

**Research Article**

**Effect of sago waste, manure and straw biochar on peanut (*Arachis hypogaea* L.) growth and yield on an Ultisol of Southeast Sulawesi**

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**Abstract:** Farmland in Southeast Sulawesi is largely dominated by Red and Yellow Podzolic soil type or Ultisol up to 60.30% of total soil. Aspects that caused low productivity, deteriorating soil physically and chemical properties in Ultisol soil is low soil organic matter content. Average peanut production in Southeast Sulawesi 2014 reached 0.46 t, on the other hand average domestic production is 1.87 t. The decrease in production is caused by decline in land productivity. Low peanut production is caused by soil fertility. Declining soil fertility can be restored by applying organic matter into the soil, but, in a tropical environment, the rate of organic matter decomposition and mineralization take place very quickly, resulting in additional organic material each planting season. Another alternative is to reduce the organic matter decomposition rate and release carbon in the soil through utilizing agricultural and animal waste into biochar which is resistant to corrosion. The experiment was conducted using a randomized block design which consisted of nine treatments and three replications. The results exhibited that straw biochar at 25%, or 2.48 t/ha + manure biochar at 75% equivalent to 5.87 t/ha was capable of increasing growth and yield rate for peanut varieties *Talam 1*. Peanut varieties *Talam 1* yield increased after sago waste, manure and straw application, by 45.62% compared to peanut crops yield without utilizing biochar on Ultisol.

**Keywords:** *biochar, peanut, sago, ultisol*

**Introduction**

Farmland in Southeast Sulawesi is largely dominated by Red and Yellow Podzolic soil type or Ultisol amounted to 60.30% (BPS Sultra, 2015). Aspect that causes low productivity, deteriorating soil in physical and chemical properties in ultisol soil is low soil organic matter content. Dry acid ultisol soil have acid ground reaction, Al content that could be exchanged and P fixations, low organic matter content, low alkali and cation exchange, alkali saturation and low biological activity (Hidayat and Mulyani 2005; Hartatik and Setyana, 2012). Soil physical properties limiting factors is described as follows. high BD (bulk density), low water mitigation ability and soil densification (Erfandi et al., 2003). Average peanut production in Southeast Sulawesi 2014 is 0.46 t, it could be considered low compared to the average domestic peanut production which is at 1.87 t (CBS, 2015).

Decrease in production is caused by decline in peanut productivity (Raja et al., 2013). In addition, said decline is caused by several factors, e.g. soil fertility, cultivation techniques, the availability of improved seed as well as pests and diseases (Mulyani, 2006). Soil fertility decline can be restored by applying organic matter into the soil through administering organic matter in the form of manure, compost and green fertilizer or *pupuk hijau* (Sudiarso 2007). Application of organic matter into the soil through manure and agricultural crops waste can increase soil N and C content (Fliebbach et al., 2007). However, in a tropical environment, the organic matter decomposition and mineralization rate take place very quickly, therefore requiring additional organic material each planting season to maintaining land productivity (Glaser et al., 2002). This resulted in the declining effectiveness of organic materials usage for agricultural

productivity and increase in farming cost. An alternative to reduce organic matter decomposition rate and release carbon from soil is through utilization of agricultural and animal waste into biochar or bio-charcoal which is resistant to corrosion.

Lehmann and Joseph (2009) states that biochar is a material derived from biomass or processing plant waste which is heated in a container with little to no oxygen. Additionally, biochar is fine grains of porous charcoal, when in maintaining soil it can reduce the amount of CO<sub>2</sub> from the air (Gani 2009). Lehmann (2007) states that all organic material added to soil will give significant effect in increasing soil functions variety, including retention (ability to reserve nutrients) for plant growth, but biochar hold nutrients more effectively so there are more available nutrient compared leaf, compost and manure fertilizer. Biochar application into soil has the potential of increasing the C content - soil, water and nutrient retention in soil (Mawardiana et al., 2013).

Biochar potential use in maintaining soil is huge in Southeast Sulawesi, considering the availability of raw materials from the agricultural crops and animal waste. Sago waste is one type of organic matter derived from plant tissues that contain macro and micro nutrients important to plants growth. Based on Chemistry and Soil Fertility Laboratory, Faculty of Agriculture UNTAN analysis, it exhibits that sago waste

bokashi contain high C-Organic (52.62%). (Sulistiyowati, 2011). Sudiarso (2007) stated that fresh cow manure (undecomposed manure) contained 0.92% N, 0.43% P and 12.54% K, after anaerobic decomposition for 10 weeks contained 1.52% N, 0.71% P and 0.79% K. Straw is rice crops waste, that is easily obtained, can be utilized as environmentally sound fertilizers. Waste straw is one type of organic material containing high C / N ratio (50-70%). Materials that have high C / N give greater influence to change the soil physical properties (Nurhayati et al., 2011).

The purpose of this research was to study the effect of sago waste, manure and straw biochar on peanut growth and yield in an Ultisol.

### **Materials and Methods**

The research was conducted in the Ranomeeto Village, Ranomeeto Sub-District, South Konawe, Southeast Sulawesi Province, from January 2016 to June 2016. The study area is geographically located on 04003.017 S and 122027.569 E, at an altitude of 109 meters above sea level (masl), pH 4.3 (high acid), Ultisol soil type. Humidity average is 80.01%, and the average daily temperature is 28.15<sup>0</sup>C. The experiment was conducted using a randomized block design, which consisted of nine treatments and three replications (Table 1)

Table 1. Biochar application treatment.

<b>Treatment</b>	<b>Description</b>
P0	Control (without biochar)
P1	Sago dreg biochar 100% equivalent to 12.93 t/ha
P2	Manure biochar 100% equivalent to 7.82 t/ha
P3	Straw biochar 100% equivalent to 9.91 t/ha
P4	Sago dreg biochar 75% equivalent to 9.69 t/ha + Manure biochar 25% equivalent to 1.95 t/ha
P5	Sago dreg biochar 50% equivalent to 6.46 t/ha + Manure biochar 50% equivalent to 3,91 t/ha
P6	Straw biochar 75% equivalent to 7.44 t/ha + Sago dreg biochar 25% equivalent to 3.23 t/ha
P7	Straw biochar 50% equivalent to 4.96 t/ha + Sago dreg biochar 50% equivalent to 6.46 t/ha
P8	Straw biochar 25% equivalent to t/ha + Manure biochar75% equivalent to 5.87 t/ha

Research stages involve land cultivation, biochar manufacture, liming, biochar application, planting, base fertilizing, plant reform and harvest. Plant growth parameter observed included. the number of leaf, leaf area and leaf area il index. Unfolded leaves at 21, 35, 49, 56 and 70 DAP (day after planting), the number of nodules and ginofor at 21, 28, 35, 42 and 49 days

after planting and the total dry weight of the plant life at 70 DAP. Crops component include. number of pods, pods dry weight, yield and harvest index. Additional observations include; soil analysis at the beginning and end of the study, sago waste, cow manure and straw biochar analysis. The data were analyzed using variety analysis (ANOVA) and using the F count test. If F count > F table, it

would be followed by Least Significant Difference test (LSD) at 5%.

## Results and Discussion

### *Nutrient status prior to biochar application*

Soil fertility status or soil nutrient at research site, prior to biochar application is presented in Table 1. The soil at the research site according to Pusat Penelitian dan Pengembangan Tanah dan Agroklimat (2005) had low values of pH, C

content, N content, C/N ratio, available P content, exchangeable K content, and cation exchange capacity. Furthermore, according to Pusat Penelitian dan Pengembangan Tanah dan Agroklimat (2005), Ultisols and prime agricultural dry land soils are characterized by acidic soil reaction (pH 4.1 - 4.8), thin upper layered organic matter content (8-12 cm), low to moderate, and low C / N ratio (5-10) at the bottom layer.

Table 1. Soil nutrient status at research site, prior to biochar application

Location	Parameter						
	pH (H <sub>2</sub> O)	C (%)	N(%)	C/N	P <sub>2</sub> O <sub>5</sub> Bray (ppm P)	K (me/100 g soil)	KTK (me/100 g soil)
Ranomeeto Sub-district Value*)	4.3	0.09	0.02	4	5.01	0.01	5.16
	Very Low	Very Low	Very Low	Very Low	Low	Very Low	Low

Note . Estimation criteria of soil analysis (Penelitian dan Pengembangan Tanah dan Agroklimat, 2005)

### *Plant growth*

Data presented in Table 2 exhibit difference between treatment with and without biochar biochar on number of leaves at 35 49, 56 and 70 DAP. Application Straw Biochar 25% equivalent of 2.48 t/ha + Manure biochar 75% equivalent of 5.87 t/ha (P8), Straw Biochar 75% equivalent of 7.44 t/ha + sago dreg biochar 25% equivalent of 3.23 t/ha (P6) and Straw biochar 100% equal 9.91 t/ha (P3), showed an increase in leaf area compared to those without biochar application (P0). Increasing the number of leaves under the influence of biochar application, likely due to

biochar having a role in creating growing environment for plant growth by improving the physical, chemical and biological soil properties. Biochar potential as land reform media can improve the physical, chemical and biological soil and improve plant growth by supplying a number of useful nutrients (Glauser et al., 2002). With N, P and K availability, then the plant possess adequate nutrient availability, thus increasing plant growth. The increase in growth is caused by soil chemical properties include increased levels of N and P in soil (Chan et al., 2007; Harsono et al., 2010).

Table 2. Average number of leaves at various age observation (days after planting = DAP).

Treatment	Number of Leaves each Crops				
	21 DAP	35 DAP	49 DAP	56 DAP	70 DAP
P0	7.83	20.83 a	31.50 a	28.63 a	48.33 a
P1	9.00	23.17 a	35.00 ab	50.67 ab	61.00 ab
P2	10.83	24.50 ab	38.17 ab	60.83 b	66.00 ab
P3	12.33	36.83 b	48.50 b	52.17 ab	78.67 b
P4	13.17	28.83 ab	43.83 ab	61.67 bc	73.83 b
P5	11.67	21.83 a	45.83 ab	79.83 bc	64.00 ab
P6	10.50	35.17 b	55.17 b	63.50 bc	72.00 ab
P7	14.17	28.50 ab	45.17 ab	50.83 ab	73.33 b
P8	15.33	36.50 b	54.83 b	90.00 c	98.17 b
LSD 5%	tn	11.54	14.97	28.95	24.86

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

Table 3 shows the difference between the treatment with or without biochar. Variation trend of increased leaf area at various ages observations. Application Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) exhibits bigger leaf area compared to those without biochar (P0). This is likely due to the biochar ability to help create an environment

fitting to grow crops and biochar nutrient availability spurs the growth of leaves to carry out photosynthesis. Laird et al. (2010) stated that application of biochar into the soil reduced the N, P and K leaching. Subsequent biochar application can improve soil C-organic, pH, structure, CEC and the capacity to store water (Chan et al., 2007).

Table 3. Average leaf area per plant at various age observation (days after planting = DAP).

Treatment	Leaf Area (cm <sup>2</sup> )				
	21 DAP	35 DAP	49 DAP	56 DAP	70 DAP
P0	27.77 a	88.23 a	193.03 a	320.23 a	326.27 a
P1	31.60 ab	91.38 a	204.87 a	481.97 ab	506.20 ab
P2	40.47 ab	92.13 a	252.13 ab	622.27 b	605.40 b
P3	65.22 b	163.90 b	374.97 b	580.70 ab	613.77 b
P4	61.03 b	129.47 ab	317.87 ab	489.42 ab	584.63 b
P5	48.73 ab	109.30 ab	243.50 ab	667.85 b	459.20 ab
P6	42.23 ab	162.60 b	353.90 b	721.73 b	644.47 b
P7	65.43 b	142.00 ab	233.07 ab	349.27 ab	567.60 b
P8	67.02 b	176.98 b	393.47 b	810.63 b	654.63 b
LSD 5%	23.02	62.05	131.48	276.67	183.84

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAT (days after planting).

Table 4 shows the difference between the treatment with and without biochar regarding leaf area index at 21, 35, 49 and 56 DAP. Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) resulted in higher leaf area index compared to those without biochar (P0). This was probably due biochar role in creating a growing environment that support crops vegetative growth through improved physical, chemical and biological soil properties. Biochar in maintaining soil role can improve soil physical properties, biology as well as supplying a number of nutrients essential for plant growth (Lehmann

et al., 2003; Lehmann and Rondon, 2006; Steiner, 2007). thus indirectly support plant growth. The vegetative growth development followed by peanut plants leaf area index. According to Sitompul (2016), the value of leaf area index > 1 illustrates the leaves mutual shading with the consequent reduction in the exposure to the leaf canopy shaded in the bottom layer with a lower rate of photosynthesis compared to shaded leaves. But this does not mean that the leaf area index ≤ 1 is left without shade from one leaf to another. It is highly dependent on the morphology of the leaf (distribution, shape and position of the leaves).

Table 4. Average Leaf Area Index at various age observation (days after planting = DAP).

Treatment	Leaf Area Index				
	21 DAP	35 DAP	49 DAP	56 DAP	70 DAP
P0	0.05 a	0.15 a	0.32 a	0.53 a	0.65
P1	0.05 a	0.15 a	0.34 a	0.80 ab	0.84
P2	0.07 ab	0.15 a	0.42 ab	1.04 b	1.01
P3	0.11 b	0.27 b	0.62 b	0.97 ab	1.02
P4	0.10 b	0.22 ab	0.53 ab	0.82 ab	0.97
P5	0.08 ab	0.18 ab	0.41 ab	1.11 b	0.77
P6	0.07 b	0.27 b	0.59 b	1.20 b	1.02
P7	0.11 b	0.24 ab	0.39 ab	0.58 a	0.95
P8	0.11 b	0.29 b	0.72 b	1.35 b	1.09
LSD 5%	0.04	0.10	0.22	0.46	tn

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

Table 5 shows the difference between the treatment with and without biochar crop leaves the number of observations at various ages. Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) indicates the number of root nodules was higher compared to those without biochar (P0). Increasing the number of root nodules under the influence of biochar proved that it can be a good medium for soil microbes growth and development. Biochar application can increase the number of beneficial microbes. Microbes can aid peanut crops in fixating N through advantageous cooperation (Atkinson et al., 2010). The molecular structure of chemical biochar shows high stability for

microbes. Porous physical structure and large surfaces that provide favorable habitat for microorganisms such as bacteria and mycorrhizal which plays an important role in increasing nutrient. As a result of the specific surface area of biochar which reaches 400-800 m<sup>2</sup> / g, it becomes adequate growth habitat, develops and accelerates activities for soil microorganisms, thereby increasing the nutrient availability for crops (Fiscer and Glaser, 2012). The existence of biochar in the soil can be used as a habitat for fungi and other soil microbes. Saito and Marumoto (2002) has reported that in the biochar micropores, fungi can sporulate, because of low competition that occurs with other saprofit.

Table 5. Average number of root at various age observation (days after planting = DAP).

Treatment	Number of Root Nodules (buah)				
	21 DAP	28 DAP	35 DAP	42 DAP	49 DAP
P0	1.17 a	18.50 a	19.83 a	51.33 a	54.83 a
P1	2.17 ab	23.67 ab	23.67 ab	67.17 ab	69.83 ab
P2	3.00 b	28.83 ab	37.00 b	87.67 ab	108.50 ab
P3	3.83 b	41.33 b	41.50 b	109.00 b	158.17 b
P4	2.67 b	32.83 ab	36.67 b	78.33 ab	118.83 b
P5	2.50 ab	41.33 b	43.33 b	86.67 ab	116.67 b
P6	3.67 b	46.17 b	45.50 b	94.50 b	123.00 b
P7	3.17 b	35.50 b	47.67 b	84.00 b	106.67 ab
P8	5.33 c	46.83 b	49.67 b	120.33 b	167.50 b
LSD 5%	1.44	15.64	16.66	37.15	54.07

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

Table 6 shows the difference between the number of ginofor with and without biochar treatment at 28, 35, 42 and 49 DAP. Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) indicates higher ginofor amount compared to those without biochar (P0). Increased number of ginofor caused by biochar influence

capable of improving physical, chemical and biological through soil reform that facilitates ginofor growth and develop easily into the soil. Biochar utilization raises productivity through improved soil chemical, physical and biological soil properties (Glaser et al., 2002; Chan et al., 2007).

Table 6. Average number of ginofor at various age observation (days after planting = DAP).

Treatment	Number of ginofor (/crops)				
	21 DAP	28 DAP	35 DAP	42 DAP	49 DAP
P0	0.00	0.37 a	2.00 a	13.33 a	14.67 a
P1	0.00	2.00 b	3.83 ab	13.17 a	16.33 a
P2	0.33	3.33 bc	3.67 ab	13.83 a	18.67 ab
P3	0.83	4.00 c	5.33 b	17.67 ab	27.17 b
P4	0.50	2.67 bc	5.17 b	17.17 ab	23.83 b
P5	0.00	2.33 bc	5.00 b	16.17 ab	27.17 b
P6	0.83	4.33 c	6.33 b	21.00 b	21.17 ab
P7	0.00	3.67 c	5.67 b	12.50 a	17.33 ab
P8	2.00	5.00 c	8.83 c	23.67 b	27.00 b
LSD 5%	tn	1.37	2.23	5.54	7.13

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

Biochar application of organic materials can improve soil's physical properties and beneficial to crops. The organic material may influence soil density, so reduced soil density will allow crop roots to grow easily and facilitate ginofor into the ground (Martin and Wijayanti, 2011).

Table 7 shows the total dry weight difference between crop treatment with and without biochar at 70 DAP. Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) shows the total crops dry wight are higher compared to those without biochar (P0). The increase crops dry weight is caused by biochar ability to improve physical, chemical and biological soil properties, so as to facilitate the plant roots in improving nitrogen, phosphorus and potassium uptake and distributed to the plants' vital organ which are reflected in total crop dry weight. Biochar can directly increase the crop nutrient content productivity and indirectly release nutrients and improve the nutrient retention, making it available to plants (Lehmann et al., 2003).

Table 7. Average crop dry weight at 70 days after planting

Treatme nt	Dry weight of total crop (9) at 70 DAP
P0	23.10 a
P1	27.25 ab
P2	29.30 ab
P3	35.00 b
P4	38.34 bc
P5	30.97 ab
P6	37.74 bc
P7	39.47 bc
P8	48.29 c
LSD 5%	10.86

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

#### **Component of peanut crops**

Table 8 shows the difference between the number of pods with and without treatment. Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) showed higher number of pods compared to those without biochar (P0) at harvested at 93 DAP. Increased number of pods is high likely caused by biochar ability to improve physical, chemical and biological soil property, especially on low soil fertility such as in research sites, which have a low C-organic, low organic matter and a very low pH. Biochar can function as a soil reform media because it has high porous structure to reserve water and increase surface

area of the ground. Otherwise it could absorb anions, cations and molecules in the form of organic and inorganic compounds, solvents and gas (Asai et al., 2009). Table 8 shows the difference between the number of pods with and without biochar treatment. Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) showed a high number of pods crop compared to those without biochar (P0) at 93rd DAP harvest.

Table 8. Average number of pods at 93<sup>rd</sup> day after planting

Treatment	Number of pods each crop
P0	16.56 a
P1	20.69 ab
P2	21.63 b
P3	25.43 b
P4	23.00 b
P5	21.33 ab
P6	25.24 b
P7	24.80 b
P8	25.44 b
LSD 5%	5.00

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

Table 9 shows the difference in pods dry weight cropping with and without biochar treatment at 93rd DAY harvest. On the other hand, Table 10 shows the difference between the peanut yield with and without biochar at 93rd DAP harvest. Biochar influence on crop productivity depends on the amount and the ingredients applied. This is consistent with the statement of Gani (2010) that increased crop productivity is affected by applied biochar amount.

Table 9. Average pods dry weight at 93<sup>rd</sup> day after planting

Treatment	Pods dry weight each crop (g)
P0	12.34 a
P1	23.35 b
P2	24.55 b
P3	29.68 b
P4	26.93 b
P5	26.91 b
P6	28.62 b
P7	25.73 b
P8	30.17 b
LSD 5%	8.74

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

The results showed straw biochar 25% equivalent of 2.48 t/ha + manure biochar 75% equivalent of 5.87 t/ha (P8) indicates the pods dry weight and high yields compared to those without biochar (P0) at 93rd day harvest.

Table 10. Average harvest at 93<sup>rd</sup> day after planting.

Treatment	Harvest (t/ha)
P0	1.20 a
P1	2.28 b
P2	2.40 b
P3	2.90 b
P4	2.63 b
P5	2.63 b
P6	2.79 b
P7	2.51 b
P8	2.95 b
LSD 5%	0.85

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

This was caused by influence of biochar which could improve physical and chemical soil properties so that it could meet plant nutrient needs and in the end influence peanut yield.

Lehman et al. (2003) stated that with increasing biochar doses, encourages plants positive response and and increase maximum achievement in certain areas. In this study, sago waste, animal manure and straw biochar can increase pods dry weight by 45.72% and its yield by 45.93% compared to those without biochar. In addition, the influence of biochar can improve physical, chemical and biological soil fertility, especially on soils with low fertility such as in research sites, which have low C-organic (12.09%), low organic matter (0.15%) and very low pH (4.3). Glaser et al. (2002) states that increase in nutrient retention and availability occurred after biochar application, increased nutrient retention can improve fertilizer efficiency and reduce nutrient leaching (Steiner et al., 2008) and increase crop yields (Verheijen, 2009).

Table 11 shows the harvest index difference between those with and without biochar treatment. Harvest index is a value that describes the photosynthesis distribution (biomass) plants between the two parts of the plant which are photosynthesis organ and economically valuable organs (pods). Straw biochar 7.44 75% equal to 2.48 t/ha + 25% sago dreg biochar 3.23 t/ha (the P6), Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) and Straw biochar 25% equal to 2.48 t/ha + manure biochar 75% equal to 5.87 t/ha (P8) and Straw

biochar equal to 50% 4.96 t/ha + sago waste biochar 50% equal to 6.46 t/ha (P7) shows the harvest index were higher than those without biochar (P0) during harvest. The increased harvest index is caused by biochar influence, which is capable of improving growth conditions through improvements in physical, chemical and biological properties, crops will grow well and possess improved results.

Table 11. Average harvest index at 93<sup>rd</sup> day after planting.

Treatment	Harvest Index
P0	0.22 a
P1	0.39 b
P2	0.32 ab
P3	0.40 b
P4	0.40 b
P5	0.37 b
P6	0.47 b
P7	0.41 b
P8	0.41 b
LSD 5%	0.13

Note . Numbers accompanied by the same letter in the column or the same age are not significantly different based on the LSD 5%; DAP (days after planting).

Latuponu et al. (2011) exhibits that sago waste biochar can increase C-organic, pH, Al-dd, KPK and prevent N leaching. Moreover, the results of Yamato et al. (2006) research exhibits that biochar application from acacia wood plus fertilizer, can increase peanut yield. Manure fertilizer and manure biochar application on cassava and peanut significantly increased crop yields. Biochar application and fertilizer is capable of optimizing efficient use of land (Islami et al., 2011)

#### *Nutrient status after biochar application*

Based on the results of soil analysis after the study, showed that overall soil with biochar applied possess increased nutrient levels compared to prior condition where biochar has not been applied (Table 12). After the study, pH (5.6 - 6.5), C, P, N, K nutrient in the soil increased. CEC before the study is 5.16 became 6.02 after the study. The biochar application into the soil resulted in a change in pH, electrical conductivity (EC), cation exchange capacity (CEC) and nutrient content (Liang et al., 2006; Warnock et al., 2007; Amonette and Joseph, 2009). This has positive impact on growth and peanut yield on Ultisol soil. Growth increase in caused by soil chemical properties improvement which includes increased levels of N, P in soil (Chan et al., 2007; Harsono et al., 2010).

Table 12. Nutrient Status in research site after biochar application

Treatment	Parameter						
	pH (H <sub>2</sub> O)	C (%)	N(%)	C/N	P <sub>2</sub> O <sub>5</sub> Bray (ppm P)	K (me 100 g Soil <sup>-1</sup> )	KTK (me 100 g Soil <sup>-1</sup> )
P0	5.1	0.72	0.08	9	2.89	0.06	7.35
P1	5.7	1.07	0.12	9	91.12	0.07	6.12
P2	6.5	1.26	0.12	11	59.44	0.27	5.19
P3	6.0	1.00	0.11	9	60.35	0.26	6.17
P4	5.6	0.99	0.10	10	34.23	0.06	6.13
P5	6.2	1.07	0.11	10	45.72	0.10	5.11
P6	6.0	0.91	0.10	9	117.28	0.39	6.14
P7	6.1	1.24	0.13	10	40.16	0.24	8.22
P8	6.4	1.07	0.09	11	49.82	0.19	5.10

## Conclusion

Straw Biochar 25% equivalent to 2.48 t/ha + Manure biochar 75% equivalent to 5.87 t/ha could increase growth and an increase in peanut Talam 1 varieties yield due to the sago waste, manure and straw biochar influence by 45.93% compared to Ultisol without biochar.

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