Utilization of rice husk biochar and tofu dregs compost to growth and yield of sweet corn (*Zea mays saccharata* Sturt.)

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**Abstract.** This research aimed to obtain the appropriate dosage of rice husk biochar and tofu dreg compost for the growth and yield of corn plants. It was also to find out the interaction between biochar rice husk and tofu dreg compost on the growth and yield of corn plants. The study was conducted at the BPTP Lampineung field, Banda Aceh, from April to July 2018. The analysis used in this study was a randomized complete block design (RBD) with a factorial pattern of 3 x 3 with 3 replications. The factors studied are; a. rice husk biochar consist of 3 levels b. Tofu waste compost factor consists of 3 levels. The parameters observed included plant height, flowering age, cob length, and cob weight. The results showed that the treatment of rice husk biochar had no significant effect on plant height 15, 30, 45 DAP, the cob diameter and weight, but had a significant effect on flowering age, and had a very significant effect on plant height of 60 DAP. The treatment of various tofu dregs compost doses significantly affected plant height at 60 DAP but did not significantly affect plant height at 15, 30, 45 DAP, flowering age and cob weight. There was a very significant interaction of providing rice husk biochar and tofu compost to the length of corn cobs.

**1. Introduction**

The development of the agricultural sector is currently being promoted because in addition to domestic needs it also contributes to the country’s GDP from the non-oil and gas sector. The direction of economic development policy in the agricultural sector is determined as agropolitan development with corn-based competence [1]. According to Dongoran [2] corn has been known and planted by the North American people since 200 BC, but the origin of the corn was then developed by explorers from Europe in the 17th century, which was used as animal feed and human food.

Sweet corn (*Zea mays saccharata* STURT.) discovered by an inventor around central America, the beginning of the discovery of sweet corn in central America around 1965. According to the note, sweet corn entered Indonesia in the 1980s [3]. Sweet corn spread widely in Indonesia because it has a sweeter taste, more fragrant aroma, and contains sucrose sugar and low fat so it is safe for diabetics. Market demand for sweet corn continues to increase but there are various obstacles. The productivity of sweet corn in the country is still low compared to other countries due to the improper cultivation system [4].

One of the limiting factors for the growth of sweet corn is nutrient in the soil. To achieve optimum results, sweet corn requires adequate input [5]. A review from a different perspective understands that agricultural waste is a source of organic material, carbon, and fertilizer that plays a very important role in sustainable agriculture. Likewise, the development of agriculture in Indonesia has led to an increase in agricultural waste such as rice straw, and husks, corn stalks.
Rice husk can be processed into biochar which is used as the main ameliorant to increase the content of organic matter, increase the pH and production of various plants. The provision of biochar can increase the absorption of nitrogen, phosphorus, and potassium. The existence of plant nutrients, surface area, and high biochar absorption function as a medium of microorganisms so that it is the main reason for biochar as a material to improve physical properties [6].

The use of organic fertilizer, in the long run, can increase land productivity and can prevent land degradation. One of organic fertilizer is tofu dreg which is a solid waste produced by the soybean processing industry into tofu which is currently underutilized. One way the waste is utilized is to use it as organic fertilizer [7]. The purpose of the study was to determine the application of rice husk biochar and tofu waste compost to the growth and yield of sweet corn.

2. Research Methodology

2.1. Place and time

This research was conducted at BPTP, Banda Aceh. The implementation time started from April 2018 until July 2018.

2.2. Material and tools

The seeds were BONANZA F1 variety, biochar rice husks were obtained from the Aceh BPTP and solid tofu dreg compost was obtained from the tofu processing place in Penanggulan Barat Village, Subulussalam District. The tools used are nameplate, hose, bucket, hand sprayer, scales, camera, and stationery.

2.3. Research methods

This research used a factorial Randomized Complete Block Design (RCBD) 3x3 with 3 groups. The treatment that was tried consisted of 2 factors, they were, rice husk biochar consisted of 3 levels of treatment and tofu dreg compost factor consisted of 3 levels of treatment. The composition of combination biochar treatment of rice husk and tofu dregs compost is presented in Table 1.

| No | Treatment combination symbol | Rice husk biochar (ton/ha) | Rice husk biochar (kg/plot) | Tofu dregs compost (ton/ha) | Tofu waste compost (kg/plot) |
|----|------------------------------|--------------------------|---------------------------|---------------------------|----------------------------|
| 1  | B0A0                         | 0                        | 0                         | 0                         | 0                          |
| 2  | B0A1                         | 0                        | 0                         | 10                        | 2.5                        |
| 3  | B0A2                         | 0                        | 0                         | 20                        | 5                          |
| 4  | B1A0                         | 10                       | 2.5                       | 0                         | 0                          |
| 5  | B1A1                         | 10                       | 2.5                       | 10                        | 2.5                        |
| 6  | B1A2                         | 10                       | 2.5                       | 20                        | 5                          |
| 7  | B2A0                         | 20                       | 5                         | 0                         | 0                          |
| 8  | B2A1                         | 20                       | 5                         | 10                        | 2.5                        |
| 9  | B2A2                         | 20                       | 5                         | 20                        | 5                          |
2.4. Research implementation
The first preparation were cleaning the research area from weeds that grew in the area to be planted. Then made plots/plots on the land with a size of 1 m x 2.5 m totaling 27 plots/ spacing between 0.5 m plots and between groups/blocks 75 cm.

Planting did by making a seed hole as deep as 5 cm, each hole is planted 2 seeds, with a spacing of 20 cm x 75 cm to obtain 16 plants/plot. The basic fertilizer given is Mutiara 16:16:16 NPK fertilizer with a dose of 200 kg/ha (50 grams/plot). Provided in stages; i.e. half the dose of each fertilizer given 5 days after planting and the second stage 3 weeks after planting.

2.5. Maintenance
- Watering twice a day, i.e. in the morning and evening. Watering is not necessary if it was rain.
- Controlling pests and diseases did in various ways both mechanically and chemically. Pest control did by using the Decis pesticide.
- Weeding weeds did when the weeds begin to grow manually.
- Thinning did by leaving one plant for each planting hole that has been planted with two seeds. Thinning did 7 days after planting.
- Harvesting did when the plants are 75 days old when the corn is still young (in the milk phase ripening). The morphological characteristics are: the leaves turn to yellow, yellowish-green cornhusk, brownish cob hair.

2.6. Observation
Observations were made on plant height, the number of leaves, age of flowering, cob length, cob diameter and cob weight.

3. Result and Discussion
3.1. The effects of Biochar Rice Husk
The height of plants that given biochar treatment at ages of 15, 30, and 45 DAP did not show any significant difference in all treatments. Whereas the plant height at the age of 60 DAP was obtained at the highest dose of 5 kg/plot, significantly different from controls but not significantly different from dosing of 2.5 kg/plot. At the age of 60 DAP it was suspected that the nutrients present in the rice husk biochar up to a dose of 5 kg/plot had been able to be absorbed by the plant completely. The results of the study by [8] showed that soil-based biochar fixers tended to increase the percentage of soil aggregation, where the formation of soil improve. The biochar in use is from rice husk that has characteristic pH 8.3, Carbon 30.76%, Nitrogen 0.05%, Phosphor 0.23%, Potassium 0.06%, water holding capacity 40% and burning temperature 250-350 °C.

Hanafiah [9] added that the physical properties of the soil are one of the important things in determining a good soil condition for the planting process; the physical properties of the soil consist of texture, structure, and porosity. The type of soil in study area is inceptisol with pH 6-6.5.

The physical properties of the soil determine the chemical properties which affect soil fertility, including sodium and soil organic matter. Both of these are important in determining good soil for plants, sodium is an important element in determining soil characteristics, then soil organic matter makes up about 5% of total soil weight, although only a little but have a very important role in determining fertility land [8] and providing biochar showed the highest results on the growth of corn plants at 6 weeks after planting. The average height of corn plants and the number of leaves at 15, 30, 45 and 60 days after the plant (DAP) because of Giving Biochar Husk is presented in Table 2.
Table 2. The average height of corn and the number of leaves at 15, 30, 45 and 60 days after the plant (DAP) because of giving Biochar Rice Husk.

| Biochar Rice Husk | Plant Height (cm) | (DAP) | 30 DAP | 45 DAP | 60 DAP |
|-------------------|-------------------|-------|--------|--------|--------|
| B₀ (Control)      | 12,71 a           | 34,80 a| 117,98 a| 131,14 a|
| B₁ (2.5 kg/plot)  | 12,86 a           | 38,16 a| 119,97 a| 143,31 b|
| B₂ (5 kg/plot)    | 13,68 a           | 38,57 a| 122,89 a| 146,19 b|
| HSD               | 2,22              | 5,89   | 14,64  | 11,30  |

| Biochar Rice Husk | Number of Leaves | (Strands) | (DAP) | 30 DAP | 45 DAP | 60 DAP |
|-------------------|------------------|-----------|-------|--------|--------|--------|
| B₀ (Control)      | 1,97 a           | 2,78 a    | 6,31 a| 10,33 a|
| B₁ (2.5 kg/plot)  | 2,31 b           | 2,89 a    | 6,81 a| 10,67 a|
| B₂ (5 kg/plot)    | 2,36 b           | 2,89 a    | 6,69 a| 10,81 b|
| HSD               | 0,32             | 0,44      | 0,69  | 0,38   |

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% level.

Observation data showed that the highest number of leaves at the age of 15 DAP was found at a treatment dose of 5 kg/plot which was different from the control, but not significantly different from the treatment dose of 2.5 kg/plot. While the number of leaves at the age of 30 and 45 DAP did not show any significant difference in all treatments, then the number of leaves at 60 DAP are highest at the 5 kg/plot treatment which was significantly different from the 2.5 kg/plot and control treatment.

According to Endriani [10], biochar applied in agricultural land can increase plant growth by providing nutrients as well as improving physical properties and soil biota. Hanafiah [9] added that the role of soil physical properties influences plant growth and production, as well as influences soil texture which help the decomposition of organic matter and binding/supply of nutrients, both of which lead to provision of nutrients available for plants. Observation of the flowering age of corn showed that the fastest flowering age was found in the control treatment which was significantly different in the treatment dose of 2.5 kg/plot and dose 5 kg/plot. Although statistically, the control was the highest number, in general, providing rice husk biochar showed good results, as presented in Table 3.

Table 3. The average age of flowering, cob length, diameter and weight of crop cobs due to providing Biochar Rice Husk.

| Biochar Rice Husk | Flowering Age (DAP) | Cob Length (cm) | Cob Diameter (cm) | Cob Weight (gr) |
|-------------------|---------------------|-----------------|------------------|-----------------|
| B₀ (Control)      | 54,89 b             | 14,17 a         | 2,98 a           | 161,11 a        |
| B₁ (2.5 kg/plot)  | 54,33 a             | 16,62 b         | 3,06 a           | 161,11 a        |
| B₂ (5 kg/plot)    | 53,33 a             | 16,97 b         | 3,15 a           | 185,44 a        |
| HSD               | 1,51                | 1,05            | 0,46             | 52,00           |

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% level.

It was suspected that biochar had been able to carry out its function properly. This is in accordance with the opinion of Nuridaet.et.al [11] in her study that providing biochar is able to increase pH, C-organic, CEC on restoring degraded soil properties. Hanafiah [9] added that the pH value can be used
as an indicator of soil chemical fertility because it can reflect the availability of nutrients in the soil. Each plant requires some nutrients in different compositions and the optimum pH of corn is 5.5 - 7.5.

Observation of corn cobs length showed that the longest cobs resulting from providing rice husk biochar were at a 5 kg/plot treatment that was not significantly different in the control treatment but was not significantly different at 2.5 kg/plot doses. It was suspected that providing biochar up to a dose of 5 kg/plot gives a good result for plants. According to Ningtyas [12], biochar is a soil supplement that has the potential to improve soil capability. Sudjana [6] added that rice husk is a special nutrient requirement for maize, sugar cane, and other cereals. The silica found in rice husks has a purpose to increase the supply of oxygen to the roots thereby increasing the ability of the roots to oxidize.

The data showed that the largest diameter of the cobs did not show any significant difference in all treatments. It was suspected that the nutrients present in rice husk biochar up to a dose of 5 kg/plot had not been able to meet the nutrient needs for the process of fruit formation. The environmental factors at this research conducted that the rainfall intensity was very high so that the land/experimental plot was submerged in water for several days so it affected the generative process of maize. The F test results of variance analysis showed that the influence of the rice husk biochar on the study did not affect the weight of corn cobs. The average weight of corn cobs from rice husk biochar was shown in Table 3. Table 3 showed that the weight of the heaviest cob was at a dose of 5 kg/plot which was not significantly different at the dose of 2.5 kg/plot and control. It was suspected that providing rice husk biochar at these doses sufficient the N, P, and K nutrients needed by corn plants to increase the weight of the cob.

Hardjowigeno (1987) in [13] added that good plant growth and development need to balance the number of nutrients following plant needs for nutrients. Table 4 shows that plant height at the ages of 15, 30, 45 DAP did not show any significant difference in all treatments, while plant height at 60 DAP was highest at a dose of 2.5 kg/plot that was not significantly different in the control but not significantly different at 2.5 kg/plot. It was suspected that the nutrients found in compost dregs at a dose of 2.5 kg/plot had been able to meet the nutrient requirements for plants. According to Syarief (1986) in [11] which states that the availability of nutrients that can be absorbed by plants is one of the factors that can affect the growth rate and yield of plants. According to Pujiastuti [14] tofu waste contains lots of protein, calcium, phosphorus. These elements have a very important role including proteins that function as movers of metabolic processes.

The highest number of leaves at the aged of 15, 30, 45 and 60 DAP did not show any significant difference in all treatments. It was suspected that the application of tofu waste compost had not been

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**Table 4.** The Average Height of Corn Plants and The Number of Leaves at the age of 15, 30, 45 and 60 Days after Planting (DAP) as a result of Providing Tofu Dregs Compost.

| Tofu Dreg Compost | Plant Height (cm) | 15 DAP | 30 DAP | 45 DAP | 60 DAP |
|-------------------|------------------|--------|--------|--------|--------|
| A₀ (Control)      |                  | 12,25 a| 34,82 a| 115,53 a| 132,69 a|
| A₁ (2,5 kg/plot)  |                  | 13,94 a| 38,42 a| 125,58 a| 144,59 b|
| A₂ (5 kg/plot)    |                  | 13,06 a| 38,29 a| 119,73 a| 143,36 b|
| HSD               |                  | 2,22   | 5,89   | 14,64  | 11,30  |

| Tofu Dreg Compost | Number of Leaves (Strands) | 15 DAP | 30 DAP | 45 DAP | 60 DAP |
|-------------------|---------------------------|--------|--------|--------|--------|
| A₀ (Control)      |                           | 2,31 a | 2,67 a | 6,31 a | 10,42 a|
| A₁ (2,5 kg)       |                           | 2,11 a | 2,89 a | 6,89 a | 10,87 a|
| A₂ (5 kg)         |                           | 2,22 a | 3,00 a | 6,64 a | 10,61 a|
| HSD               |                           | 0,32   | 0,44   | 0,69   | 0,38   |

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% level.
completely decomposed. According to Hanafiah [9] one of the conditions that influence the decomposition of organic matter is humidity, generally, the maximum decomposition process occurs at temperatures of 30ºC - 35ºC. This was in accordance with the rain intensity was very high which resulted in the experiment plot being submerged in water, so the humidity was high and interfered with the decomposition process of tofu compost. The observation data on the flowering age of corn plants, cob length, diameter and weight of cob can be seen in Table 5.

**Table 5.** The average age of flowering plants due to Tofu Dreg Compost.

| Tofu Dreg Compost | Flowering Age (DAP) | Cob Length (cm) | Cob Diameter (cm) | Cob Weight (gr) |
|-------------------|---------------------|-----------------|------------------|---------------|
| A₀ (Control)      | 54,22 a             | 14,46 a         | 2,81 a           | 145,11 a      |
| A₁ (2.5 kg/plot)  | 54,56 a             | 17,55 c         | 3,19 a           | 195,33 a      |
| A₂ (5 kg/plot)    | 53,78 a             | 15,75 b         | 3,19 a           | 167,22 a      |

HSD 1,51  1,05  0,46  52,00

Note: Numbers followed by the same letter in the same column are not significantly different at the 5% level.

From Table 5, between the 3 doses of tofu dreg compost treatment at 2.5 kg/plot had been able to increase the rate of flowering rate of corn, and it started to decrease when the tofu dreg compost dose was increased to 5 kg/plot. Plants need nutrients with a certain concentration to form generative organs (flowers). The data of cob length shows that the longest cob was at a treatment dose of 2.5 kg/plot which was significantly different from the treatment of a dose of 5 kg/plot and control. It was suspected that the nutrient found in the tofu dregs compost at a dose of 2.5 kg/plot was sufficient for the formation of corn fruit. According to Hasibuan [7], the content of organic matter in tofu waste has quite high nutrition including 21.66% protein, crude fat 2.73%, calcium (Ca) 1.09%, Phosphorus 0.88% /100-gram of wet material. The observation data of corn cobs diameter of corn plants showed that the tofu dreg compost studied had no significant effect on the diameter of corn cobs.

**Table 6.** The Average Length of Plant Cobs Due to Biochar Rice Husk Tofu Compost.

| Rice Husk Biochar Factor (B) | Tofu Dreg Compost Factor (A) |
|-----------------------------|-------------------------------|
|                             | A₀   | A₁     | A₂     |
| B₀                          | 11.67 a | 18.25 b | 12.58 a |
| A                           | A    | A      | A      |
| B₁                          | 15.87 b | 17.62 b | 16.38 a |
| B                           | A    | A      | B      |
| B₂                          | 15.83 a | 16.79 a | 18.29 b |
| C                           | A    | A      | C      |

HSD 1.51

Note: Numbers followed by the same letter (lowercase) horizontal, uppercase (vertical) indicate different not at the level of 5%.

The widest cob diameter due to the tofu waste compost did not show any significant difference in all treatments. The highest cob weight was found at a dose of 2.5 kg/plot which was not significantly different at the dose of 5 kg/plot and control. It was suspected that the provision of tofu dreg compost up to a dose of 2.5 kg/plot had been able to be utilized by corn plants, especially in increasing the weight of the cob. According to Perdana [15], internal factors stimulate plant growth and development also in genetic control, but environmental factors such as soil, and climate also affect plant growth and yield. At the time of this study the heavy rainfall resulted in research plots were flooded. The observation data of biochar rice husks and tofu dregs compost treatment is presented in the appendix (even number). F
results test of variance analysis in attachments (odd numbers) indicates that there was a real interaction with the length of the cob.

4. Conclusion
1. The treatment of various doses of biochar rice husk has a very significant effect on plant height at 60 days after planting (DAP) and cob length, significantly affecting the number of leaves at 15 and 60 days after planting (DAP) and flowering age.
2. The treatment of various tofu dregs compost doses has a very significant effect on cob length and has a significant effect on plant height, the number of leaves at 60 days after planting (DAP).
3. There is a real interaction between biochar rice husk and tofu dregs compost to the length of the cob.

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