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# Using two dosages of biochar from shorea to improve the growth of *Paraserianthes falcataria* seedlings

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**Abstract.** The objective of the study was to examine the effect of biochar addition on the growth of *Paraserianthes falcataria* seedlings. Biochar from shorea was produced using a traditional kiln at 400 °C and 600 °C. The scarification of *P. falcataria* seeds were conducted using hot water with temperature at 80 ℃ and then soaked for 24 h. The seeds were then spread on to the germination media and after germinated, the seedlings were moved to polybags contain soil and biochar. Two dosages of biochar such as 25 and 50% were applied and compared with control. The research was arranged in a completely randomized design with 15 replicates. The examination of seedlings growth was conducted one week after transplanting, then subsequently monitored every month. The results showed that the addition of biochar improved the survival rate of seedlings, height and diameter increments, root length and root volume. The results showed a potential of using biochar to improve the growth of *P. falcataria* seedlings in the nursery.

## 1. Introduction

The *Paraserianthes falcataria* is well-known as industrial plants in Indonesia due to it is ability on fast growing and multi-purpose use [1]. Fast growing species always requires large amounts of nutrients, especially in early growing period. The efforts are needed to fulfil the nutritional needs, which are often provided by the fertilizers [2].

Nowadays, the fertilizer application is considered less economical than the provision of soil amendments. This is because of the providing soil amendments will not only improve the soil nutrient status, but also improve the physical and biological properties of soil. Biochar is, a form of soil amendment, starting to be widely recommended [3]. In addition to improve ability on soil physical, biological and chemical properties [4], biochar is also a form of efficient utilization of forest biomass waste [5].

Biochar is a solid material that was formed during the thermochemical biomass decomposition process and defined as solid material obtained from biomass carbonization [6]. The main raw material for making biochar is generally waste or residue from production systems in forestry and agriculture such as waste harvesting and felling, deadwood, residual pulpwood milling, crop residues from fields, garden decorations and so on [7].

Biochar was produced by a method called thermal decomposition with a limited supply of oxygen ($O_2$), and at relatively low temperatures (<700 °C) [8]. In previous studies, it has been found that temperature differences will produce different biochar characteristics [9]. Furthermore, [9] found that the higher the temperature, the less biochar will be produced and the lower of bulk density. This seems to affect the effectiveness of biochar when applied as a soil repairer.

Meranti wood waste (*Shorea sp.*) from the carpentry industry is quite high. Meranti wood is generally used as planks, so that many parts of the wood are not used properly. Generally, this wood waste is only used as fuel for stoves, or burned it. The using of meranti wood waste for biochar could reduce the waste, increase the economic value and is an excellent way to return nutrients to forest soil. The purpose of this study was to determine the effect of biochar from meranti waste on the growth of P. falcataria in the nursery. The difference in temperature and dose is presumed affect the observed growth of *P. falcataria*.

## 2. Materials and methods

Biochar was produced using harvested meranti wood waste (*Shorea.sp.*). The meranti wood waste was cut to a size of 50 cm. The air-drying treatment of meranti greenwood was conducted to reduce the moisture content during one week outdoor. The air-dried wood was then arranged in a furnace with a capacity of 5 $m^3$. The combustion was carried out slowly (slow pyrolysis) to obtain a low heating rate until it was reached the target temperature of 400 and 600 ℃. The temperatures were maintained for about 8 h by regulating the oxygen supply from the control holes above the furnace.

The final stage of cooling was carried out in the furnace by closing the all holes in the furnace to cut off the oxygen supply completely. The final conditioning was exposed the outside of room for 24 h. After that, it was sieved to separate the ash from the combustion residue from the biochar.

The biochar was sieved to uniform the size as an application on planting medium of *P. falcataria* seeds. The *P. falcataria* seeds were germinated for two weeks in nursery. The seed sprouts step was used sand as a growth medium. Before sowing, the seeds of *P. falcataria* were scarificated using hot water immersion at 80 ℃ and then soaked for 24 h [10]. The *P. falcataria* seeds were germinated in sprouts potrays with a hole size of 180cc. After having leaves and wood, *P. falcataria* seedlings, used 320cc potrays, were transferred to a planting medium consisting of topsoil soil that had been air-dried, sieved and mixed with biochar beforehand according to the treatment dose. The *P. falcataria* seeds were maintained the watering field capacity, countermeasures pests and diseases, and weed weeding.

The study was designed using a complete randomized design with 15 replications for each treatment. The treatment 1 was 100% of top soil (without the addition of biochar meranti). The treatment 2, 3, 4 and 5 were added the biochar meranti 600 ℃ as much as 50%, 600 ℃ as much as 25%, 400 ℃ as much as 50%, and 400 ℃ as much as 25% in the growth medium, respectively.

The parameters were observed such as height and diameter increasing, root length and volume. The plant height and diameter were observed monthly, while the root length and volume were observed in fourth month of planting when the plants were unloaded. Data were analysed by ANOVA to see the effect of treatment on the observation of growth parameters, and continued with the BNJ real difference test.

## 3. Results and Discussions

### 3.1. *Analysis result of ANOVA*

The ANOVA analysis result showed that the addition of biochar has a very significant effect (1%) on the parameters of height and diameter increasing, while the root length and volume had a significant effect (5%). The results of the follow-up test (LSD) were shown in Table 1.

**Table 1.** ANOVA recapitulation on the effect of application of biochar to some growth parameters of *P. falcataria* seedlings.

| Treatments | Height Increment (cm) | Diameters Increment (mm) | Root Length (cm) | Root Volume ($mm^3$) |
|---|---|---|---|---|
| Application of Biochar | ** | ** | * | * |

Evidence : ** : significant at 1% level
: * : significant at 5% level

**Table 2.** Recapitulation of further test results on the effect of biochar on the growth parameters of *P. falcataria* seedlings.

| Treatments | Height Increment (cm) | Diameter Increment (mm) | Root Length (cm) | Root Volume ($mm^3$) |
|---|---|---|---|---|
| Meranti (600 ºC) 50% | 15.17a | 3.99a | 14.39c | 5.88a |
| Meranti (600 ºC) 25% | 13.65a | 3.71ab | 15.77abc | 3.43bc |
| Meranti (400 ºC) 50% | 10.59b | 3.32bc | 15.65bc | 3.63b |
| Meranti (400 ºC) 25% | 9.03bc | 3.24c | 16.23ab | 2.63c |
| Control | 6.81c | 3.10c | 17.26a | 5.91a |

The 600 ℃ meranti biochar dose result showed better growth than 400 ℃ meranti biochar dose shown in Table 2. [11] stated that the temperature increasing of pyrolysis will cause an increase in pH and C stability of biochar. The temperature increasing will also cause an increase in the content of Na, K, Ca, Fe and Mg although it will also be greatly influenced by the basic ingredients of biochar [12]. Several studies have also shown that giving biochar has been shown to increase soil CEC [13], which will affect the availability of nutrients for plants and ultimately increase plant growth [14].

The increase in plant growth with biochar has also been shown by [15] that there was a high growth increment in *Guazuma crinita* Mart and *Terminalia amazonia* plants treated with biochar. This study showed that the biochar application produced growth as good as fertilizer application. The same thing was also shown by [16], where the *Melia azedarach* Linn plant has 4.5% better growth compared to plants that do not get the addition of biochar in their growing medium.

### 3.2. *The average growth of P. falcataria seedling*

The height gain data showed that the difference in height gain speed has occurred since the second month shown in Figure 1. The study showed that biochar has affected on the soil fertility. The ability of biochar as soil amendment could increase the soil fertility by improving the soil properties has been proven by [17]. The increase in soil fertility was influenced by the increasing of nutrient availability due to the addition of biochar. The study was assumed the process occur through the following mechanisms, (1) direct supply of biochar [18], (2) The ability of biochar to bind nutrients and an increase in the activity of microorganisms [19].

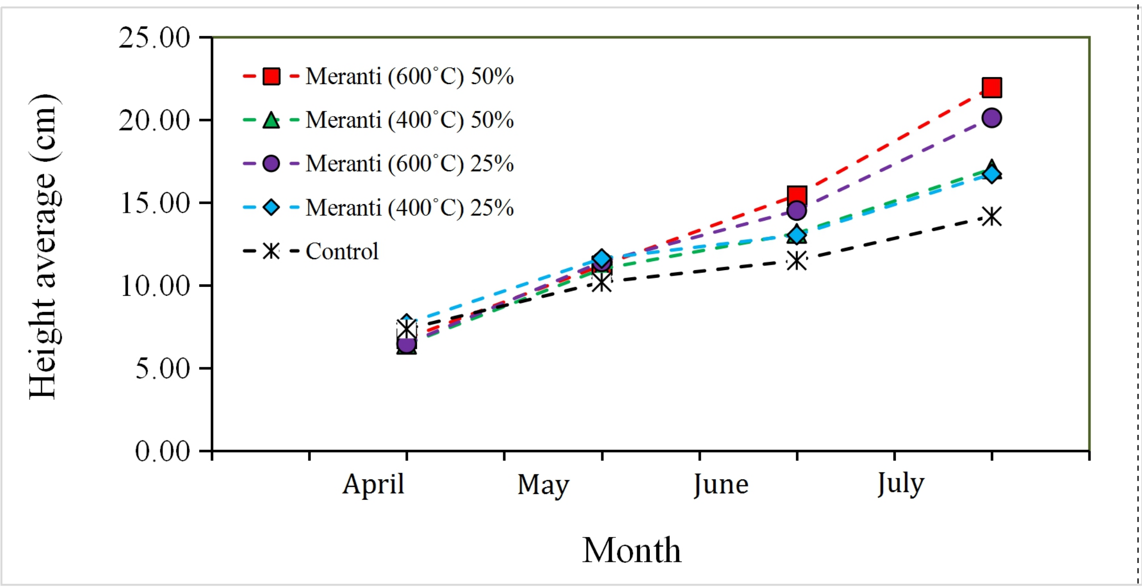


**Figure 1.** The average height of *P. falcataria* seedling in each month.

### 3.3. Correlation of *P. falcataria* seedling height to diameter

In this study, the correlation of seedling height to diameter showed that there three types of growth, such as high significant, normal and less significant (Figure 2). The correlation showed the positive trend which indicates that the growth of diameter is also followed by height growth. The meranti biochar of 600 °C 50% and 25% concentrations indicate the high significant in this study (Figure 2). While, the meranti 400 °C 50% and 25% concentrations and control indicate normal and less significant in this study, respectively (Figure 2).

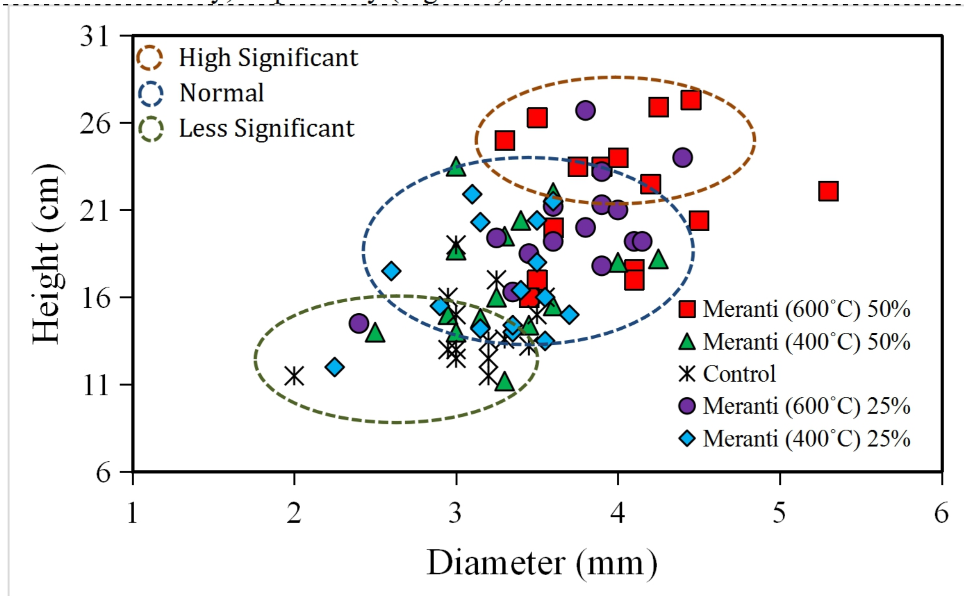


**Figure 2.** The correlation of *P. falcataria* seedling height to diameter in each of treatments.

In soil, biochars (those produced at or below 600-700 ℃) seem to oxidize rapidly and attain greater amounts of CEC (Cheng et.al., 2008). This is likely that happened to the meranti biochar 600 ℃ 50% and 25% concentrations so that the sengon seedling could absorb the soil nutrient rapidly. The commonly observed greater microbial biomass has been presented as a reason for a greater decomposition of soil C in the presence of biochar [20]

*3.4. Correlation of P. falcataria seedling height to root length*

[19] stated that some characteristics of biochars such as increased water-holding capacity, reduced bulk density, and supplementation with additional cation exchange sites may improve seedling production conditions in small-volume containers. Plant uptake of N and P and growth of fine roots and root hairs into biochar pores stimulate the production of organic N and P mineralizing enzymes [21]. In this study, the correlation of sengon seedlings height to root length shows that meranti biochar of 600 ℃ 50% and 25% concentrations dominantly have high significant height to root length (Figure 3). While meranti biochar of 400 ℃ 25% concentrations and control result low significant height to root length (Figure 3).

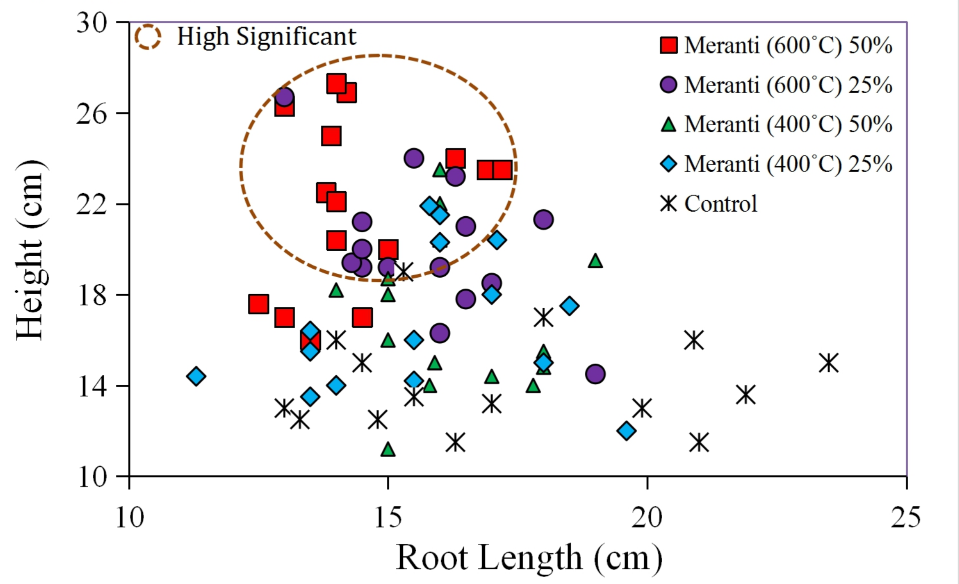


**Figure 3.** The correlation of *P. falcataria* seedling height to diameter in each of treatments.
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Biochar application had significant effects on some aspects of plant growth and nutrition in soil. Plants with a more robust root system are expected to perform better over time and to show higher resistance to drought in comparison to plants with a less robust root system [15]. Even though aboveground morphology, such as height and root collar diameter, was the most useful characteristic in assessing quality of seedlings, it was not always an accurate predictor of seedlings' performance after out planting [22]. The biochar treatments increased seedling quality index which is one of the comprehensive indices to evaluate seedling quality [23]

## 4. Conclusion

This study was concluded that the growth of *P. falcataria* seedling enhance by added biochar to the growth media in nursery stage. The meranti biochar 600 °C with 50% dose showed the highest shoot yields compare to other treatment. The correlation between the growth parameter also showed that meranti biochar 600 °C with 50% dose was the best growth yield.

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