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# Arabica Coffee Growth Response on Composting Time Treatment and Coffee Skin Biochar Dosage

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**Abstract**
*This study aims to determine the effect of composting time, biochar dose, and the interaction between composting time and biochar dose on the growth of Arabica coffee seedlings. This research was conducted at UPP Arabica Coffee Plantation. Catur Paramitha in Catur Village, Kintamani District, Bangli Regency, Bali Province. The altitude of the place is between 1,250 meters above sea level. The time of the research was carried out from September to December 2021. This study used a Randomized Block Design (RAK) with 2 factors arranged in a factorial manner. The first factor is the time of composting of wet coffee skin waste material which consists of 2 levels, namely P1 = 2 weeks of composting and P2 = 4 weeks of composting. The second factor is the dose of biochar as raw material for dried coffee cherries, consisting of 4 levels, namely, B0 = control, B1 = 5 tons/ha, B2 = 10 tons/ha and B3 = 15 tons/ha thus obtained 8 repeated combination treatments. 3 times so 24 plants are needed. The variables observed were plant height, number of leaves per plant, stem diameter, plant leaf area, root fresh weight per plant, stem fresh weight per plant, leaf fresh weight per plant, stem, and leaf fresh weight per plant, and total fresh weight per plant. and total oven-dry weight per plant. The treatment with 4 weeks of composting gave the highest total fresh weight per plant, which was 10.43 g, which increased by 11% when compared to the treatment with 2 weeks of composting, which was 9.44 g. The treatment with a dose of 15 tons/ha of biochar gave the highest total fresh weight per plant, which was 10.45 g, which increased by 13% when compared to the treatment without biochar, which was 9.27 g. The interaction of 4 weeks of composting with a dose of 15 tons/ha of biochar (P2B3) gave the highest total fresh weight yield per plant of 11.73 g which increased by 24% when compared to the interaction of 2 weeks of composting without biochar (P1B0) which was 9.4g.*

**Keywords**: *Arabica coffee; composting time; biochar dose.*

## 1. Introduction

Indonesia is included in the list of the largest coffee-producing countries in the world. The International Coffee Organization (ICO) stated that in 2020 Indonesia was able to occupy the fourth position with coffee production of 11.95 million sacks measuring 60 kg and compete with other countries such as Brazil, Vietnam, and Colombia [1]. Based on data from the Central Statistics Agency, the volume of Indonesian coffee exports with the main destination to various countries such as Europe, America, and Asia fluctuated from 2012-2017. In 2012 the volume of coffee exports was 447,010.8 tons, in 2013 the volume of coffee exports was 532,139.3 tons and in 2017 the export volume obtained by Indonesia reached 464,198.3 tons. Thus, the highest export volume was obtained in 2013 which was 532,139.3 tons. Therefore, high export yields are able to develop and increase Indonesian coffee production in the global market [2].

Coffee is a type of plant that produces side waste in the form of large coffee husks. The proportion of coffee husk produced in coffee processing is 40-45% of the coffee skin consisting of the outer skin (exocarp) and fruit flesh (mesocarp) [3]. By-products of coffee processing range from 50-60 percent of their harvest, most farmers have not been able to optimize coffee waste, which still has high usability because coffee husks have good content for plants such as nitrogen, phosphorus, and potassium [4]. An example of an effort to optimize the coffee husk waste is to use it as compost because the skin content of coffee waste is very good for soil fertility and nutrients for plants.

In the composting process, the compost will go through a composting period. Composting is a process in which organic matter undergoes biological decomposition by microbes that utilize organic matter as an energy source [5]. Compost can be formed after 4 weeks of incubation with a crumb texture, blackish-brown color, and an earthy smell [6]. Coffee husk waste can not only be used as compost, it can also be used as biochar. Biochar is a soil enhancer that has long been used in agriculture and is useful to help improve and increase soil productivity. The beneficial effect of using biochar on agricultural land is that it helps plant growth and provides nutrients to the soil [7]. Giving a dose of 10 tons/ha was able to increase the overweight per plant by 87.80 g which increased by 26.02% when compared to the treatment without biochar with a weight of 69.67 g for plant growth [8]. The purpose of this study was to determine the effect of composting time on the growth of Arabica coffee seedlings, to determine the effect of biochar dose on the growth of Arabica coffee seedlings an,d to determine the interaction between composting time and biochar dose on the growth of Arabica coffee seedlings.

## 2. Materials and Methods

This research was conducted at UPP Arabica Coffee Plantation. Catur Paramitha in Catur Village, Kintamani District, Bangli Regency, Bali Province. The altitude of the place is between 1,250 meters above sea level. The time of the research was carried out from September to December 2021. This study used 12-month-old Arabica coffee seeds. This study used a Randomized Block Design with 2 factors arranged in a factorial manner. The first factor is the time of composting of wet coffee husk waste material which consists of 2 levels and the second factor is the dose of biochar raw material for dry coffee fruit skin waste consisting of 4 levels. The first factor tested was the composting time of wet coffee skin waste material, which consisted of 2 levels y: P1 = 2 weeks composting, P2 = 4 weeks composting. While the second factor tested was biochar as raw material for dried coffee cherries, which consisted of 4 levels, namely: B0 = Control (Without Biochar), B1 = (5 tons/ha), B2 = (10 tons/ha), B3 = (15 tons/ha). The combination treatments were repeated 3 times each so that 24 arabica coffee seed plants were needed. The results of the soil analysis are as follows:

**Table 1.** Soil Analysis Results of Research Site

| No | Analysis Type | Unit | Mark | Information |
|---|---|---|---|---|
| 1 | Texture | | | |
| | Sand | % | 69.49 | Clay |
| | Dust | % | 21.75 | Sandy |
| | clay | % | 8.76 | |
| 2 | Water content | | | |
| | Air Dry | % | 6,68 | |
| | Dry Field | % | 35,21 | |
| 3 | pH $H_2O$ | | 7.10 | Neutral |
| 4 | Electrical Conductivity | mmhos/cm | 1,60 | Low |
| 5 | N-total | % | 0.28 | Currently |
| 6 | C-organic | % | 2.49 | Currently |
| 7 | P-available | ppm | 161.07 | Very high |
| 8 | K-available | ppm | 154.68 | Currently |

Source = Laboratory of Soil Science, Faculty of Agriculture, Udayana University (2021).

The research materials used were arabica coffee seeds, cow manure, water, compost from wet coffee husk waste, biochar from dried coffee cherries waste, pruning leaf waste, bran, dolomite, effective microorganism-4 (EM 4), and molasses.

**Table 2.** Results of analysis of compost and biochar

| Sumber | pH | DHL (mmhos/cm) | C-organic (%) | N-total (%) | P (ppm) | K (ppm) | WC (%) |
|---|---|---|---|---|---|---|---|
| Biochar | 8,1 AA | 32,2 ST | 29,05 ST | 0,36 S | 536,2 ST | 449,36 ST | 6,51 |
| Compost F2 | 8,0 AA | 7,93 ST | 36,85 ST | 0,7 S | 562,91 ST | 510,75 ST | 18,23 |
| Compost F4 | 8,3 AA | 14,44 ST | 36,59 ST | 0,43 S | 619,07 ST | 611,71 ST | 17,41 |

Information :

F2 : Fermentation 2 weeks
F4 : Fermentation 4 weeks
AA : Slightly alkaline/alkaline
S : Medium
DHL : Electrical conductivity
WC : Water Content
ST : Very high
N,P,K : Nitrogen, Phosphorus, Potassium

Based on the results of the analysis of biochar and various types of composting time in the laboratory presented in Table 2 above, it was obtained that the levels of pH, DHL, C-organic, total N, P, K, and water content varied from each type of fertilizer composting time. Fermented compost for 2 weeks (F2) has the highest organic C content compared to other fertilizers and biochar. Fermented compost for 4 weeks (F4) has the highest DHL, N total, P, and K content compared to biochar and other fertilizers. The stages of making compost are: to make 100 kg of compost, it takes 60 kg of coffee pods from farmers to be spread on a tarpaulin, then added 25 kg of manure, 10 kg of coffee trimming waste that has been chopped into small pieces and sprinkled with 5 kg of fine bran and 2 kg of dolomite evenly. Then pour a mixture of 100 ml of EM4 and 100 ml of molasses which has been dissolved in 10 liters of water until it reaches a moisture content of 40% (if you clench it, it doesn't release air and when you open your fist, the compost media doesn't break or fall apart) and then close it tightly with a tarp. During the composting process, the temperature in the tarpaulin will rise ±50 oC then the temperature will drop again. Once a week the material inside the tarpaulin is turned over and if there are large chunks, they are reduced by using a shovel or hand. Composting will be stopped if it has undergone 2 weeks the composting process is stopped if it has experienced 4 weeks of the composting process. The compost is odorless, not wet, dark brown, and has a crumb texture. The finished compost will be applied to the plants.

Materials and tools used for the manufacture of biochar are waste skin of dried coffee cherries, biomass burner or cauldron, gas stove, stirrer, charcoal, crusher, and sieve. The stages of making biochar are: collecting dry coffee rind waste then putting the dried coffee rind waste into the skillet (according to its capacity) turning the stove with a gas composing process has started, immediately it evenly until the charcoal is perfectly formed. After the charcoal is formed, it is crushed into small granules and sieved to form uniform granules, then the charcoal or biochar is ready to be applied to plants.

The plant material used in this study was Arabica coffee plant seeds that were 12 months old already in polybags with a spacing of 10 x 10 cm per polybag and a weight of 10 kg. The criteria for the plants used were: the variety used was Arabica kopyol coffee with a plant height of 15-17 cm, 4-6 leaves, and a stem diameter of 0.2-0.3 cm. Mixing of fertilizer and biochar in polybags is carried out a week before planting Arabica coffee seeds.

The variables observed in this study were plant height (cm), number of leaves per plant (strands), stem diameter (cm), leaf area (cm), root fresh weight per plant (g), stem fresh weight per plant (g), leaf fresh weight per plant (g), stem and leaf fresh weight per plant (g), total fresh weight per plant (g) and total oven-dry plant.

This study used statistical fingerprint analysis (ANOVA) by the research design, the results of the variance showed a significant interaction effect ($P<0.05$) to very significant ($P<0.01$) from the treatment, followed by the Duncan Muli test. Range (DMRT). In the single with a significant to very significant effect, followed by the BNT test with a treatment level of 5%. To find out the close relationship between the observed variables, a correlation analysis was carried out.

## 3. Results and Discussion

### 3.1. Results

The results of the statistical analysis of all the variables observed in this study are presented in Table 3. The significance of the response or the effect of the treatment duration of composting (P) and biochar (B) and their interaction (PB) on the observed variables is shown in Table 3. Average variables The observed effect due to the interaction effect between composting time (P) and biochar (B) can be seen in Table 4. The correlation between variables due to the interaction effect between composting time and biochar can be seen in Table 5.

**Table 3.** Significance of the effect of composting time and biochar and their interactions on all observed variables.

| | Variable | Treatment | | |
|---|---|---|---|---|
| | | Composting Time (P) | Biochar (B) | Interaction (PxB) |
| 1 | Plant height (cm) | ns | ** | ** |
| 2 | Number of leaves per plant (strands) | ns | ns | ns |
| 3 | Rod diameter (cm) | ns | ns | ns |
| 4 | Plant leaf area (cm) | ns | * | ** |
| 5 | Root fresh weight per plant (g) | ** | * | * |
| 6 | Stem fresh weight per plant (g) | ns | ns | ns |
| 7 | Leaf fresh weight per plant (g) | * | ns | ** |
| 8 | Fresh weight of stems and leaves per plant (g) | ns | ns | ns |
| 9 | Total fresh weight per plant (g) | ** | ns | * |
| 10 | Total oven-dry weight per plant (g) | * | ns | ns |

ns : Not significant ($P \geq 0.05$), ** : Very influential ($P < 0.01$), * : significant effect ($P < 0.05$)

From Table 3 it can be seen that the composting time treatment had a significant (P<0.05) to very significant (P<0.01) effect on fresh root weight per plant, leaf fresh weight per plant, total fresh weight per plant, and dry weight. total oven per plant and had no significant effect (P≥0.05) on the variables of plant height, number of leaves per plant, stem diameter, plant leaf area, stem fresh weight per plant, and stem and leaf fresh weight per plant. Biochar dosage treatment showed no significant effect (P≥0.05) on the number of leaves per plant, stem diameter, stem fresh weight per plant, leaf fresh weight per plant, stem, leaf fresh weight per plant, and total fresh weight per plant. and total oven-dry weight per plant and significantly (P<0.05) to very significant (P<0.01) on the variables of plant height, leaf area, and root fresh weight per plant. The interaction between composting time treatment and biochar dose had a significant (P<0.05) to very significant (P<0.01) variable on plant height, leaf area per plant, root fresh weight per plant, leaf fresh weight per plant, and plant weight. total fresh weight per plant and had no significant effect (P≥0.05) on the number of leaves per plant, stem diameter, stem fresh weight per plant, stem, leaf fresh weight per plant, and total oven-dry weight per plant.

Biochar does treatment showed no significant effect (P≥0.05) on the number of leaves per plant, stem diameter, stem fresh weight per plant, leaf fresh weight per plant, stem, and leaf fresh weight per plant, and total fresh weight per plant. and total oven-dry weight per plant and significantly (P<0.05) to very significant (P<0.01) on the variables of plant height, leaf area, and root fresh weight per plant. The interaction between composting time treatment and biochar dose had a significant (P<0.05) to very significant (P<0.01) variable on plant height, leaf area per plant, root fresh weight per plant, leaf fresh weight per plant, and plant weight. total fresh weight per plant and had no significant effect (P≥0.05) on the number of leaves per plant, stem diameter, stem fresh weight per plant, stem, leaf fresh weight per plant, and total oven-dry weight per plant.

**Table 4.** Effect of interaction between composting time (P) and biochar (B) on all variables observed per plant.

| Treatment | The interaction of composting with biochar | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | P1B0 | P1B1 | P1B2 | P1B3 | P2B0 | P2B1 | P2B2 | P2B3 |
| Plant height (cm) | 36.03 bc | 34.60 cd | 39.39 a | 36.40 cd | 32.70 d | 38.07 ab | 36.67 bc | 36.77 bc |
| Number of leaves (strands) | 13.67 a | 15.67 a | 11.00 a | 12.00 a | 10.00 a | 13.00 a | 13.67 a | 13.67 a |
| Rod diameter (cm) | 0.42 a | 0.46 a | 0.47 a | 0.46 a | 0.49 a | 0.48 a | 0.46 a | 0.49 a |
| Plant leaf area (cm) | 367.70 ab | 430.80 a | 390.05 a | 290.73 bc | 224.13 c | 344.98 ab | 371.98 ab | 388.10 ab |
| Root fresh weight (g) | 2.03 c | 2.27 c | 2.47 c | 2.07 c | 2.97 bc | 2.47 c | 3.50 ab | 4.23 a |
| Stem fresh weight (g) | 1.77 a | 1.97 a | 2.27 a | 2.07 a | 2.23 a | 2.73 a | 2.07 a | 2.03 a |
| Leaf fresh weight (g) | 5.90 a | 5.00 bc | 5.17 bc | 4.77 c | 4.13 d | 5.13 bc | 5.03 bc | 547 ab |
| Fresh weight of stems & leaves (g) | 7.67 a | 6.97 a | 7.43 a | 6.83 a | 6.37 a | 7.87 a | 7.10 a | 7.50 a |
| Total fresh weight (g) | 9.47 bc | 9.23 bc | 9.90 bc | 9.17 bc | 9.07 c | 10.33 bc | 10.60 ab | 11.73 a |
| Total oven-dry weight (g) | 2.50 a | 2.60 a | 2.63 a | 2.70 a | 2.80 a | 2.93 a | 3.07 a | 3.10 a |

Numbers followed by the same letter on the same factor are not significantly different in Duncan's 5% test.

## 3.2 Discussion

The results showed that the highest total fresh weight per plant resulting from the interaction of composting time with a dose of biochar was found in the interaction between 4 weeks of composting time and a dose of biochar of 15 tons/ha (P2B3), which was 11.73 g, an increase of 24% when compared to the interaction duration of 2 weeks composting with no biochar (P1B0) was 9.47 g (Table 4). Total fresh weight per plant treatment with composting time showed the best results in treatment with composting time of 4 weeks (P2), which was 10.43 g, which increased by 11% and showed a significant difference with composting time of 2 weeks (P1), which was 9.44 g. The highest total fresh weight per plant produced from the treatment with biochar dose was found in biochar 15 tons/ha (B3), which was 10.45 g, which increased by 13% with treatment without biochar (B0) which was 9.27 g but showed no significant difference with other biochar treatments.

The high total fresh weight per plant on the interaction of composting time with biochar dose was supported by a significant correlation between root fresh weight per plant (r=0.82**) and total oven-dry weight per plant (r=0.79** ) (Table 5).

**Table 5.** Variable correlation value (r) due to the interaction effect of composting time with biochar dose

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | | | | | | | | | |
| 2 | 0,12ns | 1 | | | | | | | | |
| 3 | -0,09ns | -0,39ns | 1 | | | | | | | |
| 4 | 0,47ns | 0,87** | -0,32ns | 1 | | | | | | |
| 5 | -0,03ns | 0,00ns | 0,62ns | 0,07ns | 1 | | | | | |
| 6 | 0,34ns | -0,35ns | 0,60ns | -0,24ns | 0,00ns | 1 | | | | |
| 7 | 0,50ns | 0,61ns | -0,58ns | 0,70* | -0,01ns | -0,35ns | 1 | | | |
| 8 | 0,72* | 0,43ns | -0,26ns | 0,58ns | -0,01ns | 0,22ns | 0,84** | 1 | | |
| 9 | 0,44ns | 0,27ns | 0,40ns | 0,40ns | 0,82** | 0,14ns | 0,43ns | 0,53ns | 1 | |
| 10 | 0,08ns | -0,04ns | 0,68* | -0,05ns | 0,86** | 0,36ns | -0,13ns | 0,08ns | 0,79** | 1 |

r (0,05)= 0,632
r (0,01)= 0,765
1. Plant height (cm)
2. Number of leaves per plant (strands)
3. Rod diameter (cm)
4. Plant leaf area (cm)
5. Root fresh weight per plant (g)
6. Stem fresh weight per plant (g)
7. Leaf fresh weight per plant (g)
8. Fresh weight of stems and leaves per plant (g)
9. Total fresh weight per plant (g)
10. Total oven-dry weight per plant (g)

This is because compost and biochar as raw materials for coffee pods contain high total N, P, and K and can improve soil properties and add nutrients to the soil. Nutrient content in 2 weeks of fermented wet coffee husk compost was 0.7% N total, 562.91 ppm P and 510.75 ppm K, 4


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weeks of fermented wet husk compost 0.43% N total, 619, 07 ppm P and 611.71 ppm K, as well as biochar as raw material for dry coffee skin 0.36% N total, 536.2 ppm P and 449.36 ppm K (Table 2).

The nutrient content of compost and biochar can affect the vegetative growth of plants such as plant roots, with improved root growth in plants, the absorption of nutrients and water available in the soil will run well. Nutrients and water absorbed by the roots will undergo the process of photosynthesis in the leaves then carbon dioxide and water are processed with the help of sunlight. The products of photosynthesis are glucose, oxygen, and water. The resulting oxygen is then released through the stomata. The glucose produced will be distributed to plant tissues and organs that are active in plant metabolism so that it will affect the plant's fresh weight and total oven-dry weight per plant. The better the root length produced by plants, the better the absorption of nutrients [9]. The presentation of coffee husk waste compost was very significant for the wet weight of roots [10]. The treatment of biochar composition, coffee rind, and soil affected the variables of leaf number, leaf length x width, crown dry weight, fresh weight quality index, and dry weight quality index. The composition of biochar used, namely coffee husk and soil 1:1:2 gave better seedling growth than the 0:1:2 composition (control without biochar) based on the quality index of fresh seeds and quality index of dry seeds [11]. The application of biochar to coffee pods on the ground can increase pH, electrical conductivity, and cation exchange capacity [12]. Another study conducted by [13] stated that the administration of biochar at a dose of 15 tons/ha could give a positive response to plant growth.

Organic fertilizer is one component to increase soil fertility by repairing soil physical damage due to excessive use of inorganic fertilizers on the soil which results in damage to soil structure in the long term. The application of organic fertilizers can improve the growth of coffee plants because the application of organic fertilizers has a role in improving the physical, chemical, and biological properties of the soil, as well as increasing the availability of nutrients in the soil [14]. The application of compost fertilizer for coffee bean husks can increase the nutrient content of nitrogen, phosphorus, and potassium in Arabica coffee plants [15]. High nutrient content in soil is very good for coffee plant growth because coffee plants require high availability, both micro, and macro to reduce growth and production [16]. Another study by [17] stated that the treatment of organic fertilizer as raw material for coffee skin improved soil chemical properties in the form of increasing organic C, total N levels, phosphorus, and potassium.

The treatment of coffee husk compost was able to replace urea fertilizer in coffee nurseries, although the treatment of coffee husk compost was not significantly different from the urea treatment. The increase in growth was shown in the parameters of plant height, the number of leaves, root dry weight, shoot dry weight, and root crown ratio [18]. The addition of organic fertilizer to coffee husk waste in the planting medium would experience good growth in the growth of coffee beans in the growing height and leaf width of the coffee [19],

## 4. Conclusion

The 4-week composting treatment gave the highest total fresh weight per plant, which was 10.43 g, an increase of 11% when compared to the 2-week composting treatment, which was 9.44 g. Treatment with a dose of 15 tons/ha of biochar gave the highest total fresh weight per plant, which was 10.45 g, an increase of 13% when compared to without biochar, which was 9.27 g. The interaction of 4 weeks of composting with a dose of 15 tons/ha of biochar gave the highest total fresh weight per plant of 11.73 g, an increase of 24% compared to the interaction of 2 weeks of composting without biochar of 9.47 g.

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