Effect of Sawdust Biochar and Cow Manure Application on Soil Fertility at Peanut (*Arachis Hypogaea* L.) Land

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Abstract. The low available nutrient and C-organic cause dryland has a low fertility rate. Biochar and manure application in agricultural cultivation must be reviewed further in order to obtain an effective and applicable way to increase production yields and to improve soil fertility. The purpose of this study was to determine the effect of sawdust biochar and cow manure on soil fertility in peanut land. This includes two types of soil amendment made from locally available raw materials (sawdust biochar and cow manure). Data analysis was conducted by using Randomized Block Design with factorial 3 x 3 and 3 replications. First factor was sawdust biochar (0 t/ha; 2.5 t/ha; and 5 t/ha). Second factor was cow manure (0 t/ha; 2.5 t/ha; and 5 t/ha). Soil samples were analysis on 45 days after planting and the observed variables were : (1) C Organic; (2) Total N; (3) C/N ratio; and (4) soil pH. The sawdust biochar application has a significant effect on C-Organic and soil pH. The best biochar application was 2.5 t/ha. Cow manure application has not significant effect on C-Organic, Total N, C/N ratio, and soil pH.

1. Introduction

Agricultural production on dryland is considerably lower when compared to agricultural production in wetland systems. This happens because wetlands generally have a relatively higher soil fertility rate when compared to dryland. In addition, other constraints are acid soil reactions, low organic C and N content, cation exchange capacity and low base saturation, high phosphate fixation, erosion problems and water availability [1], especially during the dry season, so the index of cropping in dryland is still relatively low. However, when viewed from characteristics of dryland, it is still necessary some action to overcome the limiting factors that become constraints in its development.

Land extensification for food crops is currently experiencing constraints due to limited productive land. Efforts to maintain the land extensification is by extension to dryland. Dryland farming system is agricultural cultivation practice which has high dependency on climatic factors, so it is easily degraded if its management is not appropriate. The low available nutrient and C-organic cause dryland has a low fertility rate. Improvement of soil fertility on dryland can be done with the addition of organic materials, either with manure, commercial compost and plant residues [2]. Biochar and manure application in agricultural cultivation must be reviewed further in order to obtain an effective and applicable way to increase production yields and to improve soil fertility.

Peanut production has decreased by 2015. Peanut production in Indonesia in 2015 was 605,449 tons, while in 2013 and 2014 reached 701,680 and 638,896 tons. The decline in production is also accompanied by a decrease in the area of peanut harvest in Indonesia. In 2013, the peanut harvest area decreased from 519,056 ha to 499,338 ha and decreased by 19,718 ha in 2014. In 2015 the decrease reaches 67,707 ha, so the harvest area in 2015 is only 454,349 ha [3]. This decrease in production shows that the practice of peanut cultivation has problems.

The purpose of this study to determine the effect of sawdust biochar and cow manure on soil fertility in peanut land.
2. Materials and Methods
This research conducted at Campus experimental site, Syiah Kuala University on May to September 2017. The research was conducted by experimental method in field and laboratory. Soil amendment formulation was evaluated for improving soil and crops productivity. This includes two types of soil amendment made from locally available raw materials (sawdust biochar and cow manure). It was expected that the kind of soil amendment (sawdust biochar and cow manure) can be evaluated to know which the more effective as soil amendment to increase soil fertility at peanut cultivation land.

Data analysis was conducted by using Randomized Block Design with factorial 3 x 3 and 3 replications. Total 27 plots. First factor was sawdust biochar (0 t/ha or 0 kg/plot; 2.5 t/ha or 0.9 kg/plot; and 5 t/ha or 1.8 kg/plot). Second factor was cow manure (0 t/ha or 0 kg/plot; 2.5 t/ha or 0.9 kg/plot; and 5 t/ha or 1.8 kg/plot).

Biochar and cow manure application was 2 weeks before planting according to treatments. Urea fertilizer as base fertilizer was given 25% recommended (50 kg/ha) and applied at planting time. Plot size was 1.2 m x 3 m and planting size 30 cm x 30 cm. Peanut, Bima variety, harvested 100 days after planting. Soil samples were analysis on 45 days after planting and the observed variables were: (1) C Organic; (2) Total N; (3) C/N ratio; and (4) soil pH.

3. Results and Discussion

3.1. Pretreatment Soil Analysis
The soil type in the Campus Experimental Site The ACIAR Project is Entisol with sandy loam texture with coarse class. Table 1 describes the soil chemical properties of Entisol of the Campus Experimental Site, The ACIAR Project, Syiah Kuala University.

3.2. Effect of Sawdust Biochar on Organic C, Total N, C/N Ratio, and pH on Entisol
Table 2 shows that C-Organic in peanut land was higher in application of sawdust biochar 2.5 t/ha and significantly different application of sawdust biochar 5 t/ha, but not significantly different from application of sawdust biochar 0 t/ha. Furthermore, the soil pH was higher in the application of sawdust biochar 5 t/ha and significantly different from the application of sawdust biochar 0 t/ha, but not significantly different with the application of sawdust biochar 2.5 t/ha. N-Total in peanut land tends to be higher in sawdust biochar 2.5 t/ha, although was not significantly different with N-Total due to sawdust biochar 0 t/ha and 5 t/ha. The C/N ratio in peanut land was higher in application of sawdust biochar 5 t/ha, although not statistically different with C/N ratio on application of sawdust biochar 0 t/ha and 2.5 t/ha.

Sawdust biochar application has significant effect on C-Organic and soil pH. This was presumably due to the provision of biochar can play a role as soil amendment. The biochar function for soil was as soil ameliorant because it has a relatively high pH and cation exchange capacity (CEC) [4]. In addition, carbon in sawdust biochar can increase the content of C in soil (Figure 1). The lower organic content of C in the treatment of 5 t/ha compared to other treatments (Table 2) showed that the carbon was more utilized by soil microorganisms as a source of energy. The amount of pore space on sawdust biochar can provide suitable habitats for the growth of soil microorganisms (Figure 2), so that soil microorganisms can work well.

The results of [5] showed that 1 t/ha biochar was able to increase soil pH. The higher biochar given to the soil causes the pH to increase. [6] also showed that giving pine sawdust biochar increases soil pH and the higher biochar dosage was also soil pH higher. The increasing soil pH and being neutral would be good for the crop, in accordance with [7] statement that the soil pH around neutral nutrients would be widely available to plants.

Sawdust biochar application was not significant effect on N-Total and C/N ratio. This was presumably because sawdust biochar has not functioned properly. This was indicated by a moderate C/N value. Nitrogen competition between plants and microorganisms occurs when the C/N ratio is high. This
is because more C than N, so there will be many sources of energy and microorganisms using existing nitrogen for its development [3].

**Tabel 1.** Soil chemical properties at Campus Experimental Site Syiah Kuala University [9]

| Parameters       | Criteria                  | Value          |
|------------------|---------------------------|----------------|
| pH (H₂O)         | Neutral-Slighty Alkaline  | 7.2-8.6        |
| C organic (%)    | Very low to Low           | 0.74-1.54      |
| Total N (%)      | Very low to Low           | 0.05-0.11      |
| Total P (mg 100 g⁻¹) | High to Very High      | 49-122         |
| Total K (mg 100 g⁻¹) | High to Very High      | 49-42          |
| P available (ppm) | High to Very High        | 28-85          |
| Ca               | Low to High               | 5.33-15.97     |
| Mg               | High                      | 3.51-6.27      |
| K                | Low to Medium             | 0.12-0.39      |
| Na               | Very low to High          | 0.08-1.60      |
| Σ Cations (cmol kg⁻¹) | Very High             | 10.77-19.75    |
| CEC (cmol kg⁻¹)   | Low                       | 9.42-14.57     |
| Exch Al          | Very low                  | 0              |
| Exch H           | Very low                  | 0.02-0.04      |
| Base Saturation Basa (%) | Very High           | >100           |
| Soil fertility Status | Medium                   |                |

**Tabel 2.** Effect of sawdust biochar on C Organic, Total N, C/N ratio, and pH at peanut land.

| Sawdust Biochar (t/ha) | C Organic (%) | Total N (%) | C/N   | pH     |
|------------------------|---------------|-------------|-------|--------|
| 0                      | 1.06          | 0.08        | 13.68 | 6.43   |
| 2.5                    | 1.17          | 0.09        | 13.67 | 6.64   |
| 5                      | 0.99          | 0.08        | 14.52 | 6.71   |
| HSD 5%                 | 0.12          | -           | -     | 0.24   |

Letters in superscript indicate differences at 5% level

3.3. Effect of Cow Manure on Organic C, Total N, C/N Ratio, and pH on Entisol

The cow manure application was not significant effect on C-Organic, N-Total, C/N ratio and pH. This is assumed because the cow manure has not been decomposed perfectly so it has not given effect on some parameters of soil chemical analysis. This was supported by C-Organic and N-Total were also at a low dose and can be measured from C/N levels was classified as moderate. If the C/N ratio was relatively high, there will be nitrogen competition between plants and microorganisms, there will be a lot of energy sources and microorganisms using existing nitrogen for their formation and development and causing competition with plants [7].
Figure 1. Sawdust biochar pore with Scanning Electron Microscopy (SEM)

Figure 2. Sawdust biochar analysis with Energy Dispersive Analysis (EDS)

Table 3. Effect of cow manure on C Organic, Total N, C/N, and pH at peanut land

| Cow Manure (t/ha) | C-Organic (%) | Total N (%) | C/N   | pH   |
|-------------------|---------------|-------------|-------|------|
| 0                 | 1.02          | 0.08        | 13.22 | 6.68 |
| 2.5               | 1.07          | 0.08        | 13.92 | 6.50 |
| 5                 | 1.12          | 0.08        | 14.72 | 6.59 |
4. Conclusion
The sawdust biochar application has a significant effect on C-Organic and soil pH. The best sawdust biochar application was 2.5 t/ha. Cow manure application has not significant effect on C-Organic, Total N, C/N ratio, and soil pH.

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