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Chapter 17

Application of husk charcoal for waste risk minimization by growing *Acacia mangium* (Willd.) on gold mining media

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Chapter contents

Abstract

Husk charcoal is a crop waste that can be used to improve tailings media. Tailings have several characters including, low organic matter content, low microorganism activity, low essential nutrient content, low cation exchange capacity and high heavy metals. The design used in this experiment was a complete randomized design factorial with 2 factors. The first factor was the husk charcoal and the second factor was the application of compost fertilizer. The treatment of husk charcoal and compost did not significantly affect the growth of total dry weight and root

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shoot ratio. The interaction between husk charcoal and compost has a significant effect on total dry weight and root shoot ratio. The treatment of A4B1 (1000 g of tailing + 100 g of husk charcoal + 20 g of compost) gave the most significant effect on the total dry weight of *Acacia mangium* seedlings with an average of 9,630 g and with an increase in control of 57,53%. Husk charcoal, which is waste from rice plants and compost from urban waste, can be used for bioremediation of ex-gold mine land.

Keywords: *Acacia mangium* (Willd.), Environmental impacts, Gold mining media, Husk charcoal

Introduction

Excessive exploitation of natural resources and not paying attention to environmental aspects will have an impact on natural damage and a decrease in the quality of land. Activities of exploitation of natural resources which have an impact on decreasing the quality of land, namely mining activities of minerals such as gold mining, where the mining method is deep mining (Fauzi, 2006; Setiadi, 2006). The results of the processing of gold are produced by waste in the form of rock-dump and tailings. Tailings are one form of waste produced in large quantities in gold mining activities. Tailings have several characters including, low organic matter content, low microorganism activity, low essential nutrient content, low cation exchange capacity (CEC) and high heavy metal content (Winata *et al*., 2016; Komboj *et al*., 2017; Wasis and Andika, 2017; Wasis *et al*., 2018). The tailings waste generated from the treatment process will be accommodated in special storage areas at the expense of the surrounding land which has an impact on decreasing the quality of the land. The clearing of forest land designated as a storage area for tailings waste needs revegetation as an effort to restore and restore land function. (Wasis and Andika, 2017, Wasis *et al*., 2018). The success rate of revegetation activities is influenced by soil conditions (edafis), climate (climatic), type selection, and handling. The choice of type is prioritized using pioneer, catalytic, and fast growing species. The type of plant according to these characteristics is acacia (*Acacia mangium*).

One type of fast-growing plant commonly used for revegetation is Acacia mangium. Willd. (Herianto and Siregar, 2004; Siregar, 2004; Zulkifli, 2013). *A. mangium* does not require high growth requirements, A. mangium is able to grow on poor and infertile land such as land with low pH, eroded soil, and former logging and is easy to adapt to the local environment (Retnowati, 1998; Setiadi and Cakyayanti, 2014). Husk charcoal is a result of rice crop waste which is expected to be used to improve gold taling media. Compost is a municipal waste treatment product that is often used to improve soil fertility (Shalsabila *et al*., 2017; Wasis *et al*., 2018. Wasis *et al*., 2019). The treatment of husk charcoal and municipal waste is new and needs to be tried to improve ex-gold mine land and increase the growth of *A. mangium*.

Materials and methods

Time and place of research

The research was conducted from September to November 2015, housed in a permanent nursery greenhouse dramaga, Faculty of Forestry IPB, and soil analysis in the Laboratory of the Department of Soil Sciences and Land Resources, Faculty of Agriculture, Bogor Agricultural University (IPB), Indonesia.

Experimental design and data analysis

Experimental design used was factorial completely randomized design with two factors. Factor A was husk charcoal with 5 doses (0, 25, 50, 75, 100 g) and factor B (0, 20, 40, 60 g) was compost with 4 doses. Each treatments were conducted with four repetitions. Obtained data based on measurement of height, diameter, total wet weight, total dry weight and Root-shoot ratio was analyzed by using linear model (Mattjik and Sumertajaya, 2013; Stell and Torries, 1991; Wibisono, 2009). Only if there is significant effect, Duncan's Multiple Range Test will be measured for getting further statistic data.

Research tools and materials

The tools used in this study are hoes, watering tools, small shovels, scales (analytical balance), digital scales, rulers, calipers, Tallysheet, calculators (stationery), stationery, digital cameras, Microsoft Excel 2007 software, and SAS 9.1.3 software.The materials used in this study were used as tailings gold media, polybags with a size of 20 cm x 20 cm compost, husk charcoal, and A. mangium aged ± 3 months.

Research procedures

The initial step taken in this study was the retrieval of tailings media in Pongkor District, Bogor Regency. This research was carried out through several stages, namely preparation of planting media, seed weaning, seedling maintenance, observation and data collection, as well as experimental design and data analysis.

Media preparation

The preparation stage includes media preparation and preparation of *A. mangium* seedlings. The prepared media consisted of the composition of tailings, compost, and husk charcoal. All of these ingredients are dry air. Measuring the composition of the media using scales (analytic balance) with the composition of the material for the media according to the dose, after obtaining a dose combination of each ingredient and then put into polybags. The dosage composition for control is tailings at a rate of 1 kg. The composition of the husk charcoal ingredients, each is 0 g/polybag (as a control), 25 g/polybag, 50 g/polybag, 75 g/polybag and 100 g/polybag. The dosage composition of compost fertilizer is 0 g/polybag (as a control), 20 g/polybag, 40 g/poly bag, 60 g/poly bag. Preparation of *A. mangium* seedlings was carried out including selection of healthy seedlings, which were uniform and fresh, fresh and free of pests and diseases.

Seed weaning and maintenance

Weaning is the stage of transferring *A. mangium* with its root ball (root ball) to the media prepared in the previous stage. Weaning is done in the afternoon. The steps taken in weaning *A. mangium* seeds are pressing polybags to compact the soil media. Then remove the poly bag and make a planting hole. The seedlings are planted into polybags along with the soil media to maintain the condition of the seeds so that the roots do not experience stress when weaning into the tailings media. All *A. mangium* was weaned, then placed in a greenhouse for 3 months. Watering is done in the morning and evening and weeding is needed as needed by observing the condition of the planting media in a polybag.

Data collection and analysis

Data collection was conducted every week in the period of September – November 2015. The variables observed were height and diameter. In the last week *A. mangium* seedlings were harvested. After that, those were weighed to know the wet weight. Then, seedlings were dried off in the oven at 80°C as long as 24 hours (Wasis and Fathia, 2011; Wasis and Angga, 2017). After that, *A. mangium* seedlings were weighed again to know the dry weight. In other hand, two samples of soil / tailing (planting medium) were analyzed to know the soil characteristics. The two samples of these medium were soil / medium with control treatment and the best treatment which gave the best growth prefromance of *A. mangium*.

Results and discusion

Growth of *A. mangium* seedling in the tailing

The results of variance showed that the treatment of single husk charcoal, single compost fertilizer and the interaction of the combination of husk charcoal and compost did not significantly affect the height, diameter and total wet weight. The combination of husk charcoal and compost was significantly affected for total dry weight and root shoot ratio (Table 17.1). The Duncan test results of the interaction between the combination treatment of husk charcoal and compost showed that the treatment of husk charcoal of 100 g with compost 10 g with (A4B1) was the best combination treatment that could increase the total dry weight of *A. mangium* seedlings with an increase of 57 53%, while the lowest total dry weight in the combination of giving husk charcoal was 75 g with compost 60 g with an increase of control of -36.69% (Table 17.2). The combination of husk charcoal of 25 g and compost fertilizer of 40 g (A1B2) showed the highest yield and different from other treatments, with an average root shoot ratio value of 6.957 and an increase in percentage of control of 104.80%. Root shoot ratio was obtained based on a comparison between the dry weight of shoot tops divided by the dry weight of plant roots.

***Table 17.1.** The recapitulation of the variance of the effect of various treatments on the parameters of A. mangium seedling growth.*

Parameter	**Treatment**		
	Husk charcoal	*Compost*	*Husk charcoal x Compost*
Height	0.0648 ^{tn}	0.1396 ^{tn}	0.0756 ^{tn}
Diameter	0.1510 ^{tn}	0.8830 ^{tn}	0.2904 ^{tn}
Total wet weight	0.7056 ^{tn}	0.6670 ^{tn}	0.8659^{tn}
Total dry weight	0.1615 ^{tn}	0.6560 ^{tn}	0.0233 *
Root shoot ratio	0.9918 ^{tn}	0.8293 ^{tn}	0.0485 *

** Factual treatment with trust range 95%, significant value (Pr < F) 0.05 (a) ^{tn} factual treatment with trust range 95% (Pr > F) 0.05 (a).*

***Table 17.2.** Duncan's further test results interaction of husk charcoal and compost fertilizer on the total dry weight of A. mangium seedlings.*

Treatment	**Average of total dry weight (g)**	**Increasing toward control (%)**
A0B0	6.113 bc	0.00
A0B1	5527 bc	-9.59
A0B2	6.737 abc	10.21
A0B3	5.917 bc	-3.21
A1B0	8.103 ab	32.55
A1B1	5.097 bc	-16.62
A1B2	5.230 bc	-14.44
A1B3	7.580 ab	24.00
A2B0	5.560 bc	-9.05
A2B1	6.747 abc	10.37
A2B2	7.023 abc	14.89
A2B3	7.927 ab	29.67
A3B0	5.870 bc	-3.98
A3B1	6.610 abc	8.13
A3B2	5.033 bc	-17.67
A3B3	3.870 c	-36.69
A4B0	6.417 bc	4.97
A4B1	9.630 a	57.53
A4B2	6.417 bc	4.97
A4B3	4.967 bc	-18.75

The number followed by the same letter shows that the treatment is not significantly different from the 95% confidence interval.

This value has an important role because with a balanced ratio between shoots and roots, the plants will grow well. The best root shoot ratio range from 1-3. (Wasis and Andika, 2017; Wasis *et al*., 2018). Research shows that A. mangium seedling root shoot ratio > 3 shows that plants do not grow well on tailings media (Figure 17.1).

Effects on soil nutrient properties

Nutrient analysis was carried out at the end of the study, which was taken from several treatments as supporting data. Soil analysis was carried out on the control treatment (A0B0) and

Table 17.3. *Duncan's further test results on the interaction of husk charcoal and compost fertilizer on A. mangium seedling root shoot ratio.*

Treatment	Average of root shoot ratio	Increasing toward control (%)
A0B0	3.397 bc	0.00
A0B1	5.357 abc	57.70
A0B2	5.120 abc	50.72
A0B3	4.183 abc	23.14
A1B0	3.460 abc	1.85
A1B1	4.370 abc	28.64
A1B2	6.957 a	104.80
A1B3	3.470 abc	2.15
A2B0	6.920 ab	103.71
A2B1	3.167 c	-6.77
A2B2	3.690 abc	8.63
A2B3	3.257 c	-4.12
A3B0	4.060 abc	19.52
A3B1	4.250 abc	25.11
A3B2	3.953 abc	16.37
A3B3	6.070 abc	78.69
A4B0	4.993 abc	46.98
A4B1	3.417 abc	0.59
A4B2	3.710 abc	9.21
A4B3	5.630 abc	65.73

The number followed by the same letter shows that the treatment is not significantly different from the 95% confidence interval.

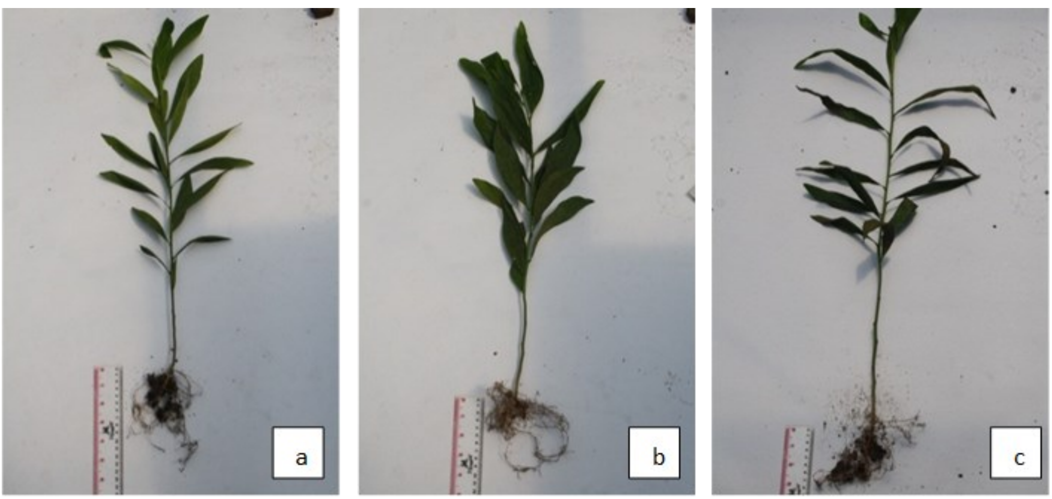

Figure 17.1. *Growth of shoots and roots of A.mangium seedlings on media a) A0B0 (control); b) A1B2 (root shoot ratio Value 6,957); c) A2B1 (root shoot ratio value 3,167).*

Table 17.4. *Characteristic of planting medium (tailing) of A. mangium.*

Parameter	A0B0	A4B1	Change
pH (H_2O)	7.4 N	7.45 N	+0.05
organic C (%)	0.07 VL	0.69 VL	+0.62
Nitrogen (N) (%)	0.03 VL	0.07 VL	+0.04
Phosphorus (ppm)	3.22 VL	22.8 M	+19.58
Calcium (Ca) (me/100g)	22.05 VH	4.05 L	-18.00
Magnesium (Mg) (me/100g)	0.83 L	3.69 H	+2.86
Potasium (K) (me/100g)	0.24 L	1.45 VH	+1.21
Cation exchange capacity (CEC) (me/100g)	2.39 VL	22.49 M	+20.10

Criteria for soil chemistry according to Hardjowigeno (2003), N = neutral VL = very low, L = Low, M = Medium, H = High, VH = very high

the best treatment was a combination of husk charcoal of 100 g with compost fertilizer of 10 g (A4B1) (Table 17.3 and 17.4). Based on the results of soil analysis shows that the most basic problem of tailings is the very low CEC value of 2.39 me/100 grams. At CEC very low, the water and nutrients given will be washed away.

Soils with high CEC are able to absorb and provide nutrients better than those with low CEC (Tan, 1994; Hardjowigeno, 2003; Kusuma *et al*., 2013). In the treatment A4B1 has a CEC of 22.49 me/100 g so that the media can store water and nutrients higher than A0B0 (control). This study shows that the treatment of the interaction of husk charcoal and compost can increase soil CEC due to organic colloidal formation. The interaction of charcoal and compost can improve the physical, chemical and biological properties of the soil. Generally, soil with high texture such as tailings will have a low CEC due to low clay content (Hardjowigeno, 2003; Munawar, 2011, Phillip *et al*., 2015).

The results of soil analysis on tailings media through the interaction treatment of 100 g of husk charcoal and 20 g of compost have also improved soil fertility. Increased soil fertility can be seen by increasing soil pH, organic C, soil N, available P, Mg, and K. Increased soil fertility has improved the growth of A. mangium plants. Fertilization aims to add nutrients to the soil with the aim of improving soil fertility (Tan, 1994; Hardjowigeno, 2003; Wasis *et al*., 2018; Wasis *et al*., 2019). But the treatment of husk and compost charcoal has not significantly increased the levels of N and P in the media, this is the main reason why the administration of husk and compost does not significantly influence the main parameters such as height, diameter and total wet weight. This research shows that husk charcoal which is an agricultural waste can be reused for bioremediation of ex-gold mine land. Likewise, organic waste from households that are processed into compost can also be reused to repair former gold mining land. The use of husk charcoal and compost can reduce agricultural land waste and can increase the growth of *A. mangium*.

Conclusion

The treatment of husk charcoal and compost fertilizer did not significantly affect the growth of total dry weight and root shoot ratio. The interaction between husk charcoal and compost has a significant effect on total dry weight and root shoot ratio. The treatment of A4B1 (1000 g of tailing + 100 g of husk charcoal + 20 g of compost) gave the most significant effect on the total dry weight of *A. mangium* seedlings with an average of 9.630 g and with an increase in control of 57.53%. The treatment of A2B1 (1000 g of tailing + 50 g of husk charcoal + 20 g of compost) gave the most significant influence on the root shoot ratio of *A. mangium* seedlings with an average of root shoot ratio 3.167. Husk charcoal, which is waste from rice plants and compost from urban waste, can be used for bioremediation of ex-gold mine land.

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