land. There was a decrease in production by 22.77%.

MATERIALS AND METHODS

Study areas

The study used polybags in the experimental garden of Gang Pancasila4, no.16, Pontianak. The study lasted for 8 months where the analysis of soil chemical properties was carried out at the Fertility and Soil Chemistry Laboratory, Faculty of Agriculture,Tanjungpura University. The stages of the study include: 1. Taking soil samples with a depth of 0-20 cm, then composited and analyzed completely in the Laboratory. 2. Preparation of media in polybags (10 kg/polybag). 3. Incubation treatment (NPK fertilizer as base fertilizer, Biochike+fertilizer according to the dose, lime with a dose of 79 g/polybag to increase the pH to 6 and Alluvial soil). 4. Seeding of large chilies, after 7 days transferred to polybags. 5. Analysis of N,P,K absorption. 6. Maintenance, 8 Harvesting.

Research design

The design used was a completely randomized design (CRD) with Biochike+ dose treatment. Each treatment was repeated 5 times so that 25 experimental units were obtained. The treatment in question is as follows: B0=control, B1=10 $t.ha^{-1}$; B2=20 $t.ha^{-1}$; B3=30 $t.ha^{-1}$; B4=40$t.ha^{-1}$. Research parameters: A. Chemical Properties of Biochike+b. Biochike+Pore morphology; c. Chemical Properties of Biochike+ Incubated Soil; d. Leaf N,P,K uptake; f. Large chili crop production. g. Financial calculations used cost and profit analysis. To determine the effect of treatment on the observed parameters, Anova statistical analysis was carried out with the F test. If there were significant differences between treatments, it was continued with the DMRT's with a confidence level of 5%.

RESULTS AND DISCUSSION

Observation results

Chemical properties of alluvial soil

The soil used for research material is Alluvial soil.

Table 1, the Alluvial soil used as a planting medium has a pH that is still in the acid category, CEC is high, BS is low and the C and N content is medium. Base saturation is closely related to soil pH, where soil with a low pH has low base saturation and conversely. Soil with a high pH also has a high base saturation (Kabała and Łabaz, 2018). The land in the research location can still produce high yields of large chilies if Biochike+soil amendment is used.

Pore of biochike+

Biochike+ pores with the composition of tank's biochar: chicken manure biochar (50: 50) can be seen in Fig 1.

The appearance of the pores on the surface of Biochike+ pyrolyzed at a temperature of 500°C for 4 hours, the structure is solid and regular, with large macro and micro pore sizes. The arrangement and shape of large and neatly arranged pores will increase the role of biochar as an ameliorant in the soil. The formation of intact pores 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 of biochar (Indrawati and Alhaddad, 2023)

Chemical properties of alluvial soil after incubation

Table 2, after incubation for 4 weeks, the average pH was neutral, Organic C was very high, total N was moderate, C/N was high, available P was high and total K was low. Jamila and Safridar, (2012) also stated that the application of biochar to the soil can increase pH by up to 1 pH unit. Yulies *et al*. (2022) stated that biochar made from tankos raw materials can be used as an ameliorant for long-term soil quality recovery and improvement. The chemical properties of tanks biochar have a neutral pH, besides that it also has Ca, Mg content due to the presence of a little ash from the carbonation process. The increase in pH is only temporary. The incubation treatment between soil and biochar, for 4 weeks found that the longer the incubation period, the more perfect the weathering process and the higher the CEC and BS values. Likewise, the content of available P in the soil and exchangeable K increased with increasing doses of biochar.

N Uptake (mg)

Analysis of variance showed that giving Biochike+ had a significant effect on N nutrient uptake and was followed by the DMRT test (Table 3).

Treatment B4 was significantly different from B0 but not significantly different from other treatments, but there

Table 1: Results of preliminary analysis of chemical properties of alluvial soil (2023).

Parameter	Value
pH H_2O	5.00
Organik-C (%)	9.17
Total nitrogen (%)	0.36
Phosphorus extraction	
P_2O_5 (ppm)	105.95
Ammonium acetate extraction calsium [cmol(+)kg^{-1}]	21.42
Magnesium [cmol(+)kg^{-1}]	2.22
Potassium [cmol(+)kg^{-1}]	0.25
Sodium [cmol(+)kg^{-1}]	0.40
CEC [cmol(+)kg^{-1})]	34.82
Saturated base (%)	19.76
Kalium chlorite extraction	
Alumunium [cmol(+)kg^{-1}]	1.51
Hidrogen [cmol(+)kg^{-1}]	1.85
Texture	
Sand (%)	0
Loam (%)	65.04
Clay (%)	38.16

was an increase in the value of each treatment. The lowest average N absorption value was found in B0 (0.05) while the highest was in B4 (0.434). Application of Biochike+ organic fertilizer can increase N absorption because chicken manure is rich in N nutrients. This is in accordance with the opinion of Rosmarkam and Yuwono (2002) that chicken manure fertilizer in the mineralization process will release complete plant nutrients such as N, P and K. The more doses of chicken manure biochar are given, the more the N absorption value will increase in plants.

The provision of organic materials in the form of biochar from Biochike+ has an effect on increasing soil organic C and will directly increase the total N in the soil, the organic C content has an effect on the availability of total N in the soil, because N can be available due to the decomposition that occurs in organic materials which then undergo decomposition which produces amino acids and undergoes hydrolysis into ammonium (NH_4^+) and nitrate (NO_3^{2-}). The addition of organic materials means an increase in the level of total N in the soil which also directly increases N absorption in plants. Utilization of Biochike+ can leave a residual effect, is very helpful in providing C-Organic for a long time, can increase the fertility of Alluvial soil and can directly affect the growth and yield of eggplant plants (Olivia, 2024).

P uptake (mg)

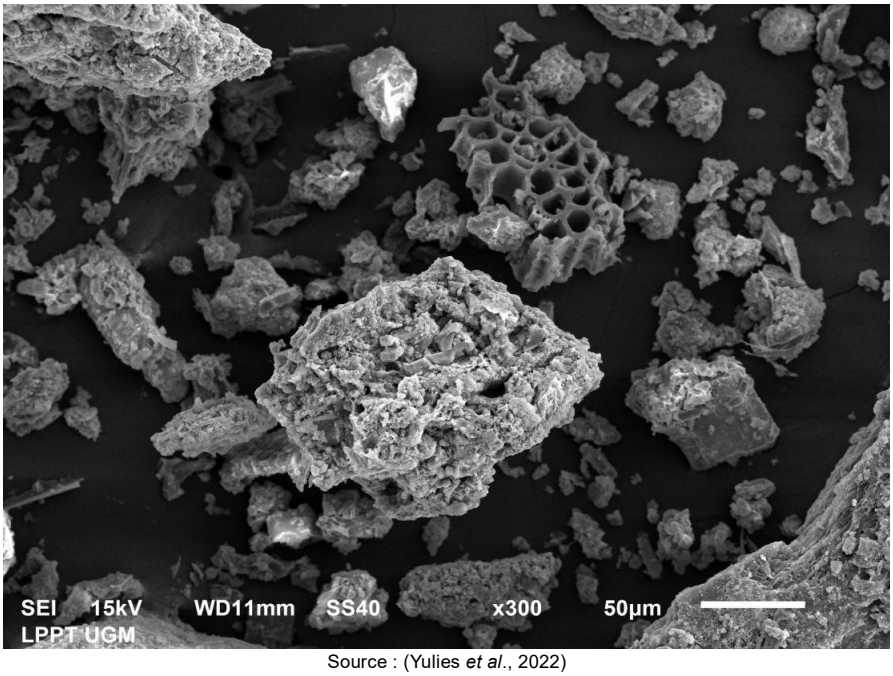
Analysis of variance showed that the application of Biochike+had a real effect on P nutrient uptake followed by the DMRT test.

Table 4 shows that B4 provides the highest P uptake value. This can be caused by the increased availability of available P in the soil sourced from chicken manure and the addition of NPK fertilizer. One of the benefits of giving biochar is that it can reduce leaching because there are pores and functional groups on the surface, so the more biochar is given, the more available these nutrients are to plants (Indrawati *et al*., 2017).

According to (Shen *et al*., 2011) that plant P uptake is largely determined by root contact with P nutrients, the P concentration in the soil solution and the plant's ability to absorb P elements in the soil. (Guppy *et al*., 2005),

Table 2: Data from the results of the analysis of the chemical properties of alluvial soil after incubation (2023).

Sample	pH	C-organik (%)	N-total (%)	C/N	P-bray II (ppm)	K-total
B0	5.00	9.15	0.36	25.41	105.95	0.25
B1	6.37	9.25	0.38	24.34	464.21	5.81
B2	6.49	9.30	0.39	23.85	489.72	9.11
B3	6.71	9.40	0.43	21.89	528.23	14.33
B4	6.89	9.55	0.44	21.70	589.21	17.15
Average	6.29	9.33	0.40	23.44	435.06	9.33



Source : (Yulies *et al*., 2022)

Fig 1: With a magnification of 300 × 50 µ.

decomposition of organic matter can increase the availability of phosphate through its decomposition to form humic P which is easily taken up by plants.

K uptake (mg)

Analysis of variance showed that the application of Biochike+ had a significant effect on K nutrient uptake and then the DMRT test.

Table 5 Shows that concentration of available K in the soil increased after being given Biochike+at 40 $t.ha^{-1}$, by 0,056 mg. Meanwhile, the concentration of K av in the tank biochar of 3.65 $cmol(+)kg^{-1}$ was much greater than the concentration of K av in the soil (Yulies *et al*., 2022). This shows that the provision of biochar can increase K av based on the increase in the dose of biochar added (Indrawati *et al*., 2017). B4 was significantly different from B0, B1, B2, but not significantly different from B3. B4 provided the highest K absorption value, but B3 could be said to be optimal in providing K absorption considering that a dose of 30 t/ha was sufficient for the K needs of large chili plants.

Weight of large chilies (g)

Analysis of variance showed that giving Biochike+had a significant effect on the weight of large chilies and then the DMRT test.

The average production of large chilies per treatment from Table 6 can be seen where B0 106.5 g, B1 325.6 g, B2 435.8 g, B3 and B4 were 500.9 g and 591.6 g per treatment. Production in harvest 1 of the B4 totaled 1,529.6 g. The higher the dose of Biochike+ given, the greater the production.

According to Fitriyani (2023), the increase in the weight of red chili peppers is due to chicken manure biochar 1. being rich in nutrients such as nitrogen (N), phosphorus (P) and potassium (K), which are essential for plant growth and development. 2. increasing the activity of soil microbes that help in the digestion of organic matter into nutrients available to plants. 3. can increase the water retention capacity of the soil, which helps plants cope with drought and maintain optimal growth. 4. improving soil structure and organic matter content, which contributes to better growth and higher yields.

Financial analysis

Financial analysis of biochike + fertilizer manufacturing

The manufacture of Biochike+ fertilizer in the form of granules consists of components that will be analyzed financially, consisting of fixed costs and variable costs. The fixed cost of making Biochike fertilizer/month is Rs. 419,618/ month or Rs. 5,035,416/year. The fixed costs incurred come from the depreciation cost of equipment used in the manufacture of Biochike+, namely Kontiki furnaces, sieving machines, shovels, mortar crushers and granular mixing machines.Variable costs include the cost of the main raw materials of tank's, chicken manure, sacks, labels, starch, labor. Total variable costs/month incurred amounted to IDR 216,144,000/year.

The total cost of making Biochike+/month is IDR 18,431,168 or IDR 221,174,016/year.

Cost of Goods Manufactured (CGM) is:

$$CGM = \frac{\text{Production cost per year}}{\text{Total production per year}}$$

Selling price = CGM+(mark-up+CGM)

Therefore: CGM = IDR 18.431.168/756 kg = IDR 24.379/kg

Selling Price = IDR 24.379 /kg + (10%*IDR 24.379/kg)

= IDR 26.000/kg

Cost of goods manufactured

Biochike fertilizer manufacturing business revenue per month is IDR 20,273,652 or IDR 243,283,824/year. The income obtained from making Biochike+ fertilizer per year is IDR 22,109,808.

Table 3: DMRT test results effect of biochike+ administration on N uptake (mg).

Treatment	BNJ
B0	0.050a
B1	0.406b
B2	0.415b
B3	0.418b
B4	0.434b

Source : (2023).

Table 4: DMRT test results effect of biochike+ administration on P uptake (mg).

Treatment	BNJ
B0	0.01a
B1	0.56b
B2	0.55b
B3	0.61c
B4	0.73d

Table 5: DMRT test results on the effect of giving tank's manure biochar chicken against K uptake (mg).

Treatment	BNJ
B0	0.014a
B1	0.034a
B2	0.036a
B3	0.050b
B4	0.056b

Table 6: BNJ results effect of Biochike+ on large chili fruit. (g).

Treatment	BNJ
B0	106.50a
B1	325.60a
B2	435.80b
B3	500.90c
B4	591.60d

Financial analysis of large chili farms after using biochike+

The costs incurred in large chili farms are divided into 2 types of costs, namely fixed costs and non-fixed costs. Fixed costs are costs that are always the same even though the amount of production changes. Fixed costs incurred in this study include the depreciation value of tools which is IDR 5,100,579.67/ha. The equipment used consists of hoes and sprayers. Variable costs are all costs incurred by farmers in the production process that affect production results whose costs change. Variable costs consist of fertilizer, seed, pesticide and labor costs. Seed costs amounted to IDR 1,500,000/ha. The NPK fertilizer at IDR 1,200,000/ha and Biochike+ fertilizer at IDR 2,600,000/ha. The total cost of fertilizer is IDR 3,800,000/ha. Pesticide costs are IDR 300,000/ha and labor costs are IDR 6,650,000/ha (Table 7).

Red chili production is produced at 10 tons/ha with a selling price of IDR 80,000/kg. So the amount of income from red chili farming is IDR 80,000,000/ha. The amount of income obtained is shown in the following Table 8.

From the results of financial calculations, it shows that red chili farming using biochike+ fertilizer is feasible because the amount of income received is greater than the production costs incurred. The profit obtained by large chili farming with biochike+ fertilizer is IDR 62,649,420.3/ha/year.

Alluvial soil has a low level of soil fertility, therefore Biochike+ can be used as an alternative to increase soil fertility. Biochike+ is made from biochar tank's and chicken manure biochar with a ratio of 50:50 has chemical properties of pH 9.44, C/N Ratio 29.63%, total N 0.78%, organic C 23.20%, P 3.99% and K 1.70%. Biochike+ can increase pH even if only for a moment, because of its high pH (pH> 7). The K content is high because K is still there when heated to 350°C.

Increasing the provision of Biochike+will increase the absorption of N, P, K and the weight of large chili fruit in this study, this may be due to the availability of N, P, K in the soil also increasing compared to the soil before treatment. In the case of biochar application, there is a change in soil pH from acidic to neutral, resulting in three benefits: reducing the capacity of phosphate absorption by soil minerals, binding Al and Fe metals (Al-P and Fe-P) and reducing nutrient retention on the biochar surface (Indrawati *et al*., 2017).

Financial analysis shows that Biochike+fertilizer production provides many benefits, not only increasing soil fertility but also from a financial aspect providing profitable economic value. The profit obtained by large chili farmers with Biochike+fertilizer is IDR 62,649,420.3 per harvest.

Table 7: Recapitulation of production costs of red chili farming/ha.

Type of cost	Amount (IDR)
Fixed costs	5.100.579,67
Tool depreciation costs	
Variable/Non-fixed costs	
a. Fertilizer cost (TSP and Biochike+)	3.800.000
b. Seedling costc.	1.500.000
c. Pesticide costd.	300.000
d. Labor cost	6.650.000

Table 8: Recapitulation of total income from ted chili farming business/ha.

Description	Amount (IDR)
Total Revenue	80.000.000
Total Production Cost	17.350.579,7
Revenue (1-2)	62.649.420,3

Source: Data processed 2024.

CONCLUSION

Biochike+ organic fertilizer can help increase N, P and K uptake and the production of large chili plants, whereas the dose of organic fertilizer increases, the soil's N, P and K uptake will also increase. In the 40 $t.ha^{-1}$, large chili fruit production reached 300%, N uptake was 352%, P uptake was 200% and K uptake was 120% compared to the control. Financially, Biochike+ fertilizer production provides profitable economic benefits.

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Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Informed consent

All procedures for using tankos biochar and chicken manure for experiments were approved by the Faculty of Agriculture, Tanjungpura University to be developed into organic fertilizer as ameliorant in Alluvial soils.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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