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The Comparison Production Growth of Potato Plants (*Solanum Tuberesum*, L) between Various Dosages of Biochar and Coffee Skin Compost

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Authors' contributions

This work was carried out in collaboration among all authors. Author Khadijah designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Authors Eliyin and Mulyono managed the analyses of the study. Authors Basyirah and Amiruddin managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Potatoes (*Solanum tuberesum*, L) are one of the main foods for the needs of the world community. Therefore, increasing potato crop production is considered important. For this purpose, the utilization of a mixture of rice husk biochar with compost can provide the best results up to three times the planting season. Coffee skin can also be found in form of compost for the utilization process. However, due to the lack of farmer's knowledge about the benefits that can be provided by skin compost to maintain the level of soil fertility. This study aims to analys the effect of biochar and coffee skin compost on the growth and yield of potato crops. Plant height, number of shoots, number of tubers per clump, and per plot tuber weight was a parameter of observation. This experiment used a factorial randomized planting block design using several doses of biochar and coffee skin compost. The treatment of biochar dosage did not significantly affect all parameters observed. The treatment of the effect of doses of coffee skin compost had a very significant effect on plant height at all ages of observation. The average plant height increases with the higher doses of red coffee skin

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compost given has a very significant effect on the number of tubers per clump and the weight of per plot tubers. There was no real interaction between the biochar dose and the red coffee skin compost dosage against all observed parameters.

Keywords: Potato, organic matter, fertilization, biochar, coffee skin compost.

1. INTRODUCTION

1.1 Background

Potato plants are among of food source for the needs of the world community [1,2]. Among the world foodstuffs, potato plants are also included with wheat, corn, and rice. There are few staple foods in Indonesia society [3]. Potatoes are one of them. Therefore, many farmers are growing potato crops. This plant is the plant a season and have the ability to evolve in vegetative through tuber. The cultivation of potatoes thrives on cool temperate regions, the good for cultivating potatoes to be around 1000-2000 meters from the sea surface temperatures 14-22 degress [3–5].

Central Aceh is an agricultural development area based on mountainous geographical contours that is very suitable for horticulture [6]. The potato crop is also a staple crop that farmers choose every year. However, the quantity production of potato crops produced by farmers still under expectation, the production around 12 to 15 tons/ha, while the production of potato crops can reach 20 to 25 tons/ha. The problem came since by several things including inappropriate use of seeds. Some constraints derive from the biological characteristics of the potato itself. The lower level multiplication rates of seed tubers also influence the potato's quality. The technical knowledge limitation and high costs associated with maintaining seed quality influences susceptibility to soil and seed-borne insect pests and diseases.

Potatoes have high fertilizer requirements but low utilization efficiency [7]. Therefore, increasing the fertilizer efficiency utilization research become important for intensify the potato's quality. The knowlegde of the utilization of agricultural waste and land managers have to maximized. For the purpose, utilization of a mixture of rice husk biochar with compost can provide the best results up to three times the planting season. According to the results of various studies, biochar can increase moisture and fertility of agricultural land. Biochar is a porous charcoal substance of charcoal that produce from living things or biological charcoal [8]. In the soil, biochar provides a good habitat for soil microbes [9]. However, biochar does not become a food ingredient for soil microbes as is the case with other organic materials. In other hand, the advantage of biochar is that in the long term biochar does not disturb the carbon-nitrogen balance in the soil, it is even able to hold and make air and nutrients more available to plants [10]. The application of biochar to the soil increases the availability of main cations and phosphorus, total nitrogen, and soil exchange capacity [11,12]. Adequate nutrient availability for plants is the effect of increasing nutrients directly from biochar and increasing nutrient retention.

In Indonesia, there are hundreds of millions of tons of agricultural, livestock, plantation and forest waste products every year [13]. As an illustration, out of 50 million tons of rice production each year, around 60 million tons of waste is produced in the form of organic husk containing carbon which can be processed into biochar. Utilization of a mixture of rice husk biochar with compost can provide the best results up to three times the planting season on potatos plants on ultisol soil [10,11,14]. One other organic material that is widely available in Central Aceh is dregs of coffee skin. Central Aceh is one of the best coffee production areas in Indonesia [15]. Thus, utilization dregs of ceffee skin become easy to be found. The dregs of coffee skin is a good organic material in an effort to maintain soil fertility [16,17]. However, since of the limitation farmers knowledge about the utilization of the organic material, a lot of dregs of coffee skin are left in vain. Therefore, this study was conducted to analyze the effects of biochar and dregs of coffee skin in increasing soil fertility, which focuses on increasing potato crop production.

2. RESEARCH METHODS

The research location is at an altitude of 1600 m above sea level. With a pH of 6,0. The ingredients used are fourth generation Granola potato seeds (G4), biochar, red coffee skin compost and Urea, Za, Sp 36 and Kce

fertilizers which are used as basic fertilizers and pesticides to control pests and diseases. The experiment used factorial randomized block design using a dose of biochar (B) consisting of three levels, (B0) without biochar, (B1) dose of biochar 10 tons / ha, and (B2) dose of biochar 15 tons / ha . The second factor is the dose of coffee skin compost (K) which consists of 4 levels; (K0) without compost, (K1) coffee skin compost dose of 10 tons / ha, (K2) coffee skin compost dose of 15 tons / ha, and (K3) coffee skin compost dose of 20 tons/ha. Thus, there were 12 combinations of treatments and repeated 3 times. Therefore, 36 experimental plots were employed whit the combination of treatment arrangements.

The mathematical model used is a factorial linear group design.

$$Yijk = \mu + \beta i + Bj + Kk + (BK)\,jk + \sum ijk$$

Where :

Yijk : The observational value of the biochar dose effect on the level –*i* and the dregs coffee skin effect on level –*j*

μ : Median value

βi : The block effect on he level –*i*

Bj : Effect of Biochar dose at level –*j*

Kk : Effect of dregs coffee skin doses at level *k*

(BK)jk : The interaction effect (BK)jk

∑ijk : Error factor on the calculation

2.1 Field Preparation

Field preparation is carried out 15 days before planting, multi soil treatment was processed to change the physical properties of the soil. The research plot was made with a size of 280 cm x 200 cm, the distance between plots was 70 cm, the distance between replications was 100 cm and the plot height was 30 cm.

2.2 Basic Fertilization and Planting

In order to support the potato growth, basic fertilizers was applied in the form of inorganic fertilizers 56 gr / plot or equivalent to 100 kg / ha, 140 gr / plot equivalent to 250 kg / ha, SP36 252 gr / plot equivalent to 450 kg / ha and KCl 168 gr / plot is equivalent to 300 kg / ha. Basic fertilizer is given 7 days before planting. Furthermore,

planting is done with a spacing of 70 cm x 30 cm, the number of plants per plot consists of 24 plants.

2.3 Application of Biochar and the Coffee Skin Dregs

In the planting process, biochar was applied with a certain dose: without biochar (B_0), 5.6 kg/plot or equivalent to 10 tons/ha (B_1) and 8.4 kg/plot equivalent to 15 tons/ ha (B_2). Meanwhile, the dregs of coffee skin was applied also with certain doses. Different applied treatment was given by the method, the coffee skin dregs was immmersed on the planting row line. The applied the cofee skin dregs dose is: without the coffee skin dregs (K_0), 5.6 kg/plot equivalent to 10 tons/ha (K_1), 8.4 kg/plot equivalent to 20 tons/ha (K_2) and 11.2 kg/plot equivalent with 20 tons/ha (K_3). Watering volume also one of the important process in order to control and maintain the planting growth. For this research, the watering process was done twice every day during 15 days after planting process. During the planting process, Pest and disease control was concern since the beginning of plant growth by using insecticides. The treatment was applied to control insects and pests.

2.4 Result Observation

The variable observation on the analysis:

- Plant height was observed on 25, 35 and 45 days during planting process,
- The number of shoots was observed on 25, 35 and 45 days after planting,
- The number of tubers per clump in the age of 100 days after planting (at harvest). The analysis was carry out based on the average the number of tubers per clump and was expressed in units of per/potato.
- Tuber weight per plot is observed at 100 days after planting (at harvest) as a whole in the plot, then tubers are cleared of the remaining soil that is attached and then weighed, expressed in kilograms.

3. RESULTS AND DISCUSSION

3.1 Effects of Biochar

3.1.1 Potato plant height

Fig. 1 shows the average height of potato plants after observation on 25, 35, and 45 days after planting. The figure shows the difference in height of the potatoes plant. The figure shows the highest biochar dose influence the planting height. However, the result shows a similar

trendline of the planting height of 5,6 kg/plot with 8,4 kg/plot. It can be inferred that adding the biochar able to increase the planting height. However, additional research must be applied to analyze the dose ingredient biochar adding process.

3.1.2 Total of shoots

Fig. 2 shows the results of field observations regarding the number of potato shoots at each observation 25, 35 and 45 days after planting. Control plants (Bo, without biochar) were not significantly different from the biochar dose (B1) of 5.6 kg / plot and did not differ significantly from the doses of biochar (B2) 8.4 kg / plot. It since of basically biochar treatment on the planting not able to contribute nutrients to potatoes plant. In observing the number of potato shoots, genetic factors in the soil are an important thing. This is due to the growth of shoots that are built up by the many genetic factors in the soil that come from the nutrient content in the soil. Biochar elements are not able to increase nutrient content in the soil. The number of buds in potato tubers is very dependent on variety, creating and in many tubers, the bigger the potato tubers, the more buds. It can be ignored that the biochar content has not been able to increase the number of shoots in potato plants.

3.1.3 Number of bulbs per Clump

Fig. 3 shows the increase in the number of tubers per hill in the potato crop. The figure shows that the more biochar composition shows an increase in the number of tubers growing on potatoes. Based on the figure a significant increasing the number of tubers was occur on the planting process beetwen the potato plant without biochar and planting biochar added. Therefore, the results of the analysis can be inferred the positive impact that occurs due to the addition of biochar to potato plants is to increase the number of tubers growing in one clump.

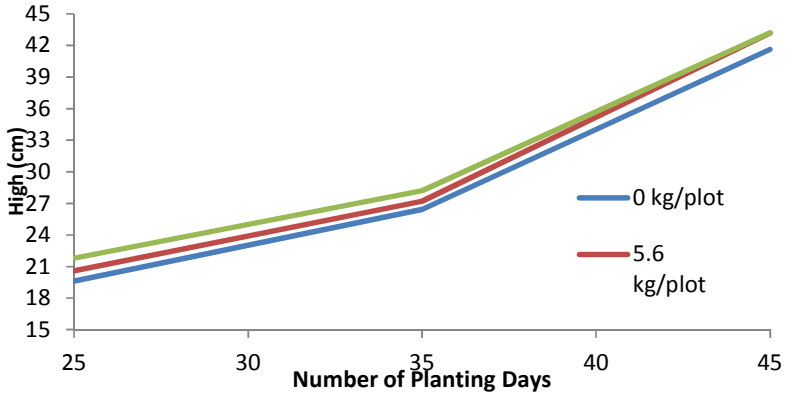

Fig. 1. Average potato plant height at 25, 35 and 45 days after planting due to effect of biochar doses

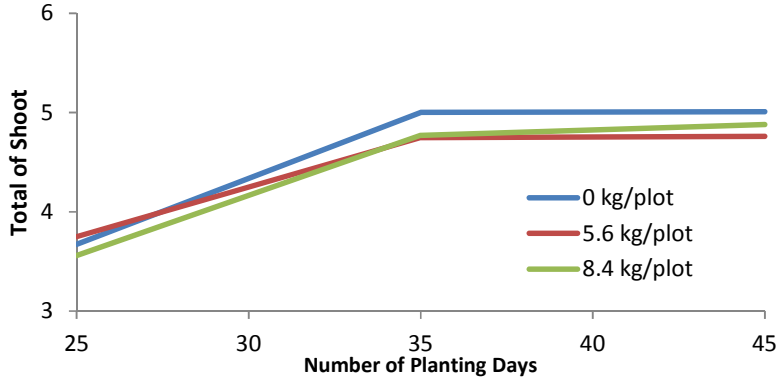

Fig. 2. The average number of potato' shoots at the age of 25, 35 and 45 days after planting process due to the treatment of biochar doses

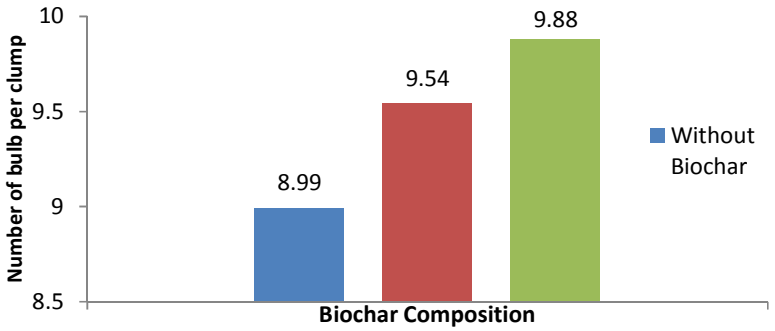

Fig. 3. Average number of bulbs per potato clump due to treatment of biochar dosage at the age of 100 days after planting

3.1.4 Dry weight of tuber Per Plot

Similar to the number of tubers in one clump, the increase in tuber weight also occurred in each potato plot. This is due to the influence of the number of tubers that occur in each potato plant in the potato planting process. The average dry weight of tuber per plot of potato plants due to biochar dosage treatment is presented in Fig. 4.

Fig. 4 shows the increase in tuber weight per plot between control plants (without biochar) and plants biochar adeed plants. It can be argued that although the addition of biochar cannot increase the genetic factor content in the soil, the addition of biochar quality can improve the health of the plant. By the addition of biochar in the soil, plants are better able to growth. This is evidenced by the increase in the number and weight of potato tubers growing in the soil. However, a more in-depth study must be carried out in this study to analyze the effectiveness of biochar in increasing the amount of plant production. In-depth studies must be carried out at least 3 times the harvest period to analysis the quality of the biochar in several times and periods of harvest.

3.2 The Effect of Red Coffee Skin Compost Dosage

3.2.1 Potato plant height

Potato plant height was involved in this field reserch. The analysis was shown as Fig. 5. The figure shows the highest average plant height was due to the treatment of coffee skin dregs compost on the observation of 25 days, 35 days and 45 days after planting. The results of the study showed that 11.2 kg / plot (K3) was significantly different from other treatments, 8.4 kg/plot (K2) and 5.6 kg/plot (K1) and control plant. Meanwhile, the treatment of 8.4 kg / plot (K2) was not significantly different from the treatment of 5.6 kg / plot (K1) and control (K0).

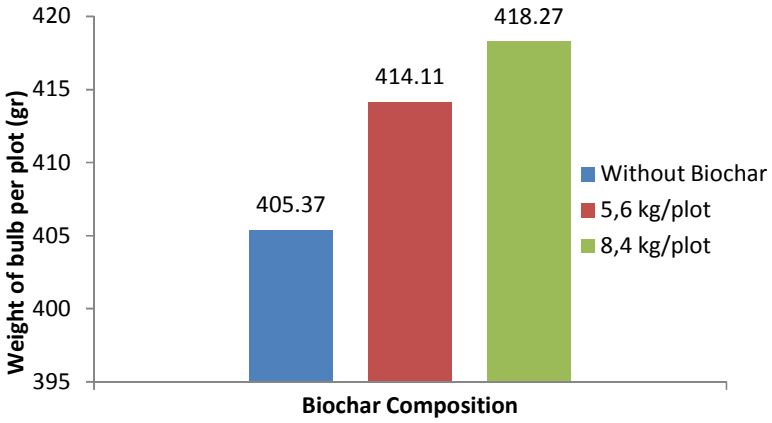

Fig. 4. The average tuber weight per plot of potato plants due to biochar dosage treatment

In the observation 35 days after planting, the highest plant height was found in the 11.2 kg/plot (K3) treatment which was significantly different from all treatments. In the observations of 45 days after planting, the highest plant height was found in the treatment of 11.2 kg / plot (K3). While the treatment of 5.6 kg / plot (K1) was not significantly different from the control treatment (Ko), it since of influence by the dregs of coffee skin that embedded into the soil. The compost of the red coffee skins dregs provided had been completely decomposed so that it could provide nutritional intake for the needs of plant growth. Nisa K (2008) states that the greater the organic dose given to the soil, the greater the amount and nutrients available for plant growth. The content of organic matter in the soil can be increased by providing organic matter, both agricultural waste in the form of crop residues, green manure and manure (Syehfani, 2003).

3.2.2 Number of shoots

Number of shoot was analysis also in this research. the influence of biochar adding into the potatos planting soil was analysis. Fig. 6 shows that, the average number of potato shoots at each age of observation in each treatment was not significantly different. The observations showed that the time planting period influence the shoots amount. Excellent growth is shown by each sample. The observations showed that the difference that was not too significant was due to the growth of shoots in each treatment due to the genetic characteristics of the plant.

Garner (2009) states that growth is influenced by factors originating from within the plant (genetic factors), meanwhile, those from outside the plant are known as environmental factors. The growth of shoots on potato tubers depends on the variety, generation and size of tubers, the bigger/heavier the potato tubers, the more buds. So it can be concluded that the growth in the number of shoots is influenced by the size of the potato tubers

3.2.3 Number of tuber per clump

Fig. 7 showed that, the average tuber numbers per potatos clump in all treatments was very significant. The highest number of tubers per hill was found in the 11.2 kg/plot treatment, the difference the tuber number was due to the differences in the treatment obtained. It since of the higher the dose given, the more nutrients the plant roots can absorb. Novijan (2005) argues that organic fertilizers can improve the physical, chemical and biological properties of the soil, it can also increase plant production and improve the quality of plant products.

3.2.4 Weight of dry tuber per plot

The average of potato weigh per plot after 100 days planting process treatment of coffee skin dregs was analys. The result shows in the Fig. 8.

Fig. 8 shows the average tuber weight per plot of potato for each treatment. The results of the analysis showed that the highest tuber weight per plot was in the treatment of 11.2 kg / plot, the addition of tuber weight per plot due to the treatment of red coffee husk compost provided benefits for plant growth and yield, the more compost is given, the more nutrients that can be absorbed by plant roots to meet the needs both during vegetative growth and generative growth of plants. Plants fertilized with compost also tended to be of better quality than plants fertilized with chemicals, yields more resilience to storage, heavier weight and fresher plants.

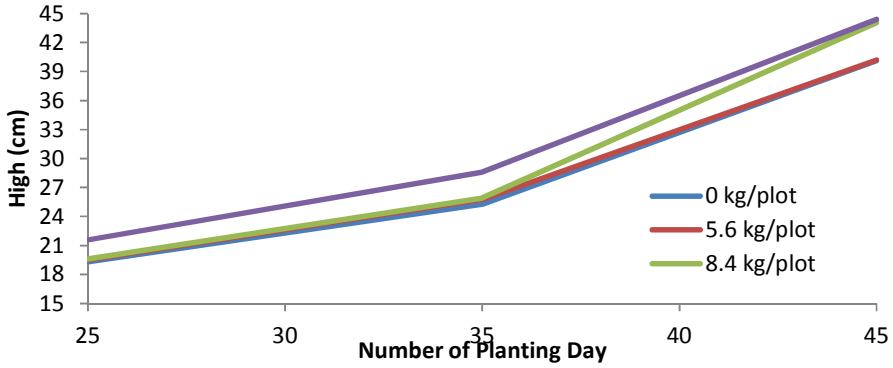

Fig. 5. Average potato plant height at 25, 35 and 45 days after planting due to dose compost treatment of coffee skin dregs

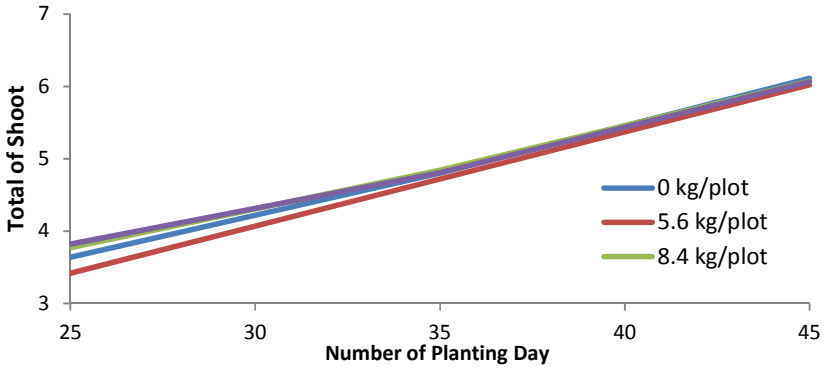

Fig. 6. Average number of shoots of potato plants at the age of 25, 35 and 45 days after planting due to compost dosage treatment

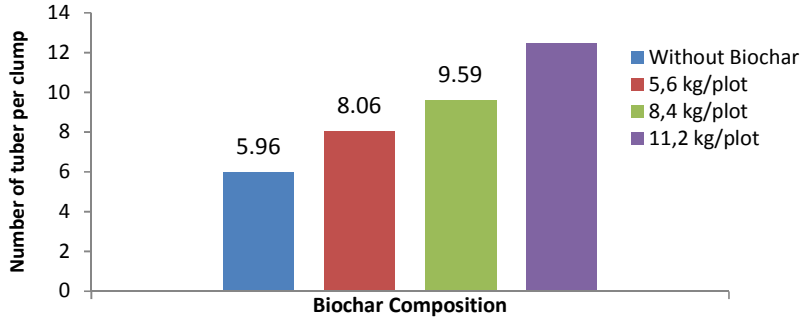

Fig. 7. Average number of potato tuber per clump at 100 days after plants due to compost dosage treatment

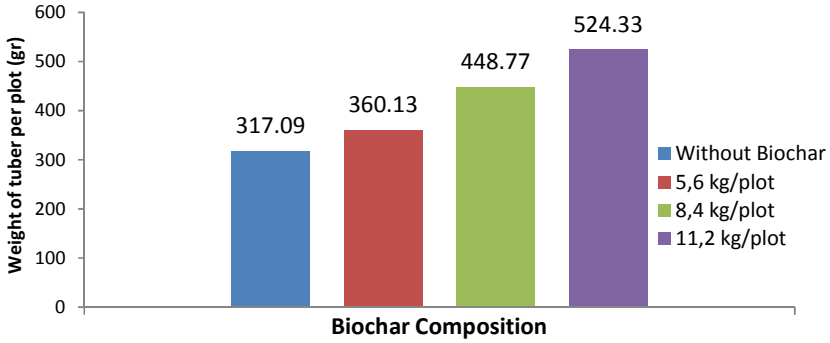

Fig. 8. The average of potato dry tuber weigh per plot after 100 days planting process treatment of coffee skin dregs

4. CONCLUSION

Analysis of the effect of biochar and dreg of coffee skin compost has been successfully carried out. From the analysis, it was found that the addition of biochar and coffee husk compost was able to increase the quality and production of potato plants. It was inferred based on the results of research where with the addition of biochar or coffee husk compost, the number of tubers per clump and the weight of tubers per plot increased significantly. With the increase of these two parameters, the production of the potato crop will increase. The addition of biochar and coffee husk compost did not significantly affect the height of the potato plants. However, the increase in the quality of the coffee plant does not depend on plant height. The increase in potato crop production was influenced by the number of tubers per plot and tuber weight per

plot. The more tubers and the heavier the tubers per plot, the amount of potato production will increase. Therefore, it can be concluded that the addition of biochar or coffee husk pulp is able to increase potato crop production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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