The Effect of Biochar and Cow Manual Fertilizer on Nutrition Upport and Production of Sweet Corn (*Zea Mays* L.)

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ABSTRACT

The demand for sweet corn is increasing every year, one of the efforts to increase the production of sweet corn is to utilize suboptimal land such as post-PETI land. The purpose of the study was to examine the application of biochar and cow manure to nutrient uptake and the yield of sweet corn crops. This research was carried out in the experimental garden of the Faculty of Agriculture. This study is a factorial experiment arranged in a complete randomized design (RAL) with biochar and cow manure treatment. The first factor is biochar which consists of four dose levels, namely without biochar, biochar 6 tons / ha, 12 tons / ha and 18 tons / ha. The second factor is the application of manure with four dose levels, namely without manure, 20 tons / ha, 40 tons / ha and 60 tons / ha of manure each repeated 3 times, so that there are 48 experimental units. The results showed that pemberian pupuk cowshed as much as 60 tons / hectare and biochar as much as 18 tons / hectare can increase N absorption by 16.7%. The provision of cow shed p upuk as much as 40 tons / hectare and biochar as much as 18 tons / hectare can increase P and K absorption by 32.57% and 39.13%, respectively. The provision of cowshed p upuk as much as 20 tons / hectare and without biochar can increase Ca uptake by 3.74%. Hasil of sweet corn plants ranges from 0.3 to 1.67 tons / ha due to the application of manure and biochar.

Keywords: Biochar; Sweet Corn; Cow Manure; Nutrient Uptake; Post-PETI Soil.

INTRODUCTION

Sweet corn (*Zea mays* L. *Saccharata Sturt*.) is a plant that is often used by the people of Indonesia for nutritional fulfillment needs. The limitations of sweet corn in the country require Indonesia to import sweet corn. The productivity of sweet corn in Indonesia averages 8.31 tons / ha with the potential yield of sweet corn reaching 14-18 tons / ha (Maryamah., et al. Efforts to increase the production of sweet corn are utilizing suboptimal land. Post-PETI soil is a satu among the less than optimal soil types that can be used as land for the development of sweet corn crops. Post-PETI land has suffered physical, chemical and biological damage and contains Hg (Neneng et al., 2012). The results of research by Ferianto et al., (2013) showed that Hg levels on post-PETI land in West Kalimantan were low, furthermore Hg content in post-PETI land aged 4-5 years after mining of 0.02 ppm. The development of food crop cultivation on post-PETI land requires the right technology because the soil in the area has been damaged and its fertility is low. This can be overcome by providing soil-improving materials that can increase soil fertility, namely biochar and manure (Saputro et al, 2022).

Biochar can overcome the loss of nutrients N, P, K, caused by the washing process so that it is available to plants (Novak *et al*., 2010). The addition of 5% biochar to the soil can increase soil fertility and affect the growth and absorption of nutrients by corn plants (Khumairoh et al, 2021). One of the biochar used to increase adsorbtion and nutrient availability in the soil is biochar from empty bunches of oil palm (Sulakhudin, 2019).   Cow manure is an organic fertilizer that contains nutrients that can improve soil fertility. Cow manure also increases the soil's ability to store water which serves to mineralize organic matter into nutrients that can be utilized directly by plants during their growth period. Therefore, the addition of biochar and cow manure is expected to be able to support soil fertility by increasing nutrient uptake and growth yields of sweet corn plants in post-PETI soil (Rahmawati &

Hartanti, 2021). This study aims to examine the application of biochar and cow manure to the absorption of N, P, K, Ca, Mg nutrients and the growth yield of sweet corn plants in post-PETI fields.

METHOD

The research was carried out at the Greenhouse and Soil Chemistry and Fertility Laboratory, Faculty of Agriculture. The research is planned for 6 months starting from preparation to presentation of the results. The materials used for the study consisted of sweet corn seeds, post-PETI soil, cow manure, biochar and polybags. The research method was designed using a Complete Randomized Design (RAL) with biochar treatment carried out with four dose levels without biochar (B_0), 6 tons / ha (B_1), 12 tons / ha (B_2) and 18 tons / ha (B_3) as well as the second factor of manure with four dose levels without manure (P_0), 20 tons / ha (P_1), 40 tons/ha (P_2) and 60 tons/ha (P_3). The experiment was repeated 3 times, so there were 48 experimental units. The effect of the treatment on the observed parameters was carried out a variety analysis using the F test at a 5% confidence level using the DMRT test to show real or unreal influences.

The preparation of research and planting is carried outkan using post-PETI soil by lightening the soil and sifting until it passes a sieve of 0.5 cm, mixing the treatment on each polybag containing 12 kg of soil then inkubasi for two weeks andm enyiram planting medium, sweet corn seeds are planted by cutting 7 cm deep as many as 3 seeds per polybag. The observation variables of this study were nutrient absorption of N, P, K, Ca, Mg, wet and dry weight of plants, trubus weight and variable results of cob weight, cob diameter and length of sweet corn cob.

RESULT AND DISCUSSION

- **Soil Characteristics**

The soil used in this study was post-PETI soil which suffered severe damage both physically, biologically and chemically so that it was unable to help plant growth. The results of the post-PETI soil analysis can be seen in Table 1. The results of the initial soil analysis describe the characteristics of the soil before the treatment of applying kendang fertilizer and biochar. The results of the soil pH analysis had very sour (3.89%) , very low C-organic (0.24 %), N-Total (0.03 %) very low, Nisbah C / N (8 %) low and P_2O_5 high (13.68 ppm). This relatively high available P content is in line with the results of research by Mastur *et al*., (2017) which showed that P-available in post-PETI   soils from Monterado was high with value of 15.21 ppm / KTK value of 4.70 (cmol (+) $^{kg-1}$) is very low, kandungan Ca 0.26 (cmol(+)$^{kg-1}$), Mg 0.17 (cmol(+)$^{kg-1}$), K 0.02 (cmol(+)$^{kg-1}$), Na 0.04 (cmol(+)$^{kg-1}$) and alkaline saturation of 10.43% in very low-grade post-PETI soils and Fe content of 13.53 ppm which is high-priced.

Table 1. Post-PETI Soil Analysis Results

Soil Parameters	Post-CRATE Land	
	Value	**Dignity**
pH H_2O	3,89	Very Sour
C-Organic (%)	0,24	Very Low
N Total (%)	0,03	Very Low
C/N	8	Low
P_2O_5 Bray (ppm P)	13,68	Tall
KPK/CEC (cmol (+) $^{kg-1}$)	4,70	Very Low
Ca (cmol(+)$^{kg-1}$)	0,26	Very Low
Mg (cmol(+)$^{kg-1}$)	0,17	Very Low
K (cmol(+)$^{kg-1}$)	0,02	Very Low
Na (cmol(+)$^{kg-1}$)	0,04	Very Low
Alkaline Saturation (%)	10,43	Very Low
Texture Sand (%) Dust (%) Clay (%)	 87,52% 12,48% 0	Sand Loamed

Source : Laboratory of Chemistry and Soil Fertility 2020

Table 2. Nutrient Absorption Value of N Plants (mg) in The Application of Manure and Biochar.

Manure (P)	Biochar (B)				
	No Biochar	**6 tons/ha**	**12 tons/ha**	**18 tons/ha**	**Average**
No Manure	24.76	10.62	12.37	2.29pm	15.51
20 tons/ha	18.32	21.04	12.29 pm	23.42	18.77
40 tons/ha	15.37	13.55	12.36	14.46	13.94
60 tons/ha	13.58	6.65	12.48	29.74	15.61
Average	18.01	12.97	12.38 pm	20.48	(-)

- **Effect of Cow Manure and Biochar on Nutrient Absorption of Sweet Corn Plants**
  - **Uptake of Nitrogen Nutrients**

Based on the results of the 5% DMRT test analysis in Table 2, it shows that the effect of manure application on N nutrient uptake tends to increase compared to controls. Table 2 shows that manure application to N nutrient uptake tends to increase compared to controls. It is suspected that the increase in plant N nutrient uptake is caused by the increasing availability of nitrogen in the soil sourced from manure. In line with the research of Isrus (2010) that the increase in N uptake of plants is related to an increase in the dry weight of the canopy, an improvement in root development and an increase in the availability of soil N.

The effect of biochar administration was able to increase the absorption of N nutrients at the highest treatment of 18 tons / ha. The increase in N nutrient absorption in plants is thought to be due to the role of biochar applied to be able to provide a growing medium for plant roots to absorb nutrients in the soil that are translocated to parts of the important plant tissue. This shows that biochar acts as a soil reformer that can improve soil physical properties, soil biology and supply a number of nutrients important for plant growth. Perperan biochar as a bioactivator providing N fertilizer so that it can increase biomass and N absorption in plant leaves.

  - **Phosphorus Nutrient Uptake**

Based on the results of the 5% DMRT test analysis in Table 3, it shows that the application of cow kendang fertilizer and biochar has no real effect on the absorption of P nutrients. The application of cow manure tended to increase P uptake compared to control. The results of the analysis showed that the best cow manure application contained P absorption of 18.20 mg at a dose treatment of 20 tons / ha. This is thought to be due to manure being able to increase the availability of P in the soil. This is in accordance with the research of Enaime et al, (2020). which states that organic matter affects the absorption of P which is an important element in vegetative growth so that roots can develop more easily and more easily absorb nutrients.

The administration of biochar at a dose of 18 tons / ha was able to increase the absorption of P nutrients in sweet corn plants in the soil after PETI. The dose of biochar administration of 18 tons/ha is able to increase P uptake allegedly because biochar can improve soil conditions and increase crop production, especially on less fertile soils. The ability of biochar to bind water and nutrients in the soil helps toreduce the occurrence of fertilizer loss due to surface erosion and washing, so it is suspected to be able to save fertilization and reduce residual pollution of accumulation in the surrounding environment.

  - **Nutrient Uptake of Potassium**

The results of the analysis of the DMRT advanced test at the level of 5% on plant K nutrient absorption in Table 4 showed a single real effect on biochar administration. Hasil of the DMRT test on manure application has no effect on K uptake which is suspected because the potassium needs of plant tissues have not been met, but the results of applying cow manure to K absorption in post-PETI soil can be seen that the highest K nutrient absorption is at a dose of 20 tons / ha of 71.56 mg. The increase in nutrient uptake of K is thought to be due to the ability of biochar to increase the uptake of essential nutrients and increase plant growth. The application of biochar has a positive effect on crop productivity.

Table 3. Plant P Nutrient Absorption Value (mg) in Manure and Biochar Treatment

Manure (P)	Biochar (B)				
	No Biochar	6 tons/ha	12 tons/ha	18 tons/ha	Average
No Manure	18.9	8.26	12.23 pm	13.45	13.21
20 tons/ha	19.73	22.5	13.29	17.27	6.20pm
40 tons/ha	16.65	15.67	12.32 pm	28.03	18.17
60 tons/ha	14.02	7.96	14.17	16.37	13.13
Average	17.33	13.60	13.00	18.78	(-)

Table 4. Nutrient Absorption Value of Plant K (mg) in the treatment of Manure and Biochar Application

Manure	Biochar				
	No Biochar	6 tons/ha	12 tons/ha	18 tons/ha	Average
No Manure	75.45	45.72	58.56	64.97	61.18
20 tons/ha	70.15	64.03	67.32	84.74	71.56
40 tons/ha	55.33	49.71	48.9 0	123.96	69.48
60 tons/ha	50.84	35.4 0	50.71	78.95	53.98
Average	62.94 ab	48.72 a	56.37 ab	88.16 b	(-)

Description: 1. The numbers in the column followed by the same letter do not differ markedly in the DMRT test at a level of 5%   2. (-) No interaction
Source : Data analysis 2020

The effect of biochar administratio on K nutrient uptake in sweet corn plants was able to have a noticeable influence on a dose of 18 tons / ha singularly as much as 88.16 mg. The highest K nutrient absorption was obtained in the B3 treatment at a dose of 18 tons / ha compared to the B2 treatment with a dose of 12 tons / ha and B1 as much as 6 tons / ha. It is suspected that biochar contains K nutrients which are able to improve K nutrient uptake and plant growth. This research is in line with Xie et.al., (2015) which states that potassium contained in biochar can be in soil solution so that it is easily absorbed by plants and sensitive to leaching.

- **Calcium Nutrient Uptake**

Based on the results of the 5% DMRT test analysis in Table 5, it shows that the effect of manure application tends to increase Ca uptake compared to controls. Pbuckets of manure tend to increase Ca uptake compared to controls. The highest increase in Ca uptake was at a dose of 20 tons/ha. This is thought to be because the ability of plants to absorb calcium is limited because Ca can only be absorbed by the tips of the young roots of the plant. This result is in line with the research of Firmansyah (2017) which states that the application of cow manure at a dose of 5 tons / ha can increase ca absorption in plants.

Table 5. Nutrient Absorption Value of Plant Calcium (mg) in manure and biochar treatment

Manure (P)	Biochar (B)				
	No Biochar	6 tons/ha	12 tons/ha	18 tons/ha	Average
No Manure	11.32	6.18 pm	5.71	6.07 pm	7.32
20 tons/ha	11.76	8.42	6.36	11.57	9.53
40 tons/ha	7.85	8.24	6.7	13.5	9.07
60 tons/ha	7.19	5.13	7.76	8.59	7.17
Average	9.53	6.99	6.63	9.93	(-)

Table 6. Nutrient Absorption Value Magnesium Plant (mg) in manure and biochar treatment treatment

Manure	Biochar				
	No Biochar	6 tons/ha	12 tons/ha	18 tons/ha	Average
No Manure	12.99	5.83	4.79	5.6	7.30a
20 tons/ha	11.76	7.92	4.34	8.72	8.19a
40 tons/ha	6.55	7.54	5.61	10.15 pm	7.46a
60 tons/ha	5.72	3.7	5.91	7.78	5.78a
Average	9.26a	6.25bc	5.16c	8.06ab	(-)

Description: 1. The numbers in the column followed by the same letter do not differ markedly in the DMRT test at a level of 5%   2. (-) No interaction

Source : Data analysis 2020

The application of biochar is able to increase the absorption of Ca nutrients in sweet corn plants in the soil after PETI at a dose of biochar administration of 18 tons / ha.   Ca nutrient absorption in the control treatment was 9.53 mg, while in the treatment of biochar the absorption of Ca nutrients ranged from 6.63 – 9.93 mg. The application of biochar to Ca uptake in the treatment is not much different from the nutrient absorption in the control, this is thought to be due to the dry sandy soil conditions with dominant levels sand, very shaft and high *leaching* potential.

- **Absorption of Magnesium Nutrients**

The results of the analysis of the dmrt advanced test at the level of 5% in Table 6 showed that the administration of biochar decreased the absorption of Mg nutrients. The results of further DMRT tests showed that the   application of manure had no effect on the absorption of Mg nutrients allegedly because the magnesium needs of plant tissues could not be fulfilled for plants. In addition, the sandy post-PETI soil condition causes nutrients not easily bound by the soil and are easily washed off due to the soil being shafted. Table 6 shows that the effect of biochar administration actually decreases mg nutrient uptake, this is thought to be

due to biochar contributing to higher K nutrient uptake. In line with the research (Prasad *et al.* , 2019) which states that high plant K nutrient uptake can suppress and reduce the uptake of Mg nutrients by plants because both nutrients are antagonistic.

- **Effect of Cow Manure and Biochar on The Growth Yield of Sweet Corn Plants**
 - **Cob Weight**

Based on the results of the 5% DMRT test analysis, it can be seen in Figure 1, pbuckets of cow manure and biochar are able to increase the weight of the cob compared to the control.

Figure 1a shows the effect of applying cow manure on the cob weight of plants in the post-PETI soil. The application of cow manure is able to increase the weight of the cob compared to the control. The cob weight result in the control treatment was 8.28 grams, while the cob weight result in various treatments increased, which ranged from 3.22 to 10.27 grams. Although this result is lower than the potential results of Kartika's research (2019) which showed the weight of the Bonanza variety sweet corn plant cob of 383.47 / cob or 15,118 tons / ha.

The administration of biochar tends to increase the weight of the cob compared to the control. The weight of the cob in the control treatment was 6.96 grams, while the weight of the cob in various treatments increased, which ranged from 5.13 to 8.21 grams. Biochar treatment at 6 tons / ha was able to have the highest influence on the weight of sweet corn cobs.
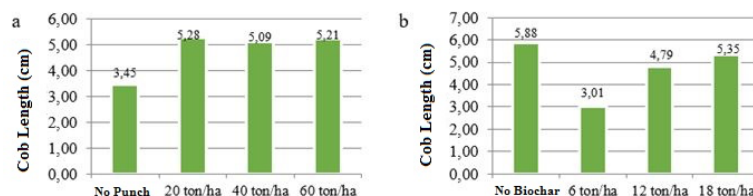
- **Cob Diameter**

Theresult of the DMRT test analysis of the level of 5% application of manure and biochar to the cob diameter of the sweet corn plant can be seen in Figure 2.
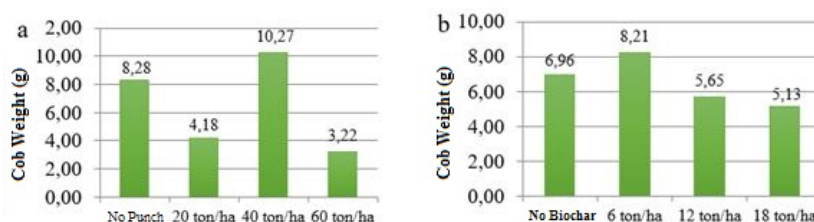
Figure 1. Average Weight of Corn Cobs (a) With Manure Treatment (b) With Biochar Treatment
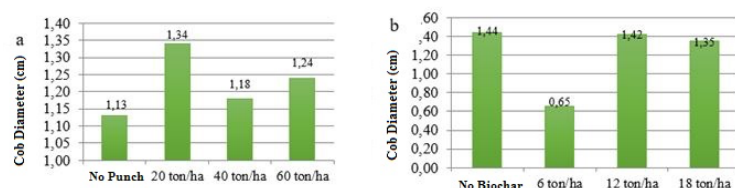
Figure 2. Average Diameter of Corn Cobs (a) With Manure Treatment (b) With Biochar Treatment

Figure 3. Graph of Average Length of Corn Cobs (a) With Manure Treatment (b) With Biochar Treatment

The application of cow manure tends to increase the diameter of the cob of the plant compared to the control. The diameter of the cob in the control treatment was 1.13 cm, while the diameter of the cob in various treatments increased in the range of 1.18 – 1.34 cm. It is suspected that the application of manure at a dose of 20 tons / ha is more able to provide nutrients for plants so that it increases in the diameter of the sweet corn cob.

- **Cob Length**

Based on the results of the DMRT test analysis, the level of 5% application of manure and biochar to the cob length of the sweet corn plant can be seen in Figure 3.

The application of cow manure in various treatments tends to increase the length of the cob compared to the control. The length of the cob in the control treatment was 3.45 cm, while the length of the cob in various treatments increased which ranged from 5.09 – 5.28 cm. The effect of the highest manure application on the length of the corn cob was in the P1 treatment of 5.28 cm. This is thought to be because manure can supply macro nutrients and micronutrients even though it is in relatively small quantities, in addition to being able to improve soil structure so that it makes it easier for plants to take nutrients in the soil.

- **Effect of Cow Manure and Biochar on The Weight Yield of Sweet Corn Trubus**

The average yield of manure and biochar application to the weight yield of sweet corn trubus in post-PETI soil isseen in Table 7. The application of cow manure tended to increase the yield of trubus weight compared to the control. The trubus weight yield in the control treatment was 28.78 grams, while the trubus weight result in various treatments increased , which ranged from 22.06 - 33.14 grams. Table 7 also shows the effect of biochar administration on B3 treatment is able to increase the uptake of P nutrients in sweet corn plants in post-PETI soils. Trubus weight results against various treatments improved compared to controls. The trubus weight of the control plant was 28.41 grams, while the weight of trubus yields with various treatments ranged from 22.47– 34.80 grams, it is suspected that giving biochar was able to increase the weight of the trubus. The application of manure and biochar is able to give the best results on the trubus weight of sweet corn.

Table 7. Trubus Weight Value (g) in manure and biochar treatment

Manure (P)	Biochar (B)				
	No Biochar	6 tons/ha	12 tons/ha	18 tons/ha	Average
No Manure	38.72	16.57	23.22	36.59	28.78
20 tons/ha	16.85	16.91	23.86	30.63	22.06
40 tons/ha	32.64	22.78	39.2	30.53	31.29
60 tons/ha	25.43	33.63	32.06	41.44	33.14
Average	28.41	22.47	29.59	34.80	

Source: Data analysis 2020

The application of cow manure tended to increase the yield of trubus weight compared to the control. The trubus weight yield in the control treatment was 28.78 grams, while the trubus weight result in various treatments increased , which ranged from 22.06 - 33.14 grams.   Table 7 shows that the effect of biochar administration on B3 treatment is able to increase the absorption of P nutrients in sweet corn plants in post-PETI soils. Trubus weight results against various treatments improved compared to controls. The trubus weight of the control plant was 28.41 grams, while the weight of trubus yields with various treatments ranged from 22.47– 34.80 grams, it is suspected that giving biochar was able to increase the   weight of the trubus.

- **Effect of Cow Manure and Biochar on Wet Weight and Dry Weight of Sweet Corn Plants**
  - **Wet Weight Plant**

The resultsof u ji DMRT on the wet weight of plants in Table 8 showed that the application of manure had a significant effect on the wet weight of plants in the control treatment, but decreased the amount of wet weight of plants against dosing doses of 40 and 60 tons / ha.

The provision of biochar on the wet weight of plants was able to have a noticeable influence on the   highest treatment, which was 119.43 grams at a dose of 18 tons / ha, compared to the control of 103.32   grams. It is suspected that biochar can provide P nutrients indirectly useful for the photosynthesis process so that it is easy in the formation of glucose.

Table 8. Wet Weight Value of Plants (g) on Manure Application Treatment and Biochar

Manure (P)	Biochar (B)				
	No Biochar	6 tons/ha	12 tons/ha	18 tons/ha	Average
No Manure	153.69	93.68	106.72	117.43	117.88 a
20 tons/ha	119.99	117.35	81.85	129.35	112.14 a
40 tons/ha	73.23	67.68	67.35	64.98	68.31 b
60 tons/ha	66.39	51.16	63.28	165.97	86.70 b
Average	103.33 ab	82.47 b	79.80 b	119.43 a	(+)

Table 9. Plant Dry Weight Value (g) in Manure and Biochar Treatment

Manure (P)	Biochar (B)				
	No Biochar	6 tons/ha	12 tons/ha	18 tons/ha	Average
No Manure	50.36	34.89	35.67	41.81	40.68 a
20 tons/ha	41.76	38.21	31.07	45.62	39.17 a
40 tons/ha	30.61	30.72	30.99	31.79	31.03 b
60 tons/ha	30.78	27.63	30.82	51.02	35.06 b
Average	38.38 ab	32.86 b	32.14 b	42.56 a	(+)

Description: 1. The numbers in the column followed by the same letter do not differ markedly in the DMRT test at a level of 5%   2. (+) There is interaction

- **Dry Weight of the Plant**

The resultsof u ji DMRT on the dry weight of plants can be seen in Table 9 showing that the application of manure had a noticeable influence on the control treatment.

The results of the DMRT test on the dry weight of plants showed that the provision of biochar on the dry weight of plants was able to have a noticeable influence on the highest treatment, which was 42.56 g at a dose of 18 tons / ha, compared to   with control only 38.38 g. An increase in the dry weight of the plant is generally used as a hint of an increase in plant growth. Safitri et al., (2018) stated that giving biochar can increase the dry weight of sweet corn plants.

CONCLUSION

Based on the results of the study on the effect of applying cow manure and biochar empty bunches of oil palm on nutrient uptake and the yield of sweet corn crops in the soil after PETI, it can be concluded that:

- The application of cow manure as much as 60 tons / hectare and biochar as much as 18 tons / hectare can increase N uptake by 16.7% compared to control.

- The application of cow manure as much as 40 tons / hectare and biochar as much as 18 tons / hectare can increase P and K absorption by 32.57% and 39.13% respectively compared to the control.
- The application of cow manure as much as 20 tons / hectare and without biochar can increase Ca uptake by 3.74% compared to controls.
- The yield of sweet corn crops in the application of manure and biochar ranges from 0.3 to 1.67 tons / ha while the optimal production of sweet corn plants is 15.12 tons / ha.

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