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Research article

Effect of Organic Fertilizer Products on the Growth and Health of Acacia Crassicarpa Seedlings

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Abstract.
Acacia crassicarpa seedlings face challenges with growth and health. *Xanthomonas* leaf blight, *Fusarium* wilt, and leaf spots caused by *Pestalotiopsis* or *Phaeotrichoconis* are all major nursery diseases of *A. crassicarpa*. This study was carried out to consider solutions for improving seedling conditions. The growth and health of *A. crassicarpa* seedlings were assessed using two commercial products: an organic biofertilizer (LOB-BS) and an organic multipurpose fertilizer (OMF). The LOB-BS + basal fertilizer (BF) treatment led to a higher germination rate than the other treatments, according to our findings. Similarly, at 12 weeks after sowing, the same treatment produced the tallest *A. crassicarpa* seedlings. In comparison to other treatments, the incidence of *Xanthomonas* leaf blight, *Fusarium* wilt, and leaf spot diseases was lower in the plots of OMF and OMF + BF treatments. Based on these findings, the LOB-BS product could be used to improve the growth of *A. crassicarpa* seedlings, while the MOF product could be used to reduce the incidence of major *A. crassicarpa* seedling diseases in the nursery.

Keywords: *Fusarium*, leaf spot, *Xanthomonas*, organic biofertilizer (LOB-BS), organic multipurpose fertilizer (OMF).

1. Introduction

In addition to nutritional issues, pests and diseases are critical limiting factors in sustainable production of estate forests [1-8]. Efforts have been made to obtain plant materials having characteristics of high resistance to pests and/or diseases through nursery screenings [9-10]. Other initiatives include silvicultural practices as well as utilization of biocontrol agents and/or plant biostimulants [11-26]. A good example of available products is an organic biofertilizer (LOB-BS) produced by LIPI (Indonesian Institute of Sciences). An organic multipurpose fertilizer (OMF), is another commercial product available in the market. It has an inorganic element which increases nutrient availability and becomes active precursors of antagonistic microorganisms in the growing media.

The organic biofertilizer product used in this study was developed using the LOB-Beyonic-StarTmik (LOB-BS) technology. It is a consortium of 10 microbial isolates comprising 3 different *Bacillus*, *Brevibacillus*, *Brevundimonas*, *Burkholderia*, *Microbacterium*, *Ochrobactrum*, *Pseudochrobactrum*, and *Pseudomonas* [27-28]. This LOB-BS technology is intended to minimize the use of synthetic chemical products. The microbes were originated from various soil ecosystems, which have been selected and characterized for their enzymatic activities (single species with multi enzyme activities) considering their roles as bio fertilizers and biocontrol agents. The organic biofertilizer formula contains a combination of multi-biocatalyst producing microbes (P solubilizer, N-fixer, and producers of IAA, organic acids and biopesticides). These microbes improve chemical and biological properties of the planting media, suppress disease attacks, increase nutrient availability, and maintain the quality of growth [29].

The OMF products contain a number of macro nutrients (N, P, K, Ca, Mg and S) and micronutrients (Fe, B, Mn, Cu, Zn, Mo, Na and Co), which are essential for plant growth. This multipurpose fertilizer is generally applied to agricultural soils to help release bonds of clay minerals. The application of OMF to the soil will open the soil pores so that C, H, O can easily enter the soil and the transpiration and respiration processes run normally. The presence of C (CO_2), H (H_2O) and O (O_2) which enter the soil freely triggers the release of nutrients through clay minerals through bio-metabolic mechanisms by the microbes. Bio-metabolism will produce new bio-metabolites which are rich in nutrients and available to plants [30].

This study was aimed at elucidating the impact of both LOB-BS and OMF applied at sowing on the growth, particularly height, and early disease infestation of *Acacia crassicarpa* seedlings. This experiment was conducted in the nursery of PT FSS, Muara Toyu, East Kalimantan.

2. Methodology

This study used a randomized complete block design consisting of 5 treatments with 10 replications. The experimental unit per replication was 3 trays each containing 96 seedlings. Thus, the total number of trays used was 150. The LOB-BS treatment was preceded by soaking the seeds in the LOB-BS solution with a concentration of 225 ml/7.5 liters of water for 30 minutes before being sown in the tube. The remaining water used for soaking the seeds was evenly sprayed onto the growing media. For OMF application, the growing media is sprayed with the OMF solution of the concentration of 100 gr/15 liters of water prior to seed sowing. In addition to the single application of both LOB-BS and OMF, mixed treatments with basal fertilizer (BF) as the current nursery regime, were included. Thus, the treatments included the application of LOB-BS, LOB-BS + BF, OMF, OMF + BF, and BF (Control). The evaluation started from the germination rate up to 4 weeks old. The assessment was continued with the height response of the seedlings every week until the seedlings were ready for planting. Incidence of major diseases, namely Xanthomonas leaf blight, Fusarium wilt and leaf spot caused by the pathogens *Pestalotiopsis* and *Phaeotrichoconis*, was also assessed on a weekly basis. Analysis of Variance was carried out using SPSS for Windows. Once a significant difference between treatments was detected, the data analysis was continued using Tukey Multiple Comparison test at the 95% confidence level.

3. Result and Discussion

Germination rate was observed from seed germination until 18 days after sowing. The percentage of *A. crassicarpa* seed germination in plots without the addition of BF to the cocopeat growing media after the application of LOB-BS and OMF was lower than that of the BF treatment. The highest germination rate of 80 % was demonstrated in the LOB-BS + BF treatment. The opposite result was observed in OMF + BF treatment with the lowest germination rate of 64 % (Figure 1). The LOB-BS seems to increase availability of nutrients through the bio-metabolite mechanism of microorganisms contained in the BOF fertilizer. OMF provides additional inorganic elements, both macro and micro. Addition of micro elements to the level exceeding the requirement may cause seed toxicity [31], lowering the percentage of *A. crassicarpa* seed germination.

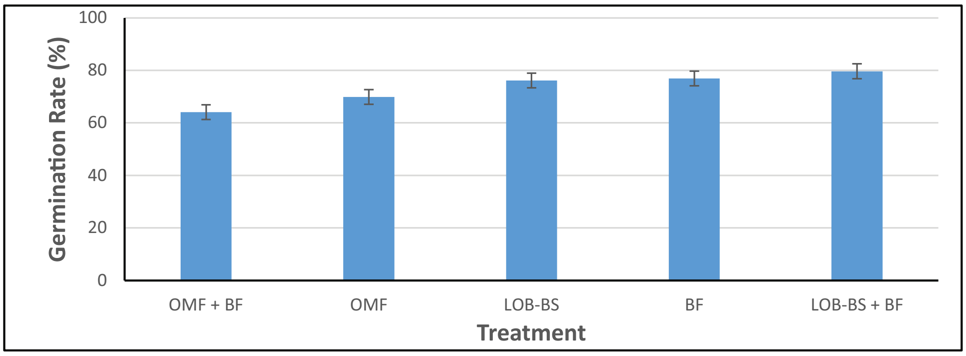

Figure 1: Effect of LOB-BS and OMF on the germination rate of *Acacia crassicarpa*.

As presented in Figure 2 below, the height of *A. crassicarpa* seedlings at 5 weeks in the plots of OMF (3.64 cm), OMF + BF (4.00 cm) and LOB-BS (4.51 cm) treatments was not significantly different from that in the BF plot (4.08 cm). The LOB-BS + BF treatment (5.06 cm), however, gave a significant difference from the BF treatment.

At 12 weeks after application, the height of seedlings in the OMF plots showed no significant differences from that in the BF treatments at 21.84 cm (single application) and 17.88 cm (+ BF). The interaction between macro and micronutrients are thought to affect nutrient availability in the cocopeat medium which in turn results in slow growth of the seedlings. The fastest growth of *A. crassicarpa* seedlings was exhibited in the LOB-BS plots at 26.15 cm (single application) and 26.35 cm (+ BF), which were significantly different from that in BF plots (Figure 2).

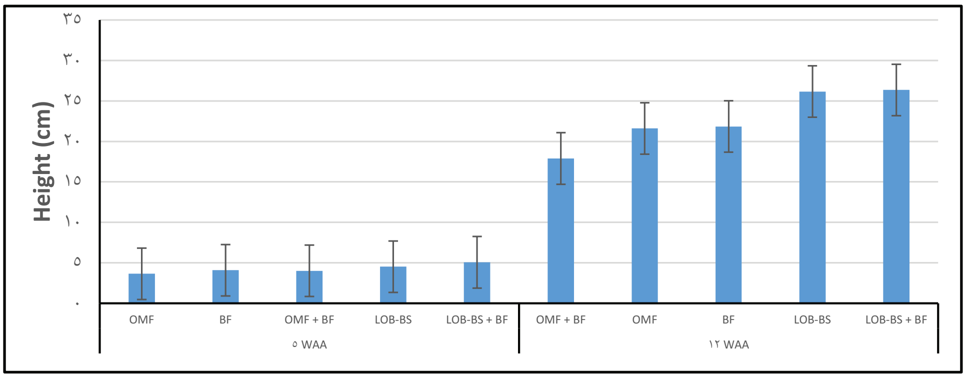

Figure 2: Effect of LOB-BS and OMF on the growth of *Acacia crassicarpa* seedlings 5 and 12 weeks after application (WAA).

The microbial consortium of LOB-BS functions to substitute chemical products. Such microbes accelerate the decomposition process of organic matter [32]. This is in line with the media used, i.e. cocopeat, which is source of organic matter that becomes available nutrients for seedlings. In addition, these microbes play a critical role in reducing immobilization of available nutrients in the media, thereby increasing nutrient absorption [33]. Thus, it gives a positive effect on the height of *A. crassicarpa* seedlings for optimal growth (Figure 3).

It is suspected that the concentration of inorganic elements in the OMF solution affects the availability of nutrients for plants in the growing media [34]. The addition of inorganic elements causes a change in the pH of the media so that some nutrients are not available to plants. Excess availability of micro elements may cause toxicity to plants, causing the growth to slow down [31]. The OMF is generally applied to agricultural soils. Meanwhile, the growing medium for the *A. crassicarpa* seedlings uses cocopeat, in which the organic matter content is higher, leading to the speculation that in the growing medium OMF does not work as well as in agricultural soil.

Observations were also made on the incidence of major diseases of *A. crassicarpa* seedlings, such as Xanthomonas leaf blight, Fusarium wilt and leaf spots caused by

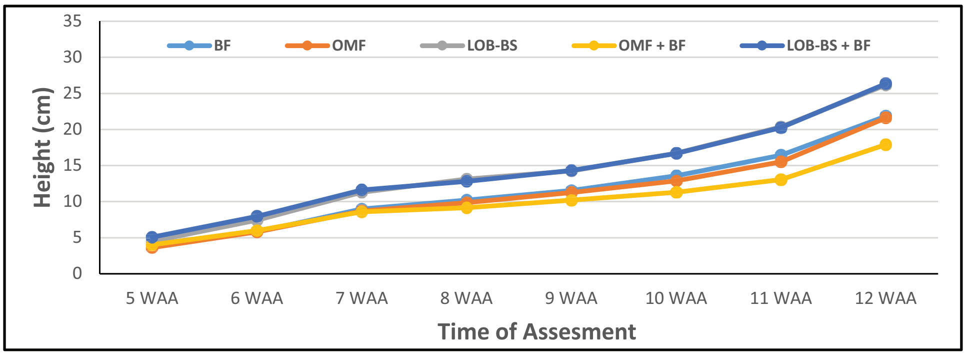

Figure 3: Growth trend of *Acacia crassicarpa* 5 – 12 weeks after application (WAA) of LOB-BS and OMF.

pathogens *Pestalotiopsis* sp. and *Phaeotrichoconis* sp. Figure 4 shows that LOB-BS and OMF can reduce the incidence of major diseases on *A. crassicarpa* seedlings. OMF and OMF + BF treatment plots had lowest incidence of diseases.

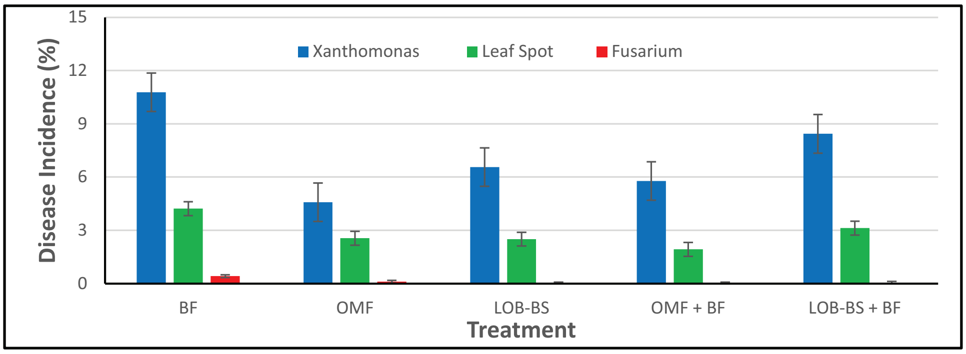

Figure 4: Incidence of major diseases on *Acacia crassicarpa* seedlings 12 weeks after application.

From Figure 4 it can be seen that OMF and OMF + BF treatments provide lower incidence of major diseases on *A. crassicarpa* seedlings than other treatments do. The OMF works by "restoring" nutrients in the soil and providing "repelling" effect against various plant pests and diseases [34]. In addition, OMF can neutralize pH as required for optimum plant growth. pH > 6.5 will be neutralized by Al, Fe and Mn, while pH < 6.5 will be neutralized by Ca. Al, Fe and Mn elements also bind P so it doesn't dissolve easily; Ca binds P if the pH is < 6.5. Similarly, K (potassium) plays a critical role in controlling and maintaining turgor pressure (water supply) in the process of photosynthesis and mineral movement. Boron (Bo) is related to the metabolism of Ca and K, distributing nutrients throughout the whole plant parts. Molybdenum (Mo) contributes to N fixation by microbes in Leguminoceae and is a catalyst in reducing nitrogen. Thus, the low incidence of pests and diseases is thought to be due to the interaction of inorganic elements of OMF which benefits the growth of *A. crassicarpa* seedlings but not to the development of pathogenic microbes in the media. In poplar (*Populus x canescens*), its association with ectomycorrhizal fungus *Paxillus involutus* is found to increase activities of defence-related and salt-tolerance enzymes [35-37].

The role of LOB-BS includes growth-promoting agents, pest and disease biocontrol and residue decomposers. These microbes function as biocatalysts that play a critical role in providing N, solubilizing P and K, removing pollutants, and producing growth regulators, organic acids and biopepticides [26]. Similar findings have also been reported in other pathosystems [38-40]. LOB-BS directly provides antagonistic microbes in the media and may dominate competition with plant pathogens and thus reducing disease incidence as shown in Figure 4, in which disease incidence in the LOB-BS or LOB-BS + BF treatment plots is lower than that in BF plots.

4. Conclusion

The results of this study indicate that the LOB-BS increases the growth rate of *A. crassicarpa* seedlings, while the application of the OMF reduces the incidence of its major diseases in the nursery.

5. Acknowledgements

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