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Application of Mulch and Palm Oil Waste as Bioremediation Agents in Post Mining Land

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Abstract. Post-tin mining land in Bangka Island can be utilized by application of mulch and nutrient from organic material to stimulate plant growth. The aims of this study is to know the effect of mulch and palm oil waste to stimulate growth of mustard. The research was conducted in Post-Tin Mining, Bangka, from December 2018 to May 2019. This study used Factorial Randomized Block Design with two factors. The first factor was application of mulch consisted of without (M0) and application of mulch (M1). The second factor was application of palm oil waste consisted of empty palm fruit bunch (T1), empty palm fruit bunch + cow manure + Effective Microorganism-4 (T2) and empty palm fruit bunch + palm bunch ash (T3). The result of variance analysis showed that mulch and palm oil waste gave significant effect on all parameter except ash content. Mulch gave the highest result than without mulch, and empty palm fruit bunch + cow manure + effective microorganism-4 gave the highest result than the other treatment. Interaction between mulch and empty palm fruit bunch + cow manure + effective microorganism-4 gave the best result and could be a profitable solution to stimulate the growth of mustard.

1. Introduction

Bangka Belitung province is a major producer of tin in Indonesia. The area of tin mining was getting increased time by time and caused the change of micro-climate and soil quality [1]. The main impacts of tin mining are critical landforms, landscape destructions, and damage in natural vegetation and biodiversity [2]. The effort to improve soil quality in post-tin mining is using post-tin mining as a cultivation land. Cultivation in post-tin mining land can utilized application of mulch and palm oil waste. Mulch has a potential to prevent weed growth, reduce evaporation and increase infiltration of rain water during growing season [3].

Palm oil waste is one of the biggest waste in Bangka Belitung that system was not fully utilized yet. Palm oil waste such as empty palm fruit bunch and palm bunch ash can be direct source of nutrients for plant [4]. One of system that can be used is a bioremediation to increase plant growth and improve soil quality. The research aims to know the e application of mulch and palm oil waste to as bioremediation agents in post mining land.

2. Methodology

The research was conducted in Post-Tin Mining land, Dwi Makmur Village, and Bangka Regency from December 2018 to May 2019. The materials and tools consisted of mustard, yellow tail grass mulch



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¹ (*Pennisetum polystachion*), empty palm fruit bunch, palm bunch ash, cow manure, EM4, chemical fertilizer, hoe, meter, chlorophyll meter, measuring glass, oven, digital scale, and muffle furnace. This study used Factorial Randomized Block Design with two treatment consisted of mulch and palm oil waste. The first treatment consisted of without (M0) and application of mulch (M1). The second treatment consisted of empty palm fruit bunch (T1), empty palm fruit bunch + cow manure + EM4 (T2) and empty palm fruit bunch + palm bunch ash (T3). The experiment using 4 replications and each block consist of 3 samples.

The procedures include of land preparation, application of organic materials, seed preparation, planting, application of mulch, harvest, roasting in oven and ash content determination. The first step is land cleared from weeds, then 24 plots made by 3 m x 2 m. The next is organic materials was done by putting to the hole with determined dose (Table 1).

¹ **Table 1.** Dose of organic material

¹ Materials	Dose
Empty palm fruit bunch	400 g/plot
Cow manure	450 g/plot
Palm bunch ash	¹ 100 g/plot
EM4	250 ml/plant

Process of planting was done by putting seedling mustard (Samhong King cultivar) that already had 2-3 leaves to planting hole. Then application of mulch was done by putting yellow tail grass (*Pennisetum polystachion*) on the surface soil. Watering was done twice a day. Mustard was controlled and was ready to be harvested when reach 30 day after the plant. Harvesting was done by dig up the whole of shoot and root. Then shoot of mustard was roasted in the oven for two days with 80°C. Then ash content determination was done by burned the dry shoot into muffle furnace for 5 hours and measured the weight of ash on digital scale.

The parameters used plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, and ash content determination. The data analysis used F test in 95% significant level and if the data give significant effect it will continue by using Duncan's Multiple Range Test.

3. Results and Discussions

The result of variance analysis showed that application of mulch gave good effect on plant height, number of leaves, chlorophyll content, root volume, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight, and gave no significant effect on ash content. Application of palm oil waste gave significant effect on plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, and ash content. (Table 2).

Table 2. Analysis of the average variation of growth of mustard

Parameter	Mulch		Palm Oil Waste		Interaction		CV (%)
	Mean	Pr>F	Mean	Pr>F	Mean	Pr>F	
¹ Plant height	7.33	0.0144*	7.86	0.0035**	4.62	0.0069*	12.94%
Number of leaves	18.41	0.0004**	38.41	<.0001**	20.57	<.0001**	14.04%
Chlorophyll content	38.68	<.0001**	16.14	<.0001**	15.49	<.0001**	15.76%
Root volume	17.33	0.0006**	15.78	0.0001**	10.57	<.0001**	33.50%
Root fresh weight	17.21	0.0006**	41.59	0.0000**	35.88	<.0001**	23.93%
Shoot fresh weight	10.85	0.0040**	19.25	<.0001**	1055	<.0001**	33.71%
Root dry weight	25.40	<.0001**	66.24	<.0001**	35.88	<.0001**	31.68%
Shoot dry weight	31.03	<.0001**	84.08	<.0001**	44.80	<.0001**	20.27%
¹ Ash content	0.32	0.5783 ^{ns}	4.55	0.252*	0.64	0.5370 ^{ns}	28.11%

Note: CV = Coefficient of variation; * = Significant at the level 5%; ** = Significant at the level 1%; ns = Not significant; Pr>F = Probability value

The result of Duncan's Multiple Range Test (DMRT) showed that application of mulch gave the highest result than without mulching on plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, and gave no significant effect on ash content (Table 2).

Table 2. Data of Duncan's Multiple Range Test (DMRT) on application of mulch treatment to growth of mustard

Mulch	Parameter							
	Plant height (cm)	Number of leaves (amount)	Chlorophyll Content (CCI)	Root volume (g)	Root fresh weight (g)	Shoot fresh weight (g)	Root dry weight (g)	Shoot dry weight (g)
Without mulch	12.09 ^b	5.80 ^b	7.75 ^b	0.98 ^b	1.13 ^b	12.94 ^b	0.15 ^b	1.07 ^b
Application of Mulch	14.65 ^a	7.43 ^a	11.63 ^a	1.75 ^a	1.70 ^a	20.53 ^a	0.30 ^a	1.72 ^a

Application of mulch treatment gave the highest result compared to without treatment on parameter ash content (Figure 1).

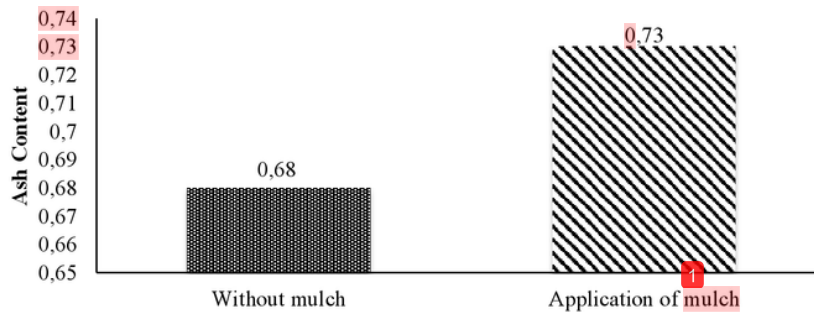


Figure 1. Treatment application of mulch on ash content determination.

The result of Duncan's Multiple Range Test (DMRT) showed that application of palm oil waste such as empty palm fruit bunch, cow manure, and EM4 (T2) gave the highest result compared to the other treatment on plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight, and treatment of empty palm fruit bunch + ash palm bunch gave the highest result on ash content (Table 3).

Table 3. Data of Duncan's Multiple Range Test on application of palm oil waste treatment to growth of mustard

Palm Oil Waste	Parameter								
	Plant height (cm)	Number of leaves (total)	Chlorophyll content (CCI)	Root volume (g)	Root fresh weight (gr)	Shoot fresh weight (gr)	Root dry weight (g)	Shoot dry weight (g)	Ash content (%)
Empty palm fruit bunch	11.99 ^b	4.75 ^c	7.70 ^c	0.97 ^b	0.76 ^b	8.61 ^b	0.06 ^c	0.69 ^c	0.54 ^b
Empty palm fruit bunch + Cow manure + EM4	15.48 ^a	8.79 ^a	12.00 ^a	2.10 ^a	2.27 ^a	26.25 ^a	0.45 ^a	2.43 ^a	0.74 ^{ab}
Empty palm fruit bunch + Palm bunch ash	13.53 ^b	6.32 ^b	9.38 ^b	1.01 ^b	1.22 ^b	15.34 ^b	0.15 ^b	1.07 ^b	0.83 ^a

Interaction of application between mulch combined with empty palm fruit bunch, cow manure, and EM4 gave the highest result compared to the other treatment on plant height, number of leaves, chlorophyll

content, root volume, shoot fresh weight, root fresh weight, shoot dry weight, root dry weight and gave no significant effect on ash content (Table 4).

Table 4. Data of Duncan's Multiple Range Test on application of palm oil waste treatment interaction to growth of mustard.

Treatment interaction	Parameter							
	Plant height (cm)	Number of leaves (total)	Chlorophyll content (CCI)	Root volume (ml)	Root fresh weight (g)	Shoot fresh weight (g)	Root dry weight (g)	Shoot dry weight (g)
Without mulch+ Empty palm fruit bunch	10.97 ^c	4.42 ^d	6.36 ^d	0.76 ^b	0.62 ^c	5.41 ^c	0.03 ^d	0.67 ^d
Without mulch + Empty palm fruit bunch+ Cow manure + EM4	14.60 ^{ab}	7.25 ^b	8.94 ^{bc}	1.32 ^b	1.84 ^b	20.21 ^b	0.29 ^b	1.72 ^b
Without mulch + Empty palm fruit bunch + Palm bunch ash	12.51 ^{bc}	5.75 ^{cd}	7.96 ^{cd}	0.90 ^b	0.92 ^c	13.20 ^{bc}	0.14 ^{cd}	0.83 ^d
Mulch + Empty palm fruit bunch	13.01 ^{bc}	5.08 ^d	9.04 ^{bc}	1.19 ^b	0.90 ^c	11.81 ^{bc}	0.09 ^d	0.71 ^d
Mulch + Empty palm fruit bunch + Cow manure+ EM4	16.38 ^a	10.34 ^a	15.06 ^a	2.88 ^a	2.70 ^a	32.29 ^a	0.62 ^a	3.14 ^a
Mulch + Empty palm fruit bunch + Palm bunch ash	14.56 ^{ab}	6.89 ^{bc}	10.80 ^b	1.19 ^b	1.51 ^b	17.48 ^a	0.19 ^{bc}	1.30 ^c

Interaction of without mulch combined with empty palm fruit bunch and palm bunch ash gave the higher result compared to the other treatment interaction on parameter ash content (Figure 2).

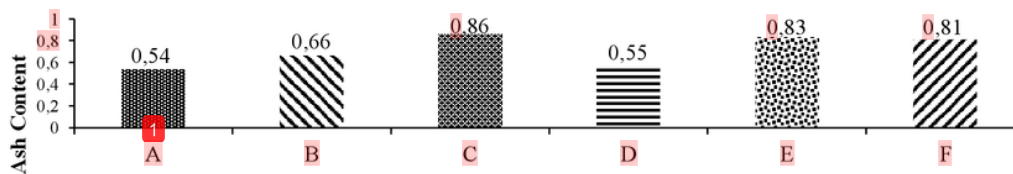


Figure 2. The interaction treatment of mulch and palm oil waste on parameter ash content. A (Without mulch + empty palm fruit bunch) , B (Without mulch + Empty palm fruit bunch + cow manure + EM4), C (without mulch + empty palm fruit bunch + palm bunch ash), D (mulch + empty palm fruit bunch), E (mulch + Empty palm fruit bunch + cow manure + EM4), F (mulch + empty palm fruit bunch + palm bunch ash)

Post-tin mining land containing 97% sand texture, <2% C-Organic material and low of CEC [5] that showed that post-tin mining land has bad soil traits. Improvement effort of mining land utilize by reclamation and re-vegetation program with addition of organic materials [6]. The result of analysis variance showed that application of mulch gave significant effect on plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight. This indicated that mulch able to protect the soil surface and improve the soil quality in post-tin mining land. Post-tin mining has soil traits such as high temperature and low moisture. Organic mulch

1 has potential to improve product quality by reducing temperature, conserving moisture of soil, controlling weed growth, and provide essential nutrient [7].

Application of palm oil waste showed that the treatment of empty palm fruit bunch, cow manure, and EM4 gave the highest results on plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight. This indicated that empty palm fruit bunch which with addition of cow manure and EM4 has more significant effect compared to the other treatment. Empty palm fruit bunch is one of the products left in the palm oil and can be used as local fertilizer [8]. Empty palm fruit bunch containing N 1,91%, P 0,54%, and K 1,51%. Empty palm fruit bunch is able to increase the activity of microorganism trough decomposition. Addition of cow manure and EM4 accelerate the process of decomposition and provide essential nutrient to growth of mustard.

Cow manure can provide a method to dispose of waste materials in an environmentally beneficial manner [9]. Cow manure containing of N 0,25%, P 0,25%, and K 0,5% which able to improve the soil quality. EM4 is a bio-activator that has potential to accelerate the process of organic material decomposition in soil. The addition of manure and EM4 can increase the total of organic material, and reduce nutrient leaching [10].

Interaction of mulch combined with empty palm fruit bunch, cow manure, and EM4 showed the highest results on plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, shoot dry weight. This indicated that the interaction has more significant effect compared to the other interaction. Mulch gave suitable micro-environment for mustard growth. Ameliorant consist of empty palm fruit bunch, cow manure, and EM4 gave essential nutrient and improve soil quality to growth of mustard in post-tin mining land.

The mineral content in vegetable determined by ash determination [11]. The value of mineral is to define the quality of mustard that plant in post-tin mining land. The determination of ash based on the loss of weight with a burning process. The results showed that ash determination gave no significant effect on mulch and the interaction. That indicated that caused by the amount of mineral loss when the plant samples burned inside the muffle furnace. Indonesia National Standard [12] determinate the number of ash for vegetable is 1%. The more higher the amount, the worse quality of vegetable. Based on the result determination, the range number of each samples is 0,25% - 0,98%, so the sample are categorized has a good quality.

4. Conclusion

Application of mulch combined with empty palm fruit bunch, cow manure and EM4 gave the best effect on growth of mustard. The best impact based on parameter plant height, number of leaves, chlorophyll content, root volume, root fresh weight, shoot fresh weight, root dry weight, and shoot dry weight.

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