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Soil Ameliorant in Post Tin Mining Land of Bangka Island for Pepper Growth

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***Abstract*–Pepper is one of the spices plant and its production countinous decrease caused by converting of the planting areas to tin-mining areas. One of the effort that could be done was the usage of sub-optimal land which has low fertility. The research was aimed to study the effect of soil ameliorant application for early growth of pepper plant in the sand tailing area and obtain the proper ameliorant. The research was carried from February to May 2017 in post tin mining land of PT Timah, Dwi Makmur Village, District of Merawang, Bangka Island. The research was arranged in a Randomized Block Design (RBD) single factor dan three replications. The factor used was soil ameliorant combination consisted of seven level i.e. NPK fertilizer, arbuscular mycorrhiza fungi (AMF), biofertilizer, NPK + biofertilizer, NPK + AMF, AMF + organic fertilizer, and NPK + AMF + organic fertilizer. The soil ameliorant applications showed significant effect to plant height, leaves number, segment number, stem diameter, leaf area and chlorophyll content. Complete combination (NPK + AMF + biofertilizer) was the best ameliorant to pepper growth in sand tailing area – post tin minning.**

Keywords–ameliorant, AMF, NPK, biofertilizer, pepper, post tin mining land

I. INTRODUCTION

Production of white pepper has continued to decrease in the recent years. It's caused by the decrease of planting area that relate to the high of deforestation by mining activity. The planting area of white pepper decreases of 19.2% in last ten years, from 2004 to 2014, i.e. 201.484 ha in 2004 and 162.751 ha in 2014 [1]

In the future, ex-mining land is one of the biggest challenge of white pepper cultivation. According to [2], Bangka Belitung has post-tin mining land about 390.000 ha, and it's very potential to be utilized. Generally, post-tin mining land is sand tailing site which was dominated by sand fraction about 81% [3], 82% [4], 92% [5], 93% [6] and 96% [7]. Domination of sand tailing leads the low of soil water holding capacity about 5-10% [8], and its capacity just supply about 50-100 mm of the crops water requirement [4]. The soils has characteristics like these, describe the low of fertility, well on physical, chemical, and biology properties.

The utilization of post tin mining land for pepper cultivation requires of adding soil ameliorant. The soil ameliorant is required to improve the soil properties, viz physical, chemical, and biological, furthermore to supply the nutrition, directly. The soil ameliorant that could be used for improving the fertility of post-tin mining land among others; organic fertilizer [9, 10], inorganic fertilizer [11, 12], and mycorrhiza fungi [4].

Organic and biological fertilizers could increase the plant growth [13, 14], increased the soil biology activity [15], and could decreased the use of NPK fertilizer [16, 17, 18]. Furthermore, the adding of organic fertilizer increased the absorption of rainfall, slowed the run-off, decreased the evaporation rate and increased the plant production [19]. Biological agent fertilizers also could increase the physical and chemical soil properties [20].

In the post-tin mining land that has poor nutrient, inorganic fertilizer play a role to supply the nutrient for plant development, directly [21]. The use of Urea, SP-36, and KCl fertilizers could increase the growth and corn yield in the post-tin mining land [22]. Furthermore, application of NPK fertilizer increased the growth of shorgum [23], lettuce [11], and *Samanea saman* [15] which were cultivated in post-tin mining land.

Mycorrhiza is one of the soil fungi, and according to [24], could association with more than 80% types of crop, like forestry, agriculture, horticulture, and plantation. Application of mycorrhiza was required to rehabilitation of soil biology properties and mycorrhiza [25, 26]. Moreover, mycorrhiza could increases the ability of water uptake and nutrient [27]. The use of mycorrhiza as a soil ameliorant in post-tin mining land can improve the soil physical properties [28], chemical and biology properties [29]. Mycorrhiza could increase the rubber growth in post-tin mining land [4].

The adding of three materials as soil ameliorant is expected could increase the fertility of post-tin mining land. The increasing of fertility will promote the white pepper growth in the land. To date, the type of soil ameliorant that could promote the white pepper growth in post-tin mining land hasn't been informed. The research was aimed to study

the soil ameliorant effect for early growing of white pepper in the sand tailing area and obtain the proper ameliorant.

II. METHODS

Schedule and site

The research was carried out from February to May 2017 in post-tin mining land of PT TIMAH Tbk which was located in Merawang, Bangka. The land used is 10 years old after post mining.

Experiment design

A Randomized Block Design (RBD) with single factor and three replications was applied in the research. The factor was soil ameliorant combination, i.e nitrogen-phosphor-kalium (NPK) fertilizer 'Mutiara', arbuscular mycorrhiza fungi (AMF) genus G*lomus* in zeolit carrier medium, and biofertilizer (*Nano Bio*). The combination consisted of seven levels i.e. B1 (60 g NPK plant^{-1}), B2 (20 g AMF plant^{-1}), B3 (2 cc biofertilizer l^{-1} water), B4 (60 g NPK plant^{-1} + 20 g AMF plant^{-1}), B5 (60 g NPK plant^{-1} + 2 cc biofertilizer l^{-1} water), B6 (20 g AMF plant^{-1} + 2 cc biofertilizer l^{-1} water), and B7 (60 g NPK plant^{-1} + 20 g AMF plant^{-1} + 2 cc biofertilizer l^{-1} water).

Living climbing tree planting

Living tree for pepper climbing used *Pterocarpus indicus* which was obtained from Pangkalpinang City. The selection of living tree climbing was used based on plant height criteria, > 1 m and stem diameter about 3-5 cm. Living climbing tree was planted on the planting hole (40 cm x 40 cm x 40 cm), and about 10 - 15 cm from the planting hole of pepper plant. Living climbing tree was planted about 1 month before pepper was planted.

Pepper planting

Vegetative pepper seedlings (cv. Lampung Daun Lebar) three months old was obtained from Badan Pengelolaan, Pengembangan dan Pemasaran Lada (BP3L), Province of Bangka Belitung. Pepper seedlings was planted in planting hole (40 cm x 40 cm x 40 cm) and 2 m x 2m spacing, amount of 5 kgs of chicken manure and 7 kgs of top soil were applicated on hole planting. The seedlings was planted in soil until the neck seedlings using mixed of soil tailing, top soil, and chicken manure.

Ameliorant application

2 cc l^{-1} water of biofertilizer was applicated by watered on planting hole four times, i.e. two weeks before pepper planting, one week after planting, two weeks after planting, and three weeks after planting. Mycorrhiza was applicated after planting, and the application of 20 g plant^{-1} by sown around root area. Inorganic fertilizer (NPK) was applicated twice during planting season. The first application on two weeks after planting (20 g plant^{-1}), and the second application on three weeks after planting (40 g plant^{-1}).

Observation and data analysis

White pepper growth was observed by measuring the height, (cm), diameter of stem (cm), number of leaves, nodus number, and area of leaf (cm^2), monthly. Chlorophyll content was observed on the end of observation and using chlorophyll meter. The main effect was analyzed by the analysis of variance, and countinued by the Duncan's test (α 0.05) to compare among the treatment.

III. RESULTS AND DISCUSSION

Cultivation of pepper in post-tin mining land was very affected by the availability of nutrient for its growth. Post tin-mining land had reported has a poor nutrient, and poor physical and biology properties. This condition requires the fertilizer input to make the favourable environmental for pepper growth. The fertilizer input that can be used like inorganic fertilizer to supply the nutrient directly. Other that, the organic and biofertilizer input also can be added to contribute the nutrient supply by nitrogen fixation process from the air, nor the changing of nutrient available in the soil. The effort is done to provide the nutrient for pepper growth in marginal land, like in post-tin mining land.

The effort to enhance the marginal land fertility of post-tin mining could be done by addition of soil ameliorant. In this research, the soil ameliorant used was combination of NPK, arbuscular mycorrhiza fungi (AMF), and biofertilizer. The soil ameliorant has significant effect to plant height, segment number, stem diameter, leaves number, chlorophyll content, and leaf area (Table 1). Those indicated that these combination could supply the nutrient and improve the soil physical and biology properties, so that affected the growth characters of pepper.

The differences of each combination was determined by contrast orthogonal test. This analysis showed that combination of NPK, mycorrhiza, and biofertilizer (B7) significantly different to other treatments on all of the characters observed, either to single soil ameliorant or two soil ameliorants. This was caused by directly nutrient could be absorbed by plant from NPK fertilizer, and the ability of mycorrhiza to supply the availability of P, or the its ability to provide the ecosytem to soil microbial which was added by fertilization of organic fertilizer (Nano Bio), so that could optimally to suply the nutrient.

Mycorrhiza fungi in ex mining land can play to improve the soil stability [30], by the ability of externals hyfa which plays to initiation the soil macro structure and micro agregation [31]. The formation of soil agregation could be done by the growing of hyfa in soil matrixs to structure shape which occupy the soil particle through physical bond. Hyfa and root create the physical and chemical environmental which would produce organic materials and amorf to tie up the soil particle, and the penetration of hyfa and micro-agregate of root tissue to micro-agregat structure, which increased the capacity and storage the C nutrient, and provide the mycro-ecosystem for the soil microbial.

Other that, mycorrhiza colonization also could increase the nutrient uptake by decreasing the distance to the plant nutrient, increasing the nutrient uptake average and the concentration on the surface of absorption, and the change of nutrient shape for absorption to the plant root [32]. The large of mycellium colonization lead the increasing of water uptake by plant, and will promote the plant growth i.e. cell development and elongation by metabolism assimilate. The large of water uptake will lead the N, P, and K nutrient by

NPK fertilization, as well as, N fixed and P dissolved by the organism activity of Nano Bio could be absorbed in large quantity.

The single soil ameliorant application i.e. NPK, AMF, or Nano Bio showed didn't significant different to the combination of two soil ameliorants on the all of characters. Those could be shown by B1 vs B4&B5, B2 vs B4&B6, B3 vs B5&B6 (Table 2). The single soil ameliorant (B1 & B2 & B3) no significantly to the combination of two soil ameliorant on the all of the characters. Those was occurred cause the single soil ameliorant has a the role is not optimally. NPK fertilizer just could supply the nutrient in early fertilization, but not in along plant live, and the mycorrhiza fertilizer requires long time process for associated to root system and its process requires the availability nutrients. While, the organism of biofertilizer couldn't role optimally in unfavourable environmental for the growth of organism and host.

Biofertilizer is a liquid fertilizer and contains nine microbial consortium. Five of those microbial has function in N fixation, i.e. *Azospirillum sp* [33], *Rhizobium sp* [34], *Pseudomonas sp* [35], *Azotobacter sp* [36], and *Alcaligenes sp* [37]. Three of those microbial has function to phospate solven, i.e. *Aspergillus niger* [38], *Lactobacillus sp* [39], *Bacillus sp* [40], and one of those microbial has role to decomposer, i.e. *Saccharomyces sp* [41].

The differences of among the treatments on the each charachters was determined by using Duncan's test. The White pepper applicated by ameliorant combination of NPK + mycorrhiza + organic fertilizer showed the best growth on the all of characters observed. This combination has the higher characters, i.e. plant heigh about 34.08 cm, leaves number about 18.75 blade, segment number about 11.50 segment, stem diameter about 2.45 cm, chlorophyll content about 14.63 mg l^{-1}, and leaf area about 226.48 cm^2) than the others combination (Fig. 1).

This combination showed significant different to other combination on the plant height, leaves number, stem diameter, and leaf area characthers. Its combination just didn't significant different to biofertilizer + mycorrhiza combination on the leaves number and chlorophyll content charachters.

The combination of three soil ameliorant which supply the nutrient from the NPK fertilization will promote the plant growth, and then expand of the root. Those root was colonized by AMF, so that supply the P nutrient and provide the ecosystem for the microbial by improve the soil agregation and water holding capacity. The increasing of water holding capacity would promote the nutrient absorption by mycorrhiza hyfa colonization, and furthermore these ecosystem would promote the optimally role of organism in N fixation and P solvent. The nutrient and water were absorbed by root, at same time.

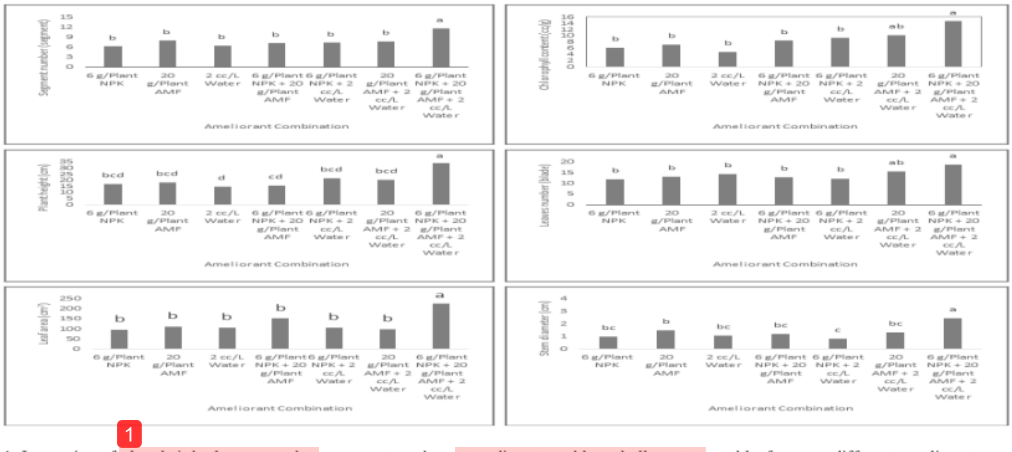

Fig. 1. Increasing of plant height, leaves number, segment number, stem diameter, chlorophyll content, and leaf area on different ameliorant combination

TABLE 1. THE EFFECT OF AMELIORANT COMBINATION TO PEPPER GROWTH IN POST-TIN MINING LAND
*significant on F test at α=0.05.

Character	F Value	CV (%)
Plant height (cm)	16.82**	13.71
Leaves number	4.32*	14.08
Segment number (segment)	11.65**	11.72
Stem diameter (cm)	11.71**	20.28
Chlorophyll content (cc/g)	3.95*	32.40
Leaf area (cm^2)	6.49*	25.04

The availability of nutrient will promote the plant metabolism activity and distribution of assimilate to the parts of plant. These is indicated by increasing of plant height, leaf number, segment number, stem diameter, chlorophyll content, and leaf area. This increasing is caused by the accumalation of assimilate which promote the cell differentiation and elongation. Mycorrhiza is a symbiotic mutualism between fungi and the rooting system [30]. In marginal land, mycorrhiza can increase the mostly plant growth, whereas not too positive impact on fertility land [42]. Mycorrhiza also increased contact area in soil, so that increased root absorption area till 47 level, and these would promote acces to nutrient in soil [28].

Mycorrhiza application to white pepper in post-tin mining land could increase plant height, leaves number, and branches [6], and could associated with root and shown by root infection about 36.67% [43]. Plant with mycorrhiza infection has higher N, P, K, and Mg absorption than plant without mycorrhiza infection [44]. Nano Bio application of 2 ml l^{-1} water pursuant to [43] could increase leaves number, stem diameter, and chlorophyll content of pepper in post-tin mining land.

IV. CONCLUSION

1. Soil ameliorant affected to the early growing of pepper in post tin mining area.
2. NPK fertilizer could be substituted by mycorrhiza and organic fertilizer for the early growing of pepper in post tin mining area.
3. The proper ameliorant to the early growing of pepper in post tin mining land was the combination of 60 g NPK, 20 g mycorrhiza, and 2 cc l^{-1} bio fertilizer.

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