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Effects of Meranti Biochar Addition on the Root Growth of *Falcataria Moluccana* Seedlings

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ABSTRACT
The purpose of this study was to determine the effect of biochar application in growing media on the development of the roots of *Falcataria moluccanna* seedlings. Biochar from the waste of meranti wood (*Shorea* sp.) was produced by a slow pyrolysis process using a traditional kiln at a temperature of 600°C. The study was arranged in a completely randomized design with three treatments and 15 replications. The treatments were 100% topsoil (control), 5% biochar, and 10% biochar addition to the planting media. *F. moluccana* was grown from seeds germinated in sand media. After one month, *F. moluccana* was transferred to polybags filled with planting media according to the treatment. The observations were conducted for four months. The parameters observed were root length, root volume, and root biomass. The results showed that the addition of biochar indicated a very significant difference in root length, root volume, and root biomass compared to the control. However, the two dosages showed no significantly different effect on root growth. This study concluded that the addition of 5% biochar meranti in the planting media could increase the root growth of *F. moluccana*.

Keywords: *Biochar, Falcataria moluccanna, root growth.*

1. INTRODUCTION

Biochar, the solid material formed during the thermo chemical decomposition of biomass, is defined as a solid material obtained from the carbonization of biomass [1].The raw material of biochar is mostly waste from agriculture and forestry such as sawmills, nutshells, dead wood, lumber, and pulp [2]. Biochar had been one of the popular soil conditioners nowadays [3, 4], due to as a soil conditioner biochar could enhancing plant growth by supplying and, more importantly, retaining nutrients [5];[6] and by providing other services such as improving soil physical and biological properties [7].

The biochar important function as a soil conditioner is to improve the soil physical properties [8]. This is due to the wide surface area of the biochar which increases water absorption, soil structure changes [9], and improvements on aeration and drainage[10]. A previous study [11] stated that the addition of biochar helps improve soil properties with the presence of nutrients and ash in the biochar with a large surface area, porous properties, and the ability to act as a medium for microorganisms.

Good soil physical properties will affect the ability of roots to grow and develop. Roots will easily grow and develop in loose soil. Strong and broad roots will have the ability to absorb nutrients and water well. This will significantly affect plant growth and productivity. This is especially for fast-growing crops such as *F. moluccana*, which require a large amount of nutrients and water for growth [12]. This study aimed to determine the effect of biochar application in the growing media of *F. moluccana* seeds on root growth and development.

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2. MATERIALS AND METHOD

The raw material for biochar was obtained from the waste of meranti (*Shorea* sp.) woods. The wood was cut into 50 cm and air-dried for one week to reduce the water content. Biochar was produced using a traditional kiln with a capacity of 12 m^3. The kilns were equipped with five control holes to control the supply of oxygen during the pyrolysis process. Meranti woods were stacked horizontally in the kiln until they reached the kiln's maximum capacity (Figure 1). The woods were burned on its upper part, and after the upper part burned, the control holes were subsequently closed to limit the kiln's oxygen supply. The biochar production was conducted at a peak temperature of 600°C. The production of biochar was performed for 14 days from burning, maintaining peak temperature, to cooling. The next stage was biochar cooling, which was conducted by closing all oxygen supply holes in the furnace. The biochar was then exposed outdoor for one day. After that, the biochar was sieved to have a uniform size for application as a growing media for *F. moluccana*.

The seeds of *F. moluccana* were scarificated before sowing. The technique used was immersion in hot water at temperature 80°C and then soaked for 24 hours. The seeds were then sown in the sand for one month in a tub of sprouts. The *F. moluccana* seedlings were transferred to the planting media which had been adjusted according to the addition treatment. The polybag used was 320 cc in size. Seedlings are cared for by watering, weeding, and controlling pests and plant diseases.

Figure 1. Pyrolysis of meranti: (a) horizontally stacking of woods and (b) covering the main door.

The study was designed with a completely randomized design with 15 replications. There were three treatments, namely (1) 100% topsoil (control), (2) adding 5% biochar meranti to the topsoil, and (3) adding 10% biochar meranti to the topsoil. After four months of weaning, the plants were dismantled to see the development of their roots. The parameters observed were root length, root volume, and root biomass. Data were analyzed by ANOVA to see the effect of treatment on the observed root growth parameters, followed by the LSD test.

3. RESULT AND DISCUSSION

3.1. Analysis Result of ANOVA

The ANOVA analysis result showed that the addition of biochar has a very significant effect (1%) onthe parameters of root length, root volume, and root dry weight (Table 1). The results of the follow-up test (LSD) were shown in Table 2.

Table 1. Anova recapitulation on the effect of the application of biochar to some growth parameters of *F. moluccana* seedlings

Paramaters	**F_{test}**		**F_{crit} (5%)**	**F_{crit} (1%)**
RootLength (cm)	10,38	**	3,35	5,49
Root Volume (ml)	8,45	**	3,35	5,49
RootDryWeight (g)	4,37	*	3,35	5,49

Table 2. Recapitulation of further test results on the effect of biochar on the root length, root volume, and root dry weight of *F. molucana* seedlings.

Treatment	**Root Length (cm)**		**Root Volume (ml)**		**Root Dry Weight (g)**	
Control	11,41	b	0,499	b	4,76	b
Meranti 5%	11,42	b	0,746	a	5,96	a
Meranti 10%	14,67	a	0,812	a	6,16	a
LSD	2,285		1,02		0,309	

Means followed by the same letter(s) are not significantly different at p<0,01 LSD test

Table 2 showed that all parameters of root growth were significantly different compared to control. All the parameters had a better result than control. Biochar could improve the soil properties such as soil moisture, soil aggregation and bulk density [13]. A previous [13] study described that biochar produced rich biomass content which provide high soil nutrient, microbial activity and soil organic matter. The root hairs of biochar associated could penetrate the water-filled macropores [14].

3.2. Root Length

Root length describes the vertical root growth, which will support plant sturdiness. The root length of the 10% biochar meranti addition showed the best results compared to the treatments (Figure 2). The addition of biochar at a dosage of 10% increased the

root length by 28.6% compared to the other two treatments. This was similar to a study conducted by [15], which used the same biochar dosage (0%, 5%, and 10%) for pine. The previous study showed that a dosage of 10% indicated the best results. Several other studies also used a 10% dosage of biochar in their media and showed the best growth results compared to other dosages [16];[17].

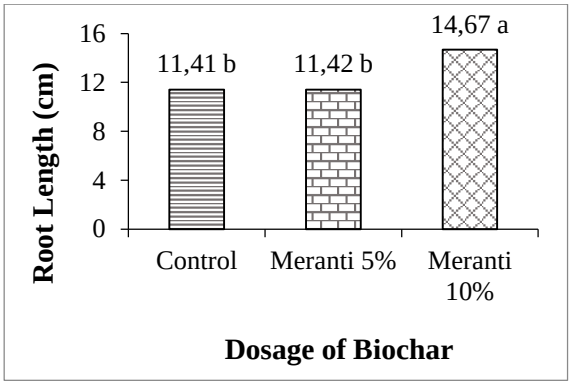

Figure 2 The effect of meranti biochar on the root length of *F. moluccana* seedlings. Means followed by the same letter(s) are not significantly different at p<0,01 LSD test.

3.3. Root Volume

The addition of biochar meranti was significantly increased the root volume compared to the control media (Figure 3). The increase in root volume ranged from 25-29% compared to the control treatment. However, it appeared that the two treatments of meranti biochar addition showed similar good results. [18] stated that biochar affects the morphology and function of plant roots because it is in direct contact with the roots in the planting media. Biochar is highly porous and finely grained, with lightweight, surface area, and high pH, all of which have positive effects when applied to the soil and will greatly affect the growth space of plant roots[19].

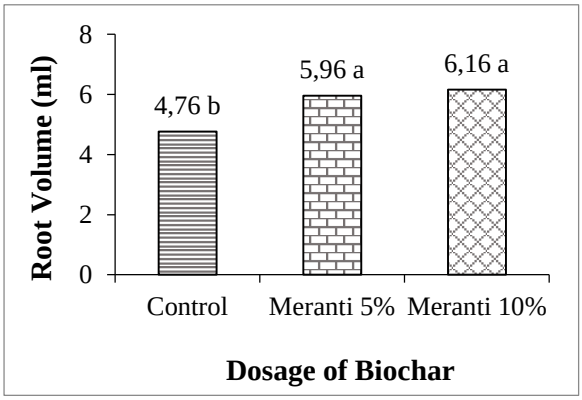

Figure 3 The effect of meranti biochar on the root volume of *F. moluccana* seedlings. Means followed by the same letter(s) are not significantly different at p<0,01 LSD test.

3.4. Root Biomass

Roots are the main vegetative organs essential for the growth and development of plants that supply water, minerals and materials. Plant root systems are controlled by genetic traits and soil conditions or the planting media [20]. A good root system could increase plants' absorption of nutrients and water, and the overall plant biomass. The addition of biochar meranti to the planting media of *F. moluccana* seedlings increased root biomass by 49-63% compared to using only topsoil as the planting media (Figure 4). The parameters indicated no significant difference between the two treatment dosages of biochar addition to the growing media. This study showed that the addition of a 5% dosage assumed a similar result to the dose of 10% in increasing root biomass. Mosts tudies showed that the addition of biochar could increase plant biomass [21], although according to[19] it will depend on the type of biochar raw material. The nature of raw materials will affect the nature of biochar in affecting soil properties and plant growth [6].

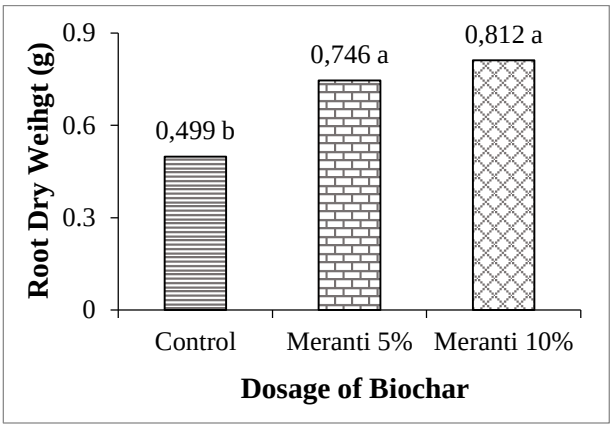

Figure 4 The effect of meranti biochar on the root biomass of *F. moluccana* seedlings. Means followed by the same letter(s) are not significantly different at the p<0,01 LSD test**.**

4. CONCLUSION

This study concluded that meranti biochar addition significantly increased the root growth of *F. moluccana* seeds in the nursery. The addition of 5% and 10% biochar meranti indicated no significantly difference on increasing the root growth of *F. moluccana*. This study recommended that the addition of 5% biochar meranti in the planting media could increase the root growth of *F. moluccana*.

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